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CORRECTIVE MEASURES IMPLEMENTATION PLAN 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 Implementation Plan for SWMU 54 TCE 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 Implementation Plan for SWMU 54 TCE 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)
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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 TCE Plume and the Corrective Measures Implementation Plan SWMU 54 TCE 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 Comments dated September 15, 2011 on the Corrective Measures Implementation (CMI) Plan dated March 2011. The CMI Plan Rev. 01 dated January 2012 was 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 Response evaluation below, additional general and specific comments on the CMI Plan Rev. 01 are presented.

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

GENERAL COMMENTS

Evaluation of Response to EPA General Comment 1: The response partially addresses the comment. The response does not address the potential displacement due to injections. However, this issue is adequately addressed in Section 3.4 of the CMI Plan Rev. 01. Also, the additional text to be added to Section 3.2, as indicated in the response, is actually in Section 3.3 of CMI Plan Rev. 01. Furthermore, there is a discrepancy between the injection well screen depths indicated in the revised response text and the text in Section 3.3 of the CMI Plan Rev. 01. The response and the text in Section 3.3 on Page 3-3 indicate the injection wells will be screened from 17 to 27 feet below the ground surface (bgs). However, the text on Page 3-4 indicates the injection wells will be screened from 19 to 29 bgs. Revisions to the CMI Plan Rev. 01 will be needed to address this discrepancy in the injection well screen depths.

Also, for further clarification in the record, it should be noted that additional text to be added to Section 3.1 of the CMI Plan Rev. 01, as provided in the response revised text, incorrectly indicates in the first sentence that "Four" monitoring wells will be installed at SWMU 54 trichloroethylene (TCE) plume. However, the CMI Plan Rev. 01 includes the additional text and correctly indicates three wells will be installed at the SWMU 54 TCE Plume.

Response:

Based on the revised CAOs, no additional injection wells will be installed at the SWMU 54 TCE plume.

Evaluation of Response to EPA General Comment 2: The response partially addresses the comment. The response does not address the downgradient data gap and explain why it is unnecessary to monitor directly downgradient of the northern lobe of the plume. This deficiency is further detailed in Specific Comment 1, below.

Response:

Comment acknowledged. The response is further detailed in Specific Comment 1, below.

Evaluation of Response to EPA General Comment 4: The response addresses the comment. However, is should be noted that the corrective action objectives (CAOs) developed in 2005 do not include the revised TCE toxicity data (September 2011). It is likely that a CAO developed using the new TCE toxicity data would be lower than the current CAO of 22 µg/L. To ensure that the current CAO developed for TCE remains protective based on the land use exposure scenario, revise the CMI Plan Rev. 01 to address this issue.

Response:

The CAOs were revised using the September 2011 toxicity data, as requested by EPA. The revised CAO for TCE is 193 µg/L. The CMI Plan has been revised to address this issue.

Evaluation of Response to EPA General Comment 7: The response does not address the comment bullet indicating site safety and security provisions (e.g., fences) have not been specified to ensure control of the remedial action implementation area. The response indicates existing land use controls (LUCs) have been included in Section 1.4 of the CMI Plan. However, a review of Section 1.4 of the CMI Plan Rev. 01 only states that current LUCs will remain in place. No specific details are provided regarding the actual LUCs that will be implemented to achieve the LUC objective for groundwater which is to prevent the use of groundwater. Additionally, the response states the conceptual model of contaminant migration is included in Section 1.3, but it is actually in Section 1.4.

Response:

A description of existing LUCs that will be maintained during the remedial action was added to Section 1.5.3 and a summary of the LUCs to be included in the deed if the parcel were to be transferred is also included in this section.

ADDITIONAL GENERAL COMMENT

1. The CMI Plan Rev. 01 indicates that existing 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. 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. Additionally, 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 1.5.3 of the CMI Plan and a summary of the LUCs to be included in the deed if the parcel were to be transferred is also included in this section.

ADDITIONAL SPECIFIC COMMENTS

1. **Section 1.5.1, Additional Characterization, Page 1-6; Section 3.1, Monitoring Well Installation, Page 3-1:** The text indicates that three additional monitoring wells will be installed to complete the delineation of the shallow groundwater above the TCE CAO of 22µg/L. However, it is uncertain whether one proposed well on the northwest side of the plume as depicted in Figure 3-1 is sufficient to monitor the west/northwest downgradient boundary, since this well appears to be cross-gradient to the flow directions depicted on Figure 3-3 in Appendix A. It appears that the lack of a monitoring well on the western side of the plume between the proposed shallow well location and well 54MW18 constitutes a data gap in this area. It is recommended that an additional shallow groundwater monitoring well be installed approximately 40 feet to the southeast of the currently proposed shallow well to address the data gap identified at the western plume boundary of the northern lobe.

   Response:

   The CAOs were revised using the September 2011 toxicity data, as requested by EPA. The revised CAO for TCE is 193 µg/L. Based on this information, the TCE plume is considered fully delineated laterally and no additional shallow monitoring wells will be installed.

2. **Section 1.6, Design Criteria, Page 1-6:** The performance criteria presented in this section appears to require complete degradation of TCE only and does not address degradation of 1,2-dichlorothene (DCE) and vinyl chloride (VC). Revise the CMI Plan Rev. 01 to provide performance criteria for DCE and VC to ensure that no accumulation of these contaminants occurs.

Response:

The CAOs were revised using the September 2011 toxicity data, as requested by EPA. The revised CAO for TCE is 193 µg/L. Based on this information, no corrective action will be taken at the SWMU 54 TCE area. However, DCE and VC will continue to be monitored. DCE and VC were not COCs at SWMU 54 in the 2005 CMS; therefore, action levels for these compounds were developed using the same method as the CAOs developed in the *Revised Corrective Action Objectives for Solid Waste Management Units 7&8, 54, and 55 Technical Memorandum*. The action levels were added to Section 1.6 of the CMI.

3. **Section 3.1, Monitoring Well Installation, Page 3-1; Section 3.3, Injection Well Installation, Page 3-3:** The CMI Plan Rev. 01 does not describe monitoring or injection well development procedures nor have applicable standard operating procedures (SOPs) been provided in the *Sampling and Analysis Plan, Corrective Action at Solid Waste Management Unit 54- TCE Plume*, dated January 2012 (CMI SAP) for the SWMU 54 TCE Plume. For completeness, revise the CMI Plan Rev. 01 to present details on the proposed monitoring well and injection well development procedures. Also, provide SOPs for well installation and well development to ensure consistent methodology is employed during the investigation. Alternatively, provide a reference in the CMI Plan Rev. 01 to an existing SAP where the details of these procedures can be found.

   Response:

   SOPs were included as an appendix to the CMI Plan.

4. **Figu e 3-1, ISB Injection Locations, Page 3-2:** Well 54MW16 is not included in the plume (blue area). Since the final TCE concentration (from Table 3-3 in Appendix A) was 22.8 µg/L which is greater than the CAO, this well should be included. Revise Figure 3-1 to address this discrepancy.

   Response:

   54MW16 is within the plume shown in Figure 2-1, showing the baseline results from the characterization phase of work. No other plume map is shown in the CMI.

