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CORRECTIVE MEASURES STUDY ADDENDUM SOLID WASTE MANAGEMENT UNIT 54 WITH TRANSMITTAL AND RESPONSE TO COMMENTS NAVAL ACTIVITY PUERTO RICO

6/1/2012

AGVIQ/CH2M HILL

AGVIQ
ENVIRONMENTAL SERVICES
CH2M HILL
JOINT VENTURE

June 15, 2012

U.S. Environmental Protection Agency – Region II
290 Broadway – 22nd Floor
New York, New York 10007-1866

Attn: Mr. Phil Flax

RE: Contract No. N62470-08-D-1006
Task Order No. JM04
Solid Waste Management Unit (SWMU) 54
Naval Activity Puerto Rico – Ceiba, Puerto Rico
Corrective Measures Study Addendum for SWMU 54 Benzene and Ethylbenzene Plume

Dear Mr. Flax:

AGVIQ-CH2M HILL Constructors Inc. Joint Venture III (AGVIQ-CH2M HILL), on behalf of the Navy, is pleased to provide one hard copy and one electronic copy provided on CD of the Corrective Measures Study Addendum for SWMU 54 Benzene and Ethylbenzene Plume at Naval Activity Puerto Rico. Additional distribution has been made as indicated below.

If you have any questions regarding this submittal, please contact Mr. Stacin Martin at (757) 322-4080.

Sincerely,

AGVIQ-CH2M HILL Constructors Inc. Joint Venture III

Tom Beisel, P.G.
Project Manager

cc: Ms. Debra Evans-Ripley/BRAC PMO SE (letter only)
Mr. David Criswell/BRAC PMO SE (letter only)
Mr. Tim Gordon/USEPA Region II (2 hard copies and 2 CDs)
Mr. Mark E. Davidson, BRAC PMO SE (1 hard copy and 1 CD)
Mr. Stacin Martin/NAVFAC Atlantic (1 hard copy and 1 CD)
Mr. Pedro Ruiz/NAPR (1 CD)
Mr. Carl Soderberg/USEPA Caribbean Office (1 hard copy and 1 CD)
Ms. Gloria Toro/PR EQB (1 hard copy and 1 CD)
Ms. Wilmarie Rivera/PR EQB (1 CD)
Ms. Connie Crossley/Booz Allen Hamilton (1 hard copy and 1 CD)
Ms. Bonnie Capito/NAVFAC LANTDIV (1 hard copy)
Ms. Lisamarie Carrubba/NMFS (1 CD)
Mr. Felix Lopez/U.S. Fish & Wildlife Service (1 CD)
Mr. Mark Kimes/Michael Baker Jr., Inc. (1 CD)

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Northpark 400, 1000 Abernathy Road, Suite 1600 • Atlanta, Georgia 30328 • tel (770) 604-9095 • fax (770) 604-9282

Responses to Comments Summary	
Regulatory Comments from:	Timothy R. Gordon (EPA Project Coordinator), Robert Young (TechLaw, Inc.), Wilmarie Rivera (PREQB Federal Facilities Coordinator)
Document:	*Corrective Measures Study Addendum SWMU 54 Benzene Plume* and the *Corrective Measures Implementation Plan SWMU 54 Benzene Plume*, Naval Activity Puerto Rico (NAPR), EPA ID PR2170027203, Ceiba, Puerto Rico, dated January 2012
Regulatory Letter Date:	Email Dated: March 30, 2012
Response Due Date:	June 18, 2012
Response Submittal Date:	June 18, 2012

The following comments were generated based on a technical review of the Responses to EPA and EQB comments dated September 9th and 13th, 2011 on the CMS Addendum and CMI Plan dated March 2011. The CMS Addendum Rev. 01 and the CMI Plan Rev. 01, dated January 2012 were also evaluated for compliance with the Responses. An evaluation of the Responses is presented below. Only those general and specific comments which were not adequately addressed are included in the evaluation of the Responses. Following the Responses evaluation below, additional general and specific comments on the CMS Addendum Rev. 01 and CMI Plan Rev, 01 are presented.

The first set of comment evaluations presented below was provided by TechLaw.

GENERAL COMMENTS

Evaluation of Response to EPA General Comment 2: The response partially addresses the comment. The response does not address how the proposed corrective action objective (CAO) and remedial actions will mitigate the at-risk exposure pathways with respect to land use controls (LUCs). The response indicates NAPR is an industrial facility and under the current land use, no direct exposure to site groundwater is occurring, thus no direct exposure to groundwater contamination is occurring. Currently, it is not known whether a LUC plan has been implemented to support the assertions that no exposure to the site groundwater is occurring. LUCs are a necessary component to the remedy to ensure long term protectiveness and will be required until the site is cleaned up for unrestricted exposure and unlimited use. Revise the CMS Addendum Rev. 01 and CMI Plan Rev. 01 to include a reference to an existing document that meets the requirements of the site specific land use control implementation plan (LUCIP) or indicate that one will be prepared for SWMU 54. See Additional General Comment No. 2, below.

Response:

A description of existing LUCs that will be maintained during the remedial action was added to Section 2 of the CMS Addendum. In addition, Section 1.5.2 of the CMI Plan was revised to include a summary of the LUCs to be included in the deed if the parcel were to be transferred.

Evaluation of Response to EPA General Comment 3a, Subpart 4: The response addresses the comment, but additional clarification is required. The information requested in the comment is presented in Section 1.6 of the CMI Plan Rev. 01 and not in Section 1.7 as indicated in the response. Revise the response to provide the correct section reference.

Response:

Comment acknowledged.

Evaluation of Response to EPA General Comment 3, Subpart e: The response partially addresses the comment. The performance criteria are provided in Table 3.1 of the CMI Plan as indicated in the response. However, the performance criteria in Table 3.1 do not specify the expected timeframe. As such, it is unclear if reductions in concentrations must be seen within the span of a few weeks, months, or if a year or more is acceptable. The text on Page 3-5 indicates the design presented in the CMI Plan is adequate to reduce the contaminant concentrations in groundwater to the CAOs within 3 years. However, Table 3-1 does not specify the 3 year time frame indicated in the text. Revise Table 3-1 to include the expected time frame so optimization of system performance is clearly understood.

Response:

Table 3-1 of the CMI Plan was revised as requested.

Evaluation of Response to EPA General Comment 5 and 7: The response addresses the comment with additional clarification required. The information requested in the comment is presented in Appendix C of the CMS Addendum Rev. 01 and not Appendix A as indicated in the response. Revise the response to provide the correct (Appendix A) reference.

Response:

Comment acknowledged.

SPECIFIC COMMENTS FOR CMS ADDENDUM

Evaluation of Response to EPA Specific Comment 2: The response addresses the comment with additional clarification required. The groundwater flow direction is presented only in Figure 3-3, Appendix A, Pilot Scale Test Report, of the CMS Addendum Rev. 01 and not in CMS Addendum Figure 1-2, or in Figure 1-2 in Appendix A as indicated in the response. Revise CMS Addendum Figure 1-2 to include the groundwater flow direction.

Response:

The arrow showing direction of groundwater flow is presented in the bottom left corner of Figure 1-2. The figure was not revised.

Evaluation of Response to EPA Specific Comment 10: The response addresses the comment. However, the TCE concentration presented in the data validation report (DVR) still indicates a

concentration of 1020 µg/L and was not corrected to 100 U µg/L as indicated in the response. Correct the DVR as indicated in the response.

Response:

The revised DVR was not included in the January 2012 submittal. The incorrect DVR has been replaced with the correct version.

TechLaw SPECIFIC COMMENTS FOR CMI PLAN

Evaluation of Response to EPA Specific Comment 1: The response addresses the comment with additional clarification required. The response indicates the requested information is included in Section 3.4.1 of the CMI Plan. However, this information is included in Section 3.5 of the CMI Plan Rev. 01. Revise the response to provide the correct section reference.

Response:

Comment acknowledged.

TechLaw ADDITIONAL GENERAL COMMENTS

1. The CMS Addendum, Appendix A, Section 3.2.3 and Table G-1 indicate TCE results measured in groundwater wells 54MW04 and 54MW05 during the January 2010 period were greater than the respective CAO of 22 µg/L. The text in Section 3.2.3 further indicates that it was determined the detections in monitoring wells that did exceed CAOs did not warrant further investigation because the values were not substantially greater than the respective standard and would be remediated during remedial action intended to address the benzene contamination in groundwater. The 5th bullet on Page 1-8 of the CMS Addendum Rev. 01 states that one deep sparge well will be used to address both the benzene and residual TCE concentrations in the vicinity of 54MW05. Currently, the extent of the TCE problem in groundwater greater than CAOs in the vicinity of 54MW05 is not known. In addition, the biosparge remedy designed to address benzene contamination in groundwater will not be very effective in reducing the TCE concentrations in groundwater via the aerobic biodegradation pathway. As such, volatilization of TCE through the operation of the proposed deep sparge well will be the most likely mechanism for removing TCE from the groundwater. The scope of the TCE problem in groundwater greater than CAOs in the Benzene Area is not known and it appears there is currently no plan or exit strategy to address this issue. Although the CMS Addendum Rev. 01 indicates a deep sparge well will be installed near 54MW05 to treat residual TCE concentrations in the area, additional sampling and analysis for TCE in wells 54MW04 and 54MW06 are not addressed in the CMS Addendum Rev. 01, the CMI Plan Rev. 01 or in the UFP Benzene Plume SAP. As such, it is uncertain how the performance of the biosparge system in reducing TCE in groundwater to below respective CAOs in the Benzene Plume area will be monitored, and evaluated for closure. Revise the CMS Addendum Rev. 01 to address this issue.

   Response:

   Based on comments from EPA, the CAOs for SWMU 54 for were recalculated using 2011 standards. Accordingly, the CAO for TCE was revised to 193 µg/L and the detections of TCE at 54MW04 and 54MW05 no longer exceed the CAO. The text in the pilot test report has been revised to reflect this change.

