N3172B_003312
NASD VIEQUES, PR
SSIC 5000-33b

FINAL REMEDIAL ACTION ANNUAL STATUS REPORT 2020 FOR AREA OF CONCERN E (AOC E) ATLANTIC FLEET WEAPONS TRAINING AREA FORMER NAVAL AMMUNITION SUPPORT DETACHMENT VIEQUES PUERTO RICO

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Final

Area of Concern E
Remedial Acton Annual Status Report
2020

Atlantic Fleet Weapons Training Area – Vieques
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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Vieques, Puerto Rico

November 2020

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Contract N62470-16-D-9000
CTO 0003

Executive Summary

This Remedial Action Annual Status Report presents the 2020 annual groundwater monitoring and land use control (LUC) inspection activities associated with the remedial action at Area of Concern (AOC) E, located within the former Naval Ammunition Support Detachment (NASD) in Vieques, Puerto Rico (Figures ES-1 and ES-2). AOC E is the site of a former 500-gallon underground storage tank (UST) that stored used oil from vehicle maintenance activities. The site is less than a tenth of an acre located within the main operation area of the former NASD, which is now part of the Municipality of Vieques (MOV) Public Works facility. This Report also includes historical analytical data to aid in the monitoring data evaluation. Details of the previous rounds of injections and 2015 (year 1), 2016 (year 2), and 2017 (year 3) monitoring events performed in accordance with the Remedial Action Workplan (RAWP) (CH2M, 2015) can be found in the Area of Concern E Remedial Action Annual Status Report 2016 (CH2M, 2107) and Area of Concern E Remedial Action Annual Status Report 2017 (CH2M, 2018a).

In accordance with the AOC E Record of Decision (ROD) (NAVFAC, 2015), the selected remedy for AOC E includes groundwater monitoring and LUCs with contingency plans to address potential residual persulfate from in situ chemical oxidation (ISCO) application and the potential rebound of contaminants of concern (COCs) above remedial goals (RGs).

The Remedial Action Objective (RAO) is to prevent exposure to COCs in groundwater at concentrations above RGs. When groundwater monitoring data from three consecutive monitoring events show COC concentrations less than or equal to RGs, the RAO will have been met. LUCs are also implemented to prevent unauthorized and uncontrolled groundwater use within the LUC boundary until the RAO is met.

Benzene, 1,2-dichloroethane (1,2-DCA) and methyl tert-butyl ether (MTBE) were detected above their respective RGs during each of the three consecutive post-ROD sampling events (2015-2017). Therefore, in compliance with the ROD (NAVFAC, 2015), an additional ISCO injection using activated persulfate was conducted for wells in which rebound was observed (ROD Contingency Plan 2, CP-2). Because implementing the ROD contingency plan was necessary, an RAWP Addendum (CH2M, 2018c) was prepared for CP-2 providing details of the oxidant solution to be injected, along with locations, scheduling, and any modifications to subsequent monitoring protocols.

From October 29, 2018 to November 16, 2018, 2,800 gallons of sodium persulfate solution (4.7%) activated by 276 gallons of hydrogen peroxide (2%) were injected into the subsurface at monitoring wells MW-01 and MW-05, the two wells in which the COC RG exceedances were observed during post-ROD sampling, in accordance with the approach defined in the AOC E RAWP Addendum (CH2M, 2018c). Details of CP-2 implementation can be found in the AOC E Interim Remedial Action Completion Report (IRACR) (CH2M, 2019).

As described in the AOC E RAWP (CH2M, 2015) and in the RAWP Addendum (CH2M, 2018c), the current remedial action (CP-2) involves periodically (at a minimum, annually) monitoring groundwater to document the decrease of residual persulfate concentrations to an acceptable level, followed by annual groundwater monitoring of COCs (benzene, 1,2-DCA, and MTBE) for a period of 3 consecutive years to observe if they rebound above RGs.

In February 2019, a screening event was conducted to determine if residual persulfate levels in groundwater had decreased to non-detect or to levels allowing for COC sampling. While persulfate concentrations were still elevated above levels acceptable for COC sampling, groundwater grab samples were collected for informational purposes only; they are not considered part of the post-ISCO injection annual COC performance sampling. In January 2020, another persulfate screening event was performed; because residual persulfate concentrations were non-detect in the three performance monitoring wells (MW-01, MW-04, MW-05), they were sampled for benzene, 1,2-DCA, and MTBE. Results can be found in Figure ES-3. Additionally, in March 2020, an LUC inspection was performed, the information from which is included in this annual report.

NOTE: THIS SUMMARY IS PRESENTED IN ENGLISH AND SPANISH FOR THE CONVENIENCE OF THE READER. EVERY EFFORT HAS BEEN MADE FOR THE TRANSLATIONS TO BE AS ACCURATE AS REASONABLY POSSIBLE. HOWEVER, READERS SHOULD BE AWARE THAT THE ENGLISH VERSION OF THE TEXT IS THE OFFICIAL VERSION.

The conclusions drawn based on the data collected during the first post-CP-2 performance monitoring and LUC inspection events are:

- Application of ISCO in 2018 resulted in a decline in COC concentrations in locations where they were elevated above RGs prior to ISCO application.
- The concentrations of two of the three COCs (i.e., benzene and 1,2-DCA) were already below or were reduced to concentrations below their respective RGs in all three wells.
- While the concentration of MTBE in well MW-05 is well below its historic high, the concentration remains above the RG.
- LUCs are in place and functioning as intended.

The recommendations are:

- In accordance with ROD CP-2, monitoring wells MW-01, MW-04, and MW-05 should continue to be monitored annually for benzene, 1,2-DCA, and MTBE for at least 2 more successive years.
- LUCs should continue to be maintained while COC(s) concentrations remain above RG(s).
- Drinking water standards upon which the RGs were established for 1,2-DCA and MTBE have been revised by the associated regulatory agencies. Therefore, a ROD memorandum to file is recommended to document the rationale for revising the RGs accordingly, as described further:
  - The RG for 1,2-DCA (3.8 micrograms per liter [µg/L]) was established using the Puerto Rico Water Quality Standards (PRWQS) drinking water standard available at the time the AOC E ROD was issued. However, since that time, Puerto Rico Department of Natural and Environmental Resources (PRDNER) has revised the PRWQS; as such revising the RG to be consistent with the current PRWQS (i.e., 5 µg/L, which is also the Maximum Contaminant Level [MCL]) is warranted.
  - The RG for MTBE (120 µg/L based on excess lifetime cancer risk [ELCR] of $1X10^{-5}$) was established using the Environmental Protection Agency (EPA) Tap Water Regional Screening Level (RSL) available at the time the AOC E ROD was issued. However, since that time, EPA has revised the RSL; as such revising the RG to be consistent with the current RSL (i.e., 140 µg/L based on ELCR of $1X10^{-5}$) is warranted.
- Based on the observed COC concentrations and physical site conditions, an alternate path forward should be considered to best address low concentrations of COC(s) above RG(s) should they be observed during the next 2 successive monitoring events.

Resumen Ejecutivo

Este Informe Anual de Estado de Acción Remedial presenta las actividades anuales de monitoreo de aguas subterráneas y control de uso de la tierra (LUC, por sus siglas en inglés) de 2020 asociadas con la acción correctiva en el Área de Preocupación (AOC, por sus siglas en inglés) E, ubicadas dentro del antiguo Destacamento de Apoyo a Municiones Navales (NASD, por sus siglas en inglés) en Vieques, Puerto Rico (Figuras ES-1 y ES-2). AOC E es el sitio de un antiguo tanque de almacenamiento subterráneo (UST, por sus siglas en inglés) de 500 galones que almacenaba aceite usado de las actividades de mantenimiento del vehículo. El sitio es menos de una décima parte de un acre ubicado dentro del área de operación principal de la antigua NASD, que ahora es parte de las instalaciones de Obras Públicas del Municipio de Vieques (MOV, por sus siglas en inglés). El presente informe también incluye datos analíticos históricos para ayudar en la evaluación de los datos de seguimiento. Detalles de las rondas anteriores de inyecciones y eventos de monitoreo en el 2015 (año 1), 2016 (año 2) y 2017 (año 3) realizados de acuerdo con el Plan de Trabajo de Acción de Remediación (RAWP, por sus siglas en inglés) (CH2M, 2015) y se puede encontrar en el Informe Anual de Actualización 2016 (CH2M, 2107) y el Informe Anual de Actualización de 2017 de la Acción de Remediación del Área de Preocupación E (CH2M, 2018a).

De acuerdo con el Registro de Decisión AOC E (ROD, por sus siglas en inglés) (NAVFAC, 2015), el remedio seleccionado para AOC E incluye el monitoreo de aguas subterráneas y LUCs con planes de contingencia para abordar la aplicación de oxidación química in situ residual (ISCO, por sus siglas en inglés) potencial y el posible rebote de contaminantes de interés (COCs, por sus siglas en inglés) por encima de los objetivos correctivos (RGs, por sus siglas en inglés).

El Objetivo de Acción Correctiva (RAO, por sus siglas en inglés) es evitar la exposición a los COCs en las aguas subterráneas a concentraciones superiores a los RG. Cuando los datos de monitoreo de aguas subterráneas de tres eventos de monitoreo consecutivos muestran concentraciones de COCs menores o iguales que las RG, el RAO se habrá cumplido. Los LUCs también se implementan para evitar el uso no autorizado y no controlado de las aguas subterráneas dentro del límite de los LUC hasta que se cumpla el RAO.

El benceno, 1,2-dicloroetano (1,2-DCA) y éter metil terbutílico (MTBE, por sus siglas en inglés) se detectaron por encima de sus respectivos RG durante cada uno de los tres eventos consecutivos de muestreo post-ROD (2015-2017). Por lo tanto, de conformidad con el ROD (NAVFAC, 2015), se llevó a cabo una inyección adicional de ISCO con persulfato activado para pozos en los que se observó rebote (Plan de Contingencia 2, CP-2 de ROD). Debido a que era necesario implementar el plan de contingencia ROD, se preparó un Apéndice del RAWP (CH2M, 2018c) para CP-2 que proporciona detalles de la solución oxidante que se administraría, junto con ubicaciones, programación y cualquier modificación de los protocolos de supervisión posteriores.

Del 29 de octubre de 2018 al 16 de noviembre de 2018, 2,800 galones de solución de persulfato sódico (4.7%) activado por 276 galones de peróxido de hidrógeno (2%) se inyectaron en el subsuelo de los pozos de monitoreo MW-01 y MW05, los dos pozos en los que se observaron excedentes de los COCs RG durante el muestreo post-ROD, de acuerdo con el enfoque definido en el Apéndice del AOC E RAWP (CH2M, 2018c). Los detalles de la implementación de CP-2 se pueden encontrar en el Informe de Finalización de la Acción de Remediación Provisional (IRACR, por sus siglas en inglés) de AOC E (CH2M, 2019).

Como se describe en el AOC E RAWP (CH2M, 2015) y en el Apéndice del RAWP (CH2M, 2018c), la acción correctiva actual (CP-2) implica el monitoreo periódico (como mínimo, anualmente) de las aguas subterráneas para documentar la disminución de las concentraciones residuales de persulfato a un nivel aceptable, seguido de la monitorización anual de las aguas subterráneas de los COCs (benceno, 1,2-DCA y MTBE) durante un período de 3 años consecutivos para observar si repuntan por encima de los RGs.

NOTA: ESTE RESUMEN SE PRESENTA EN INGLÉS Y EN ESPAÑOL PARA LA CONVENIENCIA DEL LECTOR. SE HAN HECHO TODOS LOS ESFUERZOS PARA QUE LA TRADUCCIÓN SEA PRECISA EN LO MÁS RAZONABLEMENTE POSIBLE. SIN EMBARGO, LOS LECTORES DEBEN ESTAR AL TANTO QUE EL TEXTO EN INGLÉS ES LA VERSIÓN OFICIAL.

En febrero de 2019, se llevó a cabo un evento de detección para determinar si los niveles residuales de persulfato en las aguas subterráneas habían disminuido a no detectar o a niveles que permitían el muestreo de los COC. Si bien las concentraciones de persulfato seguían estando elevadas por encima de los niveles aceptables para el muestreo de los COC, las muestras de captación de agua subterránea se recogían únicamente con fines informativos; no se consideran parte del muestreo anual de rendimiento de los COC después de la inyección de ISCO. En enero de 2020, se realizó otro evento de detección de persulfato; debido a que las concentraciones residuales de persulfato no se detectaban en los tres pozos de monitoreo de rendimiento (MW-01, MW-04, MW-05), se tomaron muestras de benceno, 1,2-DCA y MTBE. Los resultados se pueden encontrar en la Figura ES-3. Además, en marzo de 2020 se realizó una inspección de los LUCs, la información la cual se incluye en este informe anual.

Las conclusiones extraídas sobre la base de los datos recopilados durante la primera supervisión del rendimiento posterior a CP-2 y los eventos de inspección del LUC son:

- La aplicación de ISCO en 2018 dio lugar a una disminución de las concentraciones de COC en lugares donde fueron elevadas por encima de los RGs antes de la aplicación de ISCO.
- Las concentraciones de dos de los tres COCs (es decir, benceno y 1,2-DCA) ya estaban por debajo o se redujeron a concentraciones por debajo de sus respectivos RGs en los tres pozos.
- Mientras que la concentración de MTBE en el pozo MW-05 está muy por debajo de su máximo histórico, la concentración permanece por encima del RG.
- Los LUCs están en su lugar y funcionan según lo previsto.

Las recomendaciones son:

- De acuerdo con el ROD CP-2, los pozos de monitoreo MW-01, MW-04 y MW-05 deben seguir monitorizándose anualmente para el benceno, 1,2DCA y MTBE durante al menos 2 años consecutivos más.
- Los LUCs deben mantenerse mientras que las concentraciones de COC(s) permanezcan por encima de los RG.
- Las normas sobre el agua potable sobre las que se establecieron los RG para 1,2-DCA y MTBE han sido revisadas por los organismos reguladores asociados. Por lo tanto, se recomienda presentar un memorándum del ROD para documentar la justificación para revisar los RGs en consecuencia, como se describe más adelante:
  - El RG para 1,2-DCA (3,8 microgramos por litro [µg/L]) se estableció utilizando el estándar de agua potable de los Estándares de Calidad del Agua de Puerto Rico (PRWQS, por sus siglas en inglés) disponible en el momento en que se emitió el AOC E ROD. Sin embargo, desde entonces, el Departamento de Recursos Naturales y Ambientales de Puerto Rico (PRDNER, por sus siglas en inglés) ha revisado el PRWQS; como tal, la revisión del RG para que sea consistente con el PRWQS actual (es decir, 5 µg/L, que también es el Nivel Máximo de Contaminantes [MCL, por sus siglas en inglés]) sea justificada.

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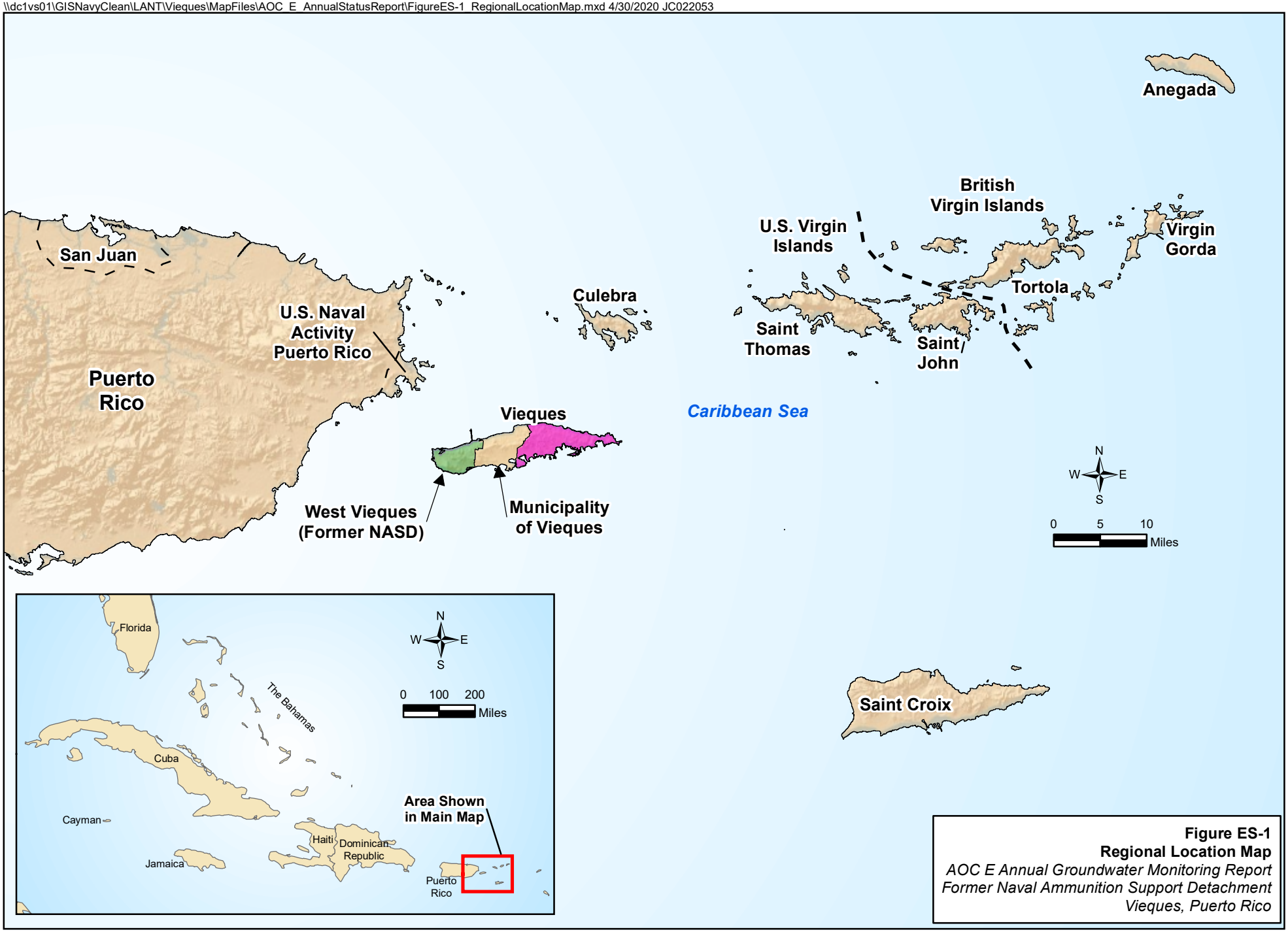

Figure ES-1
Regional Location Map
AOC E Annual Groundwater Monitoring Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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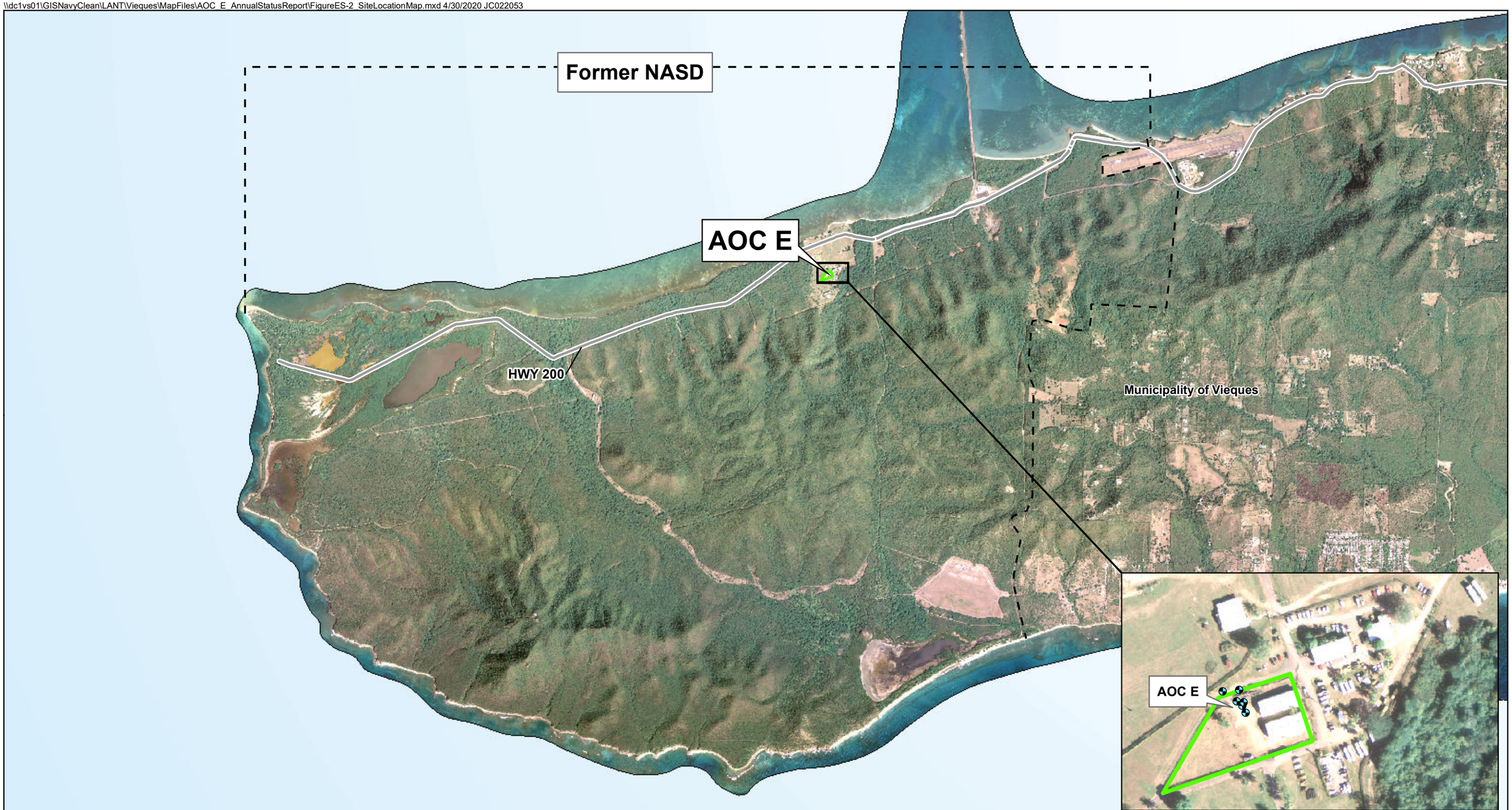