5. **Section 3.4, ISB Injection, Page 3-4 and Appendix A, Pilot-Scale Test Report for SW U 54 TCE Plume, Section 3.3.1, TCE ISB Injection Results, Page 3-11**: The text in the second paragraph in Appendix A, Section 3.3.1 states that daylighting of injection fluid was observed frequently during field operations. The text also states daylighting was observed during injection at each injection well and surfacing of injection fluid generally occurred at locations 10 to 35 feet from the injection wells or from around the injection well pad (e.g., 54IW02). The text further states that if daylighting was observed, the injection pressure was decreased to avoid additional surfacing of injection fluid. It is recommended that groundwater levels be monitored in wells surrounding the injection location in order to reduce the surfacing of injection fluids due to mounding of the water table. Increasing water table levels in monitoring wells would indicate locations where daylighting would

likely occur if actions were not taken (e.g., decrease injection pressure) to reduce surfacing of the injection fluids. Revise the CMI Plan Rev. 01 to require monitoring water levels in wells surrounding the injection location. Additionally, revise Section 3.4 to include strategies to address daylighting (like reducing the injection pressure), which is only mentioned in Appendix A and not in the CMI Plan proper.

Response:

Daylighting does not typically result from mounding of the water table. In that case, daylighting would occur over a large area, rather than a single point. Typically, daylighting results from fluid under pressure traveling along a route of extremely high permeability, such as naturally occurring fractures, a previous boring that was not abandoned properly, a well annulus that was not constructed properly, previous disturbances in the subsurface, etc. Therefore, mounding of the water table, which would definitely occur in the injection area, is not a good indicator of potential for daylighting. Additionally, based on the revised CAOs, no corrective action will be required at the SWMU 54 TCE area. Monitoring of groundwater levels was not added to the CMI Plan.

6. **Section 3.6, Exit Strategy, Page 3-6:** The text in this section only discusses the exit strategy relative to the reduction in TCE concentrations and the achievement of the TCE CAO in groundwater at all wells. The last paragraph in this section indicates if TCE concentrations do not exceed the CAO for four consecutive quarterly events, NAVFAC SE will request no further action (NFA) for the site. However, this approach is not consistent with the closure strategy presented in the CMI SAP, Worksheet #11 regarding performance and closure monitoring. On Page 34 of Worksheet #11, the first bullet indicates closure monitoring will commence once the performance monitoring data indicates TCE, VC and DCE concentrations in groundwater are below the project action limits (PALs) of 22 µg/L, 2 µg/L, and 70 µg/L, respectively for one performance monitoring event in all 16 monitoring wells. Additionally, the second bullet on Page 34 of Worksheet #11 states that NAVFAC SE will request NFA for the site once the closure monitoring data indicate TCE, VC and DCE concentrations are below the respective PALs for four consecutive quarterly monitoring events. Revise the CMI Plan Rev. 01 to address the inconsistency between the CMI Plan Rev. 01 and the CMI SAP by requiring TCE, DCE and VC concentrations below PALs to implement the NFA exit strategy.

   Response:

   The CAOs were revised using the September 2011 toxicity data, as requested by EPA. The revised CAO for TCE is 193 µg/L. Based on this information, no remedial action will be taken at the SWMU 54 TCE area and the PALs were not added to the CMI.

7. **Section 4.2, Reporting Page 4-2:** In order to properly document site specific project issues that may be relevant to future remedial actions, the report should include a lessons learned section. Revise Section 4.2 to indicate that a lessons learned section will be included in the report.

   Response:

A lessons learned section was included in Section 4.2.

The following set of comment evaluations were provided by EQB.

GENERAL COMMENTS

1. 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, waters 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:
   The CAOs were developed during the Corrective Measures Study (Baker, 2005) (hereinafter referred to as the CMS). The U.S. Environmental Protection Agency (EPA) conditionally approved the CMS Report on October 13, 2005, contingent upon completion of the pilot tests and CMI Plan. The groundwater CAOs were developed based on an industrial use of the site as was originally proposed in the 2004 Reuse Plan submitted by the Local Reuse Authority. Since groundwater CAOs developed in the CMS were risk-based for industrial use, land use controls (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. The LUCs will be included in any lease or transfer deed. In addition, any lease or transfer deed associated with SWMU 54 or 55 will state that vapor intrusion shall be considered by the new owner during the design/construction of any future structures on the parcel. If development other than industrial use (i.e., residential, or per the April 2010 amended Reuse Plan) is proposed, the new owner will have to work with the Puerto Rico Environmental Quality Board (PREQB) and EPA to establish any additional investigation/risk assessment/cleanup activities. If the property owner wishes to remove the LUC on the groundwater from the deed in the future, it will be the responsibility of the property owner to demonstrate the groundwater meets all state and federal maximum contaminant levels (MCLs), and must obtain approval from the Navy, EPA, and PREQB prior to its removal.

   PREQB Evaluation of Response:
   PREQB understands that the consent order allows for a third party to take over responsibility for cleanup. If the Navy has entered into such an agreement with a third party for this site, please provide a copy of the agreement to PREQB. Otherwise, please ensure that the CAOs comply with PRWQS, as discussed in our comment, and the cleanup is protective human health and the environment, based on anticipated land uses, consistent with the current 2010 Addendum to the 2004 Reuse Plan. Please note that additional remediation or monitoring may be required to demonstrate compliance with PRWQS.

Response:
Comment acknowledged.

2. Concurrent with the implementation of the proposed biosparge remedy to establish aerobic conditions sufficient to promote biological degradation of benzene, the Navy is proposing to perform injections of emulsified oils immediately upgradient to establish anaerobic conditions sufficient to promote the degradation of TCE. Please incorporate discussion within the document regarding how these two remedial approaches are expected to interact such that they will not interfere with the successful remediation of either contaminant plume. Additionally, describe specific monitoring that will occur to evaluate whether one remedy is negatively impacting the other and any associated corrective actions to be taken as necessary.

Response:

Groundwater sampling data has established two separate plumes with very limited co-mingling. Based on the current proposed configurations, the anaerobic TCE plume remediation will be implemented a minimum of approximately 90 feet upgradient of the biosparge remedy. Groundwater moves at one foot per year and it could take 10 years or more to migrate from the TCE plume to the benzene plume. Current groundwater conditions in the benzene plume indicate very low dissolved oxygen levels (average of less than1 mg/L) which are consistent with those conditions expected as a result of the TCE remedy. The biosparge system has been designed with aggressive well spacing (assuming an approximate 10 foot zone of influence around each well) and with the flexibility to increase air flow to each well (and resulting DO loading) as necessary, to overcome the existing DO conditions as well as any conditions (decreased DO and increased organic carbon) that may result from upgradient TCE plume remediation.

PREQB Evaluation of Response:

The Navy's response describes the air sparge system being designed with excess capacity, to allow for increased oxygen delivery, should interferences be encountered. Please address the monitoring efforts to be undertaken and how the results of these monitoring events will be evaluated to determine whether utilization of the additional capacity is needed. Please expand the discussion to provide details of the monitoring to identify such potential issues and potential decision points relative to identifying needs to adjust/optimize system operations.