2. The CMI Plan Rev. 01 indicates that existing Land Use Controls (LUCs) will be included with the corrective action to prevent unintended use of groundwater. However, it is not known whether a site specific LUC implementation plan (LUCIP) currently exits that documents the LUCs, or that one will be prepared for SWMU 54. Preparation of a site specific LUCIP providing the detailed description(s) of the LUCs and/or Institutional Controls (ICs) and procedures for their implementation for contaminated groundwater will be necessary for long term protectiveness. Since groundwater is contaminated above levels that allow for unrestricted exposure and unlimited use, LUCs/ICs will be necessary to prevent current and future exposure and unintended uses of contaminated groundwater and residential land use. Revise the CMI Plan Rev. 01 to indicate whether a LUCIP currently exists or that one will be prepared for SWMU 54. Currently, a description of the LUCs/ICs that will be required to prevent groundwater use and the procedures for verifying their establishment is not known. In addition, the frequency for monitoring and reporting effectiveness as well as the parties responsible (including contact information) for implementing, verifying and monitoring the effectiveness of LUCs/ICs is not known. Revise the CMI Plan Rev. 01 to address this issue.

   Response:

   A description of existing LUCs that will be maintained during the remedial action was added to Section 2 of the CMS Addendum. In addition, Section 1.5.2 of the CMI Plan was revised to include a summary of the LUCs to be included in the deed if the parcel were to be transferred.

3. The CMI Plan Rev. 01 indicates that 19 monitoring wells (54MW01, 54MW02, 54MW06, 54MW27 through 54MW41, and 54MW43) will be sampled as part of the baseline, performance, and closure monitoring. However, the CMI Plan Rev. 01 does not provide a rationale for the selection of these specific wells in the proposed monitoring network. In particular, it is unclear why shallow wells 54MW03, 54MW22 and 54MW42 and deep wells 54MW04, 54MW05, 54MW19 and 54MW21 will not be monitored as they are located at the downgradient edge of the plume. Revise the CMI Plan Rev. 01 to provide a rationale for the wells selected as part of the monitoring network. In addition, either include these additional wells or explain how the downgradient edge of the plume will be effectively monitored without inclusion of the noted shallow and deep wells into the proposed monitoring network.

   Response:

   The rationale for selection of monitoring locations will be provided in Section 2 of the CMI Plan. Additionally, monitoring wells 54MW03, 54MW04, 54MW05, 54MW19, 54MW21, 54MW22, and 54MW42 will be incorporated into the monitoring network for baseline, performance, and closure monitoring.

4. The CMI Plan Rev. 01, Section 3.5 repeatedly refers to the need to see a decreasing trend. However, neither the CMS Addendum Rev. 01 nor the CMI Plan Rev. 01 defines the requirements for a decreasing trend. Revise the respective documents to define the requirements for a decreasing trend (e.g., is a decrease of 100 µg/L; 10%; 20% or greater) or indicate whether trends will be statistically determined (i.e., Mann Kendall analysis).

Response:

Groundwater concentration data from each sampling event were plotted as a function of time, and numerical trends were developed using linear regression. In addition, trends were analyzed using the Mann-Kendall non-parametric statistical test to determine if COC concentrations are increasing, decreasing, or stable. This information was added to Section 3.5 of the CMI Plan.

TechLaw ADDITIONAL SPECIFIC COMMENT

1. **CMI Plan, Rev. 01, Section 1.5.2, Land Use Controls, Page 1-5:** The text indicates that LUCs to prevent the use of groundwater are included as part of the remedy (during cleanup and after reaching the CAOs) in order to be protective of human health. However, the CMI Plan Rev. 01 does not provide details of the actual LUCs that will be implemented in order to achieve the LUC objective of preventing groundwater usage. Please see Additional General Comment No. 2, above.

   Response:

   A description of existing LUCs that will be maintained during the remedial action was added to Section 2 of the CMS Addendum. In addition, Section 1.5.2 of the CMI Plan was revised to include a summary of the LUCs to be included in the deed if the parcel were to be transferred.

The following set of CMS Addendum comment evaluations were provided by PREQB.

All responses to PREQB comments were found to be adequate with the following exceptions:

GENERAL COMMENT

Puerto Rico's Water Quality Standards Regulation has been updated since the original Corrective Measures Study was prepared. The current version dated March 2010, classifies all groundwater as SG, water intended for use as a drinking water supply. Therefore, in order to comply with this Applicable or Relevant and Appropriate Requirement (ARAR), the Corrective Action Objectives (CAOs) for all chemicals of potential concern need to be updated to reflect this current ARAR.

Response:

As agreed to in the Naval Activity Puerto Rico 2004 Reuse Plan, SWMU 54 will be cleaned up to industrial standards and therefore, the CAO will remain as 22 µg/L per the approved August 2005 CMS. If future development would require lower cleanup objectives, the future developer or property owner at that time will be responsible for achieving the more stringent cleanup standards.

Evaluation of Response to PREQB Comment:

PREQB acknowledges that the future development of the site is subject to what is agreed on the Naval Activity Puerto Rico 2004 Reuse Plan and its 2010 Addendum. The 2007 Consent Order between the Navy and EPA specify that the cleanup levels will be established based on the planned future use. This should not be confused with the ARARs for the site. The 2010 Water Quality Standards Regulation of PREQB classifies all groundwater in Puerto Rico as potable, regardless future land development.

Currently the Navy submitted a Groundwater Usability Assessment to EPA and PREQB. The document was commented by PREQB and we are still awaiting response to the comments and revision to the document. Until any agreement regarding groundwater usability at the NAPR is reached, PREQB will require compliance with its Regulations.

Response:

Comment acknowledged.

PAGE SPECIFIC COMMENTS:

1. Page 1-6, Section 1.2, Bullet 2: Please clarify that when referring to VOC concentrations observed, it is referring to VOC air monitoring at the storm sewer monitoring location SS#3. Also, the storm sewer monitoring locations should be depicted in a Figure.

Response:

The text has been clarified to indicate that observed VOC concentrations are those observed at underground utility structures. Vapor monitoring locations (SS#1, SS32, SS#3) were added to Figure 3-1 and 3-2.

Evaluation of Response to PREQB Comment:

The text (now on Page 1-8, Section 1.3, Bullet 1) was adequately clarified. Please notice that the vapor monitoring locations were added to Figure 1-4 instead of Figures 3-1 and 3-2. Actually, there are no Figures 3-1 and 3-2 on the current version of the document.

Response:

Comment acknowledged.

2. Page 3-5, Section 3.1, Bullet 3: Please provide details as to how you will confirm that soils are suitable for use as backfill.

Response:

Soil will be screened using a field-calibrated photoionization detector (PID) during trenching to determine if the soils are suitable for backfill. Soils that generate a PID response less than 100 parts per million (ppm) and that are free of debris greater than ½ inch in diameter and sharp objects will be deemed suitable for backfill. Unsuitable backfill will be segregated on plastic sheeting for offsite disposal. This information was included in Section 1.6 of the CMI Plan.

Evaluation of Response to PREQB Comment:

Section 1.6 of the Corrective Measures Implementation (CMI) Plan does not mention the use of material determined free of contamination and suitable for backfill as backfill of the piping trenches. Please clarify and, if necessary, include it on the CMS Addendum. Hence, the CMI Plan should be modified to include this practice.

Response:

Because there were no exceedances of CAOs observed in surface soils at SWMU 54, all surface soils are considered free of contamination and suitable for backfill of the piping trenches.

EQB ADDITIONAL COMMENTS:

1. Page 3-1, Section 3.1.2, First Paragraph: Please complete the last sentence to clarify if AGVIQ-CH2MHILL believes that the estimated time required to achieve CAOs will be approximately 3 years.

   Response:

   Section 3.1.2 of the CMS Addendum was revised as requested.

2. Page 3-1, Section 3.1.4: Please revise the sentence. The Naval Activity Reuse Plan (NAVFAC, 2004 and 2010) established the planned reuse of the property, not the CAOs.

   Response:

   Section 3.1.4 of the CMS Addendum was revised as requested.

The following set of CMI Plan comment evaluations were provided by PREQB.

All responses to PREQB comments were found to be adequate with the following exceptions:

GENERAL COMMENT

Puerto Rico's Water Quality Standards Regulation has been updated since the original Corrective Measures Study was prepared. The current version dated March 2010, classifies all groundwater as SG, water intended for use as a drinking water supply. Therefore, in order to comply with this Applicable or Relevant and Appropriate Requirement (ARAR), the Corrective Action Objectives (CAOs) for all chemicals of potential concern need to be updated to reflect this current ARAR.

Response:

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Response:

Comment acknowledged.

Corrective Measures Study Addendum
SWMU 54 Benzene and Ethylbenzene Plume

Naval Activity Puerto Rico
Ceiba, Puerto Rico

Revision No. 00

Contract No. N62470-08-D-1006
Task Order No. JM04

Submitted to:

NAVFAC
Naval Facilities Engineering Command

U.S. Naval Facilities Engineering Command Southeast

Prepared by:

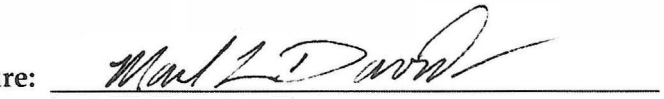
AGVIQ
CH2M HILL

1000 Abernathy Road
Suite 1600
Atlanta, GA 30328

June 2012

Certification Page
Corrective Measures Study Addendum
(Revision No. 00)
SWMU 54
Benzene and Ethylbenzene Plume

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all appendices, and that this document and its appendices were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gathered and presented the information contained herein. I further certify, based on my personal knowledge or on my inquiry of those individuals immediately responsible for obtaining the information, that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowingly and willfully submitting a materially false statement.

Signature: 

Name: Mark. E. Davidson

Title: BRAC Environmental Coordinator

Date: June 15, 2012

Executive Summary

AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III (AGVIQ-CH2M HILL) has been retained by the Department of the Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) to prepare a Corrective Measures Study (CMS) Addendum to address the cleanup of benzene and ethylbenzene in groundwater beneath Solid Waste Management Unit (SWMU) 54. SWMU 54 is located at Naval Activity Puerto Rico (NAPR), formerly known as Naval Station Roosevelt Roads, in Ceiba, Puerto Rico. The CMS Addendum was prepared under Contract No. N62470-08-D-1006, Task Order JM04. This document revises the *Corrective Measures Study Final Report* (hereinafter referred to as the CMS) (Baker Environmental, Inc. [Baker], 2005) because implementation of the in situ bioremediation remedy proposed in the CMS is not cost-effective, based on evaluation of characterization and pilot-scale test data (Appendix A).