Legend

- Remedial Action-Operations Monitoring Wells
- Road
- AOC E Land Use Control Boundary

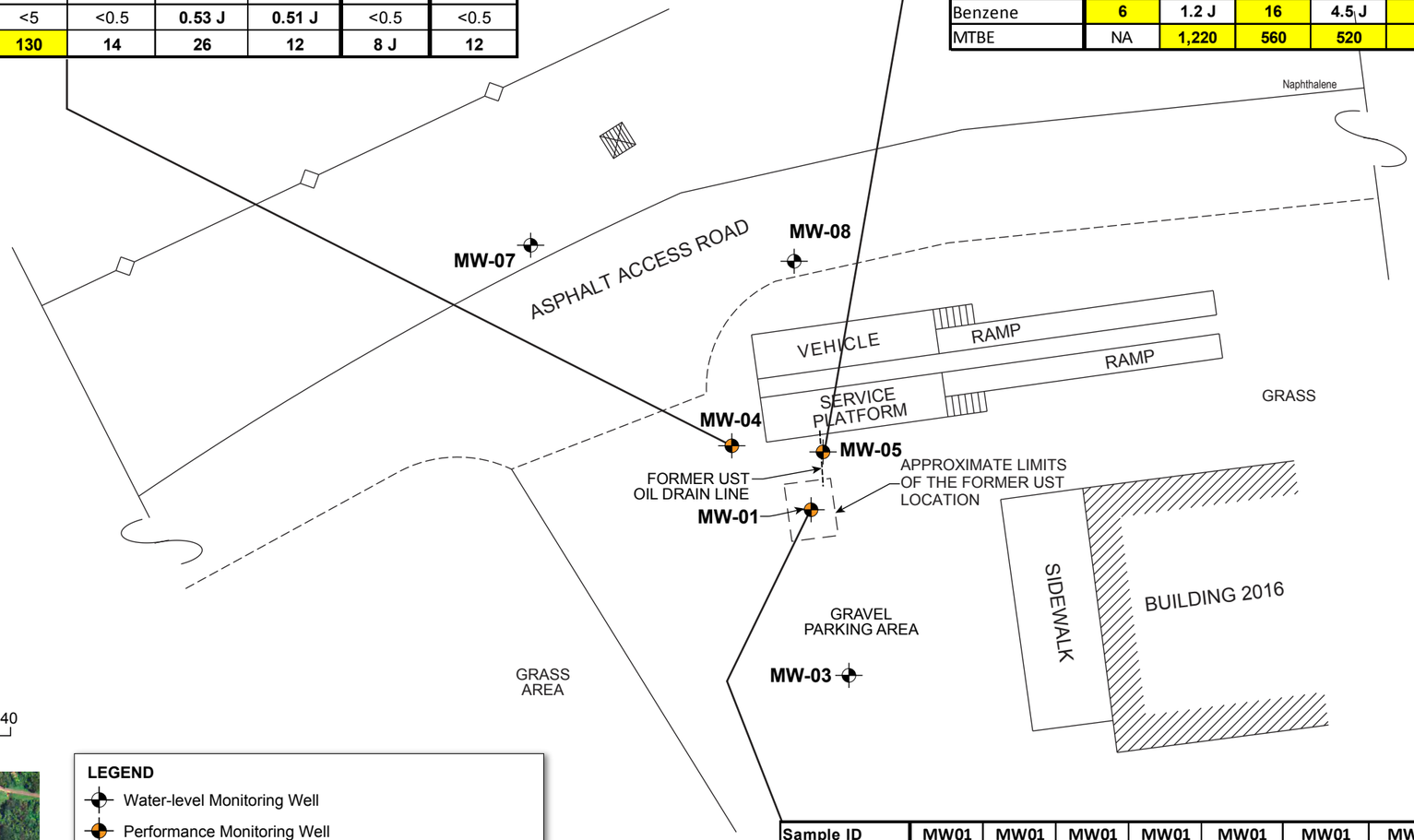
N
W E
S

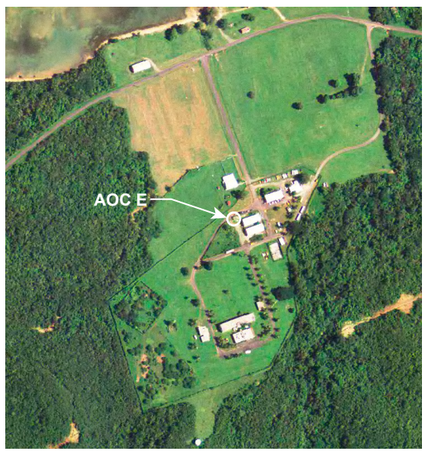
0 3,000 6,000
Feet

Figure ES-2
AOC E Site Location Map
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Sample ID	MW04	MW04	MW04	MW04	MW04	MW04	MW04	MW04	MW04
Sample Date	05/01/00	08/30/04	07/29/08	03/17/10	04/01/15	01/06/16	01/13/17	02/20/19	01/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	<1	**4.6**	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene	**2**	**0.72 J**	<0.5	<5	<0.5	**0.53 J**	**0.51 J**	<0.5	<0.5
MTBE	NA	**234**	**110**	**130**	**14**	**26**	**12**	**8 J**	**12**

Sample ID	MW05	MW05	MW05	MW05	MW05	MW05	MW05	MW05	MW05
Sample Date	5/1/00	8/30/04	7/29/08	3/17/10	4/1/15	1/6/16	1/13/17	2/20/19	1/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	**32**	**7.2**	<0.5	<0.5	**0.85 J**	**0.85 J**	<0.5	<0.5	**0.36 J**
Benzene	**6**	**1.2 J**	**16**	**4.5 J**	**9.8**	**7.8**	**7.9**	**2.7**	**0.45 J**
MTBE	NA	**1,220**	**560**	**520**	**350**	**380**	**340**	**140**	**230**





2004 Aerial Photograph

LEGEND

- Water-level Monitoring Well
- Performance Monitoring Well

Notes:

1. All concentrations are in microgram(s) per liter (µg/L).
2. **Bold** results indicate a detection.
3. Bold/highlighted results indicate RG exceedance.
4. **1st**, **2nd**, and **3rd Rounds** refer to Remedial Action-Operations Monitoring events prior to 2018 injection.

µg/L microgram(s) per liter
< Non-detected results (below detection limit)
J Estimated result
NA Not analyzed

Contaminant of Concern	RG (µg/L)
1,2-Dichloroethane (1,2-DCA)	3.8
Benzene	5
Methyl-tert-butyl ether (MTBE)	120

Sample ID	MW01	MW01	MW01	MW01	MW01	MW01	MW01	MW01	MW01
Sample Date	9/11/98	9/1/04	7/29/08	3/17/10	3/31/15	1/6/16	1/13/17	2/20/19	1/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	NA	<0.5	<0.5	<5	**4.4**	**7.5**	**6.6**	<0.5	<0.5
Benzene	**17**	**4.1**	**3.8**	**6.4**	**2.1**	**3.2**	**6.6**	**1.4 J**	**1.3**
MTBE	NA	**260**	**150**	**120**	**23**	**18**	**21**	<0.5	**0.93J**

Figure ES-3
Pre-ROD and Post-ROD Sampling Results
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

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Acronyms and Abbreviations

µg/L	micrograms per liter
1,2-DCA	1,2-dichloroethane
AOC	Area of Concern
CLEAN	Comprehensive Long-Term Environmental Action – Navy
COC	contaminant of concern
CP-2	Contingency Plan 2
CTO	Contract Task Order
DQE	Data Quality Evaluation
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency
ERP	Environmental Restoration Program
IRACR	Interim-Remedial Action Completion Report
ISCO	in situ chemical oxidation
LUC	land use control
MCL	Maximum Contaminant Level
mg	milligram(s)
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MOV	Municipality of Vieques
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl-tert-butyl ether
NASD	Naval Ammunition Support Detachment
NAVFAC	Naval Facilities Engineering Command Atlantic
Navy	Department of the Navy
PPE	personal protective equipment
PRDNER	Puerto Rico Department of Natural and Environmental Resources
PRWQS	Puerto Rico Water Quality Standards
QA	quality assurance
QC	quality control
RAO	Remedial Action Objective
RAWP	Remedial Action Work Plan
RG	remedial goal
ROD	Record of Decision
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
USFWS	United States Fish and Wildlife Service
UST	underground storage tank

SECTION 1

Introduction

This Remedial Action Annual Status Report presents the 2020 annual groundwater monitoring and land use control (LUC) inspection activities associated with the remedial action at Area of Concern (AOC) E, located within the former Naval Ammunition Support Detachment (NASD) in Vieques, Puerto Rico (Figures 1-1 and 1-2). AOC E is the site of a former 500-gallon underground storage tank (UST) that stored used oil from vehicle maintenance activities. The site is less than a tenth of an acre located within the main operation area of the former NASD, currently a part of the Municipality of Vieques (MOV) Public Works facility. This Report also includes historical analytical data to aid in the monitoring data evaluation. Details of the previous rounds of injections and 2015 (year 1), 2016 (year 2), and 2017 (year 3) monitoring events conducted in accordance with Remedial Action Workplan (RAWP) (CH2M, 2015) can be found in the Area of Concern E Remedial Action Annual Status Report 2016 (CH2M, 2107) and Area of Concern E Remedial Action Annual Status Report 2017 (CH2M, 2018a).

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The Remedial Action Objective (RAO) is to prevent exposure to COCs in groundwater at concentrations above RGs. When groundwater monitoring data from three consecutive monitoring events show COC concentrations less than or equal to RGs, the RAO will have been met. LUCs are also implemented to prevent unauthorized and uncontrolled groundwater use within the LUC boundary until the RAO is met.

Benzene, 1,2-dichloroethane (1,2-DCA) and methyl tert-butyl ether (MTBE) were detected above their respective RGs during each of the three consecutive post-ROD sampling events (2015-2017). Therefore, in compliance with ROD (NAVFAC, 2015), an additional ISCO injection using activated persulfate was conducted for wells in which rebound was observed (ROD Contingency Plan 2, CP-2). The ISCO injection was performed in accordance with the RAWP Addendum (CH2M, 2018c). From October 29, 2018 to November 16, 2018, 2,800 gallons of sodium persulfate solution (4.7%) activated by 276 gallons of hydrogen peroxide (2%) were injected into the subsurface at monitoring wells MW-01 and MW-05, the two wells in which the COC RG exceedances were observed during post-ROD sampling, in accordance with the approach defined in the AOC E RAWP Addendum (CH2M, 2018c). Details of CP-2 implementation can be found in the AOC E Interim Remedial Action Completion Report (IRACR) (CH2M, 2019).

This Annual Status Report was prepared under the Department of the Navy (Navy) Comprehensive Long-Term Environmental Action - Navy (CLEAN) Contract No. N62470-16-D-9000 Contract Task Order (CTO) 0003 for submittal to Naval Facilities Engineering Command Atlantic (NAVFAC), United States Environmental Protection Agency (EPA), and Puerto Rico Department of Natural and Environmental Resources (PRDNER). The Navy, EPA, and PRDNER work jointly, together with the United States Fish and Wildlife Service (USFWS) for property owned by the Department of Interior, to implement the Vieques Environmental Restoration Program (ERP). As noted previously, AOC E is located on property owned by the MOV.

1.1 Objectives and Approach

In accordance with the AOC E RAWP Addendum (CH2M, 2018c), implementation of ROD CP-2 involves periodic (at a minimum, annually) groundwater monitoring to confirm persulfate concentrations decline to non-detectable or otherwise acceptably low levels, followed by annual groundwater monitoring of COCs (benzene, 1,2-DCA, and MTBE) for a period of 3 consecutive years to assess if they rebound above RGs. When persulfate is no longer active (i.e., concentrations are non-detect or close to non-detect) and when groundwater monitoring data from three consecutive annual monitoring events show COCs less than or equal to RGs, the RAO will have been met.

LUCs are in place to prevent unauthorized and uncontrolled groundwater use within the LUC boundary until the RAO is met.

As described the RAWP Addendum (CH2M, 2018c), groundwater performance monitoring will be conducted using three monitoring wells (MW-01, MW-04, and MW-05) because these wells are either located within the area of COC RG exceedances (i.e., wells MW-01 and MW-05) or are immediately downgradient of these wells (i.e., well MW-04). Because concentrations of all COCs remained below the RGs in the remaining AOC E monitoring wells (i.e., MW-03, MW-07, and MW-08) for the three consecutive post-ROD annual sampling events, further monitoring of these wells was deemed not warranted. All AOC E monitoring wells are shown in Figure 1-3.

In accordance with the RAWP Addendum (CH2M, 2018c), groundwater performance monitoring parameters will comprise the three remaining COCs (benzene, MTBE, and 1,2-DCA) because the RAO for naphthalene, 2-methylnaphthalene, and xylenes has been achieved (i.e., concentrations below RGs for three consecutive annual performance monitoring events).

LUC monitoring and maintenance involves evaluating the structural integrity of the fence (including gate and lock), signs, and monitoring wells and performing repairs as warranted.

Table 1-1
Remedial Goals for AOC E
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Chemicals of Concern	Remedial Goal	Basis
Benzene	5 µg/L	MCL
1,2-Dichloroethane	3.8 µg/L	PRWQS for Groundwater (SG); an ARAR that is lower than the MCL of 5 µg/L
MTBE	120 µg/L	ELCR of $1X10^{-5}$ and HI of 0.02 (EPA, 2013)

Notes:

µg/L = micrograms per liter
ELCR = excess lifetime cancer risk
HI = hazard index
MCL = Federal Maximum Contaminant Level (EPA, 2009)
PRWQS = Puerto Rico Water Quality Standards (March 2010; for groundwater – Class SG)

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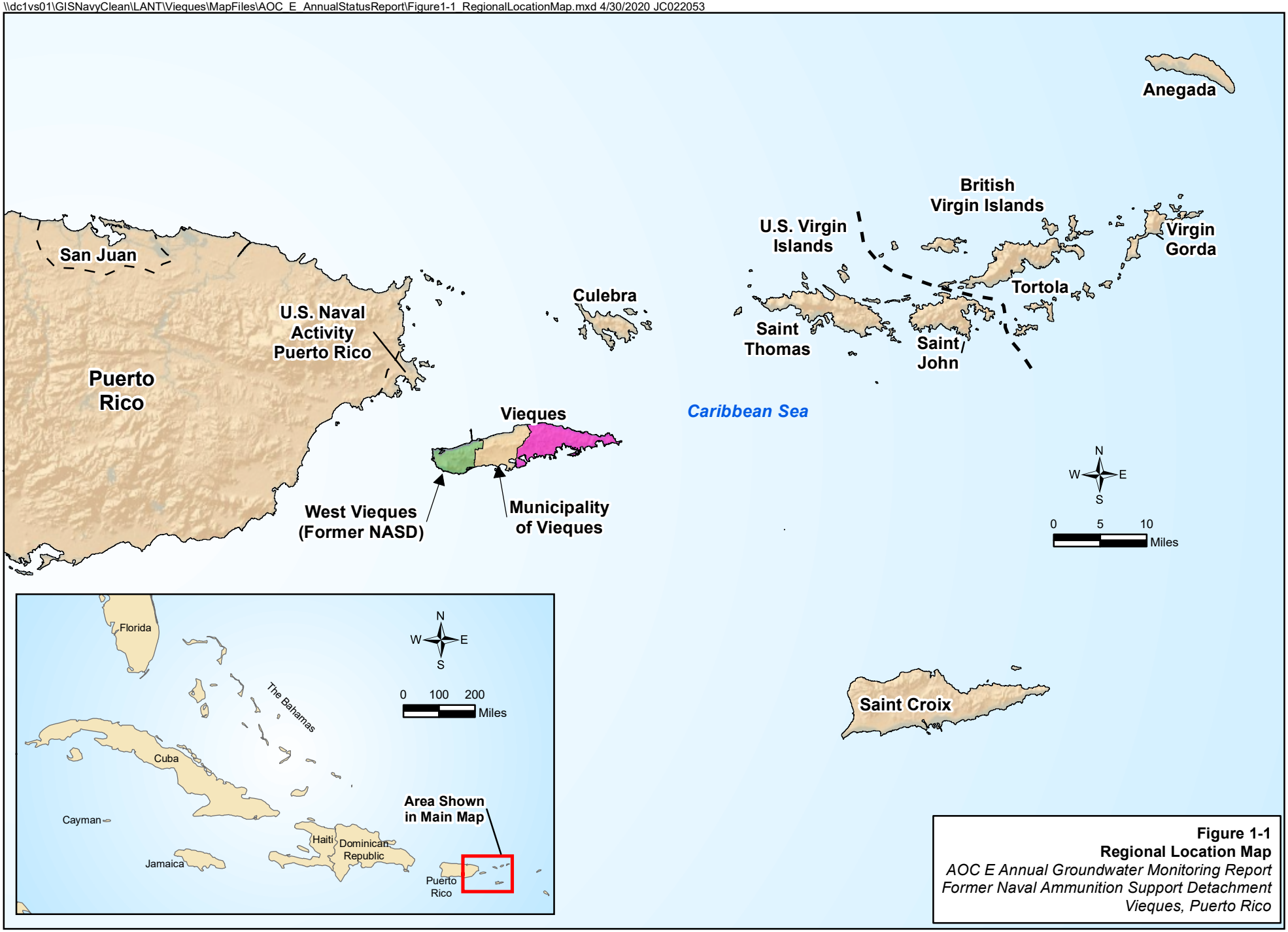
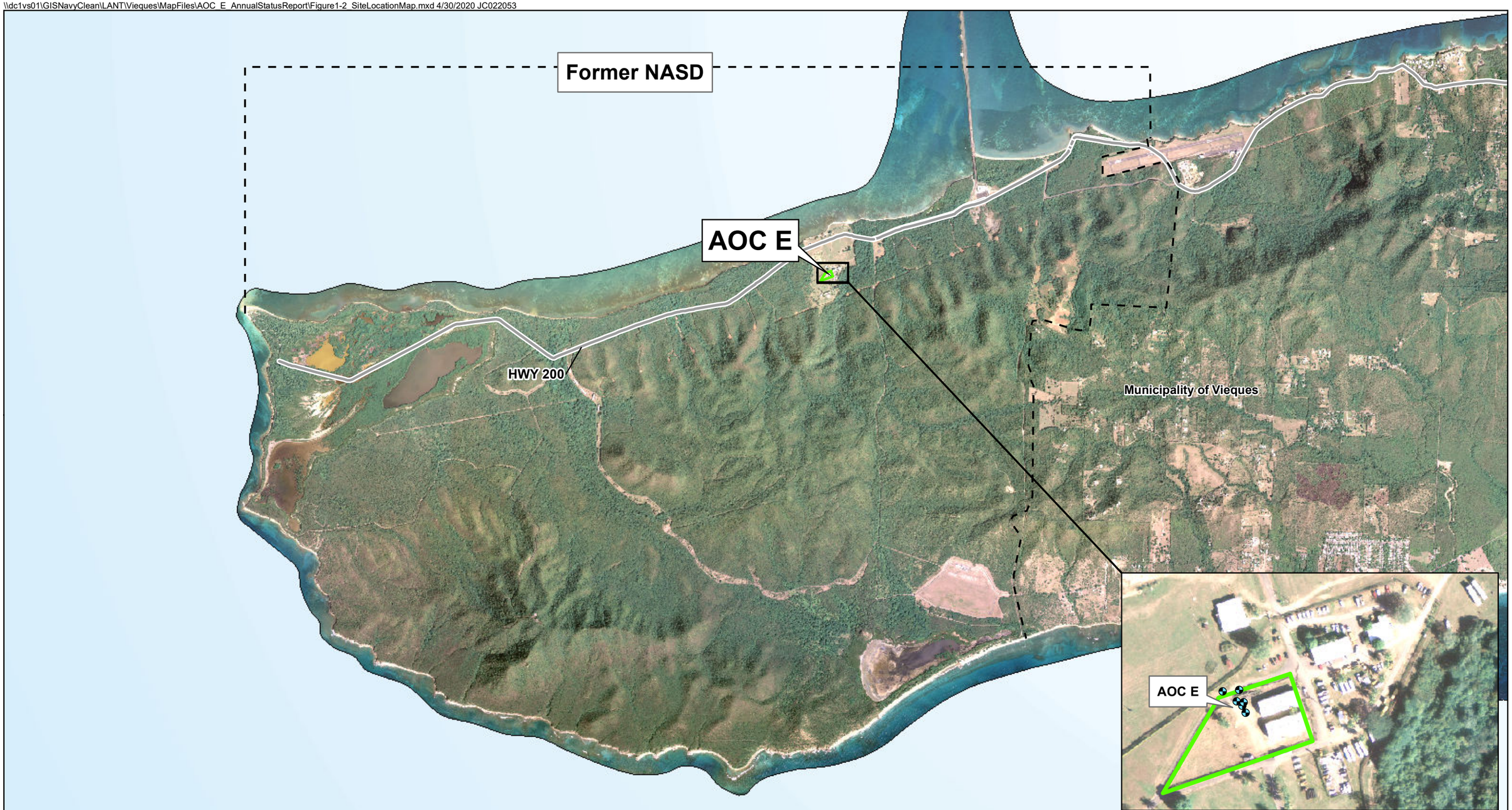


Figure 1-1
Regional Location Map
AOC E Annual Groundwater Monitoring Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

\\dc1vs01\GISNavyClean\LANT\Vieques\MapFiles\AOC_E_AnnualStatusReport\Figure1-2_SiteLocationMap.mxd 4/30/2020 JC022053



