Welcome

## **Environmental Advisory Board (EAB) Meeting**

**Robins Air Force Base** 

November 2, 2023

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# Welcome and Program Introduction

## Dr. Linda Smyth EAB Community Co-chair



## **Acronyms and Abbreviations**

- AST Above-ground Storage Tank
- CAP Corrective Action Plan
- COC Contaminant of Concern
- DNAPL Dense Non-Aqueous Phase Liquid
- EAB Environmental Advisory Board
- EFR Enhanced Fluid Recovery
- EW Extraction Well
- ft AMSL feet Above Mean Sea Level
- **GA EPD Georgia Environmental Protection Division**
- GBIA Greater Base Industrial Area
- HVR High Vacuum Recovery
- LC Leachate Collection
- LNAPL Light Non-Aqueous Phase Liquid
- μg/L micrograms per liter
- MFR Modified Fenton's Reagent



## **Acronyms and Abbreviations**

- MNA Monitored Natural Attenuation
- PFAS Perfluoroalkyl and Polyfluoroalkyl Substances
- RCRA Resource Conservation and Recovery Act
- RFI RCRA Facility Investigation
- ROI Radius of Influence
- RL Remediation Level
- SSI Supplemental Site Investigation
- SURFAC Surfactant-enhanced LNAPL Recovery
- SWMU Solid Waste Management Unit
- TCE Trichloroethene
- U Data Flag indicating Analyte Not Detected above Limit of Detection
- UFP-QAPP Uniform Federal Policy-Quality Assurance Project Plan
- UIC Underground Injection Control
- VOC Volatile Organic Compound





### Solid Waste Management Unit (SWMU) 47 (CG504) Update on Progress

Elizabeth Rhine Bhate Technical Lead

2 November 2023





- Background
- Prior Remedial Actions
- Surfactant and Bioaugmentation Injection
- High-Vacuum Recovery (HVR) Extraction Event
- Next Steps



## Background

- SWMU 47 is east of Building 177
  - Steam plant supporting Greater Base Industrial Area (GBIA) and other areas
- 250,000-gallon aboveground storage tank (AST); No. 2 diesel fuel
- Discovered release in 1996 during upgrades made to AST containment dike and fuel lines
- Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) completed in 1997





#### **Prior Remedial Actions** Since Start of Corrective Actions at Site in 2000



- More than 12,000,000 gallons of groundwater have been extracted and treated
- More than 1,400 gallons of Light Non-aqueous Phase Liquid (LNAPL) have been removed by various methods
  LNAPL remains, with thickness up to 0.8 feet







#### Ivey-Sol<sup>®</sup> Surfactant

- Non-ionic surfactant that reduces surface tension of water, improving wetting ability and allowing water to penetrate less permeable soils such as silty sand, silt, and clay
- Liberate LNAPL and sorbed contaminants from soil to make them more hydraulically available for extraction
- Non-toxic at low concentrations and increases bioavailability of hydrophobic organics



#### Petrox<sup>TM</sup> Bioaugmentation Culture

- Blend of dehydrated pseudomonas species
- Shipped in drum liners
- Install drum liner in drum, fill with potable water to rehydrate overnight, and result is slurry of bacteria that will break down petroleum constituents
- Formulas are specific to diesel (Petrox<sup>TM</sup> 106) as well as gasoline, jet fuel, and other fuels
- Compatible with Ivey-Sol®





Ivey-Sol<sup>®</sup> mixed in totes and injected with pneumatic pumps









Petrox<sup>TM</sup> mixed in drums and designated volumes mixed with Ivey Sol<sup>®</sup> and potable water in injection totes







Well head injection setup at B177MW19← Drum Storage Area



- Removed approximately 400 pounds of hydrocarbon
  - Equivalent to approximately 57 gallons of diesel
  - Treated with thermal oxidizer at 99.93% destruction efficiency
- Removed approximately 9,000 gallons of petroleumcontaminated water
  - Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) are not of concern at SWMU 47
  - Continued HVR is a viable remedy
  - Performed under an approved Underground Injection Control (UIC) Notification, so additional surfactant may be injected through 29 November 2023 (90 days)