Response:

The increase in DO planned for the benzene area should not impact the upgradient TCE area where low DO conditions are needed to promote ERD. Conversely, there should be enough separation between plumes that the substrate that would have been added in the TCE area will not adversely impact the supply of DO in the benzene area. The substrate would be consumed and so any impact on DO will be temporary. The current monitoring program is already sufficient to identify if additional sparging is

required within the treatment area. As outlined in the CMI Plan, monitoring wells 54MW29 and 54MW30 are included in the performance monitoring plan. These wells would be the first to be potentially impacted by groundwater migrating from the SWMU 54 TCE area. If sufficient mass removal is not attained at these monitoring wells, or any other monitoring well within the treatment area, the system will be optimized.

However, based on the revised CAOs, no additional EVO will be injected at the SWMU 54 TCE area.

3. Please provide additional lines of evidence to support the statement that reductive dechlorination is occurring at SWMU 54. Parameters that need to be evaluated in the case of reductive dechlorination include the strength the reducing conditions developed (highly negative ORP), the lack of dissolved oxygen, and the observation of reduced states of electron acceptors (iron, manganese, etc.) Additionally the biological reduction of trichloroethene (TCE) produces at least temporary increases in concentrations of associated breakdown products such as cis 1,2-dichloroethene, vinyl chloride and dissolve gasses (ethane and ethane).

Response:
While oxidation-reduction potential (ORP) can be an effective indicator of the reductive capacity of an aquifer, it is also not reliably measured in the field. According to Christensen et. al. (2000), "Often, electrochemical redox measurements, as referred in literature, are either considered useless or interpreted beyond their reliability. This probably is due to lack of understanding of the basic concepts and, therefore, of possibilities and limitations of the measurements. The classic paper by Lindberg and Runnells (1984) abolished meaningful interpretation of measurements of electrochemical redox potentials due to lack of internal equilibrium." Therefore, a lack of highly negative ORP is not necessarily indicative of non-reducing conditions.

In addition, according to Christensen, et. al., ORP measurements below -50 mV seem to suggest that strongly reducing condition, such as iron-reducing, sulphate-reducing, or methanogenic, prevail in the plume. Therefore, the ORP at the three pilot test target wells, 54MW07, 54MW08, and 510MW5R is indicative of strongly reducing conditions.

The VOC and geochemical data for several wells, such as 54MW07, demonstrate clear evidence that reductive dechlorination was effectively stimulated at the site. For example, at well 54MW07, TCE concentrations declined from an initial concentration 72.6 µg/L to 7.67, a decrease of approximately 90 percent. Concurrently with this decline, cis-1,2-DCE concentrations increased from 4.31 µg/L to 9.54 µg/L, with a clearly increasing t end in cis-1,2-DCE over the last three monitoring events.

Also, the geochemistry data at 54MW07 demonstrate increasingly reducing conditions throughout the pilot test period. TOC, a parameter that is indicative of the presence of substrate injected, increased from an initial concentration of

13.1 mg/L to as high as 134 mg/L, then declined to less than 5 mg/L. Iron and manganese concentrations increased from baseline concentrations of 0.19 mg/L and 0.26 mg/L, respectively, to as high as 3.79 mg/L and 3.43 mg/L, respectively. These increases suggest that the aquifer redox state was reduced to at least that of iron- and manganese- reducing. Sulfate concentrations were also significantly depleted, with an initial sulfate concentration of 62.9 mg/L reduced to as low as 1.16 mg/L, and a final concentration of 24.2 mg/L. Methane concentrations increased from an initial concentration of 2.4 µg/L to concentrations as high as 9630 µg/L and a final concentration of 9530 µg/L, suggesting that methanogenic conditions were achieved in the aquifer in the vicinity of this well.

Similar results were observed at well 54MW08. The TCE concentration in this well was reduced from an initial concentration of 139 µg/L to a final concentration of 10.3 µg/L, a reduction of approximately 93 percent. While the cis-1,2-DCE in this well did not show a significant increase, the ratio of cis-1,2-DCE to TCE increased from an initial value of 0.05 to a value of 0.59, a tenfold increase and consistent with the increase expected with the ERD process. Geochemical data for this well also indicate that increasingly reducing conditions were established, with post-injection conditions showing significantly elevated iron and manganese, depletion of sulfate, an increase in sulfide, significant increase in methane, and a significant increase then decline in TOC. All of these changes in geochemistry are consistent with those expected to occur after injection of an organic substrate to stimulate enhanced reductive dechlorination (ERD).

VOC and geochemical changes in well 510MW5R offer further evidence of ERD stimulation. TCE in well 510MW5R declined from an initial value of 50.9 µg/L to 27.3 µg/L. Concurrent with this decline, cis-1,2-DCE increased from 2.34 µg/L to 21.4 µg/L then declined to 3.96 µg/L. VC concurrently increased from less than 5 µg/L to 12.7 µg/L. This pattern of VOC transformation is consistent with that expected when TCE undergoes reductive dechlorination.

The geochemistry at 510MW5R also shows increasingly reducing conditions. TOC concentrations increased from 10.3 mg/L to as high as 111 mg/L before declining, iron and manganese concentrations increased, sulfate concentrations declined and sulfide concentrations increased, and methane concentrations increased.

The changes in both VOC and geochemical parameters in these three wells is clear evidence that ERD was effectively stimulated at the site. This information was included in Section 3.3.2 of Appendix A of the CMI Plan.

PREQB Evaluation of Response:

Please ensure that discussion concerning concentration changes (e.g., TCE vs DCE) are presented on a mol-mol ratio basis as opposed to a µg/L basis due to differences in molecular weight and these data are evaluated spatially and temporally over the plume. Please also present ratios of the terminal electron

acceptor species spatially and temporally using ratios calculated using data collected for each of the various species collected during the same sampling event. Additionally, while field measurements of ORP may experience some issues relative to precise quantification, reviewing the data in terms of qualitative analysis both spatially and temporally provides additional evidence to support that reductive dechlorination is occurring. Please address as part of the CMI report, as this information is needed to support the conclusion that contaminant concentration reductions observed are due to reductive dechlorination as opposed to advection or other mechanisms. This evaluation also applies to Comments 4 a and b of Appendix A, noting that changes to Appendix A are not necessary, but PREQB requests that this information be presented in interpreting the post-injection sampling results.

Response:

Comment acknowledged.

4. It appears as though the delineation of the TCE plume to date has been focused on the lateral extents. Please provide the data to support that the vertical extent of the plume has been adequately characterized.

Response:

One monitoring well, screened 35 to 45 feet bgs will be installed in the vicinity of 54MW08 and associated injection wells to evaluate the vertical delineation. The location of this well was selected because this appeared to be the most contaminated area. This information was added to Section 3.1 of the CMI Plan.

PREQB Evaluation of Response:

Please provide justification for the installation of only 1 well to a greater depth than the others to adequately characterize the vertical extent of the TCE plume.

Response:

The deep monitoring well location was selected to represent the potential for vertical migration of TCE in the most contaminated portion of the plume. Because the plume is so small and dilute, a single location is adequate to describe the vertical extent.