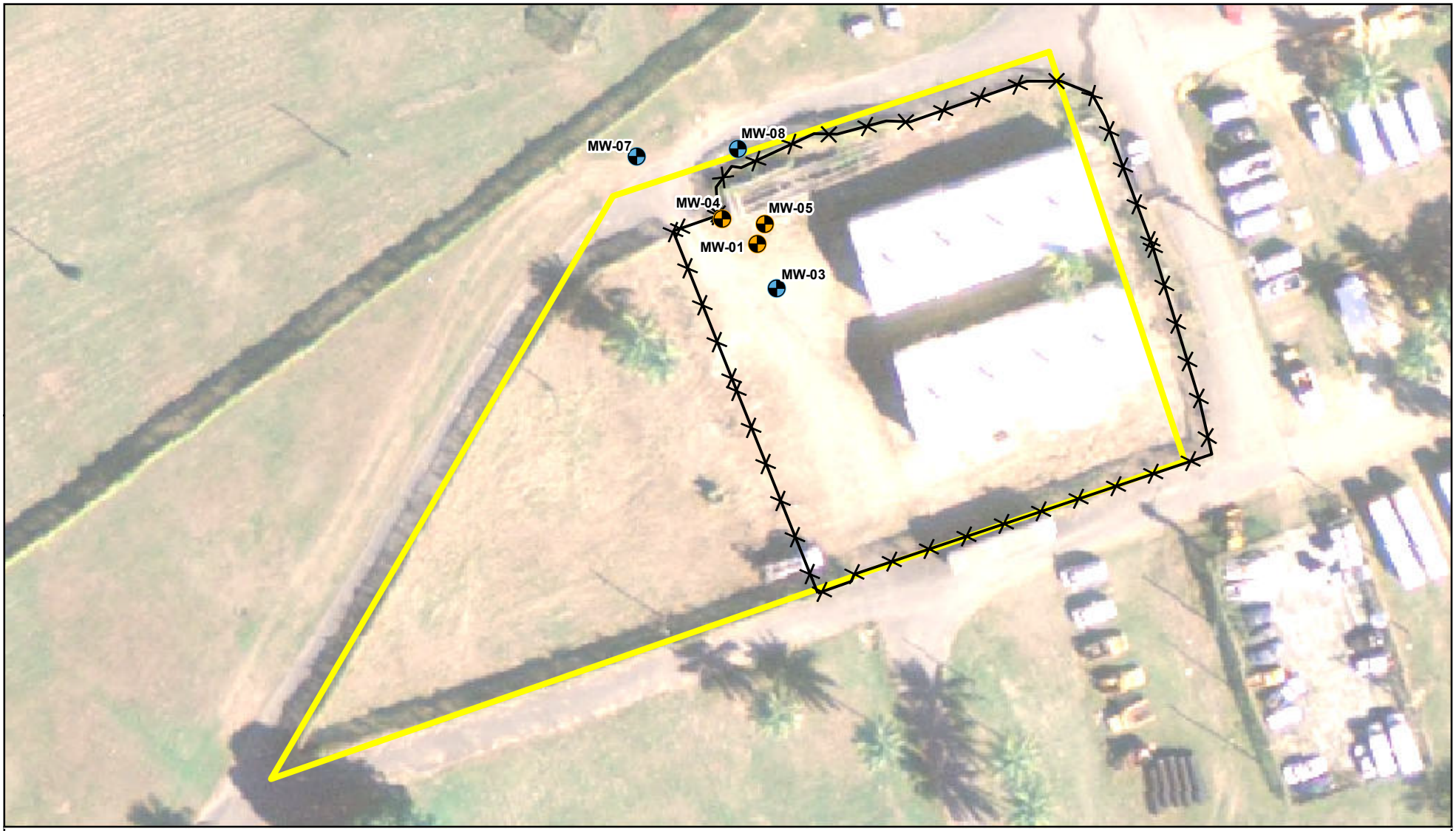
Legend

- Remedial Action-Operations Monitoring Wells
- Road
- AOC E Land Use Control Boundary

N
W E
S

0 3,000 6,000
Feet

Figure 1-2
AOC E Site Location Map
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico



Legend

- Monitoring Wells Sampled
- Monitoring Wells Removed from Performance Monitoring
- Fence
- AOC E Land Use Control Boundary

N
W E
S

0 25 50
Feet

2007 Aerial Imagery

Figure 1-3
AOC E Land Use Control Boundary and Wells for Remedial Action-Operations Monitoring
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

SECTION 2

Groundwater Sampling and Evaluation

This section provides a description of the groundwater monitoring methodology and results associated with the 2020 annual groundwater sampling event following the CP-2 ISCO injection. It also includes analytical results from historical sampling events to aid in the monitoring data evaluation.

2.1 Persulfate Screening

As noted previously, the CP-2 ISCO injection was performed in late 2018. In February 2019 persulfate concentrations were field-tested in the three performance monitoring wells (MW-01, MW-04, and MW-05) and found to be at levels that could still oxidize COCs (Table 2-1); thus, COC performance monitoring was not initiated. However, because of the onsite availability of staff and equipment, groundwater samples were collected from the wells for informational purposes; the COC data from the February 2019 sampling are provided in Table 2-2.

In January 2020 persulfate concentrations were again field-tested and found to be non-detect (i.e., measured as <0.7 milligrams per liter [mg/L] by the field test kit) in wells MW-04 and MW-05, allowing for COC performance monitoring to commence, as described in Section 2.3. It is noted the water sample from MW-01 was too turbid to obtain an accurate persulfate reading. Therefore, if the persulfate reading taken at the next annual performance monitoring event shows the residual persulfate concentration in MW-01 is above an acceptable level, COC sampling will not be performed and the results of the 2020 sampling event will be used for informational purposes only (they will not constitute the first post-CP-2 injection performance dataset).

Figure 2-1 shows the residual persulfate concentrations measured following the CP-2 ISCO application in late 2018. For perspective, it also provides historical residual persulfate concentration trends associated with the pilot study (pre-ROD) and post-ROD performance monitoring events.

2.2 Groundwater Elevation Measurements

The depth to groundwater was gauged to the nearest 0.01 foot at the six AOC E monitoring wells on January 13, 2020, prior to the 2020 COC performance monitoring sampling event. Water-level depths were used in conjunction with the top-of-casing survey data to calculate groundwater elevations at each of the six wells, as shown in Table 2-1 and displayed in Figure 2-2. The relative water elevations among the wells and the west by northwest groundwater flow direction is strongly similar to what was observed in previous events.

2.3 Groundwater Sampling

As noted in Section 2.1, persulfate screening conducted prior to initiating the January 2020 sampling event demonstrated residual persulfate concentrations had declined to non-detect or close to non-detect (reported as <0.7 milligrams per kilogram (mg/kg) by the persulfate field test kit) in two of the three performance monitoring wells (i.e., MW-04 and MW-05), but the turbidity in well MW-01 interfered with obtaining an accurate residual persulfate measurement. Nonetheless, because the team had mobilized to the site and had all the necessary equipment to collect samples, the decision was made to perform COC sample collection from all three wells using sample containers preserved with 10 milligrams (mg) of ascorbic acid as a conservative measure. Adding 10 mg of ascorbic acid to all sample containers provided an oxidant quenching capacity of up to approximately 85 mg/L of residual persulfate. While this quenching capacity would have been sufficient for samples from wells MW-04 and MW-05, it is unknown whether it would have been sufficient for the sample from well MW-01 because the residual persulfate concentration was unknown. However, as indicated in Section 2.1, if the residual persulfate concentration measured in MW-01 during the next annual sampling event is above a level that can be quenched with 10 mg/L of ascorbic acid, the 2020 results will be used for informational purposes rather than the first-post-CP-2 performance monitoring dataset.

The 2020 annual COC performance monitoring event for MW-01, MW-04, and MW-05 was conducted on January 13 and 14, 2020. Low-flow sampling techniques were employed using a monsoon submersible pump and water quality parameters were taken at 5-minute intervals using a Horiba 550 YSI. During the sampling event the flow rates were decreased in order to maintain the drawdown at 0.3 foot or less. However, none of the wells could sustain the low-flow rate and were ultimately pumped dry. Therefore, the wells were allowed to recharge and sampling was conducted the next day per Standard Operating Procedure (SOP) B-1 Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling located in the Master Standard Operating Procedures, Protocols, and Plans, Revision - 2018 (CH2M, 2018b).

2.3.1 Sample Handling

Sample handling included sample documentation, nomenclature, packaging, shipping, and custody. Procedures followed are described in SOP H-1 Preparing Field Logbooks, SOP H-4 Chain-of-Custody, and SOP H-5 Packaging and Shipping Procedures for Samples Not Considered Dangerous Goods in the Master Standard Operating Procedures, Protocols, and Plans, Revision - 2018 (CH2M, 2018b). Groundwater sampling logs for the 2020 performance monitoring event are included in Appendix A.

2.3.2 Quality Assurance and Quality Control

Field quality assurance (QA) and quality control (QC) samples were collected during the performance monitoring field activities in order to: (1) confirm that decontamination procedures were properly implemented (e.g., equipment rinsate samples); (2) evaluate sampling efficacy (e.g., field duplicates); and (3) evaluate the potential that contamination occurred during shipping (e.g., trip blanks). The field QA/QC samples were collected in accordance with Worksheet #28 of the groundwater monitoring Sampling and Analysis Plan (SAP) (Appendix C of the RAWP [CH2M, 2015]).

2.3.3 Decontamination

Non-disposable equipment involved in the field sampling activities was decontaminated upon arrival at the site, between sampling locations, and at the conclusion of the groundwater monitoring activities. Decontamination procedures followed are described in SOP E-1 Decontamination of Personnel and Equipment in the Master Standard Operating Procedures, Protocols, and Plans, Revision - 2018 (CH2M, 2018b).

2.3.4 Remediation-derived Waste Handling and Disposal

Three types of potentially contaminated wastes were generated during the fieldwork: (1) used personal protective equipment (PPE); (2) fluids from the decontamination of sampling tools, other equipment, and PPE; and (3) purge water from groundwater sampling. The PPE was decontaminated and disposed of with normal trash. Purge and decontamination water (9.5 gallons) generated during the 2020 annual performance monitoring event was allowed to evaporate.

2.4 Data Evaluation

This subsection presents information on the management and evaluation of analytical data collected during the 2020 annual performance monitoring event, including data tracking and validation.

2.4.1 Data Tracking, Validation, and Data Quality Evaluation

The management and tracking of data from the time of field collection to receipt of validated electronic analytical results reflects the overall quality of the analytical results. Field samples and their corresponding analytical tests were recorded on chain-of-custody forms for submission to the laboratory. Chain-of-custody entries were checked to determine if all designated samples were collected and submitted for the appropriate analyses. Upon receipt of the samples by the laboratory, a comparison to the field information was made to determine if each sample was analyzed for the correct parameters. In addition, a check was made to confirm that the proper

number of QA/QC samples was collected. QA/QC samples comprise equipment blanks, trip blanks, duplicates, matrix spike (MS)/matrix spike duplicate (MSD) samples, and laboratory blanks.

Groundwater samples, preserved with ascorbic acid as a precaution, were submitted to Katahdin Analytical Services in Scarborough, Maine, for benzene, 1,2-DCA, and MTBE analysis using laboratory method SW-846 8260C. The raw laboratory analytical data are provided in Appendix B. Analytical data reports for the 2020 annual performance monitoring event were submitted to Environmental Data Services, Inc. for third-party data validation. The data validator produced data validation reports, which are presented in Appendix C. Validation was performed as described in Worksheet #36 of the groundwater monitoring SAP (Appendix C of the RAWP [CH2M, 2015]). These steps (third party validation and electronic data handling) serve to increase the confidence associated with data quality and usability.

A Data Quality Evaluation (DQE) was performed on the analytical data in accordance with Worksheet #37 of the groundwater monitoring SAP (Appendix C of the RAWP [CH2M, 2015]). There were no rejected results, the reporting limit requirements were met, and reporting limits were sufficiently less than screening levels; therefore, the data are fully usable for the intended purpose. Results of the evaluation are summarized in Appendix D.

2.4.2 Groundwater Parameter Evaluation

The data for each of the water quality parameters are shown in Figures 2-3 through 2-8. These data show, in general, a similar, but more subdued near-term pattern following the CP-2 ISCO injection to what was observed following the pilot study ISCO injections. The more subdued near-term pattern is likely due to injecting a smaller substrate volume compared to the pilot study and because the CP-2 ISCO injection included a hydrogen peroxide activator to accelerate residual persulfate decline.

The other observation of note regarding the water quality parameter data is the elevated turbidity following the CP-2 ISCO injection (Figure 2-8). However, the significantly elevated readings were during the February 2019 persulfate screening event for which COC data were collected for only informational purposes. During the January 2020 event, the turbidity values had returned to levels comparable to those observed before the CP-2 injection. The elevated turbidity values are likely due to the wells not being able to sustain the low-flow pumping rates. However, given the consistency in historical COC results over recent performance monitoring events (Figure 2-9), elevated turbidity appears to be inconsequential to COC analytical results.

2.4.3 Groundwater Analytical Results

Table 2-2 and Figure 2-9 show the detections and RG exceedances for benzene, 1,2-DCA, and MTBE for groundwater samples collected in 2019 (information purposes only) and 2020 (first post-CP-2 injection performance monitoring event) from wells MW-01, MW-04, and MW-05. Historic COC data (i.e., prior to CP-2 injection) are provided in Table 2-3 and shown in Figure 2-9 for perspective. Figures 2-10 through 2-12 include time series trend graphs of the COCs for which there are or have been exceedances of the RGs: Benzene, 1,2-DCA, and MTBE.

While additional temporal data are necessary in order to draw definitive conclusions regarding COC trends, the following are observations from the 2020 performance monitoring data:

- The only RG exceedance since the 2018 CP-2 ISCO injection was observed in MW-05, closely associated with the former UST and related piping. In general, while some rebound occurred from 2014 to 2018 of select COCs in a few wells, the COC concentrations are relatively low with respect to historical concentrations and/or RG concentrations. However, the concentration of MTBE in MW-05 continues to exceed its RG.
- Benzene – The data in Table 2-3 and Figures 2-9 and 2-10 suggest the benzene concentrations in wells MW-01 and MW-05 were influenced by the CP-2 ISCO injection, declining in each well to below the RG. It is also possible the CP-2 ISCO injection affected the benzene concentration in well MW-04 (e.g., residual persulfate was detected in the well in February 2019), but data from the 15+ years have all been less than 1 microgram per liter (µg/L), suggesting the result may be associated with natural fluctuations.

- 1,2-DCA – Like benzene, the data in Table 2-3 and Figures 2-9 and 2-11 suggest the 1,2-DCA concentration in well MW-01 was influenced by the CP-2 ISCO injection, declining to below the RG. The 1,2-DCA concentrations in wells MW-04 and MW-05 have been non-detect or below the RG since the pilot study (or longer).
- MTBE – Since implementing the ISCO pilot study, MTBE concentrations have declined in all three current performance monitoring wells (MW-01, MW-04, and MW-05), as shown in Table 2-3 and Figures 2-9 and 2-12. The MTBE concentrations in wells MW-01 and MW-05 appear to have been further influenced by the CP-2 ISCO injection, which reduced the concentration in MW-01 from its pre-CP-2 level, but it was already below the RG in that well. However, while the MTBE concentration also declined in well MW-05, it remains above the RG.

TABLE 2-1
Groundwater Elevation and Field Parameters
AOC E Remedial Action Annual Status
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Well ID	TOC Elevation (ft amsl)	Well Depth (ft bls)	Screen Interval Depth (ft bls)	Screen Interval Elevation (ft amsl)	Northing UTM NAD 83 Meters	Easting UTM NAD 83 Meters	Depth to Groundwater below TOC 2/19/2019 (ft btoc)	Depth to Groundwater below TOC 1/13/2020 (ft btoc)	Groundwater Elevation on 2/20/2019 (ft amsl)	Groundwater Elevation on 1/13/2020 (ft amsl)	pH 2/20/2019	pH 1/13/2020	Conductivity (µS/cm) 2/20/2019	Conductivity (µS/cm) 1/13/2020	ORP (mV) 2/20/2019	ORP (mV) 1/13/2020	DO (mg/L) 2/20/2019	DO (mg/L) 1/13/2020	Turbidity (NTU) 2/20/2019	Turbidity (NTU) 1/13/2020	Persulfate (mg/L) 2/20/2019	Persulfate (mg/L) 1/13/2020
MW-01	43.93	50	40-50	3.93 to -6.07	232797.520	2005684.767	38.72	41.30	5.21	***	5.73	6.23	9,300	17,500	356.9	-75	7.49	0.08	<999	331	350	**
MW-03	44.06	50	40-50	4.06 to -5.94	232799.796	2005679.684	38.78	40.35	5.28	3.71	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-04	43.60	50	40-50	3.60 to -6.40	232793.297	2005687.006	38.46	40.11	5.14	3.49	10.59	10.86	11,318	7,950	9.7	-35.0	4.38	4.15	366	47	14	<0.7
MW-05	44.32	50	40-50	4.32 to -5.68	232798.483	2005687.310	38.68	40.72	5.64	3.60	6.71	6.92	11,645	10,000	3.9	-81.0	2.22	0.00	40.8	31	<0.7	<0.7
MW-07	43.41	50	40-50	3.41 to -6.59	232778*	2005704*	39.16	40.53	4.25	2.88	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
MW-08	43.04	50	40-50	3.04 to -6.96	232792*	2005698*	38.40	39.86	4.64	3.18	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

* Coordinates were obtained by CH2M in 2007 using a hand held GPS unit.

** Turbidity too high to obtain accurate persulfate reading.

*** Not measured due to instrument sensor malfunction.

Due to well recovery rates lower than low-flow pumping rates, wells MW-01, MW-04, and MW-05 were purged dry prior to sampling and samples taken the next day.

Northing and Easting coordinates are in UTM meters

MW-02 and MW-06 are not included in the water-level performance monitoring but if available a water-level will be collected from them to aid in the groundwater flow direction calculations.
On 1/13/20 a water level was obtained from MW-02 indicating a depth to water of 39.63 (ft btoc) with an elevation of 3.05 (ft amsl).

µS/cm = microSiemens per centimeter
ft amsl = feet above mean sea level (NGVD 1929)
ft bls = feet below land surface
ft btoc = feet below top of casing
mg/L = milligrams per liter
mV = millivolt
NM = Not measured; well removed from performance monitoring program
NTU = Nephelometric Turbidity Unit
ORP = oxidation-reduction potential
TOC = top of casing
UTM NAD 83 = Universal Transverse Mercator, North American Datum 83

Table 2-2
Groundwater Detections and Exceedances
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Well	Remedial Goal	MW-01	MW-01 (dup)	MW-01	MW-01 (dup)	MW-04	MW-04	MW-05	MW-05
Sample ID		VWAE-MW01P-0219	VWAE-MW01P-0219	VWAE-MW01-0120	VWAE-MW01P-0120	VWAE-MW04-0219	VWAE-MW04-0120	VWAE-MW05-0219	VWAE-MW05-0120
Sample Date		2/20/19	2/20/19	1/14/20	1/14/20	2/20/19	1/14/20	2/20/19	1/14/20
Chemical Name									
Volatile Organic Compounds (UG/L)									
1,2-Dichloroethane	3.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**0.36 J**
Benzene	5	**1.4 J**	**1.4 J**	**0.95 J**	**1.3**	0.5 U	0.5 U	**2.7**	**0.45 J**
Methyl-tert-butyl ether (MTBE)	120	0.5 U	0.5 U	**0.93 J**	**0.92 J**	**8 J**	**12**	**140**	**230**

Bolding indicates detection
Gray shading indicates RG exceedance
J = estimated
U = non-detect or not detected at significantly greater than that in an associated blank
UG/L = micrograms per liter

Table 2-3
Historic Groundwater Detections and Exceedances
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Well	Remedial Goal	MW-01	MW-01	MW-01	MW-01	MW-01	MW-01 (dup)	MW-01	MW-01	MW-01 (dup)	MW-04	MW-04	MW-04	MW-04	MW-04	MW-04
Sample ID		VWAE-MW01P-0219	VWAE-MW01P-0219	VWAE-MW01P-0219	VWAE-MW01P-0219	VWAE-MW01-0315	VWAE-MW01P-0315	VWAE-MW01-0116	VWAE-MW01-0117	VWAE-MW01P-0117	VWAE-MW04-0500	VWAE-MW04-0804	VWAE-MW04-0708	VWAE-MW04-0310	VWAE-MW04-0315	VWAE-MW04-0116
Sample Date		9/11/98	9/1/04	7/29/08	3/17/10	3/31/15	3/31/15	1/6/16	1/13/17	1/13/17	5/1/00	8/30/04	7/29/08	3/17/10	3/31/15	1/6/16
Volatile Organic Compounds (UG/L)																
1,2-Dichloroethane	**3.8**	N/A	<0.5	<0.5	<0.5	**4.4**	**3.9**	**7.5**	**6.6**	**6.1**	<1	**4.6**	<0.5	<5	0.5 U	0.5 U
Benzene	**5**	**17**	**4.1**	**3.8**	**6.4**	**2.1**	**1.9**	**3.2**	**6.6**	**5.8**	2	**0.72 J**	<0.5	<5	0.5 U	**0.35** J
Methyl-tert-butyl ether (MTBE)	**120**	N/A	**260**	**150**	**120**	**23**	**21**	**18**	**21**	**20**	N/A	**234**	**110**	**130**	**14**	**26**

Bolding indicates detection

Gray shading indicates RG exceedance

J = estimated
U = non-detect or not detected at significantly
greater than that in an associated blank
UG/L = micrograms per liter
N/A = Not aplicable