Between August 2009 and October 2010, AGVIQ-CH2M HILL conducted a groundwater investigation and performed pilot-scale testing to evaluate the use of air sparging (AS) to reduce benzene (ethylbenzene did not exceed the corrective action objective [CAO] at that time) concentrations in groundwater. The work involved the installation of 32 monitoring wells and 1 AS well, collection of water quality samples for chemical analysis, well gauging, aquifer slug testing, and completion of a AS pilot-scale test to evaluate ability to inject air into the aquifer to reduce benzene concentrations in groundwater to the CAO.

The results of the pilot-scale test indicated that a full-scale biosparge system would be more effective as a long-term remedy to reduce benzene concentrations in groundwater than the injection of oxygen-releasing material proposed in the CMS (Baker, 2005).

Contents

Appendices - (Provided on CD)

Figures

Acronyms and Abbreviations

AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III
AS	air sparge
Baker	Baker Environmental, Inc.
bgs	below ground surface
CAO	corrective action objective
cm/sec	centimeters per second
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	contaminant of concern
CSM	conceptual site model
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
ISB	in situ bioremediation
LRA	Puerto Rico Local Redevelopment Authority
LUC	land use control
µg/L	micrograms per liter
MNA	monitored natural attenuation
NAPR	Naval Activity Puerto Rico
NAVFAC SE	Naval Facilities Engineering Command Southeast
OM&M	operation, maintenance, and monitoring
ORP	oxidation-reduction potential
scfm	standard cubic foot per minute
SWMU	solid waste management unit
TCE	trichloroethene
VOC	volatile organic compound

1.0 Introduction

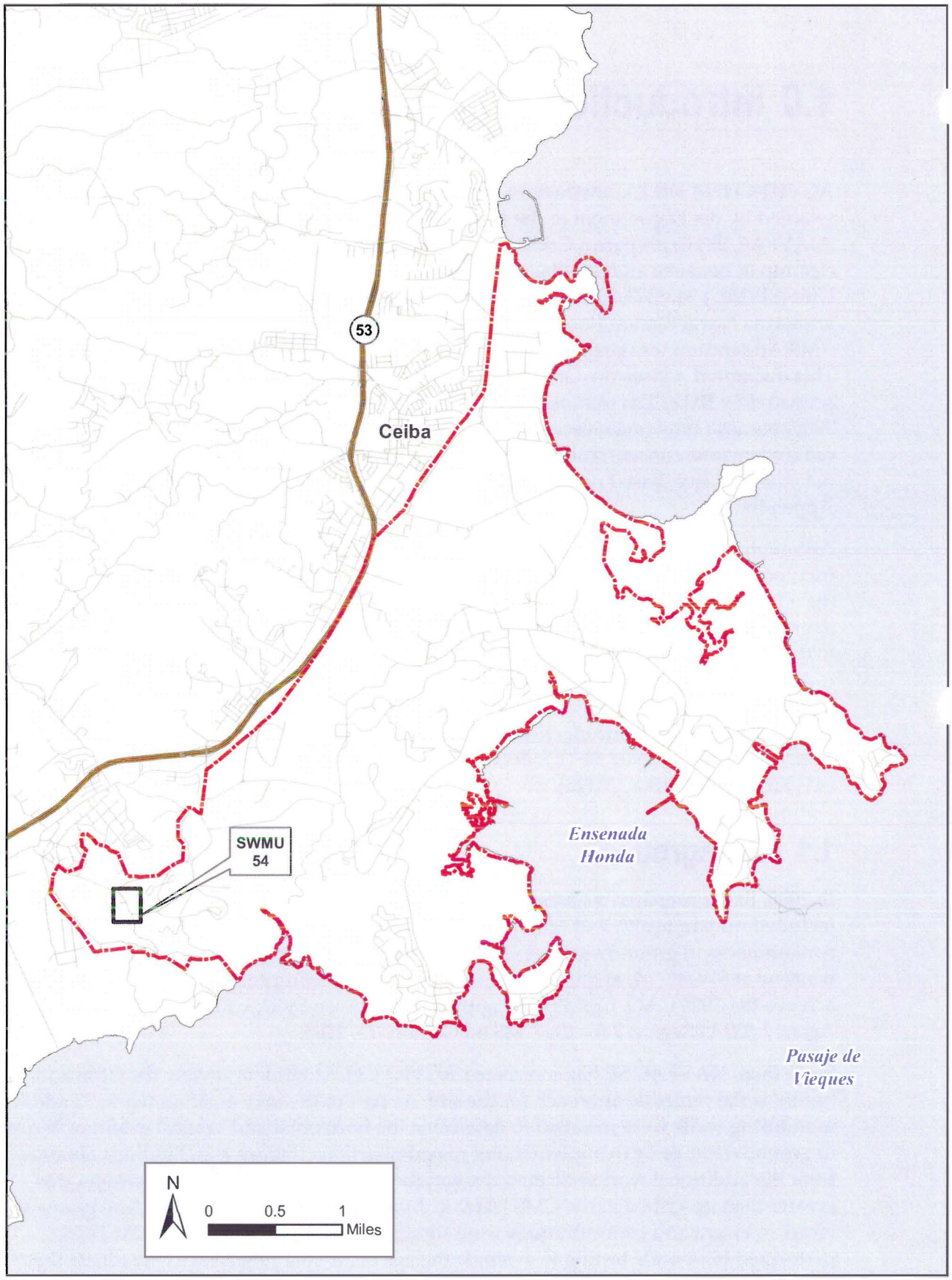
AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III (AGVIQ-CH2M HILL) has been retained by the Department of the Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) to prepare a Corrective Measures Study (CMS) Addendum to address the cleanup of benzene and ethylbenzene in groundwater beneath Solid Waste Management Unit (SWMU) 54. SWMU 54 is located at Naval Activity Puerto Rico (NAPR), formerly known as Naval Station Roosevelt Roads, in Ceiba, Puerto Rico (refer to Figure 1-1). This CMS Addendum was prepared under Contract No. N62470-08-D-1006, Task Order JM04. This document revises the *Corrective Measures Study Final Report for SWMUs 54 and 55* prepared by Baker Environmental, Inc. (Baker) (hereinafter referred to as the CMS) (Baker, 2005) because implementation of the in situ bioremediation (ISB) remedy proposed to reduce benzene concentrations in groundwater to the corrective action objective (CAO) is not cost-effective, based on evaluation of newly acquired pilot-scale test data (refer to Appendix A).

Although two areas of contamination have been identified beneath SWMU 54, a trichloroethene (TCE) plume and a benzene plume (Figure 1-2), this report describes only the additional work that was performed to determine the extent of benzene contamination in groundwater and evaluate biosparging as a technology to reduce benzene concentrations to the CAO. Ethylbenzene did not exceed its CAO at the time the pilot-scale testing and related characterization for benzene was completed. The CAOs have been updated at the recommendation of the U.S. Environmental Protection Agency (EPA), which resulted in a lower CAO for ethylbenzene. Remediation work to address the cleanup of the TCE plume is described in the *SWMU 54 TCE Plume Corrective Measures Implementation* [CMI] *Plan* (AGVIQ-CH2M HILL, 2012a).

1.1 Background

In 2005, Baker prepared a CMS for remedial actions at SWMUs 54 and 55. The CMS included human health and ecological risk assessments to develop CAOs for the cleanup of contaminants in groundwater. A CAO of 550 micrograms per liter (µg/L) was calculated for benzene at SWMU 54, and the injection of oxygen-releasing compounds was proposed to achieve the 2005 CAO. Conditional approval was given by U.S. Environmental Protection Agency (EPA) Region 2 for the CMS on October 13, 2005.

Since then, NAVFAC SE has contracted AGVIQ-CH2M HILL to review the CMS and optimize the remedial approach for the site. As part of the investigation work, 32 additional monitoring wells were installed to determine the horizontal and vertical extent of benzene in groundwater prior to implementing remedial actions (Figure 1-2). Findings obtained from the additional work indicated the horizontal and vertical extent of benzene was greater than described in the CMS (refer to Appendix B). Because the benzene plume was larger in extent and concentrations were significantly higher, AGVIQ-CH2M HILL performed pilot-scale testing to evaluate the use of air sparging (AS) to remediate the plume. Test results obtained from the additional investigation work and pilot-scale testing are presented in Appendix A and are summarized in Section 1.3.