Appendix A, Pilot-Scale Test and Investigation Results

1. Section 2.2.1:

a. Paragraph 1: Please explain why low-flow procedures from EPA Region IV were used of the low-flow procedures from EPA Region II.

Response:
Region IV protocols were used to develop the sampling SOPs followed during the pilot testing. Generally, these SOPs comply with both EPA Region II and EPA Region IV protocols.

PREQB Evaluation of Response:
Please ensure that the sampling follow EPA Region 2 protocols.

Response:
The SOPs included in the CMI Plan follow EPA Region 2 protocols.

Corrective Measures Implementation Plan
SWMU 54 TCE Plume

Naval Activity Puerto Rico
Ceiba, Puerto Rico

Revision No. 00

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

Submitted to:

U.S. Naval Facilities
Engineering Command
Southeast

Prepared by:

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June 2012

Corrective Measures Implementation Plan

SWMU 54
TCE Plume

Naval Activity Puerto Rico
Ceiba, Puerto Rico

Revision No. 00

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Submitted to:

U.S. Naval Facilities Engineering Command Southeast

Prepared by:

CH2MHILL Constructors, Inc.

June 2012

Prepared/Approved By:

Tom Beisel, Project Manager — June 15, 2012 Date

Approved By:

Michael Halil, Deputy Program Manager — June 15, 2012 Date

Client Acceptance:

U.S. Navy Responsible Authority — June 15, 2012 Date

Certification Page
Corrective Measures Implementation Plan
SWMU 54 TCE Plume

(Revision 00)

I certify under penalty of law that I have examined and am familiar with the information submitted in this document and all attachments and that this document and its attachments were prepared either by me personally or under my direction or supervision in a manner designed to ensure that qualified and knowledgeable personnel properly gather and present the information contained therein. 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

Contents

Appendices - (Provided on CD)

Figures

Acronyms and Abbreviations

AGVIQ-CH2M HILL	AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III
Baker	Baker Environmental, Inc.
bgs	below ground surface
CAO	corrective action objective
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CSM	Conceptual Site Model
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
ERD	enhanced reductive dechlorination
EVO	emulsified vegetable oil
HSP	Health and Safety Plan
ISB	in situ biodegradation
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
NFA	No further action
O&M	operations and maintenance
PCB	polychlorinated biphenyl
PREQB	Puerto Rico Environmental Quality Board
PVC	polyvinyl chloride
RCRA	Resource Conservation Recovery Act
SAP	Sampling and Analysis Plan
SVOC	semi-volatile organic compound

SWMU	solid waste management unit
TCLP	Toxicity Characteristic Leaching Procedure
TCE	trichloroethene
VC	vinyl chloride
VOC	volatile organic compound
yd^3	cubic yard

1.0 Conceptual Design

1.1 Introduction

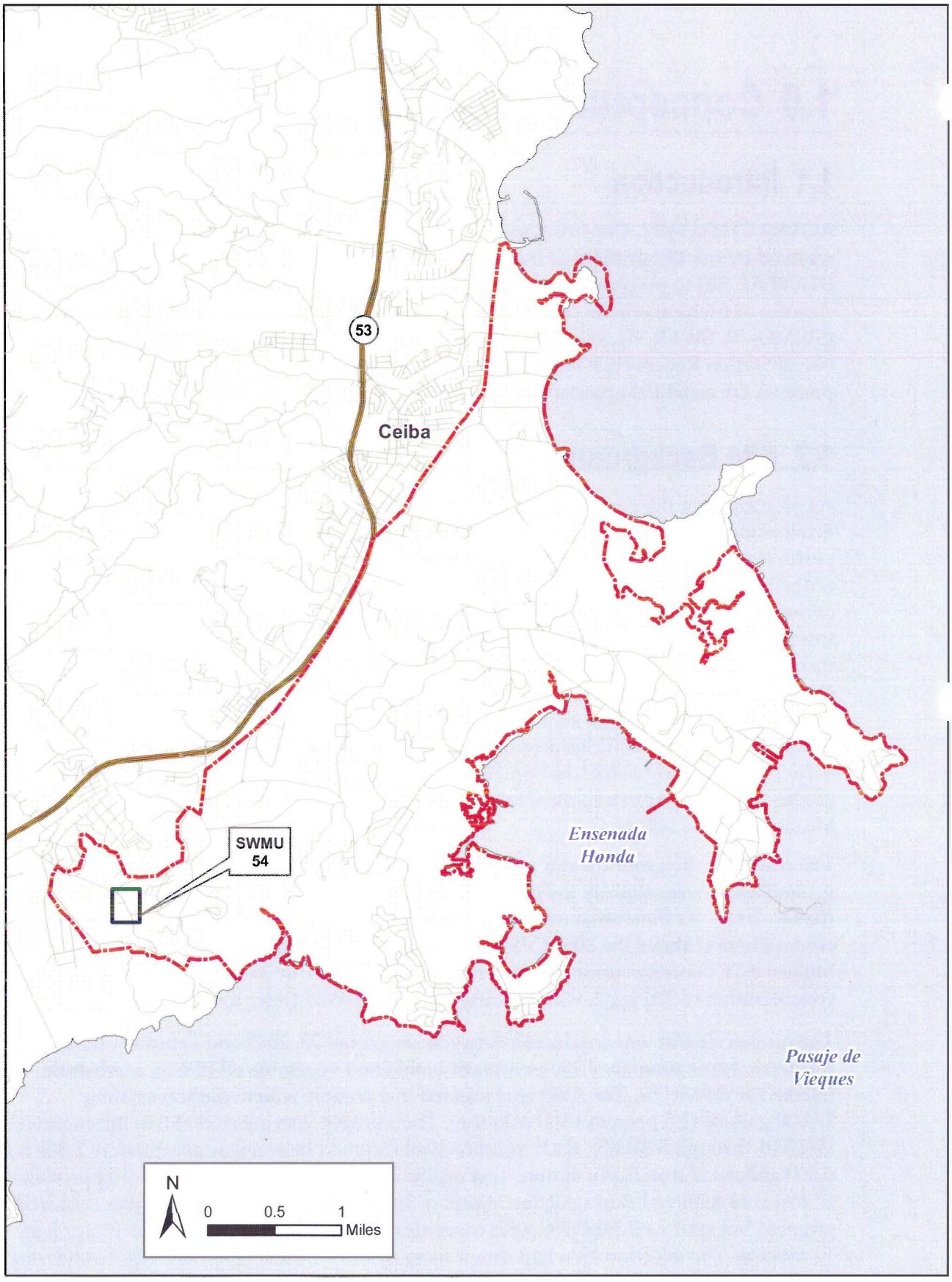
AGVIQ-CH2M HILL Constructors, Inc. Joint Venture III (AGVIQ-CH2M HILL) has been retained by the Department of the Navy, Naval Facilities Engineering Command Southeast (NAVFAC SE) to prepare a Corrective Measures Implementation (CMI) Plan to address the cleanup of trichloroethene (TCE) in groundwater 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). The CMI Plan presents the remedial approach that will be implemented at this site.

