SIXTH FIVE-YEAR REVIEW REPORT FOR BRIO REFINING, INC. SUPERFUND SITE HARRIS COUNTY, TEXAS

August 2023

Prepared by

U.S. Environmental Protection Agency
Region 6
Dallas, Texas

SIXTH FIVE-YEAR REVIEW REPORT
BRIO REFINING, INC. SUPERFUND SITE
HARRIS COUNTY, TEXAS
EPA ID#: TXD980625453

This memorandum documents the U.S. Environmental Protection Agency's performance, determinations, and approval of the sixth five-year review for the Brio Refining, Inc. Superfund site (the Site) under Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S. Code Section 9621(c), as provided in the attached sixth Five-Year Review Report.

Summary of the Sixth Five-Year Review Report

The results of the sixth Five-Year Review indicate that the remedy completed to date is currently protective of human health and the environment in the short term. Overall, the remedial actions performed are functioning as designed, and the Site is being maintained appropriately. No deficiencies were noted that currently impact the short-term protectiveness of the remedy, although items were identified that require further action to ensure the continued long-term protectiveness of the remedy.

The EJScreen report (Appendix J) identifies four EJ indexes that exceed the 80th percentile at either the national or state average level. The EJ indexes flagged are Particulate Matter 2.5, Air Toxics Cancer Risk, Air Toxics Respiratory Hazard Index, and Superfund Proximity.

The amended remedy, including containment of highly contaminated source materials and treatment of shallow groundwater, has been implemented, and institutional controls are in place. Construction of the remedy was completed in 2004, and current operations involve maintenance, monitoring and a groundwater recovery system. The Site has weathered several hurricanes including Hurricane Harvey in 2017 which did not result in any significant impacts to the remedy or loss of protectiveness. Due to the nature and resiliency of the remedy, the protectiveness of the remedy is anticipated to not be affected by climate change.

Actions Needed

The following actions must be taken for the remedy to be protective over the long term:

- Complete the Phase III investigation of the Fifty-Foot Sand Zone south of the Site and evaluate if remedial action beyond monitored natural attenuation is warranted for the Fifty-Foot Sand Zone.

Determination

I have determined that the selected remedy for the Brio Refining, Inc. Superfund Site is currently protective of human health and the environment in the short term. This Five-Year Review Report specifies the actions that need to be taken for the remedy to remain protective over the long term.

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Lisa Price
Acting Director, Superfund and Emergency Management Division

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ISSUES/RECOMMENDATIONS

SIXTH FIVE-YEAR REVIEW REPORT
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OU(s):	**Issue Category: Remedy Performance**			
	Issue: The extent of contaminants of concern in the Fifty-Foot Sand Zone in the southern part of the Site has not been fully delineated, and the remedy has not yet achieved cleanup goals for the Fifty-Foot Sand Zone.			
	Recommendation: Complete the Phase III investigation of the Fifty-Foot Sand Zone south of the Site and evaluate if remedial action beyond monitored natural attenuation is warranted for the Fifty-Foot Sand Zone.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2024

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LIST OF ABBREVIATIONS AND ACRONYMS

AER	Annual Effectiveness Report
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
AROD	Amended Record of Decision
bgs	Below Ground Surface
BSTF	Brio Site Task Force
CAG	Community Advisory Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
cPAH	Carcinogenic Polycyclic Aromatic Hydrocarbon
CPT	Cone Penetration Testing
1,2-DCA	1,2-Dichloroethane
1,1-DCE	1,1-Dichloroethene
DNAPL	Dense Non-Aqueous Phase Liquid
DOP	Dixie Oil Processors Superfund Site
EA	Endangerment Assessment
EPA	United States Environmental Protection Agency
FFSZ	Fifty-Foot Sand Zone
FLAAQS	Fence Line Ambient Air Quality Standard
FYR	Five-Year Review
HQ	Hazard Quotient
IC	Institutional Control
LNAPL	Light Non-aqueous Phase Liquid
MCL	Maximum Contaminant Level
MCU	Middle Clay Unit
mg/kg	Milligrams per Kilogram
µg/L	Micrograms per Liter
MNA	Monitored Natural Attenuation
MOM	Maintenance, Operations, and Monitoring
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ND	Not Detected
NPL	National Priorities List
NSCZ	Numerous Sand Channels Zone
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
ppm	Parts Per Million
PRP	Potentially Responsible Party
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
RSL	Regional Screening Level
SVOC	Semi-Volatile Organic Compound
TAC	Texas Administrative Code
1,1,2-TCA	1,1,2-Trichloroethane
TCEQ	Texas Department of Environmental Quality
UU/UE	Unlimited Use and Unrestricted Exposure
VOC	Volatile Organic Compound

I. INTRODUCTION

The purpose of a five-year review (FYR) is to evaluate the implementation and performance of a remedy 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 FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Section 300.430(f)(4)(ii)), and considering EPA policy.

This is the sixth FYR for the Brio Refining, Inc. Superfund site (the Site). The triggering action for this statutory review is the completion date of the previous FYR. 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 Site consists of one operable unit (OU1) which addresses the Site's soil, groundwater and source control remedies. This FYR Report addresses the OU.

EPA remedial project manager (RPM) Nathaniel Applegate led the FYR. Participants included Texas Commission on Environmental Quality (TCEQ) project manager Michael Jeude and Ryan Burdge and Claire Marcussen from EPA FYR contractor Skeo. The Site's potentially responsible party (PRP) group, the Brio Site Task Force (BSTF), was notified of the initiation of the FYR. The review began on 10/31/2022.

Appendix A provides a list of documents reviewed for this FYR. Appendix B provides the Site's chronology of events.

Site Background

The 58-acre Site is about 20 miles south of Houston in southern Harris County, Texas. A petrochemical reprocessing and refining facility operated on site from the 1950s to 1982. Dixie Farm Road divides the Site into two areas. Operators used Brio North for storage of feedstock in on-site pits. Operators used Brio South primarily for processing activities. Site operators conducted disposal activities on both Brio North and Brio South, contaminating groundwater, surface and subsurface soils and sediment with hazardous volatile and semi-volatile organic chemicals.

Land uses nearby include residential areas, a college, a hospital and commercial development to the northeast. The area to the east includes residential development, a convenience store that sells fuel and an active oil field. Undeveloped properties are north, west and south of the Site. The property to the south has been used for wetland habitat and preservation of forest habitat as part of a natural resource restoration project led by BSTF in conjunction with several state and federal agencies.

Mud Gully, a flood control ditch and a tributary of Clear Creek, runs along the southwest boundary of Brio North. Clear Creek is about a half-mile southwest of the Site. The northern part of the adjoining Dixie Oil Processors Superfund site (the DOP site) is further southwest of Mud Gully. Mud Gully also runs along the southwest boundary of the DOP site. Brio South is immediately northeast of the southern part of the DOP site (Figure 1). Groundwater occurs in two zones: the Numerous Sand Channels Zone (NSCZ) and the Fifty-Foot Sand Zone (FFSZ). The upper water-bearing zone, the NSCZ, consists of sands and silty clays and is generally encountered from 14 feet to 32 feet below ground surface (bgs). It contains dense non-aqueous phase liquids (DNAPL), elevated groundwater contamination, has a low well yield, and typically flows toward and discharges to Mud Gully to the west. The NSCZ is neither an existing nor a potential drinking water supply because of the poor yield of that zone. The FFSZ is separated from the NSCZ by the Middle Clay Unit (MCU), a confining layer. Thus, it is

less contaminated than the NSCZ. The FFSZ is generally encountered between 52 feet and 61 feet bgs and has a reasonably high well yield. Groundwater in the FFSZ generally flows to the east.

Figure 1: Site Vicinity Map

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Brio Refining, Inc.		
EPA ID: TXD980625453		
Region: 6	**State:** Texas	**City/County:** Friendswood/Harris
SITE STATUS		
NPL Status: Deleted		
Multiple OUs? No	**Has the Site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA		
Author name: Nathaniel Applegate, with additional support provided by Skeo		
Author affiliation: EPA Region 6		
Review period: 10/31/2022 - 7/11/2023		
Date of site inspection: 12/15/2022		
Type of review: Statutory		
Review number: 6		
Triggering action date: 9/20/2018		
Due date *(five years after triggering action date)*: 9/20/2023		

II. RESPONSE ACTION SUMMARY

Basis for Taking Action

The Site's remedial investigation and feasibility study (RI/FS), conducted by EPA initially and later completed by the PRPs between 1984 and 1988, showed that the major sources of contamination were the closed impoundments (pits) on the Site and contaminant migration from the pits to NSCZ groundwater. EPA completed an Endangerment Assessment (EA) after the RI/FS finished in 1988. The EA estimated the potential for adverse effects on human health and the environment from trespasser exposure to site soils (which assumed that the Site would remain a secured industrial facility) and sediment and unrestricted exposure to off-site soils. The EA concluded that the Site potentially posed five major risks to human health and the environment. The identified pathways were:

- Direct (dermal) contact with contaminated surface soils and sediments.
- Ingestion of contaminated surface soils and sediments.
- Inhalation of contaminated dust and volatile organic compound (VOC) emissions.
- Ingestion of contaminated groundwater from the FFSZ.
- Exposure of aquatic biota to NSCZ discharges of contaminated groundwater to Mud Gully.

Affected media at the Site are groundwater, surface soils/sediment and subsurface soils. The principal contaminants of concern (COCs) at the Site are organic compounds and chlorinated solvent compounds. EPA proposed the Site for listing on the Superfund program's National Priorities List (NPL) in October 1984. EPA finalized the Site's listing on the NPL in March 1989.

Response Actions

In 1985, BSTF completed a removal action by covering the waste pits. In June 1989, BSTF, the Site's PRP group, signed an Administrative Order on Consent (AOC) to begin dismantlement of the process equipment on the Site. BSTF completed facility dismantling in December 1989. The process equipment and tanks were decontaminated and sent to an off-site smelter for reclamation.

EPA issued a Record of Decision (ROD) in March 1988 selecting a cleanup plan to address sitewide contamination. The ROD does not list formal remedial action objectives (RAOs). However, EPA developed action levels in soil that were protective for restricted exposure assuming the Site would remain a secured industrial facility. In addition, the detailed analysis of alternatives provided informal RAOs:

- Reduce the risks associated with exposure to contaminated materials.
- Inhibit the migration of contaminated groundwater from the Site.
- Promote runoff and minimize infiltration of contaminated soil and material.

The remedy components that EPA selected in the 1988 ROD were on-site incineration of pit residuals, removal of surface contamination, channel improvements to Mud Gully, demobilization of remaining process equipment, removal of DNAPL, and groundwater pumping and treatment in the NSCZ. Due to emission concerns during the PRPs' initial implementation of the 1988 remedy, a "stop work" order was executed for the on-site incineration remedy component. In 1997, EPA issued an Amended ROD (AROD) that replaced the incineration remedy component with a containment remedy.

The 1997 AROD also formalized sitewide RAOs as follows:

- Protection of the health and safety of the community, workers and the environment during implementation of the remedy.
- Minimization, to the extent practicable, of disruption and inconvenience to the community during implementation of the remedy.
- Long-term control of migration of leachable organic liquids from the source area and control of off-site migration of free-phase liquids or site constituents moving through the groundwater, surface water, soil or air pathways.
- Long-term reduction of potential future risk to the community and the environment resulting from off-site exposure to site constituents by maintaining or achieving:
    - Target levels of public exposure to air emissions.
    - Target levels of affected soil dermal contact and ingestion.
    - Control of off-site transport of affected soils to acceptable levels.
    - Protection of existing aquatic life in Mud Gully.
    - Target levels of organic constituents in the FFSZ in a reasonable period.
- Minimize the potential negative impact of natural disasters such as flooding and hurricanes.
- Long-term effective site control and aesthetics.

Table 1 lists the final sitewide remedy components, as amended in 1997.

Table 1: 1988 ROD Remedy Components, as Revised by the 1997 AROD

Medium	Remedial Component
On-site residual pits and surface contamination	• Install a sub-grade vertical barrier wall enclosing the Site to limit the potential for off-site migration of contaminated groundwater in the NSCZ (replaced the incineration remedy component from the 1988 ROD). • Cap the Site with a multi-layer engineered cover system within the limits of the vertical barrier wall (includes a gas collection layer, flexible membrane liner, compacted clay and topsoil to promote vegetative growth) (replaced the incineration remedy component from the 1988 ROD). • Implement engineering controls and institutional controls to restrict site access and site use, respectively.
Off-site soil contamination	• Excavate to background levels (to be further defined in the remedial design).
Debris and rubble	• Consolidate debris and rubble and the ultimate disposition of the material determined during the remedial design
Mud Gully	• Implement flood control improvements to ensure flow capabilities in the drainage system. • Monitor sediment.
Water treatment system	• Stabilize wastes in place in the existing water treatment system impoundments. • Backfill impoundments with dike materials and other uncontaminated materials (if necessary). • Cap and cover and bring to grade to promote runoff and minimize infiltration. • Install a wastewater treatment plant or route wastewater to a publicly owned treatment works. • Use parts of the existing water treatment plant (WTP), as needed, during the remedial action and decommission the system after completion of the remedial action.
Existing tanks and drums	• Remove tank contents. • Decontaminate tanks and sell them or transport them to an EPA-approved disposal facility off site. • Transport tank contents and drums to an EPA-approved disposal facility off site. • Dismantle tanks used during remedial activities and dispose of them at an EPA-approved disposal facility off site.
Process equipment	• Dismantle and dispose of the equipment at an EPA-approved disposal facility off site.
NSCZ groundwater and DNAPL	• Pump groundwater from inside the vertical barrier wall and treat it on site, with discharge off site into Mud Gully to meet standards protective of human health and the environment (AROD addition as a groundwater flow control system). • Continue the use of the DNAPL recovery system that was ongoing during the mobilization of the incinerator and was not suspended in 1994. • Conduct long-term monitoring. • Implement institutional controls.
FFSZ groundwater	• Monitor natural attenuation. • Conduct long-term monitoring. • Implement institutional controls.
Air	• Monitor during remedy construction.
Sources: The Site's 1988 ROD and 1997 AROD.	

EPA selected target levels for soil established in the 1988 EA after the completion of the RI/FS. EPA selected the soil cleanup goals with the assumption that the Site would remain a secured industrial facility (Table 2). EPA selected EPA's drinking water maximum contaminant levels (MCLs) as the cleanup goals for the FFSZ, as specified in the 1997 AROD, but did not list numeric values. Values in Table 3 are from the most current Annual Effectiveness Report (AER), dated August 2021. The 1997 AROD also revised the remediation goals for the NSCZ from drinking water standards to surface water quality standards for the NSCZ outside the containment system and for Mud Gully and Clear Creek (Table 4). EPA also specified in the 1997 AROD that an air

monitoring system will be maintained during remedy construction to protect public health and that target levels will be established in consultation with the Texas Department of Health and the Agency for Toxic Substances and Disease Registry. Long-term air monitoring has continued post-construction of the remedy as part of site maintenance and monitoring activities. The Data Review section of this FYR Report provides more information.

Table 2: Target Levels for Soil

COC	On-site Soil[a] (mg/kg)	Off-site Soil[b] (mg/kg)
Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)		
Benzo(a)anthracene	10,200	26.9
Benzo(b)fluoranthene	1,200	5.1
Benzo(k)fluoranthene	580	5.1
Benzo(a)pyrene	44	0.04
Dibenz(a,h)anthracene	74	0.23
Indeno(1,2,3-c,d)pyrene	7,400	10.5
Volatile and Semi-volatile Organic Compounds (VOCs and SVOCs)		
1,2-Dichloroethane (1,2-DCA)	2,800	0.13
1,1,2-Trichloroethane (1,1,2-TCA)	2,300	1.4
Bis(2-chloroethyl)ether	230	0.07
Methylene chloride	33,000	12.5
Vinyl chloride	109	0.02

Notes:
Source: Table 1 in the Site's 1997 AROD.
a. Values based on restricted access and trespasser exposure and a carcinogenic risk of 1 x 10^{-6} or noncancer hazard quotient (HQ) of 1. The lower of the ingestion-based and inhalation-based value was selected for the on-site soil levels.
b. Background levels are to be achieved for off-site soil.
mg/kg = milligrams per kilogram

Table 3: FFSZ Groundwater Remedy Cleanup Goals

COC	AROD Criteria (µg/L)
Benzene	5
Carbon tetrachloride	5
Chlorobenzene	100
1,2-Dichlorobenzene	600
1,4-Dichlorobenzene	75
1,2-DCA	5
1,1-DCE	7
cis-1,2-Dichloroethene	70
trans-1,2-Dichloroethene	100
1,2-Dichloropropane	5
Ethylbenzene	700
Methylene chloride	5
Styrene	100
Tetrachloroethene	5
Toluene	1,000
1,2,4-Trichlorobenzene	70
1,1,1-Trichloroethane	200
1,1,2-TCA	5
Trichloroethene	5
Vinyl chloride	2
Xylenes (total)	10,000[a]
Trihalomethanes (total)	100

Notes:
a. All four AER reports for this FYR period list the MCL for xylene as 1,000 µg/L when the MCL is 10,000 µg/L.