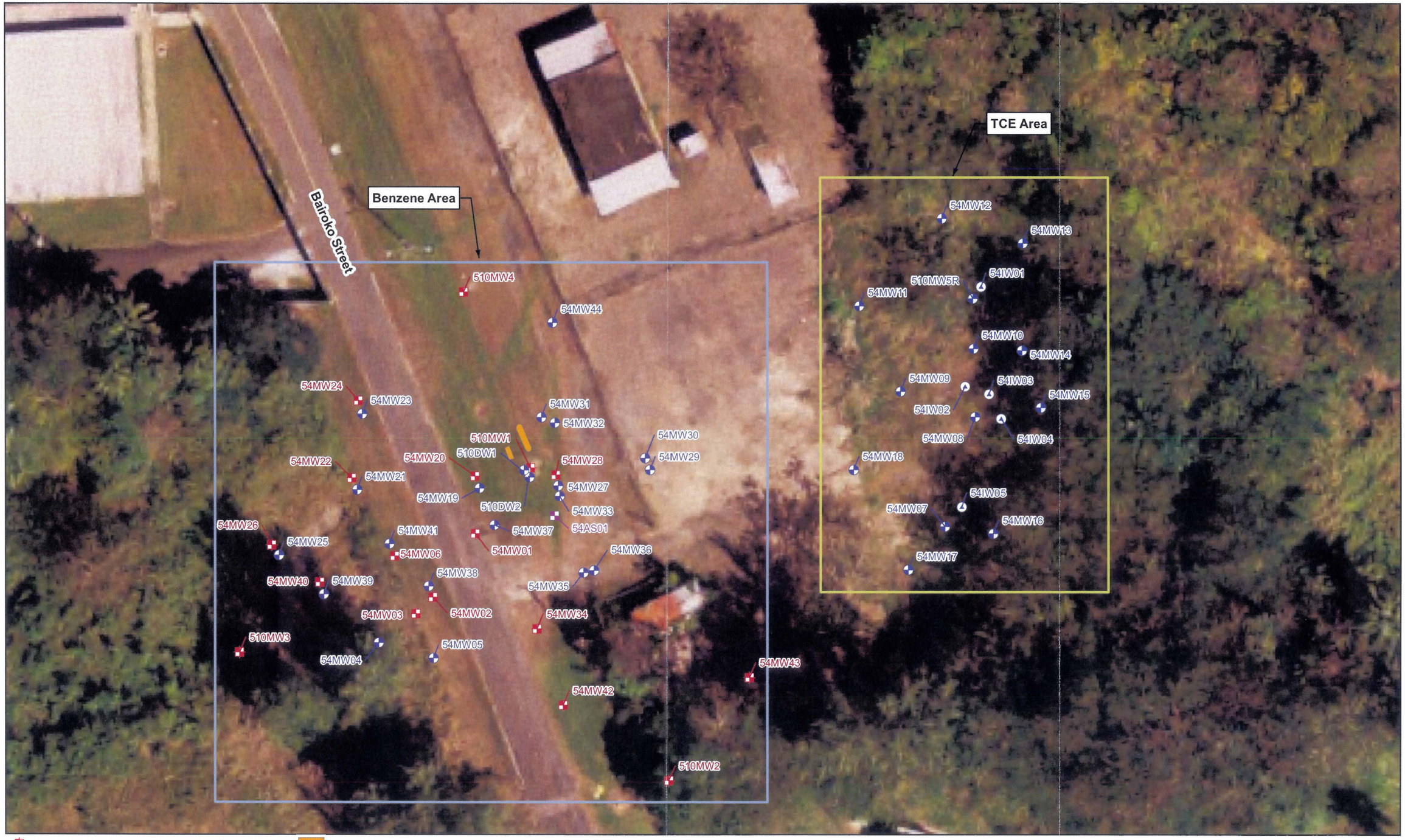


Road

Expressway

Naval Station Roosevelt
Roads Boundary

FIGURE 1-1
SWMU 54 Location
SWMU 54
Naval Activity Puerto Rico



Monitoring Well Screened Primarily Less than 15 ft bgs
Monitoring Well Screened Primarily Greater than 15 ft bgs
Injection Well Screened 17-27 ft bgs
Air Sparge Injection Well
Groundwater Flow
Former Structure

N
0 20 40 Feet
1 inch = 40 feet

FIGURE 1-2
Site Layout
SWMU 54
Naval Activity Puerto Rico

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVYPUERTORICO20000317\MAPFILES\SWMU54_201010\CMS\FIG_1-2_SWMU54_SITELAYOUT.MXD JCARR 6/4/2012 12:14:44 PM

CH2MHILL.

1.2 Corrective Action Objectives

The 2005 CAO development is summarized below and was originally described in the CMS report (Baker, 2005). The EPA conditionally approved the CMS on October 13, 2005, contingent upon completion of the pilot-scale tests and CMI Plan.

Appendix B of the CMS report (Baker, 2005) included a derivation of groundwater CAOs for volatile organic compounds (VOCs). The 2005 groundwater CAOs were developed based on an industrial use of SWMU 54. The CAOs were estimated using the Johnson-Ettinger Model for the target groundwater levels protective of industrial worker exposure to indoor air in an industrial building and construction workers having direct contact with shallow groundwater. Figure 1-3 presents a simple conceptual site model (CSM) flow chart for potential receptors of contaminated groundwater at SWMU 54 under current and future land use scenarios.

The 2005 CAO for benzene was used to delineate the benzene plume and design the corrective action during the pilot-scale testing in 2009 - 2010. Ethyl benzene did not exceed the 2005 CAO and was not taken into consideration during the pilot-scale testing, though future site work will require consideration of ethyl benzene and benzene as site contaminants of concern (COCs).

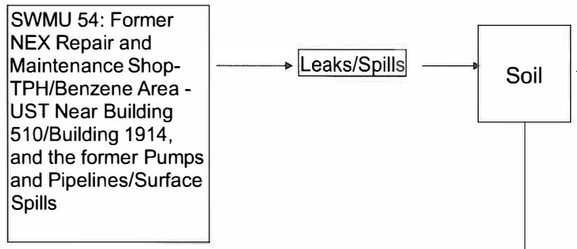
In May 2012, the 2005 CAOs were revised using EPA's regional screening levels (November 2011 version) based calculation methods and toxicity factors, as recommended by EPA Region 2 during their review of the CMS Addendum reports. The revised CAOs are based on continued industrial land use, as SWMU 54 is expected to remain industrial into the foreseeable future. The revised CAOs were developed for industrial (indoor) worker and construction worker scenarios as presented in the *Revised Corrective Action Objectives for Solid Waste Management Units 7&8, 54, and 55* Technical Memorandum (Appendix C).

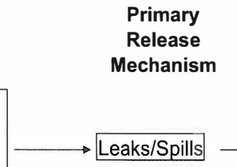
The groundwater beneath SWMU 54 was demonstrated to be unusable as a potable water supply due to brackish/saline nature of the area groundwater, noted with high levels of total dissolved solids and salinity, as detailed in the *Groundwater Usability Assessment, Naval Activity Puerto Rico, Ceiba, Puerto Rico Technical Memorandum* (Appendix D). Therefore, potable use based drinking water standards (e.g., maximum contamination levels) are not applicable for SWMU 54.

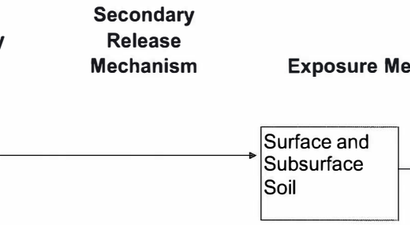
Under current land use, no direct exposure to site groundwater is occurring. Additionally, the area downgradient of SWMU 54 is undeveloped and no potential for groundwater exposure exists in this area. However, indirect exposure pathway through volatilization of benzene to ambient air and indoor air could occur in the SWMU 54 benzene plume area. Therefore this indirect exposure pathway was considered complete for deriving the CAOs for the site groundwater. A simple CSM presenting the potential migration, exposure pathways, and potential receptors under current and future land use for the benzene plume at SWMU 54 is shown on Figure 1-3.

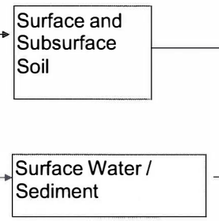
The revised CAO for benzene in groundwater is 160 µg/L and the revised CAO for ethylbenzene is 493 µg/L.

The revised plume map for benzene based on the CAO of 160 µg/L is presented in Figure 1-4. A plume map for ethylbenzene will be generated during baseline sampling during the corrective action.





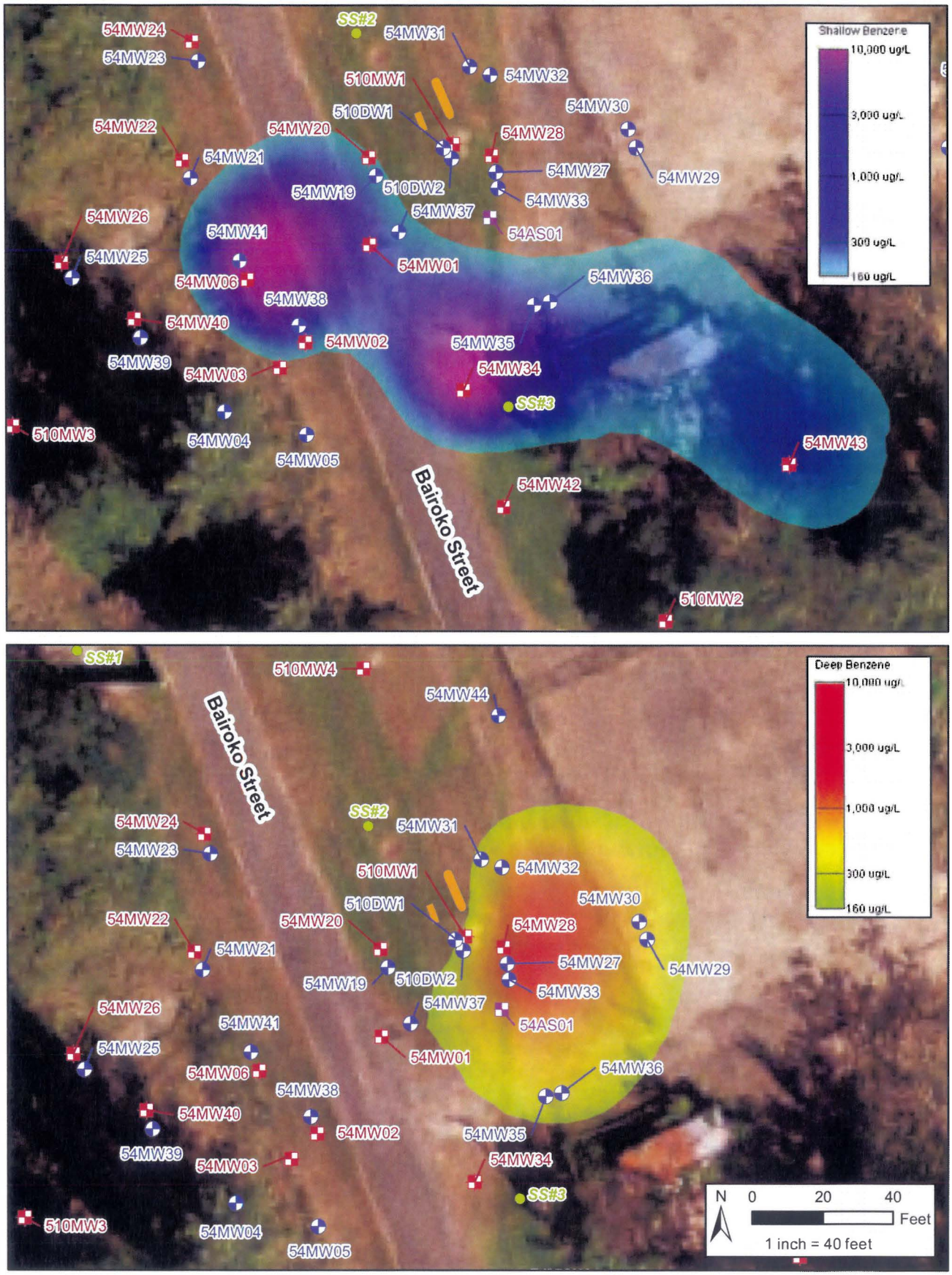




	Potential Human Receptors				Potential Ecological Receptors	
	Current/Future Land Use		Future Land Use			
Exposure Route	Indoor Worker	Outdoor Worker	Construction Worker	Onsite Residential Adult/Child*	Terrestrial Biota	Aquatic Organisms
Ingestion	NA	NFA	NFA	X**	NA	NA
Dermal Contact	NA	NFA	NFA	X**	NA	NA
Inhalation (Dust and Volatilization)	NA	NFA	NFA	X**	NA	NA
Ingestion	NA	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA	NA
Biota	NA	NA	NA	NA	NA	NA
Ingestion	NA	NA	X	X	NA	NA
Dermal Contact	NA	NA	X	X	NA	NA
Inhalation (ambient air)	X	X	X	X	NA	NA
Inhalation (indoor air)	X	NA	NA	X	NA	NA