1.2 Site Background

As prescribed in the *Final Corrective Measures Study Final Report for SWMUs 54 and 55* (Baker Environmental, Inc. [Baker], 2005) (hereinafter referred to as the CMS), AGVIQ-CH2M HILL performed an in situ bioremediation (ISB) pilot-scale test to evaluate the use of enhanced reductive dechlorination (ERD) to reduce TCE concentrations in groundwater to the 2005 corrective action objective (CAO) of 22 micrograms per liter (µg/L). Testing involved the installation of 5 injection wells (54IW01 through 54IW05) and 13 monitoring wells (54MW07 through 54MW18 and 510MW5R) to complete the delineation of the TCE plume and monitor the effects of the ISB injection during pilot-scale testing. Additionally, prior to the ISB pilot-scale test injection, aquifer slug tests were completed to evaluate hydraulic conductivity. Details of the additional characterization and pilot-scale test work are presented in the *Pilot-Scale Test Report for SWMU 54 TCE Plume, Naval Activity Puerto Rico* (AGVIQ-CH2M HILL, 2012a) located in Appendix A of this CMI Plan. The major findings from the pilot-scale test are summarized below.

The results of the groundwater sampling data indicate the baseline TCE concentrations in groundwater were slightly lower than those measured during the CMS investigation in 2002 (Baker, 2005). As illustrated on Figure 1-2, prior to the pilot-scale testing, baseline TCE contamination above the 2005 CAO of 22 µg/L was less than one-third of an acre, with the highest TCE concentrations detected near well 54MW08. In 2010, a maximum TCE concentration of 256 µg/L was measured at well 54IW04 (refer to Appendix A).

The pilot-scale test was conducted between December 23, 2009 and February 12, 2010. During this time, approximately 3,200 pounds of emulsified vegetable oil (EVO), a substrate, were injected at SWMU 54. The EVO was injected in a potable water solution totaling 27,000 gallons (1.5 percent EVO solution). The solution was injected at five injection wells (54IW01 through 54IW05). Each injection well received between approximately 1,300 and 9,000 gallons of injection solution. Test results showed an injection radius of approximately 12 feet was achieved during active injection. Significant TCE degradation was achieved in the targeted hot spot well 54MW08 with concentrations decreasing from 139 to 10 µg/L in 14 months. The injection area had minor increases in 1,2-dichloroethene (DCE) and vinyl chloride (VC), which are TCE degradation byproducts.



Road

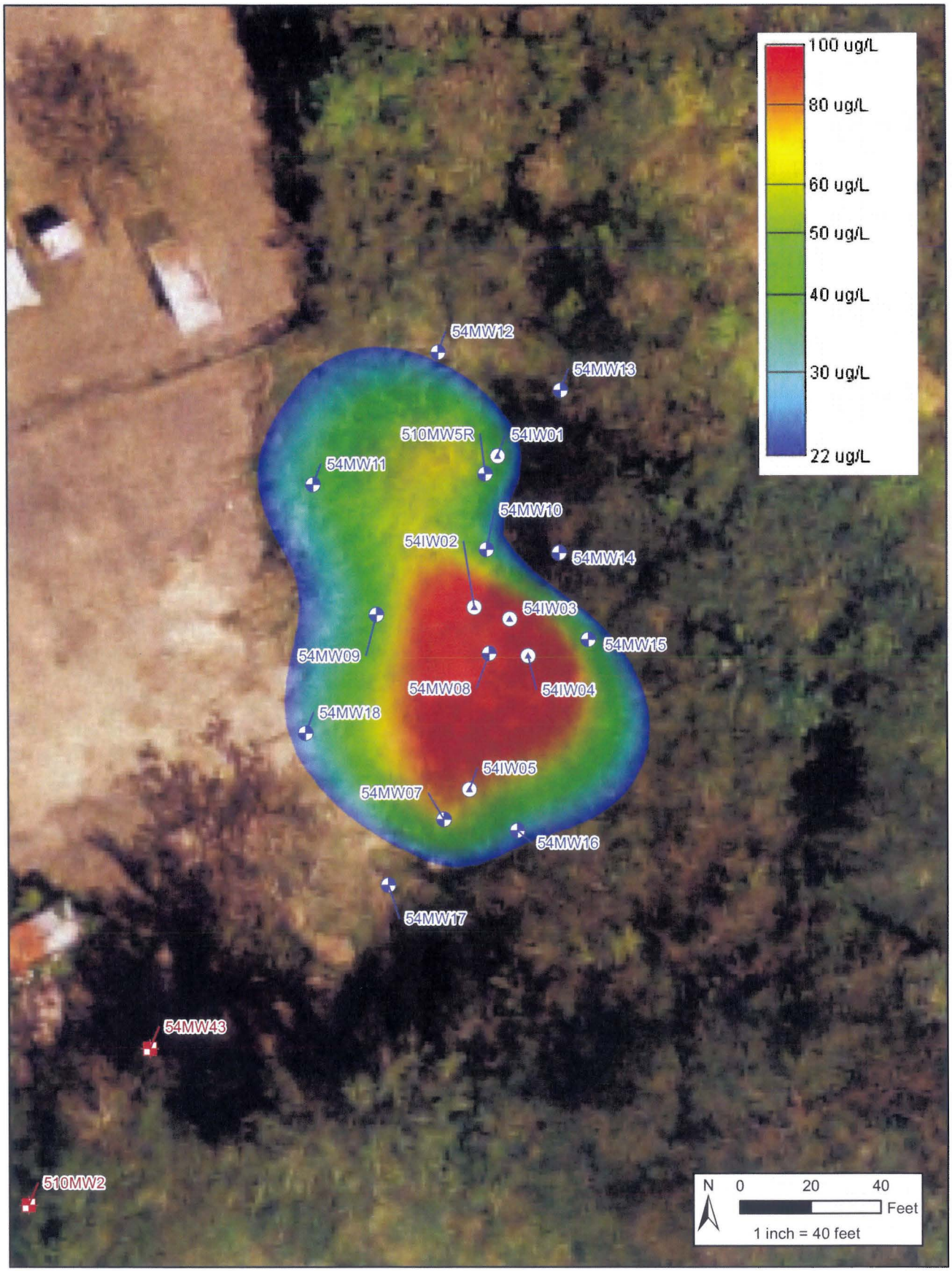
Expressway

Naval Station Roosevelt Roads Boundary

FIGURE 1
SWMU 54 Location
SWMU 54
Naval Activity Puerto Rico

CH2MHILL.

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVYPUERTORICO20000317\MAPFILES\SWMU54_TCE\FIG_1-1_SITELOCATION.MXD JCARR 6/1/2012 1:37:39 PM



Monitoring Well Screened Primarily Less than 15 ft bgs

Monitoring Well Screened Primarily 17-27 ft bgs

Injection Well Screened 17-27 ft bgs

Notes:
1. Plume map based on 2005 CAO for TCE = 22 µg/L. In May 2012, the CAO was revised to 193 µg/L.
2. The baseline results are comprised of data collected in August 2009 and December 2009.

