SECOND FIVE-YEAR REVIEW REPORT FOR BELTSVILLE AGRICULTURAL RESEARCH CENTER SUPERFUND SITE

BEAVERDAM ROAD LANDFILL (BARC 27) – OPERABLE UNIT 5

Beltsville, Prince Georges County, Maryland

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Prepared By:
U.S. Department of Agriculture
Agricultural Research Service
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Beltsville, Maryland

July 2023

Five Year Review – Authorizing Signature

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July 11, 2023
Date

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
ARS	Agricultural Research Service
AWQC	Ambient Water Quality Criteria
BARC	Beltsville Agricultural Research Center
BDRLF	Beaverdam Road Landfill
Bgs	Below Ground Surface
BW	Biowall Well
CAHs	Chlorinated Aliphatic Hydrocarbons
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CWA	Clean Water Act
DCE	Dichloroethene
EPA	United States Environmental Protection Agency
ERA	Environmental Risk Assessment
FS	Feasibility Study
FYR	Five-Year Review
HAL	Health Advisory Limit
HHRA	Human Health Risk Assessment
HI	Hazard Index
ICs	Institutional Controls
ILCR	Incremental Lifetime Cancer Risk
LUCs	Land Use Controls
LUCIP	Land Use Control Implementation Plan
MCL	Maximum Contaminant Levels
MDE	Maryland Department of the Environment
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
Ng/L	Nanograms per Liter
NPL	National Priorities List
O&M	Operation and Maintenance
OC	Organochlorine
ORP	Oxygen Reduction Potential
OU	Operable Unit
PA/SI	Preliminary Assessment/Site Inspection
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PDBE	Polybrominated diphenyl ethers
PFAS	Per and Polyfluoryl Alkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PMP	Performance Monitoring Plan
PP	Proposed Plan
PRG	Preliminary Remediation Goal
PRP	Potentially Responsible Party
Ppt	Parts Per Thousand

LIST OF ACRONYMS

RACR	Remedial Action Completion Report
RAO	Remedial Action Objectives
RBC	Risk Based Concentration
RD	Remedial Design
RI	Remedial Investigation
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Level
SDWA	Safe Drinking Water Act
SSP	Site Screening Process
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TBC	To Be Considered
TCE	Trichloroethylene
TCL	Target Compound List
TOC	Total Organic Carbon
TW	Transect Well
µg/L	Microgram per liter
UMD	University of Maryland
USDA	United States Department of Agriculture
UU/UE	Unlimited Use/Unrestricted Exposure
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The United States Department of Agriculture (USDA) Beltsville Agricultural Research Center (BARC) is a 6,600-acre facility located in the northwestern portion of Prince Georges County, Maryland which consists of agricultural fields, offices, and research laboratories. Due to historical operational practices, several areas within the BARC complex have been identified as being of environmental concern. BARC was proposed for inclusion on the National Priorities List (NPL) in May of 1993, and formally added to the NPL in 1994. A site map depicting the location of BARC is included as Figure 1.1. BARC is operated by the USDA Agricultural Research Service (ARS) with a mission to conduct agricultural research needed to enhance our capacity to provide healthy crops and animals; clean and renewable natural resources; sustainable agricultural systems; and agricultural commodities and products that are abundant, high-quality, and safe.

As stated in the Environmental Protection Agency (EPA) Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (EPA, 2001), "The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

This FYR has been prepared by the USDA BARC pursuant to its obligations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Contingency Plan (NCP) (40 CFR Section 300.430(f)(4)(ii)) and considering EPA policy and guidance. This is the second FYR for the BARC facility. The triggering action for this statutory review is the on-site construction start date (July 22, 2013) of the BARC 27 Beaverdam Road Landfill (BDRLF) Operable Unit (OU)-05 biowall remedial action. The FYR has been prepared because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure (UU/UE).

The BARC facility consists of eight designated Ous and one undesignated, of which one, OU-05, will be addressed in this FYR. The OU-5 BDRLF remedy that will be reviewed addresses volatile organic compounds (VOCs) in groundwater; the specific VOCs that have been identified above their respective actions levels include trichloroethylene (TCE) groundwater contamination above its Maximum Contaminant Levels (MCLs), as well as TCE breakdown products (1,1 Dichloroethene (DCE), cis 1,2 DCE, and Vinyl Chloride), which are created by reductive dechlorination. Additional VOCs may be added to the COC list if they are present at concentrations greater than their respective MCLs.

The eight BARC OUs that are not addressed in this FYR are:

- OU-00: BARC Sitewide (Administrative OU only)
- OU-01: BARC 6 Biodegradable Site (Proposed Remedial Action Plan (PRAP) underway)
- OU-02: College Park Landfill (Proposed Plan (PP) underway, Focused Feasibility Study (FFS) Required)
- OU-04: BARC 12 Chemical Disposal Pits (RI/FS underway)
- OU-11: BARC 4/19 (Remedial Investigation / Feasibility Study (RI/FS) ongoing)
- OU-12: BARC 32 (RI/FS underway)
- OU-13: EPIC 7/8 (RI/FS underway)
- OU-currently designated: ENTECH 7 (RI/FS underway)

The BARC facility FYR is led by John Houston, USDA Agricultural Research Service (ARS) Remedial Project Manager (RPM). Additional participants include USDA contractors Program Manager David Kindig, P.E. (Mabbett), Environmental Engineer Jason Lorenzetti, P.E. (Mabbett), Environmental Scientist David Schanzle, CHMM (Mabbett), and Justin Idzenga, P.G. (Mabbett). EPA Region 3 provides an oversight role that includes technical support in conjunction with the assigned EPA RPM, Vincent Grassi. The review process was initiated on October 2, 2022.

Site Background

Based on analysis of historical records, the BDRLF site was used for the disposal of unidentified solid wastes, possibly as early as 1943 (ENTECH, 1997a). BDRLF was reported in the 1991 Preliminary Assessment/Site Investigation (PA/SI) to have been used as a disposal site for nonhazardous substances such as building rubble (e.g., masonry and miscellaneous construction debris); vegetation such as tree clippings and wood; and broken asphalt (APEX, 1991). The 1991 PA/SI reviewed the history of the site and found that the landfill had been poorly monitored and there are no records of actual disposal activity or landfill contents. The PA/SI determined that disposal operations continued through the 1980s, after which time the landfill was closed and covered with a geo-synthetic liner beneath a clay cap (ENTECH, 1997a and KCI, 1991). A site map depicting the location of the BDRLF OU within BARC is included as Figure 1.2.

An Industrial Waste Management Permit (permit number 85-16-26) was issued by the State of Maryland Department of Health and Mental Hygiene on March 1, 1985, a requirement of which included the installation of 4 monitoring wells to be sampled annually for pH, conductivity, hardness, chlorides, total dissolved solids, chemical oxygen demand, and total dissolved organic carbon (MDE, 1985). The BDRLF Post Closure Care and Monitoring Plan proposed a semi-annual groundwater sampling program (KCI, 1991); however, it is uncertain if the site was monitored on a regular basis.

At the time of the 1996 field reconnaissance, access to the BDRLF was limited, and maintenance operations designed to ensure the integrity of the cap were the only activities being conducted. A walkover of the fill area did not reveal any evidence of debris at the surface or protruding from the landfill, although a small area of surface debris was observed in the woods just east of the landfill during the field reconnaissance. These materials, which were situated inside the eastern perimeter fence, were comprised primarily of construction and household wastes, including empty 55-gallon drums and a large, compressed gas cylinder. Additionally, four monitoring wells, (one up-gradient and three down-gradient) on the perimeter of the landfill were observed (ENTECH, 1997b).

Hydrogeology

The following provides a short summary of the most important hydrogeological information for the BDRLF site as it pertains to the assessment of the remedy. Subsurface conditions, including geology and hydrogeology, were characterized in the Remedial Investigation (RI) for the site (BMT, 2003) and discussed in depth in the BDRLF Annual Sampling Reports, available through the BARC Information Repository and Administrative Record (IR/AR) website at: BARC Information Repository/Administrative Record -- Home (usda.gov).

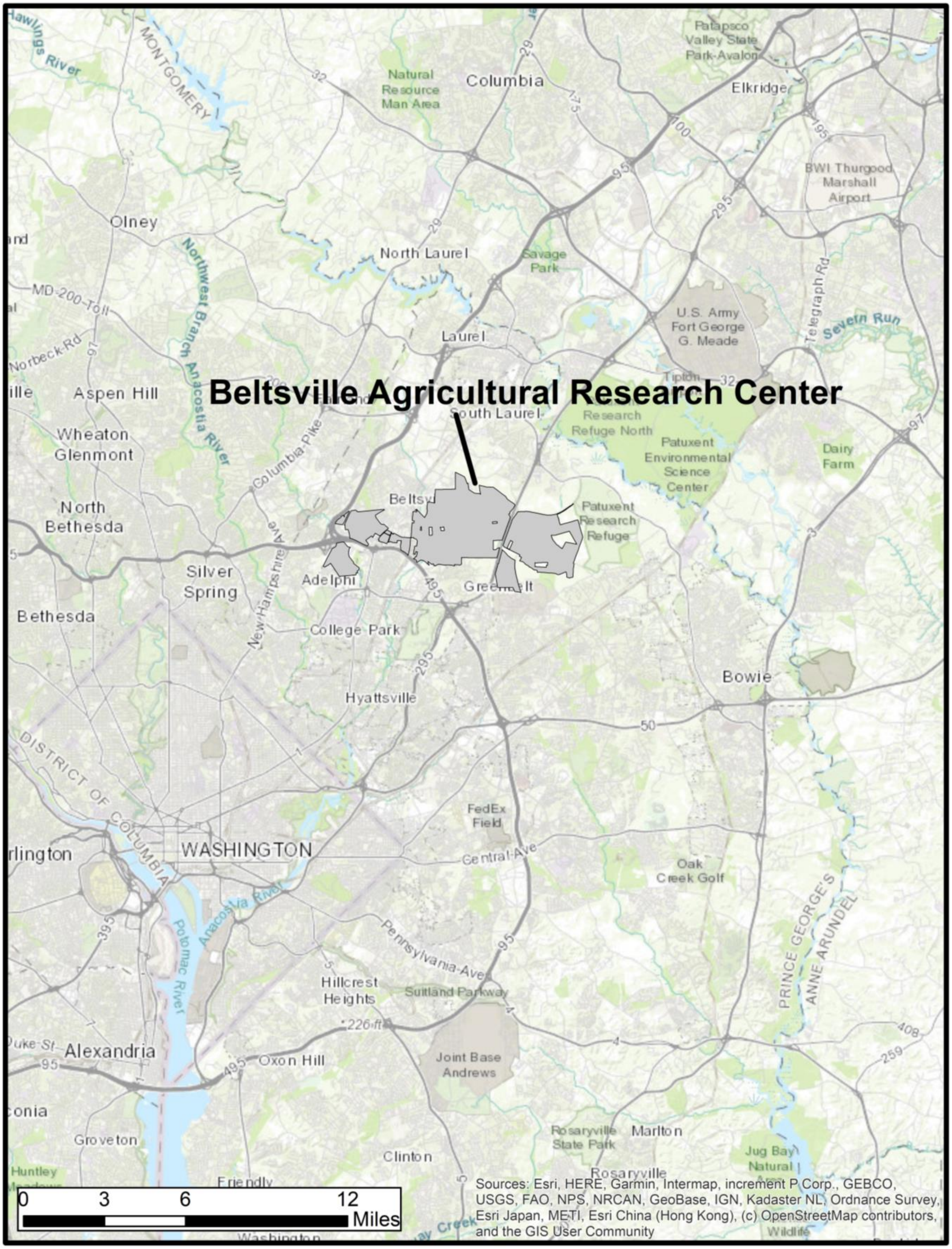
Groundwater contamination is limited to a 200-foot-wide plume within the near surface shallow aquifer. This aquifer lies within the unconfined Quaternary River terrace deposits found within the larger Beaverdam Creek stream valley and is underlain by the Arundel Clay formation. Groundwater within and directly adjacent to the biowall is typically encountered between 5 and 9 feet below ground surface (bgs). Groundwater flows southward from the landfill towards an unnamed tributary of Beaverdam Creek located approximately 300 feet south of the landfill site.

The downward vertical migration of groundwater within the contaminated shallow aquifer is limited by the presence of the underlying Arundel Clay formation. The Arundel Clay formation south of the BDRLF occurs between 20 to 25 feet bgs (BMT, 2011). The Arundel Clay has a low permeability and is a competent confining layer, preventing TCE-contaminated shallow groundwater from communicating with the underlying Patuxent aquifer, which is used for potable water supplies by BARC and surrounding communities and is not contaminated. Recharge of the Patuxent aquifer occurs by downward percolation of precipitation in outcrop areas that trend northeast-southwest and are located several miles west of the BDRLF.

Based on post remedial aquifer testing using breakdown products and confirmed with a bromide dye tracer, the groundwater flows past the biowall at a velocity of approximately 20 to 25 feet per year. To date, no preferential pathway has been identified. The 2017 Aquifer Testing Report for BDRLF, which includes the bromide dye tracer study and assessment of groundwater velocity using transport of the breakdown products has been included and additional studies that were done to estimate groundwater flow and contaminant flow velocity is discussed further in Sections 3.1 and 3.2.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: USDA Beltsville Agricultural Research Center		
EPA ID: MD0120508940		
Region: 3	**State:** MD	**City/County:** Beltsville, Prince George's County
SITE STATUS		
NPL Status: Final		
Multiple OUs? No	**Has the site achieved construction completion?** No	
REVIEW STATUS		
Lead agency: Choose an item ***[If "Other Federal Agency", enter Agency name]***: United States Department of Agriculture		
Author name (Federal or State Project Manager): John Houston		
Author affiliation: USDA		
Review period: 10/22/2022 – 7/22/2023		
Date of site inspection: 11/21/2022		
Type of review: Statutory		
Review number: 2		
Triggering action date: 7/22/2018		
Due date *(five years after triggering action date)*: 7/22/2023		



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Figure 1-1. Beltsville Agricultural Center Locater Map

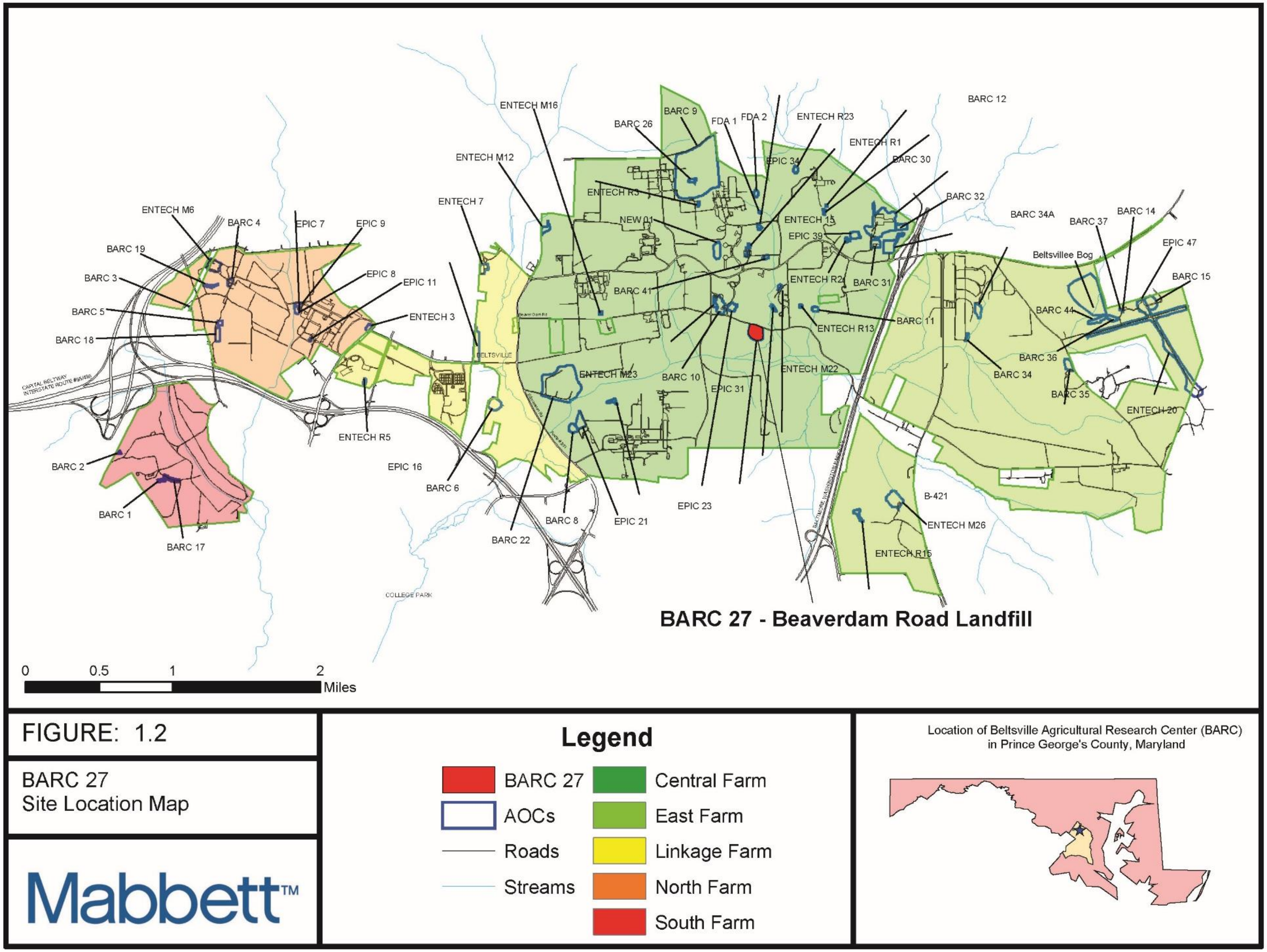


FIGURE: 1.2

BARC 27
Site Location Map

2.0 RESPONSE ACTION SUMMARY

The following section summarizes response actions developed for and implemented at the BDRLF site as described in the site-specific Record of Decision (ROD) as well as the investigation, selection of the response action, and implementation of the selected response action for the BDRLF contaminated groundwater plume of TCE.

2.1 Basis for Taking Action

The RI conducted for the site examined groundwater, soils, surface water, and sediment; however, groundwater was the only environmental medium identified that posed an unacceptable risk. The RI identified a plume of groundwater contaminated with TCE. The plume was estimated to be approximately 650 feet wide by 450 feet long and was located southeast (downgradient) of the landfill. At the completion of the RI, the maximum observed concentration of TCE in the groundwater plume was more than 600 parts per billion (ppb), which is above its MCL and therefore presented an unacceptable risk to future site residents. Though an unlikely drinking water source, the unacceptable risk and presence of TCE above its MCL (5 ug/L) precluded Unlimited Use/Unrestricted Exposure (UU/UE) closure.

Environmental investigations were completed using CERCLA guidance to complete an RI/FS to thoroughly characterize the site and select an appropriate remedy. Public comment and input were solicited throughout the remedy selection process and included a public meeting. USDA maintains a website and physical data repository to inform the public, and publishes updated Fact Sheets on all sites, including BDRLF each year. The BDRLF Record of Decision (ROD) was finalized in September 2011, presenting the final remedy for addressing contaminated groundwater at BDRLF. Remedial Action Objectives (RAOs) specified that the remedy shall:

- Remediate groundwater quality to reduce concentrations of chlorinated VOCs below MCLs.
- Prevent unacceptable human health exposure to site related COCs.
- Minimize future migration of groundwater contamination.

The ROD identified a mulch biowall and land use controls (LUCs) as the preferred alternative for remediating groundwater at the BDRLF. This alternative was selected due to effectiveness for treatment of VOCs through dechlorination, availability of the input materials, implementability with low risk of contact with contaminated groundwater, reasonable cost, and requires minimal maintenance. The remedy used readily available and inexpensive raw materials from agricultural processes and does not produce any toxic byproducts.

This remedial alternative included implementing LUCs until remedial action objectives are achieved. These controls were necessary to protect the integrity of the selected remedy and to prevent exposure to TCE as the remedial process progresses. LUCs are intended to safeguard against current or future exposure to contaminated groundwater by human populations. These include:

- A prohibition against the use of contaminated groundwater as a potable water source until cleanup levels are met.
- The prohibition of construction of buildings (industrial or residential) over the plume which may potentially be at risk due to vapor intrusion (the area of applicability for such ICs will be the known area of the groundwater plume that exceeds the MCL for TCE (5 micrograms per liter (µg/L)). The applicability of ICs also extends to the area directly under the landfill.
- Other access restrictions including complete site enclosure enforced by fencing and signage.

The ROD stipulated that LUCs were required, including physical barriers and institutional controls (ICs). ICs for the BDRLF site include notifications on applicable deeds, facility regulations to prohibit the transfer of contaminated land, and internal USDA processes that control and protect staff, visitors, and site workers from risks associated with the contaminated groundwater. The ROD includes the requirement that the LUCs be maintained and are inspected at regular intervals.

The ROD specifies the selected remedy (i.e., the design and construction of a biowall) for the treatment of VOCs in groundwater. The BDRLF ROD requires the completion of FYRs until RAOs have been achieved and remediation goals (RGs) defined in the ROD have been met to allow for UU/UE (USDA, 2011).

2.2 Status of Implementation

The BDRLF Biowall was installed on July 20, 2013, in accordance with the Remedial Design (RD) Work Plan (BMT, 2013), and described in the Remedial Action Completion Report (RACR) (BMT, 2017a). A Performance Monitoring Plan (PMP) was established in October 2013 to measure and evaluate the effectiveness of the remedy, which included the installation of additional monitoring wells and the implementation of a regular monitoring and analysis program that is detailed in the PMP (BMT, 2014).

The PMP includes the following monitoring activities, which are ongoing at BDRLF:

- Biweekly water quality monitoring for select groundwater monitoring wells and biowall piezometers, including gathering the following data:
    - Water level, pH, Dissolved oxygen, Turbidity, Specific conductivity, Temperature, Salinity, Oxygen Reduction Potential (ORP)
    - Quarterly groundwater reporting; summarizing the biweekly sampling and any other collected data or observations.
- Semi-annual sampling and reporting; including:
    - Water level monitoring and water quality parameters for all monitoring wells,
    - Analytical sampling for VOCs and nutrients in groundwater, and
    - Trend analysis for factors associated with anaerobic degeneration of TCE and breakdown products.

The BDRLF PMP was updated multiple times between 2014 and 2021 to reflect changes in sampling frequency, methodology and analytes.

Summary of Land Use Controls (2013)

The ROD for the BDRLF site specified that LUCs were to be implemented to prevent potential unacceptable risks to human receptors from exposure to TCE and breakdown products in groundwater. The LUCs were implemented immediately following the installation of the biowall and include:

- Prohibitions against use of contaminated groundwater as a potable water source until cleanup levels are achieved.
- The prohibition of construction of buildings (industrial or residential) over the plume to eliminate the risk of vapor intrusion.
- Restrict access to the site using fencing and signage.
- Prohibit disposal of hazardous and non-hazardous waste at the BDRLF.
- Maintain the integrity of any current or future remedial or monitoring systems.

A LUC Remedial Design (LUC RD) was prepared as the land use component of the Remedial Design following the completion of the remedy; a LUC Implementation Plan (LUCIP) was completed and is currently the primary document in use for implementing LUCs. In accordance with the LUCIP, LUC Inspections have been conducted on an annual basis.

A review of the physical LUCs on November 21, 2017, determined most of the site fencing was in place, with some areas requiring repair and some areas need to be extended to fully fence the site. The entrance gate used to access the site is consistently locked and secured when authorized personnel are not present. Some of the site fencing backing on to undeveloped BARC owned woodlands was found to be in disrepair. Although trespassing via this route is considered unlikely due to the difficult terrain, full ownership by BARC and routine security patrols, BARC plans future improvements to existing fencing and site security monitoring measures. BARC has developed and installed additional signage at the BDRLF.

Table 2-1 - Summary of Planned and Implemented ICs

Media, engineered controls, and areas that do not support Unrestricted Use/Unlimited Exposure (UU/UE) based on current conditions	Institutional Controls Required	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater (GW)	Yes	Yes	BDRLF – Central Farm, BARC	GW use restriction. Restriction on well construction. Restriction on activities with subsurface activities. Restriction on construction.	Land Use Control Implementation Plan (April 2016)

Systems Operations/Operation & Maintenance Site Maintenance (2013 to 2023)

Periodic site maintenance has been performed on the BDRLF site since the implementation of the remedy. The access road turnaround area in front of the access gate to the biowall was filled with gravel and graded in 2016 to ensure safe vehicular access to the biowall alignment. Additional road improvements were conducted on the access road alongside the biowall to ensure safe access for monitoring equipment and personnel. These site activities were detailed in annual LUCIP inspection reports. The site is visited periodically, and changing conditions are identified and reported to BARC maintenance to be addressed.

Performance Monitoring Activities (2013 to 2023)

Following installation of the remedy, a PMP was implemented to monitor the performance of the biowall over time (BMT, 2014). PMP activities included:

- Biweekly water quality monitoring of the biowall wells.
- Quarterly groundwater sampling of wells located within the biowall.
- Semi-annual groundwater sampling of biowall wells, downgradient surface water and monitoring wells installed during previous investigations.

Results of the monitoring and sampling program are detailed in quarterly monitoring reports and annual performance monitoring reviews that are submitted to EPA and added to the BARC IR/AR. Based on the observations of the PMP the following additional assessments were completed:

- Aquifer testing to determine plume migration velocity (BMT, 2017b)
- Microbial sampling to identify key bacterial populations within the biowall (BMT, 2018).
- Test Deployment of High-Resolution Passive Profilers at the BDRLF (Garza-Rubalcavas et al., 2022).
- Installation of additional walls within the Biowall and in the vicinity of the AOC boundaries (2019 to 2022).

The results from these additional monitoring activities are detailed in separate reports and included in the annual performance review reports and available on the BARC IR/AR. In addition to these additional assessments, remedy enhancements have been implemented at the BDRLF to improve the ability of the system to achieve the RAOs specified in the BDRLF ROD (USDA, 2011). These enhancements are described in greater detail in Section 3.

The following four figures provide a summary of the remedy (Figure 2.1), monitoring well network (Figure 2.2), the groundwater contaminant plume map from 2018 at the time of the previous FYR (Figure 2.3), and the contaminant plume map form the last site wide review conducted in September 2021 (Figure 2.4).

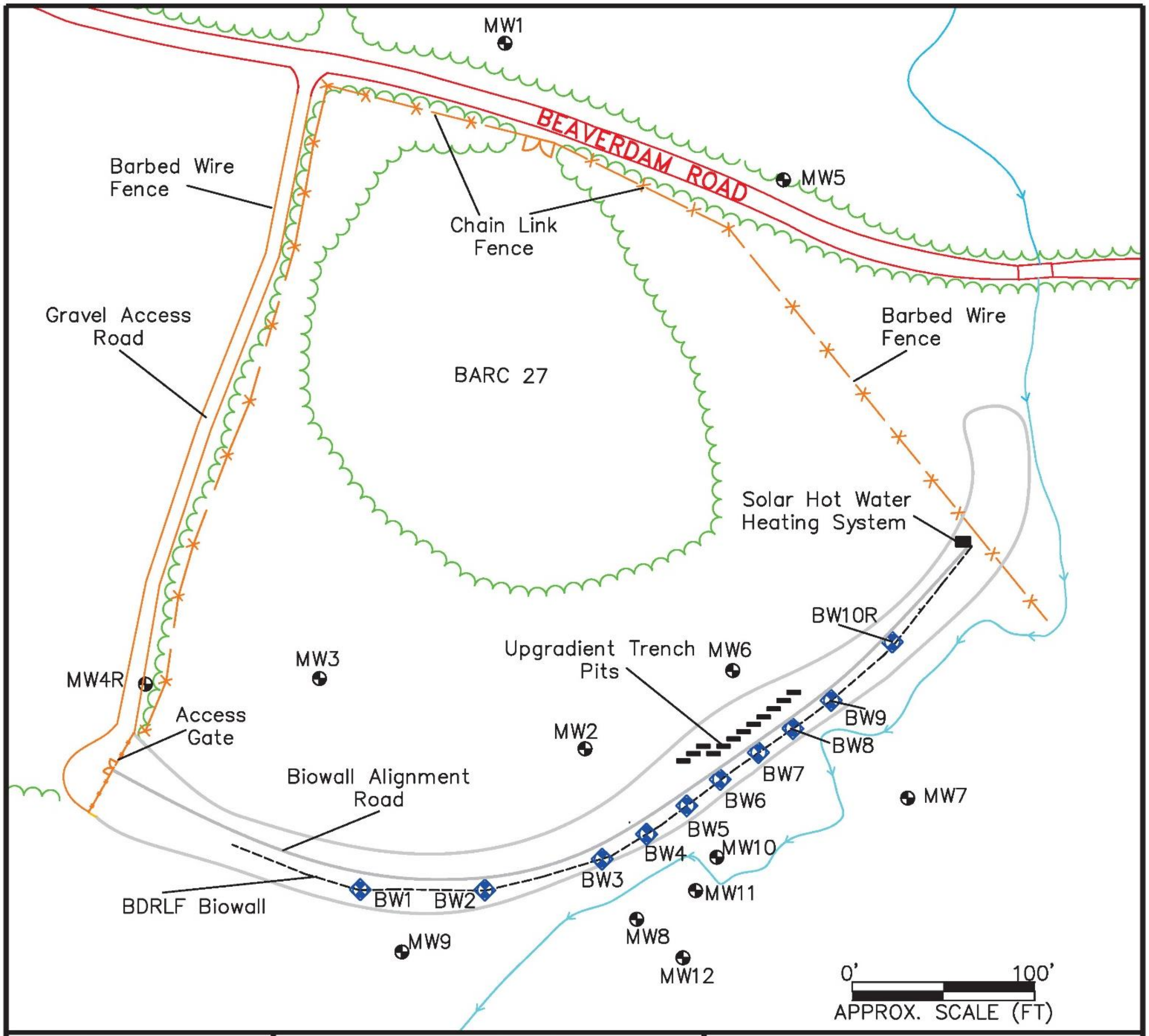
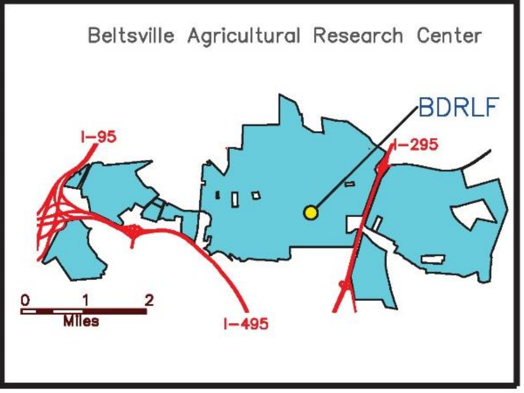


FIGURE 2.1

BARC 27:
Beaverdam Road Landfill
Site Map



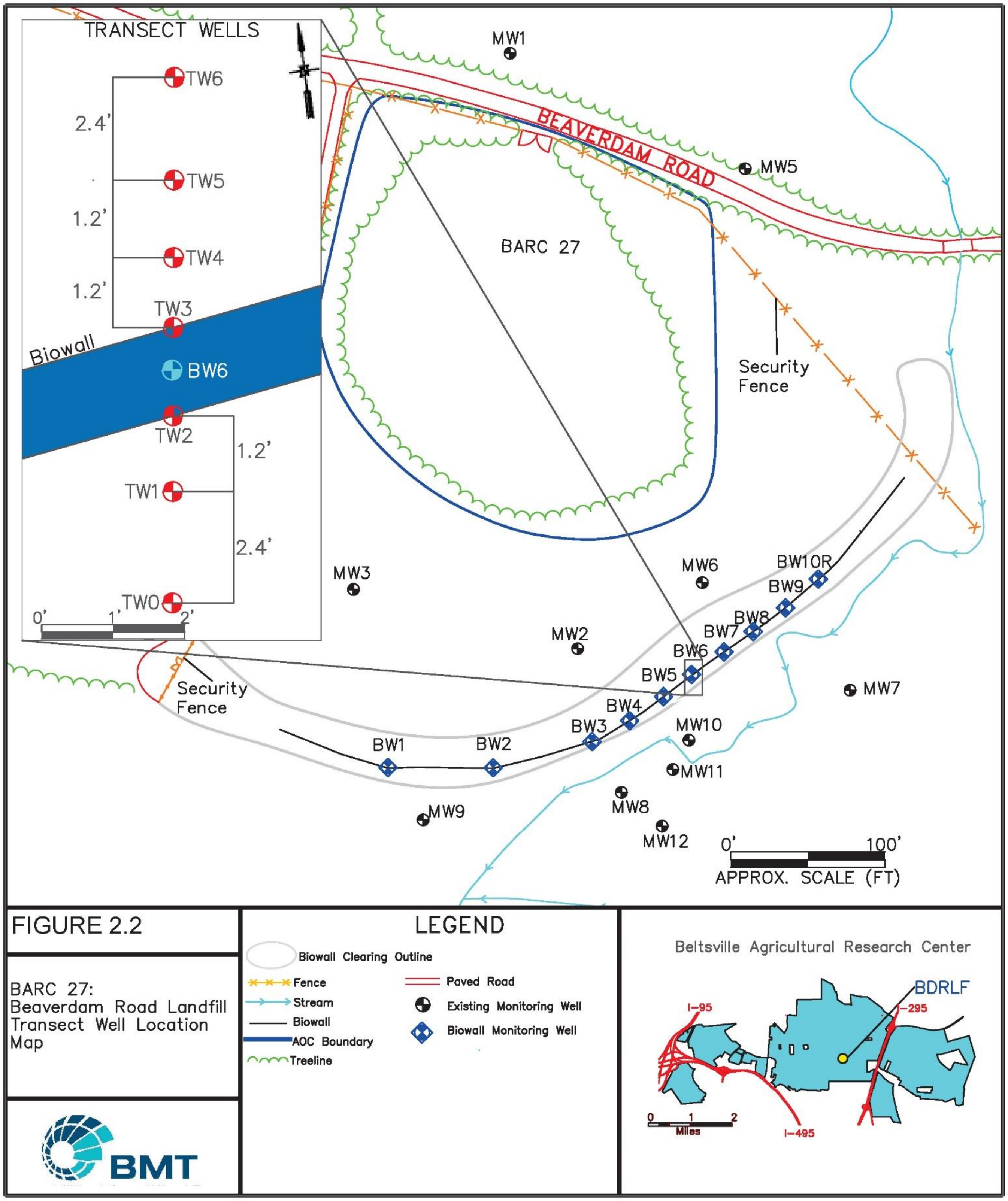


FIGURE 2.2

BARC 27:
Beaverdam Road Landfill
Transect Well Location
Map

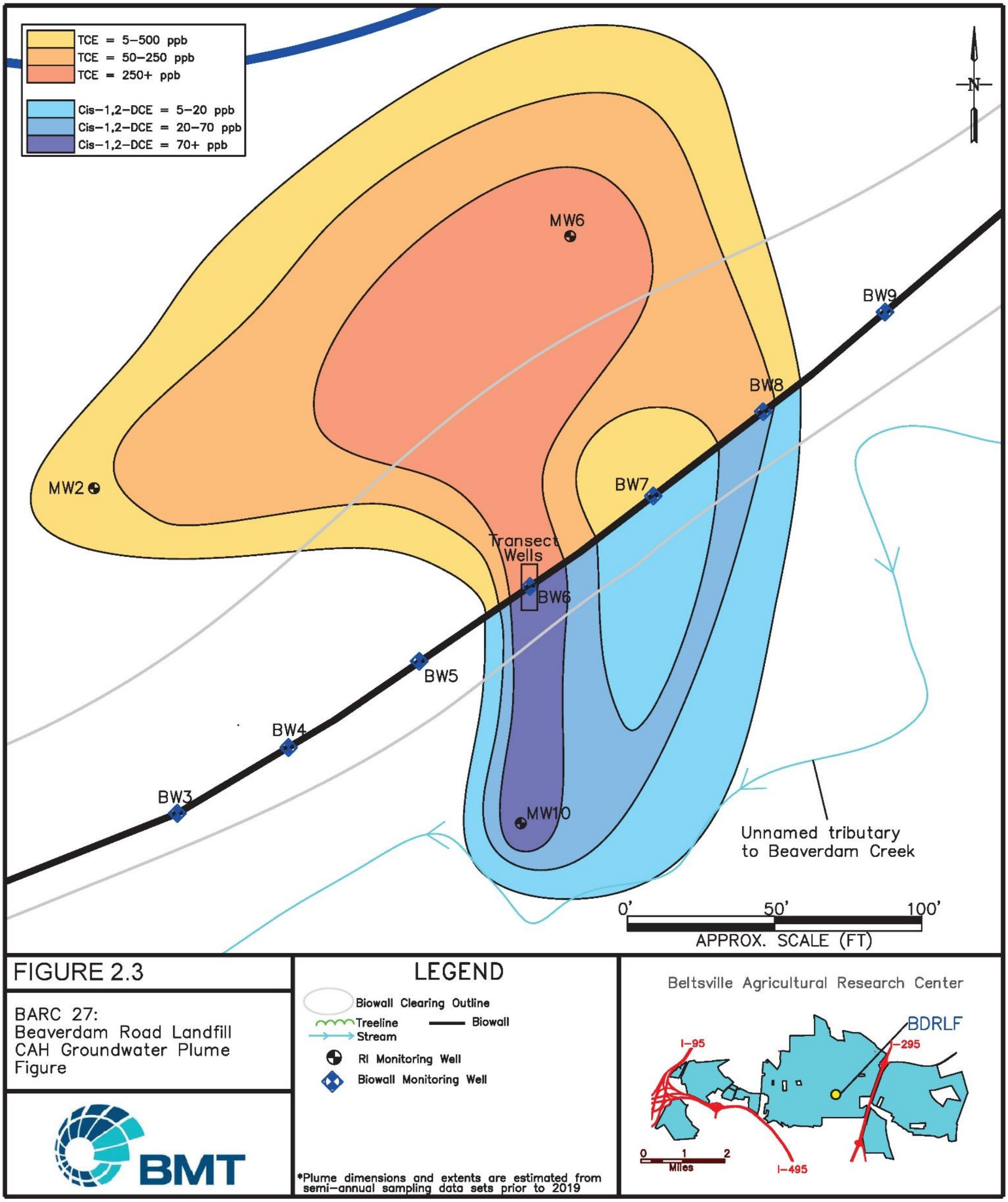


FIGURE 2.3

BARC 27:
Beaverdam Road Landfill
CAH Groundwater Plume
Figure

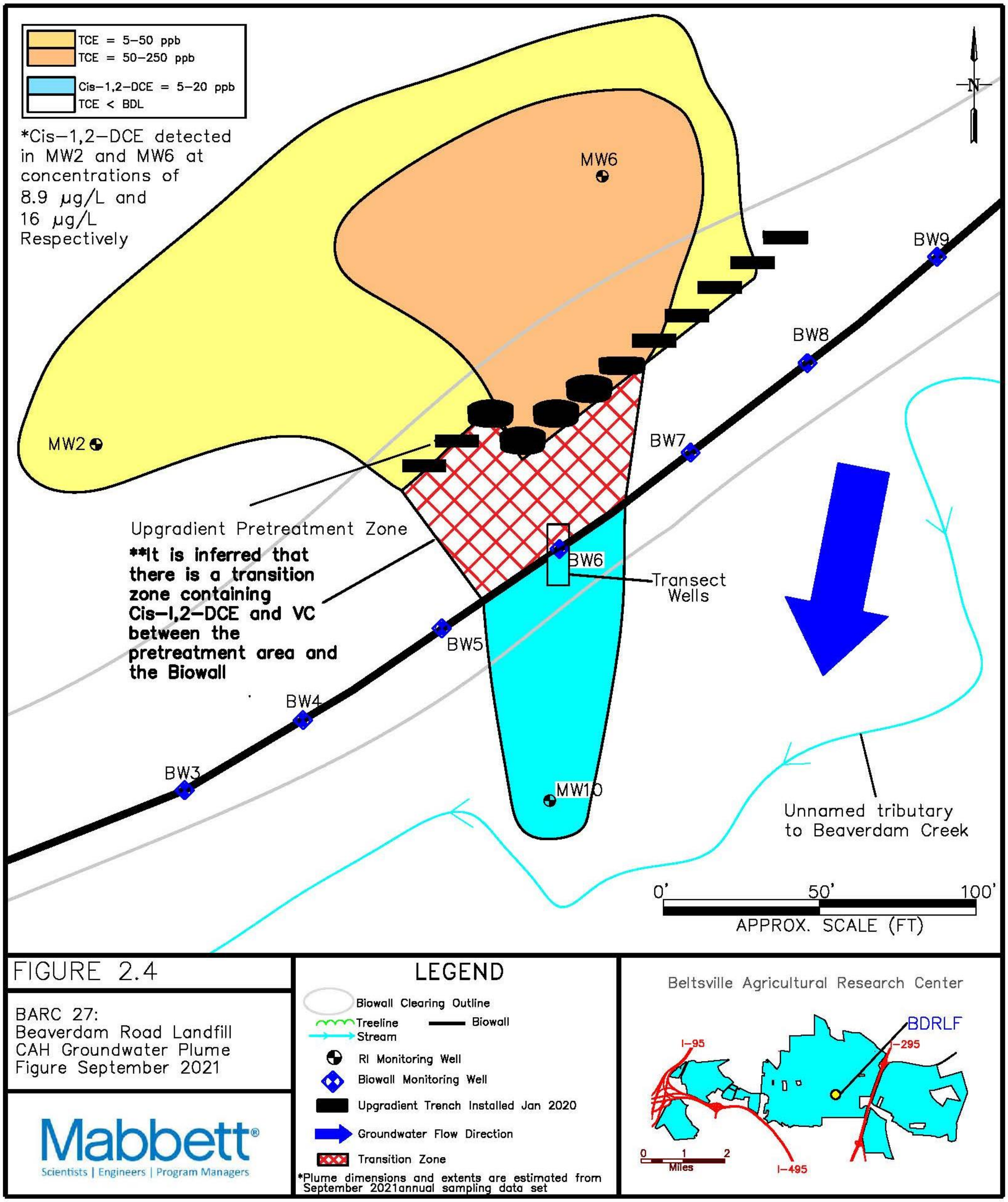


FIGURE 2.4

BARC 27:
Beaverdam Road Landfill
CAH Groundwater Plume
Figure September 2021

3.0 INSPECTION AND PROGRESS SINCE LAST REVIEW

This report presents the second FYR for BARC, and the second for the BDRLF OU-05. No other OUs at BARC have been identified as requiring a FYR at this time. Based on the reviews and inspections conducted as part of this FYR, the following protectiveness statement has been determined. Please see Section 4 Five Year Review Process, Section 5 Technical Assessment, Section 6 Issues/Recommendations, and Section 7 Protectiveness Statement for the full assessment and process for determining the Protectiveness Statement for the BDRLF AOC shown below. Appendix E presents the FYR Inspection Form completed in March 2023.