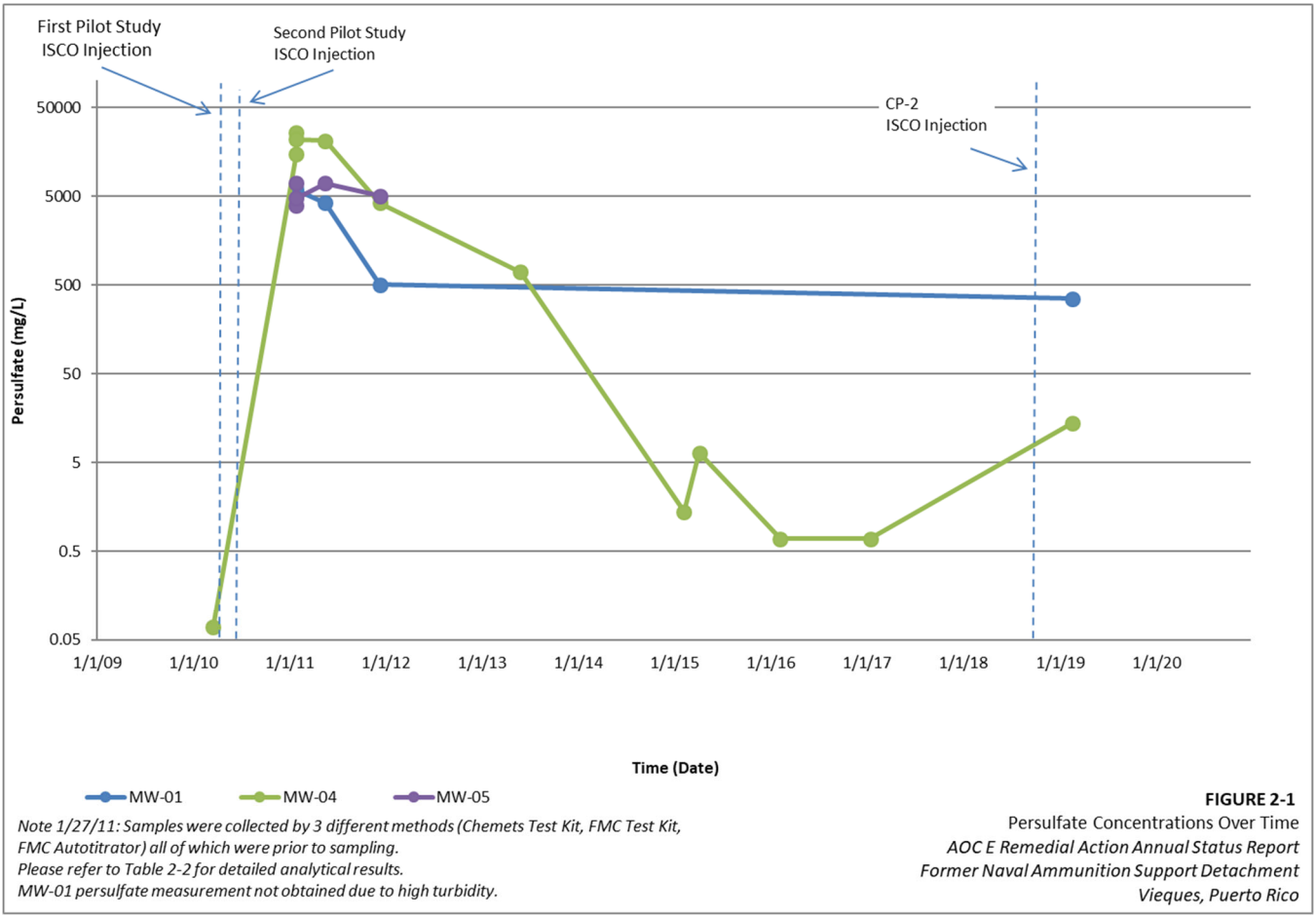
Table 2-3
Historic Groundwater Detections and Exceedances
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Well		MW-04	MW-05	MW-05	MW-05	MW-05	MW-05	MW-05	MW-05
Sample ID	**Remedial Goal**	VWAE-MW04-0117	VWAE-MW05-0415	VWAE-MW05-0415	VWAE-MW05-0116	VWAE-MW05-0117	VWAE-MW05-0415	VWAE-MW05-0116	VWAE-MW05-0117
Sample Date		1/12/17	5/1/00	8/30/04	7/29/08	3/17/10	4/1/15	1/6/16	1/13/17
Volatile Organic Compounds (UG/L)									
1,2-Dichloroethane	**3.8**	0.5 U	**32**	**7.2**	<0.5	<0.5	0.85 J	0.85 J	0.5 U
Benzene	**5**	**0.51** J	**6**	**1.2 J**	**16**	**4.5 J**	**9.8**	**7.8**	**7.9**
Methyl-tert-butyl ether (MTBE)	**120**	**12**	N/A	**1,220**	**560**	**520**	**350**	**380**	**340**

Bolding indicates detection

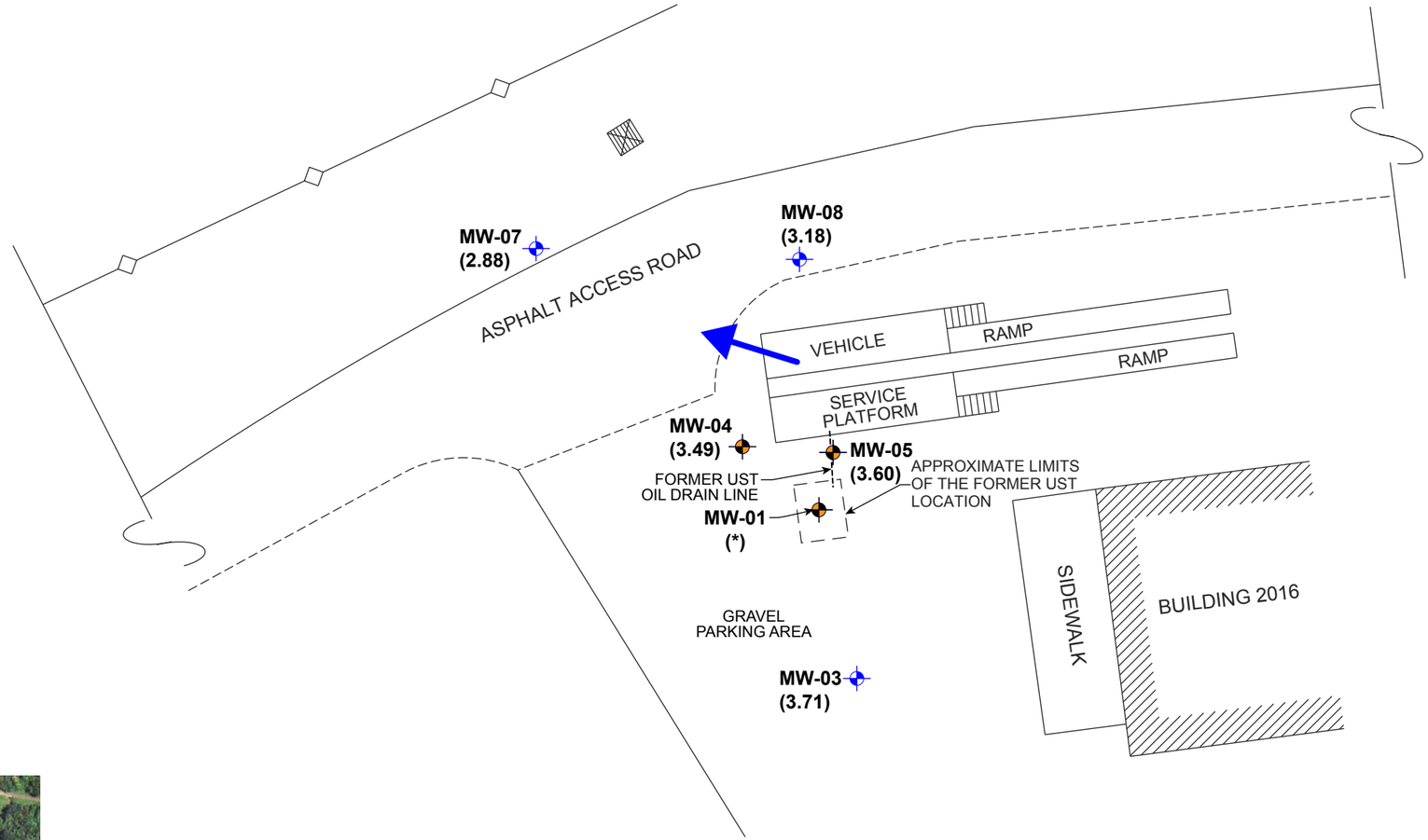
Gray shading indicates RG exceedance

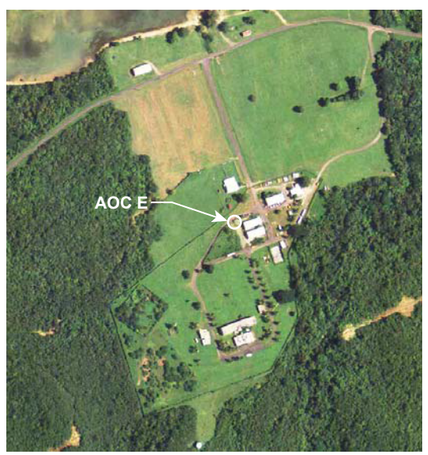
J = estimated
U = non-detect or not detected at significantly
greater than that in an associated blank
UG/L = micrograms per liter
N/A = Not aplicable



Note 1/27/11: Samples were collected by 3 different methods (Chemets Test Kit, FMC Test Kit, FMC Autotitrator) all of which were prior to sampling.
Please refer to Table 2-2 for detailed analytical results.
MW-01 persulfate measurement not obtained due to high turbidity.

FIGURE 2-1
Persulfate Concentrations Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico





2004 Aerial Photograph

Notes:

- Performance Monitoring Well
- Water-level Monitoring Well
- Estimated Groundwater Flow Direction
- All groundwater level readings shown in feet above mean sea level (ft amsl)
- Water level readings taken on January 13, 2020
- **(*)** Instrument sensor error, unable to determine water level

North

0 20 40

Scale in Feet

Figure 2-2
Groundwater Elevations – January 13, 2020
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

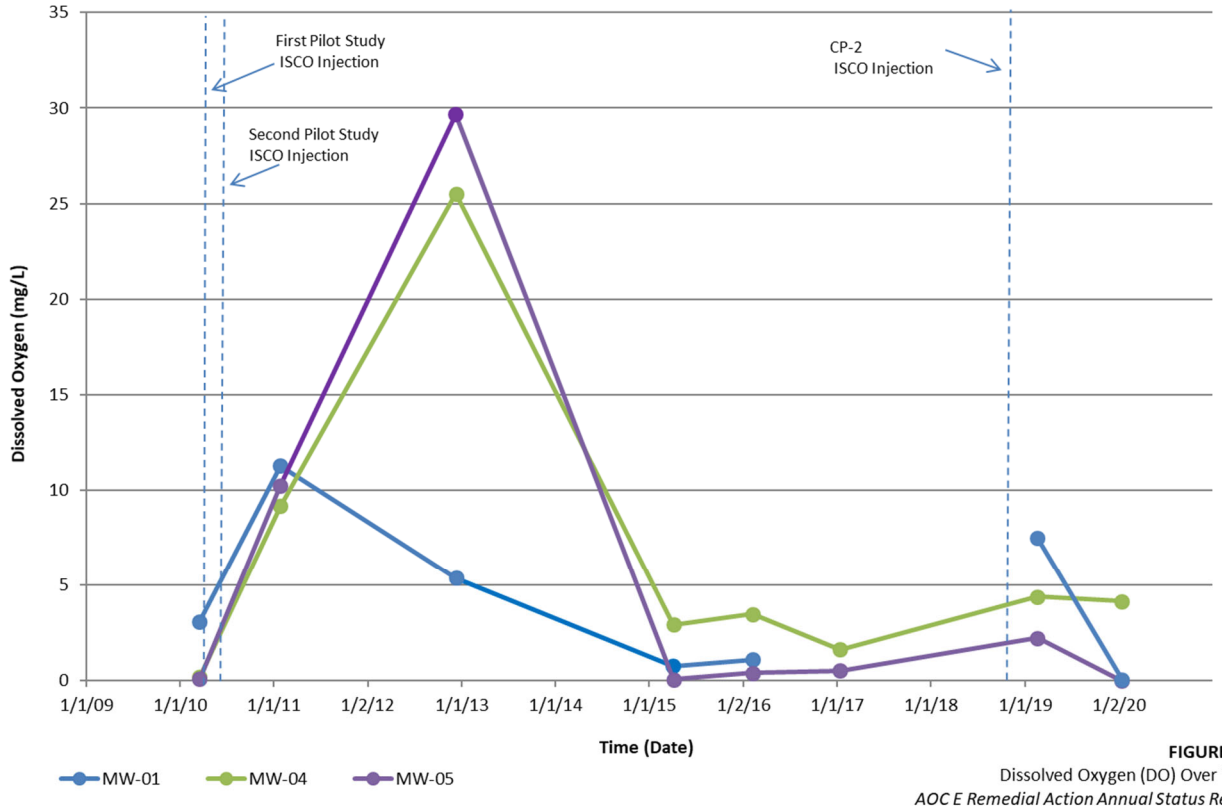


FIGURE 2-3
Dissolved Oxygen (DO) Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

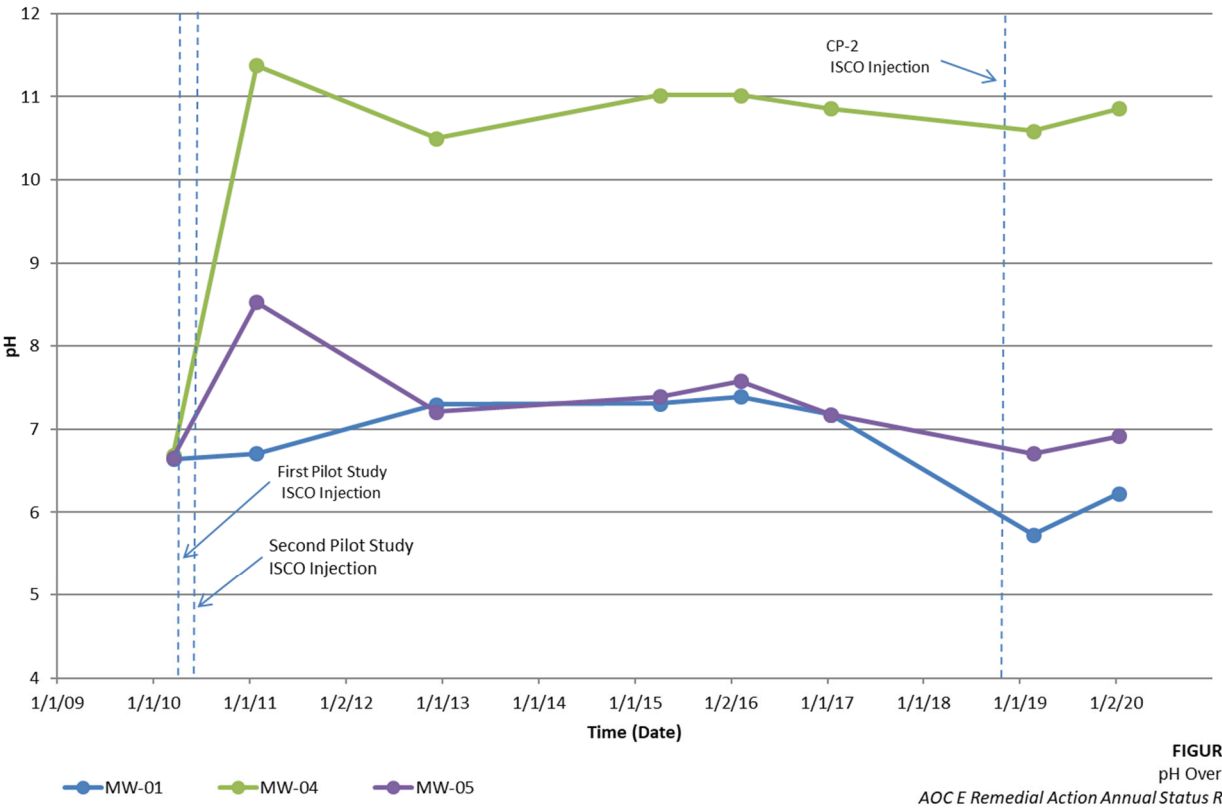


FIGURE 2-4
pH Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

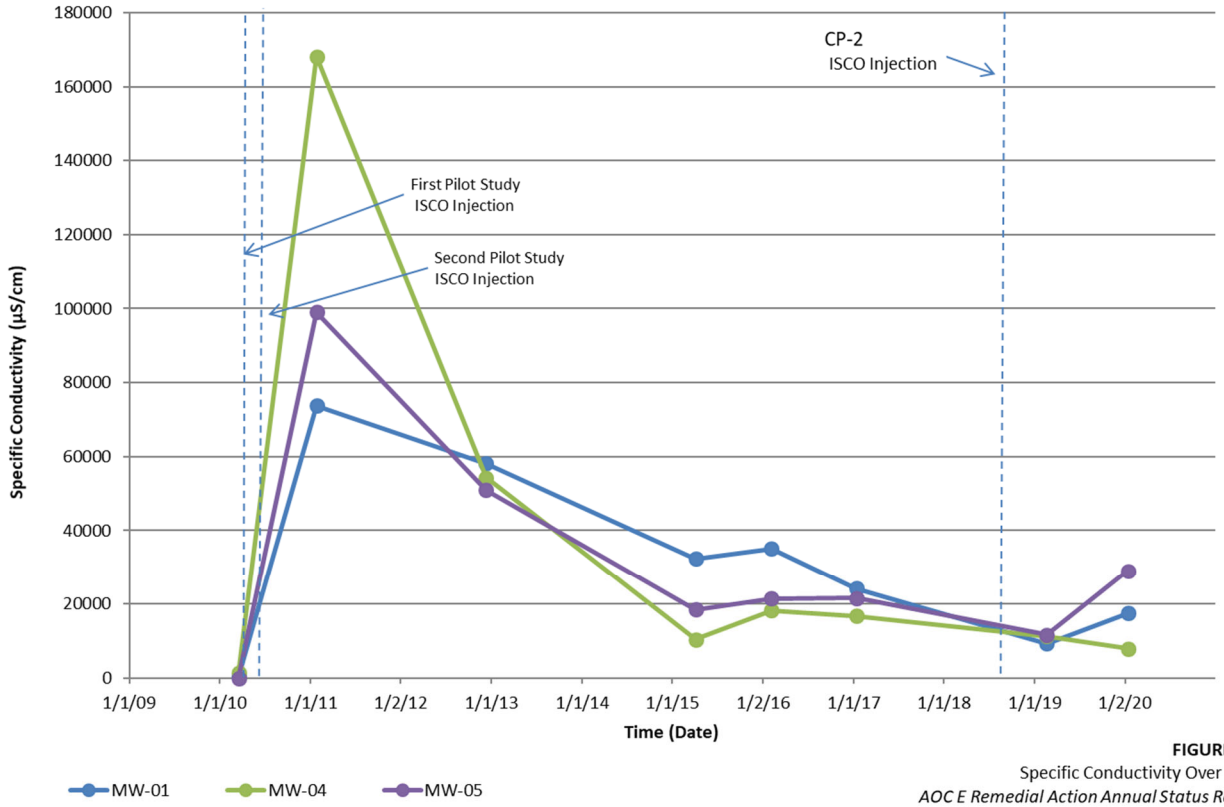


FIGURE 2-5
Specific Conductivity Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

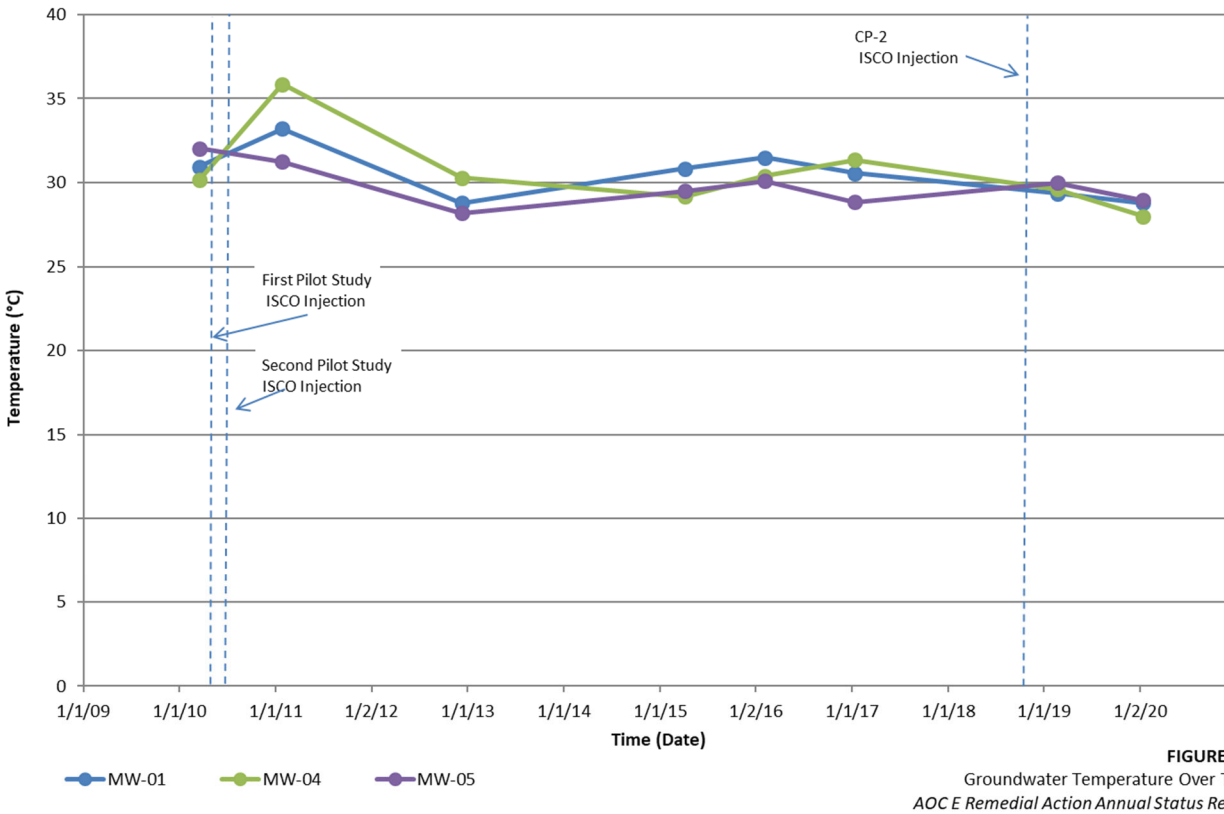


FIGURE 2-6
Groundwater Temperature Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