FIGURE 1-2
TCE Concentrations in excess of 2005 CAO
SWMU 54
Naval Activity Puerto Rico

No substantial TCE rebound was observed during quarterly monitoring. This indicates that TCE degradation is proceeding to completion and full-scale ISB injection would be an effective remedy for addressing the remaining TCE concentrations in groundwater at the SWMU 54 TCE plume. Details on the pilot-scale test results are provided in Appendix A.

1.3 Corrective Action Objectives

The 2005 CAO development is summarized below and is fully described in the CMS (Baker, 2005). The U.S. Environmental Protection Agency (EPA) conditionally approved the CMS (Baker, 2005) on October 13, 2005, contingent upon completion of the pilot-scale tests and CMI Plan.

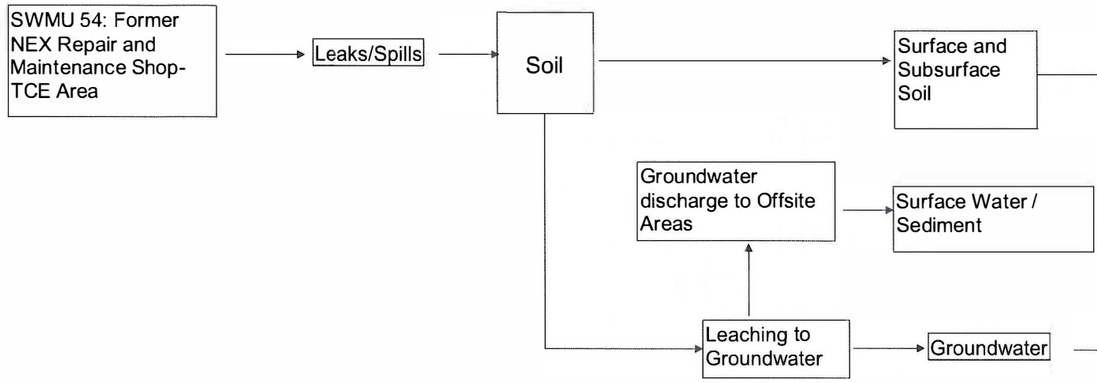
Appendix B of the CMS (Baker, 2005) included a derivation of groundwater CAOs for volatile organic compounds (VOCs). The 2005 groundwater CAOs were developed based on an industrial use of SWMU 54. The CAOs were estimated using the Johnson-Ettinger Model for the target groundwater levels protective of 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 TCE was used to delineate the TCE plume and design the corrective action during the pilot-scale testing in 2009 to 2010. During review of the draft CMS Addendum report, EPA recommended that the CAOs be revised to represent current methods and toxicity factors. Therefore, in May 2012, the 2005 CAOs were revised using EPA's regional screening levels (RSLs, November 2011 version) based calculation methods and toxicity factors, as recommended by EPA (2011). 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 B).

The groundwater beneath SWMU 54 was demonstrated to be unusable as a potable water supply because of the brackish/saline nature of the area groundwater, 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 C). 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 TCE to ambient air and indoor air could occur in the SWMU 54 TCE plume area. Therefore, this indirect exposure pathway was considered complete for deriving the CAOs for the site groundwater.

The revised CAO for TCE in groundwater is 193 µg/L. At the conclusion of the pilot-scale testing, TCE was not measured above the CAO of 193 µg/L.



	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	NA	NA	NA	NA	NA
Dermal Contact	NA	NA	NA	NA	NA	NA
Inhalation (dust and volatilization)	NA	NA	NA	NA	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
X - Completed pathway
* - 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.

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

1.4 Contaminant Migration Potential

The SWMU 54 TCE plume is located at an old maintenance shop and fuel pumping area. The TCE is likely to have originated from use as a degreaser during vehicle maintenance. Therefore, potential release volumes for TCE are expected to be small, and located near the former maintenance area and adjacent surface runoff areas, corresponding to the relatively dilute (maximum TCE concentration of 256 µg/L) groundwater plume identified at this site.

According to data collected during pilot-scale testing, a clay layer covers the site, generally right at or above the water table. Vertical migration of the TCE likely occurred through cracks or potential gaps in the clay layer. The maximum TCE concentration measured in groundwater during both the 2000/2002 investigation (Baker, 2005) and the 2009 investigation work was about 250 µg/L, indicating no continued source of TCE exists above the clay layer.

There are no surface water bodies within or in the immediate downgradient areas of SWMU 54. The downgradient extent of the TCE plume has been defined by wells 54MW17 and 54 MW18. TCE was measured in these wells at 8 µg/L and 26 µg/L, respectively. The rate of groundwater flow has been determined to be very slow at 0.003 feet per day, or about 1 foot per year. Thus, groundwater contaminated with TCE is not migrating outside the SWMU 54 area and no surface water discharge is expected from the TCE plume at SWMU 54.

Due to natural processes, including biological degradation and dispersion, and the pilot-scale testing, the TCE levels in groundwater have declined over time at SWMU 54.

1.5 Description of the Corrective Measures

At the conclusion of pilot-scale testing, TCE was not measured above the CAO of 193 µg/L. Therefore, no corrective action is required at this time. The need for corrective action will be reevaluated if TCE is measured above the revised CAO during the following site actions.

1.5.1 Additional Characterization

To complete the vertical delineation of the plume, one deep well will be installed as described in Section 3.1. The location of the deep well was selected to correspond with the highest measured TCE concentrations and the greatest potential for downward migration of TCE. This well will be sampled during the monitoring outlined in Section 3.2.

1.5.2 Closure Monitoring

Based on the revised CAO for TCE of 193 µg/L and the analytical results from the last groundwater monitoring event, groundwater at the SWMU 54 TCE plume currently meets closure criteria. Therefore, closure monitoring of the TCE plume, including the new deep well, will be initiated.

1.5.3 Land Use Controls

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 Resource Conservation Recovery Act (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.

The LUCs will be included in any lease or transfer deed. If development other than industrial use (i.e., residential or per the April 2010 amended Reuse Plan) is proposed, the new owner will be required to work with the Puerto Rico Environmental Quality Board (PREQB) and EPA to establish any additional investigation, risk assessment, and/or cleanup activities. If the property owner wishes to remove the LUC on the groundwater from the deed in the future, it will be the responsibility of the property owner to demonstrate the groundwater meets all state and federal maximum contaminant levels (MCLs), and must obtain approval from the Navy, EPA, and PREQB prior to LUC removal.

1.6 Design Criteria

The performance criteria for the closure monitoring at the SWMU 54 TCE plume are summarized below:

- **TCE Concentration in Shallow Groundwater.** The concentration of TCE in shallow groundwater must remain below the CAO of 193 µg/L. Because the ISB pilot test was conducted at the SWMU 54 TCE area, DCE and VC will also be monitored, although they are not COCs. The concentration of DCE and VC must remain below their revised CAOs of 20,901 µg/L and 39.7 µg/L, respectively.
- **TCE Concentration in Deep Groundwater.** The TCE plume is assumed to be at least 20 years old and seems to have diminished in concentration when comparing the 2002 (Baker, 2005) and 2009 groundwater analytical data (Appendix A). It is assumed TCE will not exceed the revised CAO in the new deep well. If TCE in excess of 193 µg/L is

measured in the deep well, additional characterization of the deep zone will be completed.