NA - Pathways were identified as not applicable during Site Characterization and Risk Assessment
NFA - CMS indicated no further action, as site maximum was below the CAO for these receptors
* - Site is industrial in use and since groundwater CAOs developed in the CMS (Baker, 2005) were risk-based for industrial use, LUCs to prevent use of the groundwater are included as part of the remedy (during cleanup and after reaching the CAOs) in order to be protective of human health.
** - For unrestricted land use, limited additional surface and subsurface soil sampling may be needed to demonstrate absence of PAHs due to degradation over time

FIGURE 1-3
CSM for Groundwater
SWMU 54
Naval Activity Puerto Rico



Monitoring Well Screened Primarily Less than 15 ft bgs

Monitoring Well Screened Primarily Greater than 15 ft bgs

Air Sparge Injection Well

Storm Sewer Monitoring Location

Note: CAO for Benzene = 160 µg/L

FIGURE 1-4
Benzene Concentrations Exceeding Corrective Action Objective
August 2009 Through October 2010
SWMU 54
Naval Activity Puerto Rico

CH2MHILL

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVYPUERTORICO20000317\MAPFILES\SWMU54_201010\CMS\FIG_1-4_SWMU54_BENZENE_201010.MXD JCARR 6/5/2012 10:38:25 AM

1.3 Summary of Recent Work

Between August 2009 and October 2010, AGVIQ-CH2M HILL conducted a groundwater investigation and performed pilot-scale testing to evaluate the use of AS to reduce benzene concentrations in groundwater. The impact to ethylbenzene was not evaluated at this time because ethylbenzene did not exceed the 2005 CAO upon which the pilot-scale test was based. The major findings are summarized below and serve as the basis for the amendment of the CMS.

The work involved the installation of 32 monitoring wells (54MW01 through 54MW06 and 54MW19 through 54MW44) to complete the delineation of the benzene plume. Data collected from the monitoring wells showed that benzene concentrations exceeding the 2005 CAO of 550 µg/L were detected in several monitoring wells, and benzene was present in two different zones (shallow and deep) within the water table aquifer. In the shallow zone (less than 15 feet below ground surface [bgs]), the highest benzene concentrations were detected in 54MW34 located east of Bairoko Street and 54MW06 located west of Bairoko Street (refer to Figure 1-4). In the deep zone (approximately 15 to 25 feet bgs), a benzene source area was identified east of Bairoko Street in the area formerly occupied by an underground storage tank and the highest benzene concentration was measured at 54MW27. Comparison of the recent investigation data with the October 2004 data presented in the CMS (refer to Appendix B) shows that the extent of benzene contamination above the revised CAO of 160 µg/L is greater than originally estimated in the CMS and that the highest benzene concentrations are three or more times greater than those measured by Baker (2005).

As part of the additional investigation, well gauging and aquifer slug tests were performed. The gauging data indicate the direction of groundwater flow is toward the west/ southwest. Light non-aqueous phase liquid was not detected in groundwater. Aquifer slug test results indicate the hydraulic conductivity of the water table aquifer ranges from approximately 0.9 to 5.6 feet/day and averages 3.0 feet/day. The groundwater velocity beneath SWMU 54 was determined to be 0.003 feet per day (refer to Appendix A).

Because both the extent and magnitude of the benzene plume were significantly greater than that presented in the CMS (Baker, 2005), AGVIQ-CH2M HILL determined aerobic ISB using injection of oxygen-releasing compounds would not adequately treat the benzene plume because distribution of oxygen-releasing compounds in the subsurface over the entire plume would be difficult and benzene concentrations were too high for the oxygen-releasing compounds to be cost-effective. Therefore, AGVIQ–CH2M HILL conducted a pilot-scale test to evaluate the feasibility of using AS to stimulate biodegradation of benzene.

AGVIQ-CH2M HILL conducted the pilot-scale test in May 2010. During the test, air was injected into a single injection well (54AS01) at varying pressures and flows and changes in water level, dissolved oxygen (DO), and oxidation-reduction potential (ORP) were monitored to evaluate air distribution. Conclusions from the pilot-scale test results include the following:

- Air distribution in the subsurface at SWMU 54 is highly variable and is a function of the air injection rate and the heterogeneity of the formation.

Based on these results, injected air is expected to travel along zones that have a higher permeability (and associated hydraulic conductivity). These same high permeability zones are likely the same pathways along which the benzene originally migrated. In these zones, benzene will decrease in concentration through volatilization and aerobic biological degradation. The smaller amount of benzene sorbed in the lower permeability units will decrease in concentration through a combination of aerobic biodegradation, dilution, and dispersion.

- AS was effective in distributing air to the formation at SWMU 54 to promote volatilization of benzene and increased DO to support aerobic biodegradation of benzene. Increases in DO and ORP concentrations were primarily observed in the deep monitoring wells (screened deeper than 15 feet bgs) because of the placement of the injection well screen at approximately 24 to 26 feet bgs.

- Because the hydraulic conductivity results for both the deep and shallow zones were similar (2.6E-4 centimeters per second [cm/sec] to 9.4E-4 cm/sec), the same DO and ORP response is expected in shallow zone monitoring wells with the proper placement of the injection well screen at the base of the zone. DO response was observed as far away from the injection well as 40 feet; however, results were not consistent in all directions around the monitoring well. Based on a review of pilot-scale test results, a conservative radius of influence for a single injection well is estimated to be approximately 15 feet at an injection flow rate of 4 standard cubic feet per minute (scfm). Injection well spacing of 20 feet between wells is recommended for full-scale application to provide overlap of sparging influence and adequately distribute the air into the formation at a low injection flow rate.

  An injection flow rate of 4 scfm was selected for the full-scale biosparge system operations based on DO response observed in deep zone monitoring wells during pilot testing. A similar response was not observed at 4 scfm in the shallow zone monitoring wells because the injection well was screened in the deep zone and because the nearest shallow monitoring well to the injection well was approximately 17 feet away. A similar response is expected at 4 scfm in the shallow zone when injection wells are installed in the shallow unit and monitoring wells are located at a closer proximity to the injection wells. The system will be equipped with additional capacity to increase injection flow to each AS well if necessary to achieve design flow rates.

- VOC concentrations observed during air monitoring at storm sewer monitoring location SS#3 (Figure 1-4), located approximately 65 feet south of the AS injection well, indicate that VOCs liberated from groundwater during the AS pilot-scale test may be traveling through the gravel backfill that surrounds the sewer pipe. Because of the highly variable nature of the distribution of air both horizontally and vertically, and the potential for VOC-laden air to migrate along the backfill of the utility corridors, the AS system should be designed with an operating flow rate of 4 scfm per injection point to minimize effects of volatilization.

- Shallow injection wells installed to a depth of approximately 16 to 18 feet bgs should be utilized to address VOC concentrations in the shallow zone, while deeper injection wells installed to a depth of approximately 26 to 28 feet bgs should be installed to address intermediate zone impacts.

- AS wells should be individually plumbed from a common equipment manifold and operated on a pulsed frequency to minimize the size of the AS compressor required and to limit the potential for vapor migration along utility corridors or other preferential pathways.

The pilot-scale test showed that it is possible to deliver air to the formation to promote the volatilization and aerobic degradation of benzene over a large area. AS was demonstrated to be most feasible and effective at lower injection rates. Therefore, NAVFAC SE proposes to amend the remedial approach using a low-flow AS, or biosparging, system. The following tasks will be performed as part of the installation of the biosparge system:

- Installation of 18 shallow sparge wells to a depth of approximately 18 feet bgs.
- Installation of 8 deep sparge wells to a depth of approximately 28 feet bgs.
- Utilization of the existing deep sparge well (54AS01) to address the deep zone.
- Installation and operation of a pre-fabricated air injection system to deliver air to the injection wells to promote aerobic degradation of the benzene plume. Operations can be pulsed or rotated between wells to improve performance and save energy.

The amended remedial approach and implementation schedule are described in the following sections.