COC	AROD Criteria (µg/L)
Source: Page 12 in the Site's 1997 AROD specified that the FFSZ will be monitored to ensure groundwater is below established MCLs but did not specify the numeric values. Values presented are from the most current Annual Effectiveness Report, dated August 2021. µg/L = micrograms per liter	

Table 4: Surface Water Remedy Performance Criteria

COC	Mud Gully and NSCZ[a] (µg/L)	Clear Creek (µg/L)
1,2-DCA	20,000	1,794
1,1-DCE	8,740	87.4
1,1,2-TCA	4,180	41.8
Vinyl chloride	9,450	94.5
Notes: *Source:* Table 2 in the Site's 1997 AROD. a. Surface water standards apply to the NSCZ outside the barrier wall.		

Status of Implementation

EPA and BSTF entered into a Consent Decree in April 1991 for implementation of the 1988 ROD. BSTF completed the remedial design and EPA approved it in July 1993. The design covered all aspects of the ROD, with the exception of DNAPL recovery. DNAPL recovery proceeded under a different construction track because the work is not dependent on the type of source control performed.

Demolition of the majority of the remaining process equipment finished prior to mobilization of the incinerator. In addition, a temporary groundwater treatment plant was installed to address the movement of contaminated groundwater into Mud Gully in 1994. A rotary kiln incinerator and support equipment mobilized to the Site after the demolition work. Temporary enclosures were erected over the pits requiring remediation to contain emissions during excavation. The incinerator began clean burn operations with imported material, and excavation began at pits located on Brio South for shakedown operations and to stockpile material for the trial burn. Emission problems during excavation led to a "stop work" order until appropriate emission control equipment could be installed. Before more controls could be installed, other events led to EPA's decision to allow the dismantling of the incinerator. The incinerator and support equipment were demobilized by December 1994. The groundwater treatment plant continued to operate, the DNAPL remediation proceeded, and drums stockpiled since the inception of investigations at the Site were taken off site for disposal. Figure 3 shows the remedy components installed by BSTF.

BSTF began construction of the amended remedy in July 2000 and implemented it in phases through April 2004. BSTF managed the construction pursuant to the Site's Consent Decree. Various specialty contractors did the construction work as required for each remedy component. BSTF completed the remedial action in December 2004. EPA deleted the Site from the NPL in December 2006.

Soil Bentonite Barrier Wall

BSTF contractors constructed 5,900 linear feet of slurry wall around the perimeter of the Site from September to December 2000. The slurry wall was constructed by excavating a trench to a depth that seals the wall into the low-permeable MCU. The depth of the slurry wall ranged from about 35 feet to 50 feet bgs. The trench was later filled with drilling mud fluid and a mixture of native soils and fresh slurry. EPA provided oversight of the construction and approved the Site's Remedial Action Completion Report in December 2004.

Sheet Pile Barrier Wall

BSTF contractors installed about 1,800 linear feet of sheet pile barrier wall from July to December 2001 into the low-permeability MCU. The sheet pile wall included about 1,200 linear feet installed on the Site and about 600 linear feet installed in the Mud Gully easement to contain an off-site groundwater plume.

Cover System
BSTF contractors constructed the cover system as two components, Brio North and Brio South, with both covers constructed as one unit. The covers included a gas collection layer, a flexible membrane liner, compacted clay and topsoil to promote vegetative growth. Dixie Farm Road divides the two areas and separate borrow pit areas were developed to minimize truck traffic over the road. Construction of the 11.7-acre Brio South cover took place from May 2001 to February 2002. It was constructed to the limits of the soil bentonite barrier wall on the east and south sides, to Dixie Farm Road right of way on the north side, and to the southern part of the DOP site on the west side. An additional compacted clay layer was extended over a segment of the southern part of the DOP site to provide controlled surface water runoff.

BSTF contractors constructed the 50.5-acre Brio North cover system from December 2001 to October 2003. The cover system extended to the limits of the soil bentonite barrier wall on the east and north sides, to the Dixie Farm Road right of way on the south side, and to the sheet pile barrier wall on the west side. The Brio North cover system was designed with three compartments to provide for control of surface runoff and to facilitate gas collection.

Mud Gully Improvements
Mud Gully is under the jurisdiction of the Harris County Flood Control District. Contractors constructed the Mud Gully improvements from June 2002 to June 2003. The affected area of Mud Gully comprises a length of about 1,160 feet between Brio North and the northern part of the DOP site. The construction activity consisted of the following activities:

- Clearing of trees and brushes along and in the improvement area.
- Reshaping channel surface to design elevation.
- Installing new drainage pipes and abandoning and retrofitting existing drainage pipes.
- Installing articulated concrete block.
- Restoring the northern part of the DOP site property to its pre-construction condition.
- Placing a topsoil layer and vegetative cover.

EPA provided oversight of the construction. BSTF issued an Interim Completion Report that provided construction quality assurance documentation. The interim report was incorporated by reference into the Site's Remedial Action Completion Report in December 2004.

Groundwater Control Systems
BSTF contractors completed the construction of the groundwater treatment system for the NSCZ between February 2001 and February 2004. This system is also referred to as the Groundwater/DNAPL Recovery System. It uses a pumping system to maintain an inward hydraulic gradient within the Site's barrier wall using wells in the NSCZ. Components of the recovery system include 17 groundwater recovery wells on the Brio North and Brio South areas, 13 DNAPL recovery wells on Brio North, facilities to provide air pressure for the recovery well pumps and to separate groundwater, DNAPL and light non-aqueous phase liquid (LNAPL), and a pipeline system for the recovery and transfer of collected wastewater to the water treatment facility. DNAPL recovery areas are referred to as "Hubs". The Hubs are open buildings that house the groundwater/DNAPL recovery pumps and are surrounded by the groundwater and DNAPL recovery wells. The area also included placement of a vegetative cover.

The selected remedy for the FFSZ is monitored natural attenuation (MNA). Based on the results of the previous FYRs, BSTF has been conducting more delineation investigations of the FFSZ outside of the slurry wall to the east of FFSZ interior well BMW-3B. Phase I, finished in 2011, was conducted due to the presence of two COCs, 1,2-dichloroethane (1,2-DCA) and vinyl chloride detected at concentrations above EPA's MCLs at multiple cone penetration testing (CPT) locations. BSTF completed the Phase II investigation in 2015 to further delineate and supplement the Phase I investigative results by installing two wells, CMW-2BS and CMW-1BD, outside of the slurry wall and downgradient of BMW-3B. Due to exceedances of 1,2-DCA and vinyl chloride in the two new wells, BSTF is in the process of implementing Phase III activities by securing access to the off-site tracts

necessary for completing the delineation of contamination in the FFSZ. After Phase III, BSTF will discuss the results with EPA and TCEQ to determine if an additional remedy beyond MNA is warranted for the FFSZ.

Institutional Control (IC) Review

The ROD and AROD required institutional controls to restrict site and groundwater use. The PRPs prepared an Institutional Control Plan (IC Plan) in February 2006 that provides for institutional controls to reduce the risk to public health and the environment from potential hazards posed by the Site. The PRPs incorporated the IC Plan into the Maintenance, Operations, and Monitoring (MOM) Plan as Revision 2 in April 2006. As called for by the IC Plan, deed restrictions and notices have been filed at the Harris County Clerk's Office for the Site. The recorded instruments restrict land use to industrial uses only and restrict groundwater use and installation of wells. Table 5 lists the Site's institutional controls. Figure 2 shows the locations where the institutional controls apply at the Site. Additional restrictions may be needed, pending delineation of groundwater contamination south of the Site.

Table 5: Summary of Planned and/or Implemented Institutional Controls (ICs)

Media, Engineered Controls, and Areas That Do Not Support UU/UE Based on Current Conditions	ICs Needed	ICs Called for in the Decision Documents	Impacted Parcel(s)	IC Objective	Title of IC Instrument Implemented and Date (or planned)
Groundwater, soil and sediment	Yes	Yes	0410110000200	Restricts certain activities at the Site. Provides notice of CERCLA actions and site contaminants.	Deed Restriction Harris Co. Doc.# Y730710 August 24, 2005
			0410110000309 0402230000200 0402230000199 0410110000310 0410110000180		Deed Restriction Harris Co. Doc.# Y730711 August 19, 2005
			0402230000070 0410110000261 0410110000262 0410110000288 0410110000046 1150780010001	Provides notice of CERCLA actions and contaminants at the Site.	Deed Notice Co. Doc.# Y730708 August 23, 2005

Notes:
Co. Doc# = County Document Number (used online to access the institutional control instrument at https://www.cclerk.hctx.net/applications/websearch/RP.aspx).

Figure 2: Institutional Control Map

Systems Operations/Operation and Maintenance (O&M or MOM)

The MOM plan was submitted to EPA in February 2004 and last amended in January 2011. MOM activities include:

- Inspection of security lighting, gates, fences, roads, drainage, signs and worker safety equipment/systems.
- Inspection of remedial components, including the cover system, barrier wall alignment, the groundwater/DNAPL recovery system, the gas collection system, the water treatment plant, monitoring wells, groundwater and DNAPL recovery wells, and the slope condition of Mud Gully.
- Operation, maintenance and monitoring of the gradient control/groundwater and DNAPL recovery system.
- Operation and maintenance of the water treatment plant.
- Annual groundwater sampling.
- Quarterly surface water sampling.
- Semi-annual air sampling.
- Effluent discharge sampling and monitoring.
- Maintenance of the cover system.
- Reporting to EPA.

BSTF personnel are at the Site daily performing MOM activities. Daily and weekly inspections verify the condition of the components of the groundwater treatment plant. In addition to regularly scheduled maintenance for the groundwater treatment plant, monthly inspections are performed, and inspection reports are prepared to document conditions at the Site. Groundwater treatment plant operation is monitored by computer and the systems can contact BSTF personnel on their cell phones and then at their homes during non-working hours if a problem occurs. During this FYR, MOM maintenance activities included routine fence repairs and weed control around the perimeter of the properties and cleaning out drainage ditches around the perimeter of the cover.

BSTF personnel conduct batch monitoring of the effluent discharge. After the groundwater is treated at the plant, it is stored on site and sampled and tested for site discharge standards. If the samples pass site discharge standards, the treated water is discharged to Mud Gully. The Data Review section of this FYR Report discusses evaluation of the discharge data further.

III. PROGRESS SINCE THE PREVIOUS REVIEW

This section includes the protectiveness determinations and statements from the last FYR Report (Table 6) as well as the recommendations from the last FYR Report and the status of those recommendations (Table 7).

Table 6: Protectiveness Determinations/Statements from the 2018 FYR Report

OU #	Protectiveness Determination	Protectiveness Statement
Sitewide	Short-term Protective	The Site's remedy is currently protective of human health and the environment in the short term. There is no evidence that there is current exposure to site contaminants, and the remedy is being implemented as planned to reduce contamination mass and control migration. To remain protective over the long term, pump-and-treat operations in the NSCZ water-bearing zone should continue and the MCL exceedances in the FFSZ should be addressed as set forth in Section VI.

Table 7: Status of Recommendations from the 2018 FYR Report

OU#	Issue	Recommendations	Current Status	Current Implementation Status Description	Completion Date (if applicable)
1	Site constituents were detected at concentrations above their MCLs in the FFSZ, downgradient from the Site.	Further delineate affected groundwater in the FFSZ and prepare a Remediation Action Plan. Continue quarterly sampling of FFSZ groundwater until EPA approves a return to annual sampling. Continue quarterly current pumping rate of the Pit J NSCZ groundwater to maintain an upward gradient.	Ongoing	BSTF is in the process of implementing Phase III activities by securing access to the off-site tracts necessary for completing the delineation of contamination in the FFSZ. BSTF continues to conduct quarterly sampling of the FFSZ and pumping of the NSCZ.	Not Applicable

IV. FIVE-YEAR REVIEW PROCESS

Community Notification, Community Involvement and Site Interviews

A public notice was made available by a published notice in the *Houston Chronicle* newspaper on 11/30/2022 (Appendix C). It stated that the FYR was underway and invited the public to submit any comments to EPA. The results of the review and the report will be made available at the Site's information repository, Parker Williams Library at the San Jacinto College South Campus, located at 13735 Beamer Road in Houston, Texas.

During the FYR process, interviews were conducted to document any perceived problems or successes with the remedy implemented to date. The interviews are summarized below. The completed forms are included in Appendix I.

Michael Jeude – Mr. Jeude is the Site's project manager for TCEQ. He believes the site remedy is performing well and he is unaware of any complaints from the local community in the past five years. He stated that TCEQ attends annual meetings with site operators and also checks in with them before and after major storm events. Mr. Jeude is comfortable with the institutional controls in place.

Marie Flickinger – Mrs. Flickinger, the owner of the *South Belt Ellington Leader* newspaper, and chairperson of the Brio Site Community Advisory Group (CAG), is aware of the former environmental issues at the Site and the cleanup activities that have taken place to date. She is impressed with the remedy and was not aware of any problems to date. She believes that there have been many historical effects on the local community but none since the remedy was completed. She indicated that EPA and BSTF have done a good job of keeping the community informed.

Dr. Latrice Babin – Dr. Babin is the executive director for the Office of Harris County Pollution Control Services. She is familiar with the environmental issues and cleanup activities at the Site and is not aware of any trespassing or vandalism at the Site. She indicated that EPA's site website should be updated to include more current documentation on the Site. Dr. Babin recommends that the FYR Report provide more detail on extreme weather conditions and that activities that are restricted at the Site not be allowed next to or in the right of way at the Site.

John Danna and Mathew Foresman– Mr. Danna is the Site manager and Mr. Foresman is the Site coordinator for the PRP. They believe that the site remedy and maintenance are proceeding according to plan and human health and the environment are protected. Mr. Danna noted the continuous O&M presence and past efforts to optimize the efficiency of the operations. Mr. Foresman noted changes to the system to reduce noise from system operations.

Data Review

Performance and compliance monitoring data collected as part of O&M activities were reviewed as part of this FYR. The data consists of Mud Gully and Clear Creek surface water quality data FFSZ groundwater quality monitoring data, fence line air quality data, NSCZ and FFSZ groundwater level measurements, and groundwater and DNAPL recovery volumes. Sample locations for performance and compliance monitoring are shown in Figure 3. Data are collected on an ongoing basis and included in the AERs. The data included in this FYR Report are monitoring results from 2018 to 2022. In addition, long-term trends dating to the start of monitoring in 2004 are also discussed.

Groundwater

- *FFSZ Groundwater Quality*
  During the FYR reporting period, BSTF collected annual samples from seven wells that are screened in the FFSZ (BMW-1B, BMW-2B, BMW-3B, BMW-18B, DMW-52B, CMW-1BD and CMW-2BS) (Figure 3). Since monitoring began in 2004, performance standards were met in the five FFSZ wells (BMW-1, -2, -3, -18B and DMW-52B). Starting in 2007, concentrations in one well (BMW-3B) slightly exceeded the MCL of 5 micrograms per liter (µg/L) for 1,2-DCA, with a concentration of 5.7 µg/L, and two wells (BMW-3B and BMW-18B) showed increases of 1,2-DCA, 1,1-dichloroethene (1,1-DCE) and vinyl chloride from 2006 to 2007. Based on these results, BSTF conducted a Phase I supplemental investigation in 2010 by installing multiple CPT sample points downgradient of BMW-3B. A Phase II investigation in 2015 delineated the FFSZ contamination downgradient and east of BMW-3B by installing two more wells, CMW-1BD (completed in the lower half of the FFSZ) and CMW-2BS (completed in the upper half of the FFSZ) and using more CPT borings (Figure F-1).

  Analytical results show that contaminant concentrations in the two wells that historically exceeded compliance standards for 1,2-DCA and vinyl chloride, BMW-3B and BMW-18B, were below the standards during this FYR period. However, sample results for two paired downgradient wells installed downgradient of BMW-3B, CMW-1BD and CMW-2BS (Figure 3), showed exceedances of either 1,2-DCA or vinyl chloride (Table 8). The standard for 1,2-DCA was exceeded during every sampling event from CMW-1BD and in only one sample event in CMW-2BS. Vinyl chloride exceeded the standard in most of the samples from both wells, with concentrations in CMW-1BD decreasing over time with detection exceeding the standard of 2 µg/L until November 2020 and then decreased below the standard starting in March 2021 and through February 2022. Vinyl chloride concentrations in CMW-2BS also slightly exceeded the standard in nearly every sample event, except that July 2021 through February 2022 results were below or very close to the standard.