This section includes the protectiveness determinations and statements from the last five-year review as well as the recommendations from the last five-year review and the current status of those recommendations. A summary of recommendations from the 2018 FYR and their responses is presented in Table 3-1.

Table 3-1. Protectiveness Determinations/Statements from the2018 Five-Year Review

OU#	Protectiveness Determination	Protectiveness Statement
OU-5	Short-term Protective	The remedy at BDRLF currently protects human health and the environment as the biowall is degrading TCE to below remediation goals (i.e., MCLs). LUCs are implemented, and LTM confirms the continued operation of the remedy. However, in order for the remedy to be protective in the long-term, amendments need to be made to the biowall to assure all TCE daughter products are degraded.

Table 3-2. Status of Recommendations from the 2018 Five-Year Review

OU#	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date
OU-5	Incomplete degradation of TCE and daughter products	Identify and implement amendment or engineering solution to complete degradation of daughter products to MCLs	Complete	Remedy enhancements designed and implemented 2019-2021	9/19/2020
OU-5	No assessment for emerging contaminants since completion of RI	Develop a work plan to include assessment of emerging contaminants in groundwater associated with historical site activities	Complete	Emergent contaminant screening was conducted at RI/FS OUs in 2020. Facility wide PFAS background investigation completed throughout BARC.	1/18/2021
OU-5	Change in toxicity of contaminants	Review the RI list of detected contaminants and determine if the current COC status of analytes should be revised	Complete	BDRLF RI reviewed COCs for changing toxicity. No COCs were identified as requiring additional assessment.	11/15/2022

The implementation of remedy enhancements to the biowall at the BDRLF is discussed in greater detail in Section 3.1. and in the BDRLF Supplemental Remedial Action Completion Report (BMT, 2021). The monitoring data and analysis assessing the performance of the enhanced biowall in achieving MCLs for all TCE and daughter products is discussed in more detail in Section 4.2. Results from the emergent contaminant screening that was conducted at OU-5 is discussed in Section 4.3. A review of detected groundwater contaminants from the BDRLF RI and changes in toxicity of these compounds is included in section 5.1.

3.1 Remedy Enhancements

After the completion of the Five-Year Review (FYR) in 2018, it was recommended to provide enhancements on the existing Biowall to address the issue of the persistence of concentrations of cis-1,2-DCE and VC in groundwater downgradient of the Biowall exceeding their respective MCLs. A figure showing the estimated extent of CAH contamination in groundwater at the site, prior to installing the remedy enhancements is presented in Figure 2.3. The Remedial Action Completion Report (RACR) for the Remedy Enhancements is included as Appendix A.

Remedy Enhancement Design Goals

Through a series of presentations and discussions between BMT, ARS, EPA, and University of Maryland (UMD) researchers between May 2016 and June 2019 (BMT, 2019), the following remedy enhancement design goals were identified:

- Target groundwater upgradient of the biowall for pre-contact conditioning to improve biowall performance.
- Increase pH of the groundwater entering the biowall as ongoing dechlorination has acidified groundwater to the lower bound (pH of 6) of ideal conditions for dechlorinating bacteria populations (pH between 6 and 8). Ideally this would provide a long term (five years) pH control and buffering capacity.
- Increase effective residence time or time within an environment conducive to reductive dechlorination. This provides additional time for degradation of DCE isomers (such as cis-1,2-DCE) to VC, and VC to ethenes/ethanes.
- Reduce dissolved oxygen (DO) in the surficial aquifer. Due to the shallow nature of the aquifer (approximately three feet bgs), and the recharge from meteoric water, DO fluctuates, reducing dechlorination potential.
- Increase biologically available carbon for use as an electron donor.
- Increase substrate surface area to retain dechlorinating bacteria.

In addition, BARC identified temperature as a critical component. Due to the shallow groundwater and infiltration of meteoric water, including snow melt, temperatures in the upper portion of the surficial aquifer fluctuate throughout the year, and are at times too low to provide optimal conditions for microbial activity. In late 2019 an additional goal was added (BMT, 2019):

- Increase temperature in the subsurface formation to mitigate seasonal fluctuations below ideal temperature (60 degrees Fahrenheit [°F]), and ideally increase average groundwater temperatures to increase rate of dechlorination with maximum temperatures of 140 °F.

Enhancement Design

The research team explored potential technologies that would be appropriate for performance enhancement of the Biowall. Based on the requirements above, a groundwater pretreatment zone was determined to be able to meet the requirements, was consistent with remedy selection outlined in the ROD, and was implementable at the BDRLF site. In general, performance enhancements consist of:

Installation of a biosolid filled groundwater interception trenches upgradient of the biowall for pretreatment and groundwater conditioning that would include:

- Long-term pH adjustment and buffering.
- Source of organic carbon.
- Thermal heating source to increase groundwater temperature.
- Be stable within the site conditions.

- Comply with Applicable or Relevant and Appropriate Requirements (ARARs).

The groundwater interception trenches were designed to be keyed into the Arundel formation, and have high hydraulic conductivities to encourage groundwater contact, rather than creating a subsurface low permeable zone. The design in full was presented in the Remedy Enhancement Workplan (BMT, 2019). The upgradient pretreatment zone was an enhancement to the original biowall and not a new remedy. More details of the installation are presented in the Supplemental Remedy RACR (BMT, 2020), and the Year 8 Performance Monitoring Report for the Permeable Reactive Barrier at the Beaverdam Road Landfill (BMT, 2021a), both documents are available on the BARC IR/AR.

Upgradient Groundwater Pretreatment Zone Installation

Twelve individual trenches were installed upgradient of the biowall in January 2020. The trenches are located to intercept the highest TCE concentration groundwater. As shown on Figure 3.1, four (4) trenches were over excavated due to sidewall instability. Upgradient trench pits were filled with a 50/50 mixture of crushed limestone and class A biosolids, and 1.5% biochar by volume. The mixture was formulated to increase the ambient pH of influent groundwater and to provide an adequate reservoir for beneficial microbes. Fill material was placed within each trench pit from a depth of approximately 13 – 15 feet below ground surface (bgs) to approximately 4 feet bgs and then backfilled with native material to surface. The trenches were allowed to hydrate and return to an anaerobic condition prior to the injection of the microbial solution. (BMT, 2020).

Solar Groundwater Heating System Installation

The trenches within the center line of the TCE plume had an additional heating element installed to increase the ambient temperature and maximize the performance of beneficial microbial communities. The circulation tubing was constructed from ¾” inside diameter (ID) high density polyethylene (HDPE) geothermal tubing. Tubing was formed into overlapping coils and placed at two (2) depth intervals within each selected upgradient trench pit. The tubing coils were designed to transfer sufficient heat to create a temperature increase within the selected upgradient trench pits of up to 40 degrees Fahrenheit (°F). Microbial activity decreases at temperatures less than 60 °F (Cox et al., 2007). This temperature increase was determined within the selected upgradient trench pits to a range ideal for supporting beneficial microbial communities that consume chlorinated ethenes.

Solar tubing was connected to a solar water heating system and circulation pump installed in September 2020 to maintain groundwater temperatures at the ideal range for microbial degradation. More details of the installation are presented in the Supplemental Remedy RACR (BMT, 2020).

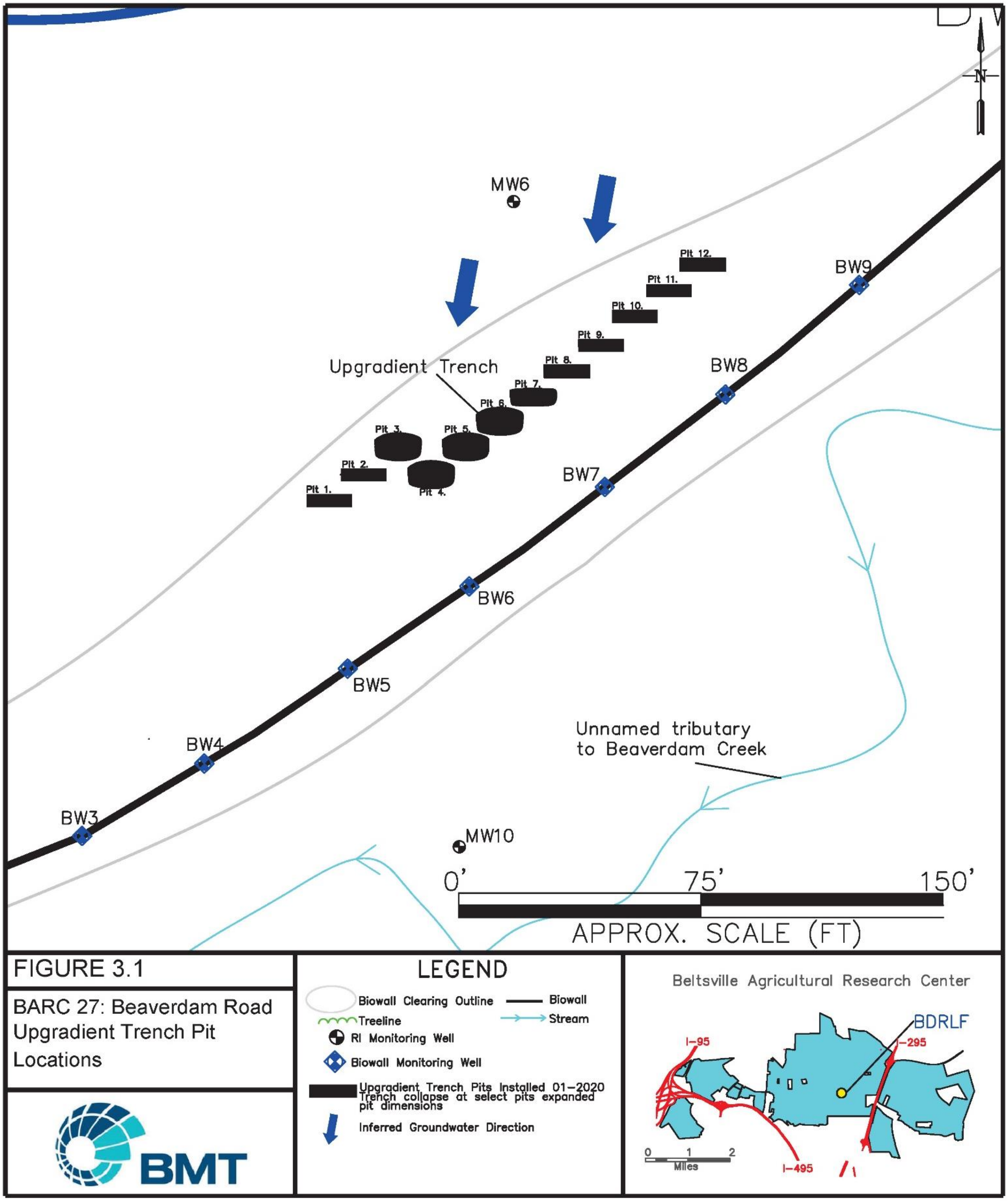


FIGURE 3.1

BARC 27: Beaverdam Road Upgradient Trench Pit Locations

Microbial Injection Program

Two (2) microbial injection wells were installed in each upgradient trench pit to ensure that the microbial injection would reach all volume within the upgradient trench pits. Twenty-four (24) microbial injection piezometer wells were installed within the upgradient trench pits in June 2020 in accordance with an approved workplan (BMT, 2020). Each microbial injection well was constructed from 1" inside diameter (ID) PVC was screened through the saturated portion of trench pits.

The WBC-2 microbial consortium, commercially available as the KB-1 microbial solution from SiREM labs was injected into the trench pits in September 2020 according to manufacturer recommendations regarding maintaining anoxic conditions for consortium viability. Each liter of KB-1 contains 10^{10} (ten billion) cells. The goal of the injection program was to distribute 10^7 (ten million) cells per saturated liter of pore space within the upgradient trench pits.

More details of the installation are presented in the Supplemental Remedy RACR (BMT, 2020), and the Year 8 Performance Monitoring Report for the Permeable Reactive Barrier at the Beaverdam Road Landfill (BMT, 2021a). Microbial injection well locations are shown in Figures 3.2 and 3.3.

3.2 Performance Monitoring Changes

A simplified monitoring program was implemented at the BDRLF following the completion of the first EPA FYR that removed bi-weekly monitoring and reduced the total sampling volume to a program that consists of:

- Quarterly sampling of only transect wells.
- Semi-annual sampling of biowall wells.
- Annual sampling of monitoring wells and surface water.

In addition to performance monitoring changes, two new RI monitoring wells (MW11 and MW12) were installed down and side gradient from the BDRLF in 2019. In addition to these new monitoring wells, MW4 and BW10, which had previously been damaged, were replaced with MW4R and biowall well BW10R.

Monitoring Program

Bi-weekly monitoring was discontinued at the conclusion of Year 5 of the performance monitoring program based on a review of monitoring data. Quarterly, semi-annual, and annual monitoring program was continued in Years 6 through 8.

Quarterly monitoring is intended to assess physical and geochemical conditions within the transect wells to determine the concentrations of CAHs upgradient, within, and downgradient of the biowall. Quarterly monitoring included gauging all site wells and the collection of groundwater samples from transect wells using low-flow methodology. In addition to the physical parameters measured during low-flow sample collection, transect well groundwater samples were submitted for laboratory analysis of VOCs, methane, ethene, and ethane.

Semi-annual monitoring is conducted according to a 6-month and 12-month schedule, concurrently with the quarterly monitoring program, and adds the collection of groundwater samples from biowall wells. Groundwater samples collected from biowall wells were submitted for laboratory analysis for VOCs, methane, ethene and ethane, total organic carbon (TOC), sulfate, iron, and manganese.

Annual monitoring is conducted at the 12-month interval, concurrently with quarterly and semi-annual monitoring and includes groundwater sampling RI wells using Passive Diffusion Bag Samplers (PDBs) and surface water sampling. RI well and surface water samples are submitted for laboratory analysis of VOCs only. All groundwater analytical data is validated in accordance with the current BARC Quality Assurance Program Plan (QAPP) (BMT, 2021b) at the time of sampling.

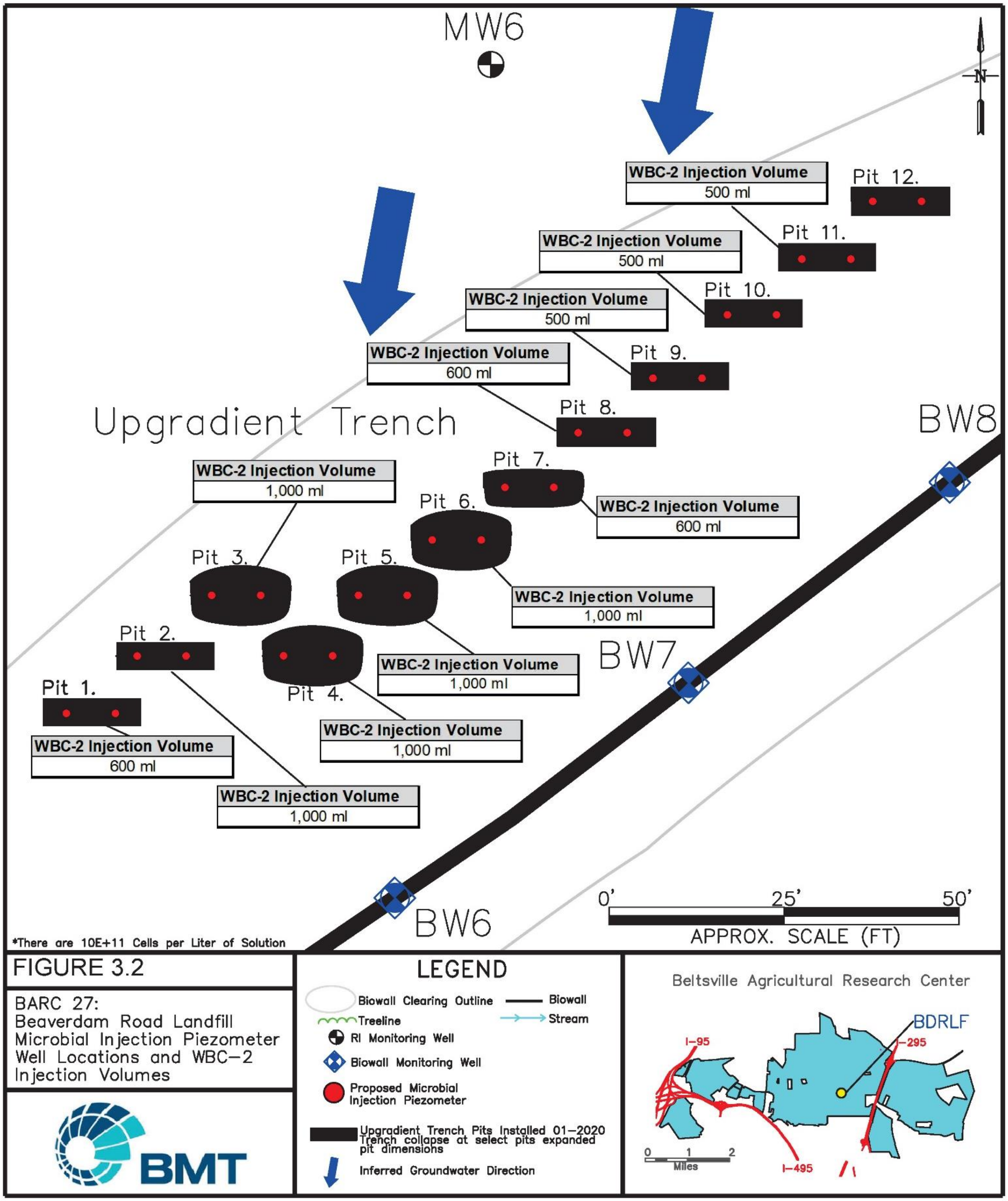


FIGURE 3.2

BARC 27:
Beaverdam Road Landfill
Microbial Injection Piezometer
Well Locations and WBC–2
Injection Volumes

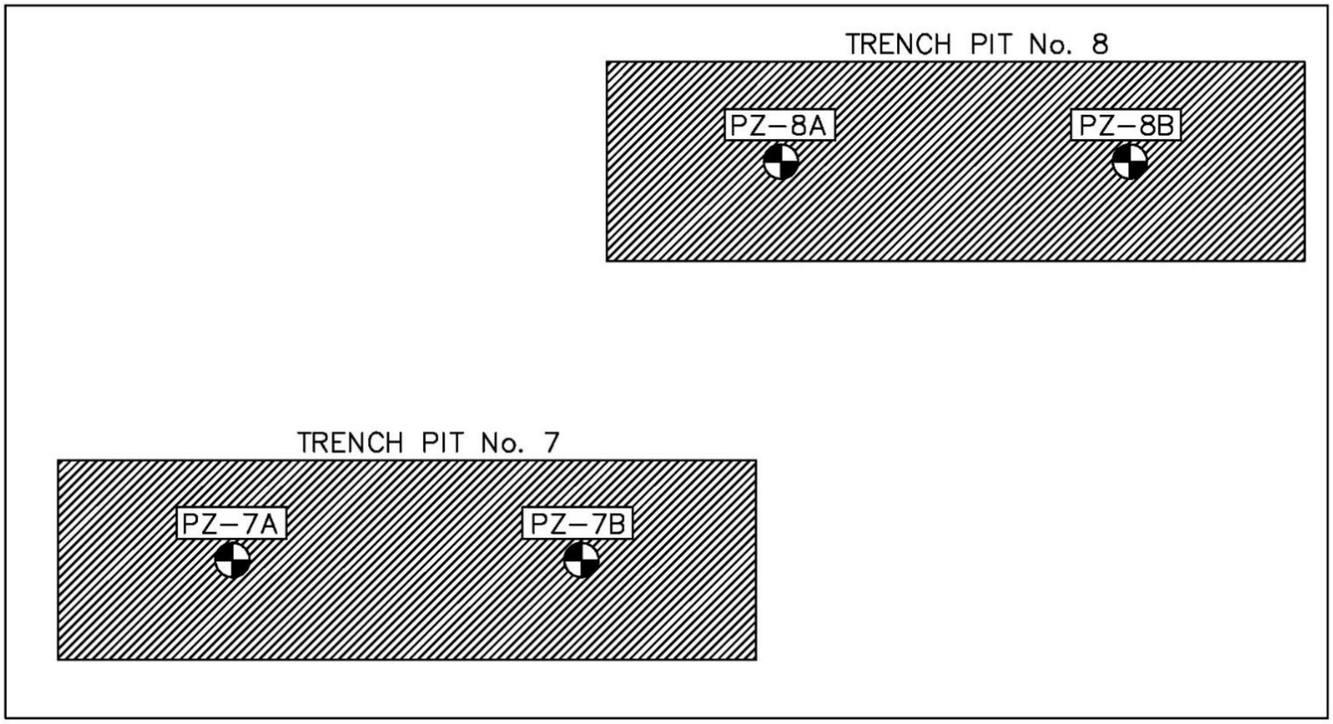


Figure 3-2. Microbial Injection Piezometers Numbering Schematic

Performance Enhancement Assessment

An assessment of the performance on the remedy enhancement was conducted in August of 2021 to measure the efficacy of the upgradient trench pit installation and of the microbial injection program in creating an environment conducive to the biodegradation of TCE to ethene.

This 'Performance Enhancement Assessment' included:

- A microbial census was conducted in all twelve (12) of the upgradient trench pits.
- Compound specific isotope analysis (CSIA) analysis on groundwater samples collected on a transect from MW6 to MW10 through the center of the TCE plume.
- Analysis of groundwater within the upgradient trench pits for VOCs.

An analysis of the data collected for the performance enhancement assessment was used to evaluate the efficacy of the remedy enhancements installed in 2020 (BMT, 2021c).

High Resolution Passive Profiler Field Testing

Additional characterization was performed at the biowall in 2019 by Texas Tech University (TTU). Operating under the Strategic Environmental Research and Development Program (SERDP) project ER-201028, TTU supervised a test deployment of High-Resolution Passive Profilers (HRPPs) with BMT at the BDRLF in March and April 2019. Passive samplers were deployed upgradient, within, and downgradient of the biowall to test the efficacy of the HRPPs and compare the collected field data to information collected during the BDRLF performance monitoring program (BMT, 2020). The overall goal of the field evaluation was to demonstrate the HRPP as a new delineation tool for site assessment (Rubalcavas et al., 2022).

Study results demonstrated the presence of a high permeability soil formation comprised of sand and gravel that is encountered at depths of between 4 and 14 feet bgs throughout the study area. The zone of highly permeable soil is only 1 to 3 feet in thickness at most sampling locations and consistently produces the highest

VOC concentrations. CSIA analysis and microbial measurements indicate that currently the environment upgradient and downgradient of the biowall is not conducive to reductive dichlorination of TCE and its daughter products. Conditions within the biowall are conducive to the reductive dechlorination of TCE to DCE isomers and to VC, but complete dechlorination was not occurring due to insufficient microbial populations and insufficient residence time within the narrow zone of relatively fast-moving groundwater where most of the VOC detections are (Rubalcavas et al., 2022).

Overall, these results were consistent with observations from the performance monitoring program. Peak measured groundwater velocities are consistent with values measured as part of the aquifer testing program. Microbial results from the HRPPs were consistent with previous microbial sampling efforts that have been conducted (BMT, 2016b).

4.0 FIVE YEAR REVIEW PROCESS

4.1 Community Notification, Involvement, and Interviews

Community Notification

BARC published a public notice titled *Commencement of Five-Year Review for Environmental Restoration at Beltsville Agricultural Research Center* in the Prince George's Post and the Greenbelts News Review, local newspapers of record that have hosted previous BARC CERCLA announcements. The announcement was published in both newspapers on December 23, 2022, and December 29, 2022, respectively, stating a five-year review was being conducted and inviting the public to submit any comments to BARC. Copies of the published announcements from the Prince Georges Sentinel and the Prince George's Post are presented in Appendix C. The results of the review and the report will be made available at the BARC information repository located at:

Information Repository
Building 003, Room 014
10300 Baltimore Avenue
Beltsville Agricultural Research Center
Beltsville, MD 20705

A third paper of record, the Prince George's Sentinel, a local paper from Baltimore, MD was contacted but did not return calls regarding the announcement.

Stakeholder Interviews

During the FYR process, interviews with stakeholders were conducted to document any perceived problems or successes with the remedy that has been implemented to date**.** The interview forms and specific notice letters to the community groups are included as Appendix C.

Stakeholder Interview Approach

The Stakeholder interview approach was developed following Five Year Review Guidance (OSWER No. 9355.7-03B-P). The guidance recommends an approach that includes numerous stakeholders, including facility staff and visitors, local residents, local and regional advocacy and interest groups, local and regional government staff and agencies, and operations stakeholders that are involved in design, implementation, and maintenance of the remedies.

In general, the stakeholder interviews are seeking the following information from the interviews.

- Background information
- State and local considerations.
- Construction and implementation considerations
- Performance, operation, and maintenance issues.
- Community involvement

To assure that the information objectives are achieved, the guidance provides some example questions to guide the conversations and interviews with stakeholders. For this FYR, these questions provide the starting point of our interviews which are summarized in Section 4.2.2 and provided in Appendix C.

Summary of Stakeholders Contacted

The BDRLF site is the only AOC at BARC undergoing review, and thus the interviews were focused on the BDRLF site, though input on other sites, and the BARC CERCLA program in general were documented if offered by the interviewees. Stakeholder interviews were conducted with the following personnel identified by their roles and organization, names are provided in Appendix C:

Summary of Stakeholder Interviews

Former EPA RPM

The former EPA RPM, Leslie Jones, was involved in the BDRLF AOC since early 2020, at which point the remedy optimization was undergoing its final installation. During her interview, Ms. Jones stated that she feels that overall progress to achieving remedial goals has been positive and communication between ARS and USDA management and the EPA has been productive. However, additional monitoring was required to determine if the remedy optimization will allow the site to meet its remedial goals.

According to the former EPA RPM, per and polyfluoroalkyl substances (PFAS) that have been detected at the BDRLF (see Section 6.1.2) will likely require additional attention and possibly a PA/SI that will be conducted separately from ongoing ROD remedy monitoring at BDRLF.

Former BARC RPM

Former BARC CERCLA Program RPM had comments and concerns in two areas:

- The ARS – UMD research collaboration which had, in his opinion, been productive in finding and justifying the use of innovative remedial solutions at active RI/FS sites had been stalled during COVID. UMD research was useful in selecting remedial amendments for the BDRLF Remedy Optimization Project (See Section 3.1.) and ongoing pesticide sequestration research at the BARC 4/19 AOC.
- A high rate of turnover in EPA RPMs assigned to oversee the BARC CERCLA Program had caused issues in the continuity of investigations, remedial designs, and the finalizations of RODs due to expanded review cycles and a lack of consistent guidance regarding what materials are required to get projects approved.

USDA Field Coordinator

The current USDA EMD CERCLA Program coordinator believes that the BDRLF original ROD remedy and the remedy optimization projects at the BDRLF are good examples of innovative, low cost and low-maintenance in-situ remediation systems.

In her experience, EPA Region III is more bureaucratic and process heavy than other EPA Regions that she has worked with. This has caused issues with developing schedules for other sites that are currently undergoing the RI/FS process and potentially delaying the completion and issuance of RODs.

She also feels well informed about ongoing work at the BDRLF and at BARC in general through the online IRAR website which is very useful for finding relevant environmental documents. She believes that this site should be a model for other USDA sites with active CERCLA Programs and a requirement host public facing documents.

Solar Solutions (Equipment Provider) Staff

The former project manager for the installation of the solar powered hot water circulation system at the BDRLF was involved in the design, scoping, consulting, and final installation of the system. He believes that the system installed at the BDRLF is a great application and very efficient application of solar technology for the purposes of environmental remediation.

He has concerns about ongoing maintenance of the system at a government facility as ongoing system maintenance is sometimes not performed leading to a degradation of system performance over time.

BARC Facility Staff and Personnel

None of the BARC facility personnel interviewed expressed concern with the protectiveness of the site remedy. None of the interviewees reported trespassers, hunting, or other issues associated with the BDRLF site. The Wildlife Management Officer stated hunting was allowed to the west and east of the BDRLF site, but since the implementation of the remedy, no hunting has been allowed on the site. No interviewees reported additional spills, staining, or odors associated with the BDRLF site or remedy implementation.

Some illegal dumping has been observed along the gravel access road that connects a stabilized construction entrance off Beaverdam Road with the main biowall access gate. Items that have been dumped along that road have included a discarded engine block and general construction debris.

Prince Georges County Police

A PG County Patrol Officer was interviewed. He stated that he encountered some local county residents (not identified) dumping brush and yard waste at the site. The officer stated that he had not previously seen anyone dumping at the site and that the material appeared to be organic yard waste rather than trash.

4.2 BDRLF Site Data Review

As part of the ongoing Performance Monitoring Program for BDRLF, BARC reviews collected data to assess trends, determine compliance with remedial goals, and determine if the remedy is and will remain protective.

The performance of the biowall is evaluated by its effectiveness in degrading COCs (i.e., chlorinated aliphatic hydrocarbons [CAHs]) in groundwater as it flows through the enhanced biowall, now expanded to include the upgradient trench pits as a combined system. To accurately evaluate the effectiveness of the biowall, CAH concentrations in groundwater are monitored over time from established monitoring wells located within, upgradient and downgradient of the biowall. Wells used for analysis include RI monitoring wells (MW), biowall wells located within the biowall itself (BW) and transect wells (TW) that are located on a transect through the biowall oriented parallel to groundwater and dissolved phase contaminant flow (Figures 2.1 and 2.2).

Biowall Transect Wells

To assess the performance of the remedy within the biowall itself and in the immediately up and down gradient areas, TWs were installed on increments of 1.2 and 2.4 feet based on original groundwater contaminant velocity estimates 2.4 feet per year.

Subsequent aquifer testing and pilot technology studies estimated contaminant transport velocities on the order of 25-50 feet per year (Rubalcavas et al., 2022) (BMT, 2017b). Prior to installing the upgradient trench pits, biowall efficacy was evaluated by comparing CAH concentrations in groundwater collected from transect wells located upgradient of the biowall (TW3, TW4, TW5, TW6) to CAH concentrations in transect wells located downgradient of the biowall (TW0, TW1, TW2).

Significantly reduced concentrations of TCE were observed in TWs located upgradient of the biowall after the installation of the upgradient trench pits. Overall biowall efficacy can be evaluated by the CAH concentration in groundwater collected from wells located downgradient of the biowall. A performance enhancement assessment of the combined remedy was conducted in August 2021 to evaluate the efficacy of the enhanced remedy.

The BDRLF Performance Enhancement Assessment project developed following the 2018 FYR included the collection of groundwater samples from microbial injection piezometers within the upgradient trench pits and of existing monitoring wells located on a transect that roughly aligns with the TCE plume at the site (Figure 2.3). Groundwater samples were analyzed for VOCs, TOC, a dehalococcoides (DHC) microbial census to measure beneficial microbial populations, and compound specific isotope analysis (CSIA) to estimates rates of biodegradation in the formation.

CAHs in Groundwater for Upgradient Trench Pit Performance Enhancement Assessment

The goal of the upgradient pre-treatment areas is to convert TCE to cis-1,2-DCE and allow time for the slower cis-1,2-DCE dechlorination to occur. This dechlorination step requires significant time, for action. The CAH concentrations in groundwater within the upgradient trench pits is considered indicative of the potential for reductive dichlorination of TCE within these features.

During the 2021 performance monitoring program, TCE was not detected in any transect well, biowall well, or monitoring well located hydraulically downgradient of the pretreatment trench pits indicating that complete dechlorination of TCE is occurring upgradient of the biowall. Cis-1,2-DCE was not detected in any transect well or biowall well but was detected in RI monitoring well MW10, which is located 80 feet downgradient of the biowall. Well locations are shown in Figures 3.2 and 3.3 above.

Downgradient of the biowall, TCE was not detected in any wells located hydraulically downgradient of the site. Cis-1,2-DCE was only detected in MW10, which is located more than 75 feet downgradient of the biowall. VC was detected at a concentration of 3.6 µg/L in TW0, which is located immediately downgradient of the biowall. CAH concentrations in downgradient transect wells is considered indicative of overall system performance. Overall concentrations of CAHs including cis-1,2-DCE and VC have been significantly reduced following the implementation of the remedy enhancements in 2020. More details are available in the BDRLF Performance Enhancement Assessment Report BMT, 2021c).

Trends in VOC Concentrations at the BDRLF

Since the construction of the biowall in October 2013, the PMP has routinely collected and analyzed groundwater samples from the monitoring wells and select transect wells for VOCs including CAHs. From this data set degradation trends can be identified.

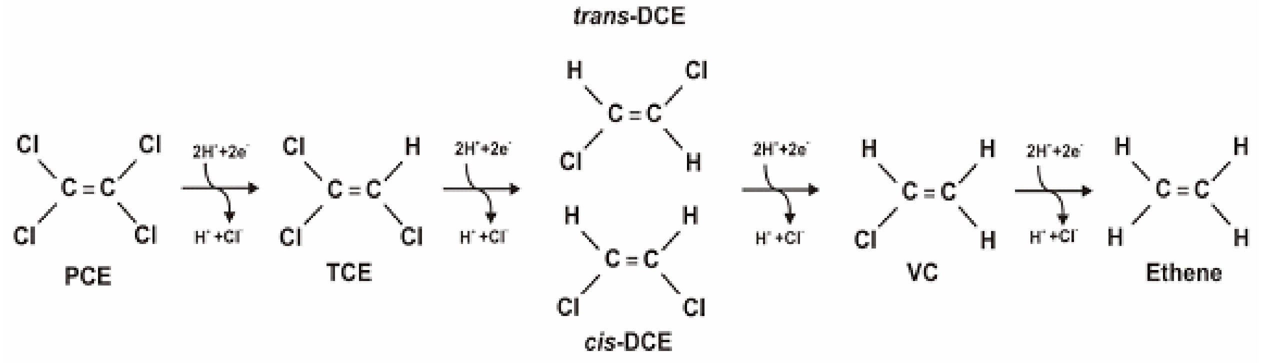
Under reductive dichlorination, TCE primarily degrades to isomers of DCE, primarily the isomer cis-1,2-DCE, and then to vinyl chloride. Vinyl chloride primarily degrades into ethene. Ethene, which does not have an MCL, readily degrades into carbon dioxide and water under anoxic conditions in the environment through several biological pathways. Other degradation pathways are possible, but these are the primary biotic dechlorination pathways at BDRLF, other CAHs are created at reduced concentrations and follow different pathways to full dechlorination and destruction. These other CAHs have not been observed at detectable levels at the site.

Ethene is expected to have a short half-life within the groundwater aquifer under these conditions and higher concentrations of carbon-dioxide would be expected. The presence of ethene in groundwater is indicative that reduction of vinyl chloride is occurring, but rates of biodegradation cannot be determined from this data (U.S. Geological Survey, 2012). A visual diagram of reductive dechlorination of chlorinated ethenes is shown in Figure 4.1.