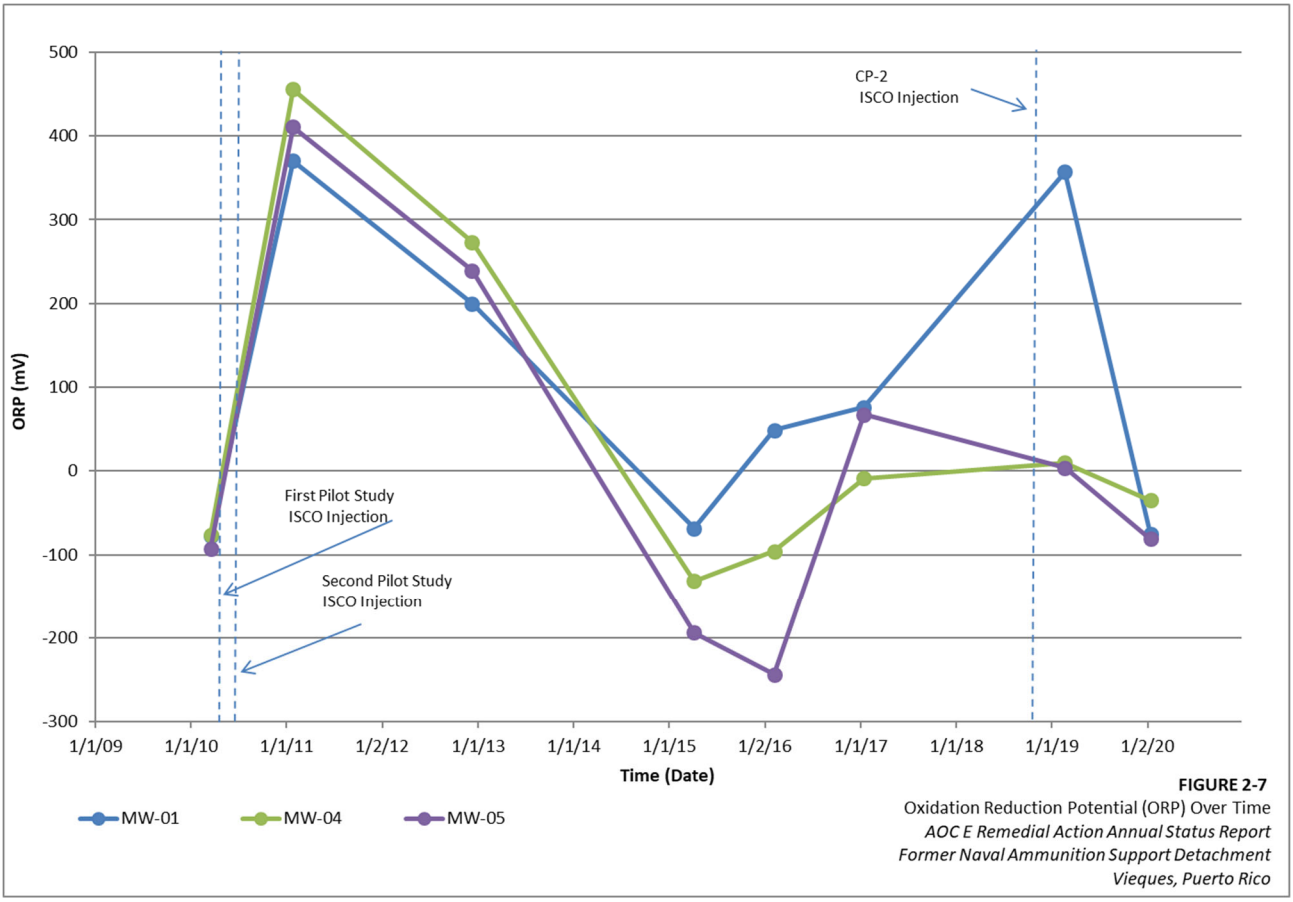


FIGURE 2-7
Oxidation Reduction Potential (ORP) Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

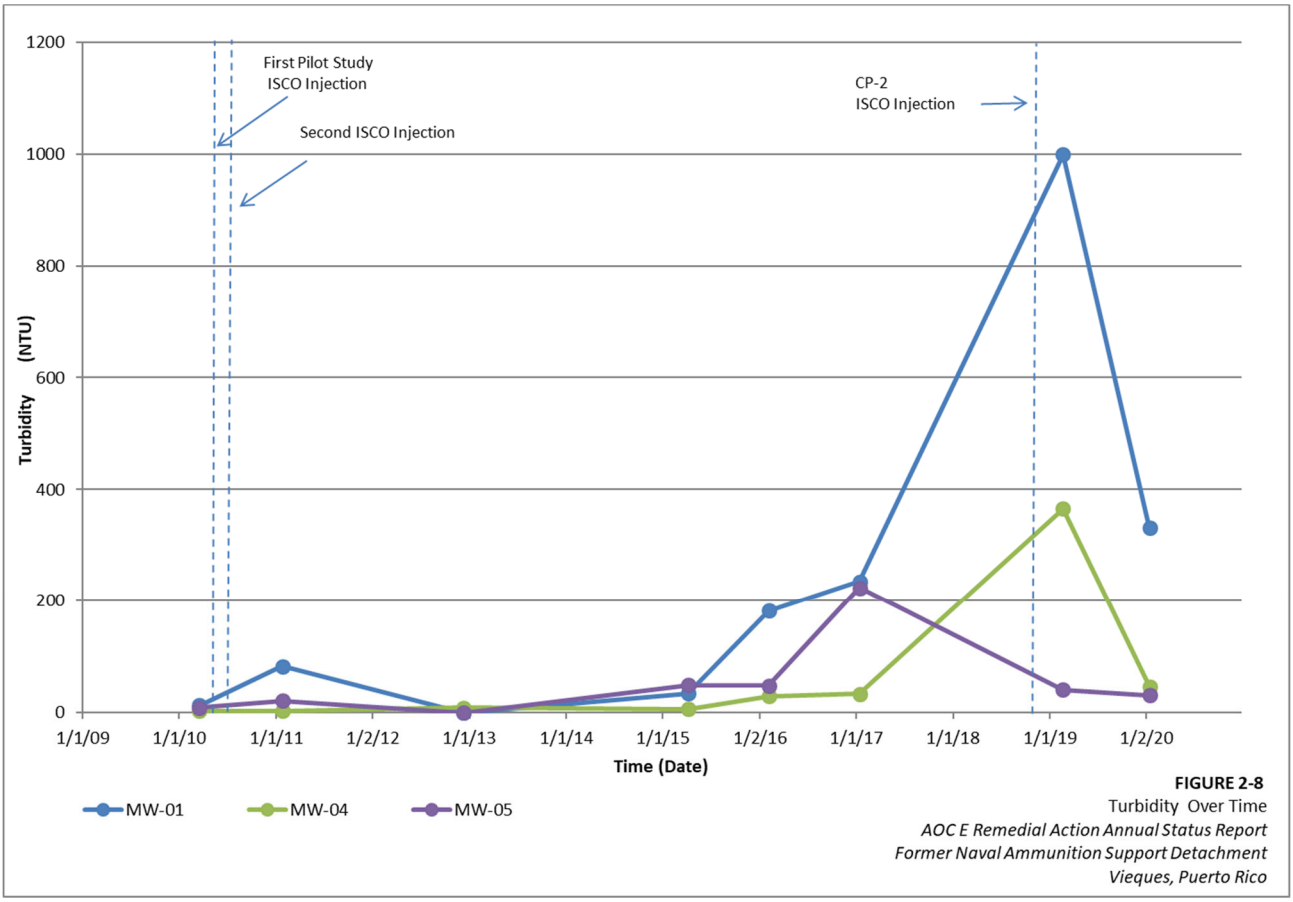
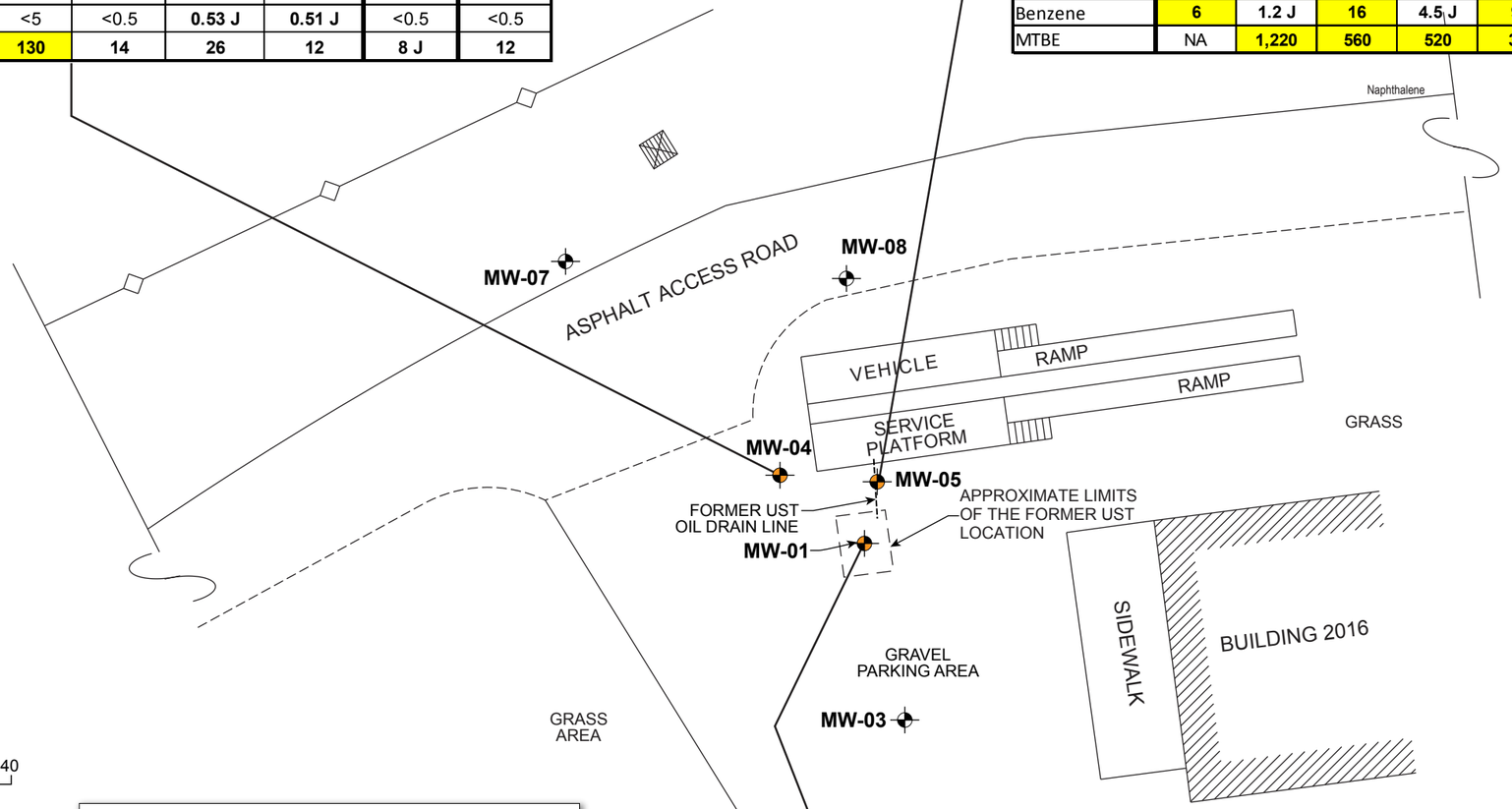
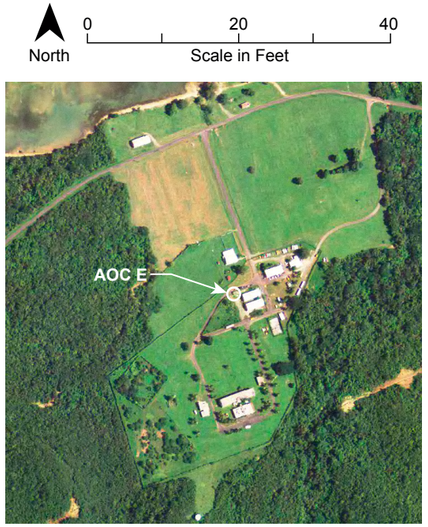


FIGURE 2-8
Turbidity Over Time
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Sample ID	MW04	MW04	MW04	MW04	MW04	MW04	MW04	MW04	MW04
Sample Date	05/01/00	08/30/04	07/29/08	03/17/10	04/01/15	01/06/16	01/13/17	02/20/19	01/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	<1	**4.6**	<0.5	<5	<0.5	<0.5	<0.5	<0.5	<0.5
Benzene	**2**	**0.72 J**	<0.5	<5	<0.5	**0.53 J**	**0.51 J**	<0.5	<0.5
MTBE	NA	**234**	**110**	**130**	**14**	**26**	**12**	**8 J**	**12**

Sample ID	MW05	MW05	MW05	MW05	MW05	MW05	MW05	MW05	MW05
Sample Date	5/1/00	8/30/04	7/29/08	3/17/10	4/1/15	1/6/16	1/13/17	2/20/19	1/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	**32**	**7.2**	<0.5	<0.5	**0.85 J**	**0.85 J**	<0.5	<0.5	**0.36 J**
Benzene	**6**	**1.2 J**	**16**	**4.5 J**	**9.8**	**7.8**	**7.9**	**2.7**	**0.45 J**
MTBE	NA	**1,220**	**560**	**520**	**350**	**380**	**340**	**140**	**230**





2004 Aerial Photograph

North 0 20 40 Scale in Feet

LEGEND

- Water-level Monitoring Well
- Performance Monitoring Well

Notes:

1. All concentrations are in microgram(s) per liter (µg/L).
2. **Bold** results indicate a detection.
3. Bold/highlighted results indicate RG exceedance.
4. **1st**, **2nd**, and **3rd Rounds** refer to Remedial Action-Operations Monitoring events prior to 2018 injection.

µg/L microgram(s) per liter
< Non-detected results (below detection limit)
J Estimated result
NA Not analyzed

Contaminant of Concern	RG (µg/L)
1,2-Dichloroethane (1,2-DCA)	3.8
Benzene	5
Methyl-tert-butyl ether (MTBE)	120

Sample ID	MW01	MW01	MW01	MW01	MW01	MW01	MW01	MW01	MW01
Sample Date	9/11/98	9/1/04	7/29/08	3/17/10	3/31/15	1/6/16	1/13/17	2/20/19	1/14/20
Volatile Organic Compounds (µg/L)					POST-ROD 1st Round	POST-ROD 2nd Round	POST-ROD 3rd Round	Infor-mational	Post-CP-2 1st Round
1,2-DCA	NA	<0.5	<0.5	<5	**4.4**	**7.5**	**6.6**	<0.5	<0.5
Benzene	**17**	**4.1**	**3.8**	**6.4**	**2.1**	**3.2**	**6.6**	**1.4 J**	**1.3**
MTBE	NA	**260**	**150**	**120**	**23**	**18**	**21**	<0.5	**0.93J**

Figure 2-9
Pre-ROD and Post-ROD Sampling Results
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

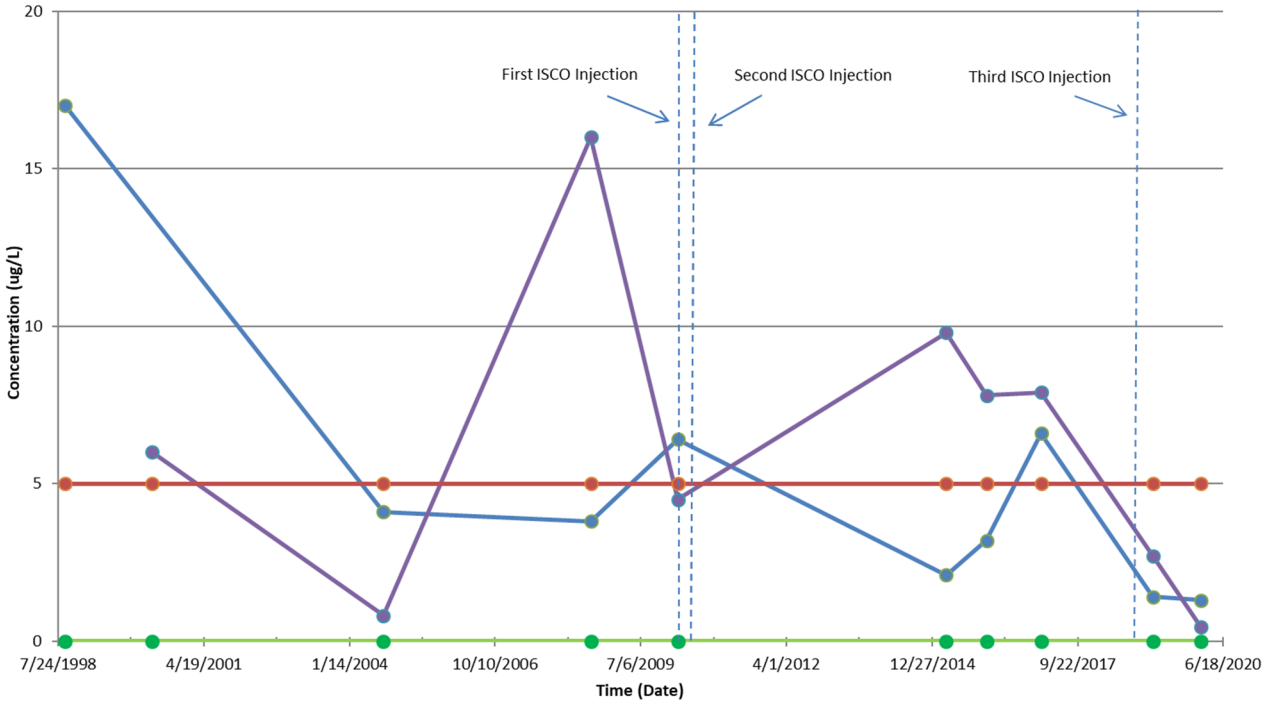


FIGURE 2-10
Groundwater COC Trends in Wells with Exceedances: Benzene
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

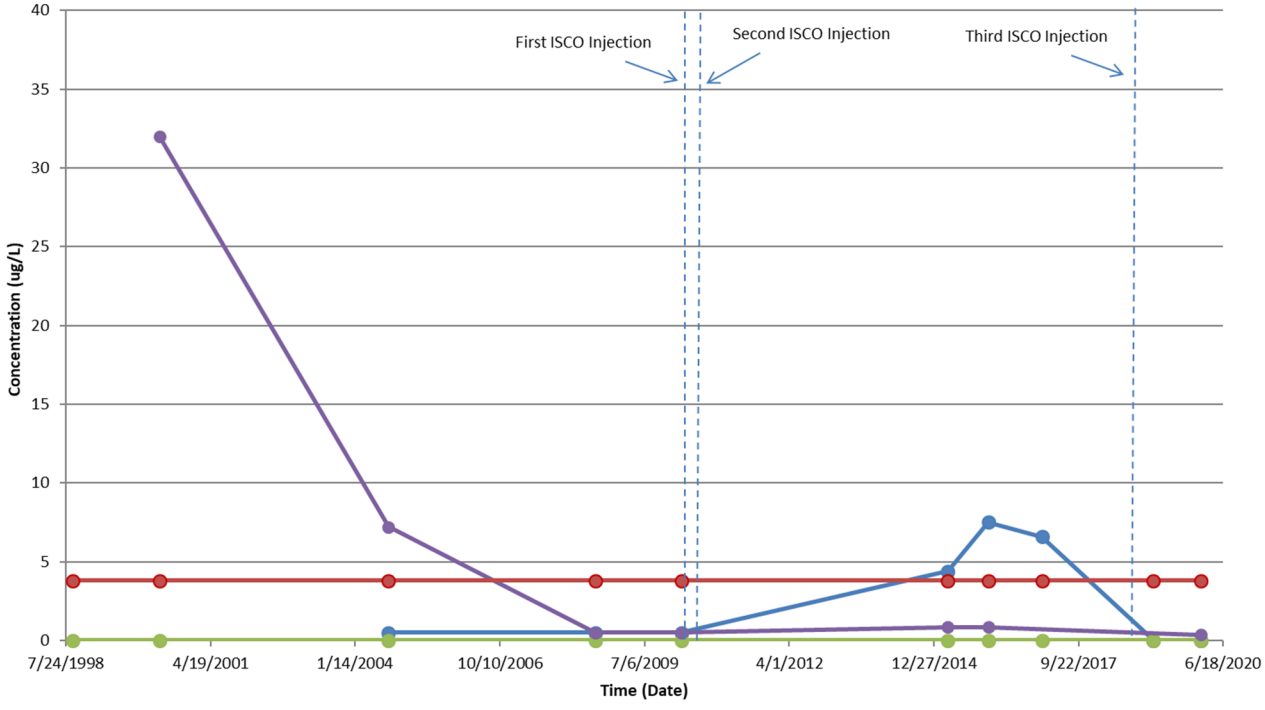


FIGURE 2-11
Groundwater COC Trends in Wells with Exceedances: 1,2-Dichloroethane
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

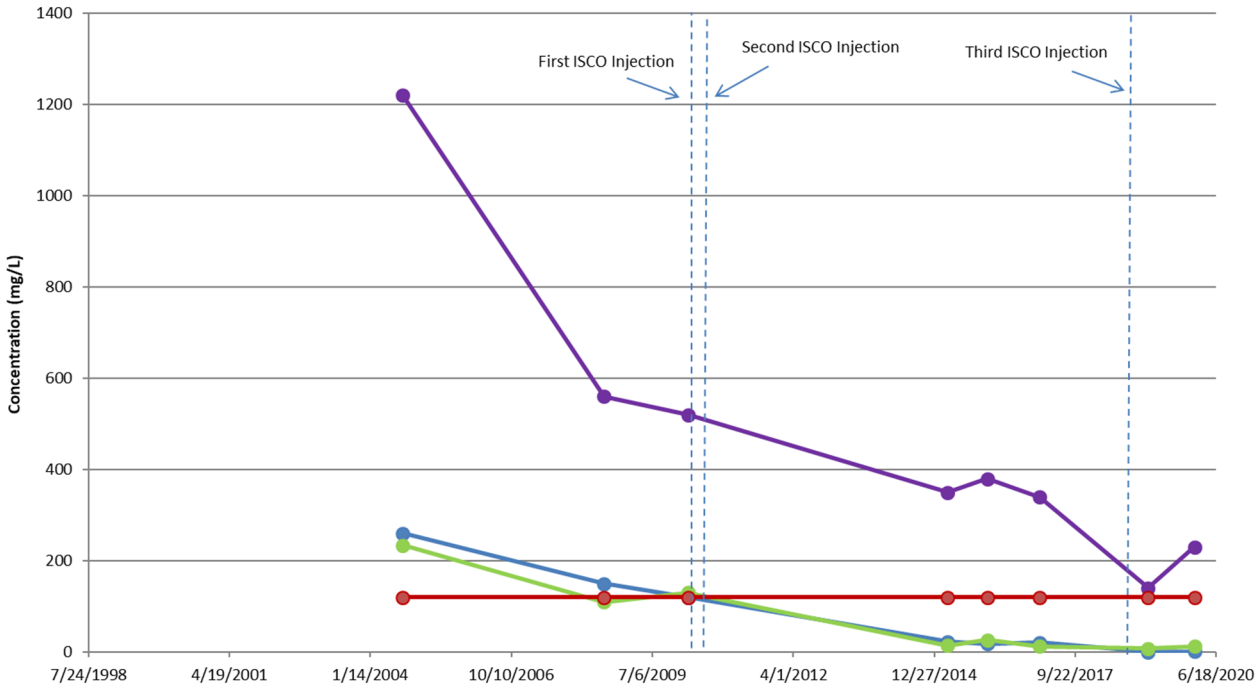


FIGURE 2-12
Groundwater COC Trends in Wells with Exceedances: MTBE
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

SECTION 3

Land Use Controls

This section discusses the inspection and findings associated with the physical controls (fence/gate, warning signs, and locks), vegetation, and condition of the monitoring wells at AOC E.