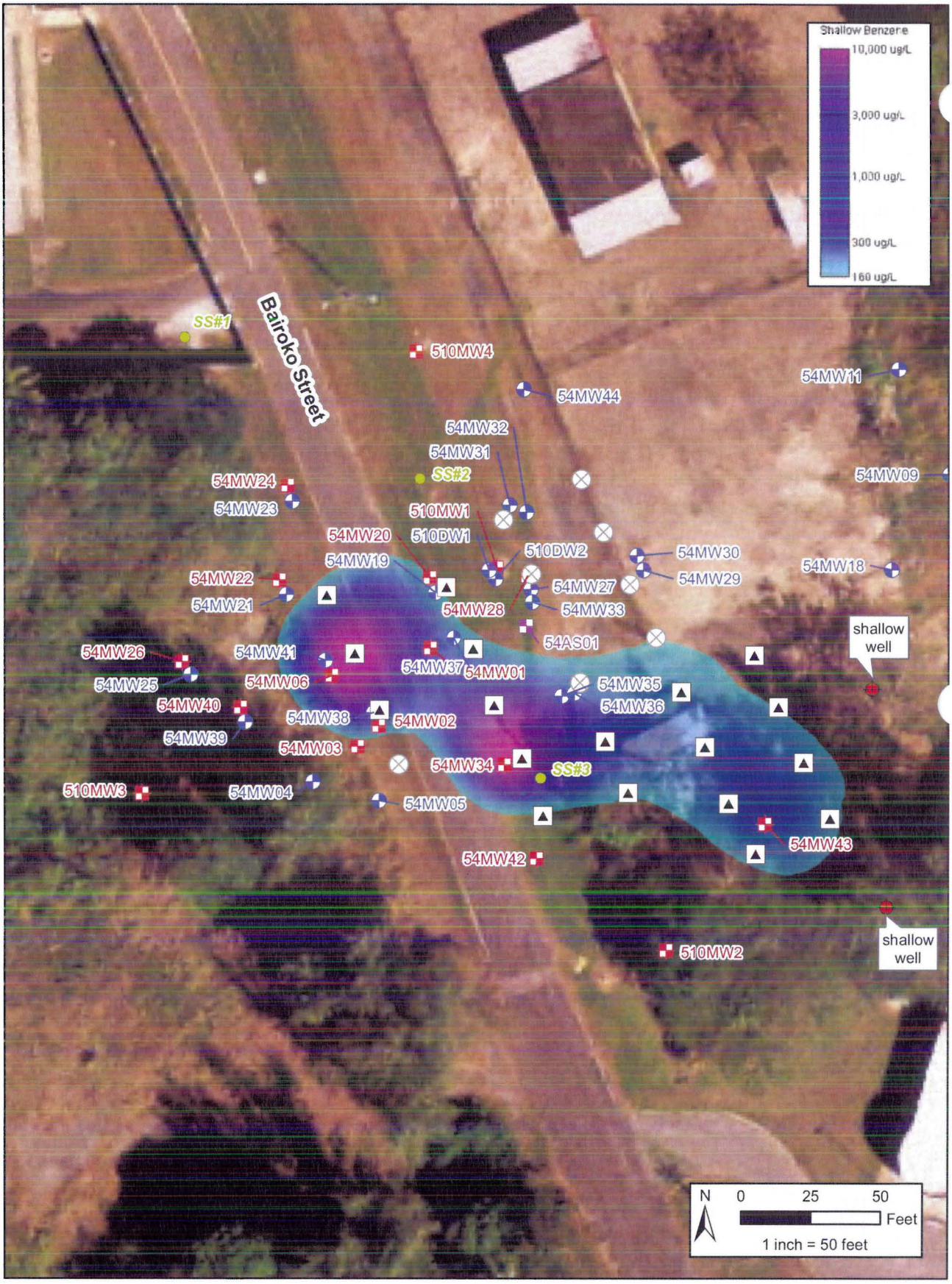
2.0 Corrective Measures Alternatives

As part of the preliminary screening process during the CMS, AS was eliminated from the alternatives for consideration for implementation because the technology would be hindered by the fine-grained soils and low permeability at SWMU 54 (Baker, 2005). However, results from the additional investigation work conducted between August 2009 and October 2010 indicated the technical approach recommended in the CMS (Baker, 2005), aerobic ISB via injection of oxygen-releasing compounds, was not viable at the site as a result of the extent and magnitude of benzene encountered in groundwater. The large mass of benzene discovered at the site would require excessive amounts of oxygen-releasing compounds and multiple injections. It was also determined that the delivery of oxygen-releasing compounds (slurry) in the subsurface would be too difficult to attain sufficient oxygen distribution to adequately stimulate aerobic ISB for the deep and shallow plume zones. As a result, AS technology was re-evaluated as a corrective measure to address benzene and ethylbenzene in groundwater at SWMU 54.

Based on the results from the pilot-scale test, biosparging was evaluated as a corrective measure alternative. Biosparging is a form of AS technology in which air is delivered to the subsurface at lower flow rates to promote aerobic degradation rather than primarily to volatize contaminants. Because benzene and ethylbenzene have similar physical properties, both compounds are expected to be adequately treated using biosparging.

Prior to installation of the biosparge system, two monitoring wells will be installed around 54MW43 to complete delineation of this area of the plume. The wells will be screened from 5 to 15 feet bgs (Figure 2-1). The biosparge system to be implemented at SWMU 54 will consist of approximately 27 vertical air injection wells to address benzene and ethylbenzene concentrations exceeding the CAOs. The sparge area was extended to encompass the benzene plume to 100 µg/L to conservatively address areas that may impact the zone where benzene and ethylbenzene exceed the revised CAOs of 160 and 493 µg/L, respectively. Because the ethylbenzene soil adsorption coefficient is higher and the solubility is lower than benzene (Oak Ridge National Laboratory, 1989), the ethylbenzene plume is expected to be contained within the benzene plume.

Sparge well locations for the shallow and deep zones are shown on Figures 2-1 and 2-2, respectively. The injection well screens will correspond to the targeted contamination zone. A total of five rows of injection wells, with wells spaced approximately 20 feet apart oriented perpendicular to groundwater flow, are proposed. This spacing was selected to ensure adequate coverage of the benzene plume based on pilot-scale test results; however, the actual spacing may require adjustment to avoid utilities. Additionally, the well spacing or number of injection wells may be revised after the baseline benzene and ethylbenzene data are acquired. Well spacing was selected based on pilot-scale test results and is consistent with recommendations in guidance including *Air Sparging Design Paradigm* (Leeson, et al., 2002) and *Air Sparging Guidance Document, NFESC Technical Report T-2193-ENV* (Naval Facilities Engineering Command, 2001). Air will be injected into the wells at a flow rate of approximately 4 scfm per well with the goal of sufficiently aerating the aquifer to increase oxygen levels in groundwater and stimulate aerobic biodegradation of benzene.



Proposed Shallow Well

Monitoring Well Screened Primarily Less than 15 ft bgs

Monitoring Well Screened Primarily Greater than 15 ft bgs

Shallow Biosparge Well

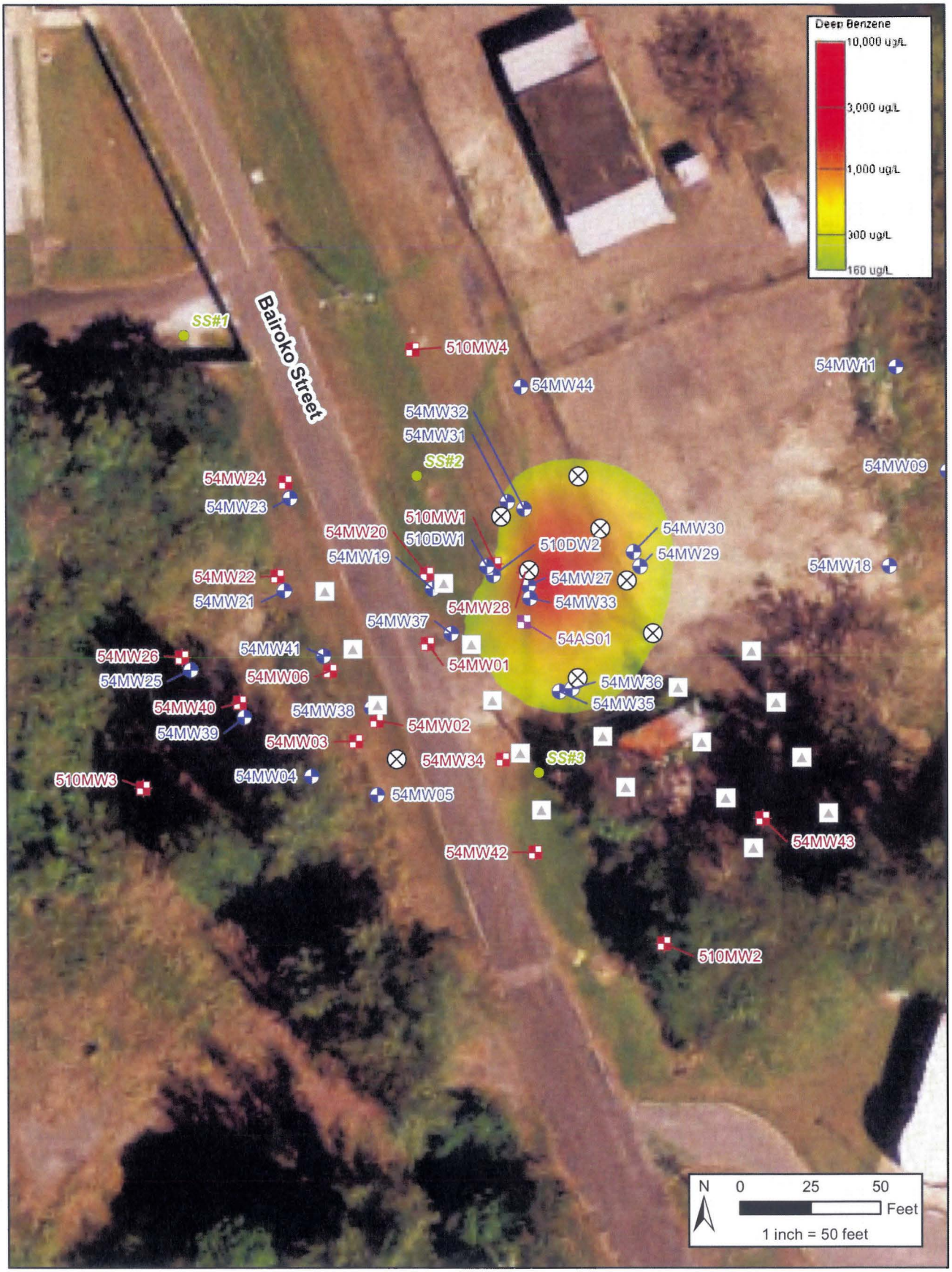
Deep Biosparge Well

Storm Sewer Monitoring Location

Note: Corrective Action Objective (CAO) for Benzene = 160 µg/L

FIGURE 2-1
Proposed Shallow Biosparge Layout
SWMU 54
Naval Activity Puerto Rico

CH2MHILL.