Prior to the installation of the upgradient trench pits, groundwater upgradient of the biowall sampled from TW6 and TW5 has consistently shown high concentrations of TCE (390 to 1,100 micrograms per liter (µg/L)), low concentrations of cis-1,2-DCE (less than 35 µg/L) and trace concentrations of vinyl chloride (less than 1 µg/L). Groundwater samples collected downgradient of the trench pits and upgradient of the biowall sampled from TW1 has shown low concentrations of TCE since March 2014 (less than 15 µg/L), higher concentrations of cis-

1,2-DCE (130 to 260 µg/L) and high concentrations of vinyl chloride (up to 56 µg/L). Low concentrations of ethene (up to 6.7 µg/L) were also detected in TW1.

Figure 4.1. Primary Anaerobic Degradation of PCE Visual Diagram



(Image taken from Clu-In.Org (https://clu-in.org/techfocus/default.focus/sec/Bioremediation/cat/Anaerobic_Bioremediation_(Direct)/

Prior to the installation of the upgradient trench pits, TCE was the primary contaminant in groundwater upgradient of the biowall, and cis-1,2-DCE was the primary contaminant in groundwater downgradient of the biowall. There is no observable temporal trend in cis-1,2-DCE or vinyl chloride concentrations in TW1 during the time span of the performance monitoring period. Trace concentrations of ethene have been detected in downgradient groundwater but there is no observable trend in the concentration of these contaminants over time.

TCE was detected in TW5 and TW6 at a concentration of 1,100 µg/L in March 2015 (Year 2), significantly greater than TCE concentrations detected in the upgradient transect wells before or after that sampling event. Concentrations of CAHs in downgradient groundwater during the March 2015 sampling event were not greater than CAH concentrations detected in TW1 or TW2 before or after this event. This data suggests that conditions within the biowall are conducive to the degradation of TCE into cis-1,2-DCE, and moderately conducive to the degradation of cis-1,2-DCE to vinyl chloride.

Total molar mass of chlorinated ethenes (i.e., TCE, DCE isomers, and VC) in average TW5/TW6 and TW1 during the eight-year performance-monitoring period is shown in Figure 4.2. The total summed concentration in ppb of detected ethenes averaged in TW5 and TW6, located hydraulically upgradient of the biowall and TW1, located hydraulically downgradient of the biowall is shown in Figure 4.3. Values were averaged between TW5 and TW6 to represent groundwater upgradient of the biowall to address outliers. The figures show that, prior to the installation of the upgradient trench pits, the molar mass of chlorinated ethenes has been significantly higher upgradient of the biowall (TW5/TW6) than downgradient (TW1).

The total mass of and overall concentrations of chlorinated ethenes in the vicinity of the biowall showed a significant drop starting in March 2020 which to very low levels measured both upgradient and downgradient of the biowall. This significant decrease in CAH concentrations demonstrates the effect of the upgradient trench pit installation which introduced an environment, upgradient of the biowall, with a great ability to degrade chlorinated ethenes. The data in Figures 4-2 and 4-3 demonstrate that the upgradient trench pits and the biowall, operating as a combined remedy, had completely degraded dissolved phase TCE at the BDRLF to ethene by September 2021.

Figure 4.2. VOC Molar Mass Concentrations in TW1 and TW5/TW6

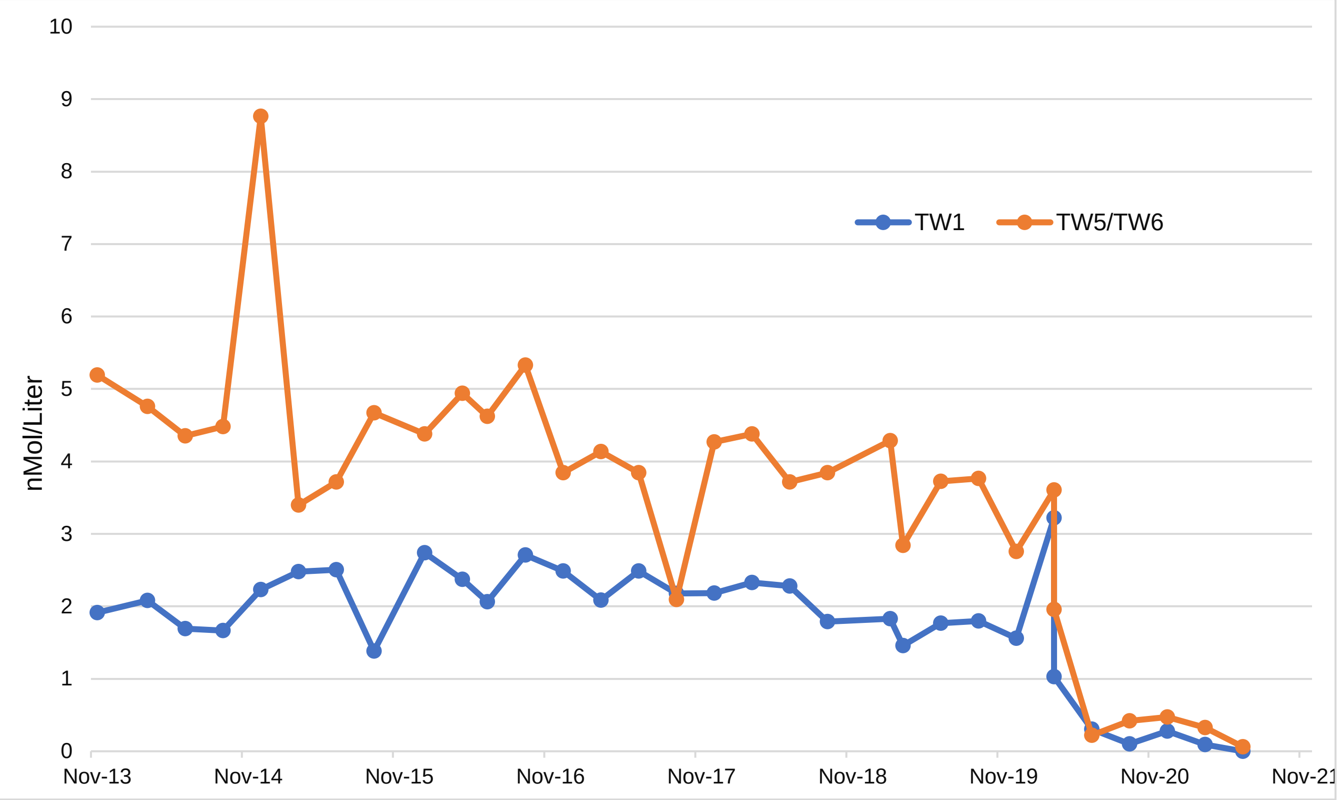
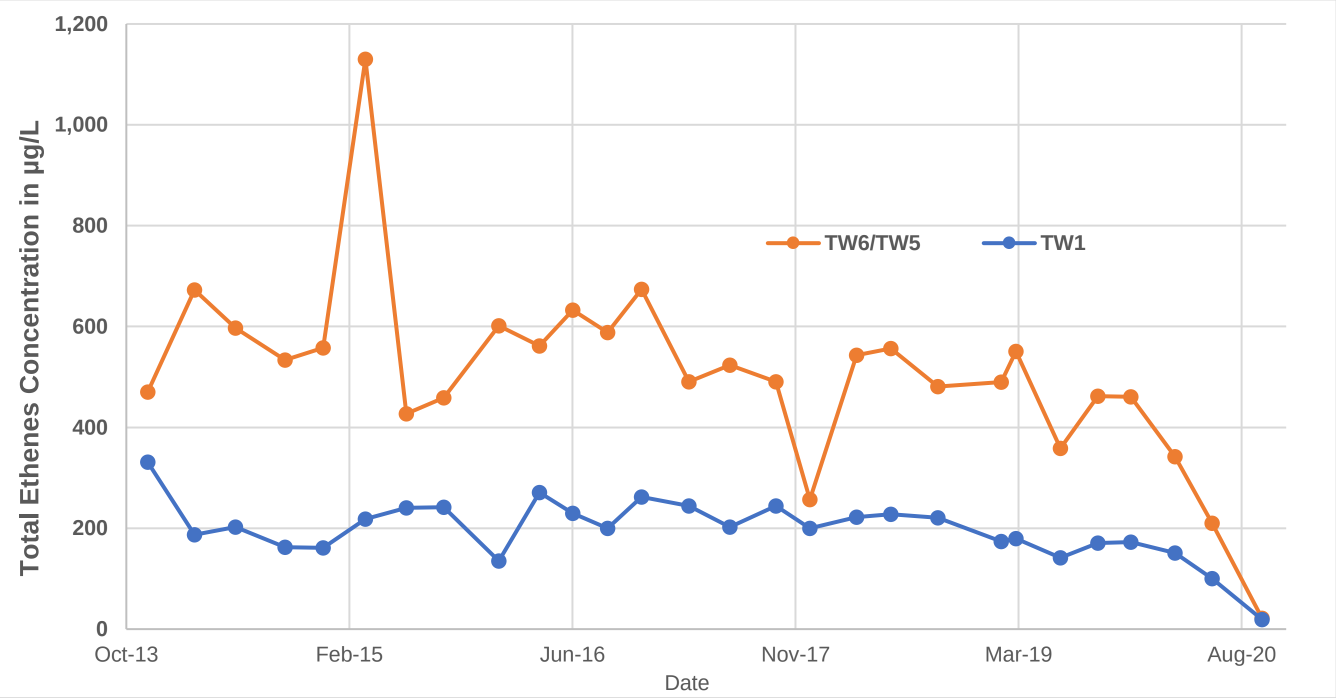


Figure 4.3. Total Summed Concentration of TCE, DCE isomers and VC in TW1 and TW5/TW6



The total molar mass of chlorinated ethenes detected in TW1 during the first six-years of monitoring was consistently lower than the molar mass of ethenes detected in TW5/TW6 during that same time span. This suggests that either abiotic processes were contributing to the reduction in CAH concentrations, or some degree of sorption was occurring. However, this does not provide any indication as to which abiotic process is predominant (e.g., adsorption or biogeochemical transformation). Adsorption to the organic substrate of the biowall, and the degradation products of the β-elimination (dichloroacetylene, chloroacetylene, and acetylene) may account for this discrepancy. Furthermore, degradation of VC may be underestimated due to the short half-life of ethene in groundwater (AFCEE et al., 2008).

A table showing overall CAH concentrations within the transect well TW0 is presented in Table 4.1. TW0 was installed 1.2 feet downgradient from TW1 in 2016. Groundwater concentrations within TW0 are considered representative of groundwater flowing out of the biowall at the point of maximum CAH concentration and thus indicative of overall remedy efficacy over time. Significant decreases in cis-1,2-DCE and vinyl chloride concentrations were observed from September 2020 that were concurrent with increases in ethene concentrations. Both trends are indicative of significant reductive dechlorination occurring upgradient of the biowall with the installation of the upgradient trench pits.

Table 4-1. CAH Concentrations within TW0 2016-2021

Sample Date	**TCE**	**cis-1,2-DCE**	**trans-1,2-DCE**	**1,1-DCE**	**Vinyl Chloride**	**Ethene**
	MCL - 5 µg/L	**MCL - 70 µg/L**	**MCL - 100 µg/L**	**MCL - 7 µg/L**	**MCL - 2 µg/L**	**MCL - NA**
Jun-2016	**4.3**	**270**	**0.55J**	**2.3**	**19**	**5.5**
Sep-2016	ND	**270-D**	ND	ND	**25**	**4.8-L**
Dec-2016	ND	**270-D**	**0.52J**	**1.9**	**24**	**5.9-L**
Mar-2017	**2**	**180**	**0.71J**	**2.2**	**16**	**3.1J**
Jun-2017	**1.4**	**210-D**	**0.46J**	**2**	**21**	**5**
Sep-2017	**0.84J**	**180**	ND	**1.1**	**26**	**6.2-J**
Dec-2017	ND	**140**	ND	**1**	**19J**	ND
Mar-2018	**14**	**190**	ND	ND	**14**	ND
Jun-2018	ND	**200**	**0.54J**	**1.6**	**23-J**	ND
Sep-2018	ND	**190**	**0.66J**	**1.2**	ND	**5.3**
Feb-2019	ND	**170**	**0.53J**	**0.83J-J**	**14**	**5.1**
Mar-2019	**0.63**	**170**	**0.62J**	**0.81J**	**16**	**4.7**
Jun-2019	ND	**170-J**	**0.53J**	**0.83J-J**	**18-J**	**5.1**
Sep-2019	ND	**210**	ND	**0.9J**	**29**	**7.6**
Dec-2019	ND	**200**	**0.33J**	**0.88J**	**30**	**8.3**
Mar-2020	ND	**170**	**0.51**	**0.84J**	**21**	**5.7**
Jun-2020	ND	**100**	ND	ND	**29**	**8**
Sep-2020	ND	**33**	ND	ND	**34**	**13**
Dec-2020	ND	**20**	ND	ND	**9.8**	**23**
Mar-2021	ND	**15**	ND	ND	**13**	**34**
Jun-2021	ND	**8J**	ND	ND	**4.1J**	**26**
Sep-2021	ND	ND	ND	ND	ND	**18.6**

Notes:
All concentrations in micrograms per liter (µg/L) or parts per billion (ppb)
MCL = Safe Drinking Water Act (SDWA) maximum contaminant level (MCL)
TCE = trichloroethene
DCE = tichloroethene
ND = not detected
Detections in bold
MCL exceedances shaded.

Data Qualifiers:
D = Sample quantitation with diluted Sample
J = Estimated analyte quantitation

Emerging Contaminant Screening

Emergent contaminant screening was conducted at the BDRLF in 2019. The sampling program was on recommendations in the previous BARC FYR (BMT, 2018b) to screen the site for emerging contaminants. Sampling locations included: (1) monitoring wells with historically high detections for TCE (MW2 and MW6), (2) within the biowall (BW6) and (3) downgradient of the biowall (MW10).

These wells were sampled for Per and Polyfluoryl Alkyl Substances (PFAS) compounds, polybrominated diphenyl ethers (PDBEs) and 1,4-dioxane. PFAS compounds were detected in groundwater at the BDRLF, including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). PFOS and PFOA compounds were detected in all sampled wells. PFAS detections in groundwater are presented in Table 4.2. PDBE compounds were non-detect in all BDRLF wells. 1,4-dioxane was detected in all sampled wells, but at concentrations below their RSL. 1,4-dioance sampling results are presented in Table 4-3.

Table 4-2. 2019 Groundwater Sampling PFAS Analytical Results

	EPA RSL	MW2		MW6		MW10		MW10 DUP		BW6	
Perfluoroalkane Sulfonic Acids	**ng/L**	**ng/L**		**ng/L**		**ng/L**		**ng/L**		**ng/L**	
Perfluorobutane sulfonic acid (PFBS)	6,000	**2.7**	**J**	**2.5**	**J**	**5.4**		**5.3**		**6.5**	
Perfluoropentane sulfonic acid (PFPeS)	NA										
Perfluorohexane sulfonic acid (PFHxS)	390	**5.3**		**3.7**	**J**	**9.8**		**9.3**		**11**	
Perfluoroheptane sulfonic acid (PFHpS)	NA	ND		ND		**0.56**	**J**	**0.65**	**J**	**0.75**	**J**
Perfluorooctane sulfonic acid (PFOS)	40	**1.9**	**J**	**2**	**J**	**11**		**9.7**		**33**	
Perfluorononane sulfonic acid (PFNS)	NA	ND		ND		ND		ND		ND	
Perfluorodecane sulfonic acid (PFDS)	NA	ND		ND		ND		ND		ND	
Perfluoroalkane Carboxylic Acids											
Perfluorobutanoic acid (PFBA)	18,000	**6**		**7.5**		**19**		**18**		**19**	
Perfluoropentanoic acid (PFPeA)	NA	ND		ND		**14**		**16**		**5.3**	
Perfluorohexanoic acid (PFHxA)	9,900	ND		ND		**27**		**26**		**11**	
Perfluoroheptanoic acid (PFHpA)	NA	**1.8**		**1.8**	**J**	**28**	**J**	**29**		**14**	
Perfluorooctanoic acid (PFOA)	60	**9.9**		**9.9**		**87**		**83**		**100**	
Perfluorononanoic acid (PFNA)	40	ND		ND		**6**		**5.5**		**14**	
Perfluorodecanoic acid (PFDA)	NA	ND		ND		**1.8**	**J**	**11.78**	**J**	**10**	
Perfluoroundecanoic acid (PFUnDA)	NA	ND		ND		ND		ND		ND	
Perfluorododecanoic acid (PFDoDA)	NA	ND		ND		ND		ND		ND	
Perfluorotridecanoic acid (PFTrDA)	NA	ND		ND		ND		ND		ND	
Perfluorotetradecanoic acid (PFTeDA)	NA	ND		ND		ND		ND		ND	
TOTAL		**17.7**		**19.2**		**182.8**		**177.5**		**173.3**	

Notes:
J = estimated quantitation
EPA RSL is residential tap water – May 2023
EPA RSL exceedances shaded in gray
NA = EPA RSL not available
ND = Analyte not detected
ng/L = nanograms per liter or parts per trillion (ppt)

Table 4-3. 2019 Groundwater Sampling 1,4-dioxane results

Well	**EPA RSL (µg/L)**	**1,4-D (µg/L)**
MW2	0.46	0.042
MW6	0.46	0.068
MW10	0.46	0.042
MW10 DUP	0.46	0.054
BW6	0.46	0.058

Notes:
EPA RSL is residential tap water RSL dated May 2023.
µg/L = micrograms per liter or parts per billion (ppb)

Emergent contaminant detections were screened against EPA regional screening levels (RSLs) for residential tap water published in May 2023. For PFAS compounds, only PFOA was detected at concentrations greater that the EPA RSL in BW6 and MW10. 1,4-dioxane was not detected at concentrations greater than the EPA RSL. On September 6th, 2022, EPA published a proposed rule designating PFOA and PFAS, including their salts and structural isomers, as CERCLA Hazardous Substances (EPA, 2022c). This rule has not been finalized at the current time. Currently, there is no SDWA MCL for PFOS or PFOA. EPA may recommend using the 2016 EPA health advisory limit (HAL) of 70 ng/L, the RSL, or other risk-based criteria as a preliminary remediation goal (PRG) for groundwater for potential drinking water sources.

Only a single round of PFAS data was collected from the BDRLF site prior to the installation of the performance enhancement in 2020. The impacts of the upgradient pretreatment pits have not been assessed.

Issues Identified During Data Review

The data review identified the following issues to be addressed:

- Issue – Confirmation of Attainment of Remedial Goals and Performance Monitoring
    - Continue performance monitoring program to confirm attainment of remedial goals as observed in 2021.
- Issue – Detection of Emerging Contaminants
    - PFAS compounds were detected at the site that will require further assessment of these compounds.

4.3 BARC FYR Site Inspection

The inspection of the site LUCs and onsite conditions was conducted on September 15, 2022.

BDRLF FYR Site Inspection and Conclusions

Mr. Jason Lorenzetti, PE, Mr. David Schanzle, and Mr. Justin Idzenga, PG (Mabbett) performed a site inspection of BDRLF on September 15, 2022. The inspection included inspection of boundary controls (fencing and signage), the closed BDRLF area, the remedy implementation area, the groundwater monitoring network, the remedy monitoring network (biowall walls), the upgradient trenches and the distribution system, the solar collection panels and controls, and the down gradient tributary to Beaver Dam Creek. A summary of findings is provided as a LUCIP Inspection Report completed during the site walk and provided as Appendix D.

Overall, the Site Inspection found the BDRLF site to be in generally good repair with no signs of dumping. However, trails were observed in the surrounding woods between the biowall area and the former landfill, including manual twisting and bypassing of the barbed wire fencing, which indicated there was some trespassing or use of the site for hunting.

The remedy implementation area was maintained with access to the monitoring network wells, though no grass cutting has been completed at the site, and some portions of the site require additional periodic maintenance, as listed below. No observed damage to the biowall or upgradient trenches, or no changes to the previously identified potential exposure and transport routes was observed. The solar panels were powering the controllers, but the system was depressurized. The inspection team reviewed the system and determined that a leak may be present in the heating lines within the upgradient trenches.

A biosolids stockpile remains on the site, with a ripped tarp, the biosolids should either be graded in and seeded, graded level with the others or removed for use elsewhere on BARC as it remains a potential source of sediment and disrupts site access.

The Site Inspection found the following issues that needs to be addressed:

- Issue – Site Maintenance

- Removal of extraneous silt fencing associated with implementation of the upgradient trenches.
- Removal or cleanup of the extra biosolids stockpiled at the site.
- Periodic inspection of the BDRLF fencing for damage by trespassers/site users.
- Continued routine cutting of grass and brush.
- Repairs to the solar heating system and distribution system, as it is currently not functioning.

5.0 TECHNICAL ASSESSMENT

The following presents the Technical Assessment for each site with a currently completed remedy or ROD, eligible for inclusion in the FYR.

5.1 Beaverdam Road Landfill (BDRLF)

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

At the time of the remedy implementation TCE and degradation compounds cis-1,2-DCE and VC were the only COCs detected in groundwater above their MCL. In response to the installation of remedy enhancements (i.e., upgradient trench pits, the injection of a custom microbial consortium into the trench pits, and solar heating) TCE and degradation compounds in groundwater downgradient of the biowall concentrations have decreased to concentrations at or below their respective MCLs (Figure 2.2 and Figure 4.3).

After implementing remedy enhancements, the biowall remedy was meeting all intended remediation objectives. Based on monitoring data collected at the BDRLF in September 2021, intended remediation objectives are being met. Complete dechlorination of TCE appears to be occurring. TCE degradation compounds cis-1,2-DCE and VC were not detected in groundwater immediately downgradient of the biowall in September 2021.

Remedial Action Performance

As a combined remedy, the biowall and the upgradient trench pits, or ‘enhanced’ biowall, have been successful in facilitating degradation of TCE to acceptable concentrations below the MCL, as required by the ROD. As a combined remedy, the enhanced biowall has demonstrated an ability fully degrade the breakdown products of TCE, including cis-1,2-DCE and VC to concentrations below their respective MCLs.

System Operations/O&M

Operating procedures have been established and implemented as part of an overarching Performance Monitoring Plan (PMP). Routine inspections have been effective and are working in a manner that will continue to maintain the remedy effectiveness.

Implementation of Institutional Controls and Other Measures

The implementation of ICs and LUCs is discussed in Section 2.1. In summary, these measures, stipulated in the ROD, include:

- A prohibition against the use of contaminated groundwater as a potable water source until cleanup levels are met.
- The prohibition of construction of buildings (industrial or residential) over the plume which may potentially be at risk due to vapor intrusion (the area of applicability for such ICs will be the known area of the groundwater plume that exceeds the MCL for TCE (5 micrograms per liter (µg/L)). The applicability of ICs also extends to the area directly under the landfill.
- Other access restrictions including complete site enclosure enforced by fencing and signage.

These measures are in place and are effective in preventing exposure. Fencing and signage have also been effective in preventing exposure; however, security improvements are planned.

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

Changes in Standards and TBCs

No ARARs specified in the ROD for the site have changed since implementing the biowall remedy in 2013. Specifically, MCLs for the COCs, including the DCE and VC, have not been revised.

Changes in Toxicity and Other Contaminant Characteristics

Groundwater COCs identified in the BDRLF RI were evaluated as part of the first EPA FYR for BARC to identify any constituents in groundwater that may be of concern due to changes in toxicity. Maximum detected concentrations for groundwater constituents for monitoring well data reported in Table 4.7 of the May 2008 Final RI report were compared to May 2018 EPA Regional Screening Levels (RSLs) for residential tapwater.

The RSL for tapwater associated with a Hazard Index (HI) = 0.1 for noncarcinogenic risk or a cancer target risk equal to 1.0E-06 were used as the screening values as multiple non-carcinogenic COCs were present. Though most of these changing screening values were determined to have no appreciable effect on the validity and protectiveness of the RI, the comparison of the updated RSLs to maximum detected concentrations in monitoring wells as reported in Table 4.7 of the RI. Five COPCs are recommended for further review:

- COCs with Remedial Goals:
    - Tetrachloroethylene - PCE should be re-evaluated on its historically low detection concentrations and recent non-detect results at the site during the first five-year monitoring period.
- COPCs without Remedial Goals:
    - Chromium (total) – Based on current USEPA guidance, the historic (pre-ROD) chromium (total) values and findings should be re-evaluated as the pre-ROD values were assessed as hexavalent chromium rather than total chromium. There were no screening criteria for total chromium in groundwater at the time the original RI was prepared. Though no hexavalent chromium is expected to be encountered in site groundwater, no site-specific chromium speciation data has been collected.
    - Nickel – The screening level for nickel (total and dissolved) has decreased.
    - Cobalt - The screening level for cobalt (total and dissolved) has decreased. Cobalt's historic maximum detection when screened against current RSLs represents a potential unacceptable human health risk in a residential scenario. No post-remedy implementation cobalt in groundwater data has been collected.
    - Butyl benzyl phthalate, a SVOC, is now classified as a carcinogen, this may alter HI and incremental lifetime cancer risk (ILCR). The presence of this analyte at its historic greatest detection at the BDRLF site would not create an unacceptable human health risk.

A comparison of maximum concentrations for these five COPCs as compared to 2008 RBC and May 2023 EPA RSL values for residential tap water is presented in Table 5.1.

For the BDRLF RI, cobalt and nickel were detected at concentrations below their respective 2008 RBCs, but at concentrations greater than their 2023 tap water RSLs. Cobalt and nickel were not carried forward as COPCs for the original BDRLF HHRA and the remedy was not designed to address them. Background concentrations for cobalt and nickel in groundwater were calculated for the BARC Facility Wide Background Study in 2002 (ENTECH, 2002). Excluding outliers, maximum background concentrations for cobalt and nickel were 45.7 and 38.1 µg/L respectively. Cobalt and nickel are both classified as non-carcinogens and do not contribute to overall ILCR for human receptors at the site.

Table 5-1. COPC Screening from 2008 BDRLF RI Against 2023 RSL Values

COPC	Max Conc. (µg/L)	2008 Tapwater RBC (µg/L)	2008 C/N	2023 Tapwater RSL (µg/L)	2023 C/N
Chromium (Hexavalent/Trivalent)	12.5	11*	N	0.035 / 100**	C/N
Cobalt	48.5	73	N	6	N
Nickel	71.7	73	N	390	N
Butyl benzyl phthalate	1.55	730	N	16	C*
Tetrachloroethene	0.143	0.1	C	4.1	N

Notes:
*RBC for Hexavalent Chromium used in 2008 RI
** 2023 EPA MCL for Total Chromium is 100 µg/L
N = non carcinogen
C = carcinogen
C* = where: N SL < 100X C SL

The RI's overall ILCR and HI risks for future child and adult residents at the site were largely driven by TCE in groundwater, and the final remediation goals were identified based on MCL values rather than risk driven values. Based on this review, although not affecting current protectiveness, changes to the toxicity values for cobalt and chromium (III and VI) warrant reassessment prior to next FYR. Likewise cobalt in groundwater should be assessed and screened for potential unacceptable risk to human health.

Changes in Risk Assessment Methods

No changes to risk assessment methods or background data (screening levels) have been identified. The BDRLF site undergoes annual assessment to determine the validity of the CSM and completed ecological and human health risk assessments completed during the RI. Though two breakdown products are present on the site, these are considered as associated with COCs for the BDRLF as part of expected degradation processes. TCE daughter compounds DCE and VC have promulgated remediation goals (MCLs), similar exposure pathways to TCE, and were included as COCs due to their expected creation as part of the dichlorination process. o change to the HHRA or ERA are required, and the RI human health and ecological risk assessments remain valid. Annual sampling includes sampling and screening of groundwater and surface water, and the new data is assessed to determine if new COPCs should be considered. Detection of COCs, or new COPCs, in site surface water or new COPCs in groundwater would create a need for an assessment of the site pathway and exposure assessment and a revision to the risk assessment methodologies and would be included in the remedy Performance Monitoring Plan (PMP) (BMT, 2014).

Changes in Exposure Pathways

There are no changes in groundwater exposure pathways to report. BARC includes quarterly sampling of the adjacent Beaverdam Creek for VOCs to monitor groundwater impacts to surface water. There have been no changes in land use practices that would affect the protectiveness of the remedy as it was designed. No new human health or ecological routes of exposure or receptors have been identified for this OU since remedy installation.

Sampling for PFAS in 2019 identified of the presence of PFAS compounds at the BDRLF site. Although regulatory requirements have not been established, further assessment of PFAS compounds is needed to evaluate their presence, concentration trends, exposure pathways, and sources at the BDRLF. Further assessment is not expected to result in current treatment methods.

Expected Progress Towards Meeting RAOs

The remedy has made expected progress toward reducing risk from groundwater exposure to COCs and meeting RAOs as defined in the ROD.

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

Following the completion of the previous Five-Year Review in 2018, potential deficiencies concerning the overall performance of the BDRLF (i.e., incomplete dechlorination) were evaluated and changes were incorporated into the design of a remedy enhancement that was installed in 2020 (Section 3.1).

Based on groundwater sampling data collected after the implementation of the 2020 remedy enhancements, RAOs as described in the ROD were met in 2021, and the current remedy is protective and operating as intended.

EPA guidance has recommended that impacts from climate change be assessed for implemented remedies during the FYR as assess if potential changes to the environment may impact the protectiveness of the remedy. The expected impacts of climate change in the Mid-Atlantic region pose increasing risks to contaminated sites. Increases in air and water temperature, precipitation, flooding, and periods of drought may result in altered fate and transport pathways and exposure assumptions, impaired aquatic habitats, dispersal of contaminants, damage to remediation related structures, and ultimately ineffective remedies. Increased frequency of extreme weather events may cause damage or releases at sites, impairing remedial efforts where remedies have not been adequately designed to protect against these risks.

The risks posed by climate change in the Mid-Atlantic Region are not expected to alter the protectiveness of the remedy at the BDRLF AOC because the remedy, including the upgradient pretreatment trenches, are installed below ground, are passive, and do not require power or intervention to function. The solar heating component is located on a raised platform, uphill from the stream, and is self-powered via photovoltaic cells.

6.0 ISSUES/RECOMMENDATIONS

The following issues and recommendations for the BDRLF have been identified during the development and performance of this FYR.

6.1 Identified Issues and Recommendations

The following issue was identified for BDRLF.

Issue: Performance Monitoring

The 2021 Annual Performance Monitoring was the last completed PMP event. The data collected found that the enhanced biowall remedy was meeting remedial goals set forth in the ROD. However, as no further performance monitoring was completed, it is uncertain if the remedial goal criteria were maintained since December 2021. Further performance monitoring should be conducted to assess if the meeting of remedial goals is continuing and represents stable conditions.

<table>
<tr><th colspan="5">Identified Issues and Recommendations</th></tr>
<tr><td rowspan="3">OU(s):</td><td colspan="4">Issue Category: Monitoring</td></tr>
<tr><td colspan="4">Issue: The PMP monitoring could not be completed, and the December 2021 data showing the meeting of Remedial Goals has not been confirmed.</td></tr>
<tr><td colspan="4">Recommendation: Conduct further performance monitoring at BDRLF to confirm results.</td></tr>
<tr><td>Affect Current Protectiveness</td><td>Affect Future Protectiveness</td><td>Party Responsible</td><td>Oversight Party</td><td>Milestone Date</td></tr>
<tr><td>No</td><td>Yes</td><td>Federal Facility
BARC - ARS</td><td>EPA</td><td>9/30/2023</td></tr>
</table>

6.2 Other Findings

In addition, the following are recommendations that were identified during the FYR and (may improve performance of the remedy, reduce costs, improve management of O&M, accelerate site close out, conserve energy, promote sustainability, etc.), but do not affect current and/or future protectiveness:

Issue: PFAS Detections and Reassessment of other COPCs

In 2019 following an emergent contaminant screening that was performed at the BDRLF of Per and Polyfluoryl Alkyl Substances (PFAS) and 1,4-Dioxane in groundwater. PFAS compounds were detected in groundwater at the BDRLF, and in groundwater downgradient of the biowall. PFAS compounds, specifically perfluorooctanoic acid (PFOA) was detected at concentrations above its' EPA RSL for residential tap water in groundwater within and downgradient of the biowall.

Changes to the toxicity of several COPCs were discussed in "Question B" (Section 5.1). These require further reassessment to ensure Long Term Protectiveness of the remedy.

Issue: Routine Maintenance

The site requires additional routine maintenance to address both short- and long-term issues that impact site security and access. The maintenance activities that were identified include: periodic grass and brush cutting, removal of silt fencing, repairs and inspections of the barbwire fence, repair, and recharge of groundwater thermal system, dressing, or removal of the biosolids stockpile.

7.0 PROTECTIVENESS STATEMENT

BARC has developed the following Protectiveness Statement for the one OU, BDRLF, with a completed ROD and implemented remedy.

Protectiveness Statement

Operable Unit: OU-5 (BARC 27)	*Protectiveness Determination:* Short-term Protective

Protectiveness Statement: The remedy at BDRLF currently protects human health and the environment as the biowall is degrading TCE to below remediation goals (i.e., MCLs). The required LUCs are implemented and maintained. Ongoing performance monitoring will confirm the continued remedy efficacy and determine when long-term protectiveness has been achieved.

An initial screening has detected PFAS in BARC 27’s groundwater at concentrations that may require further action; however, risks to human health or the environment have not been established. Future ongoing assessment of PFAS and improving maintenance objectives are needed to support long term protectiveness.

8.0 NEXT REVIEW

The next five-year review report for BARC is required five years from the planned completion date of this review, or July 22, 2028.

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APPENDIX A

BEAVERDAM ROAD LANDFILL SUPPLEMENTAL REMEDIAL ACTION COMPLETION REPORT (2021 ENHANCEMENTS)

BEAVERDAM ROAD LANDFILL UPGRADIENT TRENCH PIT PERFORMANCE ENHANCEMENT ASSESSMENT

Beltsville Agricultural Research Center
Beltsville, Maryland

Contract No. 12305B19A0001

Task No. 12305B19F0162

Prepared for:

U.S. Department of Agriculture
Agricultural Research Service
Beltsville, Maryland

Prepared by:

BMT Designers & Planners, Inc.
2900 South Quincy Street., Suite 210
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DRAFT

December 2021

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LIST OF ACRONYMS

ARS	Agricultural Research Service
BARC	Beltsville Agricultural Research Center
BDRLF	Beaverdam Road Landfill
Bgs	Below Ground Surface
BMT	BMT Designers & Planners, Inc.
Bncv	Ball and Check Valve
bvcA	BAV1 Vinyl Chloride Reductase Genes
BW	Biowall Well
^{o}C	Degree Celsius
CSIA	Compound Specific Isotope Analysis
DCE	Dichloroethene
DHB	Dehalobacter
DHC	Dehalococcoides
DHGM	Dehalogenimonas
DO	Dissolved Oxygen
DQO	Data Quality Objective
DV	Data Validation
EPA	Environmental Protection Agency
GW	Groundwater
HASP	Health and Safety Plan
ID	Inside Diameter
IDW	Investigation-Derived Waste
L/min	Liters per Minute
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
mg/L	Milligrams per Liter
MRAP	Master Risk Assessment Plan
mS/cm	millisiemens per centimeter
MS/MSD	Matrix Spike/Matrix Spike Duplicate
mV	Millivolt
NTU	Nephelometric Turbidity Unit
ORP	Oxidation-Reduction Potential
PAC	Powdered Activated Carbon
ppt	parts per thousand
QA/QC	Quality Assurance/Quality Control

LIST OF ACRONYMS (Continued)

QAPP	Quality Assurance Project Plan
qPCR	Quantitative Polymerase Chain Reaction
RI/FS	Remedial Investigation/Feasibility Study
SDWA	Safe Drinking Water Act
SpC	Specific Conductivity
TCE	Trichloroethene
tceA	TCE reductase gene
TOC	Total Organic Carbon
TW	Transect Well
UMD	University of Maryland
USDA	United States Department of Agriculture
vcrA	Vinyl Chloride Reductase Genes
VOCs	Volatile Organic Compounds

1. INTRODUCTION

1.1. Purpose

This Performance Assessment for the efficacy of the upgradient trench pits installed in January 2020 at the Beaver Dam Road Landfill Site (BDRLF), also known as BARC 27, is submitted by BMT Designers & Planners, Inc. (BMT) to fulfill contract requirements for the United States Department of Agriculture (USDA) Agricultural Research Service (ARS). Beltsville Agricultural Research Center (BARC) National Priorities List (NPL) facility via the BARC Federal Facilities Agreement (FFA) (EPA, 1998).

The BDRLF site is located within the Central Farm of BARC in Beltsville, Maryland (Figure 1). All activities carried out were performed by BMT and its subcontracted analytical laboratories (Eurofins and Microbial Insights) in compliance with the Master Quality Assurance Project Plan (QAPP) (BMT, 2021), the Master Health and Safety Plan (HASP) (BMT, 2020a), and the Master Investigation Derived Waste (IDW) Management Plan (BMT, 2020b).

The purpose of this Performance Assessment is intended to evaluate the efficacy of the upgradient trench installed in January and the efficacy of a custom microbial consortium that was injected into the upgradient trench pits in the following September. The custom microbial consortium was injected into the upgradient trench pits to enhance microbial dechlorination of trichloroethene (TCE) in groundwater. This assessment also allows the estimation the rate of reductive dechlorination within the upgradient trench pits, and to assess the viability of the environment within the upgradient trench pits to support reductive dechlorination of TCE in groundwater.

This Performance Assessment provides data on groundwater conditions at the monitoring well sampling locations, sampling methods, analytical requirements (including sample volumes, containers, preservatives, data quality objectives (DQOs), and analytical methods), quality assurance / quality control (QA/QC) requirements, and equipment decontamination procedures. Where relevant, the BARC Master Plans have been referenced.