3.1 Inspection Details

LUC inspections were conducted on March 2, 2020. The 2020 inspection form and associated photographs are included in Appendix E. All eight warning signs were observed to be fastened securely, visible and legible, and undamaged. In addition, the fence surrounding the site was structurally sound with locks functioning properly on the gates. Vegetation on the fence (vines) was observed in certain areas and grass was observed to be fairly high, likely due to a wetter winter than usual. However, vegetation was clear around the monitoring wells and the area has been regularly cut. The north fence boundary area required manual vegetation clearance because the area was inaccessible to machinery due to building debris from Hurricane Maria (2017); vegetation clearance was performed on September 1, 2020.

Each monitoring well was inspected and determined to be sound. MW-01 and MW-05 still have injection ports on them with water-proof caps. Monitoring well pads MW-01, MW-04, MW-05, and MW-08 are exhibiting minor cracking, but none of the cracking is compromising well integrity.

There is a new rum distillery within the MOV that is adjacent to the site. Though the distillery has its own entrance they have placed a vinyl sign with their logo and directions to the distillery on the AOC E north fence which does not interfere with the visibility of LUC signs.

Because LUCs are in place and working as intended, there are no integrity issues warranting repairs or modifications. However, routine maintenance for vegetation and minor cracking observed on some well pads is recommended, as shown on the LUC Inspection Form in Appendix E.

SECTION 4

Conclusions and Recommendations

This section presents the conclusions of the remedial action-operations monitoring data evaluation and LUC activities and associated recommendations.

4.1 Conclusions

- Application of ISCO in 2018 resulted in a decline in COC concentrations in locations where they were elevated above RGs prior to ISCO application.
- The concentrations of two of the three COCs (i.e., benzene and 1,2-DCA) were already below or were reduced to concentrations below their respective RGs in all three wells.
- While the concentration of MTBE in well MW-05 is well below its historic high and is below its pre-CP-2 ISCO injection level, the concentration remains above the RG.
- LUCs are in place and functioning as intended. Routine maintenance has been performed to ensure they remain viable. Groundwater at the site is not being utilized by the MOV. Therefore, no changes to LUCs are warranted under the current remedial action.

4.2 Recommendations

- In accordance with ROD CP-2, monitoring wells MW-01, MW-04, and MW-05 should continue to be monitored annually for benzene, 1,2-DCA, and MTBE for at least 2 more successive years.
- LUCs should continue to be maintained while COC(s) concentrations remain above RG(s).
- Drinking water standards upon which the RGs were established for 1,2-DCA and MTBE have been revised by the associated regulatory agencies. Therefore, a ROD memorandum to file is recommended to document the rationale for revising the RGs accordingly, as described further:
  - The RG for 1,2-DCA (3.8 μg/L) was established using the Puerto Rico Water Quality Standards (PRWQS) drinking water standard available at the time the AOC E ROD was issued. However, since that time, PRDNER has revised the PRWQS; as such revising the RG to be consistent with the current PRWQS (i.e., 5 μg/L, which is also the Maximum Contaminant Level [MCL]) is warranted.
  - The RG for MTBE (120 μg/L based on excess lifetime cancer risk [ELCR] of $1X10^{-5}$) was established using the EPA Tap Water Regional Screening Level (RSL) available at the time the AOC E ROD was issued. However, since that time, EPA has revised the RSL; as such revising the RG to be consistent with the current RSL (i.e., 140 μg/L based on ELCR of $1X10^{-5}$) is warranted.
- Based on the observed COC concentrations and physical site conditions, an alternate path forward should be considered to best address low concentrations of COC(s) above RG(s) should they be observed during the next 2 successive monitoring events.

SECTION 5

References

CH2M HILL, Inc. (CH2M). 2015. Remedial Action Work Plan, Groundwater Monitoring and Institutional Controls with Contingency Plans, Area of Concern E, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. January.

CH2M. 2017. Area of Concern E Remedial Action Annual Status Report 2016, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. February.

CH2M. 2018a. Area of Concern E Remedial Action Annual Status Report 2017, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. February.

CH2M. 2018b. Master Standard Operating Procedures, Protocols, and Plans, Revision - 2018, Environmental Restoration Program, Vieques, Puerto Rico. April.

CH2M. 2018c. Remedial Action Work Plan Addendum Area of Concern E, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. July.

CH2M. 2019. Area of Concern E Interim Remedial Action Completion Report, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. September.

Naval Facilities Engineering Command Atlantic (NAVFAC). 2015. Record of Decision, Area of Concern (AOC) E, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. January.

Appendix A
Groundwater Sampling Logs

CH2MHILL

PROJECT NUMBER
675884CH.FI.FK.AE

SYNOPTIC WATER LEVEL LOG

Project: West Vieques, AOC E

Synoptic water levels of all wells must be collected before initiation of sampling activities

Note in 'comments' if well needs attention (ex: new lock)

AOC E

Date: 1-13-2020 **Equipment:** solinst WLM **Logger:** A. Shwartz

Well ID	Time	DTW (BTOC)	DTB (table 3)	Comments
MW-01	0929	41.30#	50	full of sludge/muck, odor
MW-02	0924	39.63		
MW-03	0921	40.35	50	
MW-04	0919	40.11	51	
MW-05	0916	40.72	50	
MW-06	———	———	44.52*	under a destroyer Bldg
MW-07	0926	40.53	50	
MW-08	0923	39.86	50	

* - 2017 gauging event

Notes:

MW01 - full of muck, hard to get actual reading of DTW as sensor becomes clogged & stays on as soon as it hits. Also has odor

Signature: [signature] **Date:** 1-13-2020

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
675884CH.FI.FK.AE	VWAEMW 01	

GROUNDWATER SAMPLING DATA SHEET

PROJECT : AOC-E GW Sampling LOCATION : Vieques, PR DATE: 1/13/2020

Weather: Sunny, low 80s, windy

Sample Team: T. Hom/TPA
A. Shwartz/ATL

Total Depth: 50 FT.(BTOC) Measured

Depth to Water: (-) 41.50 FT.(BTOC) Measured

Water Column(h): (=) 8.7 FT. 2 IN.

Water Volume in Well 1.42 GAL (3.141593*h(in)*(wellDIA/2)^2*0.004329

Pump Depth: 48 FT.(BTOC) Measured

Purge Device/Equip: Bladder Pump

Measuring Device/Equipment: Horiba

Date and Time On Well: 1/13/20 ~~1037~~ 1000

Pump Start Date and Time: 1/13/20 ~~1043~~ 1007

Pump Finish Date and Time: 1/14/20 0825

Date and Time Off Well: 1/14/20 0830

Air Monitoring Readings: 3.8 WC 0.0 O2

Total Purge Volume: 3.5 GAL.

SAMPLE INFORMATION

Sample ID: VWAE-GW01-0120

Sample Date/Time: 1/14/2020 0820

Field Dup: YES/NO ID: VWAE-GW01P-0120

FD Sample Date/Time: 1/14/2020 0825

MS/MSD: YES / (NO)

Were samples filtered? YES / (NO)

If YES, Which samples?

Parameters Colleced for: VOCs ~~Hcl~~ Ascorbic 10mg

Parameters Colleced for (FD) VOCs Ascorbic 10mg

Sample Appearance: dark, turbid, gray

Field Test Kit Details: ***Persulfate measurement not obtained due to high turbidity***

FIELD PARAMETERS

Time	Purged Vol. (gals)	Depth to Water (ft)	Flow Rate (mL/min)	Temp., (°C)	SpCond (uS/cm) w/in 3%	Salinity (ppt)	DO (%)	DO (mg/L) w/in 10%	pH w/in 0.1	ORP (mV) w/in 10mV	Turbidity (NTU) w/in 10%	Color / Odor / Comments
1035	0.6	~43.5	250	28.73	17.8	10.5	2.7	0.19	6.16	-59	783	haze, odor
1040	0.9	~44.0	250	28.58	17.8	10.5	2.3	0.16	6.16	-62	713	
1045	1.2	~44.0	250	28.49	17.7	10.4	2.0	0.14	6.17	-65	539	
1050	1.5	~44.0	250	28.62	17.6	10.4	2.0	0.14	6.18	-66	400	one well volume
1055	1.8	~44.0	250	28.73	17.6	10.3	2.1	0.15	6.19	-66	437	
1100	2.1	~44.0	250	28.64	17.5	10.3	1.7	0.13	6.20	-69	309	
1105	2.4	~44.0	250	28.7	17.5	10.3	1.2	0.09	6.20	-72	506	
1110	2.7	~44.0	250	28.6	17.5	10.3	0.9	0.07	6.22	-75	310	two well vol
1115	3.0	~44.0	250	28.79	17.5	10.3	1.2	0.08	6.23	-75	331	use for parameters
1120	3.3	(~44.0)	250	28.97	17.4	10.3	11.0	0.82	6.22	-59	402	lots of airbubbles Ignore
		well dry - water level meter not picking up change due to sludge - allowed to recharge										
1/14/20 0825		48.15										

Signature: Date: 1/14/20

CH2MHILL

PROJECT NUMBER: 675884CH.FI.FK.AE | WELL NUMBER: VWAEMW04 | SHEET 1 OF 1

GROUNDWATER SAMPLING DATA SHEET

PROJECT: AOC-E GW Sampling | LOCATION: Vieques, PR | DATE: 1-13-20

Weather: partly cloudy 79°F | Sample Team: T. Horn/TPA, A. Shwartz/ATL

Total Depth: 51.0 FT.(BTOC) Measured

Depth to Water: (-) 39.86 FT.(BTOC) Measured

Water Column(h): (=) 11 FT. 14 IN.

Water Volume in Well: 1.82 GAL (3.141593*h(in)*(wellDIA/2)^2*0.004329)

Pump Depth: 47 FT.(BTOC) Measured

Purge Device/Equip: Bladder #102220 w/MP50

Measuring Device/Equipment: Horiba #21169

Date and Time On Well: 1-13-20 / 0942

Pump Start Date and Time: 1-13-20 / 0954

Pump Finish Date and Time: 1-13-20 / 1230

Date and Time Off Well: 1-14-20 / 0930

Air Monitoring Readings: 0.0 ppm

Total Purge Volume: 3.50 GAL.

SAMPLE INFORMATION

Sample ID: VWAE-GW04-0120 | Parameters Collected for: VOC

Sample Date/Time: 1-14-20 / 0900

Field Dup: YES / (NO) ID: N/A | Parameters Collected for (FD): N/A

FD Sample Date/Time:

MS/MSD: YES / (NO)

Were samples filtered? (YES) / NO | Field Test Kit Details: persulfate ~~0.0 mg/L~~ Less than 0.7 mg/L

If YES, Which samples? N/A | Sample Appearance: clear, slight amber color, odor

FIELD PARAMETERS

Time	Purged Vol. (gals)	Depth to Water (ft)	Flow Rate (mL/min)	Temp., (°C)	SpCond (µS/cm) w/in 3%	Salinity (ppt)	DO (%)	DO (mg/L) w/in 10%	pH w/in 0.1	ORP (mV) w/in 10mV	Turbidity (NTU) w/in 10%	Color / Odor / Comments
1-13-2020												
1010	1.5	42.94	285	27.65	7.85	4.3	6.4	0.10	10.59	-6	11.5	Amber color
1015	1.75	44.18	210	27.76	7.90	4.4	1.5	0.13	10.66	-20	13.2	slowed pump
1020	1.90	44.45	210	27.78	7.93	4.4	0.7	0.05	10.69	-26	10.6	
1025	2.10	44.70	↓	27.86	7.92	4.4	0.0	0.0	10.73	-33	14.2	
1030	2.25	44.71		27.90	7.93	4.4	0.3	0.0	10.77	-38	18.5	
1035	2.35	44.99		28.00	7.94	4.4	65.7	4.98	10.77	-11	35.8	well going dry
1040	2.50	45.41	↓	27.74	7.95	4.4	64.7	4.86	10.78	-13	54.2	air bubbles in the
1045	2.90	46.22	250	27.63	7.95	4.4	59.2	4.55	10.82	-24	75.7	lower pump
1050	3.25	—	↓	28.00	7.95	4.4	55.2	4.15	10.86	-35	47.1	will on top of pump
1056	— well dry - turn off & allow recharge - can't get level slow to recharge, pull pump & come back tomorrow											
0945 1-14-2020	—	40.54	—									slight purge ≈ 0.25gal then sample
		Sample @ 0900										All samples using 10mg of Asc Acid as preservative

Signature: [signature] Date: 1-14-20

CH2MHILL

PROJECT NUMBER	WELL NUMBER	SHEET 1 OF 1
675884CH.FI.FK.AE	VWAEMW05	

GROUNDWATER SAMPLING DATA SHEET

PROJECT : AOC-E GW Sampling LOCATION : Vieques, PR DATE: 1-13-20

Weather: partly cloudy 82°F

Sample Team: T. Horn/TPA
A. Shwartz/ATL

Total Depth: 50.0 FT.(BTOC) Measured

Depth to Water: (-) 40.36 FT.(BTOC) Measured

Water Column(h): (=) 9 FT. 64 IN.

Water Volume in Well 1.57 GAL (3.141593*h(in)*(wellDIA/2)^2*0.004329

Pump Depth: 48 FT.(BTOC) Measured

Purge Device/Equip: QED Bladder # 102220

Measuring Device/Equipment: Horiba # 21169

Date and Time On Well: 1-13-20 / ~~0440~~ 1340

Pump Start Date and Time: 1-13-20 / 1349

Pump Finish Date and Time: 1-13-20 / 1432

Date and Time Off Well: 1-14-20 / 0830

Air Monitoring Readings: 0.0 ppm

Total Purge Volume: 2.50 GAL.

SAMPLE INFORMATION

Sample ID: VWAE-GW05-0120 Parameters Colleced for: VOC

Sample Date/Time: 1-14-20 / 0820

Field Dup: YES/NO ID: N/A Parameters Colleced for (FD) N/A

FD Sample Date/Time: N/A

MS/MSD: YES (NO)

Were samples filtered? YES (NO)

If YES, Which samples? N/A

Sample Appearance: clear, slightly gray, odor

Field Test Kit Details: persulfate ~~= 0.0 mg/L~~

Less than 0.7 mg/L

FIELD PARAMETERS

Time	Purged Vol. (gals)	Depth to Water (ft)	Flow Rate (mL/min)	Temp., (°C)	SpCond (µS/cm) w/in 3%	Salinity (ppt)	DO (%)	DO (mg/L) w/in 10%	pH w/in 0.1	ORP (mV) w/in 10mV	Turbidity (NTU) w/in 10%	Color / Odor / Comments
1-13-2020												
1400	0.75	43.45	260	23.03	9.12	5.1	1.9	0.15	7.22	-85	60.1	
1410	1.25	44.10	↓	28.21	8.89	5.0	0.0	0.0	6.93	-89	82.8	
1415	1.50	44.73		28.31	9.05	5.1	0.0	0.0	6.87	-96	66.5	
1420	1.75	45.87		27.96	9.13	5.1	0.0	0.0	6.86	-89	34.4	
1425	2.00	46.80		28.42	10.0	5.6	0.0	0.0	6.88	-80	39.1	
1430	2.25	—	↓	28.95	10.0	5.6	0.0	0.0	6.92	-81	31.1	w/m on top of pump
1432	—	—	—	well DRY	—	—	—	—	—	—	—	—
1-14-2020												
0745	—	44.56	—	—	—	—	—	—	—	—	—	start pump & purge ≈ 1.25 gal
		sample @ 0820										
												AS per instruction from PM, use same method of preservative for all 3 wells. MW01 cannot determine persulfate as water is to murky therefore all samples will use 10mg of ASC ACID

Signature: [signature] Date: 1-14-20

Appendix B
Analytical Results Summary Tables

APPENDIX B
Analytical Results Summary Table
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Station ID	WAE-MW01		WAE-MW04	WAE-MW05	WAE-MW01		WAE-MW04	WAE-MW05	VW-AOC-E-QC			
Sample ID	VWAE-MW01-0219	VWAE-MW01P-0219	VWAE-MW04-0219	VWAE-MW05-0219	VWAE-MW01-0120	VWAE-MW01P-0120	VWAE-MW04-0120	VWAE-MW05-0120	VWAE-EB01-022019-GW	VWAE-TB01-022019	VWAE-EB01-011420-GW	VWAE-TB01-011420
Sample Date	02/20/19	02/20/19	02/20/19	02/20/19	01/14/20	01/14/20	01/14/20	01/14/20	02/20/19	02/20/19	01/14/20	01/14/20
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,2-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.36 J	0.26 J	0.21 J	0.5 U	0.5 U
Benzene	1.4 J	1.4 J	0.5 U	2.7	0.95 J	1.3	0.5 U	0.45 J	0.5 U	0.5 U	0.5 U	0.5 U
Methyl-tert-butyl ether (MTBE)	0.5 U	0.5 U	8 J	140	0.93 J	0.92 J	12	230	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

Shading indicates detections

J = analyte present, value may or may not be accurate or precise

U = the material was analyzed for, but not detected

UG/L = micrograms per liter

Appendix C
Data Validation Reports

ENVIRONMENTAL
Data Services, Inc.

DATA VALIDATION SUMMARY REPORT
VIEQUES ISLAND, PUERTO RICO

Client: CH2M HILL, Inc., Herndon, Virginia
SDG: SN0342
Laboratory: Katahdin Analytical Services, Inc., Scarborough, Maine
Site: Vieques Island, CTO-0013, AOC E, Puerto Rico
Date: February 26, 2020

EDS ID	Client Sample ID	Laboratory Sample ID	Matrix
1	VWAE-MW01-0120	SN0342-1	Water
2	VWAE-MW01P-0120	SN0342-2	Water
3	VWAE-MW04-0120	SN0342-3	Water
3MS	VWAE-MW04-0120MS	SN0342-3MS	Water
3MSD	VWAE-MW04-0120MSD	SN0342-3MSD	Water
4	VWAE-EB01-011420-GW	SN0342-4	Water
5	VWAE-TB01-011420	SN0342-5	Water
6	VWAE-MW05-0120	SN0342-6	Water
6DL	VWAE-MW05-0120DL	SN0342-6DL	Water

A full data validation was performed on the analytical data for four water samples, one aqueous equipment blank sample, and one aqueous trip blank sample collected on January 14, 2020 by CH2M HILL at the Vieques Island, AOC E site in Puerto Rico. The samples were analyzed under the "Test Methods for the Evaluation of Solid Waste, USEPA SW-846, Third Edition, September 1986, with revisions".

Specific method references are as follows:

Analysis	*Method References*
VOC	USEPA SW-846 Method 8260C

The data have been validated according to the protocols and quality control (QC) requirements of the analytical methods, the Final Area of Concern E Remedial Action Groundwater Long-Term Monitoring Sampling and Analysis Plan, January 2015, and the USEPA Region II Data Review Standard Operating Procedures (SOPs) as follows:

- SOP Number HW-33A, Revision 1, September 2016: Low/Medium Volatile Data Validation;
- and the reviewer's professional judgment.

The following items/criteria were reviewed for this report:

Organics

- Holding times and sample preservation
- Gas Chromatography/Mass Spectrometry (GC/MS) Tuning
- Initial and continuing calibration summaries
- Method blank and field blank contamination
- Surrogate Spike recoveries
- Matrix Spike/Matrix Spike Duplicate (MS/MSD) recoveries
- Laboratory Control Sample (LCS) recoveries
- Internal standard area and retention time summary forms
- Target Compound Identification
- Compound Quantitation
- Tentatively Identified Compounds (TICs)
- Field Duplicate sample precision

Data Usability Assessment

There were no rejections of data.

Overall the data are acceptable for the intended purposes. There were no qualifications.

Volatile Organic Compounds (VOC)

Holding Times

- All samples were analyzed within 14 days for preserved water samples.

GC/MS Tuning

- All criteria were met.

Initial Calibration

- All %RSD and/or correlation coefficients and mean RRF criteria were met.

Continuing Calibration

- All %D and RRF criteria were met.

Method Blank

- The method blanks were free of contamination.

Field Blank

- Field QC results are summarized below.

Blank ID	Compound	Conc. ug/L	Qualifier	Affected Samples
VWAE-EB01-011420-GW	None - ND	-	-	-
VWAE-TB01-011420	None - ND	-	-	-

Surrogate Spike Recoveries

- All samples exhibited acceptable surrogate %R values.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) Recoveries

- The MS/MSD sample exhibited acceptable %R and RPD values.

Laboratory Control Samples

- The LCS samples exhibited acceptable percent recoveries (%R).

Internal Standard (IS) Area Performance

- All internal standards met response and retention time (RT) criteria.

Target Compound Identification

- All mass spectra and quantitation criteria were met.

Compound Quantitation

- EDS Sample 6 exhibited a high concentration of MTBE over the calibration range of the instrument and was flagged (E) by the laboratory. The sample was diluted and reanalyzed and the dilution result for MTBE should be used for reporting purposes.

Tentatively Identified Compounds (TICs)

- TICs were not reported.

Field Duplicate Sample Precision

- Field duplicate results are summarized below. The precision was acceptable.

Compound	VWAE-MW01-0120 ug/L	VWAE-MW01P-0120 ug/L	RPD	Qualifier
Methyl tert-butyl Ether	0.93	0.92	1%	None
Benzene	0.95	1.3	31%	

Please contact the undersigned at (757) 564-0090 if you have any questions or need further information.

Signed: Nancy Weaver Dated: 2/29/20

Nancy Weaver
Senior Chemist

Data Qualifier	Definition
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The analyte is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
NJ	The analysis has been "tentatively identified" or "presumptively" as present and the associated numerical value is the estimated concentration in the samples.
UJ	The analyte was analyzed for but was not detected. The reported quantitation limits is approximate and may be inaccurate or imprecise.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the samples.

Katahdin
ANALYTICAL SERVICES

Report of Analytical Results

Client: CH2M
Lab ID: SN0342-1
Client ID: VWAE-MW01-0120
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4467.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 17-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270220

Analysis Date: 17-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether	J	0.93	ug/L	1	1	1.0	0.36	0.50
Benzene	J	0.95	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	U	0.50	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		94.6	%					
Toluene-d8		98.2	%					
1,2-Dichloroethane-d4		95.2	%					
Dibromofluoromethane		96.8	%					

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MT 2/26/20

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2

Report of Analytical Results

Client: CH2M
Lab ID: SN0342-2
Client ID: VWAE-MW01P-0120
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4466.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 17-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270220

Analysis Date: 17-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether	J	0.92	ug/L	1	1	1.0	0.36	0.50
Benzene		1.3	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	U	0.50	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		94.7	%					
Toluene-d8		97.6	%					
1,2-Dichloroethane-d4		95.9	%					
Dibromofluoromethane		97.1	%					

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Report of Analytical Results

Client: CH2M
Lab ID: SN0342-3
Client ID: VWAE-MW04-0120
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4503.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 21-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270429

Analysis Date: 21-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether		12	ug/L	1	1	1.0	0.36	0.50
Benzene	U	0.50	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	U	0.50	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		100.	%					
Toluene-d8		99.1	%					
1,2-Dichloroethane-d4		114.	%					
Dibromofluoromethane		102.	%					

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4

Report of Analytical Results

Client: CH2M
Lab ID: SN0342-4
Client ID: VWAE-EB01-011420-GW
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4433.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 16-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270155

Analysis Date: 16-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether	U	0.50	ug/L	1	1	1.0	0.36	0.50
Benzene	U	0.50	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	U	0.50	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		92.6	%					
Toluene-d8		97.8	%					
1,2-Dichloroethane-d4		110.	%					
Dibromofluoromethane		102.	%					

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Report of Analytical Results

Client: CH2M
Lab ID: SN0342-5
Client ID: VWAE-TB01-011420
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4432.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 16-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270155

Analysis Date: 16-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether	U	0.50	ug/L	1	1	1.0	0.36	0.50
Benzene	U	0.50	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	U	0.50	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		91.3	%					
Toluene-d8		96.8	%					
1,2-Dichloroethane-d4		104.	%					
Dibromofluoromethane		100.	%					

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Report of Analytical Results

Client: CH2M
Lab ID: SN0342-6
Client ID: VWAE-MW05-0120
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4465.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 17-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270220

Analysis Date: 17-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether	~~E~~	~~200~~ 230	ug/L	~~1~~ 10	1	~~1.0~~ 10	~~0.36~~ 3.6	~~0.50~~ 5.0
Benzene	J	0.45	ug/L	1	1	1.0	0.26	0.50
1,2-Dichloroethane	J	0.36	ug/L	1	1	1.0	0.20	0.50
P-Bromofluorobenzene		91.6	%					
Toluene-d8		97.3	%					
1,2-Dichloroethane-d4		94.0	%					
Dibromofluoromethane		95.7	%					

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ANALYTICAL SERVICES

6DL

Report of Analytical Results

Client: CH2M
Lab ID: SN0342-6DL
Client ID: VWAE-MW05-0120
Project: CTO 0003 Vieques AOC E
SDG: SN0342
Lab File ID: T4440.D

Sample Date: 14-JAN-20
Received Date: 15-JAN-20
Extract Date: 16-JAN-20
Extracted By: CR
Extraction Method: SW846 5030
Lab Prep Batch: WG270155

Analysis Date: 16-JAN-20
Analyst: CR
Analysis Method: SW846 8260C
Matrix: AQ
% Solids: NA
Report Date: 09-FEB-20

use original

Compound	Qualifier	Result	Units	Dilution	LOQ	ADJ LOQ	ADJ MDL	ADJ LOD
Methyl tert-butyl Ether		230	ug/L	10	1	10.	3.6	5.0
Benzene	U	5.0	ug/L	10	1	10.	2.6	5.0
1,2-Dichloroethane	U	5.0	ug/L	10	1	10.	2.0	5.0
P-Bromofluorobenzene		96.0	%					
Toluene-d8		98.5	%					
1,2-Dichloroethane-d4		114.	%					
Dibromofluoromethane		103.	%					

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Appendix D
Data Quality Evaluation

Final

Data Quality Evaluation
Area of Concern E
Remedial Action Groundwater Long-Term Monitoring Report

Atlantic Fleet Weapons Training Area – Vieques
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

November 2020

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

NAVFAC CLEAN Program
Contract N62470-16-D-9000

Contract Task Order 0003

Prepared by
ch2m.
Virginia Beach, Virginia

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Tables

1 Qualifiers and Availability

Acronyms and Abbreviations

AOC	Area of Concern
COC	contaminant of concern
DoD	Department of Defense
DQE	Data Quality Evaluation
DQO	data quality objective
ELCR	excess lifetime cancer risk
EPA	Environmental Protection Agency Region 2
GW	groundwater
HI	hazard index
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
MCL	Maximum Contaminant Level
MS	matrix spike
MSD	matrix spike duplicate
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
PRWQS	Puerto Rico Water Quality Standards
QA	quality assurance
QC	quality control
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SL	screening level
SOP	Standard Operating Procedure
TCE	trichloroethylene
UFP	Uniform Federal Policy
VOC	volatile organic compound

SECTION 1

Data Quality Assessment

This Data Quality Evaluation (DQE) assesses the effect of the overall analytical process on the "availability" of the analytical data. "Availability" in this context refers to whether results can be used by the project team based on their analytical soundness. If a result is analytically sound, it is available for use for evaluating the potential releases, nature and extent of contamination, and estimating potentially associated human health and ecological risks. However, a particular result or group of results may not be "usable" for these purposes if other conditions apply. For example, if there were a hypothetical site where a trichloroethene (TCE) spill had occurred and the TCE data for many or all of the samples were rejected, the data may not be usable for making site-specific determinations even if all the non-TCE data were analytically sound and available for use by the project team. In order to avoid confusion of terms, this DQE differentiates the "availability" of results from "usability" of results. "Available" results are analytically sound and available for use by the project team to make decisions, even if they are not usable for a particular purpose.

The three major categories of data evaluation are laboratory performance, field collection performance (i.e. blank contamination), and matrix interferences. Evaluation of laboratory performance is a check for compliance with the method requirements; in other words, a check of whether the laboratory analyzed the samples within the limits of the analytical method. Additionally, a third-party validator, Environmental Data Services, Inc., conducted a review of the laboratory data to assess whether the analytical methods were within required control limits at the time of analysis. Evaluation of potential matrix interferences involves the review of several areas of results, including surrogate spike recoveries, matrix spike recoveries, and duplicate sample results. Evaluation of field collection performance, such as blank contamination and field duplicates, involves the review of field quality control (QC) and the determination of their effect on the sample results.

The data evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with a review by a third-party data validator, and ends with an overall review by the Navy contractor project chemistry team. The process provides a medium for essential communication between the laboratory, validator, and project team, and allows for data quality to be thoroughly evaluated.

This document presents the results of the data quality evaluation performed on one data set:

- Vieques_West Area of Concern (AOC) E Remedial Action Groundwater Long-Term Monitoring January 2020
  - Activity: Vieques_West
  - Site: AOC E
  - Matrices: groundwater (GW)
  - Date Range: January 2020
  - Data Use: Definitive

1.1 Laboratory Internal Quality Control Review

Prior to releasing the analytical data, the laboratory, Katahdin Analytical Laboratory, reviewed both the sample and QC data to verify sample identity, instrument calibration, limits of quantitation (LOQs), dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. In addition, the QC data were tabulated, and the results were reviewed to ascertain whether they were within the contract-required or laboratory-defined limits for accuracy and precision. Any non-conforming data were discussed in the data package cover letter and case narrative. The case narrative was then reviewed by the data validator and incorporated into the data validation report. If necessary, the exceedances were verified, and qualifiers were applied based on this information.

1.2 Data Validation

Third-party data validators reviewed all data packages using the validation criteria outlined in the site-specific Uniform Federal Policy (UFP) Sampling and Analysis Plan (SAP) Worksheets #34-36 (CH2M, 2015). For the most part, these Worksheets reference the appropriate Environmental Protection Agency Region 2 (EPA) Standard Operating Procedure (SOP) if such an SOP exists for that analysis method. Then, UFP-SAP limits are used in place of those referenced in the SOP. If an EPA SOP does not exist for the analysis method, then the data are validated against the limits in the UFP-SAP. Guidance and qualifiers are taken from related EPA SOPs and guidance is taken from National Functional Guidelines. The following protocol was used for validation:

- For volatile organic compounds (VOCs) via SW-846 8260C:
  - "Low/Medium Volatile Data Validation (SOP HW-33A, Rev. 1)" (September, 2016)
  - UFP-SAP limits for accuracy/precision (CH2M HILL, 2015)

As stated previously, the data validation process was separate from the laboratory's internal review. The process was specifically focused on the effects of the laboratory's performance and sample matrix on the analytical results. Example areas of review include holding time compliance, surrogate recovery accuracy, matrix spiked sample precision and accuracy, blank contamination, initial and continuing calibration accuracy and precision, laboratory control sample accuracy, internal standard response and retention time accuracy, instrument tune criteria accuracy, and duplicate sample precision (laboratory replicates and field duplicates). Please refer to the complete data validation report for full areas of review.

Multiple analyses are most often the result of concentrations exceeding the calibration range or QC results outside of control limits. When multiple analyses were performed, the "best result" was selected for purposes of this DQE. Among multiple valid and/or invalid results, the "best result" is:

1. The non-rejected result
2. The result from the appropriate concentration range (dilution factor)
3. The detect when one or more result is detected, and one or more result is non-detect
4. The greater of detects, and
5. The lesser of non-detects (U-Values)

Qualification of data is not an unusual occurrence. To define a laboratory QC exceedance and when a laboratory QC exceedance occurs, the laboratory refers to its in-house SOPs. The SOPs are based on United States Department of Defense (DoD) requirements, the requested analytical method, and accumulated laboratory experience. When a laboratory QC exceedance occurs, the situation may be acceptable, or it may require further action by the laboratory, such as application of a laboratory qualifier or re-extraction and/or re-analysis of the sample. The data validator uses a separate set of QC criteria, based on guidance from the EPA region that applies to the samples. A laboratory QC exceedance may not constitute a data validation exceedance and a data validation exceedance may not constitute a laboratory QC exceedance. Data validation criteria exceedances may result in the qualification of or rejection of data, as deemed appropriate by the data validator.

The data validator examines each data point and determines any effects that QC exceedances have had. Most often, these effects dictate that the result or limit of detection (LOD) should be considered estimated but is still available for use. The J-qualification, J+-qualification, UJ-qualification, and U-qualification of results are common occurrences and have no adverse effect on the availability of that result to the project team for making decisions. J-qualified and J+-qualified results are available, at the reported result, for use as detects as long as they are considered "estimated" by the project team. Human health risk assessment guidance suggests that these qualifiers "indicate uncertainty in the reported concentration of the chemical, but not in its assigned identity.

Therefore, these data can be used just as positive data with no qualifiers or codes." In addition, the same risk assessment guidance (EPA, 1989) suggests that one should use "J-qualified concentrations the same way as

positive data that do not have this qualifier." U-qualified and UJ-qualified results are available, at the reported LOD or level, for use as non-detects as long as they are considered "non-detect or not detected at significantly greater than that in an associated blank" or "non-detect, estimated LOD," as appropriate.

In extreme cases, a result is rejected and deemed to be unusable. "Unusable" in this instance is defined as a result that is not analytically sound and is not generally considered available for use by the project team. In some cases, the project team may still decide to use a rejected result. An example of this occurrence would be if a result is rejected because it is biased extremely high, yet it is still less than the screening level (SL). A conservative decision may be made to consider this result a non-exceedance, even if its concentration was rejected. For that reason, it is important to examine why a result was rejected. For the most part, however, rejected results are not usable, and the R-qualifier is the only qualifier that has an adverse effect on the availability of data.

In large data sets, rejected results are often inconsequential because there are sufficient non-rejected data available to the project team. If there are enough non-rejected data or the project team is able to infer results from adjacent sampling locations or there is other site-specific information that can provide additional lines of evidence, it may not be necessary to know the concentrations of some rejected constituents. It may also not be necessary to prove a constituent's absence if there are sufficient additional lines of evidence.

1.3 Primary Data Validation Qualifiers

The following data validation qualifiers were applied to one or more analytical results:

- U – Not detected. Sample was analyzed for this parameter, but it was not detected at greater than the reported LOD. The data validator may also apply this qualifier to indicate that a concentration was not detected at significantly greater than that in an associated blank. Thus, this qualifier does not necessarily indicate a quality control exceedance.
- J – Concentration estimated. The parameter was positively identified, and the associated numerical value is the approximate concentration of the parameter in the sample. Often, a J-qualifier is applied simply because the result was less than the limit of quantitation and thus does not necessarily indicate a quality control exceedance.
- [none] – Detected. Qualification was not warranted.

1.4 Impact of Data Quality on Project Data Quality Objectives and Data Usability

The laboratories analyzed the samples in accordance with the respective analysis methods and SOP. The data packages were reviewed by a data validator taking guidance from EPA Region 2 validation procedures. Field QC samples were collected and analyzed at the planned frequencies.

The laboratory utilized various qualifiers to represent "below reporting limit," "non-detect," and "detected." Any other extraneous laboratory qualifiers were superseded by data validation qualifiers. The data validator utilized J-qualifiers and U-qualifiers to represent "estimated," and "non-detect," respectively. The only time the data validator changed a result's detect status was when J-qualifiers were changed to U-qualifiers (detect to non-detect) as a result of blank contamination.

The J-qualifiers indicate that some results are estimated. These qualifiers indicate that data are available for use as detects. These qualifiers do not necessarily indicate a problem that adversely affects the availability of data. For example, J-qualifiers are often applied simply because results are below the quantitation limit.

EPA Region 2 data validation guidance mandates the use of J- and UJ-qualifiers when quality assurance (QA)/QC exceedances dictate their necessity. In Region 2, if a result is attributable to blank contamination, it is U-qualified and is no longer distinguishable from results that are simply non-detect. The U-qualified value is elevated to the LOD if necessary. This supports the practice that J-qualified results, while estimated, are available for use as detects at their qualified concentration and U- and UJ-qualifiers are available for use as non-detects at their

qualified LOD or level. In general, J-, J^+-, J^--, UJ-, and U-qualified results are available for use as qualified for evaluating potential releases, the nature and extent of contamination, and estimating potentially associated human health and ecological risks.

It is a common occurrence for achieved LODs to be greater than SLs or for LODs to be elevated above what was expected or requested. In many cases, SLs are simply unreasonably low, or the laboratory was forced, by the analytical method or sample matrices, to raise limits for various reasons. In the instance where non-detect LODs are greater than SLs, the results are available for use as non-detects, but their use adds uncertainty to the conclusions drawn. There are a variety of typical and potentially unavoidable reasons why the reporting limits of non-detect results may exceed SLs:

- If an SL is unreasonably low, current instrumentation technology may not be able to achieve an LOD less than the SL.
- The laboratory-specific limits may have been established at a time when the SL was higher (less stringent) or not present, but the reporting is being done using new (more stringent) criteria. Published screening levels, such as EPA Regional Screening Levels (RSLs), may change periodically as toxicity values are updated.
- If a target compound or analyte is present at an elevated level, the laboratory will dilute the entire sample in order to report that concentration within the instrument's linear calibration range. It may not be possible to analyze the sample at a lesser dilution if the target compound's high concentration is likely to damage or saturate the instrument. The high concentration of a non-target compound or analyte may also necessitate initial dilution for the same reason.
- If matrix effects mask low concentrations, the laboratory may be forced to elevate their limits to demonstrate the fact that low concentrations cannot be detected.
- If matrix effects are particularly strong, the laboratory may be forced to analyze the sample at an initial dilution in an attempt to dilute the matrix effects.
- If historical concentrations warrant, the laboratory detects an odor, or the field team designates a sample as "expected high concentration," the laboratory may pre-screen the sample and initially dilute it.
- If the sample appearance indicates possible high concentrations, the laboratory may be forced to analyze the sample at a concentration range different from what is requested. For example, if a sample is designated as "groundwater," but is actually an emulsion or sludge, the laboratory may be forced to analyze the sample using the "medium" instead of the "low" or "SIM" concentration range.
- If the field team cannot provide the full sample volume, the laboratory may be forced to dilute the sample by adding water until the minimum volume is achieved.
- If a soil or sediment sample is characterized by high percent moisture, the reporting limits will be elevated such that the concentrations and quantitation limits are reported on a dry-weight basis.

1.5 Comparison of Non-detects to Screening Levels

When evaluating the data and making decisions, the project team compares detected sample results to SLs in order to determine exceedances. For this project, the SLs are as follows:

- A given GW sample result is compared to a selected screening level based on:
  - Puerto Rico Water Quality Standards (PRWQS) for Groundwater (SG)
  - Federal Maximum Contaminant Levels (MCLs) (EPA, 2009)
  - Excess Lifetime Cancer Risk (ELCR) of $1x10^{-5}$ and HI of 0.02
  - Hazard Index (HI) of 1 and ELCR of $4x10^{-5}$

When there are contaminants of concern (COCs), it is a project goal to demonstrate presence or absence of individual contaminants at a screening level. In order to do this with certainty, it is necessary for reporting limits to be less than screening levels. For this effort:

- The laboratory met the reporting limit requirements. It was not necessary to elevate reporting limits. There was no blank contamination which significantly affected data usability.
- There are no non-detect U-results at greater than a screening level. The non-rejected data are fully usable for this purpose, to demonstrate presence or absence at the screening level.

1.6 Laboratory Qualifications, Data Validation Qualifiers, Data Validation Reason Codes, Data Availability, and Data Use

This DQE focuses on any issues identified regarding the data and their potential impact on the project team's ability to use the data as intended. The data quality objectives (DQOs) for this project were met and there were no impacts on data quality such that data use as intended was negatively impacted. The reader should note that the DQE focuses on data quality issues and, therefore, if there is no discussion regarding a particular data feature, an issue was not identified with the data and the associated DQO(s) provided in the SAP document(s) were met.

Please refer to Table 1, which is a summary of qualifiers grouped by site and matrix. For the complete data set, all combinations of final qualifier and reason code are provided for each sample matrix. To help identify trends, for each combination, the count (number of results that possess this combination) is provided as well as the determination of whether such a result is affected by a bias, is available for use as reported, is available for use as qualified, or is not available for use (rejected). Totals for each are provided. Additionally, the data are available for use as reported by the laboratory; therefore, the data validator did not apply any qualifiers to this data set.

A total of 100% of the data are available for use as reported by the laboratory. The data set is 100% complete and the UFP-SAP project completeness goal of "95% available data" was met.

All results except those R-qualified as "rejected" are available for use. There were no rejected results.

1.7 Data Quality Evaluation

The purpose of this DQE is to summarize the findings of the data validation and any effects it found concerning the availability of the data for the AOC E groundwater long-term monitoring.

1.7.1 Groundwater Volatile Organics Data

Select VOCs were analyzed by SW-846 method 8260C. Excluding field QC samples, 12 distinct data points were generated. The select volatile organic compounds (Select VOCs) data set is 100% complete; all results are available for use as reported. The validation process issued the following qualifiers for results in the Select VOCs fraction:

DV Qual	DV Qual Code	Count	Percent	Available as Reported
J		5	41.67%	X
U		4	33.33%	X
None		3	25.00%	X
		12	100.00%	100.00%

Please see Table 1 for an explanation of qualifications and their impact on data usability.

SECTION 2

Precision, Accuracy, Representativeness, Comparability, and Completeness Considerations

2.1 Precision

Precision is measured via percent difference or relative percent difference. Percent difference is typically used when one value is considered theoretically correct and relative percent difference is typically used when both values are experimental. Percent difference is calculated by taking the absolute value of the difference divided by the theoretical value. This is also expressed as:

$$((|X_1 - X_2|) / X_1) * 100\%$$

where X_1 is the theoretical value and X_2 is the experimental value. If it is necessary to imply the direction of a bias, such as for percent drift, the absolute value need not be considered. Relative percent difference is calculated by taking the absolute value of the difference divided by the mean. This is also expressed as:

$$((|X_1 - X_2|) / ((X_1 + X_2)/2)) * 100\%$$

where X_1 and X_2 are both measured values. Percent difference and relative percent difference often have upper control limits for precision.

Precision is defined as the agreement between duplicate results and was characterized by comparing duplicate matrix spike (MS) recoveries, laboratory replicates, and field duplicate sample results. Precision was acceptable and there is no negative impact on precision because no data points were deemed unusable (rejected) due to precision exceedances.

2.2 Accuracy

Accuracy is measured via percent recovery. This is calculated by taking the measured value divided by the theoretical value. This is also expressed as:

$$(X_2 / X_1) * 100\%$$

where X_1 is the theoretical value and X_2 is the experimental value, both positive numbers because they are 'amounts' or concentrations. Percent recovery can be negative, such as for MS and matrix spike duplicate (MSD) recovery, if X_2 is calculated by subtracting a parent concentration from an experimental recovery. Percent recovery often has upper and lower control limits for accuracy.