  BSTF's delineation of contamination in the FFSZ during the previous three FYR periods show that groundwater is moving very slowly to the south and east of well BMW-3B toward undeveloped land. The presence of degradation products and the geochemical conditions in the FFSZ appear conducive for the reductive dechlorination of chlorinated solvents. Data from the investigations suggest that MNA processes continue to address remaining 1,2-DCA and vinyl chloride COC concentrations in FFSZ groundwater in the affected areas outside of the slurry wall, as the slurry wall only addresses contamination in the NSCZ. BSTF is conducting a third investigative phase to delineate COC contamination south of BMW-18B using CPT borings. Once Phase III results are available, a determination will be made if any more action is warranted for the FFSZ beyond MNA.

Figure 3: Site Monitoring Well Location Map

Table 8: Summary of 1,2-DCA and Vinyl Chloride Exceedances in Wells CMW-1BD and CMW-2BS

Date	CMW-1BD		CMW-2BS	
	1,2-DCA (MCL = 5 µg/L)	Vinyl Chloride (MCL = 2 µg/L)	1,2-DCA (MCL = 5 µg/L)	Vinyl Chloride (MCL = 2 µg/L)
April 2018	**51**	**27**	5.0	**2.2**
July 2018	**60**	**37**	**8.1**	**4.8**
October 2018	**40**	**35**	4.2	**4.0**
January 2019	**23**	**32**	3.5	**3.4**
April 2019	**15**	**24**	3.1	**3.4**
July 2019	**32**	**23**	2.6	**3.2**
November 2019	**26**	**18**	2.2	**3.3**
January 2020	**35**	**14**	2.8	**3.4**
April 2020	**44**	**16**	3.0	**4.0**
July 2020	**34**	**11**	2.1	**2.8**
November 2020	**30**	**13**	2.3	**3.2**
March 2021	**27**	1.6	1.9	**2.7**
April 2021	**29**	0.59	0.18 J	**2.4**
July 2021	**24**	0.53	1.8	1.8
October 2021	**25**	1.7	1.7	**2.1**
February 2022	**17**	<0.5	1.3	1.7

Notes:
Sources: Annual Effectiveness Reports covering data from April 2018 – March 2022.
J = estimated value.
Bold value = value exceeds the current MCL.

- *NSCZ Gradient Control and South Plume*

  BSTF pumps water from wells screened in the NSCZ to lower the NSCZ groundwater table to cause an inward groundwater gradient toward the plumes. Figure F-2 shows the locations of NSCZ groundwater recovery wells and the piezometers arranged in eight arrays to measure NSCZ groundwater table elevations. Measurements generally show there is an inward gradient, with exceptions during maintenance and repair activities on the groundwater collection system. Figure F-3 provides an example of an inward gradient.

  A plume of COCs termed the South Plume is in the NSCZ and exists outside of the containment remedy on Brio South (Figure F-4). Two NSCZ groundwater recovery wells (PO-610R and PO-613R) along the bank of Mud Gully were installed in this plume as part of the remedy (Figure 3, Figure F-4). BSTF recovers and treats water from these wells except during maintenance and repair activities. A minimum drawdown requirement at each of the two South Plume recovery wells has been established for effective plume containment and recovery of affected groundwater. The drawdown is measured on a quarterly basis and the recovery rates are adjusted as needed to maintain the minimum drawdown.

- *Groundwater Treatment Plant*

  BSTF operates the treatment plant to treat water collected from the groundwater collection system and to temporarily store each batch of treated water. BSTF analyzes samples from each batch prior to discharge during the AER periods. The discharge volume of treated water has been consistent during this FYR period with an average discharge volume of 165,796 gallons per month (Table F-1) and the treated water meets the discharge standards prior to discharge to Mud Gully.

- *DNAPL Recovery*

  Thirteen DNAPL recovery wells are located on Brio North (Figure 3) in the NSCZ. The DNAPL recovery has decreased over time, which is expected as contaminant mass is removed and not replenished at the Site. Table F-2 shows that BSTF recovered 2,128 gallons of DNAPL between 2018 and 2019 and 2,750 gallons between 2019 and 2020 for off-site disposal. While no DNAPL was sent for offsite disposal

between 2020 and 2022, it is still being collected and stored onsite until an adequate volume of DNAPL has been accumulated for disposal.

- *Surface Water*
  BSTF collects surface water samples from four locations along Mud Gully and Clear Creek on a quarterly basis during the AER reporting periods (Figure 3). A comparison of the results to the surface water performance standards shows that all samples were below detection or well below the cleanup levels in Mud Gully and Clear Creek (Table F-3 and Table F-4, respectively).

- *Air Monitoring*
  BSTF collected semi-annual ambient air samples between April 2018 and November 2021 (Figure F-5) from six locations. The samples were collected over a 24-hour period and submitted for analysis for the Brio fence line ambient air quality standards (FLAAQS). The air quality during the FYR period was in compliance with the FLAAQS.

- *Site Cover Gas Collection System*
  BSTF monitors vent gas from four cover compartments in the gas collection system on the Site's cover system (Figure 3). The four gas collection vents use carbon canisters to scrub VOCs from the gas stream. The AERs show that no readings were measured above the compliance standard of 50 parts per million (ppm) during the FYR period.

Site Inspection

The site inspection took place on 12/15/2022. Participants included EPA RPM Nathaniel Applegate, Michael Jeude from TCEQ, PRP representative Matt Foreman, BSTF site manager John Danna, and Ryan Burdge and Claire Marcussen from EPA FYR contractor Skeo. The purpose of the inspection was to assess the protectiveness of the remedy. The site inspection checklist and photographs are provided in Appendix D and Appendix E, respectively.

Site inspection participants met at the groundwater treatment plant office, where they reviewed site logs, documents and records. Hard copies of the Site's Administrative Record were available. The entrance to the treatment plant is surrounded by a fence with a locked gate. Inspection participants observed groundwater treatment plant components, located immediately northwest and next to Brio North. Groundwater treatment system components observed included the DNAPL holding tank, the groundwater recovery holding tank, carbon filters and a blower unit, which was recently insulated to reduce noise after complaints from off-site residents. Site inspection participants also observed the air stripper and carbon vessel and the treated groundwater holding ponds that temporarily store treated water, which is batch tested prior to discharge to Mud Gully. Participants observed the adjacent maintenance shed where spare parts are stored and repairs can be made to site remedy components.

A large detention pond was observed off site to the northwest. The Harris County Stormwater Control Department is building the pond for stormwater management due to the development occurring around the Site. The site inspection continued, entering Brio North along the storm drainage road to observe several of the DNAPL recovery areas, also referred to as "Hubs." The Hubs are open buildings that house the groundwater/DNAPL recovery pumps and are surrounded by the groundwater and DNAPL recovery wells. Participants observed Hub B, which is the location where the highest concentrations of DNAPL from former Pit J (Figure F-4) are routinely detected. Participants also observed the gas collection vents next to the Hub buildings. The Brio North cover included tall natural grasses. Any woody plants are removed as part of regular MOM activities. Site inspection participants followed a stormwater road to the southern boundary of Brio North to observe the sheet pile keyed into the soil-bentonite wall. Participants also observed Mud Gully and the vegetated banks over the articulating rock. No erosion was observed. Mud Gully was flowing and no obstructions were observed. The access roads were in good condition and sloped to direct drainage away from the cap to Mud Gully.

Site inspection participants proceeded to Brio South to see Hub D, where groundwater extraction well D03GW was observed. Participants also observed an aboveground pipe protected by concrete slabs that carries extracted groundwater from Brio South to the groundwater treatment plant. Participants also observed NCSZ recovery wells PO610 and PO613 adjacent to Mud Gully, which extract groundwater preventing shallow groundwater contamination from Brio South from discharging to Mud Gully. The cover at Brio South was covered with tall natural grass species. Participants observed that fencing topped with barbed wire surrounded Brio North and Brio South and appeared to be in good condition, with "no trespassing" signs posted at regular intervals. The gated entries were all locked and functional, and the drainage roads were in good condition directing overland flow to Mud Gully.

V. TECHNICAL ASSESSMENT

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

Question A Summary:

Yes. The remedy is generally functioning as intended by the decision documents. The review of the decision documents, remedy effectiveness data and the results of the site inspection indicate that the remedy is generally functioning as intended by the AROD. AERs demonstrate that an upward gradient has been achieved and maintained across the NCSZ. All measures appear to be functioning as designed to control NSCZ groundwater gradients, treated groundwater discharges and air emissions. Concentrations continue to exceed MCLs in some FFSZ monitoring wells (CMW-1BD and CMW-2BS). However, evidence of contaminant degradation is present.

The work during previous three FYR periods shows that groundwater is moving slowly to the south of well BMW-18B and east of well BMW-3B toward undeveloped land off site. The presence of degradation products and the geochemical conditions in the FFSZ appear conducive for the reductive dechlorination of chlorinated solvents. Data from the investigations suggest that MNA processes continue to address the COC concentrations in FFSZ groundwater in the affected areas outside of the slurry wall as the slurry wall only addresses contamination in the NSCZ. BSTF is completing Phase III of COC delineation in the FFSZ. Upon completion, BSTF will discuss the results with EPA and TCEQ to determine if an additional remedy beyond MNA is warranted for the FFSZ.

O&M activities are occurring, as required by the MOM. Regularly scheduled maintenance for the groundwater treatment plant and regular site inspections are performed. These inspections cover gates, fences, access roads, wells, the cap, the gas venting system, the slurry wall cap and drainage facilities. During the FYR site inspection, a visual inspection of site features included the water treatment facility and treated groundwater storage ponds, the caps, compliance wells, DNAPL and groundwater recovery wells, gas collection vents, the sheet pile wall, drainage roads, fences and gates. All fencing appeared to be in good condition. Gates were secured at all site entrance points. The caps were vegetated. No erosion or cracks were observed. Institutional controls are in place and are effective at preventing exposure to contaminants on site. Additional restrictions may be needed, pending delineation of groundwater contamination south of the Site.

QUESTION B: Are the exposure assumptions, toxicity data cleanup levels and RAOs used at the time of the remedy selection still valid?

Question B Summary:

Yes. The exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy selection are still valid. A review of the AROD-specified applicable or relevant and appropriate requirements (ARARs) demonstrate that the remedy remains protective. Even though several surface water criteria became more stringent (Appendix G), long-term monitoring data for Mud Gully and Clear Creek are below the most current standards. The drinking water standards in the AERs have not changed for the evaluation of FFSZ data. No new regulations have been promulgated by the state or federal governments that would call into question the protectiveness of the selected remedy. There have been no changes in toxicity characteristics or other contaminant characteristics

related to the Site that affect the protectiveness of the remedy, as shown in the screening-level risk evaluation of the soil cleanup goals (Appendix H). Additionally, there has been no change to the standardized risk assessment methodology that would affect the protectiveness of the selected remedy.

The 1997 ROD Amendment does not include human contact to surface water as a potential exposure pathway or in its remedial action objectives. Recent residential development adjacent to the Site increases the potential that people may be wading, swimming, or recreating in Mud Gully. However, there is no known complete human exposure pathway for contact with surface water. Should use of Mud Gully be noted during regular site inspections, EPA will determine if additional assessment of the pathway and associated risk is warranted.
The remedy has achieved most of the RAOs, except for the FFSZ. Target levels of organic COCs have not yet been achieved. However, the concentrations are gradually decreasing over time. BSTF has completed the Phase II investigation of the FFSZ south of the Site to evaluate if a remedy beyond MNA is warranted for the FFSZ. There has not been a change in exposure pathways that may call into question the protectiveness of the remedy. Upon completion of the Phase III of COC delineation in the FFSZ, BSTF will discuss the results with EPA and TCEQ to determine if the vapor intrusion pathway presents a potential change in exposure pathways. The known contaminant plume is not under inhabited buildings.

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

No other information has come to light that could call into question the protectiveness of the remedy.

The Site has weathered several hurricanes including Hurricane Harvey in 2017 which did not result in any significant impacts to the remedy or loss of protectiveness. Due to the nature and resiliency of the remedy, the protectiveness of the remedy is anticipated to not be affected by climate change.

VI. ISSUES/RECOMMENDATIONS

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the FYR:
None

Issues and Recommendations Identified in the FYR:

OU(s):	Issue Category: Remedy Performance			
	Issue: The extent of COC contamination in the FFSZ in the southern part of the Site has not been fully delineated and the remedy has not yet achieved cleanup goals for the FFSZ.			
	Recommendation: Complete the Phase III investigation of the FFSZ south of the Site and evaluate if remedial action beyond MNA is warranted for the FFSZ.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party/Support Agency**	**Milestone Date**
No	Yes	PRP	EPA	9/30/2024

OTHER FINDINGS

Two additional recommendations were identified during the FYR. These recommendations do not affect current and/or future protectiveness.

- AER reports for this FYR and prior FYRs compare FFSZ data to MCLs. However, the reports list the incorrect MCL of 1,000 µ/L for xylene when it should be 10,000 µg/L. Update the AER to ensure the most current MCLs are being used to evaluate the data.
- The County requested more site documents be made available on the Site's webpage. EPA will ensure the website remains up to date.

VII. PROTECTIVENESS STATEMENT

Sitewide Protectiveness Statement
Protectiveness Determination: Short-term Protective
Protectiveness Statement: The Site's remedy is currently protective of human health and the environment in the short term. The containment of site contamination prevents direct exposure to site soils and waste. The groundwater/DNAPL recovery and treatment system maintains contamination in the NSCZ within the Site's barrier walls and treats groundwater and recovers DNAPL and LNAPL. For the remedy to be protective over the long term, BSTF should complete the Phase III investigation of the FFSZ south of the Site, and EPA may evaluate if a remedy beyond MNA is warranted for the FFSZ.

VIII. NEXT REVIEW

The next FYR Report for the Brio Refining, Inc. Superfund site is required five years from the completion date of this review.

APPENDIX A – REFERENCE LIST

Amended Record of Decision, Brio Refining, Inc. Superfund Site, Harris County, Texas. EPA Region 6. July 1997.

Annual Effectiveness Report – Fourteenth (April 2018-March 2019), Brio Refining, Inc. Site Superfund. November 2020.

Annual Effectiveness Report – Fifteenth (April 2019-March 2020), Brio Refining, Inc. Site Superfund. August 2021.

Annual Effectiveness Report – Sixteenth (April 2020-March 2021), Brio Refining, Inc. Site Superfund. December 2022.

Annual Effectiveness Report – Seventeenth (April 2021-March 2022), Brio Refining, Inc. Site Superfund. November 2022.

Five-Year Review Report – Fifth. Brio Refining, Inc. Superfund Site, Harris County, Texas. September 2018.

Five-Year Review Report – Fourth. Brio Refining, Inc. Superfund Site, Harris County, Texas. September 2013.

Five-Year Review Report – Third. Brio Refining, Inc. Superfund Site, Harris County, Texas. April 2008.

Five-Year Review Report – Second. Brio Refining, Inc. Superfund Site, Harris County, Texas. May 2003.

Five-Year Review Report – First. Brio Refining, Inc. Superfund Site, Harris County, Texas. January 1998.

Institutional Control Plan for the Brio Refining, Inc. Superfund Site, Harris County, Texas. April 2006.

Maintenance, Operations, and Monitoring Plan, Brio Refining Inc. Superfund Site, Harris County, Texas. February 2004 (Rev. 4, January 2011).

Phase II Fifty-Foot Sand Zone Groundwater Investigation, Brio Refining Inc. Superfund Site, Harris County, Texas. December 2015.

Phase III Investigation Work Plan for the Fifty-Foot Sand Zone, Brio Refining, inc. Superfund Site, Harris County, Texas. July 2018.

Record of Decision, Brio Refining, Inc. Superfund Site, Harris County, Texas. EPA Region 6. March 1988.

APPENDIX B – SITE CHRONOLOGY

Table B-1: Site Chronology

Event	Date
Operators conducted chemical reprocessing and refining activities at the Site	1950s – 1982
Operators closed all of the on-site pits prior to ceasing operations	December 1982
EPA began the Site's RI/FS	September 26, 1984
EPA proposed the Site for listing on the NPL	October 1984
PRP began a removal action to cover pits	February 1, 1985
PRP completed the removal action to cover pits	March 31, 1985
PRP completed the RI/FS and EPA signed the Site's ROD	March 31, 1988
EPA finalized the Site's listing on the NPL	March 31, 1989
BSTF signed AOC to begin the dismantling of the process equipment on the Site	June 1989
PRP began the first phase of the remedial design and some remedial activities	June 29, 1989
PRP dismantled former facility structures	December 1989
BSTF entered into a Consent Decree with EPA to implement the Site's ROD	April 4, 1991
PRP completed the first phase of the remedial design	July 13, 1993
EPA issued an AROD changing part of the remedy from on-site incineration to containment	July 2, 1997
PRP completed the first phase of remedial activities	September 30, 1997
EPA issued the Site's first FYR Report	January 8, 1998
PRP entered into an Amended Consent Decree with EPA to implement the modified remedy PRP began the second phase of the remedial design	March 5, 1999
PRP completed the second phase of the remedial design	April 11, 2001
PRP began the second phase of remedial activities	July 11, 2000
EPA issued the Site's second FYR Report	May 13, 2003
PRP completed the second phase of remedial activities and began long-term O&M activities	December 16, 2004
Deed Restriction filed at Harris County Clerk's Office, Doc.#Y730711	August 19, 2005
Deed Restriction filed at Harris County Clerk's Office, Doc.#Y730708	August 23, 2005
Deed Restriction filed at Harris County Clerk's Office, Doc.#Y730710	August 24, 2005
EPA signed the Site's Final Close-Out Report	May 26, 2006
EPA deleted the Site from the NPL	December 28, 2006
TCEQ issued the Interim Forest and Wetlands Planting Completion Certificates	June 21, 2007
EPA determined the Site achieved Sitewide Ready for Anticipated Reuse	September 24, 2007
EPA issued the Site's third FYR Report	April 25, 2008
BSTF completed the Phase I FFSZ groundwater investigation	November 1, 2010
EPA issued the Site's fourth FYR Report	September 18, 2013
The Trustees certified that BSTF completed the Natural Resources Damage Assessment of the wetlands and forest projects and have fulfilled all obligations under the Natural Resources Damage Consent Decree	April 17, 2015
BSTF completed the Phase II FFSZ groundwater investigation	March 11, 2016
BSTF completed the Phase III Investigation Work Plan for FFSZ groundwater	July 27, 2018
EPA issued the Site's fifth FYR Report	September 20, 2018

APPENDIX C – PRESS NOTICE

Brio Refining, Inc. and Dixie Oil Processors, Inc. Superfund Site
Public Notice
U.S. Environmental Protection Agency, Region 6
November 2022

The U.S. Environmental Protection Agency Region 6 (EPA) will be conducting the sixth five-year reviews of the implementation and performance of the remedies at the Brio Refining, Inc. and Dixie Oil Processors, Inc. Superfund sites in Houston, Texas.

Brio Refining, Inc.

From the 1950s to 1982, the 58-acre site operated as a chemical processing and refining facility. Facility disposal operations contaminated groundwater, surface soils and subsurface soils with hazardous chemicals. EPA added the site to the Superfund program's National Priorities List (NPL) in March 1989. EPA's selected remedy includes the excavation and removal of contaminated soils, debris, and storage drums, as well as continued operations of a wastewater treatment system. EPA updated the remedy to include construction of a vertical barrier wall, a site cover, a groundwater pumping system, and maintenance and stabilization of the mud galley. Institutional controls were also implemented limiting land use. Maintenance and monitoring are ongoing at the site. The site was deleted from the NPL in December 2006.

Dixie Oil Processors, Inc.

From 1969 to 1984, the 26.6-acre site operated as a copper recovery and hydrocarbon washing facility. Site activities and waste disposal practices contaminated soil and groundwater with hazardous chemicals. EPA added the site to the Superfund program's National Priorities List (NPL) in October 1989. EPA's selected remedy includes removal of surface contamination, improvement of surface water controls, maintenance and stabilization of the mud galley, and the installation of a security fence. Cleanup also included removal and off-site disposal of tank wastes, breakdown of process tanks and drums, disposal of process equipment, and institutional controls. Groundwater monitoring activities are ongoing. Following clean up, the EPA removed the site off the NPL in August 2006.

The five-year reviews will determine if the remedies are still protective of human health and the environment. The five-year reviews are scheduled for completion in September 2023.

The reports will be made available to the public at the following local information repository:

Parker Williams Library/San Jacinto College
South Campus
13735 Beamer Road
Houston, Texas 77089
(832) 927-7870

Site status updates are available on the Internet at
https://www.epa.gov/superfund/brio-refining
https://www.epa.gov/superfund/dixie-oil-processors

All media inquiries should be directed to the EPA Press Office at (214) 665-2200

For more information about the Site, contact:

Nathaniel Applegate/Remedial Project Manager
(214) 665-2253
or by email at applegate.nathaniel@epa.gov

Jason McKinney/Community Involvement Coordinator
(214) 665-8132
or 1-800-887-6063 (toll-free)
or by email at mckinney.jason@epa.gov

APPENDIX D – SITE INSPECTION CHECKLIST

FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST

I. SITE INFORMATION

Site Name: Brio Refining, Inc.	**Date of Inspection:** 12/15/2022
Location and Region: Friendswood, Texas 6	**EPA ID:** TXD980625453
Agency, Office or Company Leading the Five-Year Review: EPA Region 6	**Weather/Temperature:** 48°F/Sunny

Remedy Includes: (check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☒ Other: DNAPL/groundwater collection system, air monitoring, long-term groundwater monitoring, cover gas collection and treatment
- ☒ Monitored natural attenuation
- ☒ Groundwater containment
- ☒ Vertical barrier walls

Attachments: ☒ Inspection team roster attached ☐ Site map attached

II. INTERVIEWS (check all that apply)

1. **O&M Site Manager** John Danna (Name) | BSTF Site Manager (Title) | _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   Problems, suggestions ☐ Report attached: _____

2. **O&M Staff** _____ (Name) | _____ (Title) | _____ (Date)
   Interviewed ☐ at site ☐ at office ☐ by phone Phone: _____
   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). Fill in all that apply.

   Agency TCEQ
   Contact Michael Jeude (Name) | Project Manager (Title) | _____ (Date) | _____ (Phone)
   Problems/suggestions ☐ Report attached: _____

   Agency Office of Harris County Pollution Control Services
   Contact Dr. Latrice Babin (Name) | Executive Director (Title) | 3/3/2023 (Date) | _____ (Phone)
   Problems/suggestions ☐ Report attached: _____

   Agency _____
   Contact _____ (Name) | _____ (Title) | _____ (Date) | _____ (Phone)
   Problems/suggestions ☐ Report attached: _____

4. **Other Interviews** (optional) ☐ Report attached: _____
   Marie FlickingerChairperson, Site's Community Advisory Group, and owner of the *South Belt Ellington Leader* newspaper
   Matthew Foresman, BSTF

III. ON-SITE DOCUMENTS AND RECORDS VERIFIED (check all that apply)

1. **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: O&M manual should be brought up to date to reflect current water treatment plant layout and the South Plume recovery well check procedure. Waste shipment manifests are available and up to date.

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: _____

IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for state
☒ PRP in-house ☐ Contractor for PRP
☐ Federal facility in-house ☐ Contractor for Federal facility
☐ _____

2. **O&M Cost Records**
☒ Readily available ☒ Up to date
☒ Funding mechanism/agreement in place ☐ Unavailable
Original O&M cost estimate: _____ ☐ Breakdown attached
Total annual cost by year for review period if available

From: _____ To: _____ _____ ☐ Breakdown attached
Date Date Total cost

From: _____ To: _____ _____ ☐ Breakdown attached
Date Date Total cost

From: _____ To: _____ _____ ☐ Breakdown attached
Date Date Total cost

From: _____ To: _____ _____ ☐ Breakdown attached
Date Date Total cost

From: _____ To: _____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs during Review Period**
Describe costs and reasons: Phase III groundwater investigation, which is not part of routine O&M

activities.

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

A. Fencing

1. **Fencing Damaged** ☒ Location shown on site map ☒ Gates secured ☐ N/A
   Remarks: All fencing was in good condition. No breaches or damage observed.

B. Other Access Restrictions

1. **Signs and Other Security Measures** ☐ Location shown on site map ☐ N/A
   Remarks: "No trespassing" signs are posted at all main entrance gates.

C. Institutional Controls (ICs)

1. **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
   Frequency: Institutional control monitoring is conducted daily on site by PRP staff.
   Responsible party/agency: BSTF
   Contact John Danna (Name) BSTF Site Manager (Title) ____ (Date) ____ (Phone)
   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

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A
   Remarks: Deed restrictions and deed notices have been executed for all site properties. Certified copies were obtained from the Harris County Clerk's Office and are maintained on site at 11810 South Hill Drive, Houston Texas.

D. General

1. **Vandalism/Trespassing** ☐ Location shown on site map ☒ No vandalism evident
   Remarks: BSTF's site manager reports that the fence is occasionally breached and trespassers steal copper wire. This happens infrequently due to security cameras with an alarm and there are O&M personnel on site on a daily basis.

2. **Land Use Changes On Site** ☒ N/A
   Remarks: ____

3. **Land Use Changes Off Site** ☐ N/A
   Remarks: A residential development is located west of the water treatment plant.

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

1. **Roads Damaged** ☒ Location shown on site map ☒ Roads adequate ☐ N/A
   Remarks: Drainage roads are in good condition and allow for surface flow away from caps and diversion to drainage pipes to Mud Gully.

B. Other Site Conditions

Remarks: Site is in good condition and maintained.

VII. LANDFILL COVERS ☒ Applicable ☐ N/A

A. Landfill Surface

1. **Settlement** (low spots) ☐ Location shown on site map ☒ Settlement not evident
   Area extent: ____ Depth: ____
   Remarks: ____

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
   Lengths: ____ Widths: ____ Depths: ____
   Remarks: ____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
   Area extent: ____ Depth: ____
   Remarks: ____

4. **Holes** ☐ Location shown on site map ☒ Holes not evident
   Area extent: ____ Depth: ____

Remarks: _____

5. **Vegetative Cover** ☒ Grass ☒ Cover properly established
☒ No signs of stress ☐ Trees/shrubs (indicate size and locations on a diagram)
Remarks: Any woody cover present on Brio North is removed.

6. **Alternative Cover** (e.g., armored rock, concrete) ☒ N/A
Remarks: _____

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Area extent: _____ Height: _____
Remarks: _____

8. **Wet Areas/Water Damage** ☒ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	Area extent: _____
☐ Ponding	☐ Location shown on site map	Area extent: _____
☐ Seeps	☐ Location shown on site map	Area extent: _____
☐ Soft subgrade	☐ Location shown on site map	Area extent: _____

Remarks: _____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map
☒ No evidence of slope instability
Area 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.)

1. **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.)

1. **Settlement** (Low spots) ☐ Location shown on site map ☐ No evidence of settlement
Area extent: _____ Depth: _____
Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type:_____ Area extent: _____
Remarks: _____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Area extent: _____ Depth: _____
Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Area extent: _____ Depth: _____
Remarks: _____

5. **Obstructions** Type: _____ ☐ No obstructions
☐ Location shown on site map Area extent: _____
Size: _____
Remarks: _____

6. **Excessive Vegetative Growth** Type: _____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Area extent: _____
Remarks: _____

D. Cover Penetrations ☒ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☒ Passive

☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ Evidence of leakage at penetration ☐ Needs maintenance ☐ N/A
Remarks: Gas vents are connected to carbon canisters with hoses and these areas are surrounded by a perimeter fence and locked gates.

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: Wells are located within a perimeter fenced topped with barbed wire and locked entrance gates.

4. **Extraction Wells Leachate**
☐ 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

1. **Gas Treatment Facilities**
☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☒ Good condition ☐ Needs maintenance
Remarks: Passive with carbon canisters. Gas collection records are up to date.

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)
☐ Good condition ☐ Needs maintenance ☒ N/A
Remarks: ____

F. Cover Drainage Layer ☐ Applicable ☒ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
Remarks: ____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
Remarks: ____

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

1. **Siltation** Area extent: ____ Depth: ____ ☐ N/A
☐ Siltation not evident
Remarks: ____

2. **Erosion** Area extent: ____ Depth: ____
☐ Erosion not evident
Remarks: ____

3. **Outlet Works** ☐ Functioning ☐ N/A
Remarks: ____

4. **Dam** ☐ Functioning ☐ N/A
Remarks: ____

H. Retaining Walls ☐ Applicable ☒ N/A

1. **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

1. **Siltation** ☐ Location shown on site map ☒ Siltation not evident
Area extent: ____ Depth: ____

Remarks: _____

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
☒ Vegetation does not impede flow
Area extent: _____ Type: _____
Remarks: _____

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Area extent: _____ Depth: _____
Remarks: _____

4. **Discharge Structure** ☒Functioning ☐ N/A
Remarks: _____

VIII. VERTICAL BARRIER WALLS ☒ Applicable ☐ N/A

1. **Settlement** ☒ Location shown on site map ☒ Settlement not evident
Area extent: _____ Depth: _____
Remarks: _____

2. **Performance Monitoring** Type of monitoring: _____
☒ Performance not monitored
Frequency: _____ ☐ Evidence of breaching
Head differential: _____
Remarks: NSCZ groundwater outside the barrier wall is monitored to demonstrate compliance with water quality criteria for Mud Gully.

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

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

1. **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
Remarks: _____

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

1. **Collection Structures, Pumps and Electrical**
☐ Good condition ☐ Needs maintenance
Remarks: _____

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes and Other Appurtenances**
☐ Good condition ☐ Needs maintenance
Remarks: _____

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

C. Treatment System ☒ Applicable ☐ N/A

1. **Treatment Train** (check components that apply)
☐ Metals removal ☒ Oil/water separation* ☐ Bioremediation
☒ Air stripping ☒ Carbon adsorbers
☐ Filters: _____
☐ Additive (e.g., chelation agent, flocculent): _____
☐ Others: _____
☒ 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: About 2 to 3 million gallons.
☐ Quantity of surface water treated annually: None.
Remarks: * Includes DNAPL/water separation.

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

☐ N/A ☒ Good condition ☐ Needs maintenance
Remarks: _____

3. **Tanks, Vaults, Storage Vessels**
☐ N/A ☒ Good condition ☒ Proper secondary containment ☐ Needs maintenance
Remarks: DNAPL and extracted groundwater holdings tanks have secondary containment.

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

1. **Monitoring Data**
☒ Is routinely submitted on time ☒ Is of acceptable quality

2. **Monitoring Data Suggests:**
☒ Groundwater plume is effectively contained ☒ Contaminant concentrations are declining
NSCZ)
Remarks: Data from ongoing investigations suggest that MNA processes continue to address the COC concentrations in FFSZ groundwater in the affected areas. BSTF is completing Phase III of COC delineation in the FFSZ. Upon completion, BSTF will discuss the results with EPA and TCEQ to determine if a remedy beyond MNA is warranted for the FFSZ.

E. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)
☒ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☐ All required wells located ☐ Needs maintenance ☐ N/A
Remarks: MNA is the selected remedy for the FFSZ and BSTF is completing Phase III of COC delineation in the FFSZ. Upon completion, BSTF will discuss the results with EPA and TCEQ to determine if a remedy beyond MNA is warranted for the FFSZ.

X. OTHER REMEDIES

If there are remedies applied at the site and 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 designed to accomplish (e.g., to contain contaminant plume, minimize infiltration and gas emissions).
Remarks: The goal of the remedy is to contain site groundwater contamination and air emissions. The vertical barrier wall consists of a soil bentonite wall and a sheet pile wall (adjacent to Mud Gully) to prevent downgradient lateral movement of contaminated groundwater. The natural horizontal barrier provided by the MCU, combined with a natural upward pressure differential and an artificial upward pressure differential provided by extracting the NSCZ groundwater, prevents or greatly inhibits the downward movement of contaminants. The flexible membrane layer of the cap system prevents the infiltration of surface water and the escape of volatile gases from the contaminated soil. The MNA remedy appears to be addressing contamination in the FFSZ. However, more delineation is ongoing to determine if remedial action beyond MNA is warranted.

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.
O&M procedures are adequately ensuring the current and long-term protectiveness of the remedy.

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. The FFSZ has not been fully delineated to the south and the PRP is completing the delineation to support whether remedial action beyond MNA is warranted for the FFSZ.
D	**Opportunities for Optimization**
	Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy. EPA and TCEQ will evaluate the additional delineation of the FFSZ and determine if MNA is sufficient for addressing residual contamination or if active remediation may be warranted.

APPENDIX E – SITE INSPECTION PHOTOS

Secured site entrance on South Hill Drive

Groundwater treatment plant and site office, with aboveground storage ponds in the background

Recovered DNAPL storage tank

Recovered groundwater storage tank

Groundwater treatment system air stripper

Air stripper blower unit, insulated to reduce noise

Aboveground storage pond for treated groundwater

O&M maintenance shed behind the groundwater treatment facility

Harris County Stormwater Control's retention basin next to the Site

South Autumn Road secured entrance to Brio North, with Hub B in background

Brio North drainage road to access Hub B

Brio North Hub B groundwater recovery system and gas collection vent (outside on the right of the building)

Brio North DNAPL recovery well near Hub B (groundwater treatment plant in background)

Brio North sign next to the Hub B gas collection vent

Brio North groundwater recovery wells near Hub B

Brio North Hub C groundwater recovery system and gas collection vent (outside on the right of the building)

Surface runoff discharge to Mud Gully at the end of drainage road on the south end of Brio North

View looking east at the sheet pile along the Brio North southern boundary drainage road, with Mud Gulley on the right

View looking west at the sheet pile along the Brio North southern boundary drainage road, with Mud Gulley on the left

Drainage road, looking northeast from the southern boundary of Brio North

Secured entrance to Brio South

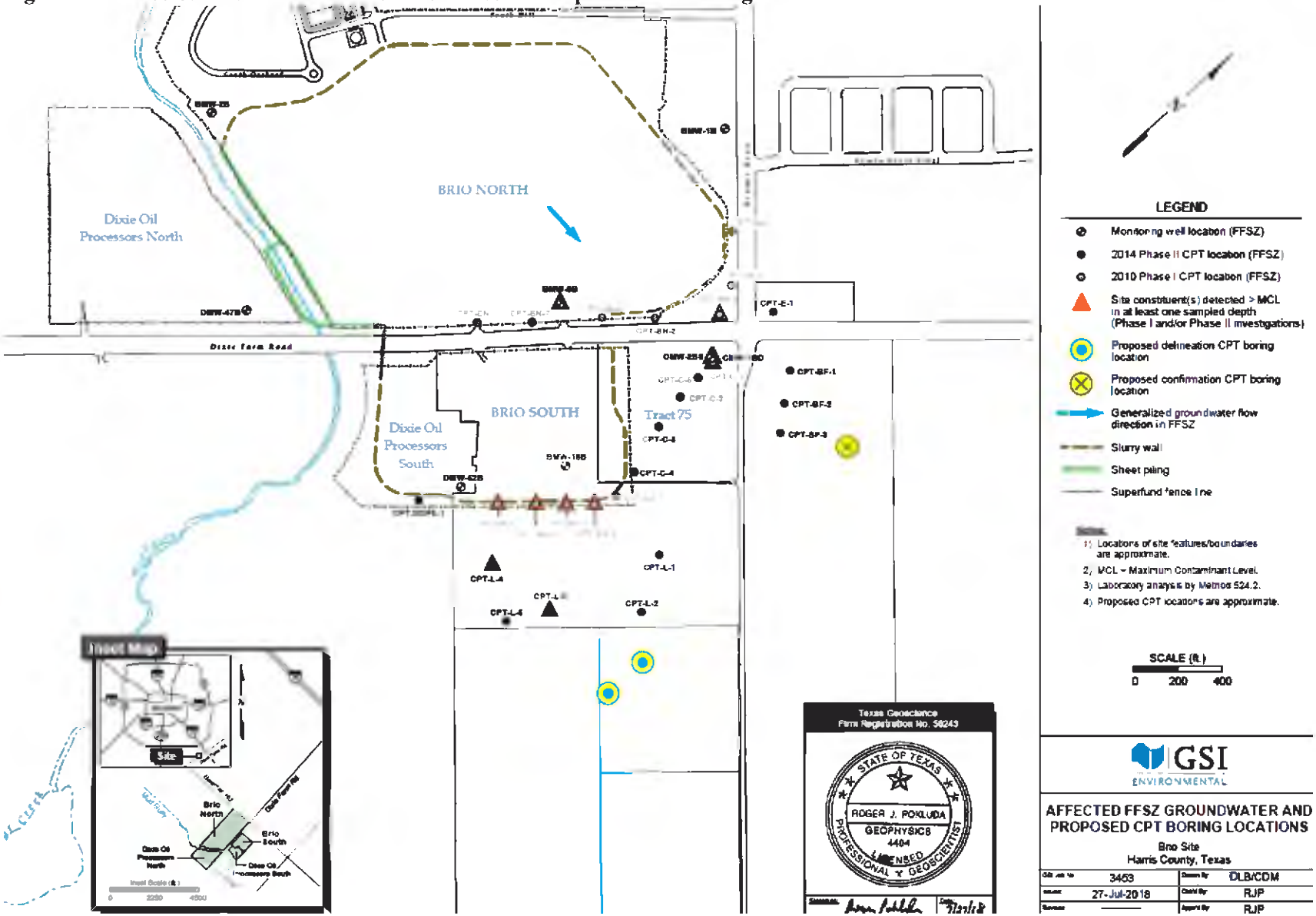
Interior of the Brio South Hub D building

Brio South groundwater recovery well

Brio South NCSZ recovery wells next to Mud Gully and aboveground groundwater extraction water to Hub D

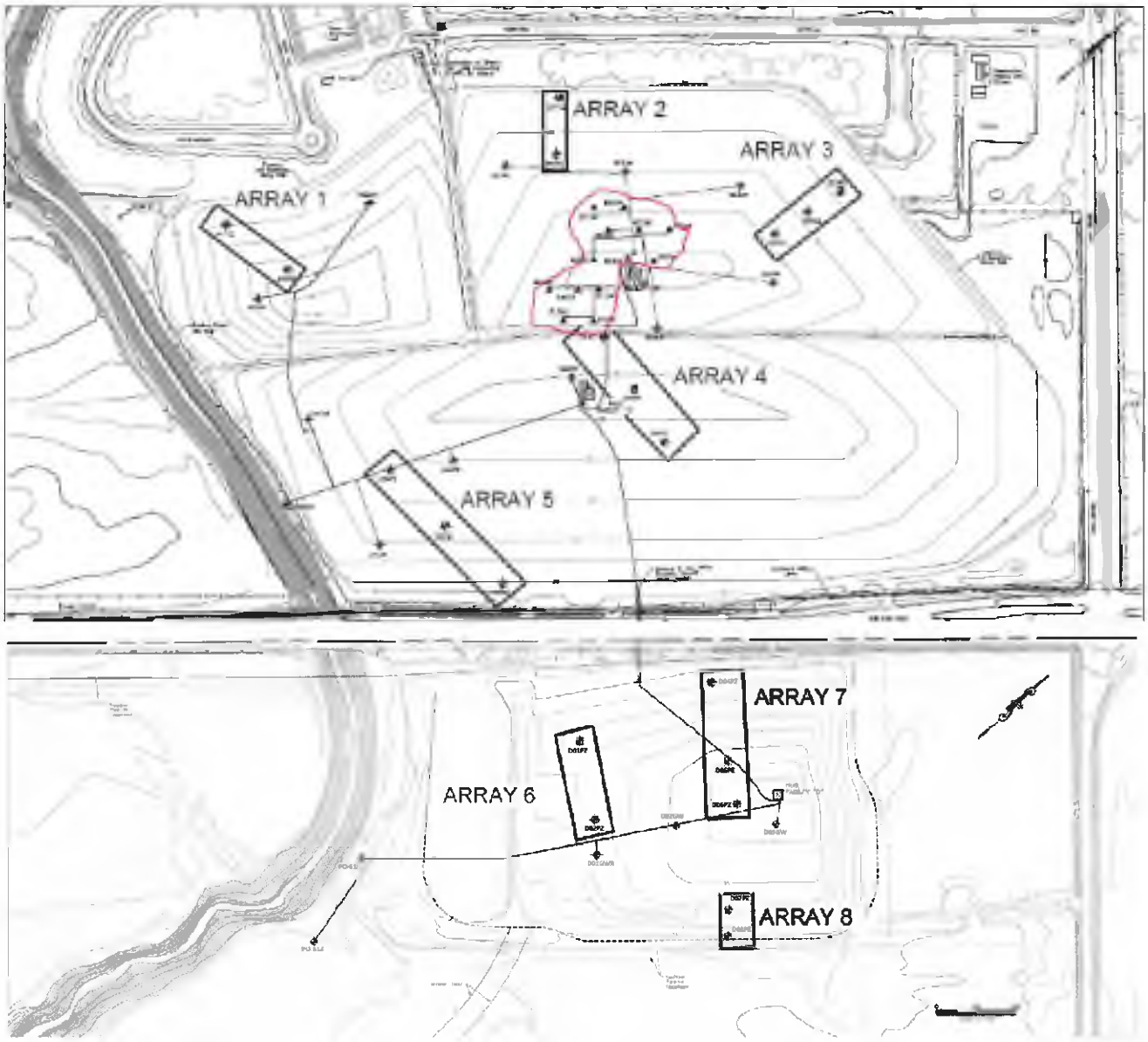
APPENDIX F – DATA ANALYSIS FIGURES AND TABLES

Figure F-1: Affected FFSZ Groundwater and Phase III Proposed CPT Boring Locations



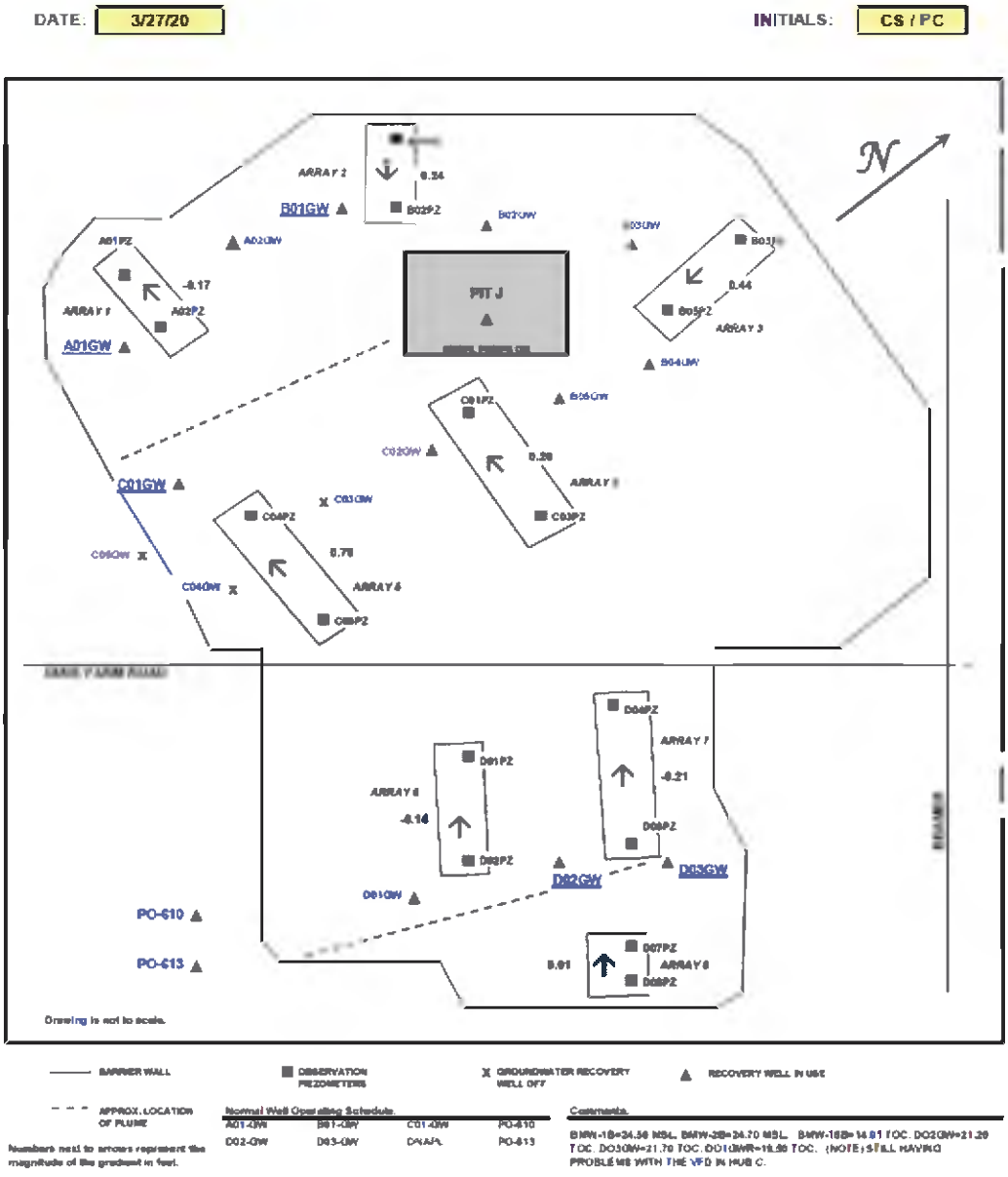
Source: Phase III Investigation Work Plan for the Fifty-Foot Sand Zone (FFSZ), Brio Refining Superfund Site. Prepared by GSI Environmental. July 2018.

Figure F-2: Arrays of NSCZ Groundwater Recovery Wells and Piezometers



Source: The Site's 17th AER.

Figure F-3: Site Gradient Measurement Example



Source: The Site's 15th AER, Figure 3-2.

Figure F-4: NSCZ Recovery Wells and Historical Plumes, 2015

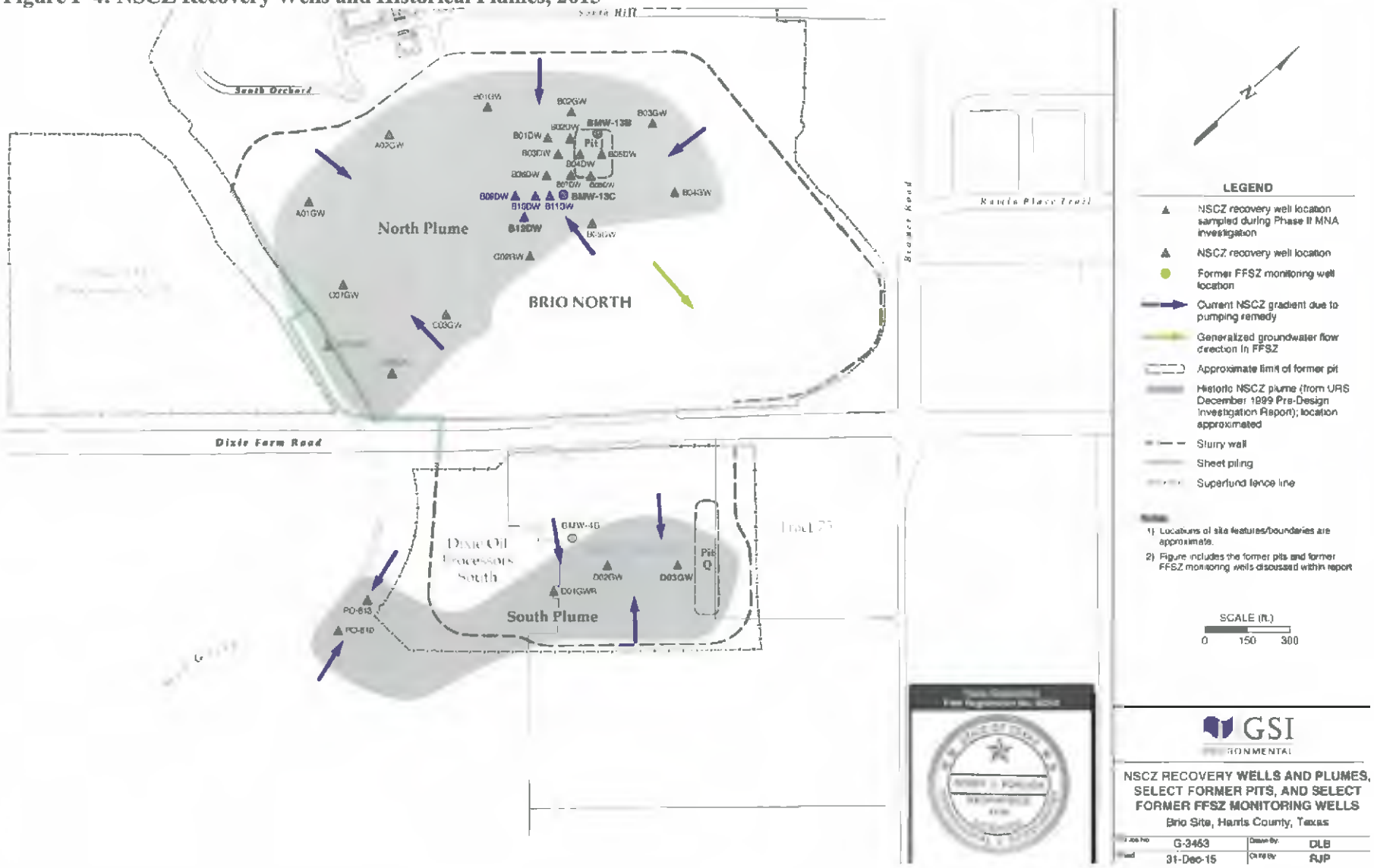
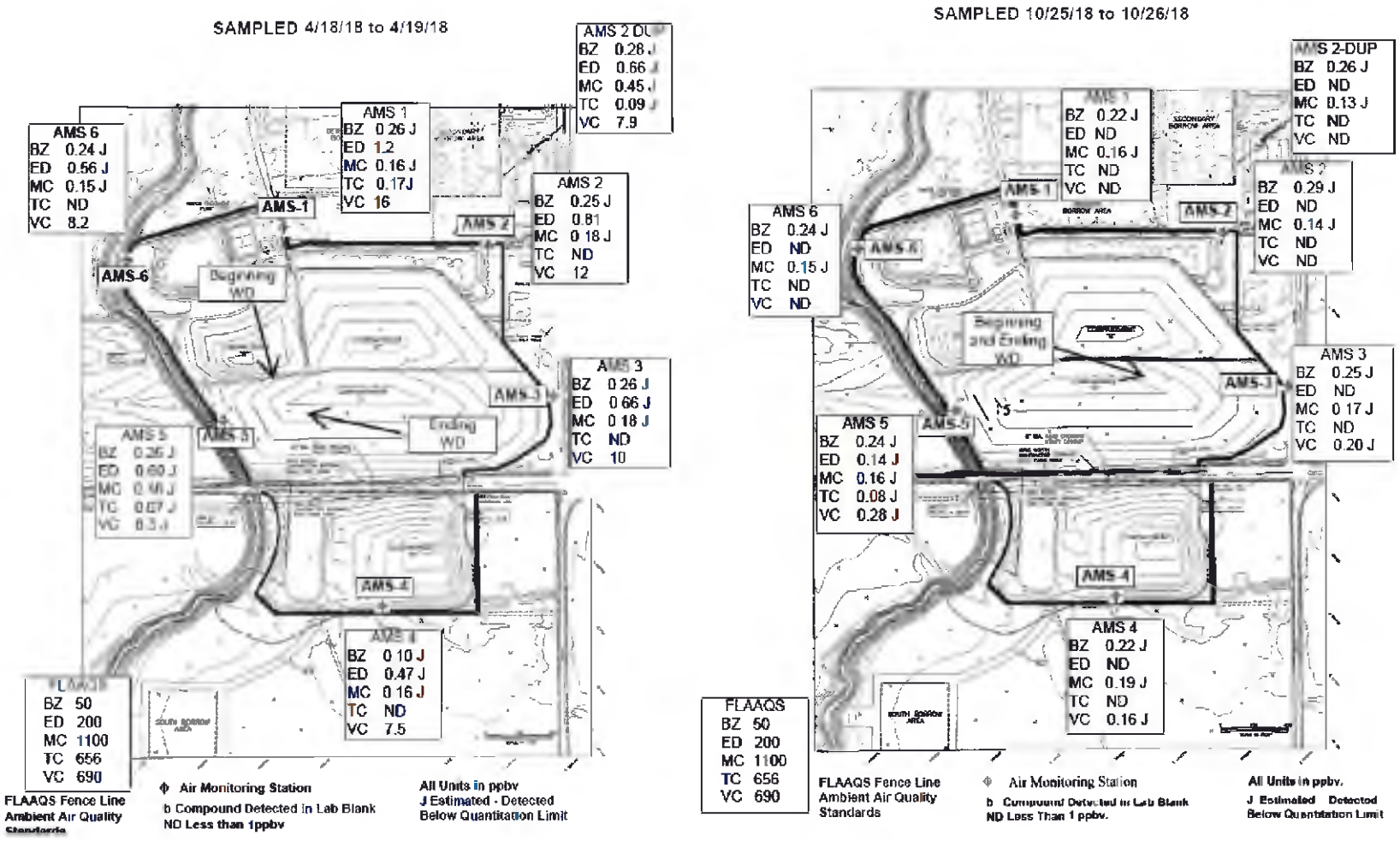
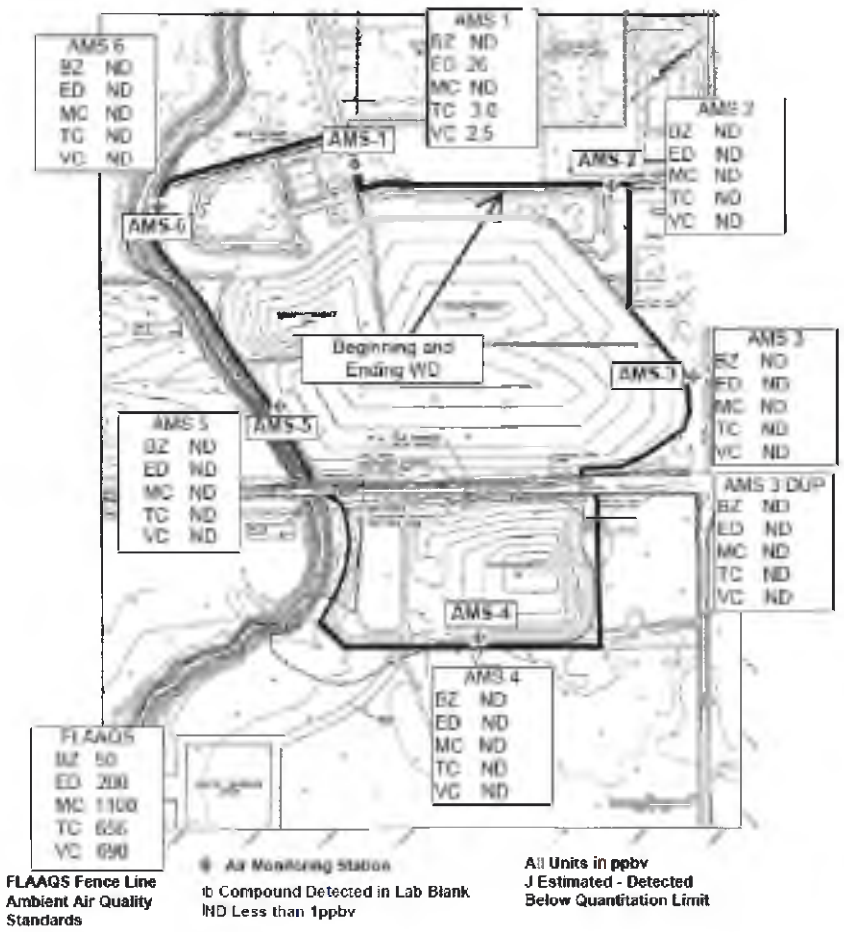


Figure F-5: Summary of Fence Line Air Monitoring Data

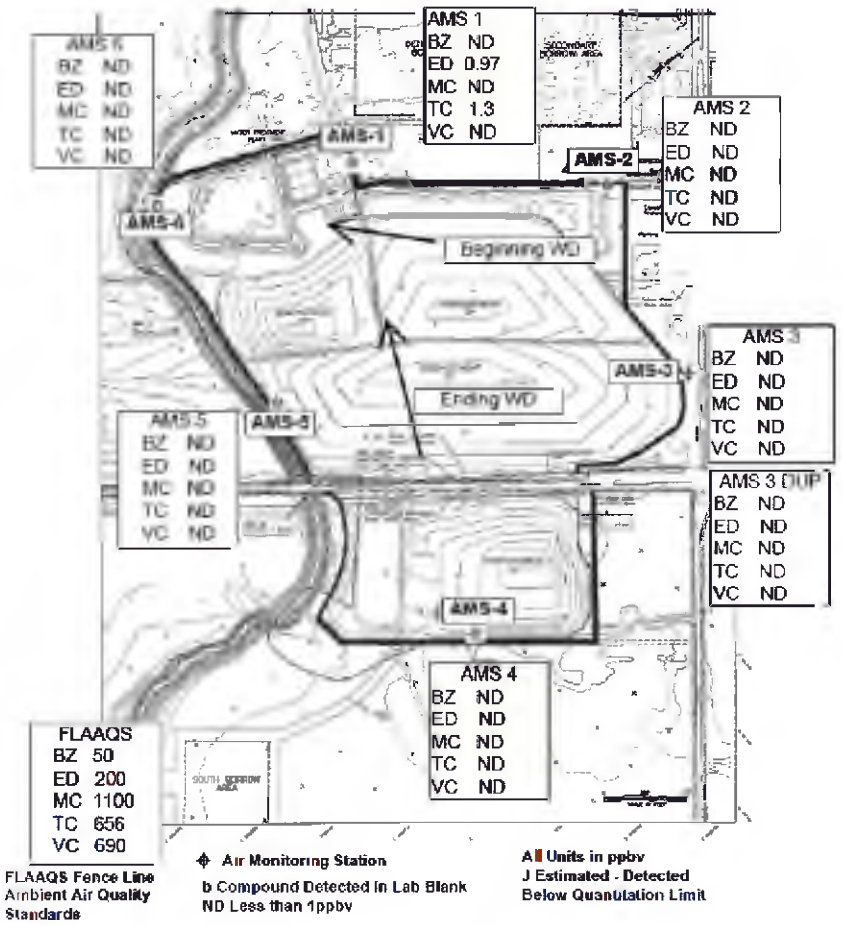


SAMPLED 4/29/19 to 4/30/19



SAMPLED 11/25/19 to 11/26/19

SAMPLED 4/21/20 to 4/22/20



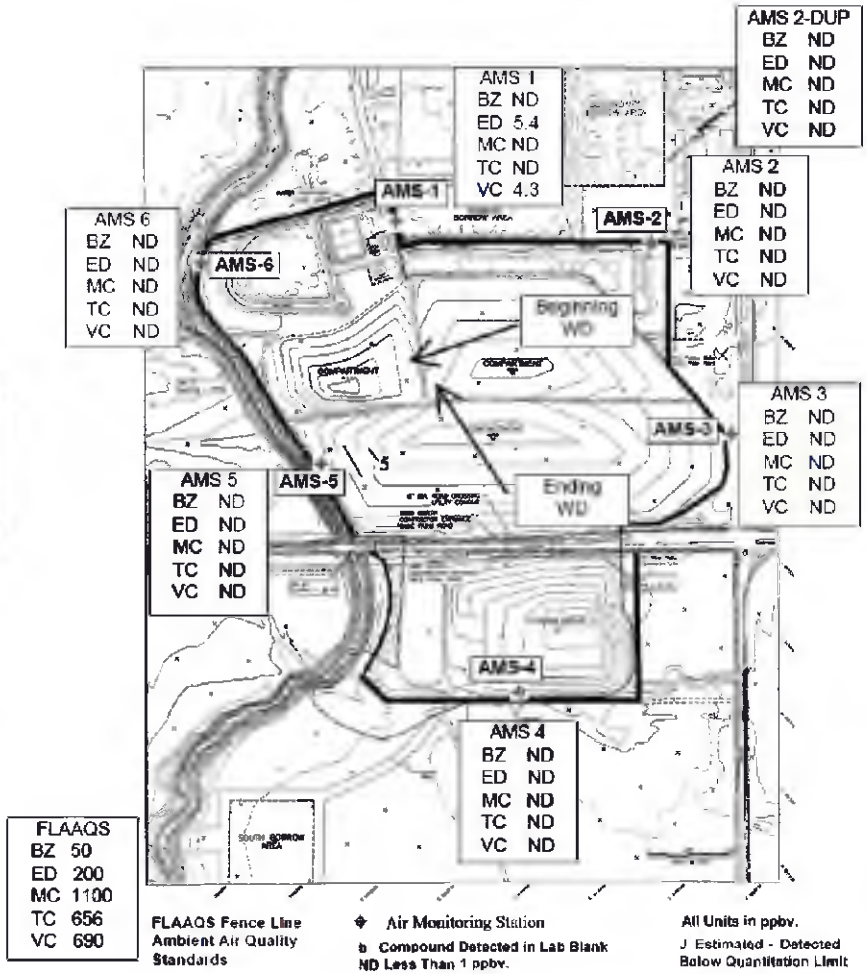
FLAAQS Fence Line
Ambient Air Quality Standards

Air Monitoring Station

b Compound Detected in Lab Blank
ND Less than 1ppbv

All Units in ppbv
J Estimated - Detected Below Quantitation Limit

SAMPLED 11/2/20 to 11/3/20

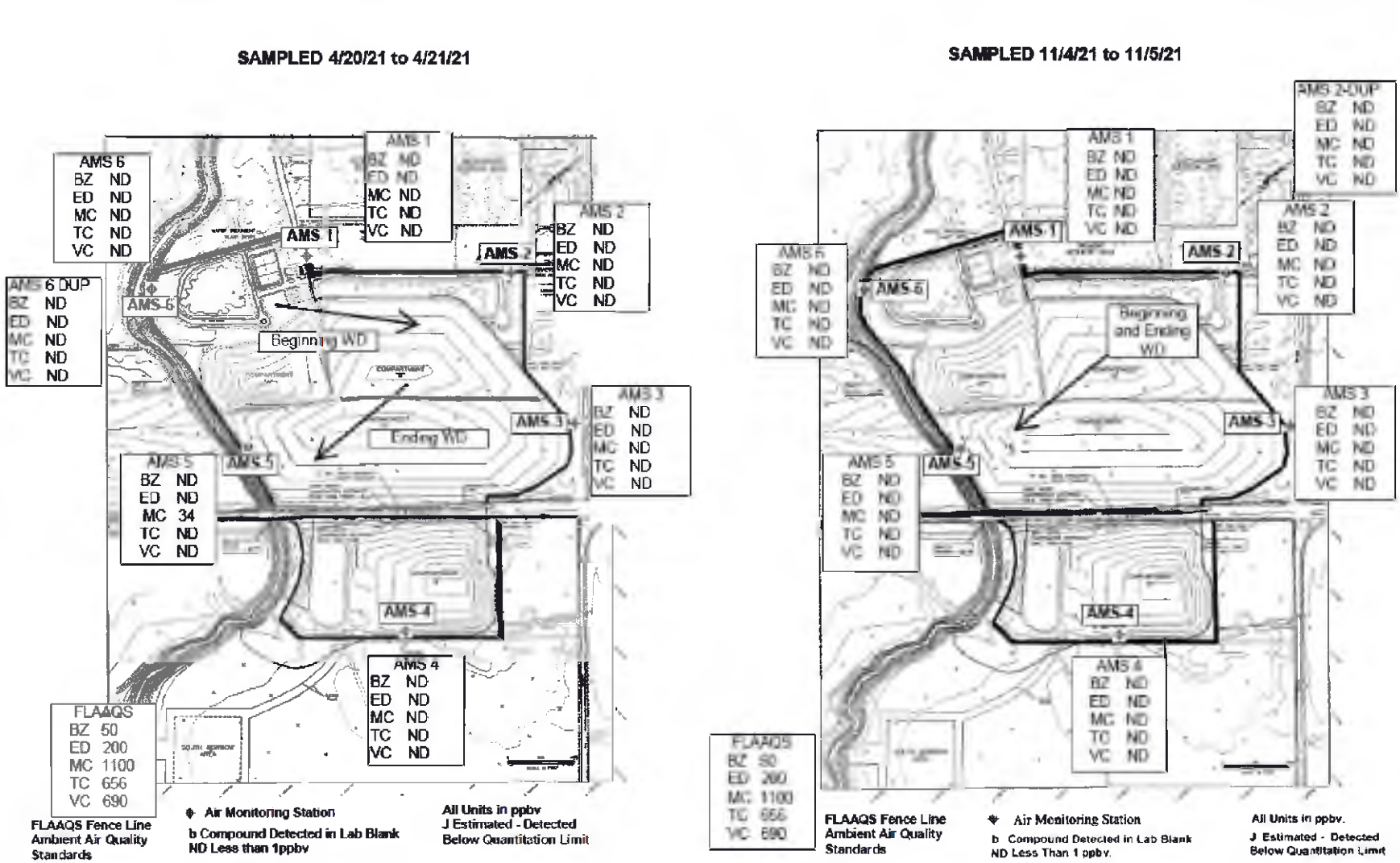


FLAAQS Fence Line
Ambient Air Quality Standards

Air Monitoring Station

b Compound Detected in Lab Blank
ND Less Than 1 ppbv.

All Units in ppbv.
J Estimated - Detected Below Quantitation Limit



Sources: The Site's 14th – 17th AERs, Figure 3-3.

Table F-1: Summary of Water Treatment Plant Discharge Data

PARAMETER	Units	Discharge Limit	3/31/15	6/8/15	10/15/15	10/30/15	11/15/15	6/15/16	7/25/16
			T-213B	T-213A	T-213A	T-213B	T-213C	T-213B	T-213C
Copper	mg/l	0.074	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	mg/l	0.7	0.0030 J	<0.005	<0.005	<0.005	0.0042 J	<0.005	<0.005
Biochemical Oxygen Demand (BOD)	mg/l	81	3.8	5.4	<2.4	3.7	3.5	2.5	4.8
Chemical Oxygen Demand (COD)	mg/l	568	40	39	66	30	56	31	36
Sulfide	mg/l	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phosphorus (Total)	mg/l	4	0.052	0.043 J	<0.050	0.34	0.14	0.11	0.029 J
Ammonia (N) [1]	mg/l	23	12	10	1.2	9.6	9.6	15	10
Oil and Grease	mg/l	31	1.2 J	1.1 J	1.8 J	1.1 J	2.1 J	1.1 J	1.7 J
Total Suspended Solids (TSS)	mg/l	62	17	17	7.6	17	28	21	9.0 J
pH	—	6.9	7.6	7.9	7.5	7.6	7.9	8.2	8.6
1,2-Dichloroethane	mg/l	0.211	1.3 J	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylene Chloride	mg/l	0.089	<0.010	<0.010	0.0033 J	<0.010	<0.010	<0.010	<0.010
1,1,2-Trichloroethane	mg/l	0.064	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vinyl Chloride	mg/l	0.268	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bis(2-chloroethyl) ether	mg/l	0.757	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
Total Carcinogenic PAHs	mg/l	0.550	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
Total Noncarcinogenic PAHs	mg/l	6.470	<0.096	<0.096	<0.096	<0.096	<0.096	<0.096	<0.096
Discharge Begin			3/31/15	6/8/15	10/15/15	10/30/15	11/15/15	6/15/16	7/25/16
Discharge End			3/31/15	6/8/15	10/15/15	10/30/15	11/15/15	6/15/16	7/25/16
Discharge Location			MG	MG	MG	MG	MG	MG	MG
Discharge Volume (approx.)	Gal		169,781	164,736	169,781	164,736	163,057	164,736	169,100

PARAMETER	Units	Discharge Limit	8/2/16	8/22/16	8/29/16	9/12/16	10/23/16	2/24/20	3/19/20
			T-213A	T-213B	T-213A	T-213C	T-213B	T-213A	T-213C
Copper	mg/l	0.074	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	mg/l	0.7	2.6 JB	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Biochemical Oxygen Demand (BOD)	mg/l	81	2.7	<2.4	<2.4	<2.4	<2.4	<2.4	<2.4
Chemical Oxygen Demand (COD)	mg/l	568	60 J	37	45	49	30	21	18 J
Sulfide	mg/l	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phosphorus (Total)	mg/l	4	0.027 J	<0.050	<0.050	<0.050	0.024 J	0.021 J	<0.050
Ammonia (N) [1]	mg/l	23	0.6	0.7	2.0	1.6	5.9	0.0061 JB	7.7 B
Oil and Grease	mg/l	31	2.3 J	1.1 J	1.8 J	2.0 J	1.4 J	2.2 J	1.1 J
Total Suspended Solids (TSS)	mg/l	62	3.0	<2.0	2.8	3.6	3.6	3.4	1.3 J
pH	—	6.9	7.9	8.1	8.1	7.7	7.9	7.8	7.6
1,2-Dichloroethane	mg/l	0.211	<0.005	<0.005	1.3 J	<0.005	<0.005	<0.005	<0.005
Methylene Chloride	mg/l	0.089	<0.010	<0.010	0.0033 J	<0.010	<0.010	<0.010	<0.010
1,1,2-Trichloroethane	mg/l	0.064	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vinyl Chloride	mg/l	0.268	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bis(2-chloroethyl) ether	mg/l	0.757	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
Total Carcinogenic PAHs	mg/l	0.550	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048	<0.048
Total Noncarcinogenic PAHs	mg/l	6.470	<0.096	<0.096	<0.096	<0.096	<0.096	<0.096	<0.096
Discharge Begin			7/9/19	7/11/19	9/10/19	10/2/19	11/15/19	3/16/19	4/9/19
Discharge End			7/10/19	7/12/19	9/11/19	10/2/19	11/14/19	3/17/19	4/10/19
Discharge Location			MG	MG	MG	MG	MG	MG	MG
Discharge Volume (approx.)	Gal		169,419	169,781	164,736	169,100	169,100	169,781	169,419

PARAMETER	Units	Discharge Limit	4/15/21	5/13/21	7/8/21	8/5/21	8/13/21	9/30/21	10/14/21
			T-213B	T-213A	T-213C	T-213A	T-213B	T-213C	T-213A
Copper	mg/l	0.074	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenol	mg/l	0.7	<0.005	0.0034 J	<0.005	<0.005	0.0045 J	<0.005	5.1
Biochemical Oxygen Demand (BOD)	mg/l	81	3.7	<2.4	<2.4	2.5	<2.4	3.1	<2.4
Chemical Oxygen Demand (COD)	mg/l	568	28	27	28	16	55.0	48	210
Sulfide	mg/l	0.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phosphorus (Total)	mg/l	4	<0.050	<0.050	<0.050	1.4	0.034 J	2.9	0.029 J
Ammonia (N) [1]	mg/l	23	13	85	7.9	3.9	47	12	47
Oil and Grease	mg/l	31	1.3 J	1.8 J	1.3 J	1.1 J	1.8 J	1.4 J	2.1 J
Total Suspended Solids (TSS)	mg/l	62	4.2	1.2 J	2.8	4.0	2.8	4.2	14 J
pH	—	6.9	7.9	7.7	7.7	7.3	8.0	7.7	8.2
1,2-Dichloroethane	mg/l	0.211	7.7	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methylene Chloride	mg/l	0.089	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
1,1,2-Trichloroethane	mg/l	0.064	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Vinyl Chloride	mg/l	0.268	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bis(2-chloroethyl) ether	mg/l	0.757	<0.0048	<0.050	<0.0096	<0.0048	<0.0048	<0.0048	<0.010
Total Carcinogenic PAHs	mg/l	0.550	<0.0096	<0.050	<0.0096	<0.0096	<0.0096	<0.0096	<0.010
Total Noncarcinogenic PAHs	mg/l	6.470	<0.0096	<0.050	<0.0096	<0.0096	<0.0096	<0.0096	<0.010
Discharge Begin			5/9/20	6/4/20	7/21/20	8/25/20	8/26/20	10/12/20	11/5/20
Discharge End			5/9/20	6/5/20	8/1/20	8/25/20	8/26/20	10/13/20	11/6/20
Discharge Location			MG	MG	MG	MG	MG	MG	MG
Discharge Volume (approx.)	Gal		163,057	164,736	166,419	166,100	161,376	166,419	164,736

PARAMETER	Units	Discharge Limit	4/15/21	5/25/21	6/24/21	7/21/21	8/26/21	8/31/21	12/7/21
			T-213A	T-213B	T-213A	T-213B	T-213A	T-213C	T-213B
Copper	mg/l	0.074	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Phenol	mg/l	0.7	<0.010	<0.010	0.027	<0.010	<0.010	<0.010	<0.010
Biochemical Oxygen Demand (BOD)	mg/l	81	<3.0	<600	2.5	<3.0	<4.0	<2.4	<2.4
Chemical Oxygen Demand (COD)	mg/l	568	15.8	43	28	40	36	43	31
Sulfide	mg/l	0.5	<0.50	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phosphorus (Total)	mg/l	4	0.015 J	0.0096 J	<0.030	0.018 J	<0.030	<0.030	<0.030
Ammonia (N) [1]	mg/l	23	19	19	9.7	16	0.9	1.4	2.5
Oil and Grease	mg/l	31	5.2	6.0	4.8 J	6.3	<5.0	<5.0	1.7 J
Total Suspended Solids (TSS)	mg/l	62	<4.0	4.5	5.5	12	11	5.0	<4.0
pH	—	6.9	7.7	8.0	8.0	7.7	7.4	8.3	8.2
1,2-Dichloroethane	mg/l	0.211	0.0006 J	<0.001	0.0051	0.0011	0.0004 J	<0.001	0.0023
Methylene Chloride	mg/l	0.089	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	mg/l	0.064	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vinyl Chloride	mg/l	0.268	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Bis(2-chloroethyl) ether	mg/l	0.757	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Carcinogenic PAHs	mg/l	0.550	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total Noncarcinogenic PAHs	mg/l	6.470	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Discharge Begin			5/7/21	5/7/21	7/15/21	8/17/21	10/11/21	11/22/21	12/28/21
Discharge End			5/8/21	5/8/21	7/16/21	8/17/21	10/12/21	11/23/21	12/29/21
Discharge Location			MG	MG	MG	MG	MG	MG	MG
Discharge Volume (approx.)	Gal		166,419	161,376	171,462	163,057	166,100	159,695	161,057

PARAMETER	Units	Discharge Limit	12/29/21	2/1/22	2/14/22	3/16/22
			T-213A	T-213C	T-213B	T-213A
Copper	mg/l	0.074	<0.020	<0.020	<0.020	<0.020
Phenol	mg/l	0.7	<0.010	0.016	0.0052 J	<0.010
Biochemical Oxygen Demand (BOD)	mg/l	81	<3.0	3.5 b	<3.0	<3.0
Chemical Oxygen Demand (COD)	mg/l	568	51	46	51	23
Sulfide	mg/l	0.5	<0.010	<0.010	<0.010	<0.010
Phosphorus (Total)	mg/l	4	<0.030	<0.030	0.0042 J	0.011 J
Ammonia (N) [1]	mg/l	23	9.2	19 B	26	15
Oil and Grease	mg/l	31	<5.0	4.7 J	2.8 J	<5.0
Total Suspended Solids (TSS)	mg/l	62	<4.0	<4.0	4.6	<4.0
pH	—	6.9	8.4	8.3	8.7	7.5
1,2-Dichloroethane	mg/l	0.211	0.0007 J	0.0012	0.0024	0.0025
Methylene Chloride	mg/l	0.089	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	mg/l	0.064	<0.001	0.0003 J	<0.001	<0.001
Vinyl Chloride	mg/l	0.268	<0.002	<0.002	<0.002	<0.002
Bis(2-chloroethyl) ether	mg/l	0.757	<0.005	<0.005	0.013	0.0048 J
Total Carcinogenic PAHs	mg/l	0.550	<0.005	<0.005	<0.005	<0.005
Total Noncarcinogenic PAHs	mg/l	6.470	<0.005	<0.005	<0.005	<0.005
Discharge Begin			1/18/22	2/24/22	3/15/22	4/5/22
Discharge End			1/19/22	2/25/22	3/16/22	4/7/22
Discharge Location			MG	MG	MG	MG
Discharge Volume (approx.)	Gal		165,014	164,736	166,419	161,376

J - Parameter detected below detection limit
B - Parameter detected in lab blank
b - Result detected in unseeded control blank
MG - Mud Gully

Source: The Site's 14th AER, 15th AER, 16th AER and 17th AER, Table 3-6.

Table F-2: Summary of DNAPL Recovery Volumes

PERIOD	VOLUME SHIPPED FOR DISPOSAL (gal)	CUMULATIVE VOLUME SHIPPED FOR DISPOSAL SINCE 1st AER (gal)	CUMULATIVE VOLUME SHIPPED FOR DISPOSAL – PROJECT TOTAL (gal)
Prior to 2004	123,334[2]	N/A	123,334
AER 2004-2005	2,640	2,640	125,974
AER 2005-2006	13,500	16,140	139,474
AER 2006-2007	18,150	34,290	157,624
AER 2007-2008	6,400	40,690	164,024
AER 2008-2009	17,100	57,790	181,124
AER 2009-2010	14,970	72,760	196,094
AER 2010-2011	19,656	92,416	215,752
AER 2011-2012	8,274	100,692	224,026
AER 2012-2013	10,940	111,632	234,966
AER 2013-2014	5,928	114,560	240,894
AER 2014-2015	2,800	117,360	243,694
AER 2015-2016	3,120	120,480	246,814
AER 2016-2017	3,918	124,398	250,732
AER 2017-2018	0[3]	124,398	250,732
AER 2018-2019	2,128	126,526	252,860
AER 2019-2020	2,750	129,276	255,610
AER 2020-2021	0[4]	129,276	255,610
AER 2021-2022	0	129,276	255,610

(1) Approximate volumes (2) Pit B – 38,803 gal and Pit J – 84,531 gal (3) DNAPL was shipped just prior to and just following the 2017-2018 AER period. (4) DNAPL was shipped just prior to the 2020-2021 AER period.

Source: The Site's 17th AER, Table 3-8.

Table F-3: Summary of Surface Water Monitoring in Mud Gully (µg/L)

	Stream Standard	SW-13				SW-1				SW-16			
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	ND	ND	[illegible]	[illegible]	ND	[illegible]	[illegible]	[illegible]	ND	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	ND	ND	[illegible]	[illegible]	ND	[illegible]	[illegible]	[illegible]	ND	[illegible]
[illegible]	[illegible]	[illegible]	ND	ND	ND	[illegible]	[illegible]	ND	ND	[illegible]	ND	ND	ND
[illegible]	[illegible]	[illegible]	ND	ND	ND	[illegible]	[illegible]	ND	[illegible]	[illegible]	[illegible]	ND	[illegible]

	Stream Standard	SW-13				SW-1				SW-16			
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	Steam Standard	UPSTREAM SW-13				BRIC @ DFR BRIDGE SW-1				SOUTH END OF DOP SW-16			
		6/16/2020	9/29/2020	12/17/2020	3/9/2021	6/16/2020	9/29/2020	12/17/2020	3/9/2021	6/16/2020	9/29/2020	12/17/2020	3/9/2021
1,2-DCA	20,000	ND	ND	ND	ND	3.3 J	18	9.6	27	3.8 J	18	9.4	35
1,1,2-TCA	4,180	ND	ND	ND	ND	7.7	19	15	40	9.1	20	15	51
VC	9,450	ND	ND	ND	ND	3.6 J	13	7.3	17	4.1 J	13	7.1	21
1,1-DCE	8,740	ND	ND	ND	ND	3.1 J	7.0	3.4	10	3.3 J	7.3	3.7	12

	Stream Standard	SW-13				SW-1				SW-16			
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	ND	ND	ND	ND	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Sources: The Site's 14th – 17th AERs, Table 3-1.

Table F-4: Summary of Surface Water Monitoring in Clear Creek (µg/L)

	Stream Standard	SW-21			
		1Q2018 No Sample	6/13/18	9/18/18	12/29/19
1,2-Dichloroethane	1,794	---	ND	ND	ND
1,1,2-Trichloroethene	41.8	---	ND	ND	ND
Vinyl Chloride	94.5	---	ND	ND	ND
1,1-Dichloroethene	87.4	---	ND	ND	ND

	Stream Standard	SW-21			
		6/12/19	9/16/19	12/04/19	3/10/20
1,2-Dichloroethane	1,794	1.4 J	ND	3.1 J	1.8 J
1,1,2-Trichloroethane	41.8	1.6 J	ND	5.1	3.4 J
Vinyl Chloride	94.5	ND	ND	ND	ND
1,1-Dichloroethene	87.4	ND	ND	ND	ND

	Stream Standard	SW-21			
		6/16/2020	9/29/2020	12/17/2020	3/9/2021
1,2-DCA	1,794	1.1 J	ND	ND	3.4
1,1,2-TCA	41.8	2.2 J	ND	1.7	5.4
VC	94.5	ND	ND	ND	ND
1,1-DCE	87.4	ND	ND	ND	1.1

	Stream Standard	SW-21			
		6/15/21	9/22/21	12/13/22	3/23/22
1,2-Dichloroethane	1,794	1.3	0.83 J	2.0	0.29 J
1,1,2-Trichloroethane	41.8	1.7	1.1	3.8	0.55 J
Vinyl Chloride	94.5	0.78 J	ND	0.80 J	ND
1,1-Dichloroethene	87.4	0.56 J	ND	1.5	ND

Sources: The Site's 14th – 17th AERs, Table 3-1.

APPENDIX G – DETAILED ARARS REVIEW

The 1988 ROD selected MCLs as the ARAR that applies to the FFSZ. The ROD did not include numeric standards but the AER incorporates the most current MCLs as part of the monitoring requirements for the FFSZ (Table G-1).

Table G-1: Review of Groundwater Standards for the FFSZ

Compound	Compliance Standards for the FFSZ[a] (µg/L)	Current Standards[b] (µg/L)
1,1,1-Trichloroethane	200	200
1,1,2-Trichloroethane	5	5
1,1-Dichloroethene	7	7
1,2-Dichlorobenzene	600	600
1,2-Dichloroethane	5	5
1,2-Dichloroethene (total)	70	70
1,2-Dichloropropane	5	5
1,2,4-Trichlorobenzene	70	70
1,4-Dichlorobenzene	75	75
Benzene	5	5
Carbon tetrachloride	5	5
Chlorobenzene	100	100
Ethylbenzene	700	700
Methylene chloride	5	5
Styrene	100	100
Tetrachloroethene	5	5
Toluene	1,000	1,000
Trichloroethene	5	5
Vinyl chloride	2	2
Xylenes (total)	10,000[c]	10,000

Notes:

a. All four AER reports list the MCL for xylene as 1,000 µg/L when the MCL is 10,000 µg/L when evaluating the FFSZ data.

b. Current federal Safe Drinking Water Act standards are available at https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants (accessed 11/10/2022).

Subsequent to the 1997 AROD, Texas surface water quality standards for all the surface water COCs had been revised under 30 Texas Administrative Code (TAC) §307 in 2000 (as reflected in the Site's second FYR Report) and subsequently in 2010, 2014 and 2018. Table G-2 provides a comparison of the 1997 ROD surface water criteria to current standards. These numbers would apply to Clear Creek. For Mud Gully, considered an incidental fishery, TCEQ surface water quality standards would be 10 times these revised values. The current standards have become more stringent for 1,2-DCA, 1,1,2-TCA (Clear Creek only) and vinyl chloride.

Sampling has been conducted in Mud Gully and Clear Creek to measure the effectiveness of the barrier wall and the groundwater collection system. A review of the surface water data shows that the controls implemented for the groundwater have reduced the loading to the surface water to below the ARARs established in the AROD and below the revised state water quality standards. Because the remedy is achieving the new standards, the remedy remains protective. However, if the current standards are exceeded in the future, further evaluation of the surface water standards may be required.

Table G-2: Evaluation of 1997 Surface Water Remedy Performance Criteria

COC	1997 AROD Standards		Current Standards[b]	
	Mud Gully and NSCZ[a] (µg/L)	Clear Creek (µg/L)	Mud Gully and NSCZ[a] (µg/L)	Clear Creek (µg/L)
1,2-Dichloroethane	20,000	1,794	3,640	364
1,1-Dichloroethene	8,740	87.4	3,030	3,030
1,1,2-Trichloroethane	4,180	41.8	900	900
Vinyl chloride	9,450	94.5	165	16.5

Notes:
Source: Table 2 of the Site's 1997 AROD.
a. Surface water standards apply to the NSCZ outside the barrier wall.
b. Most current standards are dated 2018 and are obtained from https://www.tceq.texas.gov/waterquality/standards (accessed on 11/4//2022).

APPENDIX H – SCREENING-LEVEL RISK EVAUATION

EPA established residential-based target levels for off-site soil and site-specific target levels for on-site soil protective of trespassers in the 1988 EA. The health-based soil target levels cleanup goals were evaluated to determine if any toxicity value changes or changes in EPA's default exposure assumptions would make any of the cleanup goals not protective. The health-based cleanup goals were compared to EPA's current regional screening levels (RSLs), because the RSLs incorporate current toxicity values and standard default exposure factors. A residential RSL comparison was conducted for the off-site soil target levels. An industrial RSL comparison was conducted for the on-site target levels to determine if the remedies remain protective for the current industrial site use.

The industrial-use evaluation shows that the target levels for five COCs exceed EPA's risk management range of 1×10^{-6} to 1×10^{-4} and three COCs exceed the noncancer hazard quotient (HQ) of 1.0 (Table H-1). The remedy contained on-site contamination within a slurry wall with a multi-layer cover. Therefore, there is no direct exposure to contaminated soils.

The off-site risk evaluation (Table H-2) shows that the target levels remain protective of residential exposure as the cleanup goals are equivalent to cancer risks that are more stringent or within EPA's risk management range and below the noncancer threshold HQ of 1.

Table H-1: Screening-Level Risk Evaluation of On-site Soil Target Levels

COC	On-site Target Level (mg/kg)	Industrial RSL (mg/kg)[a]		Cancer Risk[b]	Noncancer HQ[c]
		1×10^{-6} Risk	HQ = 1		
cPAHs					
Benzo(a)anthracene	10,200	21	-	**4.9×10^{-4}**	-
Benzo(b)fluoranthene	1,200	21	-	5.7×10^{-5}	-
Benzo(k)fluoranthene	580	210	-	2.8×10^{-6}	-
Benzo(a)pyrene	44	2.1	220	2.1×10^{-5}	0.2
Dibenz(a,h)anthracene	74	2.1	-	3.5×10^{-5}	-
Indeno(1,2,3-c,d)pyrene	7,400	21	-	**3.5×10^{-4}**	-
VOCs and SVOCs					
1,2-Dichloroethane	2,800	2	140	**1.4×10^{-3}**	**20**
1,1,2-Trichloroethane	2,300	5	6.3	**4.6×10^{-4}**	**365**
Bis(2-chloroethyl)ether	230	1	-	**2.3×10^{-4}**	-
Methylene chloride	33,000	1000	3,200	3.3×10^{-5}	**10**
Vinyl chloride	109	1.7	310	6.4×10^{-5}	0.4

Notes:

a. Current EPA RSLs, dated November 2022, are available at https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables (accessed 12/7/2022).

b. The cancer risks were calculated using the following equation, based on the fact that RSLs are derived based on 1 x 10^{-6} risk: cancer risk = (target level ÷ cancer-based RSL) × 10^{-6}.

c. The noncancer HQ was calculated using the following equation: HQ = target level ÷ noncancer-based RSL.

- = toxicity values not established by EPA, so an RSL could not be calculated.

Bold = noncancer HQ exceeds 1.0 or cancer risk exceeds 1×10^{-4}.

Source: Table 1 in the Site's 1997 AROD.

Table H-2: Screening-Level Risk Evaluation of Off-site Soil Target Levels

COC	Offsite Target Level(mg/kg)	Residential RSL (mg/kg)		Cancer Risk	Noncancer HQ
		1×10^{-6} Risk	HQ=1		
cPAHs					
Benzo(a)anthracene	26.9	1.1	-	2.4×10^{-5}	-
Benzo(b)fluoranthene	5.1	1.1	-	4.6×10^{-6}	-
Benzo(k)fluoranthene	5.1	11	-	4.6×10^{-7}	-
Benzo(a)pyrene	0.04	0.11	18	3.6×10^{-7}	0.002
Dibenz(a,h)anthracene	0.23	0.11	-	2.1×10^{-6}	-
Indeno(1,2,3-c,d)pyrene	10.5	1.1	-	9.6×10^{-6}	-
VOCs and SVOCs					
1,2-Dichloroethane	0.13	0.46	31	2.8×10^{-7}	0.004
1,1,2-Trichloroethane	1.4	1.1	1.5	1.3×10^{-6}	0.9
Bis(2-chloroethyl)ether	0.07	0.23	-	3.0×10^{-7}	-
Methylene chloride	12.5	57	350	2.2×10^{-7}	0.036
Vinyl chloride	0.02	0.059	60	3.4×10^{-7}	0.0003

Notes:

a. Current EPA RSLs, dated November 2022, are available at https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables (accessed 12/7/2022).

b. The cancer risks were calculated using the following equation, based on the fact that RSLs are derived based on 1×10^{-6} risk: cancer risk = (target level ÷ cancer-based RSL) × 10^{-6}.

c. The noncancer HQ was calculated using the following equation: HQ = target level ÷ noncancer-based RSL.

- = toxicity values not established by EPA, so an RSL could not be calculated.

Bold = noncancer HQ exceeds 1.0 or cancer risk exceeds 1×10^{-4}.

Source: Table 1 in the Site's 1997 AROD.

APPENDIX I – INTERVIEW FORMS

BRIO REFINING, INC. SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Brio Refining, Inc.	
EPA ID: TXD980625453	
Interviewer name:	**Interviewer affiliation:**
Subject name: Michael Jeude	**Subject affiliation:** TCEQ
Subject contact information: michael.jeude@tceq.texas.gov	
Interview date: 1/4/2023	**Interview time:**
Interview location: TCEQ Region 12 Office	
Interview format (circle one): In Person Phone Mail **Email** X Other:	
Interview category: State Agency	

1. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?
   The remedy is performing well.

2. What is your assessment of the current performance of the remedy in place at the Site?
   The remedy is performing well.

3. Are you aware of any complaints or inquiries regarding site-related environmental issues or remedial activities from residents in the past five years?
   No.

4. Has your office conducted any site-related activities or communications in the past five years? If so, please describe the purpose and results of these activities.
   TCEQ attended annual meetings with site operators and checked with the operators before and after major storm events.

5. Are you aware of any changes to state laws that might affect the protectiveness of the Site's remedy?
   No.

6. Are you comfortable with the status of the institutional controls at the Site? If not, what are the associated outstanding issues?
   Yes.

7. Are you aware of any changes in projected land use(s) at the Site?
   No.

8. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy?
   No.

9. Do you consent to have your name included along with your responses to this questionnaire in the FYR Report?
   Yes.

BRIO REFINING, INC. SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Brio Refining, Inc.	
EPA ID: TXD980625453	
Interviewer name:	**Interviewer affiliation:**
Subject name: Marie Flickinger	**Subject affiliation:** Resident/CAG chairperson
Subject contact information:	
Interview date: January 26, 2023	**Interview time:**
Interview location:	
Interview format (circle one): In Person Phone Mail Email X Other:	
Interview category: Resident	

1. Are you aware of the former environmental issues at the Site and the cleanup activities that have taken place to date?
   Yes, I am.

2. What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?
   I am impressed that the remedy has gone this long without having any problems. There are no reuse activities allowed.

3. What have been the effects of the Site on the surrounding community, if any?
   Many effects too complicated to mention when the Site was first named. None of any significance since the completion of the remedy.

4. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?
   No.

5. Has EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can EPA best provide site-related information in the future?
   EPA and BSTF have done a good job of informing the community. We hope they continue to use the South Belt-Ellington Leader for this purpose.

6. Do you own a private well in addition to or instead of accessing city/municipal water supplies? If so, for what purpose(s) is your private well used?
   No private well use.

7. Do you have any comments, suggestions or recommendations regarding any aspects of the project?
   No, just continue to respond when community concerns are raised.

BRIO REFINING, INC. SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM					
Site Name: Brio Refining, Inc.					
EPA ID: TXD980625453					
Interviewer name:		**Interviewer affiliation:**			
Subject name: Dr. Latrice Babin		**Subject affiliation:** Executive Director			
Subject contact information: 713-920-2831					
Interview date: 3/3/2023		**Interview time:** 2:30 pm			
Interview location: Office of Harris County Pollution Control Services					
Interview format (circle one): In Person	Phone	Mail	**Email**	Other:	
Interview category: Local Government					

1. Are you aware of the former environmental issues at the Site and the cleanup activities that have taken place to date?

   Harris County Pollution Control Services (PCS) is aware of environmental issues and cleanup activities through publicly available documents.

2. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might EPA convey site-related information in the future?

   PCS requests to be copied and included in all correspondence and communication, including those conducted by government agencies, contractors, and any other entity affiliated with the Site.

3. Have there been any problems with unusual or unexpected activities at the Site, such as emergency response, vandalism or trespassing?

   PCS is unaware of any unexpected activities at the Site related to emergency response, vandalism, or trespassing.

4. Are you aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy?

   PCS is not aware of any changes to state laws or local regulations that might affect the protectiveness of the Site's remedy.

5. Are you aware of any changes in projected land use(s) at the Site?

   PCS is not aware of any changes in the projected land use at the Site.

   PCS requests to be updated on any changes related to projected land uses at and around the Site.

6. Has EPA kept involved parties and surrounding neighbors informed of activities at the Site? How can EPA best provide site-related information in the future?

Per the 2018 Five Year Review (FYR), the Maintenance, Operations, and Monitoring Plan (MOM) encompasses many activities and includes inspection of the perimeter and equipment, operation and maintenance, groundwater, surface water, and air sampling and monitoring. Site personnel perform MOM activities daily. The 2018 FYR also mentioned a Brio Site Community Advisory Group (CAG), an information repository at the Parker Williams Library, quarterly activity meetings, annual effectiveness reports dated 2018, the records being onsite, and continued work being performed at the Site. The public notice also references the library and the EPA website as sources of information. As a note, the library is less than a mile from the Site.

PCS concern- according to the EPA website under current status states, "...the next five-year review, scheduled for completion in 2018." PCS was unable to locate any information on the EPA's website regarding groundwater sampling data, inspections, maintenance records, or other information which would have been collected per the MOM. PCS also did not find any fact sheets on the EPA website. The only available information is a Site Status Summary dated September 2015. The EPA website also did not mention a CAG or provide information on how to contact the CAG. The most recent annual effectiveness report on the website is dated 2015. Upon contacting the repository, the director of the library indicated it had been several years since the information had been updated and new information added. A satellite view of the area shows increased residential development around the Site, as well as commercial businesses adjacent to the Site, i.e., several fireworks stands.

PCS recommends keeping the website updated. PCS recommends placing all information on the EPA website, including but not limited to up-to-date fact sheets, Site Status Summary, sampling results, inspection results, maintenance findings, annual effectiveness reports, quarterly meeting summaries, and contact information for the CAG. PCS additionally recommends keeping the repository updated with Site information and a copy of records that are currently kept onsite. As a final recommendation, due to increased residential development, a sign which includes the repository information should be posted at the Site.

7. Do you have any comments, suggestions or recommendations regarding the project?

According to the EPA website, the current status of the Site is elevated groundwater contaminant concentrations have been reported in the Fifty-Foot Sand water-bearing zone (FFSZ) with ongoing fieldwork to assess the need for further remedial action.

The 2013 and 2018 FYR determined that Site protectiveness in the short term has removed the exposure pathways that could have resulted in unacceptable risks by preventing exposure of human receptor populations to contaminated air, soils, and groundwater. Items were identified that require further action to ensure the continued

at the perimeter of the Site informing the public of the Site and where to find additional information.

8. Do you consent to have your name included along with your responses to this questionnaire in the FYR report?

   Yes

BRIO REFINING, INC. SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Brio Refining, Inc.	
EPA ID: TXD980625453	
Interviewer name:	**Interviewer affiliation:**
Subject name: John Danna	**Subject affiliation:** BSTF
Subject contact information: See transmittal email	
Interview date: 3/1/2023	**Interview time:**
Interview location:	
Interview format (circle one): In Person Phone Mail (Email) Other:	
Interview category: O&M Contractor	

1. **What is your overall impression of the project, including cleanup, maintenance and reuse activities (as appropriate)?** *The cleanup and maintenance are proceeding according to Site plans. Reuse activities are very limited due to the nature of the cleanup and maintenance activities, and the construction of the remedy. I understand that the PRPs are open to reuse activities which would be compatible with the remedy and safe for workers, the community, and the environment.*

2. **What is your assessment of the current performance of the remedy in place at the Site?** *The performance of the remedy continues to protect the environment and population.*

3. **What are the findings from the monitoring data? What are the key trends in contaminant levels that are being documented over time at the Site?** *The number of Fifty-Foot Sand Zone monitoring wells showing affected groundwater has decreased, and the concentrations of site constituents seen at the affected monitoring wells continues to decrease.*

4. **Is there a continuous on-site O&M presence? If so, please describe staff responsibilities and activities. Alternatively, please describe staff responsibilities and the frequency of site inspections and activities if there is not a continuous on-site O&M presence.** *There is a continuous O&M presence at the Brio Site with two operators and two maintenance personnel working eight hours per day five days per week. An operator conducts routine checks when the groundwater recovery system and water treatment plant are operating through the weekend.*

5. **Have there been any significant changes in site O&M requirements, maintenance schedules or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.** *None.*

6. What have been the O&M costs during the FYR period?

O&M Costs Over the FYR Period

Date Range	Total Cost *(rounded to the nearest $1,000)*
2018	$856,000
2019	$1,090,000
2020	$763,000
2021	$828,000
2022	$890,000

7. Have there been unexpected O&M difficulties or costs at the Site since start-up or in the last five years? If so, please provide details. *None.*

8. Have there been opportunities to optimize O&M activities or sampling efforts? Please describe changes and any resulting or desired cost savings or improved efficiencies. *The O&M activities have been in place since 2004. There have been no major changes during the FYR period to optimize O&M activities; however, there have been many opportunities since O&M began in 2004 to optimize the efficiency of operations, maintenance, and sampling efforts. For example, the method of scrubbing VOCs from the air stripper exhaust was modified in 2011 to save over $170,000 per year in energy and maintenance costs. Another example has been to train site operators to maintain site equipment and conduct sampling instead of hiring contractors to do this work.*

9. Do you have any comments, suggestions or recommendations regarding O&M activities and schedules at the Site? *Not at this time.*

10. Do you consent to have your name included along with your responses to this questionnaire in the FYR report? *Yes.*

BRIO REFINING, INC. SUPERFUND SITE FIVE-YEAR REVIEW INTERVIEW FORM	
Site Name: Brio Refining, Inc.	
EPA ID: TXD980625453	
Interviewer name:	Interviewer affiliation:
Subject name: Matthew Foresman	**Subject affiliation:** BSTF
Subject contact information: See transmittal email	
Interview date: 4/1/2023	Interview time:
Interview location:	
Interview format (circle one): In Person Phone Mail *Email* Other:	
Interview category: Potentially Responsible Party (PRP)	

1. What is your overall impression of the remedial activities at the Site? *The chosen Remedy is in place and continues to successfully reduce the Site constituents as designed.*

2. What have been the effects of this Site on the surrounding community, if any? *The Remedy has been and continues to be protective of human health and the environment. Monitoring data continues to show that there are no adverse effects to the surrounding community.*

3. What is your assessment of the current performance of the remedy in place at the Site? *The Remedy continues to be protective of human health and the environment.*

4. Are you aware of any complaints or inquiries regarding environmental issues or the remedial action from residents since implementation of the cleanup? *A complaint was brought to the EPA during the FYR period about excessive noise from system operations. The issue was quickly identified and mitigated utilizing one of our Site consultants and is resolved.*

5. Do you feel well-informed regarding the Site's activities and remedial progress? If not, how might EPA convey site-related information in the future? *Yes*

6. Do you have any comments, suggestions or recommendations regarding the management or operation of the Site's remedy? *No, in cooperation with EPA and TCEQ, the Remedy has been and continues to be protective of human health and the environment.*

7. Do you consent to have your name included along with your responses to this questionnaire in the FYR report? *Yes*

APPENDIX J – EJSCREEN REPORT