Combined Recovery Rate of MP-02, MP-04, MW-9, and MW-16







HVR unit setup



HVR unit setup and tanker truck





HVR unit well head stinger setup

HVR smaller tanker truck

HVR set up and smaller tanker truck at night



#### HVR Extraction Event LNAPL Thickness Before/After

SMWU 47 (CG504) HVR LNAPL Comparison (October 2022 and October 2023)









- Continue to measure LNAPL thickness monthly
- Trigger for subsequent Ivey-sol<sup>®</sup> injection/HVR<sup>TM</sup> extraction event is presence of LNAPL at greater than 0.01 foot for two consecutive sampling events
  - October event shows LNAPL > 0.01 foot
- Subsequent injections will not necessarily duplicate initial effort, but will focus on wells where LNAPL is persistent
- Once free product thickness has been reduced to less than 0.010-foot, groundwater will be sampled on semiannual basis until Remediation Levels (RLs) are achieved, then annually



- Performed under an approved UIC Notification, so additional surfactant may be injected through 29 November 2023 (90 days)
  - Tentatively scheduled for early November 2023
- No additional bioaugmentation planned
  - Once injected, *pseudomonas* will proliferate as long as there is a food source
  - HVR not performed on wells injected with Petrox<sup>TM</sup> because it would have removed or slowed growth of *pseudomonas*
- Additional HVR may be conducted as site conditions indicate
  - Tentative scheduled for mid-November 2023



## **Environmental Advisory Board**



## SWMU 28 (CG028) Update on Progress

Elizabeth Rhine Bhate Technical Lead

2 November 2023





- Background
- Prior Remedial Actions
- Supplemental Site Investigation (SSI)
  - Investigation Phase
  - Modified Fenton's Reagent (MFR) Pilot Test
  - High Vacuum Recovery (HVR) Pilot Test

Next Steps



## Background

- SWMU 28 originally identified in February 1990 when purge fluid was observed in an excavation during valve maintenance at Building 45
- Leak in valve near former subgrade fuel line connecting to defueling sump DF2
- Defueling sumps were earthen
- Primary contaminants of concern (COCs) in groundwater are benzene, 1,1-dichloroethene, 1,2,4trimethlybenzene, 1,3,5trimethylbenzene, acenaphthylene, indeno(1,2,3-cd)pyrene, 1methylnaphthalene, 2methylnaphthalene, and naphthalene





- Passive recovery to reduce light non-aqueous phase liquid (LNAPL or free product) to <0.01 feet
- Enhanced Fluid Recovery (EFR)
- Surfactant-enhanced LNAPL recovery (SURFAC<sup>®</sup>)
- High Vacuum Recovery (HVR)



#### **Prior Remedial Actions** LNAPL + Benzene (March 2021)





260 J

#### **Prior Remedial Actions** LNAPL + Naphthalene (March 2021)

845 MW 72

SMW 47

B45 MW 73



845 MW 67 19

845 MW 46

20

B45 MW 71



845MW48 845MW4

**B45MW62** 

845MW2

260

5 U

845MW59

845MW 18

845 MW 60

511

**B45MW9** 

120

**B45MW61** 

**B45MW41** 

845 MW 63



- SSI Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) approved May 2022
- 1. Delineation of plume
  - Soil sampling
  - Four new monitoring wells
  - Sample existing wells not previously sampled due to free product
- 2. Pilot Test to evaluate Modified Fenton's Reagent (MFR) in areas where LNAPL <0.1 feet thick
- 3. Expand HVR test to include a 5-day event



#### **SSI** Soil and Groundwater Locations

- 8 soil borings
  - Step-outs anticipated but not needed
- 4 new wells
- 17 existing wells
  - Previously not sampled due to LNAPL
  - Removed LNAPL
  - Sampled groundwater in 2022



![](_page_30_Picture_0.jpeg)

#### **SSI – Investigation Phase** Recap of February 2023 EAB Presentation

#### LNAPL investigation in DF2 and DF3 areas

- 7 soil boring locations
- Screened with oil and gas hydrophobic dye test kits
  - Scope was to offset and collect additional samples if LNAPL was observed
  - LNAPL not observed in DF2 or DF3 areas; however, offset boring was installed because of refusal
- RLs not exceeded for any COC in soil
- Installed four monitoring wells in August 2022
  - Benzene non-detect in all four wells
  - Naphthalene below RL in all four wells