For organic analyses, each sample was spiked with surrogate compounds, and an MS/MSD and laboratory control samples (LCS) were spiked with a known parameter concentration before preparation. Internal standards also provide a measure of accuracy. Internal standards, surrogates, and MS/MSD provide a measure of the matrix effects on the analytical accuracy. LCS demonstrates accuracy of the method and the laboratory's ability to meet the method criteria. Accuracy is also assessed by calibration recoveries. Potential biases and trends were evaluated by first determining whether a QA/QC exceedance may indicate a potential bias or trend. If so, then the exceedance was examined to determine whether the bias or trend was significant enough to warrant rejection of data. Accuracy was acceptable.

2.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition (in this case, nature and extent of contamination). Representativeness is a subjective parameter and is used to evaluate the efficacy of the sample planning design. In terms of data quality, representativeness was assured because the sampling team followed approved SOPs for sample collection and handling, and the laboratory followed approved SOPs for sample handling, preparation, and

analysis. All field samples were collected and analyzed as proposed in the AOC E Remedial Action Groundwater Long-Term Monitoring SAP.

2.4 Completeness

Completeness is calculated by taking the number of available results divided by the total number of results. This is also expressed as:

$$(X_2 / X_1) * 100\%$$

where X_2 is the number of distinct results deemed "available for use" (not rejected) and X_1 is the total number of distinct results (not excluded). Completeness is calculated for the entire data set, for each matrix, and for each combination of matrix and analysis group. If patterns of rejection are evident in the data set, completeness may also be calculated for select combinations of matrix, analysis group, and analyte or other combinations as applicable for the data quality evaluation. Completeness has a lower control limit (completeness goal) and cannot exceed 100 percent.

The data validation guidance documents referenced in Section 1.2 designate all results except those R-qualified as "rejected" to be available for use as analytically-sound results. The R-qualifier is the only qualifier that negatively affects a data point's availability. Completeness is detailed in Section 1.6.

All samples, as described by the AOC E Remedial Action Groundwater Long-Term Monitoring SAP, were collected as planned. For those samples collected, all planned results were generated.

2.5 Comparability

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Factors that affect comparability are sample collection and handling techniques, sample matrix, and analytical methods. In this case, because approved SOPs were used for sample collection and handling, a common sample matrix was evaluated (groundwater) and EPA SW-846 methods were utilized, the data user may express confidence in that fact that this data set is comparable to others of acceptable data quality. Comparability is controlled by the other Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) parameters because data sets can be compared with confidence only when precision and accuracy are known. Precision and accuracy were demonstrated to be acceptable, and the data user may be confident that this data set is comparable to others of high data quality.

2.6 Sensitivity

Refer to Sections 1.4 and 1.5.

SECTION 3

References

CH2M HILL, Inc. (CH2M). 2015. Area of Concern E, Remedial Action Groundwater Long-Term Monitoring Sampling and Analysis Plan, Atlantic Fleet Weapons Training Area – Vieques, Former Naval Ammunition Support Detachment, Vieques, Puerto Rico. January.

Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual. EPA/540/1-89-002, Part A. October.

EPA. 2009. National recommended water quality criteria - 2009.

EPA Region 2. 2016. Low/Medium Volatile Data Validation. SOP HW-33A. Rev 1. September.

Tables

TABLE 1
Qualifiers and Availability
AOC E Remedial Action Annual Status Report
Former Naval Ammunition Support Detachment
Vieques, Puerto Rico

Flag	Reason Code	Count	Available as Reported	Available as Qualified	Treat As	Potential Bias
J		5	41.67%		Detect	
U		4	33.33%		Non-detect	
None		3	25.00%		Detect	
	Total:	12	100.00%			

Appendix E
Inspection Checklist and Photographic Documentation

AOC E Land Use Control Inspection Form

DATE: March 2, 2020 **WEATHER CONDITIONS:** Clear/Sunny **INSPECTOR'S NAME:** Jerry R. Fields Jr.

Item	Key Observations to Make during Each Inspection	Observations	Acceptable ?		Recommended Remedial Action	Date of Completion
			Yes	No		
Signs, Fencing, and Gate	Condition of signs, fence, gate (e.g., signs of deterioration, personnel unable to read signs due to obstruction, evidence of trespassing or vandalism [noting the location], damaged or missing gate locks, etc.)	The signs, fencing, and gates are in good order. The signage is visible, legible, and the hardware intact at all 8 locations. The site boundary fence is secure, exhibiting no issues of being breached. However, the vegetation growth (vines) on the fence is greater than normal. It could possibly be due to the large amount of rain received over the past couple of months. The gates are secure and functioning, locks were lubricated.	X		Although not impacting LUC integrity, recommend cutting vegetation on fence to prevent further growth.	To be conducted as part of routine maintenance upon return to normal operations associated with Covid-19
Vegetation	Condition of vegetation as it relates to LUC integrity (e.g., growth on fence causing damage or obscuring signage, vegetation/dirt obscuring or encroaching on wells, etc.)	Vegetation growth has been maintained across the site as normal, except for the area along the north fence boundary. That area is not easily accessible due to the presence of debris from the collapsed building associated with Hurricane Maria (2017). Until debris is removed, manual cutting is likely necessary to maintain that particular area. Even though the vegetative growth in that area is higher than normal, it is not affecting the visibility of the signage nor affecting the fence. Grass cutting is also warranted due to faster than normal growth, but grass is not interfering with LUCs or the ability to locate wells.	X		Although not impacting LUC integrity, recommend cutting vegetation on fence to prevent further growth.	To be conducted as part of routine maintenance upon return to normal operations associated with Covid-19
Wells	Condition of wells as it relates to integrity (e.g., flush mount seal leaking/missing, flush mount bolts stripped/missing/holes broken, expansion plug or lock missing/damaged, well obstructed, concrete pad significantly cracked)	All wells exhibited all bolts, caps, and locks, except for wells MW-01 and MW-05 which were used in the CP-2 ISCO injection event. However, they are capped with injection plumbing fittings that are water tight. The well pads are intact, with some exhibiting some minor cracking. None of the observations is currently impacting well integrity.	X		Although not impacting well integrity, recommend replacing the water-tight fittings on wells MW-01 and MW-05 with standard caps and locks and performing crack repair on pads where cracking is observed.	To be conducted as part of routine maintenance upon return to normal operations associated with Covid-19
Other Observations (including potential groundwater use)		Note: Recently a new rum distillery opened inside the MOV public works area, adjacent to the site. They now have their own entrance on the north side which directs public traffic by the north side of site. They have placed a vinyl sign with their name, logo, and an arrow directing traffic to the distillery on the north fence.	X			

ADDITIONAL COMMENTS:

APPENDIX E

Photographic Documentation

Figure 1. East fence facing south.

Figure 2. South fence facing northwest.

Figure 3. North fence facing east.

Figure 4. Northwest corner facing southeast.

Figure 5. West fence facing north.

Figure 6. South fence facing northeast.

Figure 7. Southeast corner facing northwest.

Figure 8. Northeast corner facing southwest.

Figure 9. Northeast corner facing southwest; rum distillery direction sign in foreground.

Figure 10. Inside fence line, southwest corner facing north.

Figure 11. Inside fence line, southwest corner facing east.

Figure 12. Inside fence line, southeast corner facing west.

Figure 13. Inside fence line, southeast corner facing north.

Figure 14. Inside fence line, northwest corner facing southeast.

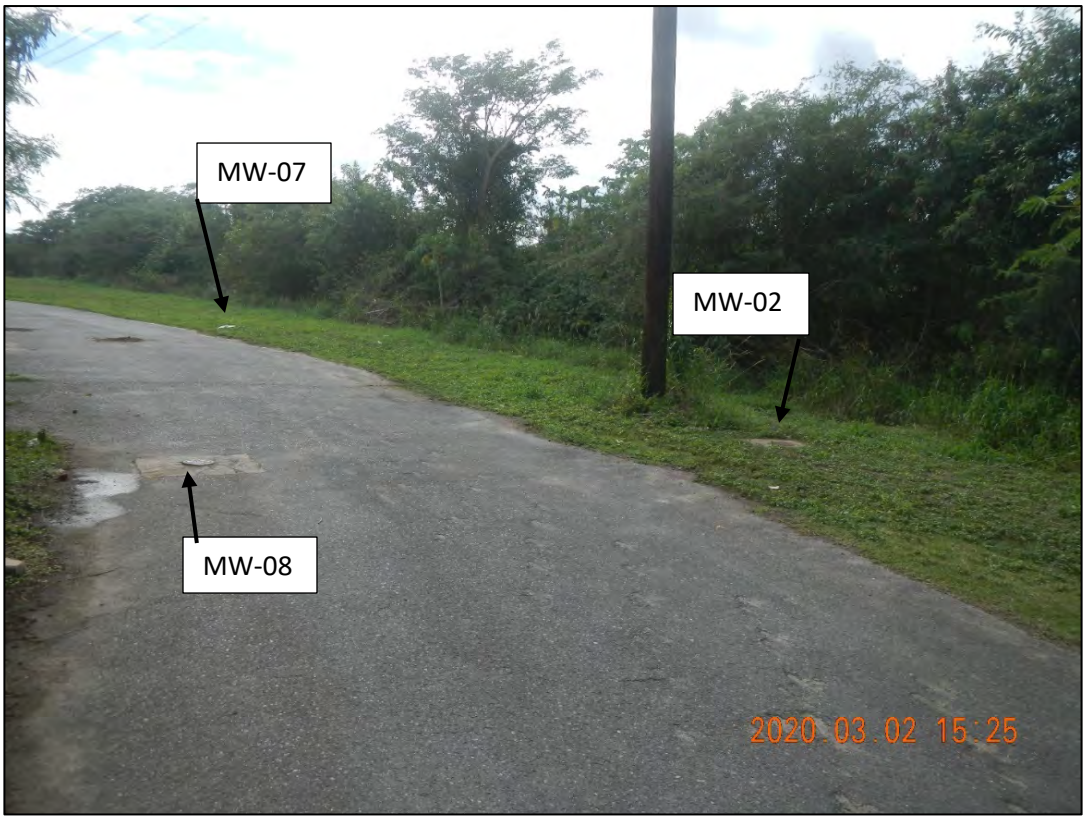

Figure 15. MW-02, MW-07, and MW-08.

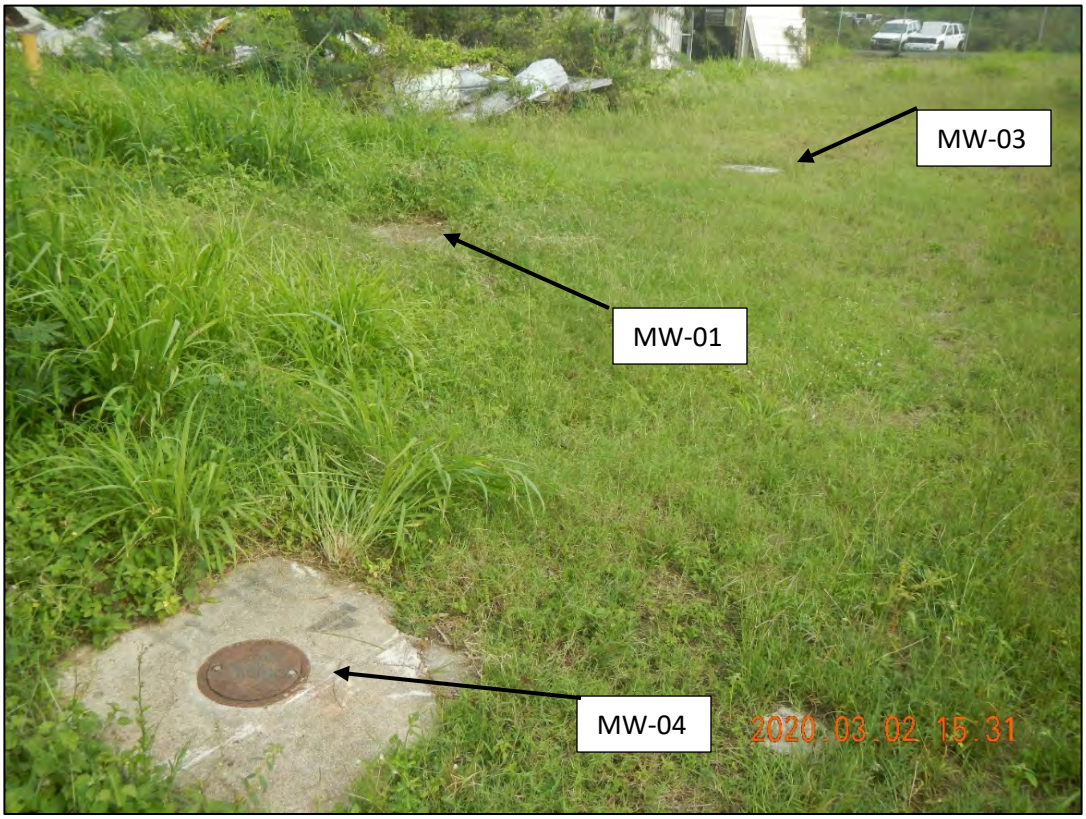

Figure 16. MW-01, MW-03, and MW-04.

Figure 17. MW-01 pad and well cover condition; minor pad cracking observed.

Figure 18. MW-01 capped following in situ chemical oxidation (ISCO) injections.

Figure 19. MW-02 pad and well cover condition.

Figure 20. MW-02 well and cap condition.

Figure 21. MW-03 pad and well cover condition.

Figure 22. MW-03 well and cap condition.

Figure 23. MW-04 pad and well cover condition; minor pad cracking observed.

Figure 24. MW-04 well and cap condition.

Figure 25. MW-05 well pad and cover condition; minor pad cracking observed.

Figure 26. MW-05 capped following ISCO injections.

Figure 27. MW-07 pad and well cover condition.

Figure 28. MW-07 well and cap condition.

Figure 29. MW-08 well cover and pad condition; minor pad cracking observed.

Figure 30. MW-08 well and cap condition.

Appendix F
Responses to Regulator Comments

APPENDIX F

Responses to Regulator Comments

Responses to EPA Comments on the
Draft AOC E Remedial Action Annual Status Report 2020

1. The report needs to specify in Section 2.3 if oxidant quenching measures were taken during the 2020 sampling event (i.e., was an appropriate amount of preservative added to each sample?). This information is critical in evaluating the accuracy of the sample results at this site.

   Navy Response: The following has been added as the first paragraph of Section 2.3: "As noted in Section 2.1, persulfate screening conducted prior to initiating the January 2020 sampling event demonstrated residual persulfate concentrations had declined to non-detect or close to non-detect (reported as <0.7 mg/kg by the persulfate field test kit) in two of the three performance monitoring wells (i.e., MW-04 and MW-05), but the turbidity in well MW-01 interfered with obtaining an accurate residual persulfate measurement. Nonetheless, because the team had mobilized to the site and had all the necessary equipment to collect samples, the decision was made to perform COC sample collection from all three wells using sample containers preserved with 10 mg of ascorbic acid as a conservative measure. Adding 10 mg of ascorbic acid to all sample containers provided an oxidant quenching capacity of up to approximately 85 mg/L of residual persulfate. While this quenching capacity would have been sufficient for samples from wells MW-04 and MW-05, it is unknown whether it would have been sufficient for the sample from well MW-01 because the residual persulfate concentration was unknown. However, as indicated in Section 2.1, if the residual persulfate concentration measured in MW-01 during the next annual sampling event is above a level that can be quenched with 10 mg/L of ascorbic acid, the 2020 results will be used for informational purposes rather than the first-post-CP-2 performance monitoring dataset."

2. The document indicates that groundwater samples were not collected in the past because persulfate levels were too high. To reiterate EPA's position - If oxidant quenching measures are taken, samples can be collected when oxidant is present. Additionally, as EPA has stated in the past, the persulfate field screening method being used at this site has a detection limit of 0.7 mg/L, which is too high to conclude that oxidant is not present. Groundwater samples collected at this site require that a quenching agent/preservative be used due to the known persistence of oxidant.

   Navy Response: Please see the response to Comment #1.

3. Information included in the report indicates that the wells may need to be redeveloped. Please address and include a plan to address these issues.

   - Samples collected from MW-01 can't be considered a representative sample when sludge was present. MW-01 was full of "sludge/muck" upon opening and had high turbidity levels according to the sampling log.

     Navy Response: Monitoring well MW-01 will be re-developed prior to the 2021 groundwater sampling event and an attempt will be made to reduce the pump flow rate during low-flow sampling.

   - All three well sampled ran dry during low flow purging according to the sampling logs.

Navy Response: While it is true the wells purged dry during sampling, but the cause of this (based on information from historical investigations) is that the saturated interval in which the wells are screened is saprolite, which has low permeability. The potential need for redevelopment is indicated for well MW-01, but not for the other wells. Additionally, an attempt will be made to reduce the pump flow rate during the next sampling event.

Response to EPA's Original Comment on the Draft AOC E Remedial Action Annual Status Report 2020

3. Information included in the report indicates that the wells may need to be redeveloped. Please address and include a plan to address these issues.

   - Samples collected from MW-01 can't be considered a representative sample when sludge was present. MW-01 was full of "sludge/muck" upon opening and had high turbidity levels according to the sampling log.

     Navy Response: Monitoring well MW-01 will be re-developed prior to the 2021 groundwater sampling event and an attempt will be made to reduce the pump flow rate during low-flow sampling.

   - All three well sampled ran dry during low flow purging according to the sampling logs.

     Navy Response: While it is true the wells purged dry during sampling, but the cause of this (based on information from historical investigations) is that the saturated interval in which the wells are screened is saprolite, which has low permeability. The potential need for redevelopment is indicated for well MW-01, but not for the other wells. Additionally, an attempt will be made to reduce the pump flow rate during the next sampling event.

Response to EPA's Follow-up Comment on the Draft AOC E Remedial Action Annual Status Report 2020

EPA Follow-up Comment: On comment #3, it should also be noted that the turbidity for MW-4 and MW-5 was slightly elevated (~30 NTU) in addition to the wells running dry during low-flow pumping. Ideally, turbidity measurements during low-flow sampling will be under 5 NTU. Unless the wells have also gone dry during previous sampling efforts (since 2010), they should be redeveloped during the mobilization to redevelop MW-1.

Navy Follow-up Response: All three monitoring wells will be redeveloped. However, as noted before, the monitoring wells are installed in saprolite and have shown elevated turbidity historically.

Responses to PRDNER Comments
Draft Area of Concern [AOC] E Remedial Action Annual Status Report 2020
Atlantic Fleet Weapons Training Area
Former Vieques Naval Training Range, Vieques, Puerto Rico

Page-Specific Comments

1. Figure 2-1: PRDNER requests that for future annual status reports, persulfate concentrations be shown with a logarithmic scale to show that persulfate concentrations reached non-detect levels with the field test kits.

   Navy Response: The figure has been revised as requested.

2. Table 2-1:

   a) Please update the groundwater elevation for MW-1 collected on January 13, 2020 to reflect the issue with the instrument sensor, as noted on Figure 2-2.

      Navy Response: In Table 2-1 the value of 2.63 listed for MW-01 on January 13, 2020 has been edited to "NM*." NM* has been defined in the footnote as: "NM* - Not measured due to instrument sensor malfunction."

   b) Please add the groundwater level data for MW-02 to the table.

      Navy Response: MW-02 (and MW-06) are not included in the water-level or performance monitoring program. The water level in MW-02 was inadvertently collected during the 2020 monitoring event.

      PRDNER Evaluation of Response to Comment 2b.: Because the water level in MW-02 was measured during the 2020 monitoring event and provides an additional data point, it would be helpful to include the water level elevation in the table and add a note to the table providing the clarification presented in the response.

      Navy Response to Evaluation Comment: Comment noted.

   c) Please correct the specific conductance for MW-05 to be consistent with the field data sheet in Appendix A which shows the result to be 10,000 µS/cm.

      Navy Response: The table has been edited as requested.

3. Table 2-2:

   a) Please clarify whether the 1,2-DCA results for MW-01 and MW-04 from 2019 should have a U qualifier (non-detect) consistent with Figure 2-9. Please correct as appropriate.

      Navy Response: The 2019 1,2-DCA results for well MW-01, MW-04, and MW-05 have been corrected to "0.5 U.

   b) Please clarify if the February 2019 result for MTBE in MW-04 (12 µg/L) as the result on Figure 2-9 is estimated at 8 µg/L. Please correct as appropriate.

      Navy Response: Table 2-2 February 2019 result for MTBE in MW-04 has been corrected to 8 J.

4. Page 3-1, Section 3.1: Please clarify if vegetation clearance along the north fence has been scheduled and when it will be completed.

   Navy Response: The last sentence of the first paragraph of Section 3.1 has been revised to read: "The north fence boundary area required manual vegetation clearance because the area was inaccessible to machinery due to building debris from Hurricane Maria (2017); vegetation clearance was performed on September 1, 2020."

5. Page 4-1, Section 4.1: Please clarify the third bullet to read "While the concentration of MTBE in well MW-05 is well below its historic high and is below its pre-CP-2 ISCO injection level, …"

   Navy Response: The bullet has been revised as requested.

6. Appendix B shows the presence of low-level 1,2-dichloroethane (0.26 J and 0.21 J µg/L) in the equipment blank and trip blank, respectively. The data validation report and the laboratory's data sheets in Appendix C do not show the same contamination. Please clarify and if these low-level detections are real, the positive result for 1,2-dichloroethane in sample MW-5 would be qualified as non-detect (U) due to the blank contamination.

   Navy Response: The equipment blank and trip blank that contain the low-level detections of 1,2-dichloroethane were collected on 2/20/2019 and were associated with only the samples collected on 2/20/2019. The 1,2-dichloroethane results for all samples collected on 2/20/2019 were non-detect; therefore, no qualifiers were required due to the equipment and trip blank detects. The detect noted for MW-5 is from the sample collected on 1/14/20, and the associated equipment blank and trip blank (which also has a collection date of 1/14/20) both had results of non-detect for 1,2-dichloroethane resulting in no qualification required for this sample.