Monitoring Well Screened Primarily Less than 15 ft bgs

Monitoring Well Screened Primarily Greater than 15 ft bgs

Deep Biosparge Well

Shallow Biosparge Well

Storm Sewer Monitoring Location

Note: Corrective Action Objective (CAO) for Benzene = 160 µg/L

FIGURE 2-2
Proposed Deep Biosparge Layout
SWMU 54
Naval Activity Puerto Rico

CH2MHILL

Salinity of groundwater was considered during the evaluation of AS as a potential remedy at the site. Salinity values calculated based on conductivity data collected during well purging average approximately 1 part per 1,000. Based on these low salinity values (representative of fresh to brackish water) and the location of the site greater than 1 mile from the ocean, the salinity is expected to have no impact on biosparge system effectiveness.

System monitoring will be performed to evaluate the effectiveness of biosparging to achieve the remedial objectives and determine when the system will be turned off. Groundwater monitoring will be performed quarterly during the first year of system operations to determine if system adjustments are necessary and to monitor system performance. Additionally, system flow and pressure measurements will be recorded bi-weekly during operations, maintenance, and monitoring (OM&M) site visits.

Current land use controls (LUCs), including restricted access to the SWMU 54 area through security fencing and prohibited use of groundwater, will be maintained until the CAOs are achieved in both the TCE area and the benzene area. When corrective action is complete, LUCs must be maintained including:

- No permanent residences may be installed on the property.
- No groundwater extraction wells may be installed by the deed grantee.
- Potential for vapor intrusion must be considered by the developer and addressed by the developer, as needed.
- The grantee may not interfere with any existing or future groundwater remedial systems.
- The grantee must complete annual inspections of the property to ensure all LUCs are being complied with and provide written certification of the inspection.
- The grantee must comply with the RCRA Administrative Order on Consent for this property (provided to the Puerto Rico Local Redevelopment Authority [LRA] by the U.S. Navy).
- Release of environmental conditions and grantee covenants can be considered only with EPA concurrence.

In order to develop, improve, use, or maintain the property in a manner inconsistent with the LUCs, the grantee must submit a written request seeking approval to the Director at the NAVFAC BRAC Program Management Office, Southeast.

3.0 Corrective Measure Evaluation

Biosparging was evaluated as a corrective measure alternative using the same criteria as the CMS (Baker, 2005). However, the evaluation presented in the following sections incorporates data obtained from the recent pilot-scale test.

3.1 Technical Evaluation

3.1.1 Protect Human Health and the Environment

The corrective action protects both human health and the environment by removing benzene and ethylbenzene contamination from groundwater, preventing any possibility of future exposure.

There is minimal exposure risk to site workers during well installation and sparge component construction. However, engineering controls and personal protective equipment will be used to prevent worker exposure.

3.1.2 Attain Media Cleanup Standards

Biosparge is a well established technology that has been widely used to address benzene and ethylbenzene in groundwater. Based on experience sparging in similar geologic terrains (heterogenous saprolitic silt), operation of the biosparge system is expected to reduce benzene and ethylbenzene concentrations by greater than 95 percent within 3 years. COC reductions of greater than two orders of magnitude have been achieved at other sparging sites operated by AGVIQ-CH2M HILL including Air Force Plant 6 (Marietta, Georgia) and a confidential pipeline client site in Georgia. At Air Force Plant 6, COC reductions in the target treatment zone (heterogenous saprolitic soil between 30 and 70 feet bgs) averaged approximately 95 percent after 3 years of operation from approximately 19,000 µg/L to approximately 10 µg/L. Given the lower initial groundwater concentrations and smaller plume size at SWMU 54, AQVIQ-CH2M HILL believes that the estimated time required to achieve CAOs will be approximately 3 years.

If necessary, the biosparge system can be fortified with additional sparge wells without requiring an upgrade of the supporting equipment such as the compressor and the blower.

3.1.3 Source Control

As described in this CMS Addendum (refer to Appendix A), the benzene and ethylbenzene plume resulted from historical site operations and there are no current releases at SWMU 54. Release of contaminant mass from the source area will be controlled by aggressively removing the material through biosparging.

3.1.4 Comply with ARARs

This approach will achieve the revised CAOs of 160 µg/L for benzene, and 493 µg/L for ethylbenzene.

3.1.5 Reliability and Effectiveness

Biosparge systems rely on several pieces of mechanical equipment, including compressors, solenoids, and process controls. All the necessary equipment is common, readily available, and widely demonstrated for use in this application. Therefore, the equipment is expected to perform reliably. Monthly inspections of the biosparge system will be required to record flows and injection pressures. Otherwise, the system will be fully automated. However, tropical climates such as at NAPR may require additional services to protect the equipment. In addition, as discussed in *In-Situ Air Sparging Without Organic Nutrient Amendment: An Effective Strategy for Treating Petroleum Contaminated Groundwater* (Shaffner and Juneau, 1993) and the *Air Sparging Guidance Document, NFESC Technical Report T-2193-ENV* (NAVFAC, 2001), fouling of sparge well screens is also a concern. An OM&M plan will be developed to ensure proper operation and longevity of the equipment, including addressing the potential for biofouling of well screens.

Based on AGVIQ-CH2M HILL's experience, biosparge systems have been demonstrated to operate reliably in a variety of climates with minimal maintenance requirements for 4 years or more. Because the mechanical equipment will be installed inside a shipping container, this system will not be impacted significantly by any type of weather or adversely affected by occasional extreme fluctuations in groundwater elevation.

Review of lithologic data indicates that clay observed during boring installations is associated with the weathered saprolite. In order to account for the vertical variations in permeability and benzene distribution, the biosparge system layout will include wells installed in both the shallow (18 wells) and deep (9 wells) vertical zones. Injection wells will be spaced conservatively with an estimated 10-foot zone of influence around each well to address the potential for variations in horizontal air distribution associated with heterogeneity. In addition, the biosparge system will be equipped with additional capacity to add injection wells (or increase flow rates to existing wells) to enhance system effectiveness if performance monitoring results indicate inadequate plume treatment in specific areas of the plume.

Contaminant concentrations in groundwater commonly rebound slightly after the sparge equipment is turned off. As a result, AGVIQ-CH2M HILL proposes 1 year of quarterly closure monitoring following deactivation of the biosparge system to confirm groundwater concentrations remain below CAO levels. Closure groundwater monitoring will only occur after performance monitoring (collected during active system operations) indicates that all wells within the plume are below accepted CAOs. If concentration rebound occurs during 1 year of quarterly closure monitoring, then reactivating system operations or long-term monitored natural attenuation (MNA) monitoring will be evaluated.

3.1.6 Implementability

Because biosparge is a commonly used technology, system installation and operation is well defined and requires commonly available equipment. At SWMU 54, the implementation can be completed quickly (less than 6 months) and can be completed in phases to enhance system optimization.

Based on the pilot-scale test results, it is possible to inject air into the aquifer to reduce benzene and ethylbenzene concentrations to the revised CAOs of 160 µg/L and 493 µg/L or

less. The results will depend on the ability to effectively address all zones of contamination and the use of vertical injection wells allows system expansion to be completed easily, if necessary, to optimize subsurface air distribution.

Minor characterization of the benzene plume near 54MW43 and possibly additional characterization for ethylbenzene may be required. However, the remaining characterization can be completed during the baseline sampling for system installation. The baseline sampling and system construction can begin upon approval of this CMS Addendum and the associated CMI Plan (AGVIQ-CH2M HILL, 2012b).

The Puerto Rico Environmental Quality Board will be provided with an amendment to the SWMU 54 injection notification detailing the biosparge system.

3.1.7 Safety

The primary safety issue associated with installation and operation of a biosparge system is related to contaminant vapors. Based on previous drilling experience, contaminant vapors from groundwater do not present a risk to onsite workers during installation of the biosparge system. Vapors produced during AS will be mitigated by pulsing air to the injection wells at flow rates less than 4 scfm. The sparging equipment will be sized with significant additional capacity to increase flows, if necessary. Based on results from the pilot-scale test, soil vapor extraction does not appear warranted at this time with proper monitoring and control of the system. Vapor monitoring using a field-calibrated photoionization detector will be completed at all storm sewer vaults daily during startup and during routine OM&M events thereafter.

There are no occupied buildings in the biosparge treatment area.

3.2 Environmental Evaluation

This alternative would benefit the environment through rapid removal of benzene and ethylbenzene from groundwater. In addition, all waste, with the exception of drill cuttings, will be treated in place without involving removal, transportation, and disposal. The energy required to operate the biosparge system is more than can be cost effectively and reliably supplied using alternative energy sources (for example, solar or wind power). In addition, electrical service is already available at the site to operate the system.

3.3 Cost Estimate

The cost estimate prepared for this alternative includes the following assumptions:

- Injection well installation is estimated to require approximately 20 days to complete.
- Biosparge system installation and commissioning is expected to require approximately 40 days to complete.
- A total of approximately 120 tons of non-hazardous petroleum impacted soil is expected to be generated from the injection well installation and trenching activities. Material determined to be free of contamination and suitable for backfill will be used to backfill the piping trenches. During the CMS, a quantitative CAO for benzo(a)pyrene was

developed for surface soils. However, no surface soil samples were observed to exceed this CAO or the revised CAO for benzo(a)pyrene and surface soils are considered appropriate for reuse.

- Electrical service currently available at the site will be sufficient to operate the biosparge system.
- Bi-weekly system OM&M visits will be completed during system operations.
- The biosparge system is expected to operate for between 2 and 3 years.
- Quarterly groundwater sampling will be completed for the first year during system operations.
- Semiannual groundwater sampling will be completed following the first year while the biosparge system is in operation.
- Quarterly groundwater sampling will be completed during 1 year of confirmation monitoring after system shutdown.

The cost to complete the installation of the biosparge system and 2 years of system OM&M is estimated to be approximately $999,000. Detailed cost information is provided in Appendix E.