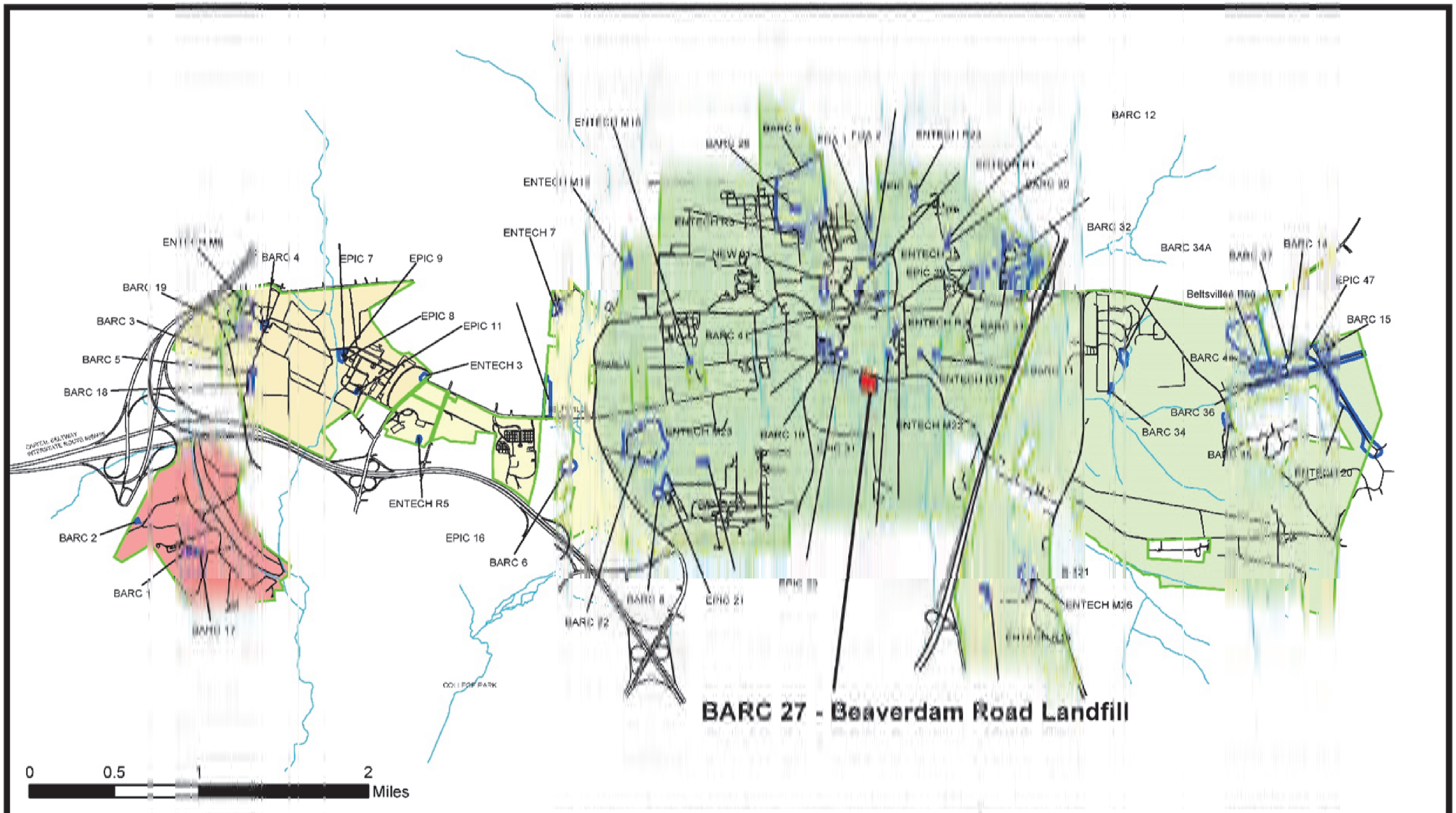


FIGURE: 1

BARC 27
Site Location Map

Legend

🟥	BARC 27	🟩	Central Farm
—	Roads	🟩	East Farm
—	Streams	🟨	Linkage Farm
☐	AOCs	🟨	North Farm
		🟥	South Farm

Location of Beltsville Agricultural Research Center (BARC)
in Prince George's County, Maryland

1.2. Background

From 1943 through the 1980s, the BDRLF site was reportedly used for disposal of non-hazardous materials including masonry construction debris, tree clippings, wood, and broken asphalt originating from BARC operations. Disposal operations at BDRLF continued until closure during the early 1980s. The BDRLF was covered with a geo-synthetic liner beneath a clay cap in accordance with the Maryland Department of the Environment (MDE) landfill closure requirements. Chain link fencing was installed along the north side of the landfill adjacent to Beaverdam Road (i.e., the vehicle accessible portion of the landfill) to prevent unauthorized access to the site. No subsequent use or access to the site has been allowed or observed since that time except for approved site maintenance and investigation activities.

Several environmental investigations were conducted at the BDRLF site as part of the Remedial Investigation and Feasibility Study (RI/FS). The RI/FS identified groundwater contaminated with TCE. The VOC plume containing TCE was estimated to be approximately 650 feet wide by 450 feet long and located southeast (downgradient) of the landfill's toe (BMT, 2008). RI investigations identified a maximum concentration of TCE in the groundwater of 600 parts per billion (ppb), although concentrations of TCE have since been observed as high as 1,100 ppb.

An approximately 1,000-foot long by 18 to 23-foot deep biowall by 2.25 feet wide was installed at the BDRLF site in July 2013 by BMT and their subcontractors (BMT, 2016). In preparing for the installation of the biowall, BMT performed site characterization activities that included a cultural resources survey, erosion control measures, vegetation clearing, construction preparation, and the mixing and testing of the biowall material. The biowall mixture composition was determined through bench-scale testing conducted by ARS and University of Maryland research staff. The findings of the bench scale study determined the optimal biowall mixture of 30% mulch, 30% compost, and 40% sand, by volume (BMT, 2013). Immediately after installation, a series of biowall wells (BW) and transect wells (TW) were installed. The location of the biowall, in relation to the former landfill and of the biowall specific wells is shown in Figure 2. The TCE plume in relation to the BDRLF biowall is shown in Figure 3.

After the installation of the biowall, it was observed that, while TCE was being degraded to other compounds, degradation processes were incomplete, resulting in a buildup of other unwanted byproducts such as 1,1-dichloroethene (DCE) and vinyl chloride (VC). In cooperation with ARS and University of Maryland (UMD) researchers, low pH was identified as a major factor contributing to incomplete degradation. Twelve (12) trench pits were installed upgradient of the biowall in January 2020 in accordance with an approved Remedy Enhancement workplan (BMT, 2019). The trench pits are located across the highest concentration areas of the TCE plume. As shown on Figure 4, four (4) trench pits were over excavated due to sidewall instability. Upgradient trench pits were filled with a 50/50 mixture of crushed limestone and class A biosolids, and 1.5% biochar by volume.

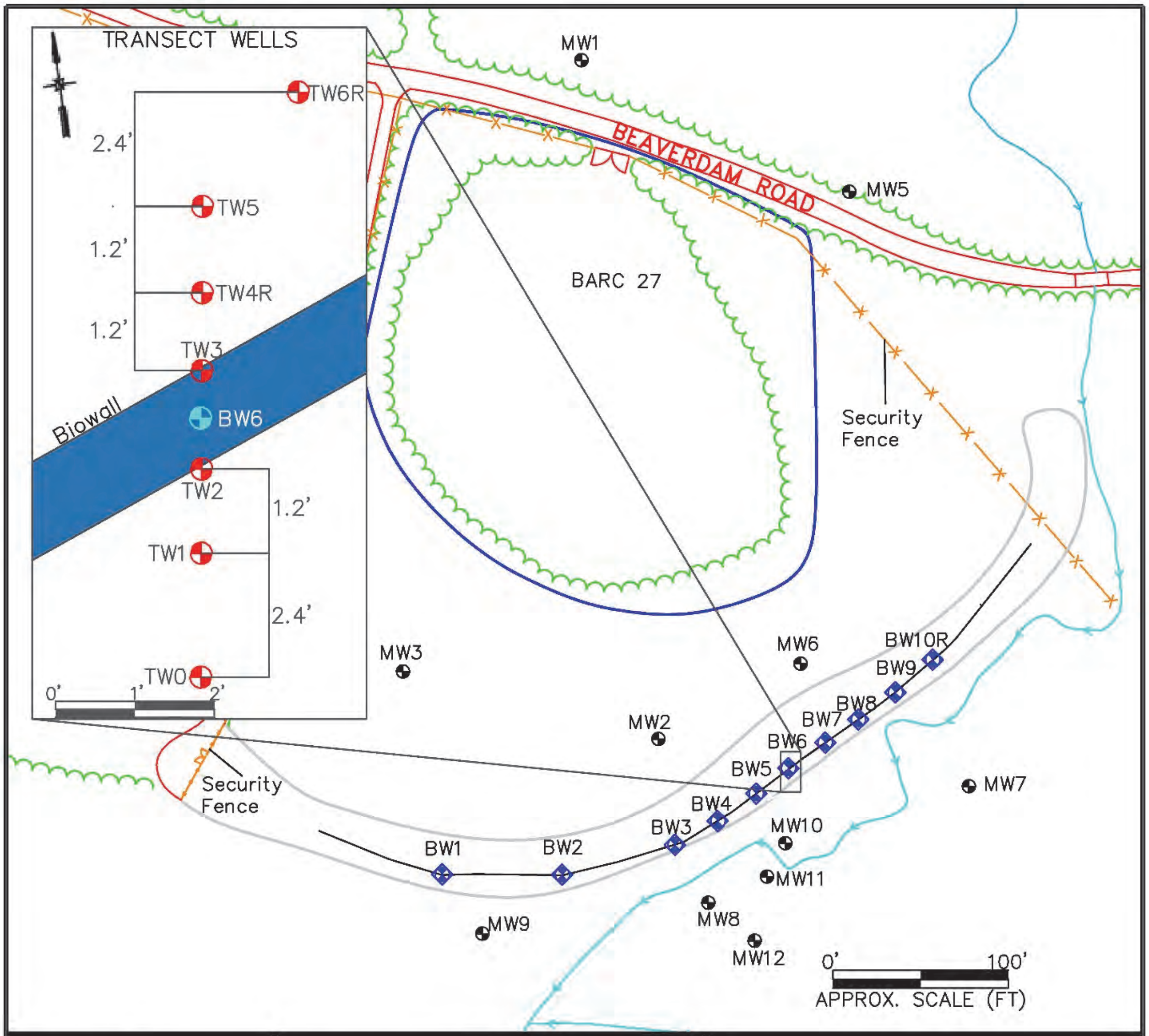
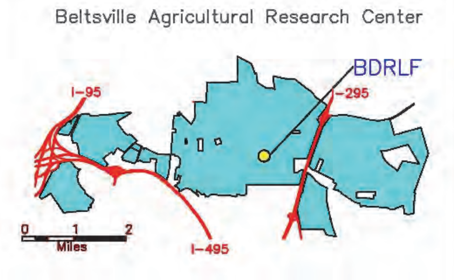


FIGURE 2

BARC 27:
Beaverdam Road Landfill
Transect Well Location
Map



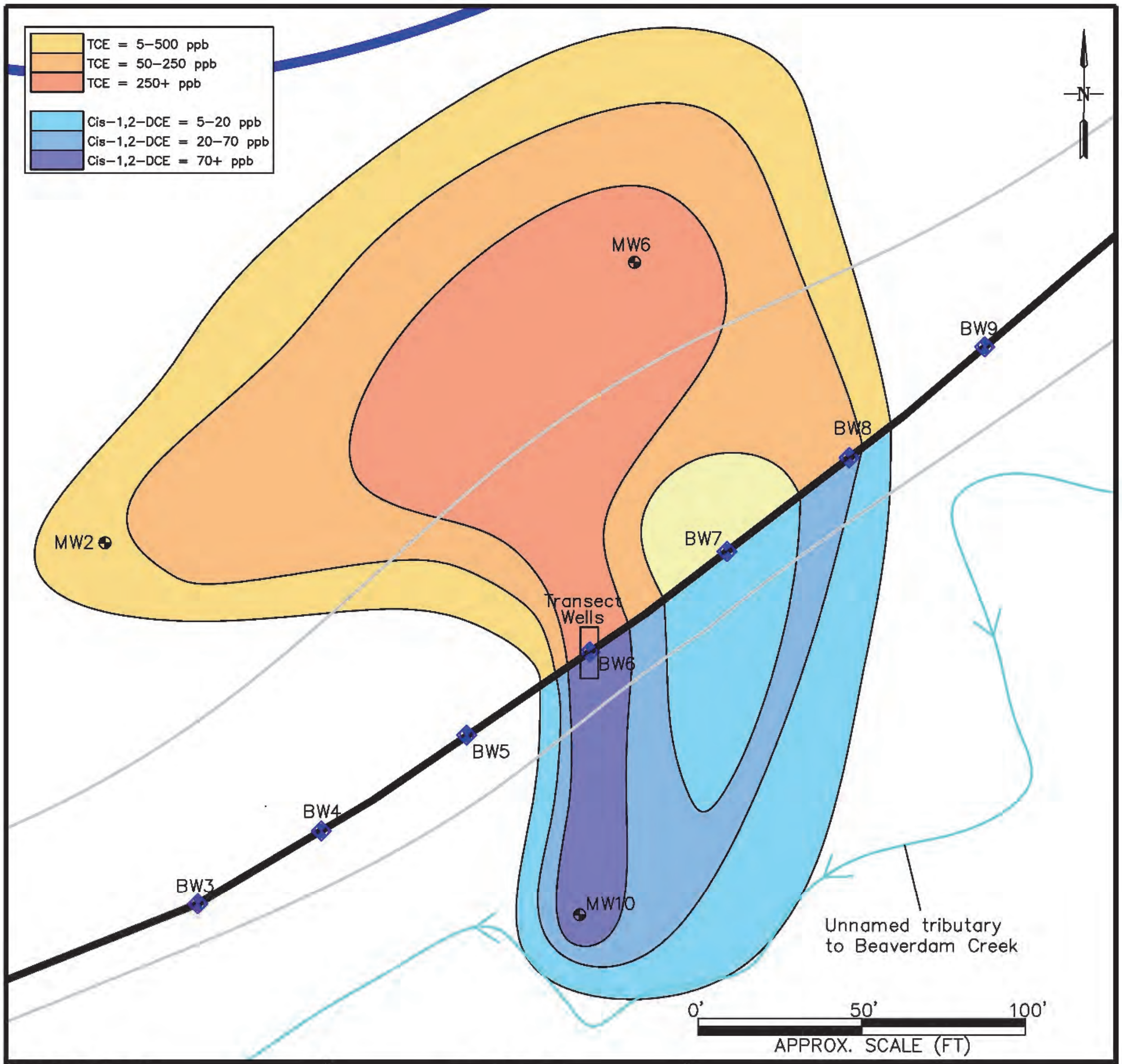


FIGURE 3

BARC 27:
Beaverdam Road Landfill
CAH Groundwater Plume
Figure

BMT

LEGEND

- ◯ Biowall Clearing Outline
- Treeline
- Stream
- Biowall
- ● RI Monitoring Well
- ◆ Biowall Monitoring Well

*Plume dimensions and extents are estimated from semi–annual sampling data sets prior to 2019

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The mixture was formulated to increase the ambient pH of influent groundwater and to provide an adequate reservoir or beneficial microbes. Fill material was placed within each trench pit from a depth of approximately 13 – 15 feet below ground surface (bgs) to approximately 4 feet bgs and then backfilled with native material to surface. The pits have been allowed to hydrate and return to an anaerobic condition prior to the injection of the microbial solution. The location of the existing upgradient trench pits in relation to the biowall is presented in Figure 4.

Twenty-four (24) microbial injection piezometer wells were installed within the upgradient trench pits in June 2020 in accordance with an approved workplan (BMT, 2020c). Two (2) microbial injection wells were installed in each upgradient trench pit. Each microbial injection well was constructed from 1” inside diameter (ID) PVC was screened through the saturated portion of trench pits. The location of the injection piezometers within the upgradient trench pits are shown in Figures 5 and 6.

The WBC-2 microbial consortium, commercially available as the KB-1 microbial solution from SiREM Labs was injected into the trench pits in September 2020 according to manufacturer recommendations. Trench Pits 2-6 received one (1) liter of solution with 500 ml being injected into each piezometer. Trench Pits 1 and 7-8 received 600 ml of solution per pit. Trench Pits 9-11 each received 500 ml of solution per pit. No solution was injected into Trench Pit 12. KB-1 was injected first into Trench Pits 2-6 then 1 and 7-11 in sequential order. Injection volume calculations developed in the program did not take into account the volume of the ¼” ID injection tubing so there was no solution to inject remaining to inject into Trench Pit 12. Trench Pit 12 was dry at the time of installation. No gravely sand was present in the soil at during installation which is a typical indicator of the water and contaminant bearing zone. Based on this, Trench Pit 12 is considered the least consequential upgradient Trench Pit.

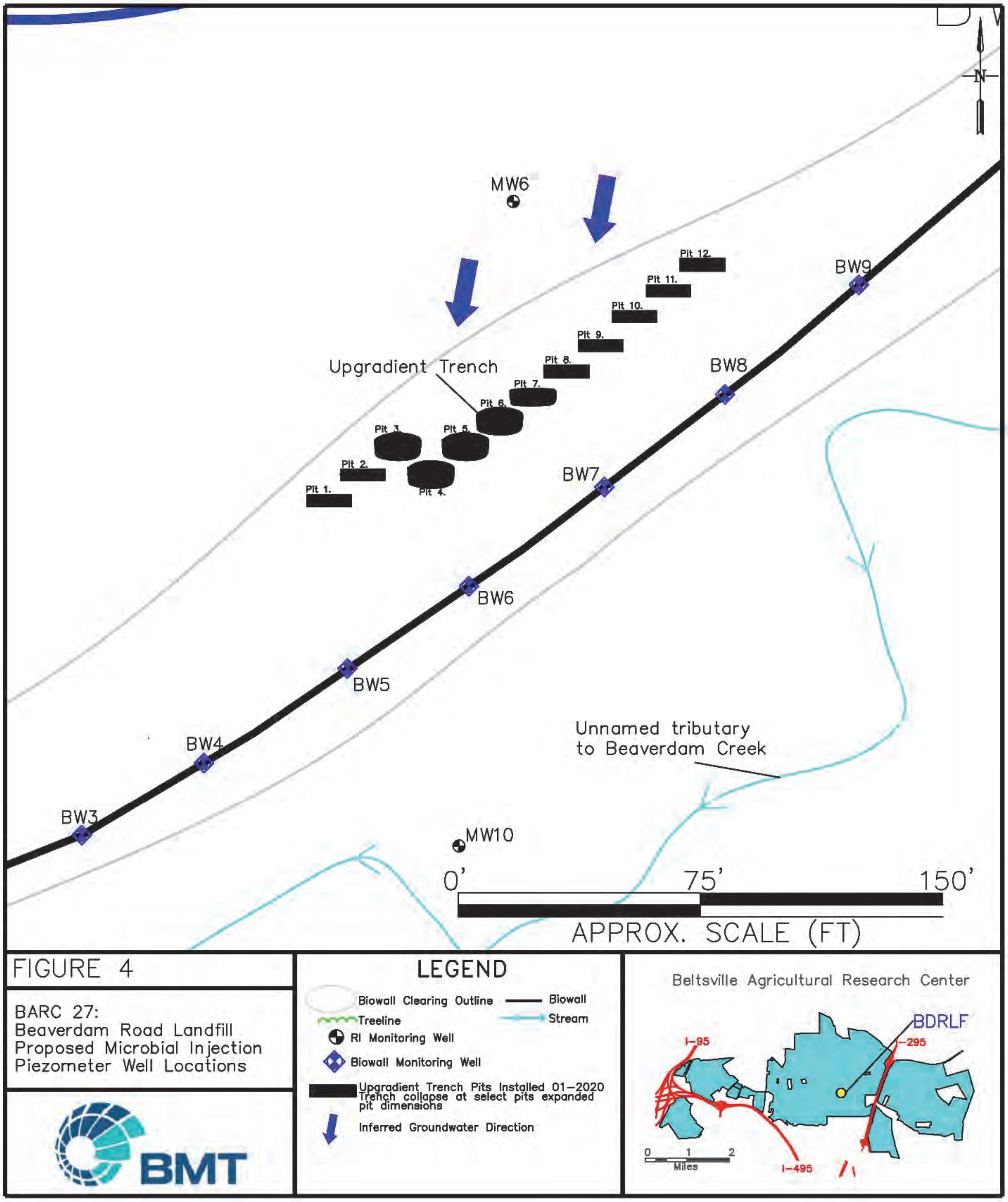

FIGURE 4

BARC 27:
Beaverdam Road Landfill
Proposed Microbial Injection
Piezometer Well Locations

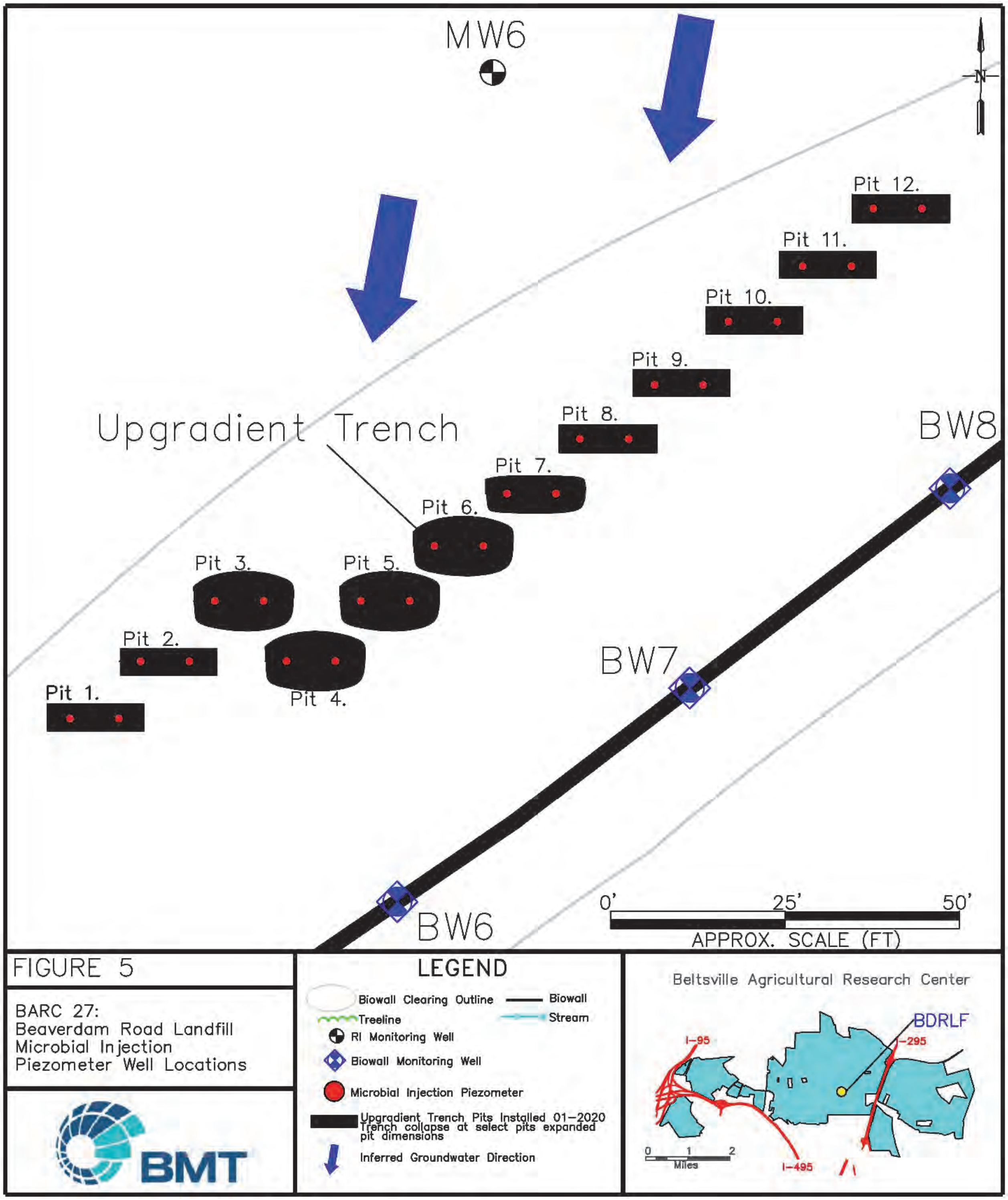

FIGURE 5

BARC 27:
Beaverdam Road Landfill
Microbial Injection
Piezometer Well Locations

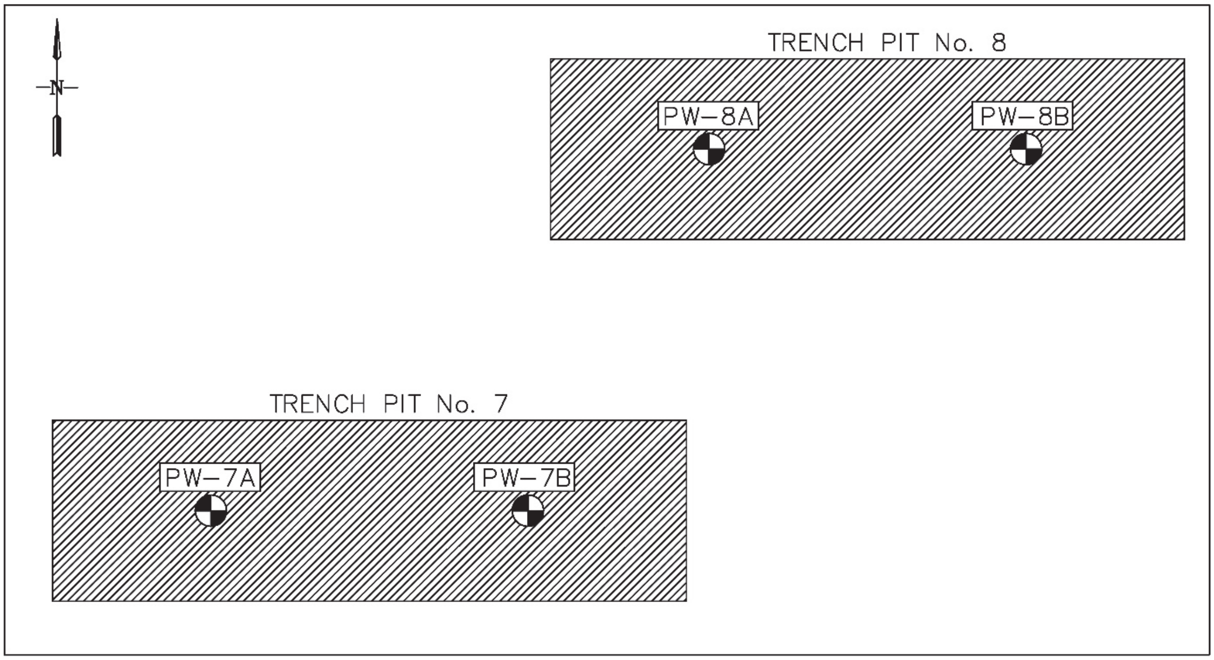

Figure 6. Microbial Injection Wells Numbering Scheme

2. BDRLF PERFORMANCE ASSESSMENT ACTIVITIES

The completed activities included monitoring of conditions at the injection piezometers installed within the upgradient trenches as well as onsite biowall and transect wells. Following collection of water quality parameters, all selected wells and piezometers were sampled in accordance with the BARC 27 Performance Monitoring Work Plan (BMT, 2021a).

2.1. Groundwater and Surface Water Physical Parameters

Physical parameters measured from the biowall and transect wells during this quarterly monitoring period include pH, Oxidation-Reduction Potential (ORP), dissolved oxygen (DO), salinity, turbidity, temperature, and specific conductivity. The same physical parameters also were measured from surface water locations. Downhole DO and downhole temperature only were measured from the RI wells during this quarterly monitoring period. These parameters were measured using a Horiba® U-53 Multi-parameter Water Quality Meter and a YSI Pro optical dissolved oxygen (ODO) meter.

2.2. Groundwater Sampling

Groundwater samples were collected from twelve (12) upgradient trench pit piezometers (PZ-1B – 12B) and monitoring wells MW6, TW5, BW6, TW0, and MW10. The upgradient trench pit piezometers were sampled to assess conditions within the upgradient trench pits. The selected monitoring wells are located within a transect that runs roughly parallel with the primary direction of groundwater and dissolved phase contaminant flow at the site. Samples were collected using low flow protocols with the exception of PZ-4B and PZ-5B which due to low recharge rates were sampled via a fixed volume purge process. Wells were sampled for the following parameters.

- **Piezometers PZ-1B – 12B:** Volatile organic compounds (VOCs), and total organic carbon (TOC).
- **Piezometers PZ-1B – 6B:** Microbial census for common dechlorinating bacteria.
- **MW6, TW5, BW6, TW0, MW10 & PW4B:** VOCs & Compound specific isotope analysis (CSIA) for stable isotope ratios of carbon in TCE.
- **Piezometers PZ-4B & 5B:** SiREM laboratories Gene-Trac® Dehalococcoides Assay.

Microbial Census is conducted using quantitative polymerase chain reaction (qPCR) to quantify specific microorganisms within groundwater. For the BDRLF Performance Assessment, the microbial census was performed on Dehalococcoides (DHC) function genes.

CSIA is an analytical method that measures the ratio of stable isotopes (the ratio of 13C to 12C is used for VOCs) of a contaminant. CSIA results can provide conclusive proof of contaminant degradation, insight into degradation mechanisms, rate estimations, and contaminant source distinction/delineation.

(Microbial Insights, 2020). CSIA analysis tracked TCE as this COC is present throughout the site. CSIA analysis cannot be completed where the target analyte is below detection limit.

SiREM laboratories Gene-Trac® Dehalococcoides Assay is an analysis performed by the supplier of the microbial consortium that was injected into the upgradient trench pits in August 2020 (Section 1.2). It is used to determine how successful the microbial injection program was by comparing measured populations of key microbes against design parameters from the injection program.

Analytical parameters sampled for at each monitoring location are shown in Table 1.

Table 1. Monitoring Event Activity Summary

Analyses		Sampling Methodology
Monitoring Location	**Laboratory Analyzed**	
PZ-1B – PZ-12B	Volatile Organic Compounds (VOCs) Total Organic Carbon (TOC)	Low-Flow Sampling
PZ-1B – PZ-6B	Dehalococcoides (DHC) Microbial Census	Low-Flow Sampling
MW6, PZ-4B, TW5, BW6, TW0, MW10	CSIA for TCE, DCE and VC	Low-Flow Sampling
PZ-4B and PZ-5B	SiREM Gene-Trac® Dehalococcoides Assay	Fixed volume purge

Notes:
BW = Biowall Well
MW = Monitoring Well
PZ = Piezometer Well
TW = Transect Well

3. BARC 27 PERFORMANCR ASSESSMENT RESULTS

The results of the performance assessment were compared to the Primary and Secondary PALs defined in the DQO Matrix (BMT, 2021a). Sample results are organized by main parameter in the following subsections, The Primary and Secondary PALs have been identified as the applicable EPA Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) and Regional Screening Levels (RSLs) for groundwater. PALS are presented in Appendix A.

3.1. Upgradient Trench Pit Water Quality Parameters

Microbial injection piezometers from each upgradient trench pit were sampled using EPA low-flow protocols. Water quality parameters measured just prior to sample collection are presented in Table 2.

Table 2. Water Quality Parameters from Upgradient Trench Pits

Well	Temp (ºC)	pH	ORP (mV)	COND (mS/cm)	TURB (NTU)	DO (mg/L)	SAL (ppt)
PZ-1B	22.08	7.52	-230	8.91	272	0.0	5.0
PZ-2B	20.01	7.52	218	7.05	46.9	0.0	3.9
PZ-3B	22.39	7.52	-168	6.65	43.7	0.0	3.6
PZ-4B	20.53	7.28	-168	4.91	335	0.0	2.6
PZ-5B	21.02	5.17	-56	4.66	186	0.0	2.5
PZ-6B	20.39	7.56	-218	6.35	69.9	0.0	3.6
PZ-7B	20.63	7.75	-214	3.07	82.4	0.0	1.6
PZ-8B	24.02	6.98	-143	3.27	172	0.0	1.7
PZ-9B	22.27	7.09	-172	2.67	291	0.0	1.4
PZ-10B	22.40	7.13	-165	7.48	365	0.0	4.1
PZ-11B	19.84	7.17	-123	3.70	10.4	3.5	1.9
PZ-12B	21.25	6.09	5	0.58	210	7.0	0.3

Notes:
ºC = Degrees Celsius
ORP = Oxidation Reduction Potential
COND = Conductivity in millisiemens per centimeter
TURB = Turbidity in nephelometric turbidity units (NTUs)
DO = Dissolved Oxygen
SAL = Salinity in parts per thousand (ppt)

Average groundwater pH within all upgradient trench pits was 7.07. Relatively low pH values were observed in PZ-5B (5.17) and PZ-12B (6.09). Low p H values in these specific microbial injection piezometers may be related to high groundwater flux in PZ-5B and very low groundwater flux in PZ-12B. The anomalous pH reading from PZ-5B have potential effects regarding the overall health of microbial populations within this portion of upgradient trench pit 5. Average pH values within the upgradient trench pit are well above the average pH values measured within MW6 of 4.59. MW6 is located directly upgradient of the upgradient trench pit piezometers. Groundwater measurements collected from MW6 are considered indicative of the condition of groundwater flowing into the upgradient trench pits.

Temperature average 21.4 degrees Celsius (70.5 degrees Fahrenheit) across the upgradient trench pits. PZ-1B – 10B were anoxic at the time of sampling while aerobic conditions were observed in PZ-11B (3.5 mg/L DO) and PZ-12B (7.0 mg/L DO).

3.2. VOCs

TCE was detected at MW6 at a concentration of 250 µg/L in MW6. The MW6 well was intentionally installed to track the center of the TCE plume in 2007 and continues to be have the highest TCE concentrations observed at the BDRLF AOC. MW6 has consistently produced the highest TCE concentrations within the RI well network at the site since installation. TCE was detected in the samples collected form microbial injection piezometers PW5B, 10B, 11B and 12B at concentrations ranging from 5.3 to 37 µg/L. TCE was not detected in any transect well, biowall well or monitoring well located hydraulically downgradient of the upgradient trench pits indicating that complete dechlorination of TCE is occurring upgradient of the biowall. TCE detections within the upgradient trench pits are likely indicative of sorption to organic material.

Within the upgradient trench pits and the biowall, and by design, TCE degrades to cis-1,2-DCE. Cis-1,2-DCE was detected microbial injection piezometers PZ-5B, 8B, 9B, 10B, 11B, and 12B at concentrations ranging from 5.4 to 26 µg/L. Cis-1,2-DCE was not detected in any transect well or biowall well but was detected in RI monitoring well MW10, which is located 80 feet downgradient of the biowall. The lack of detections for cis-1,2-DCE within TW5, BW6, indicates that complete dechlorination or sorption of this contaminant is likely occurring within the biowall.

Within the upgradient trench pits and the biowall, TCE degrades to VC. VC was detected in microbial injection piezometers PZ-5B, 6B, and 9B at concentrations ranging from 2.2 to 4.5 µg/L. VC was also detected in TW0 at a concentration of 3.6 µg/L and in MW10 at a concentration of 8.5 µg/L. VC was not detected in TW5 or BW6 which is indicative of either complete dechlorination of TCE to ethene or significant sorption of chlorinated ethenes occurring within the upgradient trench pits.

The TCE, cis-1,2-DCE and VC results from the microbial injection piezometers located within the pits are shown in Table 3. TCE, cis-1,2-DCE and VC were all detected in microbial injection piezometer PZ-5B, which is located within the TCE plume that extended from MW6 to the biowall. TCE was also detected in microbial injection piezometers PZ-10B, 11B, and 12B which area all located east of the TCE plume and may be reflective of significantly slower groundwater velocity in the formation where these upgradient trench pits were installed.

No microbial solution was injected into upgradient trench pit 12 during the microbial injection program (Section 1.2). Analytical results are shown in Appendix B.

Table 3. VOC Results in Microbial Injection Piezometers

Parameter	PCE	TCE	CIS-1,2-DCE	VC
MCL	5	5	70	2
BA27-PZ1B	3.0U	3.0U	3.0U	2.0U
BA27-PZ2B	3.0U	3.0U	3.0U	2.0U
BA27-PZ-3B	3.0U	3.0U	3.0U	2.0U
BA27-PZ-4B	3.0U	3.0U	3.0U	2.0U
BA27-PZ-5B	1.5U	**35**	**26**	**4.5**
BA27-PZ-6B	3.0U	3.0U	3.0U	**2.2**
BA27-PZ-7B	3.0U	3.0U	3.0U	2.0U
BA27-PZ-8B	3.0U	3.0U	**5.4**	2.0U
BA27-PZ-9B	3.0U	3.0U	**17**	**3.3**
BA27-PZ-10B	3.0U	**5.3**	**8.7**	2.0U
BA27-PZ-11B	3.0U	**12**	**6.9**	2.0U
BA27-PZ-12B	0.3U	**37**	**9.8**	0.2U
TW0-GW	3.0U	3.0U	3.0U	**3.6**
TW5-GW	3.0U	3.0U	3.0U	2.0U
BW6-GW	3.0U	3.0U	3.0U	2.0U
BA27-MW6	3.0U	**250**	**12**	0.4U
BA27-MW10	3.0U	3.0U	**20**	**8.5**

Notes:
Analyte Detections in Bold
MCL Exceedances are shaded
Concentrations are in µg/L.

3.3. Total Organic Carbon

The TOC content within the upgradient trench pits an important factor that influences contaminant migration (e.g., sorption, solute retardation) and can be used to determine the amount of carbon that may be available to serve as a primary substrate electron donor for microbial metabolism. Organic compounds can also act as electron acceptors during anaerobic metabolism. High TOC concentrations indicate that there is an increased potential for chlorinated aliphatic hydrocarbons (CAHs) to adsorb to organic material within the biowall. CAH adsorption will initially affect contaminant concentrations; however, it is expected that equilibrium was reached only a few months after installation (AFCEE, 2008). TOC concentrations greater than 20 mg/L can serve as a primary substrate for microbial metabolism and may drive CAH degradation through microbially mediated reductive dechlorination.

TOC was detected in microbial injection piezometers at concentrations ranging from 3.7 mg/L to 4,700 mg/L. The TOC concentrations detected at PZ-5B (4,700 mg/L) were almost an order of magnitude greater than TOC concentrations in any other upgradient trench pit. PZ-5B also had pH value (5.17) that was far below the upgradient trench average value of 7.07. TOC was detected in all upgradient trench pits at concentrations greater than 20 mg/L except for PZ-12B. PZ-12B is the eastern most upgradient trench pit and is located furthest from the center of the TCE plume. TOC concentrations in the upgradient trench pit is shown in Table 4.

Table 4. Microbial Injection Piezometer TOC Results

Parameter	**PZ-1B**	**PZ-2B**	**PZ-3B**	**PZ-4B**	**PZ-5B**	**PZ-6B**
TOC	570	360	300	240	4,700	420
Parameter	**PZ-7B**	**PZ-8B**	**PZ-9B**	**PZ-10B**	**PZ-11B**	**PZ-12B**
TOC	160	120	110	410	170	3.7

The cause of the elevated TCE concentration within PZ-5B relative to other upgradient trench pits is unknown but may be related to high rates of groundwater flux causing a more rapid breakdown of organic matter within this particular trench pit.

For comparison, average TOC concentrations within the BDRLF biowall ranged from 33 to 163 mg/L over eight (8) years of continuous monitoring. TOC was detected at a peak concentration of 350 mg/L within the biowall. Average TOC concentrations within the upgradient trench pits were higher than average TOC concentrations within the biowall and may be related to different sources of organic matter and different compost fractions used in the fill material. TOC concentrations within PZ-1B through PZ-11B are well above 20 mg/L. Analytical results are shown in Appendix B.

3.4. TCE CSIA Results

Samples from six (6) monitoring wells located on a transect extending from MW6 to MW10 were submitted for CSIA analysis. CSIA measures changes in the isotope ratios of carbon-12 and carbon 13 ($^{13}C/^{12}C$) within chlorinated ethenes to estimate overall biotic degradation rates of contaminants within the system. Within the transect that of wells that were sampled (MW6, PZ-4B, TW5, BW6, TW0, and MW10), TCE was detected only within MW6.

Based on previous groundwater delineation sampling, MW6 is located adjacent to the source area for the TCE plume at the BDRLF. This means that the CSIA value for TCE measured at MW6 is representative as a baseline value for this compound at the BDRLF. The $^{13}C/^{12}C$ data for BDRLF is presented as a deviation from an internationally accepted standard of 0.01118 for the $^{13}C/^{12}C$ ratio which is presented as $\delta^{13}C$. $\delta^{13}C$ is calculated using the following equation:

$$\delta_x = 1000 \times \frac{R_x - R_{Std}}{R_{Std}}$$

Where:

- R_x is the $^{13}C/^{12}C$ ratio measured in the sample
- R_{std} is the $^{13}C/^{12}C$ reference standard of 0.01118

For MW6, this value is -21.9, which means that the $\delta^{13}C$ for TCE is -21.9 per thousand (or mil) or 2.19 percent lower than the internationally agreed-upon standard of 0.01118 (R_{std}). Future CSIA measurements collected at locations hydraulically downgradient to MW6 can be compared to this value to estimate the degree of dechlorination within the system.

The fact that TCE was not detected in any downgradient wells along this transect is indicative that TCE is either fully dechlorinating to daughter compounds within the upgradient trench pits and the biowall, significant sorption of chlorinated compounds is occurring within these features or a combination of these factors. CSIA Results are shown in Appendix C.

3.5. Microbial Census Results

The target concentration for the microbial consortium injection that was performed in August 2020 was 10^7 cells per liter of saturated ground. This is equivalent to 10^4 cells per milliliter (cells/ml) within the formation. For microbial census analysis, a DHC concentration of 10^4 cells/ml is considered a benchmark to identify sites where reductive dechlorination will yield a generally useful biodegradation rate (Lu et al., 2006). A DHC concentration range of 10^1 to 10^4 cells/ml may still support complete reductive dechlorination of TCE if genes for vinyl chloride reductase (VCR) are also present (Lu et al., 2006).

Microbial census results include the total concentration of DHC within groundwater as well as the following genes:

- **TceA:** This gene encodes an enzyme responsible for reductive dechlorination of TCE to cis-1,2-DCE in some strains of *Dehalococcoides*. The absence of this gene does not mean that reductive dechlorination of TCE to cis-1,2-DCE will not occur at the site.
- **VcrA:** This gene encodes the vinyl chloride reductase enzyme responsible for reductive dechlorination of cis-1,2-DCE and vinyl chloride. This presence of this gene indicates the potential for reductive dechlorination of DCE isomers and/or VC to ethene.
- **BvcA:** This gene encodes the vinyl chloride reductase enzyme responsible for reductive dechlorination of VC to ethene. The presence of bvcA genes indicates the potential for reductive dechlorination of VC to ethene, but the absence or low concentration of this gene does not preclude this process.

Results for the microbial census are shown in Table 5. DHC was detected at a concentration of $1.9*10^4$ cells/ml in PZ-4B. Concentrations range from 8.4×10^2 to 5.9×10^3 cells/ml in the other microbial injection piezometers. VCR genes were detected in all microbial injection piezometers at concentrations greater than 10^1 cells/ml. TceA and bvcA genes were detected at concentrations well below 10^4 cells/ml in all microbial injection piezometers.

Based on the results of the VOC analysis, significant dechlorination of TCE, DCE isomers and VC are occurring with the upgradient trench pits. Ethene was detected at a concentration of 23 ug/L in TW5, which is located upgradient of the biowall and downgradient of the upgradient trench pits. The presence of ethene in groundwater downgradient of the upgradient trench pits is indicative that complete reductive dechlorination of TCE to ethene is occurring within the upgradient trench pits.

Table 5. Microbial Census Results

Parameters	DHC	tceA	vcrA	bvcA
PZ-1B	1.1E+03	2.50E+00 J	3.20E+01	6.40E+00 J
PZ-2B	8.4E+02	3.90E+00	3.67E+01	8.50E+00
PZ-3B	2.5E+03	6.50E+00	1.73E+02	1.62E+01
PZ-4B	**1.9E+04**	7.51E+01	2.13E+03	1.60E+02
PZ-5B	1.9E+03	1.51E+02	3.51E+01	2.60E+00 J
PZ-6B	5.3E+03	1.94E+02	2.75E+02	1.58E+01

NOTES:
Concentrations are in cells/mL
*10^4 cells/mL is the target for significantly biologically mediated dechlorination
Concentrations greater than 10^4 cells/ml are bolded and shaded

DHC = Dehalococcoides Total Cells
tceA = tceA Reductase Genes
bvcA = BAV1 Vinyl Chloride Reductase Genes
vcrA = Vinyl Chloride Reductase Genes

Laboratory Data Qualifiers
(stand to the left of dash, or alone. e.g. "U-D", or "N")
J. Estimated gene copies below PQL but above LQL

Limited microbial sampling was conducted in 2017 within the BDRLF biowall. Groundwater was collected from an unscreened piezometer located adjacent to BW6 and submitted for a DHC census via qPCR. In addition Bio-Trap® samplers were placed within BW6 and MW6 for a period of 71 days and were submitted for DHC census via qPCR. Bio-Trap® samplers are passive sampling tools designed to collect microbes over time for the purpose of better understanding biodegradation potential. The sampler contains beads that measure 2-4 mm in diameter, engineered from Nomex® and powdered activated carbon (PAC) (BMT, 2017).

In addition to groundwater samples, a sample of biowall material was collected adjacent to BW6 using a Geoprobe® direct-push methods and submitted for a DHC census. The results of the 2017 microbial sampling are presented in Table 6. Bio-Trap® results were reported as cells per bead (cell/bd) which are roughly equivalent to measuring cells/ml. Bio-Trap® samplers were placed in screened monitoring wells that had been frequently purged during based groundwater sampling activities and did not have the same volume of suspended material as groundwater collected from the unscreened piezometer located next to BW6.

Table 6. 2017 Biowall Microbial Census Results

Parameters	DHC	tceA	vcrA	bvcA
Biowall Material	5.5E+05 cells/g	4.2E+05 cells/g	7.7E+03 cells/g	ND
Biowall GW	1.2E+04 cells/ml	4.5E+03 cells/ml	9.6E+03 cells/ml	ND
BW6	9.1E+02 cells/bd	8.7+02 cells/bd	5E+02 cells/bd	ND
MW6	1.9E+01 cells/bd	ND	ND	ND

NOTES:
Cells/g = cells per gram of material
Cells/ml = cells per milliliter of solution
Cells/bd = cells per bead of material on Bio-Trap® sampler
ND = not detected above method detection limits

DHC genes including tceA and vcrA genes were detected in the biowall at sufficient concentrations to support the full reductive dechlorination of TCE. Concentrations within the biowall, from the unscreened piezometer were equivalent to concentrations detected within the upgradient trench pits. DHC concentrations within actual biowall were fairly high as well. Microbial census results are shown in Appendix C.

3.6. SiREM Laboratories Gene-Trac® Results

In addition to the microbial census described in section 3.4, microbial analysis was performed on PZ-4B and PZ-5B on September 17, 2021. This analysis was performed by SiREM laboratories which is the vendor that produces the WBC-2 microbial consortium that was injected into the upgradient trench pits in August of 2020 (Section 1.2). As part of this analysis, the following microbial populations were analyzed:

Dehalococcoides (DHC): The activities if this microbial genus is described in section 3.4

Dehalobacter (DHB): This gene is involved in the dechlorination of PCE and TCE to isomers of DCE. It is also involved in the following reduction pathways:

- PCE to TCE to cis-1,2-DCE
- 1,2-dichlorethane (1,2-DCA) to ethene
- 1,1-2,2-tetrachloroethane (1,1,2,2-PCA) to VC and ethene

The detection of Dhb cells in groundwater samples combined with the lack of detections for TCE, 1,1,1-TCA, 1,1-DCA indicates evidence that there are sufficient microbial populations to support complete dechlorination of the chlorinated ethenes present at the site.

Dehalogenimonas (DHGM): This is a genus of anaerobic bacteria that are relatives of the genus DHC. Dechlorination pathways associated to DHGM microbial populations include the following reduction pathways:

- 1,1,2-trichloethane (1,1,2-TCA) to VC
- 1,1,2,2-PCA to cis-1,2-DCE and trans-1,2-DCE
- DCE isomers to VC
- VC to ethene

Concentrations greater than 10^6 cells/L or 10^3 cells/ml are considered positive which indicates evidence for the complete dechlorination of a compound.

Results from the Gene-Trac analysis are presented in table 7. High populations of DHC, DHB and DHGM microbes were detected in both PZ-4B and PZ-5B that are supportive of the potential for full reductive dechlorination to occur within these two upgradient trench pits. These results also show that the currently dominating dechlorinating bacterial populations are those that were directly applied at the site, rather than naturally occurring populations.

Table 7. Gene-Trac® Analysis Results

Parameters	PZ-4B	PZ-5B
DHC Total	**5.E+04**	**1.E+04**
tceA	5.E+02	**1.E+04**
vcrA	7.E+03	6.E+02
bavA	1.E+03	1.E+02
DHB Total	**1.E+04**	**1.E+04**
DHGM Total	**5.E+03**	**5.E+03**

NOTES:
Concentrations are in cells/mL

For DHC, 10^4 cells/mL is the target for significant biologically mediated dechlorination
Concentrations greater than 10^4 cells/ml are bolded and shaded

For DHB, 10^3 cells/ml is the target for significant biologically mediate dechlorination

DHC = Dehalococcoides Total Cells
tceA = tceA Reductase Genes
bvcA = BAV1 Vinyl Chloride Reductase Genes
vcrA = Vinyl Chloride Reductase Genes

Of particular note are the differences in the concentration of DHC microbes, including the concentration of tceA, vcrA, and bvcA genes within PZ-5B between samples collected in July and September of 2021. Specifically, DHC and tceA genes were detected at far higher concentrations within PZ-5B in September than in July.

Differences in observed DHC concentrations in the same piezometer between summer and September may be related to seasonal variation or differences in sampling technique. Samples collected in July were collected using a peristaltic pump while the samples collected from PZ-4B and PZ-5B in September were collected using a ball and check valve (bncv). Groundwater parameters were not collected in September 2021, including pH. Collection of water quality parameters from microbial injection piezometers will be part of future editions of the performance monitoring plan. Low concentrations of tceA, vcrA, and bvcA in PZ-5B measured in July 2021 in comparison to concentrations measured in September may be related to sampling procedures or temporal changes groundwater quality between these sampling events. Additional sampling of the upgradient trench pits will be required verify this. SiREM Genetrac® results are shown in Appendix D.

4. CONCLUSIONS & RECOMMENDATIONS

4.1. Discussion

This performance enhancement assessment was conducted to determine the efficacy of the installation of the upgradient trench pits, the improvement of the groundwater conditions, and assessment of the biological reductive pathway. The trenches and treatment with the microbial blend was implemented at the BDRLF in 2020, thus this assessment provides data one year after the installation. The performance enhancements included the installation of twelve (12) trench pits located hydraulically upgradient of the BDRLF Biowall. A custom microbial consortium was injected in eleven (11) out of twelve (12) trench pits, and a solar system was installed to circulate heated water through six (6) out of the twelve (12) upgradient trench pits. The performance enhancement was designed and implemented to address deficiencies in the performance of the original biowall remedy, specifically incomplete dechlorination of TCE in groundwater. The upgradient trench pits and the biowall are also referred to as a combine remedy.

Based the results of the VOC sampling, the combined remedy has been successful at reducing the concentrations of dissolved phase COCs to concentrations at or below SDWA MCLs. TCE, cis-1,2-DCE and VC were not detected within TW5 and BW6. TW5 and BW6 are located immediately upgradient and within the biowall, respectively. Within TW0, which is located immediately downgradient of the biowall, VC was detected at a concentration of 3.6 ug/L, which is slightly above the MCL of 2 ug/L. Based on aquifer testing that was conducted in 2016, it takes approximately one-year for groundwater to flow from the upgradient trench pits to biowall (BMT, 2016). For this reason, CSIA could not be used to determine rates of biodegradation because the dataset shows complete degradation of TCE, and cis-1,2-DCE within the combined remedy.

TOC results and microbial sampling indicate that the environment within the upgradient trench pits contains sufficient populations of beneficial microbial populations and available substrate to support high rates of reductive dechlorination. The presence of DHB and DHGM microbes within trench pits 4 and 5 is indicative of an environment with the potential for full reductive dechlorination of TCE to ethene occurring within the upgradient trench pits alone. The microbial census results also support the finding that the dominant biological reductive processes are from the injected cells rather than naturally occurring cells.

The low groundwater pH reading measured in PZ-5B may be related to the high relative TOC and TCE, cis-1,2-DCE and VC concentrations measured in the same microbial injection piezometer. Low pH will negatively impact the activity of microbial communities. If low pH conditions persist within upgradient trench pit 5, an injection of a pH buffering solution can be conducted through the microbial injection piezometers.

4.2. Recommendations

Based on the results of this performance enhancement assessment, the BDRLF Performance Monitoring Plan (PMP) (BMT, 2019) will be updated to incorporate sample collection from selected microbial injection piezometers within the upgradient trench pits. Specifically, microbial injection piezometers should be sampled for VOCs and dissolved gasses (methane, ethane, ethene). In addition, future CSIA analysis can be performed at selected microbial injection piezometer with detections for TCE (PZ-5B) to estimate potential rates of dechlorination within specific upgradient trench pits.

Based on the results of this assessment and of previous monitoring reports for the BDRLF, the performance of the combined remedy appears stable in regard to efficacy at dechlorinating TCE, cis-1,2-DCE and VC. If the efficacy of the combined remedy decreases in the future, targeted sampling for microbial populations and TOC can be conducted to determine the causes of these deficiencies.

Data collected in future sampling programs can be used to develop future enhancements should the overall performance of the combined remedy decrease in the future. Future performance enhancement assessment activities can include the installation of microbial injection piezometers within portions of the BDRLF biowall and the injection of custom microbial consortia within them or re-injection into the upgradient trench pits.

Assessments should continue, especially to track the presence of dechlorinating genes in the groundwater. Changes to these populations could indicate increased or decreased reductive potential, which could impact the long term efficacy of the biowall system.

5. REFERENCES

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APPENDIX A

CSIA Limits of Detection and Laboratory Quality Control Procedures

Appendix A

CSIA Limits of Detection, Quantitation and Reporting Units for Chlorinated Ethenes

Analysis	Method	Matrix	Parameter	LOD	LOQ	TAT	Reporting Units
^{13}C CSIA	^{13}C CSIA	water	Chlorinated ethenes, chlorinated ethanes, chloroform, CT and dichloromethane	1 ppb	3 ppb	14-21 days after receiving VOC data	δ^{13}C, VPDB
^{2}H CSIA	^{2}H CSIA	water	Chlorinated ethenes, chlorinated ethanes, chloroform, CT and dichloromethane	15 ppb	20 ppb	120 days after receiving VOC data	δ^{2}H, VSMOW
^{37}Cl CSIA	^{37}Cl CSIA	water	Chlorinated ethenes, chlorinated ethanes, chloroform, CT and dichloromethane	1 ppb	3 ppb	14-21 days after receiving VOC data	δ^{37}Cl, VSMOC

Appendix A
CSIA Limits of Detection, Quantitation and Reporting Units for Chlorinated Ethenes

Analysis	Matrix	Container	Quantity	Volume	Preservative	Hold Time
CSIA	water	40ml VOA	4 per isotope	40ml	4°C	24-48 hrs

Appendix A
CSIA Limits of Detection, Quantitation and Reporting Units for Chlorinated Ethenes

Method	Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action
CSIA	Calibration Verification	Standards run with every sample batch	Mean δ^2H values are within ± 10‰ of true value	Rerun assay / check reagents; recalibrate if necessary
CSIA	Method Blank	Sample run bracketed	< lower quantitation limit	flag data, determine cause, reanalyze if possible
CSIA	Sample Replicate	min 20% of samples in batch	Standard deviation of δ^2H values are within 10‰	Rerun sample if still unacceptable flag data

Appendix A
CSIA Limits of Detection, Quantitation and Reporting Units for Chlorinated Ethenes

Method	**Quality Control Check**	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**
CSIA	Initial Calibration	Primary – initial	Standard curve r^2 >0.95	Rerun standards; remake standards; perform maintenance
CSIA	Continuing Calibration Verification	Secondary – run with every sample batch	Mean δ^{13}C values are within ± 0.5‰ of true value	Rerun assay / check reagents; recalibrate if necessary
CSIA	Method Blank	Sample run bracketed	< lower quantitation limit	flag data, determine cause, reanalyze if possible
CSIA	Sample Replicate	min 20% of samples in batch	Standard deviation of δ^{13}C values are within 0.5‰	Rerun sample if still unacceptable flag data

APPENDIX B

Laboratory Analytical Data

Appendix B - VOC Analytical Results

Parameter	MCL	TW0-GW@10.5'		TW5-GW@12.5'	
		Mar-21	Jul-21	Mar-21	Jul-21
1,1,1,2-TETRACHLOROETHANE	N/A	0.31U	NA	0.31U	NA
1,1,1-TRICHLOROETHANE	200	0.36U	3.0U	0.36U	3.0U
1,1,2,2-TETRACHLOROETHANE	N/A	0.39U	3.0U	0.39U	3.0U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	N/A	0.36U	NA	0.36U	NA
1,1,2-TRICHLOROETHANE	5	0.33U	NA	0.33U	NA
1,1-DICHLOROETHANE	N/A	0.32U	3.0U	0.32U	3.0U
1,1-DICHLOROETHENE	7	0.48U	3.0U	0.48U	3.0U
1,1-DICHLOROPROPENE	N/A	0.3U	NA	0.3U	NA
1,2,3-TRICHLOROBENZENE	N/A	0.41U	NA	0.41U	NA
1,2,3-TRICHLOROPROPANE	N/A	0.51U	NA	0.51U	NA
1,2,4-TRICHLOROBENZENE	70	0.35U	3.0U	0.35U	3.0U
1,2,4-TRIMETHYLBENZENE	N/A	0.33U	NA	0.33U	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.2	0.71U	3.0U	0.71U	3.0U
1,2-DIBROMOETHANE	0.05	0.37U	2.0U	0.37U	2.0U
1,2-DICHLOROBENZENE	600	0.31U	2.0U	0.31U	2.0U
1,2-DICHLOROETHANE	5	0.41U	3.0U	0.41U	3.0U
1,2-DICHLOROPROPANE	5	0.33U	NA	0.33U	NA
1,3,5-TRIMETHYLBENZENE	N/A	0.34U	NA	0.34U	NA
1,3-DICHLOROBENZENE	N/A	0.32U	3.0U	0.32U	3.0U
1,3-DICHLOROPROPANE	N/A	0.36U	3.0U	0.36U	3.0U
1,4-DICHLOROBENZENE	75	0.3U	3.0U	0.3U	3.0U
1-CHLOROHEXANE	N/A	0.32U	NA	0.32U	NA
2,2-DICHLOROPROPANE	N/A	0.37U	NA	0.37U	NA
2-BUTANONE	N/A	3U	5.0U	3U	5.0U
2-CHLOROTOLUENE	N/A	0.33U	NA	0.33U	NA
2-HEXANONE	N/A	3U	4.0U	3U	4.0U
4-CHLOROTOLUENE	N/A	0.32U	3.0U	0.32U	3.0U
4-METHYL-2-PENTANONE	N/A	3U	5.0U	3U	5.0U
ACETONE	N/A	10U	7.0U	**8J**	**12**
BENZENE	5	0.3U	**3.3**	**0.31J**	3.0U
BROMOBENZENE	N/A	0.33U	3.0U	0.33U	3.0U
BROMOCHLOROMETHANE	N/A	0.3U	3.0U	0.3U	3.0U
BROMODICHLOROMETHANE	80	0.32U	2.0U	0.32U	2.0U
BROMOFORM	80	0.3U	10U	0.3U	10U
BROMOMETHANE	N/A	0.61U	3.0U	0.61U	3.0U
CARBON DISULFIDE	N/A	0.31U	3.0U	**0.36J**	3.0U
CARBON TETRACHLORIDE	5	0.38U	3.0U	0.38U	3.0U
CHLOROBENZENE	100	0.34U	3.0U	0.34U	3.0U
CHLOROETHANE	N/A	0.47U	2.0U	0.47U	2.0U
CHLOROFORM	80	0.31U	3.0U	0.31U	3.0U
CHLOROMETHANE	N/A	0.45U	2.0U	0.45U	2.0U
CIS-1,2-DICHLOROETHENE	70	**8J**	3.0U	**1.3J**	3.0U
CIS-1,3-DICHLOROPROPENE	N/A	0.3U	2.0U	0.3U	2.0U
DIBROMOCHLOROMETHANE	80	0.31U	2.0U	0.31U	2.0U
DIBROMOMETHANE	N/A	0.32U	3.0U	0.32U	3.0U
DICHLORODIFLUOROMETHANE	N/A	0.55U	2.0U	0.55U	2.0U
ETHANE	N/A	**7.4**	NA	2U	NA
ETHENE	N/A	**26**	NA	**23**	NA
ETHYLBENZENE	700	0.33U	4.0U	0.33U	4.0U
HEXACHLOROBUTADIENE	N/A	0.39U	NA	0.39U	NA
IODOMETHANE	N/A	1.4U	NA	1.4U	NA
ISOPROPYLBENZENE	N/A	0.32U	2.0U	0.32U	2.0U
M+P-XYLENE	10,000	0.55U	NA	0.55U	NA
METHANE	N/A	**9**	NA	**2**	NA
METHYL TERTIARY BUTYL ETHER	N/A	0.57U	2.0U	0.57U	2.0U
METHYLENE CHLORIDE	5	1U	3.0U	1U	3.0U
NAPHTHALENE	N/A	0.52U	NA	0.52U	NA
N-BUTYLBENZENE	N/A	0.3U	NA	0.3U	NA
N-PROPYLBENZENE	N/A	0.34U	NA	0.34U	NA
O-XYLENE	N/A	0.34U	**4.4**	0.34U	4.0U
P-ISOPROPYLTOLUENE	N/A	0.36U	NA	0.36U	NA
SEC-BUTYLBENZENE	N/A	0.32U	NA	0.32U	NA
STYRENE	100	0.3U	3.0U	0.3U	3.0U
SULFATE	N/A	NA	NA	NA	NA
TERT-BUTYLBENZENE	N/A	0.34U	NA	0.34U	NA
TETRACHLOROETHENE	5	0.35U	3.0U	0.35U	3.0U
TOLUENE	1000	0.34U	**15**	**0.63J**	2.0U
TRANS-1,2-DICHLOROETHENE	100	0.42U	3.0U	**0.52J**	3.0U
TRANS-1,3-DICHLOROPROPENE	N/A	0.3U	2.0U	0.3U	2.0U
TRICHLOROETHENE	5	0.5U	3.0U	0.5U	3.0U
TRICHLOROFLUOROMETHANE	N/A	0.38U	2.0U	0.38U	2.0U
VINYL ACETATE	N/A	0.8U	NA	0.8U	NA
VINYL CHLORIDE	2	**4.1J**	**3.6**	**0.9J**	2.0U

NOTES:

Analyte Detections in bold

MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Methane results are in mg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

Data Validation Qualifiers

(stand to the right of dash. e.g., "N-J", or "-B")

B. Not detected substantially above the level reported in laboratory or field blanks

D. Result detected in sample with laboratory dilution.

J. Estimated concentration.

L. Indicates the reported value may be biased low.

R. Unreliable result.
Analyte may or may

UJ. Not detected; quantitation limit may be inaccurate or imprecise.

Appendix B - VOC Analytical Results

Parameter	MCL	BW6-GW@12'		BA27-MW6-GW@16'		BA27-MW10-GW@11'	
		Dec-21	Jul-21	Jun-20	Jul-21	Jun-20	Jul-21
1,1,1,2-TETRACHLOROETHANE	N/A	0.31U	NA	0.31U	NA	0.31U	NA
1,1,1-TRICHLOROETHANE	200	0.36U	3.0U	0.36U	3.0U	0.36U	3.0U
1,1,2,2-TETRACHLOROETHANE	N/A	0.39U	3.0U	0.39U	3.0U	0.39U	3.0U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	N/A	0.36U	NA	0.36U	NA	0.36U	NA
1,1,2-TRICHLOROETHANE	5	0.33U	NA	0.33U	NA	0.33U	NA
1,1-DICHLOROETHANE	N/A	0.32U	3.0U	0.32U	3.0U	0.32U	3.0U
1,1-DICHLOROETHENE	7	0.48U	3.0U	0.48U	**0.45**	0.48U	3.0U
1,1-DICHLOROPROPENE	N/A	0.3U	NA	0.3U	NA	0.3U	NA
1,2,3-TRICHLOROBENZENE	N/A	0.41U	NA	0.41U	NA	0.41U	NA
1,2,3-TRICHLOROPROPANE	N/A	0.51U	NA	0.51U	NA	0.51U	NA
1,2,4-TRICHLOROBENZENE	70	0.35U	3.0U	0.35U	3.0U	0.35U	3.0U
1,2,4-TRIMETHYLBENZENE	N/A	0.33U	NA	0.33U	NA	0.33U	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.2	0.71U	3.0U	0.71U	3.0U	0.71U	3.0U
1,2-DIBROMOETHANE	0.05	0.37U	2.0U	0.37U	2.0U	0.37U	2.0U
1,2-DICHLOROBENZENE	600	0.31U	2.0U	0.31U	2.0U	0.31U	2.0U
1,2-DICHLOROETHANE	5	0.41U	3.0U	0.41U	3.0U	0.41U	3.0U
1,2-DICHLOROPROPANE	5	0.33U	NA	0.33U	NA	0.33U	NA
1,3,5-TRIMETHYLBENZENE	N/A	0.34U	NA	0.34U	NA	0.34U	NA
1,3-DICHLOROBENZENE	N/A	0.32U	3.0U	0.32U	3.0U	0.32U	3.0U
1,3-DICHLOROPROPANE	N/A	0.36U	3.0U	0.36U	3.0U	0.36U	3.0U
1,4-DICHLOROBENZENE	75	0.3U	3.0U	0.3U	3.0U	0.3U	3.0U
1-CHLOROHEXANE	N/A	0.32U	NA	0.32U	NA	0.32U	NA
2,2-DICHLOROPROPANE	N/A	0.37U	NA	0.37U	NA	0.37U	NA
2-BUTANONE	N/A	3U	5.0U	3U	5.0U	3U	5.0U
2-CHLOROTOLUENE	N/A	0.33U	NA	0.33U	NA	0.33U	NA
2-HEXANONE	N/A	3U	4.0U	3U	4.0U	3U	4.0U
4-CHLOROTOLUENE	N/A	0.32U	3.0U	0.32U	3.0U	0.32U	3.0U
4-METHYL-2-PENTANONE	N/A	3U	5.0U	3U	5.0U	3U	5.0U
ACETONE	N/A	5.4U	**8.7**	**8.1J**	**2**	5.4U	0.7U
BENZENE	5	0.3U	3.0U	3.0U	3.0U	0.3U	3.0U
BROMOBENZENE	N/A	0.33U	3.0U	3.0U	3.0U	0.33U	3.0U
BROMOCHLOROMETHANE	N/A	0.3U	3.0U	3.0U	3.0U	0.3U	3.0U
BROMODICHLOROMETHANE	80	0.32U	2.0U	2.0U	2.0U	0.32U	2.0U
BROMOFORM	80	0.3U	10U	10U	10U	0.3U	10U
BROMOMETHANE	N/A	0.61U	3.0U	3.0U	3.0U	0.61U	3.0U
CARBON DISULFIDE	N/A	0.31U-UJ	3.0U	3.0U	3.0U	0.31U-UJ	3.0U
CARBON TETRACHLORIDE	5	0.38U	3.0U	3.0U	3.0U	0.38U	3.0U
CHLOROBENZENE	100	0.34U	3.0U	3.0U	3.0U	0.34U	3.0U
CHLOROETHANE	N/A	0.47U	2.0U	2.0U	2.0U	0.47U	2.0U
CHLOROFORM	80	0.31U	3.0U	3.0U	3.0U	0.31U	3.0U
CHLOROMETHANE	N/A	0.45U	2.0U	2.0U	**0.46**	0.45U	2.0U
CIS-1,2-DICHLOROETHENE	70	**2**	3.0U	**36**	**12**	**13**	**20**
CIS-1,3-DICHLOROPROPENE	N/A	0.3U	2.0U	2.0U	2.0U	0.3U	2.0U
DIBROMOCHLOROMETHANE	80	0.31U	2.0U	2.0U	2.0U	0.31U	2.0U
DIBROMOMETHANE	N/A	0.32U	3.0U	3.0U	3.0U	0.32U	3.0U
DICHLORODIFLUOROMETHANE	N/A	0.55U	2.0U	2.0U	2.0U	0.55U	2.0U
ETHANE	N/A	**5.5**	NA	NA	NA	NA	NA
ETHENE	N/A	**4.5**	NA	NA	NA	NA	NA
ETHYLBENZENE	700	0.33U	4.0U	4.0U	4.0U	0.33U	4.0U
HEXACHLOROBUTADIENE	N/A	0.39U	NA	NA	NA	0.39U	NA
IODOMETHANE	N/A	1.4U	NA	NA	NA	1.4U	NA
ISOPROPYLBENZENE	N/A	0.32U	2.0U	2.0U	2.0U	0.32U	2.0U
M+P-XYLENE	10,000	0.55U	NA	NA	NA	0.55U	NA
METHANE	N/A	**13**	NA	NA	NA	NA	NA
METHYL TERTIARY BUTYL ETHER	N/A	0.57U	2.0U	2.0U	2.0U	0.57U	2.0U
METHYLENE CHLORIDE	5	1U	3.0U	3.0U	3.0U	1U	3.0U
NAPHTHALENE	N/A	0.52U	NA	NA	NA	0.52U	NA
N-BUTYLBENZENE	N/A	0.3U	NA	NA	NA	0.3U	NA
N-PROPYLBENZENE	N/A	0.34U	NA	NA	NA	0.34U	NA
O-XYLENE	N/A	0.34U	4.0U	4.0U	4.0U	0.34U	4.0U
P-ISOPROPYLTOLUENE	N/A	0.36U	NA	NA	NA	0.36U	NA
SEC-BUTYLBENZENE	N/A	0.32U	NA	NA	NA	0.32U	NA
STYRENE	100	0.3U	3.0U	3.0U	3.0U	0.3U	3.0U
SULFATE	N/A	0.3U	NA	NA	NA	0.3U	NA
TERT-BUTYLBENZENE	N/A	0.34U	NA	NA	NA	0.34U	NA
TETRACHLOROETHENE	5	0.35U	3.0U	3.0U	3.0U	0.35U	3.0U
TOLUENE	1000	0.34U	2.0U	2.0U	2.0U	0.34U	2.0U
TRANS-1,2-DICHLOROETHENE	100	0.42U	3.0U	3.0U	3.0U	0.42U	3.0U
TRANS-1,3-DICHLOROPROPENE	N/A	0.3U	2.0U	2.0U	2.0U	0.3U	2.0U
TRICHLOROETHENE	5	0.5U	3.0U	**73**	**250**	0.5U	3.0U
TRICHLOROFLUOROMETHANE	N/A	0.38U	2.0U	2.0U	2.0U	0.38U	2.0U
VINYL ACETATE	N/A	0.8UJ	NA	NA	NA	0.8UJ	NA
VINYL CHLORIDE	2	**0.96J**	2.0U	2.0U	0.4U	**3.2**	**8.5**

NOTES:

Analyte Detections in bold

MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Methane results are in mg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

Data Validation Qualifiers

(stand to the right of dash. e.g., "N-J", or "-B")

B. Not detected substantially above the level reported in laboratory or field blanks

D. Result detected in sample with laboratory dilution.

J. Estimated concentration.

L. Indicates the reported value may be biased low.

R. Unreliable result. Analyte may or may not be present in the sample.

UJ. Not detected; quantitation limit may be inaccurate or imprecise.

Appendix B - VOC Analytical Results

Parameter	MCL	BA27-PW1B@10'	BA27-PW2B@10'	BA27-PW3B@10'	4B-GW@12.5' (Sep-2020)	BA27-PW4B@10' (Jul-2021)
1,1,1,2-TETRACHLOROETHANE	N/A	NA	NA	NA	0.31U	NA
1,1,1-TRICHLOROETHANE	200	3.0U	3.0U	3.0U	0.36U	3.0U
1,1,2,2-TETRACHLOROETHANE	N/A	3.0U	3.0U	3.0U	0.39U	3.0U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	N/A	NA	NA	NA	0.36U	NA
1,1,2-TRICHLOROETHANE	5	NA	NA	NA	0.33U	NA
1,1-DICHLOROETHANE	N/A	3.0U	3.0U	3.0U	0.32U	3.0U
1,1-DICHLOROETHENE	7	3.0U	3.0U	3.0U	0.48U	3.0U
1,1-DICHLOROPROPENE	N/A	NA	NA	NA	0.3U	NA
1,2,3-TRICHLOROBENZENE	N/A	NA	NA	NA	0.41U	NA
1,2,3-TRICHLOROPROPANE	N/A	NA	NA	NA	0.51U	NA
1,2,4-TRICHLOROBENZENE	70	3.0U	3.0U	3.0U	0.35U	3.0U
1,2,4-TRIMETHYLBENZENE	N/A	NA	NA	NA	0.33U	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.2	3.0U	3.0U	3.0U	0.71U	3.0U
1,2-DIBROMOETHANE	0.05	2.0U	2.0U	2.0U	0.37U	2.0U
1,2-DICHLOROBENZENE	600	2.0U	2.0U	2.0U	0.31U	2.0U
1,2-DICHLOROETHANE	5	3.0U	3.0U	3.0U	0.41U	3.0U
1,2-DICHLOROPROPANE	5	NA	NA	NA	0.33U	NA
1,3,5-TRIMETHYLBENZENE	N/A	NA	NA	NA	0.34U	NA
1,3-DICHLOROBENZENE	N/A	3.0U	3.0U	3.0U	0.32U	3.0U
1,3-DICHLOROPROPANE	N/A	3.0U	3.0U	3.0U	0.36U	3.0U
1,4-DICHLOROBENZENE	75	3.0U	3.0U	3.0U	0.3U	3.0U
1-CHLOROHEXANE	N/A	NA	NA	NA	0.32U	NA
2,2-DICHLOROPROPANE	N/A	NA	NA	NA	0.37U	NA
2-BUTANONE	N/A	5.0U	**9.8**	5.0U	**9.8J**	5.0U
2-CHLOROTOLUENE	N/A	NA	NA	NA	0.33U	NA
2-HEXANONE	N/A	4.0U	4.0U	4.0U	3U	4.0U
4-CHLOROTOLUENE	N/A	3.0U	3.0U	3.0U	0.32U	3.0U
4-METHYL-2-PENTANONE	N/A	5.0U	5.0U	5.0U	3U	5.0U
ACETONE	N/A	**29**	**34**	**23**	**150J**	**18**
BENZENE	5	3.0U	3.0U	3.0U	0.3U	3.0U
BROMOBENZENE	N/A	3.0U	3.0U	3.0U	0.33U	3.0U
BROMOCHLOROMETHANE	N/A	3.0U	3.0U	3.0U	0.3U	3.0U
BROMODICHLOROMETHANE	80	2.0U	2.0U	2.0U	0.32U	2.0U
BROMOFORM	80	10U	10U	10U	0.3U	10U
BROMOMETHANE	N/A	3.0U	3.0U	3.0U	0.61U	3.0U
CARBON DISULFIDE	N/A	3.0U	3.0U	3.0U	0.31U	3.0U
CARBON TETRACHLORIDE	5	3.0U	3.0U	3.0U	0.38U	3.0U
CHLOROBENZENE	100	3.0U	3.0U	3.0U	0.34U	3.0U
CHLOROETHANE	N/A	2.0U	2.0U	2.0U	0.47U	2.0U
CHLOROFORM	80	3.0U	3.0U	3.0U	0.31U	3.0U
CHLOROMETHANE	N/A	2.0U	2.0U	2.0U	0.45U	2.0U
CIS-1,2-DICHLOROETHENE	70	3.0U	3.0U	3.0U	**25**	3.0U
CIS-1,3-DICHLOROPROPENE	N/A	2.0U	2.0U	2.0U	0.3U	2.0U
DIBROMOCHLOROMETHANE	80	2.0U	2.0U	2.0U	0.31U	2.0U
DIBROMOMETHANE	N/A	3.0U	3.0U	3.0U	0.32U	3.0U
DICHLORODIFLUOROMETHANE	N/A	2.0U	2.0U	2.0U	0.55U	2.0U
ETHANE	N/A	NA	NA	NA	2U	NA
ETHENE	N/A	NA	NA	NA	**2.6**	NA
ETHYLBENZENE	700	4.0U	4.0U	4.0U	0.33U	4.0U
HEXACHLOROBUTADIENE	N/A	NA	NA	NA	0.39U	NA
IODOMETHANE	N/A	NA	NA	NA	1.4U	NA
ISOPROPYLBENZENE	N/A	2.0U	2.0U	2.0U	0.32U	2.0U
M+P-XYLENE	10,000	NA	NA	NA	0.55U	NA
METHANE	N/A	NA	NA	NA	**1.3**	NA
METHYL TERTIARY BUTYL ETHER	N/A	2.0U	2.0U	2.0U	0.57U	2.0U
METHYLENE CHLORIDE	5	3.0U	3.0U	3.0U	1U	3.0U
NAPHTHALENE	N/A	NA	NA	NA	0.52U	NA
N-BUTYLBENZENE	N/A	NA	NA	NA	0.3U	NA
N-PROPYLBENZENE	N/A	NA	NA	NA	0.34U	NA
O-XYLENE	N/A	4.0U	4.0U	4.0U	0.34U	4.0U
P-ISOPROPYLTOLUENE	N/A	NA	NA	NA	0.36U	NA
SEC-BUTYLBENZENE	N/A	NA	NA	NA	0.32U	NA
STYRENE	100	3.0U	3.0U	3.0U	0.3U	3.0U
SULFATE	N/A	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	N/A	NA	NA	NA	0.34U	NA
TETRACHLOROETHENE	5	3.0U	3.0U	3.0U	0.35U	3.0U
TOLUENE	1000	2.0U	2.0U	2.0U	**0.74J**	2.0U
TRANS-1,2-DICHLOROETHENE	100	3.0U	3.0U	3.0U	0.42U	3.0U
TRANS-1,3-DICHLOROPROPENE	N/A	2.0U	2.0U	2.0U	0.3U	2.0U
TRICHLOROETHENE	5	3.0U	3.0U	3.0U	**0.78J**	3.0U
TRICHLOROFLUOROMETHANE	N/A	2.0U	2.0U	2.0U	0.38U	2.0U
VINYL ACETATE	N/A	NA	NA	NA	0.8UJ	NA
VINYL CHLORIDE	2	2.0U	2.0U	2.0U	**2.2** ▨	2.0U

NOTES:

Analyte Detections in bold

▨ MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Methane results are in mg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

Data Validation Qualifiers

(stand to the right of dash. e.g., "N-J", or "-B")

B. Not detected substantially above the level reported in laboratory or field blanks

D. Result detected in sample with laboratory dilution.

J. Estimated concentration.

L. Indicates the reported value may be biased low.

R. Unreliable result. Analyte may or may not be present in the sample.

UJ. Not detected; quantitation limit may be inaccurate or imprecise.

Appendix B - VOC Analytical Results

Parameter	MCL	BA27-PW5B@10'	BA27-PW6B@10'	BA27-PW7B@10'	BA27-PW8B@10'	BA27-PW9B@10'
1,1,1,2-TETRACHLOROETHANE	N/A	NA	NA	NA	NA	NA
1,1,1-TRICHLOROETHANE	200	1.5U	3.0U	3.0U	3.0U	3.0U
1,1,2,2-TETRACHLOROETHANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	N/A	NA	NA	NA	NA	NA
1,1,2-TRICHLOROETHANE	5	NA	NA	NA	NA	NA
1,1-DICHLOROETHANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
1,1-DICHLOROETHENE	7	1.5U	3.0U	3.0U	3.0U	3.0U
1,1-DICHLOROPROPENE	N/A	NA	NA	NA	NA	NA
1,2,3-TRICHLOROBENZENE	N/A	NA	NA	NA	NA	NA
1,2,3-TRICHLOROPROPANE	N/A	NA	NA	NA	NA	NA
1,2,4-TRICHLOROBENZENE	70	1.5U	3.0U	3.0U	3.0U	3.0U
1,2,4-TRIMETHYLBENZENE	N/A	NA	NA	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.2	1.5U	3.0U	3.0U	3.0U	3.0U
1,2-DIBROMOETHANE	0.05	1.0U	2.0U	2.0U	2.0U	2.0U
1,2-DICHLOROBENZENE	600	1.0U	2.0U	2.0U	2.0U	2.0U
1,2-DICHLOROETHANE	5	1.5U	3.0U	3.0U	3.0U	3.0U
1,2-DICHLOROPROPANE	5	NA	NA	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	N/A	NA	NA	NA	NA	NA
1,3-DICHLOROBENZENE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
1,3-DICHLOROPROPANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
1,4-DICHLOROBENZENE	75	1.5U	3.0U	3.0U	3.0U	3.0U
1-CHLOROHEXANE	N/A	NA	NA	NA	NA	NA
2,2-DICHLOROPROPANE	N/A	NA	NA	NA	NA	NA
2-BUTANONE	N/A	**240**	**11**	**11**	5.0U	5.0U
2-CHLOROTOLUENE	N/A	NA	NA	NA	NA	NA
2-HEXANONE	N/A	2.0U	4.0U	4.0U	4.0U	4.0U
4-CHLOROTOLUENE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
4-METHYL-2-PENTANONE	N/A	2.5U	5.0U	5.0U	5.0U	5.0U
ACETONE	N/A	**2900**	**49**	**54**	**36**	**31**
BENZENE	5	1.5U	3.0U	3.0U	3.0U	3.0U
BROMOBENZENE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
BROMOCHLOROMETHANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
BROMODICHLOROMETHANE	80	1.0U	2.0U	2.0U	2.0U	2.0U
BROMOFORM	80	5U	10U	10U	10U	10U
BROMOMETHANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
CARBON DISULFIDE	N/A	**2**	3.0U	3.0U	3.0U	3.0U
CARBON TETRACHLORIDE	5	1.5U	3.0U	3.0U	3.0U	3.0U
CHLOROBENZENE	100	1.5U	3.0U	3.0U	3.0U	3.0U
CHLOROETHANE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
CHLOROFORM	80	1.5U	3.0U	3.0U	3.0U	3.0U
CHLOROMETHANE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
CIS-1,2-DICHLOROETHENE	70	**26**	3.0U	3.0U	**5.4**	**17**
CIS-1,3-DICHLOROPROPENE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
DIBROMOCHLOROMETHANE	80	1.0U	2.0U	2.0U	2.0U	2.0U
DIBROMOMETHANE	N/A	1.5U	3.0U	3.0U	3.0U	3.0U
DICHLORODIFLUOROMETHANE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
ETHANE	N/A	NA	NA	NA	NA	NA
ETHENE	N/A	NA	NA	NA	NA	NA
ETHYLBENZENE	700	2.0U	4.0U	4.0U	4.0U	4.0U
HEXACHLOROBUTADIENE	N/A	NA	NA	NA	NA	NA
IODOMETHANE	N/A	NA	NA	NA	NA	NA
ISOPROPYLBENZENE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
M+P-XYLENE	10,000	NA	NA	NA	NA	NA
METHANE	N/A	NA	NA	NA	NA	NA
METHYL TERTIARY BUTYL ETHER	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
METHYLENE CHLORIDE	5	1.5U	3.0U	3.0U	3.0U	3.0U
NAPHTHALENE	N/A	NA	NA	NA	NA	NA
N-BUTYLBENZENE	N/A	NA	NA	NA	NA	NA
N-PROPYLBENZENE	N/A	NA	NA	NA	NA	NA
O-XYLENE	N/A	2.0U	4.0U	4.0U	4.0U	4.0U
P-ISOPROPYLTOLUENE	N/A	NA	NA	NA	NA	NA
SEC-BUTYLBENZENE	N/A	NA	NA	NA	NA	NA
STYRENE	100	1.5U	3.0U	3.0U	3.0U	3.0U
SULFATE	N/A	NA	NA	NA	NA	NA
TERT-BUTYLBENZENE	N/A	NA	NA	NA	NA	NA
TETRACHLOROETHENE	5	1.5U	3.0U	3.0U	3.0U	3.0U
TOLUENE	1000	1.0U	2.0U	2.0U	2.0U	2.0U
TRANS-1,2-DICHLOROETHENE	100	1.5U	3.0U	3.0U	3.0U	3.0U
TRANS-1,3-DICHLOROPROPENE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
TRICHLOROETHENE	5	**35**	3.0U	3.0U	3.0U	3.0U
TRICHLOROFLUOROMETHANE	N/A	1.0U	2.0U	2.0U	2.0U	2.0U
VINYL ACETATE	N/A	NA	NA	NA	NA	NA
VINYL CHLORIDE	2	**4.5**	**2.2**	2.0U	2.0U	**3.3**

NOTES:

Analyte Detections in bold

MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Methane results are in mg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

Data Validation Qualifiers

(stand to the right of dash. e.g., "N-J", or "-B")

B. Not detected substantially above the level reported in laboratory or field blanks

D. Result detected in sample with laboratory dilution.

J. Estimated concentration.

L. Indicates the reported value may be biased low.

R. Unreliable result. Analyte may or may not be present in the sample.

UJ. Not detected; quantitation limit may be inaccurate or imprecise.

Appendix B - VOC Analytical Results

Parameter	MCL	BA27-PW10B@10'	BA27-PW11B@10'	BA27-PW12B@10'
1,1,1,2-TETRACHLOROETHANE	N/A	NA	NA	NA
1,1,1-TRICHLOROETHANE	200	3.0U	3.0U	0.3U
1,1,2,2-TETRACHLOROETHANE	N/A	3.0U	3.0U	0.3U
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE	N/A	NA	NA	NA
1,1,2-TRICHLOROETHANE	5	NA	NA	NA
1,1-DICHLOROETHANE	N/A	3.0U	3.0U	0.3U
1,1-DICHLOROETHENE	7	3.0U	3.0U	0.3U
1,1-DICHLOROPROPENE	N/A	NA	NA	NA
1,2,3-TRICHLOROBENZENE	N/A	NA	NA	NA
1,2,3-TRICHLOROPROPANE	N/A	NA	NA	NA
1,2,4-TRICHLOROBENZENE	70	3.0U	3.0U	0.3U
1,2,4-TRIMETHYLBENZENE	N/A	NA	NA	NA
1,2-DIBROMO-3-CHLOROPROPANE	0.2	3.0U	3.0U	0.3U
1,2-DIBROMOETHANE	0.05	2.0U	2.0U	0.2U
1,2-DICHLOROBENZENE	600	2.0U	2.0U	0.2U
1,2-DICHLOROETHANE	5	3.0U	3.0U	0.3U
1,2-DICHLOROPROPANE	5	NA	NA	NA
1,3,5-TRIMETHYLBENZENE	N/A	NA	NA	NA
1,3-DICHLOROBENZENE	N/A	3.0U	3.0U	0.3U
1,3-DICHLOROPROPANE	N/A	3.0U	3.0U	0.3U
1,4-DICHLOROBENZENE	75	3.0U	3.0U	0.3U
1-CHLOROHEXANE	N/A	NA	NA	NA
2,2-DICHLOROPROPANE	N/A	NA	NA	NA
2-BUTANONE	N/A	5.0U	5.0U	0.5U
2-CHLOROTOLUENE	N/A	NA	NA	NA
2-HEXANONE	N/A	4.0U	4.0U	0.4U
4-CHLOROTOLUENE	N/A	3.0U	3.0U	0.3U
4-METHYL-2-PENTANONE	N/A	5.0U	5.0U	0.5U
ACETONE	N/A	**33**	**33**	**1.4**
BENZENE	5	3.0U	3.0U	0.3U
BROMOBENZENE	N/A	3.0U	3.0U	0.3U
BROMOCHLOROMETHANE	N/A	3.0U	3.0U	0.3U
BROMODICHLOROMETHANE	80	2.0U	2.0U	0.2U
BROMOFORM	80	10U	10U	1.0U
BROMOMETHANE	N/A	3.0U	3.0U	0.3U
CARBON DISULFIDE	N/A	3.0U	3.0U	0.3U
CARBON TETRACHLORIDE	5	3.0U	3.0U	0.3U
CHLOROBENZENE	100	3.0U	3.0U	0.3U
CHLOROETHANE	N/A	2.0U	2.0U	0.2U
CHLOROFORM	80	3.0U	3.0U	0.3U
CHLOROMETHANE	N/A	2.0U	2.0U	0.2U
CIS-1,2-DICHLOROETHENE	70	**8.7**	**6.9**	**9.8**
CIS-1,3-DICHLOROPROPENE	N/A	2.0U	2.0U	0.2U
DIBROMOCHLOROMETHANE	80	2.0U	2.0U	0.2U
DIBROMOMETHANE	N/A	3.0U	3.0U	0.3U
DICHLORODIFLUOROMETHANE	N/A	2.0U	2.0U	0.2U
ETHANE	N/A	NA	NA	NA
ETHENE	N/A	NA	NA	NA
ETHYLBENZENE	700	4.0U	4.0U	0.4U
HEXACHLOROBUTADIENE	N/A	NA	NA	NA
IODOMETHANE	N/A	NA	NA	NA
ISOPROPYLBENZENE	N/A	2.0U	2.0U	0.2U
M+P-XYLENE	10,000	NA	NA	NA
METHANE	N/A	NA	NA	NA
METHYL TERTIARY BUTYL ETHER	N/A	2.0U	2.0U	0.2U
METHYLENE CHLORIDE	5	3.0U	3.0U	0.3U
NAPHTHALENE	N/A	NA	NA	NA
N-BUTYLBENZENE	N/A	NA	NA	NA
N-PROPYLBENZENE	N/A	NA	NA	NA
O-XYLENE	N/A	4.0U	4.0U	0.4U
P-ISOPROPYLTOLUENE	N/A	NA	NA	NA
SEC-BUTYLBENZENE	N/A	NA	NA	NA
STYRENE	100	3.0U	3.0U	0.3U
SULFATE	N/A	NA	NA	NA
TERT-BUTYLBENZENE	N/A	NA	NA	NA
TETRACHLOROETHENE	5	3.0U	3.0U	0.3U
TOLUENE	1000	2.0U	**3.1**	0.2U
TRANS-1,2-DICHLOROETHENE	100	3.0U	3.0U	0.3U
TRANS-1,3-DICHLOROPROPENE	N/A	2.0U	2.0U	0.2U
TRICHLOROETHENE	5	**5.3**	**12**	**37**
TRICHLOROFLUOROMETHANE	N/A	2.0U	2.0U	0.2U
VINYL ACETATE	N/A	NA	NA	NA
VINYL CHLORIDE	2	2.0U	2.0U	0.2U

NOTES:

Analyte Detections in bold

MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Methane results are in mg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

Data Validation Qualifiers

(stand to the right of dash. e.g., "N-J", or "-B")

B. Not detected substantially above the level reported in laboratory or field blanks

D. Result detected in sample with laboratory dilution.

J. Estimated concentration.

L. Indicates the reported value may be biased low.

R. Unreliable result. Analyte may or may not be present in the sample.

UJ. Not detected; quantitation limit may be inaccurate or imprecise.

Appendix B - TOC Analytical Data

Parameter	**Total Organic Carbon**
MCL	N/A
TW0-GW@10.5'	NA
TW5-GW@12.5'	NA
BW6-GW@12'	NA
BA27-MW6-GW@16'	NA
BA27-MW10-GW@11'	NA
BA27-PW1B@10'	570
BA27-PW2B@10'	360
BA27-PW3B@10'	300
BA27-PW4B@10'	240
BA27-PW5B@10'	4,700
BA27-PW6B@10'	420
BA27-PW7B@10'	160
BA27-PW8B@10'	120
BA27-PW9B@10'	110
BA27-PW10B@10'	410
BA27-PW11B@10'	170
BA27-PW12B@10'	3.7

NOTES:

Analyte Detections in bold

MCL Exceedances are shaded

N/A - Not Applicable, no MCL established

Concentrations are in µg/L

Laboratory Data Qualifiers

(stand to the left of dash, or alone. e.g. "U-D", or "N")

E. Value above upper calibration range

J. Estimated concentration.

U. Parameter not detected above method detection limit.

NA. Not Analyzed

APPENDIX C

Microbial Census and Compound Specific Isotope Analytical Reports

microbialinsights

10515 Research Drive
Knoxville, TN 37932
Phone: (865) 573-8188
Fax: (865) 573-8133

ilac-MRA

ANAB
ANSI National Accreditation Board
ACCREDITED
ISO/IEC 17025
TESTING LABORATORY

Client: David Kindig
BMT Designers & Planners Inc
2900 South Quincy Street
Suite 210
Arlington, VA 22206

Phone:

Fax:

Identifier: 116SG **Date Rec:** 07/29/2021 **Report Date:** 08/05/2021

Client Project #: ENV0041.00.001 **Client Project Name:** BDRLF Performance Monitoring

Purchase Order #:

Test results provided for: CENSUS

Reviewed By:

Casey Brown

Results relate only to the items tested and the sample(s) as received by the laboratory.

CENSUS

Client: **BMT Designers & Planners Inc**
Project: BDRLF Performance Monitoring

MI Project Number: **116SG**
Date Received: 07/29/2021

Sample Information

Client Sample ID:		**BA27-PW1B-GW @10**	**BA27-PW2B-G W@10**	**BA27-PW3B-G W@10**	**BA27-PW4B-G W@10**	**BA27-PW5B-G W@10**
Sample Date:		07/28/2021	07/28/2021	07/28/2021	07/28/2021	07/28/2021
Units:		cells/mL	cells/mL	cells/mL	cells/mL	cells/mL
Analyst/Reviewer:		HT/CB	HT/CB	HT/CB	HT/CB	HT/CB
Dechlorinating Bacteria						
Dehalococcoides	*DHC*	**1.05E+03**	**8.42E+02**	**2.51E+03**	**1.86E+04**	**1.90E+03**
tceA Reductase	TCE	**2.50E+00 (J)**	**3.90E+00**	**6.50E+00**	**7.51E+01**	**1.51E+02**
BAV1 Vinyl Chloride Reductase	BVC	**6.40E+00 (J)**	**8.50E+00**	**1.62E+01**	**1.60E+02**	**2.60E+00 (J)**
Vinyl Chloride Reductase	VCR	**3.20E+01**	**3.67E+01**	**1.73E+02**	**2.13E+03**	**3.51E+01**

Legend:
NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

CENSUS

Client:	**BMT Designers & Planners Inc**	**MI Project Number:**	**116SG**
Project:	BDRLF Performance Monitoring	Date Received:	07/29/2021

Sample Information

Client Sample ID:	**BA27-PW6B-GW** **@10**
Sample Date:	07/28/2021
Units:	cells/mL
Analyst/Reviewer:	HT/CB

Dechlorinating Bacteria

Dehalococcoides	*DHC*	**5.30E+03**
tceA Reductase	TCE	**1.94E+02**
BAV1 Vinyl Chloride Reductase	BVC	**1.58E+01**
Vinyl Chloride Reductase	VCR	**2.75E+02**

Legend:

NA = Not Analyzed NS = Not Sampled J = Estimated gene copies below PQL but above LQL I = Inhibited
< = Result not detected

Quality Assurance/Quality Control Data

Samples Received **7/29/2021**

Component	Date Prepared	Date Analyzed	Arrival Temperature	Positive Control	Extraction Blank	Negative Control
DHC	07/29/2021	08/05/2021	0 °C	99%	non-detect	non-detect
BVC	07/29/2021	08/05/2021	0 °C	103%	non-detect	non-detect
TCE	07/29/2021	08/05/2021	0 °C	103%	non-detect	non-detect
VCR	07/29/2021	08/05/2021	0 °C	98%	non-detect	non-detect

microbialinsights

10515 Research Drive
Knoxville, TN 37932
Phone: (865) 573-8188
Fax: (865) 573-8133

Client: David Kindig
BMT Designers & Planners Inc
2900 South Quincy Street
Suite 210
Arlington, VA 22206

Phone:

Fax:

Identifier: 116SG

Date Rec: 07/29/2021

Report Date: 09/01/2021

Client Project #: ENV0041.00.001

Client Project Name: BDRLF Performance Monitoring

Purchase Order #:

Test results provided for: CSIA

Reviewed By:

MICROBIAL INSIGHTS, INC.

10515 Research Dr., Knoxville, TN 37932
Tel. (865) 573-8188 Fax. (865) 573-8133

CSIA

Client:	**BMT Designers & Planners Inc**	**MI Project Number:**	**116SG**
Project:	BDRLF Performance Monitoring	Date Received:	07/29/2021

Sample Information

Client Sample ID:	**BA27-PW4B-GW @10**	**BA27-BW6-GW @12**	**BA27-TW5-GW @12.5**	**BA27-TW0-GW @10.5**	**BA27-MW10-GW@11**
Sample Date:	07/28/2021	07/29/2021	07/29/2021	07/29/2021	07/29/2021
Analyst/Reviewer:	MW/SR	MW/SR	MW/SR	MW/SR	MW/SR

Carbon	**Units**					
$^{13}C/^{12}C$ TCE (‰)	$\delta^{13}C$, VPDB (‰)	**NA**	**NA**	**NA**	**NA**	**NA**

Legend:

NA= Not Analyzed NS=Not Sampled J= Estimated concentration below PQL but above LQL ND= Not Detected

CSIA

Client: **BMT Designers & Planners Inc**

Project: BDRLF Performance Monitoring

MI Project Number: **116SG**

Date Received: 07/29/2021

Sample Information

Client Sample ID:	**BA27-MW6-GW @16**
Sample Date:	07/29/2021
Analyst/Reviewer:	MW/SR

Carbon	**Units**	
$^{13}C/^{12}C$ TCE (‰)	$\delta^{13}C$, VPDB (‰)	**-21.9**

Legend:
NA= Not Analyzed NS=Not Sampled J= Estimated concentration below PQL but above LQL ND= Not Detected

Quality Assurance/Quality Control Data

Samples Received **7/30/2021**

Component	Date Prepared	Date Analyzed	Arrival Temperature	Positive Control (‰ Std. Dev.)*	Blank
$^{13}C/^{12}C$ TCE (‰)	07/30/2021	08/31/2021	0 °C	0.1	Pass

* $\delta^{13}C$ positive control values are within +- 0.5‰ of true value.

Identifier: 116SG **Date Rec:** 07/29/2021 **Report Date:** 09/01/2021

Client Project #: ENV0041.00.001 **Client Project Name:** BDRLF Performance Monitoring

Purchase Order #:

Comments: VOC data received from client on 8/23/2021.Based on the provided VOC data, TCE was non-detect in all samples except BA27-MW6-GW@16, and therefore was not analyzed (NA).

APPENDIX D

Gene-Trac® Analytical Report

SiREM
Leading Science · Lasting Solutions

130 Stone Rd. W
Guelph, ON N1G 3Z2
(519) 822-2265

Certificate of Analysis: Gene-Trac® *Dehalococcoides* Assay

Customer: David Schanzle, BMT Designers and Planners

Project: BDRLF Microbe

Customer Reference: ENV0041

SiREM Reference: S-8412

Report Date: 5-Oct-21

Data Files: QS3A-DHCT-TM-QPCR-1920
QS3A-DB-DHC-TM-QPCR-1235

Table 1a: Test Results

Sample ID	*Dehalococcoides* (Dhc)	
	Percent Dhc(1)	Enumeration/Liter(2)
13027-PW-4B	0.05 - 0.1 %	5 x 10^7
13027-PW-5B	0.003 - 0.008 %	1 x 10^7

See final page for notes.

Analyst: Taylor

Taylor Aris, B.Sc.
Laboratory Technician II

Approved: Ximena Druar

Ximena Druar, B.Sc.
Genetic Testing Supervisor

Certificate of Analysis: Gene-Trac® Functional Gene Assay

Customer: David Schanzle, BMT Designers and Planners
Project: BDRLF Microbe
Customer Reference: ENV0041

SiREM Reference: S-8412
Report Date: 5-Oct-21
Data Files: iQ5B-FGA-QPCR-1270
iQ5B-DB-FGA-QPCR-0961

Table 1b: Test Results

Sample ID	**VC Reductase (*vcrA*)**		**BAV1 VC Reductase (*bvcA*)**		**TCE Reductase (*tceA*)**	
	Percent *vcrA* (3)	**Gene Copies/Liter**	**Percent *bvcA* (3)**	**Gene Copies/Liter**	**Percent *tceA* (3)**	**Gene Copies/Liter**
13027-PW-4B	0.008 - 0.02 %	7 x 10^{6}	0.001 - 0.003 %	1 x 10^{6}	0.0006 - 0.002 %	5 x 10^{5}
13027-PW-5B	0.0001 - 0.0004 %	6 x 10^{5}	0.00003 - 0.00008 %	1 x 10^{5}	0.002- 0.006 %	1 x 10^{7}

See final page for notes.

Analyst: Taylor
Taylor Aris, B.Sc.
Laboratory Technician II

Approved: Ximena Druar
Ximena Druar, B.Sc.
Genetic Testing Supervisor

Certificate of Analysis: Gene-Trac® *Dehalobacter* Assay

Customer: David Schanzle, BMT Designers and Planners
Project: BDRLF Microbe
Customer Reference: ENV0041

SiREM Reference: S-8412
Report Date: 5-Oct-21
Data Files: iQ5B-DHB-QPCR-0565
iQ5B-DB-DHB-QPCR-0372

Table 1c: Test Results

Sample ID	***Dehalobacter*** **(Dhb)**	
	Percent Dhb[1]	**Gene Copies/Liter**
13027-PW-4B	0.02 - 0.06 %	2×10^7
13027-PW-5B	0.003 - 0.009 %	1×10^7

See final page for notes.

Analyst: Taylor
Taylor Aris, B.Sc.
Laboratory Technician II

Approved: Ximena Druar
Ximena Druar, B.Sc.
Genetic Testing Supervisor

Certificate of Analysis: Gene-Trac® *Dehalogenimonas* Assay

Customer: David Schanzle, BMT Designers and Planners
Project: BDRLF Microbe
Customer Reference: ENV0041

SiREM Reference: S-8412
Report Date: 5-Oct-21
Data Files: iQ5B-DHGM-QPCR-0128
iQ5B-DB-DHG-QPCR-0128

Table 1d: Test Results

Sample ID	***Dehalogenimonas* (Dhgm)**	
	Percent Dhgm(1)	**Gene Copies/Liter**
13027-PW-4B	0.005 - 0.01 %	5 x 10^6
13027-PW-5B	0.001 - 0.004 %	5 x 10^6

See final page for notes.

Analyst: Taylor

Taylor Aris, B.Sc.
Laboratory Technician II

Approved: Ximena Druar

Ximena Druar, B.Sc.
Genetic Testing Supervisor

Table 2: Detailed Test Parameters, Gene-Trac Test Reference S-8196

Customer Sample ID	13027-PW-4B	13027-PW-5B
SiREM Dhc Test ID	DHC-21897	DHC-21898
SiREM FGA Test ID	FGA-10844	FGA-10845
SiREM Dhb Test ID	DHB-2698	DHB-2699
SiREM Dhgm Test ID	DHG-0487	DHG-0488
Date Sampled (4)	15-Sep-21	15-Sep-21
Matrix	Groundwater	Groundwater
Date Received (4)	16-Sep-21	16-Sep-21
Sample Temperature	6.0 °C	6.0 °C
Filtration Date (4)	17-Sep-21	17-Sep-21
Volume Used for DNA Extraction	10 mL	10 mL
DNA Extraction Date	27-Sep-21	27-Sep-21
DNA Concentration in Sample (extractable)	184500 ng/L	903000 ng/L
PCR Amplifiable DNA	Detected	Detected
Dhc qPCR Date Analyzed	27-Sep-21	27-Sep-21
FGA qPCR Date Analyzed	30-Sep-21	30-Sep-21
Dhb qPCR Date Analyzed	27-Sep-21	27-Sep-21
Dhgm qPCR Date Analyzed	29-Sep-21	29-Sep-21
Laboratory Controls (see Tables 3, 4, 5 & 6)	Passed	Passed
Comments	- -	- -

See final page for notes.

Table 3: Gene-Trac Dhc Control Results, Test Reference S-8412

Laboratory Control	Analysis Date	Control Description	Spiked Dhc 16S rRNA Gene Copies per Liter	Recovered Dhc 16S rRNA Gene Copies per Liter	Comments
Positive Control Low Concentration	27-Sep-21	Genomic DNA (CSLD-1558)	1.4×10^{6}	1.4×10^{6}	Passed
Positive Control High Concentration	27-Sep-21	Genomic DNA (CSHD-1558)	1.8×10^{8}	2.0×10^{8}	Passed
Extraction Control	27-Sep-21	Extraction Control (KB-0833)	1.0×10^{11}	1.2×10^{11}	Passed
DNA Extraction Blank	27-Sep-21	Sterile Water (FB-3891)	0	2.6×10^{3} U	Passed
Negative Control	27-Sep-21	Reagent Blank (TBD-1518)	0	2.6×10^{3} U	Passed

See final page for notes.

Table 4: Gene-Trac FGA Control Results, Test Reference S-8412

Laboratory Control	Analysis Date	Control Description	*vcrA*		*bvcA*		*tceA*		Comments
			Spiked Gene Copies per Liter	**Recovered Gene Copies per Liter**	**Spiked Gene Copies per Liter**	**Recovered Gene Copies per Liter**	**Spiked Gene Copies per Liter**	**Recovered Gene Copies per Liter**	
Positive Control Low Concentration	30-Sep-21	Genomic DNA (CSLF-1138)	2.4×10^6	2.8×10^6	7.8×10^5	6.0×10^5	9.5×10^5	8.2×10^5	Passed
Positive Control High Concentration	30-Sep-21	Genomic DNA (CSHF-1138)	3.3×10^8	4.5×10^8	9.0×10^7	1.4×10^8	1.4×10^8	1.3×10^8	Passed
DNA Extraction Blank	30-Sep-21	Sterile Water (FB-3891)	0	2.6×10^3 U	0	2.6×10^3 U	0	2.6×10^3 U	Passed
Negative Control	30-Sep-21	Reagent Blank (TBF-1109)	0	2.6×10^3 U	0	2.6×10^3 U	0	2.6×10^3 U	Passed

See final page for notes.

Table 5: Gene-Trac Dhb Control Results, Test Reference S-8412

Laboratory Control	Analysis Date	Control Description	Spiked Dhb 16S rRNA Gene Copies per Liter	Recovered Dhb 16S rRNA Gene Copies per Liter	Comments
Positive Control Low Concentration	27-Sep-21	Genomic DNA (CSLDB-0524)	2.9×10^{7}	2.9×10^{7}	Passed
Positive Control High Concentration	27-Sep-21	Genomic DNA (CSHDB-0524)	5.1×10^{9}	5.1×10^{9}	Passed
DNA Extraction Blank	27-Sep-21	Sterile Water (FB-3891)	0	2.6×10^{3} U	Passed
Negative Control	27-Sep-21	Reagent Blank (TBDB-0524)	0	2.6×10^{3} U	Passed

See final page for notes.

Table 6: Gene-Trac Dhgm Control Results, Test Reference S-8412

Laboratory Control	Analysis Date	Control Description	Spiked Dhgm 16S rRNA Gene Copies per Liter	Recovered Dhgm 16S rRNA Gene Copies per Liter	Comments
Positive Control Low Concentration	29-Sep-21	Genomic DNA (CSLDG-0128)	6.5×10^{7}	7.5×10^{7}	Passed
Positive Control High Concentration	29-Sep-21	Genomic DNA (CSHDG-0128)	2.0×10^{9}	1.8×10^{9}	Passed
DNA Extraction Blank	29-Sep-21	Sterile Water (FB-3891)	0	2.6×10^{3} U	Passed
Negative Control	29-Sep-21	Reagent Blank (TBDG-0128)	0	2.6×10^{3} U	Passed

See final page for notes.

Notes:

Dhc = *Dehalococcoides*
Dhb = *Dehalobacter*
Dhgm = *Dehalogenimonas*
vcrA = VC reductase
bvcA = BAV1 VC reductase
tceA = TCE reductase
FGA = functional gene assay
dsrA = dissimilatory sulfate reductase A
J The associated value is an estimated quantity between the method detection limit and quantitation limit.
U Not detected, associated value is the quantitation limit.
B Analyte was detected in the method blank within an order of magnitude of the test sample.
E Extracted genomic DNA was not detected in the sample.
I Sample inhibited the test reaction based on inability to PCR amplify extracted DNA with universal primers.
ng/L = nanograms per liter
mL = milliliter
NA = not applicable
ND = not detected
DNA = deoxyribonucleic acid
16S rRNA = 16S ribosomal ribonucleic acid
PCR = polymerase chain reaction
qPCR = quantitative PCR
°C = degrees Celsius

[1] Percent *Dehalococcoides* (Dhc), *Dehalobacter* (Dhb), *Dehalogenimonas* (Dhgm) in microbial population. This value is calculated by dividing the number of 16S ribosomal ribonucleic acid (rRNA) gene copies by the total number of bacteria as estimated by the mass of DNA extracted from the sample. Range represents normal variation in Dhc or Dhb enumeration.

[2] Based on quantification of Dhc 16S rRNA gene copies. Dhc is generally reported to contain one 16S rRNA gene copy per cell; therefore, this number is often interpreted to represent the number of Dhc cells present in the sample.

[3] Percent of functional gene in microbial population. This value is calculated by dividing the functional gene copies quantified by the total number of estimated prokaryotes in the sample (based on the total quantity of DNA extracted from the sample). A value of 100% would suggest that all microbes in the sample contain the gene.

[4] Samples are stabilized by freezing at -80 °C upon sample reception (field filters) or in-lab filtration (groundwater). Hold time not exceeded if sampling date is within 7 days of date received or filtration date.

SiREM

Chain-of-Custody Form

siremlab.com

1808 Market Place Blvd
Knoxville, TN 37922
1-865-291-4718 or 1-866-251-1747

Lab # S-8412

*Project Name: BDRLF Microbe

*Project #: ENV0041

*Project Manager: D. Schanzle

*Company: BMT D&P

*Email Address: dschanzle@bmtdp.com

Address (Street): 2900 South Quincy Street Suite 210

City: Arlington

State/Province: VA

Country: USA

*Phone #: 202-510-2037

*Sampler's Signature: Susan Thomas

Sampler's Printed Name: Susan Thomas

Analysis

Client Sample ID	Sampling Date	Sampling Time	Matrix	# of Containers	Gene-Trac DHC	Gene-Trac FGA	Gene-Trac DHB	Gene-Trac DHGM	Gene-Trac SRB	Volatile Fatty Acids	Dissolved hydrocarbon gases	Treatability Study				Other Information
✓ 13027-PW-4B	9-17-21	1400	Filter	1	X											
✓ 13027-PW-5B	↓	↓	↓	1	X											

Preservative Key

0. None
1. HCL
2. Other ______
3. Other ______
4. Other ______
5. Other ______
6. Other ______

Billing Information

P.O. #: ENV0041

*Bill To:

Turnaround Time Requested

Normal ☑
Rush ☐

For Lab Use Only

Cooler Condition: good

Cooler Temperature:

Custody Seals: Yes ☐ No ☐

For Lab Use Only

Filtered on 9-17-2021. ST

Proposal #: ______

	Relinquished By:	Received By:	Relinquished By:	Received By:	Relinquished By:	Received By:
Signature	Susan Thomas					
Printed Name	Susan Thomas	Bethany Kinsman				
Firm	SiREM	SiREM				
Date/Time	9-20-2021 1500	Sept-21-21 3:45 pm				

Distribution: White - return to Originator; Yellow - Lab Copy; Pink - Retained by Client

** Mandatory Fields*

SiREM

Chain-of-Custody Form

siremlab.com

180B Market Place Blvd
Knoxville, TN 37922
1-865-291-4718 or 1-866-251-1747

Lab # S-8412

*Project Name: BORLF MICROBE
*Project #: GWU0041
*Project Manager: D. SCHANZLE
*Company: BMT DSP
*Email Address: dschanzle@bmtdp.com
Address (Street): 2900 SOUTH QUINCY ST STE 210
City: ARLINGTON
State/Province: VA
Country: USA
*Phone #: 202-510-2037
*Sampler's Signature:
*Sampler's Printed Name: DAVID SCHANZLE

Analysis

Preservative Key

- [✓ 0. None]
- 1. HCL
- 2. Other
- 3. Other
- 4. Other
- 5. Other
- 6. Other

Client Sample ID	**Sampling**		**Matrix**	**# of Containers**	Gene-Trac DHC	Gene-Trac FGA	Gene-Trac DHB	Gene-Trac DHGM	Gene-Trac SRB	Volatile Fatty Acids	Dissolved hydrocarbon gasses	Treatability Study					**Other Information**
	Date	**Time**															
BAZZ-PW-4B	08/15	1410	GW	1	X												BK-07512
BAZZ-PW-5B	08/15	1420	GW	1	X												BK-07511 (5B)

Billing Information

P.O. #: GWU0041
*Bill To:

Turnaround Time Requested

Normal ☑
Rush ☐

For Lab Use Only

Cooler Condition: Good-wet ice Melted
Cooler Temperature: 6.0°C KY00058
Custody Seals: Yes ☑ No ☐

For Lab Use Only

Proposal #:

	Relinquished By:	**Received By:**	**Relinquished By:**	**Received By:**	**Relinquished By:**	**Received By:**
Signature		Susan Thomas				
Printed Name	DAVID SCHANZLE	Susan Thomas				
Firm	BMT DSP	SiREM				
Date/Time	08/15/2021	9-16-2021 0945				

Distribution: White - return to Originator: Yellow - Lab Copy: Pink - Retained by Client

** Mandatory Fields*

APPENDIX B

PUBLIC ANNOUNCEMENTS FOR FIVE-YEAR REVIEW

LEGALS

COUNTY COUNCIL HEARINGS

COUNTY COUNCIL OF
PRINCE GEORGE'S COUNTY, MARYLAND

NOTICE OF PUBLIC HEARINGS

TUESDAY, JANUARY 17, 2023

COUNCIL HEARING ROOM
WAYNE K. CURRY ADMINISTRATION BUILDING
1301 MCCORMICK DRIVE
LARGO, MARYLAND
https://pgccouncil.us/LIVE

10:00 A.M.

Notice is hereby given that on Tuesday, January 17, 2023, the County Council of Prince George's County, Maryland, will hold the following public hearing:

COUNCIL BILLS

CB-012-2023 (DR-2) – AN ORDINANCE CONCERNING GENERAL PROVISIONS - DEVELOPMENT AUTHORITY PURSUANT TO THE PRIOR ORDINANCE - LIMITATIONS ON DEVELOPMENT for the purpose of limiting the authority in the Zoning Ordinance for development under the prior Ordinance superseded by the revised Subtitle 27 of the Prince George's County Code, being also the Zoning Ordinance of Prince George's County.

CB-013-2023 – AN ORDINANCE CONCERNING M-X-T ZONE TRANSITION for the purpose of repealing CB-69-2022 which authorized properties that were in the M-X-T (Mixed Use--Transportation Oriented) Zone prior to the effective date of the new zoning ordinance to elect to conform to the requirement of the CGO (Commercial, General Office) Zone.

CB-014-2023 – AN ORDINANCE CONCERNING ZONING-GENERAL PROVISIONS - TRANSITIONAL PROVISIONS for the purpose of repealing CB-77-2022, including Section 27-1706, of the Zoning Ordinance of Prince George's County.

CB-015-2023 – AN ORDINANCE CONCERNING ZONING-ZONES AND ZONE REGULATIONS-PRINCIPAL USES-SPLIT-ZONED PROPERTY for the purpose of repealing CB-078-2022 and clarifying the development regulations and use tables applicable to the development of lots that were split zoned as a result of the Countywide Map Amendment by the District Council.

CB-016-2023 (DR-2) – AN ORDINANCE CONCERNING IE ZONE TRANSITIONAL PROVISIONS for the purpose of repealing CB-79-2022 and reinstating the lot coverage and green area requirements for previously I-1 (Light Industrial) zoned properties and permitting distribution warehouses in the IE (Industrial, Employment) Zone under the Zoning Ordinance of Prince George's County.

CB-017-2023 – AN ORDINANCE CONCERNING GENERAL PROVISIONS - DEVELOPMENT AUTHORITY PURSUANT TO THE PRIOR ORDINANCE - LIMITATION ON TOWNHOUSE AND ONE-FAMILY ATTACHED DWELLINGS-R-A ZONE for the purpose of limiting the authority in the Zoning Ordinance for development of Townhouse and One-family attached dwelling uses under the prior Ordinance in the R-A (Residential Agricultural) Zone of Prince George's County.

CB-018-2023 – AN ORDINANCE CONCERNING ZONING-ZONES AND ZONE REGULATIONS-BASE ZONES-EXPEDITED TRANSIT-ORIENTED DEVELOPMENT for the purpose of repealing CB-97-2022 and reinstating the development regulations applicable to certain expedited transit-oriented development in Transit-Oriented/Activity Center Base Zones within the new Zoning Ordinance of Prince George's County, being also Chapter 37, 2018 Laws of Prince George's County, Maryland (CB-013-2018), as amended by Chapter 53, 2021 Laws of Prince George's County, Maryland (CB-98-2021).

To register to speak or submit comments or written testimony please use the Council's eComment portal at: https://pgccouncil.us/Speak. For those unable to use the portal, comments/written correspondence may be emailed to: clerkofthecouncil@co.pg.md.us or faxed to (301) 952-5178.

Written comments must be submitted by 3:00 p.m. on the day BEFORE the meeting. Testimony and comments will not be accepted via social media or by telephone/voice mail message. **Speaker registration is available until 10:00 a.m. on the day of the hearing**.

These policies are in effect until otherwise changed and, any future changes to them, will be communicated on the County Council website, County Council social media channels, via Alert Prince George's, and will be shared with the press via a press release.

View meetings by selecting the "In Progress" link next to the meeting on the Council's live streaming page: https://pgccouncil.us/LIVE.

BY ORDER OF THE COUNTY COUNCIL
PRINCE GEORGE'S COUNTY, MARYLAND
Calvin S. Hawkins, II, Chair

ATTEST:
Donna J. Brown
Clerk of the Council

143639 (12-29,1-5)

YEAR REVIEW OF ENVIRONMENTAL RESTORATION
BEAVER DAM ROAD LANDFILL
BELTSVILLE AGRICULTURAL RESEARCH CENTER
BELTSVILLE, MD 20705

The Beltsville (MD) Agricultural Research Center (BARC), a part of the U.S. Department of Agriculture's Agricultural Research Service, is beginning a five-year review of its environmental restoration of the Beaver Dam Road Land Fill (BDRLF). This location is about a 14-acre area of concern that is part of BARC' National Priorities Listing (Superfund) by the U.S. Environmental Protection Agency.

From the early 1940s through the 1980s, the BDRLF was used for disposal of nonhazardous materials such as rubble from masonry construction debris, tree clippings, wood, and broken asphalt from BARC operations. A Remedial Investigation also identified a plume of groundwater contaminated with trichloroethylene (TCE) up to a maximum concentration of 1,100 parts per billion (ppb). The plume impacts an area of about two-thirds of an acre to the southeast of the BDRLF. The Safe Drinking Water Act calls for a maximum contaminant level for TCE of 5 ppb, which is the cleanup goal for the site, although there are no drinking water wells in the area. To meet this goal, a remedy that included installation of a passive groundwater treatment system with a permeable reactive barrier (PRB) or "biowall" that captures and remediates TCE was selected and implemented. The biowall is currently in place and is undergoing performance monitoring.

The first five-year review was conducted in 2018. The site remedy was expanded in 2020 to include the installation of upgradient trench pits and microbial injections. The second five-year review will include an examination of the BDRLF's Record of Decision, a review of site conditions, the implementation of remedy enhancements to improve system performance and a review of the effectiveness of the biowall. It is being conducted between January 1, 2023, and January 31, 2023.

All published data on the BDRLF and other BARC NPL/Superfund areas of concern are available for inspection at:

Information Repository
Building 003, Room 313
10300 Baltimore Avenue
Beltsville Agricultural Research Center
Beltsville, MD 20705
Open: Monday through Friday: 8:30 am to 4:30 pm
Available online at https://cercla.ba.ars.usda.gov

Facility Contacts:

John Houston, Environmental Engineer
Phone: (240) 204-3331, john.houston@usda.gov

Stephen Tushek - Environmental Management Unit Manager
Phone: ((202) 768-6595, stephen.tushek@usda.gov

143562 (12-29)

LEGALS

BWW LAW GROUP, LLC
6003 Executive Boulevard, Suite 101
Rockville, MD 20852
(301) 961-6555

SUBSTITUTE TRUSTEES' SALE OF REAL PROPERTY AND ANY IMPROVEMENTS THEREON

7929 FISKE AVE.
LANHAM, MD 20706

Under a power of sale contained in a certain Deed of Trust dated December 19, 2007, recorded in Liber 29986, Folio 89 among the Land Records of Prince George's County, MD, with an original principal balance of $420,000.00, default having occurred under the terms thereof, the Sub. Trustees will sell at public auction at the Circuit Court for Prince George's County, 14735 Main St., Upper Marlboro, MD, 20772 (Duval Wing entrance, located on Main St.), on

JANUARY 18, 2023 AT 11:23 AM

ALL THAT FEE SIMPLE LOT OF GROUND, together with any buildings or improvements thereon located in Prince George's County, MD and more fully described in the aforesaid Deed of Trust.

The property, and any improvements thereon, will be sold in an "as is" condition and subject to conditions, restrictions and agreements of record affecting the same, if any, and with no warranty of any kind.

Terms of Sale: A deposit of $33,000 in the form of certified check, cashier's check or money order will be required of the purchaser at time and place of sale. Balance of the purchase price, together with interest on the unpaid purchase money at the current rate contained in the Deed of Trust Note from the date of sale to the date funds are received by the Sub. Trustees, payable in cash within ten days of final ratification of the sale by the Circuit Court. There will be no abatement of interest due to the purchaser in the event additional funds are tendered before settlement. TIME IS OF THE ESSENCE FOR THE PURCHASER. Adjustment of all real property taxes, including agricultural taxes, if applicable, and any and all public and/or private charges or assessments, to the extent such amounts survive foreclosure sale, including water/sewer, ground rent and front foot benefit charges, to be adjusted to date of sale and thereafter assumed by purchaser. Purchaser is responsible for any recapture of homestead tax credit. All transfer taxes and recordation taxes shall be paid by Purchaser. The purchaser shall be responsible for the payment of the ground rent escrow, if required. Condominium fees and/or homeowners association dues, if any, shall be assumed by the purchaser from the date of sale. Purchaser is responsible for obtaining physical possession of the property, and assumes risk of loss or damage to the property from the date of sale. The sale is subject to post-sale audit of the status of the loan with the loan servicer including, but not limited to, determination of whether the borrower entered into any repayment agreement, reinstated or paid off the loan prior to the sale. In any such event, this sale shall be null and void, and the Purchaser's sole remedy, in law or equity, shall be the return of the deposit without interest. If purchaser fails to settle within ten days of ratification, subject to order of court, purchaser agrees that property will be resold and entire deposit retained by Sub. Trustees as liquidated damages for all losses occasioned by the purchaser's default and purchaser shall have no further liability. The defaulted purchaser shall not be entitled to any surplus proceeds resulting from said resale even if such surplus results from improvements to the property by said defaulted purchaser. Sub. Trustees will convey either marketable or insurable title. If they cannot deliver one or the other, or if ratification of the sale is denied by the Circuit Court for any reason, the Purchaser's sole remedy, at law or equity, is return of the deposit without interest. BIDDERS ARE STRONGLY ENCOURAGED TO FOLLOW CDC GUIDANCE AND WEAR A COVER OVER BOTH NOSE AND MOUTH AND PRACTICE SOCIAL DISTANCING AT THE AUCTION. (Matter No. 357595-1)

PLEASE CONSULT WWW.ALEXCOOPER.COM FOR STATUS OF UPCOMING SALES

Howard N. Bierman, Carrie M. Ward, et al.,
Substitute Trustees

ALEX COOPER
auctioneers
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www.alexcooper.com

143607 (12-29,1-5,1-12)

LEGALS

NOTICE OF APPOINTMENT
NOTICE TO CREDITORS
NOTICE TO UNKNOWN HEIRS

TO ALL PERSONS INTERESTED
IN THE ESTATE OF
JOHN DEL TUFO
AKA: JOHN RICHARD DEL TUFO

Notice is given that Todd Jon Del Tufo, whose address is 8825 Cardinal Court, Laurel, MD 20723, was on December 9, 2022 appointed Personal Representative of the estate of John Del Tufo AKA: John Richard Del Tufo, who died on August 26, 2022 without a will.

Further information can be obtained by reviewing the estate file in the office of the Register of Wills or by contacting the personal representative or the attorney.

All persons having any objection to the appointment (or to the probate of the decedent's will) shall file their objections with the Register of Wills on or before the 9th day of June, 2023.

Any person having a claim against the decedent must present the claim to the undersigned personal representative or file it with the Register of Wills with a copy to the undersigned, on or before the earlier of the following dates:

(1) Six months from the date of the decedent's death; or

(2) Two months after the personal representative mails or otherwise delivers to the creditor a copy of this published notice or other written notice, notifying the creditor that the claim will be barred unless the creditor presents the claims within two months from the mailing or other delivery of the notice.

A claim not presented or filed on or before that date, or any extension provided by law, is unenforceable thereafter. Claim forms may be obtained from the Register of Wills.

TODD JON DEL TUFO
Personal Representative

Cereta A. Lee
Register Of Wills For
Prince George's County
P.O. Box 1729
Upper Marlboro, MD 20773-1729

Estate No. 126905

143629 (12-29,1-5,1-12)

NOTICE OF APPOINTMENT
NOTICE TO CREDITORS
NOTICE TO UNKNOWN HEIRS

TO ALL PERSONS INTERESTED
IN THE ESTATE OF
MARCIA ELLEN PORTERFIELD

Notice is given that Theodore Michael Verbich, whose address is 109 Tingle Rd, Berlin, MD 21811, was on May 24, 2022 appointed Personal Representative of the estate of Marcia Ellen Porterfield, who died on March 28, 2022 without a will.

Further information can be obtained by reviewing the estate file in the office of the Register of Wills or by contacting the personal representative or the attorney.

All persons having any objection to the appointment (or to the probate of the decedent's will) shall file their objections with the Register of Wills on or before the 24th day of November, 2022.

Any person having a claim against the decedent must present the claim to the undersigned personal representative or file it with the Register of Wills with a copy to the undersigned, on or before the earlier of the following dates:

(1) Six months from the date of the decedent's death, except if the decedent died before October 1, 1992, nine months from the date of the decedent's death; or

(2) Two months after the personal representative mails or otherwise delivers to the creditor a copy of this published notice or other written notice, notifying the creditor that the claim will be barred unless the creditor presents the claims within two months from the mailing or other delivery of the notice.

A claim not presented or filed on or before that date, or any extension provided by law, is unenforceable thereafter. Claim forms may be obtained from the Register of Wills.

THEODORE MICHAEL VERBICH
Personal Representative

Cereta A. Lee
Register Of Wills For
Prince George's County
P.O. Box 1729
Upper Marlboro, MD 20773-1729

Estate No. 125120

143399 (12-15,12-22,12-29)

LEGALS

BWW LAW GROUP, LLC
6003 Executive Boulevard, Suite 101
Rockville, MD 20852
(301) 961-6555

SUBSTITUTE TRUSTEES' SALE OF REAL PROPERTY AND ANY IMPROVEMENTS THEREON

10701 BAYVIEW CT.
FORT WASHINGTON, MD 20744

Under a power of sale contained in a certain Deed of Trust dated October 21, 2006, recorded in Liber 26927, Folio 725 among the Land Records of Prince George's County, MD, with an original principal balance of $594,000.00, default having occurred under the terms thereof, the Sub. Trustees will sell at public auction at the Circuit Court for Prince George's County, 14735 Main St., Upper Marlboro, MD, 20772 (Duval Wing entrance, located on Main St.), on

JANUARY 18, 2023 AT 11:25 AM

ALL THAT FEE SIMPLE LOT OF GROUND, together with any buildings or improvements thereon located in Prince George's County, MD and more fully described in the aforesaid Deed of Trust.

The property, and any improvements thereon, will be sold in an "as is" condition and subject to conditions, restrictions and agreements of record affecting the same, if any, and with no warranty of any kind.

Terms of Sale: A deposit of $66,000 in the form of certified check, cashier's check or money order will be required of the purchaser at time and place of sale. Balance of the purchase price, together with interest on the unpaid purchase money at the current rate contained in the Deed of Trust Note from the date of sale to the date funds are received by the Sub. Trustees, payable in cash within ten days of final ratification of the sale by the Circuit Court. There will be no abatement of interest due to the purchaser in the event additional funds are tendered before settlement. TIME IS OF THE ESSENCE FOR THE PURCHASER. Adjustment of all real property taxes, including agricultural taxes, if applicable, and any and all public and/or private charges or assessments, to the extent such amounts survive foreclosure sale, including water/sewer, ground rent and front foot benefit charges, to be adjusted to date of sale and thereafter assumed by purchaser. Purchaser is responsible for any recapture of homestead tax credit. All transfer taxes and recordation taxes shall be paid by Purchaser. The purchaser shall be responsible for the payment of the ground rent escrow, if required. Condominium fees and/or homeowners association dues, if any, shall be assumed by the purchaser from the date of sale. Purchaser is responsible for obtaining physical possession of the property, and assumes risk of loss or damage to the property from the date of sale. The sale is subject to post-sale audit of the status of the loan with the loan servicer including, but not limited to, determination of whether the borrower entered into any repayment agreement, reinstated or paid off the loan prior to the sale. In any such event, this sale shall be null and void, and the Purchaser's sole remedy, in law or equity, shall be the return of the deposit without interest. If purchaser fails to settle within ten days of ratification, subject to order of court, purchaser agrees that property will be resold and entire deposit retained by Sub. Trustees as liquidated damages for all losses occasioned by the purchaser's default and purchaser shall have no further liability. The defaulted purchaser shall not be entitled to any surplus proceeds resulting from said resale even if such surplus results from improvements to the property by said defaulted purchaser. Sub. Trustees will convey either marketable or insurable title. If they cannot deliver one or the other, or if ratification of the sale is denied by the Circuit Court for any reason, the Purchaser's sole remedy, at law or equity, is return of the deposit without interest. BIDDERS ARE STRONGLY ENCOURAGED TO FOLLOW CDC GUIDANCE AND WEAR A COVER OVER BOTH NOSE AND MOUTH AND PRACTICE SOCIAL DISTANCING AT THE AUCTION. (Matter No. 332978-1)

PLEASE CONSULT WWW.ALEXCOOPER.COM FOR STATUS OF UPCOMING SALES

Howard N. Bierman, Carrie M. Ward, et al.,
Substitute Trustees

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www.alexcooper.com

143608 (12-29,1-5,1-12)

LEGALS

NOTICE OF APPOINTMENT
NOTICE TO CREDITORS
NOTICE TO UNKNOWN HEIRS

TO ALL PERSONS INTERESTED
IN THE ESTATE OF
DOROTHY D SINGLETON

Notice is given that Joy Singleton Jackson, whose address is 811 Arbor Park Place, Mitchellville, MD 20721, was on September 8, 2022 appointed Personal Representative of the estate of Dorothy D Singleton, who died on June 15, 2022 without a will.

Further information can be obtained by reviewing the estate file in the office of the Register of Wills or by contacting the personal representative or the attorney.

All persons having any objection to the appointment (or to the probate of the decedent's will) shall file their objections with the Register of Wills on or before the 8th day of March, 2023.

Any person having a claim against the decedent must present the claim to the undersigned personal representative or file it with the Register of Wills with a copy to the undersigned, on or before the earlier of the following dates:

(1) Six months from the date of the decedent's death; or

(2) Two months after the personal representative mails or otherwise delivers to the creditor a copy of this published notice or other written notice, notifying the creditor that the claim will be barred unless the creditor presents the claims within two months from the mailing or other delivery of the notice.

A claim not presented or filed on or before that date, or any extension provided by law, is unenforceable thereafter. Claim forms may be obtained from the Register of Wills.

JOY SINGLETON JACKSON
Personal Representative

Cereta A. Lee
Register Of Wills For
Prince George's County
P.O. Box 1729
Upper Marlboro, MD 20773-1729

Estate No. 126004

143400 (12-15,12-22,12-29)

NOTICE OF APPOINTMENT
NOTICE TO CREDITORS
NOTICE TO UNKNOWN HEIRS

TO ALL PERSONS INTERESTED
IN THE ESTATE OF
GARY DOUGLAS LILES

Notice is given that Joshua Liles, whose address is 16-M Ridge Rd, Greenbelt, MD 20770, was on November 9, 2022 appointed Personal Representative of the estate of Gary Douglas Liles, who died on September 11, 2019 without a will.

Further information can be obtained by reviewing the estate file in the office of the Register of Wills or by contacting the personal representative or the attorney.

All persons having any objection to the appointment (or to the probate of the decedent's will) shall file their objections with the Register of Wills on or before the 9th day of May, 2023.

Any person having a claim against the decedent must present the claim to the undersigned personal representative or file it with the Register of Wills with a copy to the undersigned, on or before the earlier of the following dates:

(1) Six months from the date of the decedent's death; or

(2) Two months after the personal representative mails or otherwise delivers to the creditor a copy of this published notice or other written notice, notifying the creditor that the claim will be barred unless the creditor presents the claims within two months from the mailing or other delivery of the notice.

A claim not presented or filed on or before that date, or any extension provided by law, is unenforceable thereafter. Claim forms may be obtained from the Register of Wills.

JOSHUA LILES
Personal Representative

Cereta A. Lee
Register Of Wills For
Prince George's County
P.O. Box 1729
Upper Marlboro, MD 20773-1729

Estate No. 126930

143401 (12-15,12-22,12-29)

Stranger in a Strange Land Finds Solace in Greenbelt

by Melanie Iversen

Being a stranger in a strange place is not something I am accustomed to after living 52 years in the same North Carolina city, so moving here not long ago has presented some real challenges.

I was initially concerned that every mile of this area was surrounded by a vicious family of highways named the X95s. Only the love of family could lure someone into this tangle. There did not seem to be a quiet time on any road. People drove like they had either won the lottery and were rushing to collect, or they had lost and were mad about it.

Eventually, I began venturing out and that is when I came across a road called Crescent. The minute I turned in, my car and I exhaled. The road was winding and I followed it to a small shopping area that had, of all things, a Co-op. How delightful! I entered and perused the comfortably intimate grocery. I noticed people chatting with each other, waving and smiling. The experience made me want to explore more. That's when I saw the local paper.

I, like many folks, enjoy reading this weekly rag. I find it warm, informative and educational, especially for someone, like me, who is relatively new to the area. When I open the paper, I feel it speaks to those who are familiar with the who, what, when, where and therenesses. What about those who are not familiar? I am working on that, but still find myself feeling foreign much of the time. I write to share the perspective of an outsider who is coming into this lovely place called Greenbelt.

PHOTO BY MELANIE IVERSON

Crescent Road, just after leaving Kenilworth Avenue

Pedestrians and Bikes Are Focus Of City Planning Worksession

by Cathie Meetre

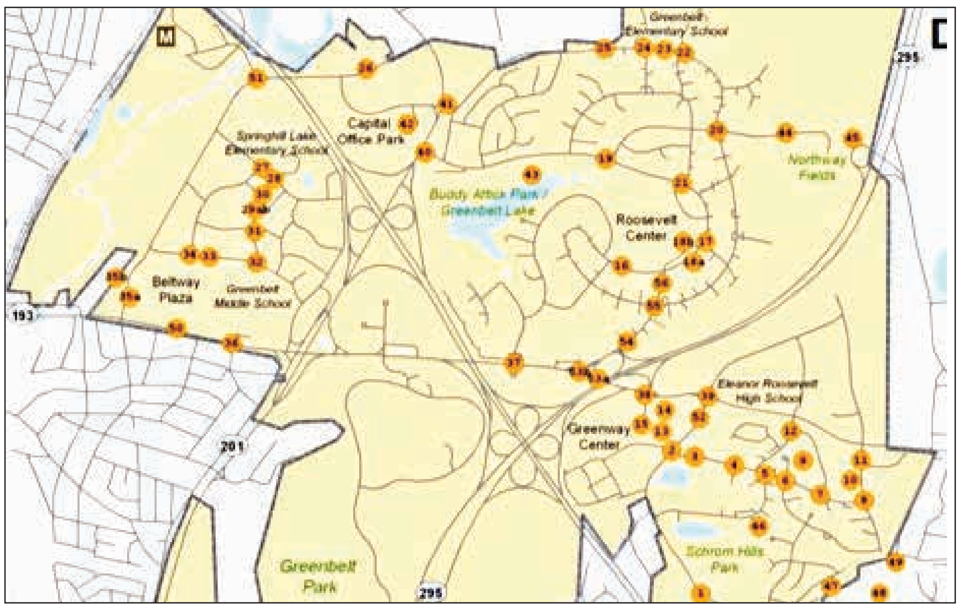

PHOTO COURTESY CITY OF GREENBELT

Map of Greenbelt showing locations where initiatives are planned

In a November 30 exploration of the recently updated Master Plan relating to pedestrian and bicycle access in the city, Mayor Emmett Jordan praised the work of the Advisory Planning Board, represented in person by Ben Friedman, Director of Planning and Development Terri Hruby and their teams.

Hruby pointed out during the meeting that getting money was one challenge, but having the technical bandwidth to manage the project implementation was almost as limiting a factor. In response to a question by Councilmember Ric Gordon, she noted that the addition of a grants coordinator to the staff was already paying dividends both in identifying which grants were good future targets and in the organized spending of current grant funds.

The city currently has unspent American Rescue Plan Act (ARPA) money and there are also state and federal grant monies available. But writing grant proposals and then overseeing the spending of the money require time and effort that have to be

See **WORKSESSION,** page 10

Year Review of Environmental Restoration

Beaver Dam Road Landfill

Beltsville Agricultural Research Center

Beltsville, MD 20705

The Beltsville (MD) Agricultural Research Center (BARC), a part of the U.S. Department of Agriculture's Agricultural Research Service, is beginning a five-year review of its environmental restoration of the Beaver Dam Road Land Fill (BDRLF). This location is about a 14-acre area of concern that is part of BARC' National Priorities Listing (Superfund) by the U.S. Environmental Protection Agency.

From the early 1940s through the 1980s, the BDRLF was used for disposal of nonhazardous materials such as rubble from masonry construction debris, tree clippings, wood, and broken asphalt from BARC operations. A Remedial Investigation also identified a plume of groundwater contaminated with trichloroethylene (TCE) up to a maximum concentration of 1,100 parts per billion (ppb). The plume impacts an area of about two-thirds of an acre to the southeast of the BDRLF. The Safe Drinking Water Act calls for a maximum contaminant level for TCE of 5 ppb, which is the cleanup goal for the site, although there are no drinking water wells in the area. To meet this goal, a remedy that included installation of a passive groundwater treatment system with a permeable reactive barrier (PRB) or "biowall" that captures and remediates TCE was selected and implemented. The biowall is currently in place and is undergoing performance monitoring.

The first five-year review was conducted in 2018. The site remedy was expanded in 2020 to include the installation of upgradient trench pits and microbial injections. The second five-year review will include an examination of the BDRLF's Record of Decision, a review of site conditions, the implementation of remedy enhancements to improve system performance and a review of the effectiveness of the biowall. It is being conducted between January 1, 2023, and January 31, 2023.

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10300 Baltimore Avenue
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Beltsville, MD 20705
Open: Monday through Friday: 8:30 am to 4:30 pm
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Facility Contacts:

John Houston, Environmental Engineer
Phone: (240) 204-3331, john.houston@usda.gov

Stephen Tushek - Environmental Management Unit Manager
Phone: ((202) 768-6595, stephen.tushek@usda.gov

GRIEF continued from page 2

or cup of tea shared with a friend can lift the mood. Having someone tackle the to-do list will make one feel supported – be specific in a request so others don't overstep.

Remember to honor the process. This is your unique grief experience and response and you are simply attempting to cope. Feel what you feel. If you are sad, acknowledge it, sit with it, cry if needed, breathe and allow the emotion the space and time to pass – it will.

Traditional or Something New?

Whether to acknowledge loved ones during this season depends on how difficult it is for you. Placing an empty chair, displaying a favorite ornament or creating a new one and making a loved one's favorite dish are all ways to honor them. These activities can warm and comfort or prove too emotionally hot to handle right now – you decide. Keep up a favorite tradition or create a new one.

Creating a memory box, writing a letter and journaling thoughts and feelings are ways to channel and process emotions and help with the healing process.

Grief ebbs and flows and looks different from day to day. Some days are easier than others. Being flexible is being kind to yourself. Have a Plan A and a Plan B. Imagine you've received an invitation to an event and, on the day of, decide it is too overwhelming; consider having a friend on standby ready to come over to watch a movie as your Plan B.

Take it one moment and emotion at a time this holiday season.

Glenda Willis, a counselor with Greenbelt CARES, who works with seniors, says, "Grieving is a process – it does not only occur in our lives when someone transitions but can occur when we experience change as we try to find peace in a new normal."

May you feel moments of peace this holiday season.

Gloria Walters-Flowers is a staff writer for the Greenbelt News Review. She is a certified health coach, a birth doula and a bereavement doula and is passionate about helping people develop coping skills when facing difficult moments and transitions.

APPENDIX C

STAKEHOLDER INTERVIEW FORMS AND REQUESTS FOR PUBLIC COMMENT

INTERVIEW RECORD

Site Name: Beltsville Agricultural Research Center **Time:** 1100-1200 **Date:** 01/19/2023
Subject: Beltsville Agricultural Research Center CERCLA Program Beaverdam Road Landfill Remedy

Type of Interview: Telephone

Interview Conducted by:
David Schanzle
Project Environmental Scientist
Mabbett and Associates, Inc.

Individual Contacted:
Dana S. Jackson, P.G.
NEPA/ECP Program Manager
ARNG-IEE-E

Dana Jackson was the Remedial Project Manager (RPM) for the Beltsville Agricultural Research Center (BARC) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) between 2008 and 2020.

Summary of Conversation:

1. **What is your overall impression of the project? (general sentiment)?**

The Beaver Dam Road Landfill project was in the second review cycle and was investigating compliance and efficacy of the implemented remedy per the ROD. The project was doing well at the time of his departure, and as he understands continues to do well after the implementation of supplemental treatment galleries. The success has been levering excellent contract support and a special research relationship between ARS and the University of Maryland's engineering program. This relationship provided insight that assisted in the fine tuning of the implemented remedy through applied research. This complementary relationship between ARS, UMD and the contractors has provided opportunities to investigation proposed remedies at the bench and pilot scale as part of the remedy selection process for preferred remedies.

During this review cycle, this specific project and the overall BARC CERCLA program has continued to move more sites towards RODs. Ongoing BARC 4/19 research had been determining the efficacy of bio-sequestration through land application of inexpensive soil amendment for DDT and Dieldrin pesticides.

2. **What effect have site operations had on the surrounding community?**

Negligible. Site operations don't have not had any significant impact on the surrounding community, since this site and other OUs are all within the continuous federal farm properties. To support green remediation goals. Past Time and Non-Time Critical Removal Actions offered sites for reforestation and pollinator friendly projects to support the local Anacostia Watershed and the restoration of the Chesapeake Bay per EO 13508.

One concern that Mr. Jackson has is that due to cost the annual BARC Field Day event is no longer held at the facility. This was an opportunity where not only BARC research was presented to the public, but also an informal venue to provide the community with the current status regarding the BARC CERCLA program. During his tenure there was no general interest or concern from the surrounding community regarding BARC CERCLA Program actions otherwise and limited participation from the community when public meetings regarding CERCLA related actions were convened.

Mr. Jackson mentioned that, in the past, the ARS public relations officer would pass along questions provided from a local high school class studying their local environment and responses would be provided as part of the community outreach.

3. **Are you aware of any community concerns regarding the site or its' operation and administration.**

According to Mr. Jackson, there has never been any concern to his knowledge. For example, the public meeting that was held for the implementation of the Beaverdam Road Landfill Record of Decision was sparsely attended by the public and there were no concerns about the program.

There were some concerns about the Low-Level-Radiation Burial Site (LLRBS) site removal action which involved the transport of low-level radioactive wastes on public roads. These concerns were mitigated through the ARS public relations office.

Under the guidance of Mr. Jackson who worked with the contractor to design and implement a public facing BARC IRAR has been a very useful not only for BARCs preservation of institutional knowledge, but also a ready resource for public and those doing local environmental condition of property surveys for all available documents and information regarding the BARC CERCLA program.

4. **Are you aware of any events, incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?**

None to his knowledge. He is aware that the lock at the gate to the BDRLF biowall was broken and the gate was bent some 6 years ago.

5. **Do you feel well informed about the site's activities and progress?**

Since his Departure in 2020 Mr. Jackson has not been contacted an no knowledge of the current program activities beyond those associated with BARC 18, the Low-Level Radiological Burial Site.

6. **Do you have any comments, suggestions, or recommendations regarding the site's management or operation?**

Mr. Jackson has no concerns regarding the site's management or operation based on his current knowledge of site activities.

Mr. Jackson mentioned that the BARC CERCLA program was impacted by the multiple remedial program manager changed through retirement, reassignment, and departures. Prior to his departure EPA had implemented a quarterly progress meeting to address program continuity issues that was hoped to minimize the effect of RPM turnover that, in his opinion, had delayed execution of additional RODs.

INTERVIEW RECORD

Site Name: Beltsville Agricultural Research Center **Time:** 1300-1330 **Date:** 01/18/2023
Subject: Beltsville Agricultural Research Center CERCLA Program Beaverdam Road Landfill Remedy

Type of Interview: Telephone

Interview Conducted by:
David Schanzle
Project Environmental Scientist
Mabbett and Associates, Inc.

Individual Contacted:
Holly Fliniau
EMD CERCLA Program Coordinator
United States Department of Agriculture

Summary of Conversation:

1. **What is your overall impression of the project? (general sentiment)?**

Regarding the BDRLF project, Holly is glad that ARS was able to implement the biowall and the upgradient trench pits as a fairly low cost and passive in-situ remediation system at the site.

Regarding the overall BARC CERCLA program, Holly wishes the overall program could be more efficient in addressing environmental issues in a timely manner. In her opinion, EPA Region 3 is much more bureaucratic and process-heavy than any of the other EPA Regions that she works with.

2. **What effect have site operations had on the surrounding community?**

Holly is not aware of overall community impacts from the BDRLF project specifically as the site is located within BARC and is not bordered by public or private lands of potential concern.

3. **Are you aware of any community concerns regarding the site or its' operation and administration.**

Holly had general comments regarding the BARC CERCLA program, but not regarding the BDRLF specifically. The combined remedy that was installed in 2013 and 2020 appears to be functioning as intended.

4. **Are you aware of any event , incidents, or activities at the site such as vandalism, trespassing, or emergency responses from local authorities?**

Holly mentioned hearing of illegal dumping along the access road to the BDRLF main gate. Source of dumping unknown, she believes that a security gate would be warranted to prevent unauthorized vehicular access to the site.

5. **Do you feel well informed about the site's activities and progress?**

Holly feels well informed about progress at the BDRLF. She finds the online Information Repository/Administrative Record (IRAR) maintained by BARC to be particular useful for finding relevant documents and believes that it should be a model for other USDA sites with CERCLA programs that need to place public facing documents.

6. **Do you have any comments, suggestion, or recommendations regarding the site's management or operation?**

Holly mentioned that her colleague, Karl Winson, was concerned about a material stockpile located at the western end of the biowall. He believed the material may have been excavated soil that was never disposed of. Mr. Schanzle informed Ms. Fliniau that the stockpile in question fill material comprised of sand compost and mulch used in the original permeable reactive barrier installation and is not a waste product or excavated soil. The stockpile can potentially be used for future remedy optimization programs at the BDRLF.

A similar stockpile of material is now located at the eastern end of the biowall consisting of fill material for the upgradient trench pits that was left over at the conclusion of that project. Both stockpiles can be used in future remediation projects at the BDRLF.

INTERVIEW RECORD

Site Name: Beltsville Agricultural Research Center **Time:** 1100-1130 **Date:** 01/17/2023
Subject: Beaverdam Road Landfill Remedy solar powered hot water circulation system

Type of Interview: Telephone

Interview Conducted by:
David Schanzle
Project Environmental Scientist
Mabbett and Associates, Inc.

Individual Contacted:
Roger Perry
Owner and Project Manager
Solar Energy Services Inc.

Summary of Conversation:
Roger Perry supervised the installation of the solar water heating and hot water circulation system in 2020 that was installed at the Beaverdam Road Landfill to circulate heated water through selected upgradient trench pits.

According to Mr. Perry, this was the first installation that he was involved in of a solar system with a remote power system that was installed solely for purposes of environmental remediation. He believes that it is a fantastically efficient method of heating areas of groundwater without the need for external power or other heating sources.

He is concerned, however, that system maintenance can be overlooked. Though designed to work without manual input, the system does require routine inspections and upkeep maintenance to ensure continued performance. In addition, some degree of vegetation clearing should be performed around the solar panels so that the panels are not thrown into shade.

Mr. Perry had no other comments regarding the overall groundwater remediation system, site access issues or site security.

INTERVIEW RECORD

Site Name: Beltsville Agricultural Research Center **Time:** 1000-1030 **Date:** 01/05/2023
Subject: Beltsville Agricultural Research Center CERCLA Program Beaverdam Road Landfill Remedy

Type of Interview: Telephone

Interview Conducted by:
David Schanzle
Project Environmental Scientist
Mabbett and Associates, Inc.

Individual Contacted:
David Johnson
Facility Security Officer
Security Services Unit
Beltsville Agricultural Research Center

Summary of Conversation:
Mr. Johnson is aware familiar with the fencing and gate access for the BDRLF site but has only limited knowledge of the purpose and the scope of the BDRLF Remedy.

According to Mr. Johnson, his office has not observed or reported problems or concerns within extents of site itself. BARC Security did intervene with two incidents that occurred within the agricultural fields located east of the BDRLF site:

1. Several individuals were illegally trespassing on the site to take personal photographs.
2. An individual was caught target shooting on BARC land adjacent to the BDRLF site.

No security incidents were reported as occurring within the fenced outline of the BDRLF site.

Mr. Johnson was not aware of illegal dumping that was observed along the access road from Beaverdam Road to the biowall main gate. Going forward, Mr. Johnson requested that all observations of illegal dumping at the site be reported to the BARC Security.

INTERVIEW RECORD

Site Name: Beltsville Agricultural Research Center **Time:** 1000-1030 **Date:** 12/01/2022
Subject: Beltsville Agricultural Research Center CERCLA Program Beaverdam Road Landfill Remedy

Type of Interview: Telephone

Interview Conducted by:
David Schanzle
Project Environmental Scientist
Mabbett and Associates, Inc.

Individual Contacted:
Mike Dudley
Biological Sciences Technician
USDA Wildlife Management

Summary of Conversation:
Mr. Dudley did not report any concerns that could affect protectiveness. He has not noted any hunting, trespassing, or dumping on the site. There have been no reports from hunters or other people who interact with the BARC Wildlife Office addressing these concerns.

According to Mr. Dudley, hunting is permitted to the sides of BDRLF, one side is for employees and the other is for public users, but no hunting is permitted on the landfill or within biowall area. The hunting areas are presented on a publicly available map published by BARC; and clearly show no hunting on the BDRLF site, including the remedy area. Mr. Dudley stated that he has seen no evidence of hunters accessing the site.

Five Year Review Stakeholder Interview Form
For Environmental Restoration at Beltsville Agricultural Research Center
Beltsville, MD 20705

NAME: Cpl. Kenneth Hibbert
ORGANIZATION: Prince Georges Police Beltsville
POSITION: Community Outreach Unit

INTERACTIONS WITH BDRLF:
GOES ONSITE **NO** **IF YES, WHAT**: ________________
ACTIVITIES OFFSITE **NO** **IF YES, WHAT**: ______

OBSRVATIONS: Returning home from work in January 2023, saw a pickup truck backed into the entry road of BDRLF preparing to unload brush and yard waste. Ordered the people to collect it and take it with them. Collected identification and license plate. No charges pressed.

ACCESS AND SITE CONTROLS: Familiar with site. Never seen dumping activity or trespassers before.

SITE MAINTENANCE: **NA**

PROBLMS/CONCERNS: No observed problems or concerns within extents of site itself. There have been other issues in the BARC area, but nothing at the BDRLF.

OTHER ISSUES THAT COULD AFFECT PROTECTIVENESS

No additional issues that would impact preventiveness.

INTERVIEW NOTES

Wants to be more involved at the community level. Interested in being informed for public outreach days, information about BARC, and about the BARC environmental program.

Primary questions to be answered in FYR:

- o *Successes/problems in the implementation of access and ICs*
- o *Successes/problems with the construction of the remedy and/or O&M*
- o *Unusual situations or problems at the site*

INTERVIEW DATE: **03/22/2023**

INTERVIEWER: **JASON LORENZETTI**

David P. Schanzle

From: David P. Schanzle
Sent: Thursday, January 12, 2023 12:12 PM
To: info@anacostiaws.org
Subject: Interview for Beltsville Agricultural Research Center (BARC) EPA Five-Year Review (FYR)

To whom it may concern,

I am an environmental contractor for the Beltsville Agricultural Research Center (BARC) who is working on the facilities Comprehensive Environmental Response, compensation and Liability Act (CERCLA) Program. My firm completing the second Five-Year Review (FYR) for BARC which involves community outreach to groups and individuals with an interest in the environmental program at the facility.

In 2013, a site called the Beaverdam Road Landfill (BDRLF) had an EPA remedy installed to address chlorinated solvents in groundwater that had previously been identified. The site is located close the intersection of Beaverdam Road and Research Road, within BARC. The site is also located about a quarter mile north of active Beaver ponds on Beaverdam Creek. Based on recent sampling data, the remedies are operating as designed and remediating groundwater before it flows into Beaverdam Creek.

For the FYR interviews, we are interested in recording any concerns or questions that AWS may have concerning the BDRLF and of the BARC environmental program in general. The recommended questions are general in nature and essentially solicit your thoughts about the site, concerns you may have about operations and past activities and any observations concerning issues (ecological concerns, availability of documents etc.).

Do you have time for a quick interview about BARC/BDRLF for the BARC FYR?

Let me know if you have any questions.

David Schanzle, CHMM
Project Environmental Scientist

Phone 781-275-6050 Ext. 107
Mobile 202-510-2037 (Preferred)

Web www.mabbett.com -
Email schanzle@mabbett.com

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January 13, 2023

Mr. Tom Taylor
Friends of Lowe Beaverdam Creek, Inc.
3206 Lake Ave
Cheverly, MD 20785-3141

Subject: Beltsville Agricultural Research Center EPA Five-Year Review

To whom it may concern,

Mabbett is an environmental contractor for the Beltsville Agricultural Research Center (BARC). We are working on the facility's Comprehensive Environmental Response, compensation and Liability Act (CERCLA) Program, which addresses contaminated areas of the facility. We are currently completing BARC's second Five-Year Review (FYR), which includes outreach to community groups and individuals with an interest in the environmental program at the facility and regionally.

In 2013, the investigation of the Beaverdam Road Landfill (BDRLF) was completed, based on the results of the investigation it was determined that a groundwater remedy was justified to assure the protection of the environment. The remedy was installed to address chlorinated solvents in groundwater that had previously been identified. The site is located close the intersection of Beaverdam Road and Research Road, within BARC. The site is also located about a quarter mile north of active Beaver ponds on Beaverdam Creek. Based on recent sampling data, the remedies are operating as designed and remediating groundwater before it flows into Beaverdam Creek. BARC is continuing monitoring and assessment of the site to assure the remedy will provide long term protection.

As part of this FYR, we are interested in speaking with local stakeholders, recording any concerns or questions that they may have concerning the BDRLF specifically, or the BARC environmental program in general. The recommended questions are general in nature and essentially solicit your thoughts about the site, concerns you may have about operations and past activities and any observations concerning issues (ecological concerns, availability of documents etc.).

I can also provide information concerning environmental programs ongoing at BARC and provide links to the available public documents and investigation reports of potential interest to you and colleagues. Do you have time for a quick interview about BARC/BDRLF for the BARC FYR? Feel free to email me at schanzle@mabbett.com or to call me at 202-510-2037. Let me know if you have any questions.

MABBETT & ASSOCIATES, INC.
Prepared by:

David Schanzle, CHMM
Project Environmental Scientist

Phone: 781-275-6050 Ext. 107
Mobile: 202-510-2037 (Preferred)

APPENDIX D

LAND USE CONTROLS INSPECTION PROGRAM (LUCIP) INSPECTION FORM (SEPTEMBER 2022 AND MARCH 2023)

BARC ANNUAL SITE INSPECTION

Beaverdam Road Landfill

September 2022

In accordance with the Land Use Control Implementation Plan (LUCIP) for the Beaverdam Road Landfill (BDRLF) the annual inspection of the site was conducted on September 14, 2022. Refer to the LUCIP for detailed requirements. Land use restrictions include the following:

- Access restrictions assessments at the site.
- No residential or industrial use at the site.
- No potable use of groundwater on the installation.
- No installation of groundwater withdrawal wells at the site.

Verification that land use restrictions are being accomplished and LUCs remain effective:

- Verify that any boundary fence in the site vicinity is intact.
- Verify that no residential housing, development activities are occurring at the site.
- Verify that no groundwater wells have been installed (except for monitoring wells installed as part of the remedy) and that no consumptive use of groundwater is occurring.
- Verify that applicable LUCs are intact, meet specifications, and/or are in good working order.
- Inspect the BDRLF cover, biowall, water management, and other features. Note deficiencies/corrective actions below:

Inspection Notes

The site inspection was performed on both the interior and exterior portions of the BDRLF in accordance with the LUC Plan for the site. The exterior of the site was examined for security and to ensure all LUC control features were intact (i.e. signage, locks, gates).

Description and location of any intrusive activities that are apparent or observed:

There was no evidence of intrusive activities within the fenced area of the BDRLF.

Description and location of any deficiency or violation of the land use restrictions:

The chain link fence that borders the landfill to the north along Beaverdam Road was repaired in May 2018. In addition, a barbed wire fence was installed around the perimeter of the site, from the access gate west of the Biowall to the eastern banks of an unnamed tributary that borders the site. At the time of the site inspection, a small portion of the barbed wire fence appeared to have been manipulated to allow site access to the woodlands north of the BDRLF. There were no other signs of unauthorized access.

The access gate and chain link fence at the entrance to the Biowall alignment was in intact and in good condition (Refer to Figure 1). There was no evidence of unauthorized entry.

Figure 1 shows the location of the northern, eastern, and western fence sections as well as all onsite monitoring wells and biowall wells.

Description of any proposed measures or corrective actions taken to remediate a deficiency or violation.

LUCIP controls were observed to be intact with signs of obvious tampering in one location where strands of barbed wire were twisted together, presumably to allow easier access through the fence line. Tree falls have the potential to break sections of barbed wire fence on the eastern borders of the property. These breaks have been repaired in the past. Periodic surveys should be conducted to identify breaks and conduct repairs when necessary. No further action is necessary at this time beyond conducting routine inspections of the integrity of the security fence.

The gravel access road that connects the construction entrance off of Beaverdam Road to the BDRLF main access gate was in good condition at the time of the site inspection. In the past there has been evidence of unauthorized dumping along this gravel road. There were no signs of unauthorized dumping at the time of the site inspection.

Additional Notes.

Silt fencing that was installed for the installation of the BDRLF upgradient trench pits is still in place and should be removed at this time.

Excess fill material for the upgradient trench pits was stockpiled within the eastern extents of the biowall clearing for site repairs and potential system expansions. This stockpile was covered with a tarp that should be removed at this time.

Solar panels to heat water for the hot water circulation system to the upgradient trench pits were installed within the eastern extents of the biowall clearing. Vegetation within this clearing should be cleared to prevent the system from being overgrown.

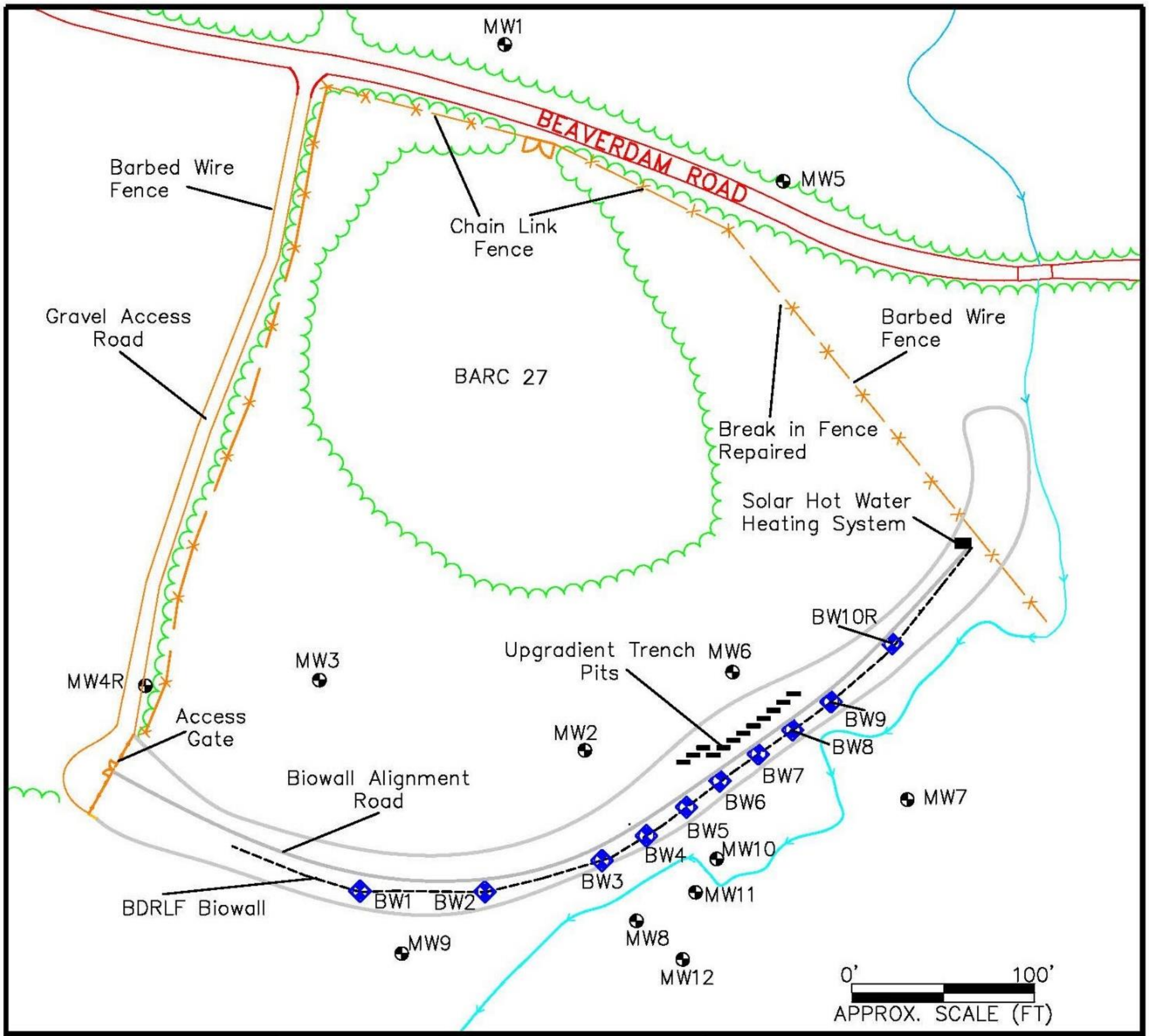
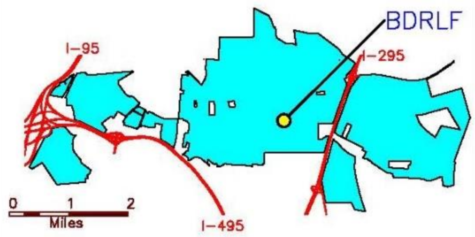


FIGURE 1

BARC 27:
Beaverdam Road Landfill
Site Map

BMT

Beltsville Agricultural Research Center



Certification Statement:

I, the undersigned, document that the inspection was performed as indicated above, and that the above information is true and correct to the best of my knowledge and belief. I have reviewed the provisions of the BDRLF LUCIP to verify requirements and restrictions.

Inspector: Justin Idzenga, Geologist

Signature: ________________________________ Date: _11/23/2022___

Name and Title: John Houston, Remedial Project Manager

Signature: ________________________________ Date:_______________

Within 30 days of the inspection, completed annual site inspection forms shall be sent to:

U.S. Environmental Protection Agency, Region 3
Attention: Vincent Grassi
Remedial Project Manager
1650 Arch Street
Philadelphia, PA 19103

PHOTOGRAPH 01: Strands of barbed wire were twisted to allow easier site access past the BDRLF fence line on the western site boundary. No other signs of unauthorized site access were observed.

PHOTOGRAPH 02: Eastern Biowall fence with signage (See Figure 1).

PHOTOGRAPH 03: BDRLF Solar water heating system distribution manifold is located north of the upgradient trench pits that were installed in 2020. There was no evidence of tampering or damage to this system at the site of the LUCIP inspection in September 2020.

PHOTOGRAPH 04: Solar panels to heat water for circulation through selected upgradient trench pits (See Figure 1). There were no signs of damage or tampering on this system at time of inspection. Vegetation in clearing will require clearing.

PHOTOGRAPH 05: Solar hot water circulation system main control panel. No signs of tampering or unauthorized access were observed at time of site inspection.

PHOTOGRAPH 06: Excess fill material for upgradient trench pits was stockpiled at the eastern extents of the biowall and covered with a tarp in 2020 to be available for potential system repairs. Tarp should be removed.

PHOTOGRAPH 07: Signage on site fencing on Beaverdam Road.

PHOTOGRAPH 08: BDRLF Gravel access road, facing north towards Beaverdam Road from main access gate. Gravel road was in good condition at time of site inspection.

BARC ANNUAL SITE INSPECTION

Beaverdam Road Landfill

March 2023

In accordance with the Land Use Control Implementation Plan (LUCIP) for the Beaverdam Road Landfill (BDRLF) an additional annual inspection of the site was conducted on Tuesday March 7, 2023. The inspection was conducted in accordance with the BARC LUCIP requirements.

The inspection was conducted by a multi-agency inspection team that visited the site to complete a site inspection for the ongoing five Year Review (FYR). The inspection team included the following staff and personnel:

- Mr. Vincent Grassi – EPA Remedial Project Manager (RPM)
- Mr. John Houston – BARC RPM
- Dr. Karen Zhang – USDA Chief, Environmental Division
- Mr. Cal Mather – USDA Chief, Safety, Health and Environmental Management Branch
- Ms. Lindsey David – USDA Environmental Protection Specialist
- Mr. Karl Wilson – USDA Environmental Engineer Office of Property and Environmental Management
- Mr. Stephen Tushek – BARC Environmental Management Unit Manager
- Mr. David Kindig – Mabbett Senior Project Manager
- Mr. Jason Lorenzetti – Mabbett Practice Lead Site Assessment and Remediation
- Mr. David Schanzle – Senior Project Scientist Site Safety and Health Officer

Land use restrictions identified in the LUCIP include the following:

- Access restrictions assessments at the site.
- No residential or industrial use at the site.
- No potable use of groundwater on the installation.
- No installation of groundwater withdrawal wells at the site.

Verification that land use restrictions are being accomplished and LUCs remain effective:

- Verify that any boundary fence in the site vicinity is intact.
- Verify that no residential housing, development activities are occurring at the site.
- Verify that no groundwater wells have been installed (except for monitoring wells installed as part of the remedy) and that no consumptive use of groundwater is occurring.
- Verify that applicable LUCs are intact, meet specifications, and/or are in good working order.
- Inspect the BDRLF cover, biowall, water management, and other features. Note deficiencies/corrective actions in the following sections.

As discussed within the team during the site inspection, the BDRLF LUCs do not address the landfill cap itself, only the fencing around the cap. At the time of the BDRLF Remedial Investigation / Feasibility Study (RI/FS), and subsequent Record of Decision (ROD), which required the development and implementation of the LUCIP, the landfill cap was inspected and identified as present. But no further evaluation of the landfill cap has been conducted. Observations of the landfill cap are presented below.

Inspection Notes

The site inspection was performed on both the interior and exterior portions of the BDRLF in accordance with the LUC Plan for the site. The exterior of the site was examined for security and to ensure all LUC control features were intact (i.e. signage, locks, gates).

Description and location of any intrusive activities that are apparent or observed:

Fencing was wrapped up/bent, and a trail across the toe of the landfill was observed. The trail passes near the solar heating system.

Some waste (e.g. food wrappers, cans) was observed along the main road. While the team was discussing site history, Officer Hibbert of the Prince George County Police arrived. He stated that he observed some dumping of yard waste, and required the people to clean it up. No charges were filed. Officer Hibbert was interviewed for the FYR.

Description and location of any deficiency or violation of the land use restrictions:

The chain link fence that borders the landfill to the north along Beaverdam Road was repaired in May 2018. In addition, a barbed wire fence was installed around the perimeter of the site, from the access gate west of the Biowall to the eastern banks of an unnamed tributary that borders the site. At the time of the site inspection, a small portion of the barbed wire fence appeared to have been manipulated to allow site access to the woodlands north of the BDRLF. There were no other signs of unauthorized access.

The access gate and chain link fence at the entrance to the Biowall alignment was in intact and in good condition (Refer to Figure 1). There was no evidence of unauthorized entry.

The drainage swale to the north of the Biowall was filled with water, which is normal. Vegetation was growing on the check dam and should be removed. The swale could potentially receive near surface water and is not sampled directly during the site monitoring. Surface water samples are taken from Beaverdam Creek just below the outfall. To date no chlorinated solvents have been detected in the receiving waterway.

A landfill camp inspection and maintenance is not included in the BDRLF LUCs. However, the landfill cap was observed to have sizable trees (more than three inches in diameter at waste height growing throughout. The status of the cap could not be determined via visual inspection at the time of the site walk.

The solar groundwater heat transfer system was powered but depressurized. The location of the leak could not be determined at the time of the inspection. To complete the repairs, a technician will be required to determine the nature of the pressure loss and the extent of repairs and recharging.

Empty metal and plastic drums were observed adjacent to the solar system. The drums were empty (inspected on March 22, 2023). The drums were left over from the installation of the upgradient groundwater treatment system. The drums were used for mixing.

Figure 1 shows the location of the northern, eastern, and western fence sections as well as all onsite monitoring wells and Biowall wells.

Description of any proposed measures or corrective actions taken to remediate a deficiency or violation.

LUCIP controls were observed to be intact with signs of obvious tampering in one location where strands of barbed wire were twisted together, presumably to allow easier access through the fence line. Tree falls have the potential to break sections of barbed wire fence on the eastern borders of the property. These breaks have been repaired in the past. Periodic surveys should be conducted to identify breaks and conduct repairs when necessary. No further action is necessary at this time beyond conducting routine inspections of the integrity of the security fence.

The gravel access road that connects the construction entrance off of Beaverdam Road to the BDRLF main access gate was in good condition at the time of the site inspection. In the past there has been evidence of unauthorized dumping along this gravel road. There were no signs of unauthorized dumping at the time of the site inspection.

The drums will be removed from the site in spring 2023. Any remaining liquid in them will be managed in accordance with the BARC Master IDW Plan (BMT, 2021).

The solar groundwater heating system will be inspected in summer 2023 and a repair schedule developed with the technical input. The system was designed to operate without the solar groundwater heating system, but the system improves remediation efficiency.

The drainage swale will be cleared of vegetation. The Performance Monitoring Plan (PMP) will be reviewed, and recommendations developed for discussion regarding potential changes to monitor all media onsite.

Additional Notes

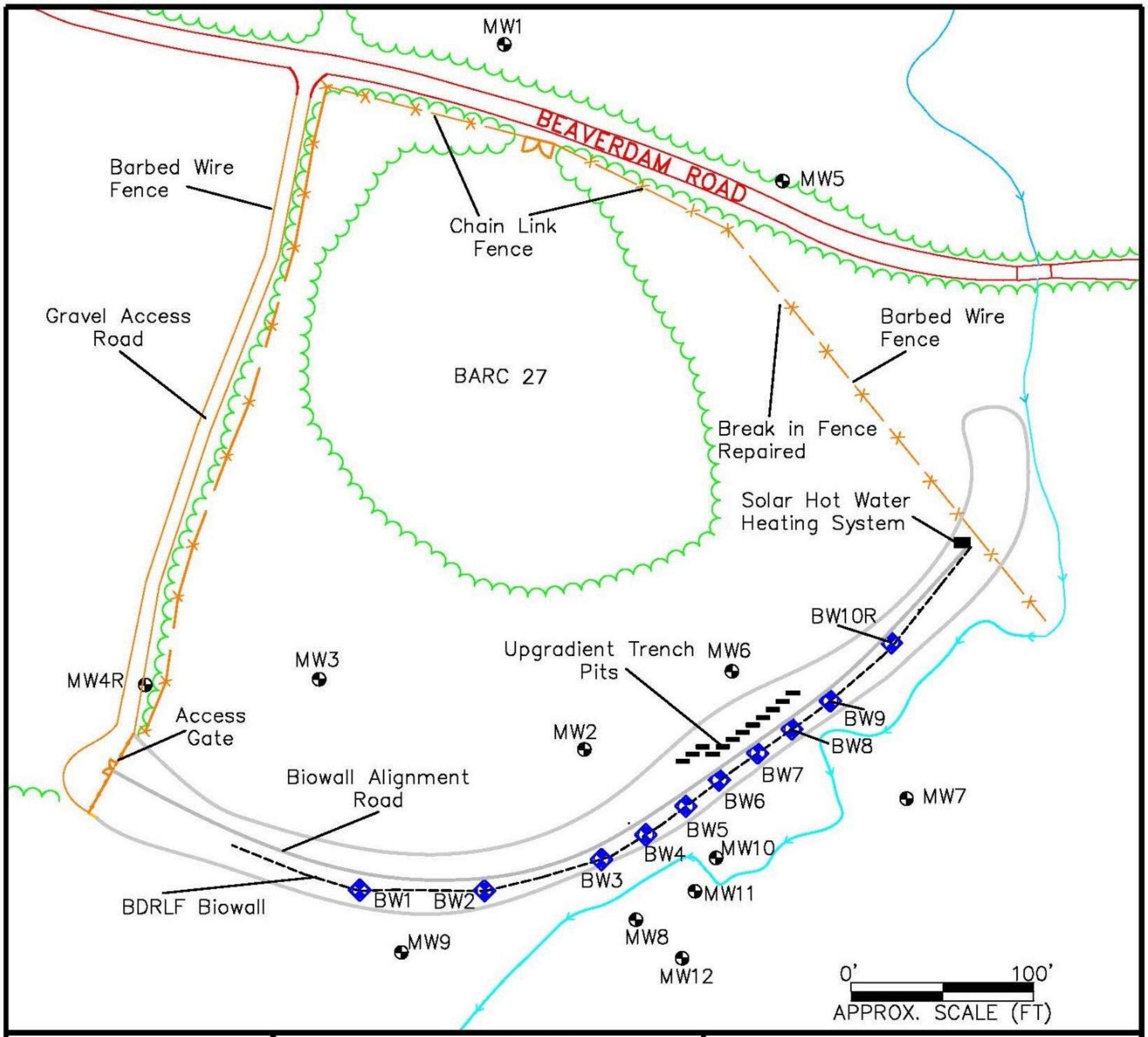
Silt fencing that was installed for the installation of the BDRLF upgradient trench pits is still in place and should be removed at this time.

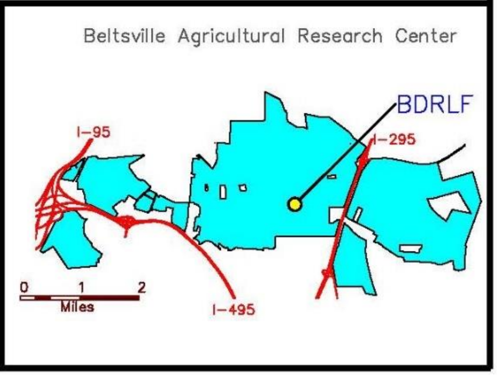
Excess fill material for the upgradient trench pits was stockpiled within the eastern extents of the biowall clearing for site repairs and potential system expansions. This stockpile was covered with a tarp that should be removed at this time.

Solar panels to heat water for the hot water circulation system to the upgradient trench pits were installed within the eastern extents of the biowall clearing. Vegetation within this clearing should be cleared to prevent the system from being overgrown.

FIGURE 1

BARC 27:
Beaverdam Road Landfill
Site Map





BMT

Certification Statement:

I, the undersigned, document that the inspection was performed as indicated above, and that the above information is true and correct to the best of my knowledge and belief. I have reviewed the provisions of the BDRLF LUCIP to verify requirements and restrictions.

Inspector: David Schanzle, Project Manger

Signature: ________________________________ Date: _3/22/2023_

Name and Title: John Houston, Remedial Project Manager

Signature: ________________________________ Date:_______________

Within 30 days of the inspection, completed annual site inspection forms shall be sent to:

U.S. Environmental Protection Agency, Region 3
Attention: Vincent Grassi
Remedial Project Manager
1650 Arch Street
Philadelphia, PA 19103

PHOTOGRAPH 01: Strands of barbed wire were twisted to allow easier site access past the BDRLF fence line on the western site boundary. No other signs of unauthorized site access were observed.

PHOTOGRAPH 02: BDRLF Gate. Good condition, lock present. No evidence of trespassing.

PHOTOGRAPH 03: Ponded water on the north of Biowall access path. Becomes a swale and enters a culvert to the tributary creek. The swale has a gravel check dam with vegetation growing on it. Vegetation to be removed.

PHOTOGRAPH 04: Evidence of beavers near the swale and check dam, north of the biowall.

PHOTOGRAPH 05: Stockpiles of mixed crushed limestone and biosolids. Old silt fencing around piles, as well as a tarp (not pictured). Silt fencing and tarp to be removed. Stockpiles to be removed and used elsewhere.

PHOTOGRAPH 06: Empty drums at the solar water heating area. Initial inspection identified the drums as containing some liquid. Subsequent review determined they were empty, but sunk into the ground. Drum to be removed, all liquids handled as per the BARC Master IDW Plan.

APPENDIX E

EPA SITE INSPECTION FORM – BARC BDRLF (March 2023)

BARC 27, Beaver Dam Road Landfill
Five-Year Review Site Inspection Checklist
(OSWER No. 9355.7-038-P)

I. SITE INFORMATION

Site name: Beaver Dam Road Landfill (BDRLF) (OU-5)	**Date of inspection:** March 7, 2023
Location and Region: BARC, Beltsville, MD**.** Reg. 3	**EPA ID:** MD0120508940
Agency, office, or company leading the five-year review: USDA, ARS, BARC Facility	**Weather/temperature:** 40s, Sunny, Windy

Remedy Includes: (Check all that apply)

■ Landfill cover/containment
■ Access controls
■ Institutional controls
☐ Groundwater pump and treatment
☐ Surface water collection and treatment
■ Other Permeable barrier wall that provides reductive dechlorination to solvents.

☐ Monitored natural attenuation
■ Groundwater containment
■ Vertical barrier walls

Attachments: ■ Inspection team roster attached ■ Site map attached

II. INTERVIEWS (Check all that apply)

I. **O&M site manager** David Schanzle (Mabbett) Project Scientist 3/7/2023
Name Title Date
Interviewed ■ at site ☐ at office ☐ by phone Phone no.________________
Problems, suggestions; ■ Report attached _________
Dumping observed, Some signs of trespassing. Solar heating system needs to be recharged. Site Maintenance to be completed. No protectivity issues noted.

2. **O&M staff** ________________________
Name Title Date
Interviewed ☐ at site ☐ at office ☐ by phone Phone no. ________________
Problems, suggestions; ☐ Report attached ________________

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency PG County Police
Contact Cpl. Ken Hibbert Corporal 3/7/2023 In Person
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached Observed Dumping (See Interview form)

Agency USDA Environmental Management Division
Contact Holly Fliniau Field Coordinator See Interview Form
Name Title Date Phone no.
Problems; suggestions; ☐ Report attached

Agency EPA Region 3
Contact Leslie Jones Former RPM See Interview Form
Name Title Date Phone no.
Problems: suggestions; ☐ Report attached

Agency
Contact
Name Title Date Phone no.
Problems: suggestions: ☐ Report attached

4. **Other interviews** (optional) ☐ Report attached.

Additional interviews were conducted outside of the site inspection, including:
BARC's Wildlife Management Officer, BARC's former RPM, Solar Solutions Project Manager, BARC Security Office.

In addition, the following community stakeholders were contacted:
Anacostia Watershed Society, Greater Beltsville Business Association, Friends of Lower Beaverdam Creek Society, and Beaverdam Creek Watershed Watch Group.

See the FYR for the details of these interviews.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

I. **O&M Documents**

☐ O&M manual ☐ Readily available ☐ Up to date ■ N/A
■ As-built drawings ■ Readily available ■ Up to date ☐ N/A
■ Maintenance logs ■ Readily available ■ Up to date ☐ N/A
Remarks
After Action Report, Design Drawings, and Maintenance Logs available on BARC IR/AR

2. **Site-Specific Health and Safety Plan** ■ Readily available ■ Up to date ☐ N/A
☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ■ N/A
Remarks

3. **O&M and OSHA Training Records** ☐ Readily Available ☐ Up to date ■ N/A
Remarks

4. **Permits and Service Agreements**

☐ Air discharge permit ☐ Readily available ☐ Up to date ■ N/A
☐ Effluent discharge ☐ Readily available ☐ Up to date ■ N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ■ N/A
☐ Other permits ☐ Readily available ☐ Up to date ■ N/A
Remarks

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ■*N/A*
Remarks

6. **Settlement Monument Records** ☐Readily available ☐ Up to date ■ N/A
Remarks

7. **Groundwater Monitoring Records** ■Readily available ■ Up to date ☐ N/A
Remarks

8. **Leachate Extraction Records** ☐Readily available ☐ Up to date ■ N/A
Remarks

9. **Discharge Compliance Records**

☐Air ☐ Readily available ☐ Up to date ■ N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date ■ N/A
Remarks

10. **Daily Access/Security Logs** ☐Readily available ☐ Up to date ■ N/A
Remarks
BARC Security manages site. Does not maintain daily access logs as no active systems or hazards.

IV. O&M COSTS

I. **O&M Organization**

☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
■ Federal Facility in-house ■ Contractor for Federal Facility
☐ Other ______

2. **O&M Cost Records**

■ Readily available ■ Up to date
■ Funding mechanism/agreement in place
Original O&M cost estimate $1.5 Million ☐ Breakdown attached

Total annual cost by year for review period if available

From	July 2018	To	June 2019	$200,000	☐ Breakdown attached
	Date		Date	Total cost	
From	July 2019	To	June 2020	$130,000	☐ Breakdown attached
	Date		Date	Total cost	
From	July 2020	To	June 2021	$250,000	☐ Breakdown attached
	Date		Date	Total cost	
From	July 2021	To	June 2022	$140,000	☐ Breakdown attached
	Date		Date	Total cost	
From	July 2022	To	June 2023	$0	☐ Breakdown attached
	Date		Date	Total cost	

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons:

Fiscal Year (FY) 2018 – $200,000 Project Monitoring Plan (PMP) costs.
FY 2019 – Lower costs following FY2018 FYR for reduced PMP monitoring. Additional remedy construction costs totaling $30,000.
FY 2020 – Higher costs for installation of groundwater pre-treatment systems. Additional remedy costs totaling $150,000.
FY 2021 – Lower costs for Performance Enhancement Assessment Monitoring. Additional remedy costs totaling $60,000.
FY 2022 – No major expenditures due to contracting issues. PMP revisions contracted out in April 2023.

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable ☐ N/A

A. Fencing

I. **Fencing damaged** ☐ Location shown on site map ■ Gates secured ☐ N/A
Remarks ______

B. Other Access Restrictions

I. **Signs and other security measures** ☐ Location shown on site map ☐ N/A
Remarks Signs present on Beaverdam Road (landfill entrance), and at the main biowall access gate.

C. Institutional Controls (ICs)

I. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ■ No ☐ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ■ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by) Self reporting, drive by inspections. No hazards present.

Frequency Quarterly systems inspections and reports on the IR/AR.

Responsible party/agency BARC

Contact John Houston, Environmental Engineer 3/22/2023 240-204-3331

Name	Title	Date	Phone no.
John Houston	Environmental Engineer	3/22/2023	240-204-3331

Reporting is up-to-date ■ Yes ☐ No ☐ N/A

Reports are verified by the lead agency ■ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ■ Yes ☐ No ☐ N/A

Violations have been reported ■ Yes ☐ No ☐ N/A

Other problems or suggestions: ☐ Report attached

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2. **Adequacy** ■ ICs are adequate ☐ ICs are inadequate ☐

Remarks Roads require annual/semi-annual upkeep due to soil saturation and soft ground surface conditions. Okay at time of Inspection.

D. General

I. **Vandalism/trespassing** ■ Location shown on site map ☐ No vandalism evident.

Remarks Minor trespassing from hunters or locals. Reports of dumping brush onsite. No access or damage to the Area of the remedy, or activities at or near the remedy.

2. **Land use changes on site** ■ N/A

Remarks

3. **Land use changes off site** ■ N/A

Remarks

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable ☐ N/A

I. **Roads damaged** ☐ Location shown on site map ■ Roads adequate ☐ N/A

Remarks Roads require annual/semi-annual upkeep due to soil saturation and soft ground surface conditions. Okay at time of Inspection.

B. Other Site Conditions

Remarks
Ground along biowall road waterlogged. Stockpiles of limestone and biosolids to be removed. Silt fencing to be removed. Check dam vegetation to be cleared. Solar water heating system not functioning and requires repair.

1

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

I. **Settlement** (Low spots) ☒ Location shown on site map ☐ Settlement not evident
Areal extent 100% Depth Up to 1 foot.
Remarks Landfill cap settled throughout footprint; not included as part of the ROD.

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
Lengths ______ Widths ______ Depths ______
Remarks No visible cracks. Too much debris and vegetation to make observation.

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident.
Areal extent ______ Depth ______
Remarks No visible erosion. Very gentle side slopes.

4. **Holes** ☐ Location shown *on* site map ☒ Holes not evident.
Areal extent ______ Depth ______
Remarks No visible holes. Some animal burrows may be present, but not observed.

5. **Vegetative Cover** ☐ Grass ☐ Cover properly established ☐ No signs of stress.
☒ Trees/Shrubs (indicate size and locations on a diagram)
Remarks Trees and shrubs throughout. No maintenance on cap to prevent tree growth. Not part of LUCs.

6. **Alternative Cover (armored rock, concrete, etc.)** ☒ N/A
Remarks ______

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident.
Areal extent ______ Height ______
Remarks ______

8. **Wet Areas/Water Damage** ■ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent
☐ Ponding ☐ Location shown on site map Areal extent
☐ Seeps ☐ Location shown on site map Areal extent
☐ Soft subgrade ☐ Location shown on site map Areal extent
Remarks No wet areas on landfill. Wet areas near biowall, where groundwater is within three foot of surface.

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ■ No evidence of slope instability
Areal extent
Remarks

B. Benches ☐ Applicable ■ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

I. **Flows Bypass Bench** ☐ Location shown on site map ■ N/A or okay
Remarks

2. **Bench Breached** ☐ Location shown on site map ■ N/A or okay
Remarks

3. **Bench Overtopped** ☐ Location shown on site map ■ N/A or okay
Remarks

C. Letdown Channels ☐ Applicable ■ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

I. **Settlement** ☐ Location shown on site map ■ No evidence of settlement
Areal extent Depth
Remarks Some settlement visually observed, but not included as part of the ROD/remedy.

2. **Material Degradation** ☐ Location shown on site map ■ No evidence of degradation
Material type Areal extent
Remark:-.

3. **Erosion** ☐ Location shown on site map ■ No evidence of erosion
Areal extent Depth
Remarks

4. **Undercutting** ☐ Location shown on site map ■ No evidence of undercutting
Areal extent ______ Depth ______
Remarks ______________________________

5. **Obstructions** Type ______________ ■ No obstructions
☐ Location shown on site map Areal extent ______
Size ______
Remarks ______________________________
1

6. **Excessive Vegetative Growth** Type Trees and brush
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent ______
Remarks Brush in drainage swale requires periodic attention.

D. Cover Penetrations ☐ Applicable ■ N/A

I. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance
☐ N/A
Remarks ______________________________

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks ______________________________

3. **Monitoring Wells** (within surface area of landfill)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks ______________________________

4. **Leachate Extraction Wells**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
Remarks ______________________________

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ☐ N/A
Remarks ______________________________

E. Gas Collection and Treatment ☐ Applicable ■ N/A

I. **Gas Treatment Facilities**
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs
Maintenance Remarks

2. **Gas Collection Wells, Manifolds and Piping**
☐ Good condition ☐ Needs
Maintenance Remarks

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
D Good condition ☐ Needs Maintenance ☐ N/A
Remarks

F. Cover Drainage Layer ☐ Applicable ■ N/A

I. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
Remarks
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2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
Remarks

G. Detention/Sedimentation Ponds ☐ Applicable ■ N/A

I. **Siltation** Areal extent __________ Depth ______ ☐ N/A
■ Siltation not evident
Remark5

2. **Erosion** Areal extent __________ Depth
■ Erosion not evident
Remark.

3. **Outlet Works** ☐ Functioning ■ N/A
Remarks

4. **Dam** ☐ Functioning ■ N/A
Remarks

H. Retaining Walls ☐ Applicable ■ N/A

I. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement ________ Vertical displacement
Rotational displacement ________
Remarks ________

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks ________

I. Perimeter Ditches/Off-Site Discharge ■ Applicable ☐ N/A

I. **Siltation** ☐ Location shown on site map ■ Siltation not evident
Areal extent ________ Depth ________
Remarks ________

2. **Vegetative Growth** ■ Location shown on site map ☐ N/A
■ Vegetation does not impede flow.
Areal extent ________ Type ________
Remarks Drainage swale contains vegetation. Check dam contains brush and saplings.

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
Areal extent ________ Depth ________
Remarks ________

4. **Discharge Structure** ☐ Functioning ■ N/A
Remarks ________

VIII. VERTICAL BARRIER WALLS ☐ Applicable ■ N/A

I. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent ________ Depth ________
Remarks ________

2. **Performance Monitoring** Type of monitoring! ________
☐ Performance not monitored
Frequency ________ ☐ Evidence of breaching
Head differential ________
Remarks ________

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☐ Applicable ☒ N/A

I. **Pumps, Wellhead Plumbing, and Electrical**
☐ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A
Remarks

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs Maintenance ☒ N/A
Remarks passive remedy

3. **Spare Parts and Equipment**
☒ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks

B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable ☐ N/A

I. **Collection Structures, Pumps, and Electrical**
☐ Good condition ☒ Needs Maintenance
Remarks
Swale needs vegetation clearing.

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
☐ Good condition ☐ Needs Maintenance ☒ N/A
Remarks

3. **Spare Parts and Equipment**
☒ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
Remarks

C. Treatment System ■ Applicable ☐ N/A

I. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ■ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters
☐ Additive (*e.g.*, chelation agent, flocculent)
■ Others limestone for pH adjustment
☐ Good condition ☐ Needs Maintenance
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
■ Equipment properly identified
☐ Quantity of groundwater treated annually
☐ Quantity of surface water treated annually
Remarks

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☐ Good condition ■ Needs Maintenance
Remarks Solar system needs recharging. Electrical panel powered in in good repair.

3. **Tanks, Vaults, Storage Vessels**

☐ N/A ☐ Good condition ☐ Proper secondary containment ■ Needs Maintenance
Remarks Glycol system needs repair.

4. **Discharge Structure and Appurtenances**

■ N/A ☐ Good condition ☐ Needs Maintenance
Remarks

5. **Treatment Building(s)**

☐ N/A ■ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored
Remarks

6. **Monitoring Wells** (pump and treatment remedy)

■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
■ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks

D. Monitoring Data

I. Monitoring Data

■ Is routinely submitted on time ■ Is of acceptable quality

2. Monitoring data suggests:

■ Groundwater plume is effectively contained ■ Contaminant concentrations are declining

D. Monitored Natural Attenuation

I. **Monitoring Wells** (natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ■ N/A
Remarks

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The remedy was designed to intercept the chlorinated solvent plume while providing ideal conditions for microbial
Populations that can use reductive dechlorination to convert the TCE to ethylene. The biowall provides carbon, pH
Controls, and a preferential flow path. The upgradient pretreatment area provides additional time for treatment for time
Limited processes, controls pH, and prepares the groundwater for final treatment within the biowall.
No Performance Monitoring conducted between January 2022 and April 2023 due to contracting issues. PMP set to
Resume in May 2023. January 2022 data showed reductions of COCs to below Remediation Goals.
Remedy is functioning as intended.
RI did not consider landfill cap to be relevant to groundwater conditions and was not included as an element of the ROD.
Consideration of water quality of the drainage swale.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

Site requires maintenance for silt fencing, clearing, and soil/material stockpiles.
Solar heating system requires maintenance.
Road will require periodic maintenance to assure access.
Fencing needs to be repaired. Signage added to where fencing is disturbed.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

Remedy performance significantly improved since 2018 FYR. Additional performance monitoring required.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

Several optimization initiatives were identified and implemented in 2019/2020. These included pH adjustment (limestone to increase pH), solar heating to optimize microbial activity in groundwater, and insertion of microbial consortia aimed at treating chlorinated compounds.

None currently identified beyond maintenance of the solar heating system and the assessment of current efforts.