1.7 Waste Management

1.7.1 Solid Waste

Soil cuttings generated from well installation will be containerized in 20-cubic yard (yd^3) roll-off boxes at a Base-approved temporary storage location pending waste characterization and offsite disposal. Based on soil waste characterization data collected during the pilot-scale testing, soil cuttings are expected to be non-hazardous.

One soil sample will be collected for waste characterization and analyzed for toxicity characteristic leaching procedure (TCLP) VOCs (SW1311/8260C), TCLP semivolatile organic compounds (SVOCs) (SW1311/8270D), TCLP metals (SW1311/6010C/7470A), TCLP pesticides (SW1311/8081B), TCLP herbicides (SW1311/8151A), polychlorinated biphenyls (PCBs) (SW8082), corrosivity (SW9045), and ignitability (SW1010).

1.7.2 Liquid Waste

Liquids from decontamination, well development, and purge water will be placed in 600-gallon poly tanks within secondary containment at Base-approved temporary storage locations pending waste characterization and offsite disposal. Based on liquid waste characterization data collected during the pilot-scale testing, liquid waste is expected to be non-hazardous.

One liquid sample will be collected per a year and analyzed for

RCRA VOCs (SW8260C), RCRA SVOCs (SW8270D), RCRA metals (SW6010C/7470A), RCRA pesticides (SW8081B), PCBs (SW8082A), herbicides (SW8151A), corrosivity (SW9045), and ignitability (SW 1010).

1.8 Required Permitting

According to the NAPR, no dig permit will be required for this project.

2.0 Operations and Maintenance Plan

Because there is no operating equipment onsite after the groundwater sampling is completed, an operations and maintenance (O&M) plan is not applicable for this site. Closure monitoring of the TCE plume and reporting will be conducted as outlined in Section 4.0 of this CMI Plan.

3.0 Final Plans and Specifications

The recommended corrective action at the SWMU 54 TCE plume is closure monitoring. All field activities will be conducted in accordance with the Health and Safety Plan (HSP) (AGVIQ-CH2M HILL, 2012) and all groundwater monitoring activities will be conducted in accordance with the Sampling and Analysis Plan (SAP) (AGVIQ-CH2M HILL, 2012b).

3.1 Monitoring Well Installation

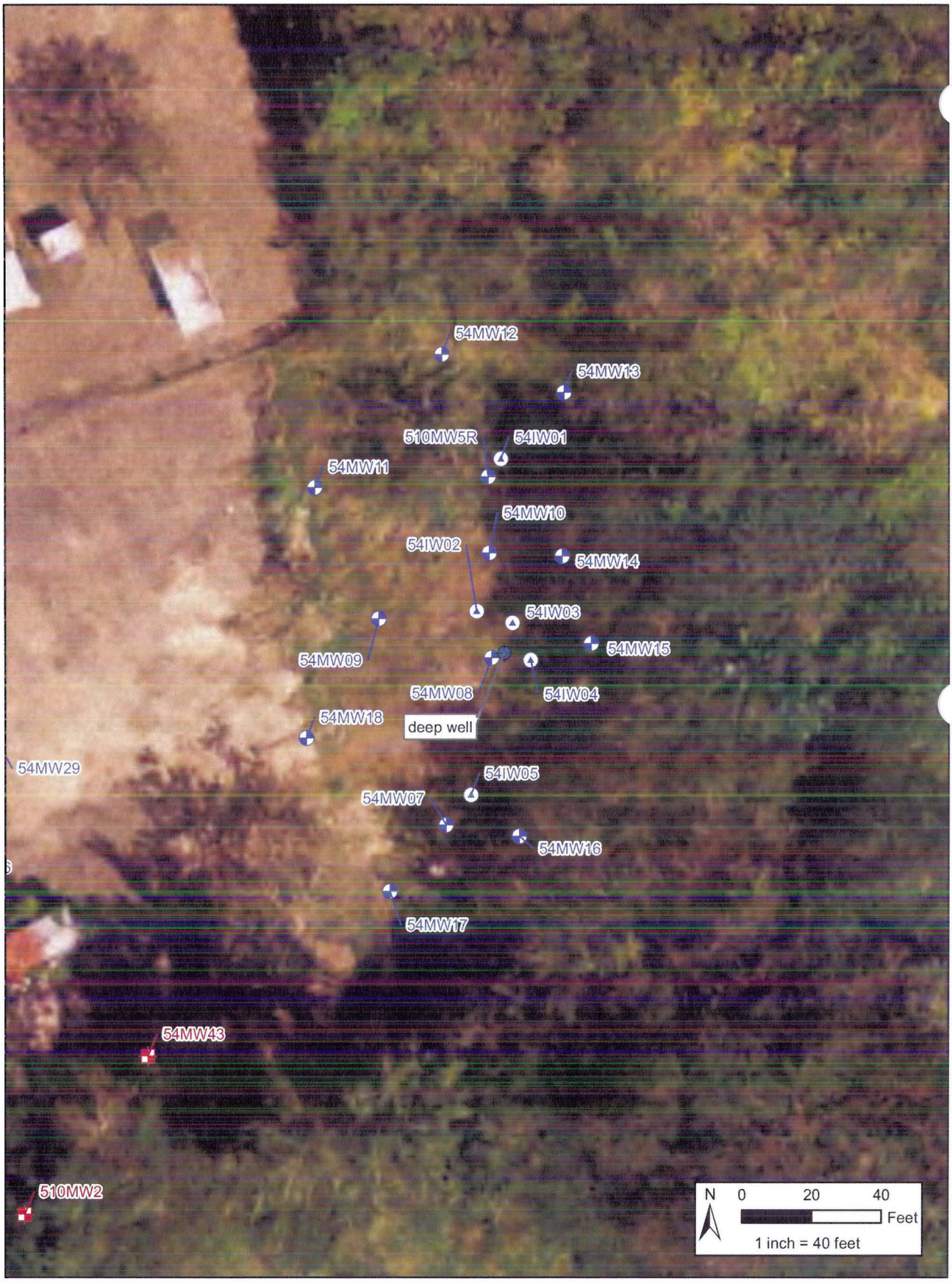
One monitoring well will be installed at the SWMU 54 TCE plume to complete the vertical delineation (installed to 45 feet below ground surface [bgs]). The proposed new monitoring well location, as shown on Figure 3-1, is based on the November 2010 groundwater sampling event and results of the pilot-scale testing (refer to Appendix A). The deep well location was selected to characterize the vertical zone where the greatest TCE concentration, and most potential for vertical migration of contamination, was identified. Prior to installation of the monitoring well, the approximate location of the well will be staked or flagged, and a utility locate will be conducted in the area. The final well location may be refined based on the results of the utility locate.

The well will be installed using hollow-stem auger drilling techniques. As the boring is advanced, soil samples will be collected every 5 feet for lithologic description and headspace screening using a photoionization detector (PID). A portion of the soil sample will immediately be placed in a plastic bag, sealed, and allowed to equilibrate for 10 minutes. The bag will then be pierced with the PID probe and a headspace reading will be recorded. The standard operation procedure is provided in Appendix D.