![](_page_31_Picture_0.jpeg)

SSI – MFR Pilot Test

- Chelated iron followed by hydrogen peroxide
- Treatment mechanism is desorption followed by aqueous treatment
- Promotes distribution in formation and enhances desorption of mass from soil
- Reaction generates hydroxyl radicals
  - Highest oxidation potential of available oxidizers
  - Also generates superoxide anions
- Grid injection pattern provides greater coverage

![](_page_32_Picture_0.jpeg)

## SSI – MFR Pilot Test

#### Injection events

- November 2022 (Desorption Phase)
- December 2022 (Aqueous Treatment Phase)
- January 2023 (Polishing Phase)
- First event to desorb contaminants from soil and drive them into dissolved phase
- Second event to oxidize dissolved phase contaminants, or to desorb in areas not targeted during first event
- Third event to polish, provided within radius of influence (ROI) of prior event

![](_page_33_Picture_0.jpeg)

#### **SSI – MFR Pilot Test** Locations of Injection Wells and Injection Points

![](_page_33_Figure_2.jpeg)

- Note that injection wells are not so close to monitoring wells that monitoring well is directly affected
- Treating aquifer, not just the well

#### Legend

![](_page_33_Figure_6.jpeg)

Acronyms: MFR - Modified Fenton's Reagent DPT - Direct Push Technology

![](_page_34_Picture_0.jpeg)

#### **SSI – MFR Pilot Test** Trend Plot for Benzene

![](_page_34_Figure_2.jpeg)

![](_page_35_Picture_0.jpeg)

#### **SSI – MFR Pilot Test** Trend Plot for Naphthalene

![](_page_35_Figure_2.jpeg)

![](_page_36_Picture_0.jpeg)

#### **SSI – MFR Pilot Test** Benzene Plume (March 2022 and March 2023)

![](_page_36_Figure_2.jpeg)

![](_page_37_Picture_0.jpeg)

#### **SSI – MFR Pilot Test** Naphthalene (March 2022 and March 2023)

![](_page_37_Figure_2.jpeg)

![](_page_38_Picture_0.jpeg)

- 52% reduction in areal extent of benzene plume (B2)
- 35% reduction in average benzene concentration (B2)
- 96% reduction in areal extent of naphthalene plume (N2)
- 71% reduction in average naphthalene concentration (N2)

Areal extent of plume (square feet)				Average concentration (µg/L)			
Area	2022	2023	Reduction	2022	2023	Reduction	Constituent
B1	1,387	679	51%	8	NS	0%	Benzene
B2	4,500	2,145	52%	13	9	35%	Benzene
N1	1,671	1,671	0%	14	<mark>16</mark>	0%	Naphthalene
N2	8,679	383	96%	19	5	71%	Naphthalene
N3	1,502	441	71%	14	11	24%	Naphthalene
N4	9,489	9,489	0%	101	100	0%	Naphthalene

#### **AST Area - MFR Pilot Test Reductions in Plume**

![](_page_39_Picture_0.jpeg)

- Conducted extended 5-day HVR event to reduce LNAPL to <0.01 feet in DF2 area</p>
  - 6 10 March 2023
  - Approximately 2 inches of rainfall during Day 5
- Removed approximately 51,500 gallons of petroleum-contaminated water
- Removed approximately 1,300 gallons of hydrocarbon
  - Equivalent to 186 gallons of jet fuel

![](_page_40_Picture_0.jpeg)

#### SSI – HVR Pilot Test Drawdown

![](_page_40_Figure_2.jpeg)

![](_page_41_Picture_0.jpeg)

#### **SSI – HVR Pilot Test** LNAPL Thickness Before/After

SWMU 28 (CG028) DF2 Area (HVR Area) LNAPL Comparison (October 2022 and October 2023)

![](_page_41_Figure_3.jpeg)

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![](_page_42_Picture_0.jpeg)

#### SSI – HVR Pilot Test LNAPL Appearance

![](_page_42_Picture_2.jpeg)

![](_page_42_Picture_3.jpeg)

![](_page_42_Picture_4.jpeg)

B45MW12 Surfactant, not product B45MW67 2-phase liquid, but both are clear B177MP04 Typical LNAPL Example from CG504

![](_page_43_Picture_0.jpeg)

#### SSI – HVR Pilot Test LNAPL Appearance

![](_page_43_Picture_2.jpeg)

![](_page_43_Figure_3.jpeg)

- B45MW67 LNAPL was screened using Porous Medium Surface Tension Test (bottom test)
- Purified drinking water as control (top test)
- Test indicates LNAPL is surfactant
- Additional laboratory analyses are proposed to evaluate COC content

![](_page_44_Picture_0.jpeg)

#### **SSI – HVR Pilot Test** Trend Plot for Naphthalene

![](_page_44_Figure_2.jpeg)

![](_page_45_Picture_0.jpeg)

- 71% reduction in areal extent of naphthalene plume (N3)
- 24% reduction in average naphthalene concentration (N3)
- However, HVR generates petroleum contact water that must be treated for PFAS prior to disposal
- LNAPL reduced but not eliminated

Areal extent of plume (square feet)				Average concentration (µg/L)			
Area	2022	2023	Reduction	2022	2023	Reduction	Constituent
B1	1,387	679	51%	8	NS	0%	Benzene
B2	4,500	2,145	52%	13	9	35%	Benzene
N1	1,671	1,671	0%	14	16	0%	Naphthalene
N2	<mark>8,</mark> 679	383	96%	19	5	71%	Naphthalene
N3	1,502	441	71%	14	11	24%	Naphthalene
N4	9,489	9,489	0%	101	100	0%	Naphthalene

#### AST Area - MFR Pilot Test Reductions in Plume

![](_page_46_Picture_0.jpeg)

- Sample both phases in B45MW67 to evaluate if lighter layer contains petroleum constituents
  - Determine if MFR is appropriate in DF2 area
  - No HVR or recovery due to PFAS contamination
- Prepare Corrective Action Plan (CAP) Addendum and Remedial Design/Remedial Action Work Plan
  - Will require UIC permit

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## **Environmental Advisory Board**

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## SWMU 3 (Landfill 3) Update on Progress

Elizabeth Rhine Bhate Technical Lead

2 November 2023

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- Background
- Remedial Actions
- Supplemental Site Investigation (SSI)
- Hydraulic Study
- Conclusions

![](_page_49_Picture_0.jpeg)

## Background

- Landfill 3 accepted waste from 1964 to 1967
- Received approximately 65,000 cubic yards of general refuse, fuel, waste oil, paint residue, and spent solvents
- Includes Laboratory **Chemical Disposal Area** (WP13), which consists of two unlined disposal pits
- Includes fire protection training area FT06

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![](_page_50_Picture_0.jpeg)

## Background – LF003 Site Map

![](_page_50_Figure_2.jpeg)

![](_page_51_Picture_0.jpeg)

- Final CAP for SWMU 3 identified following volatile organic compounds (VOCs) as COCs for groundwater:
  - benzene; carbon tetrachloride; chlorobenzene; chloroform; 1,2-dichlorobenzene; 1,3-dichlorobenzene; 1,4-dichlorobenzene; 1,2-dichloroethane; cis-1,2dichloroethene; trans-1,2-dichloroethene; ethylbenzene; methylene chloride; 1,2,4-trichlorobenzene; tetrachloroethene; toluene; trichloroethene (TCE); vinyl chloride; and total xylenes

![](_page_52_Picture_0.jpeg)

- Soil-bentonite slurry containment wall keyed into confining clay layer about 20 to 30 feet below ground surface
- Leachate collection (LC) system within landfill
- Geocomposite cover system (i.e., clay/synthetic membrane landfill cap)
- Landfill gas collection and flare system
- Groundwater extraction system

![](_page_53_Picture_0.jpeg)

- COC concentrations increasing in LF3EW9 and LF3EW10
- LC system has not consistently maintained requisite 2-foot drawdown inside slurry wall
  - Waiver granted 25 March 2009 by Georgia Environmental Protection Division (GA EPD)
  - Contingent on continuing groundwater extraction
- SSI warranted to investigate these concerns

![](_page_54_Picture_0.jpeg)

#### **SSI** Chlorobenzene Plume (March 2022)

![](_page_54_Figure_2.jpeg)

![](_page_55_Picture_0.jpeg)

#### **SSI** TCE Plume (March 2022)

![](_page_55_Figure_2.jpeg)

![](_page_56_Picture_0.jpeg)

### **SSI – LF003 Cross Section**

![](_page_56_Figure_2.jpeg)

U - The parameter was analyzed for, but not detected

(reported at limit of detection)

J - The parameter was positively identified, the

quantitation is an estimation

AFB = Air Force Base

SWMU - Solid Waste Management Unit

![](_page_57_Picture_0.jpeg)

- Is integrity of slurry wall sufficient to contain dissolved COCs?
- Are exterior extraction wells, adjacent to wall, drawing contamination through or under slurry wall?
- Can 2-foot inward hydraulic gradient be achieved if exterior extraction wells are turned off?
- Can inward gradient be maintained to prevent outward migration?
- Are additional LC wells inside slurry wall necessary to support hydraulic control?

![](_page_58_Picture_0.jpeg)

- 10 data logger transducers were placed in monitoring wells
- Manual water levels collected daily (Monday Friday) in additional monitoring wells
- Transducers already installed in extraction wells (EWs)
- Evaluated water level data when LC and EW systems was operated in various configurations
  - Static (no wells pumping)
  - LC only
  - EWs brought online individually
  - Compared to precipitation
- Bromide tracer test

![](_page_59_Picture_0.jpeg)

#### Hydraulic Study Wells Inside Slurry Wall

![](_page_59_Figure_2.jpeg)

Wells inside slurry wall influenced by LC

![](_page_60_Picture_0.jpeg)

#### Hydraulic Study Wells Outside Slurry Wall

![](_page_60_Figure_2.jpeg)

Wells east of slurry wall near LF3EW10

![](_page_61_Picture_0.jpeg)

#### Hydraulic Study Response to Precipitation

![](_page_61_Figure_2.jpeg)

![](_page_62_Picture_0.jpeg)

- Monitoring wells LF03PZ37, LF3MW3, LF3-4, LF3-6, and RI3-2W, exhibit extraordinary changes in water level elevation following precipitation events
  - Likely representative of infiltration of rainwater into well due to poor well construction, damage to well (e.g., struck by mowing equipment), or soil fissure that allows precipitation to drain into annular space of well
  - LF3MW3, LF3-4, and RI3PTW are located inside landfill and exhibit low COC concentrations
  - Could be result of infiltration, flushing, and dilution of COCs
  - While unintentional, flushing has had positive effect on groundwater quality

![](_page_63_Picture_0.jpeg)

Hydraulic Study

- Bromide not detected in LF3EW7A or LF3EW10
  - However, bromide was detected in LC wells
  - LC wells are capturing impacted leachate as designed
  - No evidence that slurry wall has been breached or that impacted leachate is being pulled across slurry wall by extraction wells
  - Increasing concentrations of COCs observed at LF3EW10 are result of capture of contaminant mass present outside slurry wall
    - These trends appear to be reversing for all COCs
    - As extraction system continues to operate, COC concentrations are expected to peak and subsequently reduce

![](_page_64_Picture_0.jpeg)

- 2-foot inward hydraulic gradient cannot be achieved if exterior extraction wells are turned off
- Lateral hydraulic control of plume is achieved by slurry wall and LC wells without maintaining 2-foot inward gradient
- Extraction system currently provides hydraulic control over seeps that contain contaminated groundwater; therefore, extraction system should continue to operate

![](_page_65_Picture_0.jpeg)

## Questions?

#### **Elizabeth Rhine**

erhine@bhate.com

864.982.9890

![](_page_66_Picture_0.jpeg)

## New Business and Program Closing

Mr. Fred Otto EAB Manager

![](_page_67_Picture_0.jpeg)

## **Recommended EAB Modifications**

#### Meeting time

- Begin meetings at 6:00 pm
- Meeting frequency
  - Move to semi-annual meetings
    - Spring/Fall
- Structure change to align with Air Force guidance
  - EAB to RAB
  - EAB Installation Co-chair
- EAB Charter update

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#### Please...

**Complete meeting evaluation and** 

feedback form and return to sign-in table or leave at seat

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#### Thank you!