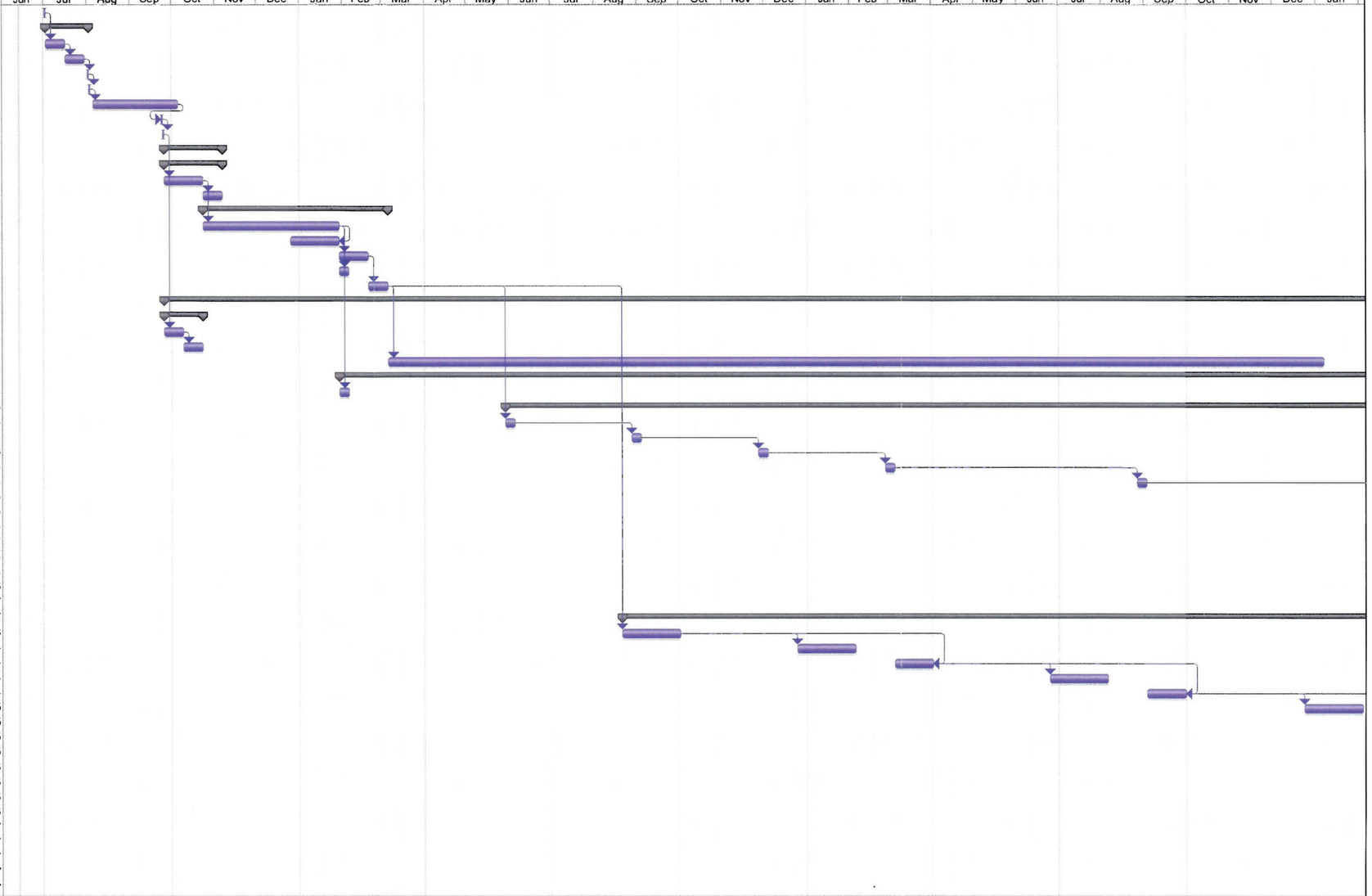
4.0 Recommended Corrective Measure

AGVIQ-CH2M HILL agrees with the CMS in the selection of MNA and institutional controls as the recommended remedy for the SWMU 54 benzene plume. However, the CMS also recommended the injection of oxygen-releasing compounds to achieve site closure more rapidly. Based on the additional investigation and pilot-scale testing work conducted between August 2009 and October 2010 and the information presented in this CMS Addendum, biosparge is the selected corrective measure recommendation and will include LUCs to be maintained during the corrective action and after the corrective action is complete. Additionally, characterization of the benzene plume in the vicinity of 54MW43 will be completed. Also, if the ethylbenzene plume is not contained within the benzene plume, it will be characterized further.

An implementation schedule is presented on Figure 4-1.

Benzene Plume Biosparge Implementation Schedule
SWMU 54

ID	Task Name	Duration	Start	Finish
1	**CMS Addendum Approval by EPA**	1 day	Mon 7/2/12	Mon 7/2/12
2	**Statement of Basis**	**23 days**	**Tue 7/3/12**	**Thu 8/2/12**
3	Development	10 days	Tue 7/3/12	Mon 7/16/12
4	EPA Approval	10 days	Tue 7/17/12	Mon 7/30/12
5	Include in Repository	1 day	Thu 8/2/12	Thu 8/2/12
6	Public Notice	1 day	Fri 8/3/12	Fri 8/3/12
7	Public Comment and RAB Involvement	45 days	Mon 8/6/12	Fri 10/5/12
8	Public Meeting	1 day	Mon 9/24/12	Mon 9/24/12
9	**Notice to Proceed**	1 day	Tue 9/25/12	Tue 9/25/12
10	**Biosparge Installation**	**30 days**	**Wed 9/26/12**	**Tue 11/6/12**
11	**Pre-Mobilization**	**30 days**	**Wed 9/26/12**	**Tue 11/6/12**
12	Design and Procurement	20 days	Wed 9/26/12	Tue 10/23/12
13	UIC	10 days	Wed 10/24/12	Tue 11/6/12
14	**Field Implementation**	**95 days**	**Wed 10/24/12**	**Tue 3/5/13**
15	Equipment Fabrication	70 days	Wed 10/24/12	Tue 1/29/13
16	Biosparge Well Installation	25 days	Wed 12/26/12	Tue 1/29/13
17	Trenching	15 days	Wed 1/30/13	Tue 2/19/13
18	Electrical Installation	5 days	Wed 1/30/13	Tue 2/5/13
19	Startup/Shakedown Testing	10 days	Wed 2/20/13	Tue 3/5/13
20	**Biosparge Operations**	**1296 days**	**Wed 9/26/12**	**Wed 9/13/17**
21	**OM&M Plan**	**20 days**	**Wed 9/26/12**	**Tue 10/23/12**
22	Work Plan Generation	10 days	Wed 9/26/12	Tue 10/9/12
23	Navy Review	10 days	Wed 10/10/12	Tue 10/23/12
24	Operation and Maintenance	24 mons	Wed 3/6/13	Tue 1/6/15
25	**Monitoring**	**1175 days**	**Wed 1/30/13**	**Tue 8/1/17**
26	**Baseline**	**5 days**	**Wed 1/30/13**	**Tue 2/5/13**
27	**Performance Monitoring**	**720 days**	**Wed 5/29/13**	**Tue 3/1/16**
28	YR 1 Q1	5 days	Wed 5/29/13	Tue 6/4/13
29	YR1 Q2	5 days	Wed 8/28/13	Tue 9/3/13
30	YR1 Q3	5 days	Wed 11/27/13	Tue 12/3/13
31	YR1 Q4	5 days	Wed 2/26/14	Tue 3/4/14
32	YR2 S1	5 days	Wed 8/27/14	Tue 9/2/14
33	YR2 S2	5 days	Wed 2/25/15	Tue 3/3/15
34	YR3 S1	5 days	Wed 8/26/15	Tue 9/1/15
35	YR3 S2	5 days	Wed 2/24/16	Tue 3/1/16
36	**Closure Monitoring**	**200 days**	**Wed 5/25/16**	**Tue 2/28/17**
37	Closure Monitoring (1st quarter)	5 days	Wed 5/25/16	Tue 5/31/16
38	Closure Monitoring (2nd quarter)	5 days	Wed 8/24/16	Tue 8/30/16
39	Closure Monitoring (3rd quarter)	5 days	Wed 11/23/16	Tue 11/29/16
40	Closure Monitoring (4th quarter)	5 days	Wed 2/22/17	Tue 2/28/17
41	**Reporting**	**1030 days**	**Wed 8/21/13**	**Tue 8/1/17**
42	6-month Post Installation Report	30 days	Wed 8/21/13	Tue 10/1/13
43	Draft Semi-Annual Report	30 days	Wed 12/25/13	Tue 2/4/14
44	Final Semi-Annual Report	20 days	Wed 3/5/14	Tue 4/1/14
45	Draft Semi-Annual Report	30 days	Wed 6/25/14	Tue 8/5/14
46	Final Semi-Annual Report	20 days	Wed 9/3/14	Tue 9/30/14
47	Draft Semi-Annual Report	30 days	Wed 12/24/14	Tue 2/3/15
48	Final Semi-Annual Report	20 days	Wed 3/4/15	Tue 3/31/15
49	Draft Semi-Annual Report	30 days	Wed 6/24/15	Tue 8/4/15
50	Final Semi-Annual Report	20 days	Wed 9/2/15	Tue 9/29/15
51	Draft Semi-Annual Report	30 days	Wed 12/23/15	Tue 2/2/16
52	Final Semi-Annual Report	20 days	Wed 3/2/16	Tue 3/29/16
53	Draft Semi-Annual Report	30 days	Wed 6/22/16	Tue 8/2/16
54	Final Semi-Annual Report	20 days	Wed 8/31/16	Tue 9/27/16
55	Draft Semi-Annual Report	30 days	Wed 12/21/16	Tue 1/31/17
56	Final Semi-Annual Report	20 days	Wed 3/1/17	Tue 3/28/17
57	Draft Semi-Annual Report (Request NFA)	30 days	Wed 4/26/17	Tue 6/6/17
58	Final Semi-Annual Report (Request NFA)	20 days	Wed 7/5/17	Tue 8/1/17
59	**Attain NFA (request in last Annual Report)**	**1 day**	**Wed 9/13/17**	**Wed 9/13/17**



Project: Worksheet 16
Date: Wed 6/13/12

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Figure 4-1
Project Schedule
SWMU 54 Naval Activity Puerto Rico

5.0 References

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