The monitoring well will be constructed using 2-inch inner diameter polyvinyl chloride (PVC) casing and 0.020-inch slot screen placed between 35 and 45 feet bgs. The well will have threaded 2-inch PVC riser to reach ground surface and be finished with a 2-inch PVC female thread. Sand filter pack will be installed to 2 feet above the screen, bentonite seal material will be installed to 3-feet above the sand filter pack, and the annular space will be grouted to the ground surface with Portland cement grout. The well will be completed with a 3-foot by 3-foot cement pad and a locking cover.

The well will be developed after the grout has been allowed to cure for 24 hours. Soil cuttings and development water will be contained pending characterization and proper disposal, as outlined in Section 1.7.

The coordinate locations and elevation of the newly installed monitoring well will be determined by a land surveyor registered in Puerto Rico. The well will be surveyed relative to a previously established benchmark. The horizontal location will be surveyed to an accuracy of 0.1 foot, and the ground surface and top of casing elevations will be surveyed to an accuracy of 0.01 foot.



Proposed Deep Well

Monitoring Well Screened Primarily Less than 15 ft bgs

Monitoring Well Screened Primarily 15-25 ft bgs

Injection Well Screened 17-27 ft bgs

Note: CAO for TCE = 193 µg/L

FIGURE 3-1
Deep Well Installation Location
SWMU 54
Naval Activity Puerto Rico

3.2 Exit Strategy

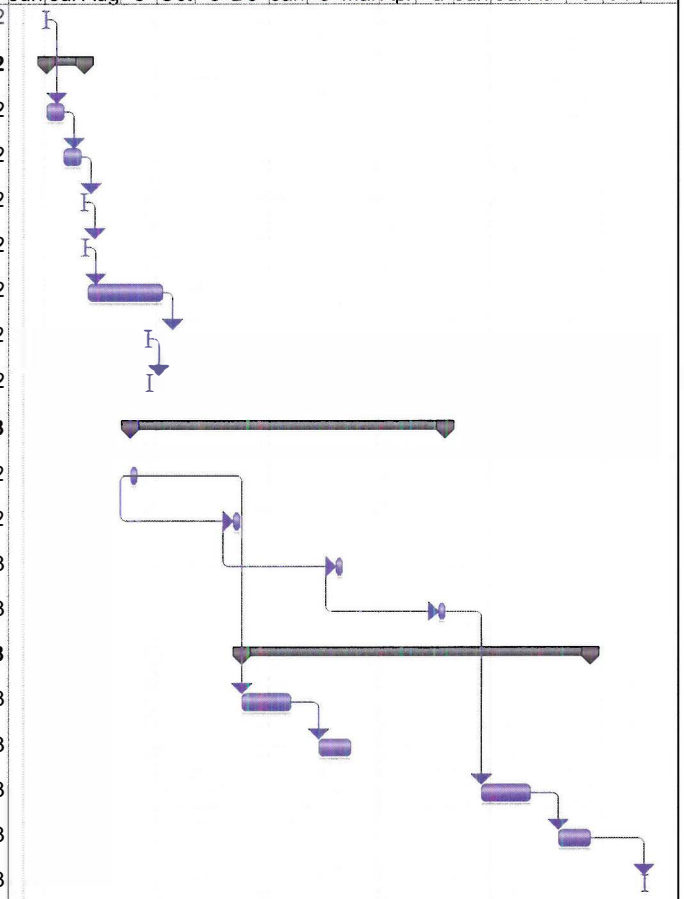
One year of closure quarterly groundwater monitoring data will be collected to determine if additional monitoring or corrective measures are required. If TCE, DCE, and VC concentrations do not exceed the revised CAOs, NAVFAC SE will request no further action (NFA) for the SWMU 54 TCE site.

3.3 Implementation Schedule

An implementation schedule is presented on Figure 3-2. This schedule outlines the project activities for the expected duration of the technical approach, estimated as 1.5 years.

TCE Plume ISB 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	**Closure Monitoring**	**185 days**	**Mon 9/10/12**	**Fri 5/24/13**
11	Closure Monitoring (1st quarter)	5 days	Mon 9/10/12	Fri 9/14/12
12	Closure Monitoring (2nd quarter)	5 days	Mon 12/3/12	Fri 12/7/12
13	Closure Monitoring (3rd quarter)	5 days	Mon 2/25/13	Fri 3/1/13
14	Closure Monitoring (4th quarter)	5 days	Mon 5/20/13	Fri 5/24/13
15	**Reporting**	**205 days**	**Mon 12/10/12**	**Fri 9/20/13**
16	Draft Annual Report	30 days	Mon 12/10/12	Fri 1/18/13
17	Final Annual Report	20 days	Mon 2/11/13	Fri 3/8/13
18	Draft Annual Report (Request NFA)	30 days	Mon 6/24/13	Fri 8/2/13
19	Final Annual Report (Request NFA)	20 days	Mon 8/26/13	Fri 9/20/13
20	**Attain NFA (request in last Annual Report)**	1 day	Mon 11/4/13	Mon 11/4/13



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

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

Figure 3-2
Project Schedule
SWMU 54 Naval Activity Puerto Rico

4.0 Monitoring and Reporting Requirements

4.1 Closure Monitoring

Groundwater samples will be collected from 14 monitoring wells (510MW5R, 54MW07 through 54MW18, and the new well) for laboratory analysis of VOCs (TCE, DCE, and VC). Field parameters, including DO, turbidity, conductivity, pH, salinity, temperature, and ORP, will be recorded during well purging. The sample locations are shown on Figure 3-1. All sampling and analyses will be conducted in accordance with the SAP (AGVIQ-CH2M HILL, 2011b). Purge water will be contained pending proper disposal, in accordance with Section 1.7.

4.2 Reporting

A summary of the SWMU 54 activities described in this CMI Plan, and the progress of each activity, will be presented in annual reports. The outline of the annual reports is as follows:

Executive Summary

1.0 Introduction

- Purpose and Scope
- Background Information

2.0 Summary of Field Activities

- Well Gauging and Sampling Procedures

3.0 Discussion of Results

- Groundwater Flow
- Groundwater Test Results
- Lessons Learned

4.0 Conclusions and Recommendations

5.0 References

5.0 References

AGVIQ-CH2M HILL. 2011a. *Pilot-Scale Test Report for SWMU 54 TCE Plume, Naval Activity Puerto Rico.* December.

AGVIQ-CH2M HILL. 2011b. *Sampling and Analysis Plan, Corrective Action at Solid Waste Management Unit 54 – TCE Plume, Naval Activity Puerto Rico.* Prepared for Naval Facilities Engineering Command Southeast. December.

AGVIQ-CH2M HILL. 2012. *Health and Safety Plan, Corrective Action SWMU 54 TCE Plume 54 at Naval Activity Puerto Rico.* Prepared for Naval Facilities Engineering Command Southeast. February; currently being revised.

Baker Environmental, Inc. 2005. *Final Corrective Measures Study Final Report for SWMUs 54 and 55.*

U.S. Environmental Protection Agency (EPA). 2011. *USEPA Regional Screening Levels Table and Users Guide. November.* http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm.