Naval Facilities Engineering Systems Command Hawaii
JBPHH HI

Groundwater Protection Plan Update – Defueling Revision
Red Hill Bulk Fuel Storage Facility
JOINT BASE PEARL HARBOR-HICKAM, O‘AHU, HI

September 28, 2023

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ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
AFFF	aqueous film-forming foam
AOC	Administrative Order on Consent
BWS	Board of Water Supply, City and County of Honolulu
CAS	Chemical Abstracts Service
CCIR	Commander's Critical Information Requirement
CNO	Chief of Naval Operations
CNRH	Commander, Navy Region Hawaii
COA	course of action
COPC	chemical of potential concern
DoD	Department of Defense, United States
DOH	Department of Health, State of Hawai'i
DW LTM	drinking water long-term monitoring
EAL	Environmental Action Level
EPA	Environmental Protection Agency, United States
Facility	Red Hill Bulk Fuel Storage Facility
FRP	Facility Response Plan
GWPP	Groundwater Protection Plan
JBPHH	Joint Base Pearl Harbor-Hickam
JP	Jet Fuel Propellant
JTF	Joint Task Force
LNAPL	light nonaqueous-phase liquid
LOD	limit of detection
LTM	long-term monitoring
NAVSUP FLC PH	Naval Supply Systems Command Fleet Logistics Center Pearl Harbor
NOI	Notice of Interest
NPDES	National Pollutant Discharge Elimination System
OIC	Officer in Charge
P	population
PAH	polycyclic aromatic hydrocarbon
PFAS	per- and polyfluoroalkyl substances
PID	photoionization detector
ppbv	parts per billion by volume
ppmv	parts per million by volume
QC	quality control
SGC	silica gel cleanup
SOP	standard operating procedure
SPCC	Spill Prevention, Control, and Countermeasure
TAT	turnaround time
TPH	total petroleum hydrocarbons
TPH-d	total petroleum hydrocarbons – diesel range organics
TPH-o	total petroleum hydrocarbons – residual oil range organics
U.S.	United States
VOC	volatile organic compound

1. Introduction/Objectives

This document updates the Red Hill Groundwater Protection Plan (GWPP) (DON 2008; 2014b) for the Red Hill Bulk Fuel Storage Facility (the "Facility") located on O'ahu, Hawai'i with revisions that present an integrated strategy to manage risks associated with potential inadvertent fuel releases from the tanks or associated infrastructure (e.g., pipelines) by establishing detection and mitigation measures to protect groundwater resources. The Navy first developed the Red Hill GWPP in 2008 at the request of the Hawai'i State Department of Health (DOH) after previous environmental investigations (DON 1999; 2002; 2007) showed that past inadvertent releases had impacted the fractured lava rock (basalt), basal groundwater, and soil vapor beneath portion of the Facility with petroleum hydrocarbons.

The Navy has prepared this 2023 GWPP Update – Defueling Revision in response to an April 2023 request from the United States Environmental Protection Agency (EPA) to "prepare an additional supplement for EPA and DOH review... [to] confirm or update trigger action levels and associated response procedures for detection of fuel constituents in environmental media." This GWPP Revision specifically addresses monitoring for potential impacts to the environment if an inadvertent spill occurred during the Facility's upcoming defueling process, including activities to be conducted to ensure that steps are taken to protect groundwater until the defueling process is complete. Defueling includes removal of fuel from the tank mains and flowable tank bottoms. Non-flowable residue remaining in the tank bottoms will be removed during the Facility Closure process, which will follow defueling. The GWPP will be revised, if necessary, for activities associated with the Facility Closure.

This 2023 GWPP Update – Defueling Revision is intended to augment the spill prevention, containment, and cleanup measures that are detailed in the Defueling Plan and its supplements (DoD 2022a; 2022b; 2022c; 2023), the Facility Response Plan (FRP) (DoD 2022b, Enclosure (4), Revised Draft FRP), and the Spill Prevention, Control, and Countermeasure (SPCC) Plan (DoD 2022b, Enclosure (3), Revised Draft SPCC Plan) in the following ways:

- Provides for increased sampling frequency during defueling to monitor the subsurface environment for impacts from potential releases during defueling (Sections 2.3 and 2.4).
- Provides soil vapor and groundwater action levels to help identify the subsurface environment has been impacted by a fuel release during defueling (Sections 2.3.2 and 2.4.2).
- Provides step-by-step protocol for responding to action level exceedances and coordinating with DOH, EPA, and Joint Task Force (JTF) Red Hill if an action level were to be exceeded.

To avoid potential conflicts and redundancy, this 2023 GWPP Update – Defueling Revision does not address spill prevention and response measures that are already detailed in other documents that are subject to regulatory approval such as the Defueling Plan (including Supplements 1 and 2), the FRP, and the SPCC Plan.

With the cessation of fuel storage at the Facility after defueling, it is anticipated that another revision to the Red Hill GWPP will be prepared to ensure long-term protection of groundwater and drinking water resources.

Groundwater protection measures that are currently implemented at the Facility include:

- Preventive inspection, maintenance, and repair in accordance with modified American Petroleum Institute 653 procedures.
- Leak detection via weekly soil vapor monitoring under the fuel storage tanks.

- Regular groundwater monitoring in accordance with the Consolidated Groundwater Sampling Program (DON 2023a), which consolidates several previously separate groundwater sampling programs (i.e., the Notice of Interest [(NOI]), Groundwater Long-Term Monitoring (LTM), Delineation and Sentinel Well, and Per- and Polyfluoroalkyl Substances [(PFAS] programs) into one comprehensive, optimized groundwater sampling program.
- Update Spill Response Plans (Facility Response Plan, Integrated Contingency Plan) and increased spill exercises specific to the Facility.
- Contingency planning for response actions, including actions that would be required to remediate the basal drinking water aquifer if a large release of fuel were to migrate to the water table.

1.1 DESCRIPTION OF THE FACILITY

The Facility is a large underground fuel storage complex that stored and provided fuel for operations in Hawai'i and throughout the Pacific. Its twenty 12.5-million-gallon bulk fuel storage tanks were field-constructed of steel-lined concrete under a volcanic mountain ridge in the early 1940s. The tanks are connected to a fuel pumping station and fueling piers 2.5 miles away at Pearl Harbor via a tunnel system. The Facility is owned by Defense Logistics Agency (DLA), and prior to ceasing fueling operations in late 2021 was operated by Naval Supply Systems Command Fleet Logistics Center Pearl Harbor (NAVSUP FLC PH).

Each fuel tank is 100 feet in diameter and approximately 250 feet in height with a capacity of approximately 12.5 million gallons. Fourteen fuel storage tanks currently contain fuel and store either Jet Fuel Propellant (JP)-5, North Atlantic Treaty Organization-grade F-24 jet fuel, or F-76 Marine Diesel Fuel. The 104 million gallons of fuel that currently remain in Facility tanks are scheduled for defueling (DoD 2022a).

The Facility's fuel storage tanks are located approximately 100 feet above the Oahu Sole Source Aquifer (also referred to as the Southern Oahu Basal Aquifer, designated a Sole Source Aquifer in 1987 under Section 1424(e) of the Safe Drinking Water Act [61 Fed. Reg. 47752]), which supplies a significant portion of the island's drinking water. The nearest active or inactive drinking water supply wells are:

- Navy Well 3-2254-001 (Red Hill Shaft), located topographically downgradient from the tank farm approximately 2,600 feet to the west of the Facility tanks (i.e., the tank farm), which previously provided drinking water to Joint Base Pearl Harbor-Hickam (JBPHH) customers until November 2021. Red Hill Shaft is currently physically disconnected from the drinking water system and will be unable to serve drinking water for as long as it remains physically disconnected from the drinking water system.
- Honolulu Board of Water Supply (BWS) Well 3-2354-001 (BWS Hālawa Shaft), located approximately 4,600 feet to the north-northwest, which provided municipal drinking water to the City and County of Honolulu until it ceased pumping in December 2021.
- BWS Moanalua Wells 3-2153-010, -011, and -012 (Moanalua 1, 2, and 3), located approximately 1.3 miles to the south, which continue to provide municipal drinking water to the City and County of Honolulu.
- Navy Well 3-2254-032 (Navy 'Aiea Hālawa Shaft), located approximately 1.9 miles to the west-northwest, which provided drinking water to JBPHH customers until December 2021.
- Navy Well 3-2558-010 (Waiawa Shaft), located approximately 5.5 miles northwest of the Facility.

1.2 SCOPE AND OBJECTIVES

This GWPP Revision identifies monitoring measures that will be implemented during the defueling process for protection of the groundwater resources. The measures established in this GWPP Revision include visual observations of the pipelines within the tunnels, monitoring of soil vapor concentrations under the fuel storage tanks, and groundwater monitoring in wells located in and around the Facility. Response procedures and trigger points (i.e., chemical action levels) are also provided.

As previously noted, to avoid potential conflicts and redundancy, this 2023 GWPP Update – Defueling Revision does not address spill prevention and response measures that are already detailed in other documents that are subject to regulatory approval such as the Defueling Plan (including Supplements 1 and 2) (DoD 2022a; 2022b; 2022c; 2023), the FRP (DoD 2022b, Enclosure (4), Revised Draft FRP), and the SPCC Plan (DoD 2022b, Enclosure (3), Revised Draft SPCC Plan).

After defueling is accomplished, the Red Hill Bulk Fuel Storage Facility GWPP will be revised for site closure and long-term management to protect the groundwater resources.

2. Monitoring Program

This section describes visual inspections, soil vapor monitoring, and groundwater monitoring that will be performed during the defueling operations. JTF watchstanders will be responsible for the visual inspection. Navy contractors will be responsible for implementing the monitoring program for the duration of the defueling program. Analytical laboratories accredited under the Department of Defense (DoD) Environmental Laboratory Accreditation Program, and data validators are currently under subcontract to Navy prime contractors to perform soil vapor and groundwater analytical services.

2.1 SPILL MITIGATION MEASURES

The Navy and its sampling contractors will comply with the following spill mitigation measures while sampling inside the Facility during defueling:

- The Navy will provide JTF with a sampling schedule for the full expected duration of defueling (currently scheduled for October 16, 2023 through January 19, 2024) no later than October 9, 2023 and will obtain confirmation from JTF that no sampling is scheduled to occur during the scheduled initiation or completion of fuel movement evolutions. The sampling schedule will specify sampling locations.
- If JTF identifies any schedule conflicts between sampling and the initiation or completion of fuel movement evolutions, the Navy will modify the sampling schedule accordingly and resubmit to JTF.
- The sampling schedule will be updated weekly and shared with JTF for continuous verification that sampling will not occur during initiation or completion of fuel movement evolutions.
- Sampling contractors will check in with the JTF watch supervisor or approved designee at the beginning of each sampling shift and provide the watch supervisor with a list of locations to be sampled.
- Before removing a seal for sampling, the sampling contractor will inspect and photograph the seal, and will note the condition of the seal in a field log.
- The sampling contractor will replace the seal immediately after sampling and again photograph the seal and note the condition of the seal in a field log. If for any reason the seal cannot be properly replaced, the sampling contractor will immediately notify the JTF watch supervisor and the Navy.

- The sampling contractor will submit photographs of the seals to the Navy weekly.

2.2 VISUAL INSPECTIONS

Similar to the unpacking process, JTF Red Hill will assign a supervisor and work leader to oversee all phases of the defueling operation, including daily visual verification of all valve positions. The supervisor and work leader will be supported by validators who will independently complete these inspections and confirm proper operation of valves to ensure correct system configuration.

Watchstander teams under the oversight of the JTF Red Hill supervisor and work leader will continuously monitor the full length of the pipeline and the tanks during the defueling process. The watchstanders will be assigned specific coverage areas each day to ensure full coverage of the operations and will be trained in spill response and communications procedures to ensure timely reporting of observed releases (if any).

2.3 SOIL VAPOR MONITORING

Soil vapor monitoring points (SVMPs) were installed under the Facility's active fuel storage tanks in the mid-2000s (DON 2007) following environmental investigations at the Facility (DON 1999, 2002) and are currently sampled weekly with a photoionization detector (PID). In addition, passivated (Summa) canister samples are collected monthly for analysis of volatile organic compounds (VOCs) at the SVMPs with the highest contemporary PID readings (i.e., SV15S, SV17S, SV18S, SV20M) and the associated deep (outermost) probes for those four tanks (i.e., SV15D, SV17D, SV18D, SV20D).

As described in the following subsections, the frequency of soil vapor monitoring during defueling will generally be increased during defueling. The soil vapor monitoring procedures that are currently in practice at the Facility and have previously been provided to the Regulatory Agencies will continue to be implemented during defueling. The current soil vapor monitoring procedures that are currently in place are described in the Red Hill Work Plan/Sampling and Analysis Plan, Long-Term Soil Vapor and Fuel Product Monitoring (DON 2021a) and Appendix E of the January 2022 Red Hill Shaft Recovery and Monitoring Plan (IDWST 2022, Appendix E).

2.3.1 Soil Vapor Monitoring Network

The soil vapor monitoring network under the fuel storage tanks consists of two to three monitoring points installed in angle borings under the active storage tanks (Tanks 2 through 18 and Tank 20), as shown on Figure 1. The angles of the borings are relatively flat (generally within 10–15 degrees of horizontal), such that all monitoring probes are relatively close to the tank bottoms.

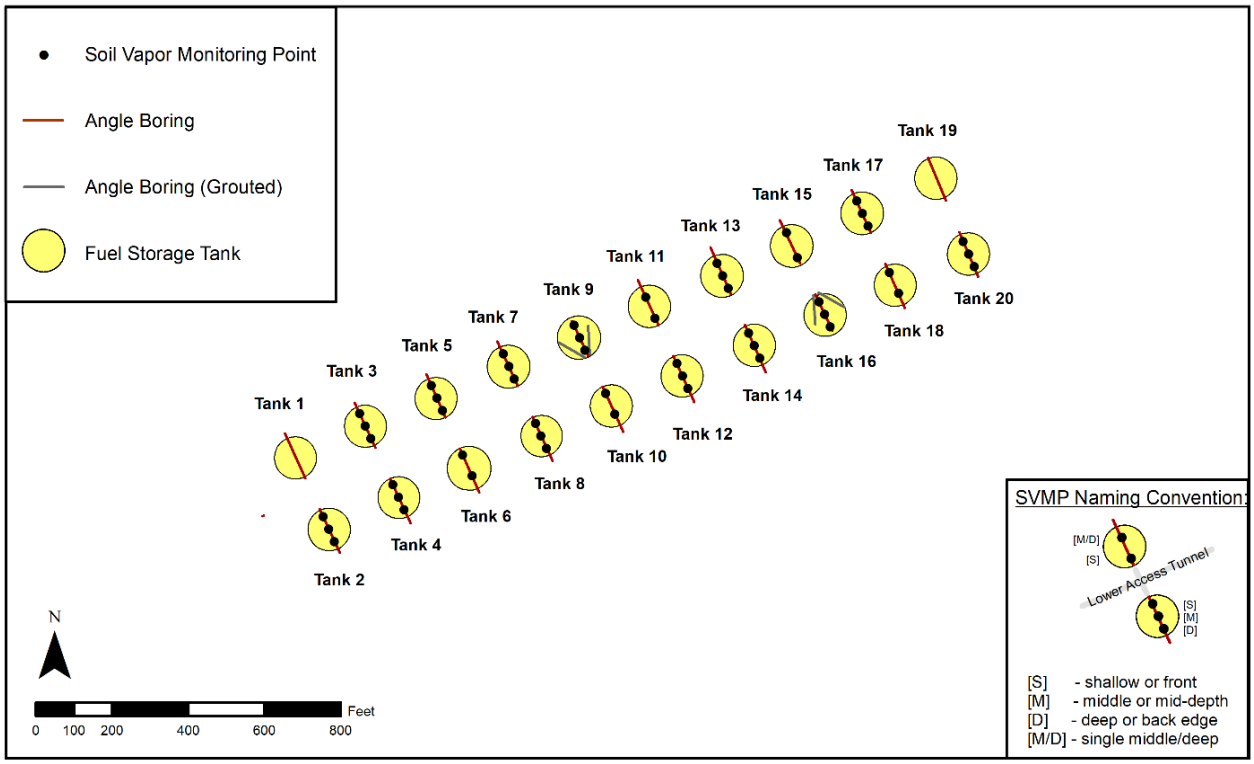

Figure 1: Soil Vapor Monitoring Network Below the Red Hill Fuel Storage Tanks

During defueling, each of the SVMPs underneath the Facility's fuel storage tanks except for SV15M will be sampled with a PID two times per week (Mondays and Thursdays or the next workday if there is a holiday or a conflict with the initiation or completion of fuel movement evolutions). SV15M has not been sampled since 2021 due to historically insufficient gas flow since 2014; Tank 15's other SVMPs (SV15S and SV15D) are operational and will provide adequate coverage for Tank 15.

Historically, soil vapor monitoring beneath the Facility's fuel storage tanks has been conducted monthly at a minimum in accordance with the existing GWPP (DON 2008; 2014b), the Red Hill Administrative Order on Consent (AOC) (EPA Region 9 and DOH 2015), and DOH NOIs for the January 2014 JP-8 Release (DON 2014a). Since the 2021 releases, all SVMPs beneath the tanks have been sampled with a PID at least weekly.

2.3.2 Soil Vapor Action Levels

During defueling, the soil vapor actions level for tanks that currently contain or last contained JP-5 or JP-8 (Tanks 1 through 12 and 17 through 20) is 50,000 parts per billion by volume (ppbv); the action level for tanks that currently contain or last contained F-76 Marine Diesel fuel (Tanks 13 through 16) is 8,000 ppbv. These soil vapor action levels were developed following review of the extensive soil vapor data, including data collected after known releases, and account for routine fluctuations. They are consistent with the AOC Statement of Work Sections 3 and 4 deliverable Supplement to AOC Tank Upgrade Alternatives and Release Detection Decision Document (DON 2021b, Response to RFI 9).

A PID reading above 50,000 ppbv from SVMPs beneath Tanks 1–12 and 17–20 or above 8,000 ppbv from SVMPs beneath Tanks 13–16 will require the response actions detailed in Section 3.2, including but not

limited to collection of a passivated (Summa) canister soil vapor sample for laboratory analysis and evaluation.

2.4 GROUNDWATER MONITORING

As noted in Section 1, the current groundwater sampling effort is conducted in accordance with the Consolidated Groundwater Sampling Program (DON 2023a), which consolidates several required or requested sampling programs that were previously conducted under separate programs (i.e., NOI, Groundwater LTM, Delineation and Sentinel Well, and PFAS programs). During defueling, the Consolidated Groundwater Sampling Program will continue. However, during defueling, the Navy has revised the process for evaluating for LNAPL in 2-inch wells associated with the Facility tunnels and associated delineation (P-)wells. During defueling, LNAPL will be evaluated in 2-inch wells with screens that intersect the water table by collecting a headspace organic vapor measurement as soon as each well cap is removed:

1. If the organic vapor reading is greater or equal to 8 parts per million by volume (ppmv), that information will be recorded in the field log. The well pump and other in-well instrumentation will then be removed, a bailer will be deployed to the water table, and a liquid sample from the water table will be collected to measure the thickness of free product using the current standard operating procedures (SOPs).
2. If the organic vapor reading is less than 8 ppmv, that information will be recorded in the field log and no additional evaluation of LNAPL will be conducted.

2.4.1 Groundwater Monitoring Network

The Red Hill groundwater monitoring network is currently being expanded and will eventually consist of 41 monitoring locations once additional proposed groundwater monitoring wells are completed, including 39 monitoring wells installed by the Navy; the state-owned well HDMW2253-03 (Hālawa Deep Monitor Well) located on Hālawa Correctional Facility property; and the sampling location at Navy supply well Red Hill Shaft (RHMW2254-01). The following prefixes are used in the wells' nomenclature:

- "RHMW": existing, in-progress, or proposed monitoring location installed by the Navy within the Facility boundaries and surrounding the tank farm.
- "RHP": existing or in-progress well installed by the Navy within the Facility boundary in the immediate vicinity of Red Hill Shaft for site characterization and evaluating (i.e., delineating) the nature and extent of the November 2021 JP-5 release.
- "NMW": existing or proposed well installed by the Navy outside the Facility boundary to monitor aquifer conditions in the direction of potential offsite receptors (water supply wells) and to gain a better understanding of site hydrogeologic conditions around Red Hill.

The groundwater monitoring network is shown on Figure 2.

Table 2-1 identifies the following three categories of groundwater monitoring locations:

- **Primary Release Detection Wells** are positioned to identify tank releases or impacts from pipeline releases in the tank farm. During defueling, the Primary Release Detection Wells will be sampled weekly for analytes identified in Section 2.4.2.1, which identifies analytes that will be observed in the leading edge of a JP-5, JP-8, or Navy Marine Diesel fuel release. These analytes are optimized to allow subcontracted laboratories to meet turn-around times that provide adequate release

detection during defueling. RHP07 is located within the Adit 3 tunnel and is therefore considered a Primary Release Detection Monitoring Well.

- **Secondary Release Detection Wells** are positioned to monitor groundwater conditions entering or leaving the tank farm and tunnel areas, including locations near the Facility boundary. During defueling, Secondary Release Detection Wells will be sampled monthly in accordance with the Consolidated Groundwater Sampling Program (DON 2023a). Sampling frequency will increase if there is an exceedance, as described in Section 3.3. Sample analyses for these increased sampling events will be in accordance with those identified in Section 2.4.2.2.

  RHP01, RHP02, PHP03, RHP04A/B/C, RHP05, RHP06, and RHP08 are located adjacent to the site boundary and are therefore considered Secondary Release Detection Monitoring Wells.

- **Sentinel Wells** are used to monitor groundwater conditions between the Facility and offsite locations or receptors, and to provide advance warning prior to impacts should offsite migration occur in these directions. During defueling, Sentinel Wells will be sampled monthly in accordance with the Consolidated Groundwater Sampling Program (DON 2023a). Sentinel Wells are important in evaluating potential impacts to the basal aquifer drinking water resource and offsite supply wells, and to validate and calibrate Navy and regulatory groundwater models over time.

Table 2-1: Groundwater Monitoring Network Categories

Primary Release Detection Wells	Secondary Release Detection Wells		Sentinel Wells
RHMW01R	RHMW04	RHMW18 (JJ) [a]	RHMW12A
RHMW02	RHMW06	RHMW19	NMW22(MM) [b]
RHMW03	RHMW09	RHMW20(BB)	NMW23 (XA) [b]
RHMW05	RHMW10	RHP01	NMW24 (ZZ)
RHMW08	RHMW11	RHP02	NMW25 (TT)
RHMW2254-01	RHMW13	RHP03	NMW26 [b]
RHP07	RHMW14	RHP04A, 04B, 04C	NMW27 (QQ) [b]
	RHMW15	RHP05	NMW28 (PP) [b]
	RHMW16	RHP06	NMW29 (MW1) [b]
	RHMW17	RHP08	NMW32
			NMW30 (MW3) [a]
			NMW33 [a]
			HDMW2253-03

[a] Drilling and well installation activities currently in progress
[b] Proposed for future installation, may be installed during defueling

The Navy will evaluate all sampling results to determine if any adjustments will be made to the schedule and analyte list.

(b) (3) (A)

Figure 2
Groundwater Monitoring Well Network
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In addition, Figure 2 shows the location of the surrounding water supply wells identified in Section 1.1 that are the main potential exposure points for groundwater impacts to human health. The following wells are or will be located between the Facility, BWS Hālawa Shaft to the north, and Navy 'Aiea Hālawa Shaft to the west:

- Eleven Secondary Release Detection Wells located near the Facility perimeter: RHP01, RHP02, RHP03, RHMW04, RHMW06, RHMW11, RHMW13, RHMW14, RHMW16, RHMW17, RHMW20(BB)
- Eight offsite Sentinel Wells: RHMW12A, HDMW2253-03, NMW22 (MM), NMW23 (XA), NMW24 (ZZ), NMW27 (QQ), NMW28 (PP), NMW29,

The following wells are or will be located between the Facility and the BWS Moanalua water supply wells to the south:

- Eleven Secondary Release Detection Wells located near the Facility perimeter: RHP04A, RHP04B, RHP04C, RHP05, RHP06, RHP08, RHMW09, RHMW10, RHMW15, RHMW18, RHMW19
- Two offsite Sentinel Wells: NMW25 (TT), NMW30 (MW3)

2.4.2 Groundwater Action Levels

Groundwater action levels for this GWPP were referred to as "trigger levels" in the original 2008 GWPP and 2014 Interim Update (DON 2008; 2014b). At the time of the 2014 Interim Update, the groundwater monitoring network consisted of:

- Four monitoring wells located in the lower access tunnel to the tank farm (RHMW01, RHMW02, RHMW03, RHMW05)
- One groundwater sampling point at Red Hill Shaft (RHMW2254-01)
- One background monitoring well (RHMW04)

At that time, the focus was on monitoring tank releases within the tank farm that had the potential for impacting water quality at the nearest downgradient water supply well, Red Hill Shaft. Specific risk-driving compounds in middle distillate petroleum hydrocarbon mixtures (JP-5, JP-8, Navy Marine Diesel fuel) were developed as chemicals of potential concern (COPCs), based on the regulatory limits at the time of the document's publication.

The groundwater monitoring network has since expanded and continues to do so to include the following:

- Primary Release Detection Wells in proximity to the tanks to monitor for evidence of a new significant release
- Secondary Release Detection Wells along the Facility perimeter monitoring for COPC concentrations in groundwater that exceed regulatory limits and may be moving off site
- Sentinel Wells to monitor and be protective of surrounding water supply wells

2.4.2.1 PRIMARY RELEASE DETECTION WELLS

Primary Release Detection Wells are in close proximity to the Facility's fuel storage tanks and underground piping systems. RHMW01 RHMW02, and RHMW03 were installed in 2005 in response to regulatory requirements to begin a groundwater LTM program at the Facility. Petroleum-related compounds have been observed in these wells, including well-specific COPCs, since their initial sampling. RHMW01R was

installed in 2021 in the vicinity of RHMW01 and is currently sampled in lieu of RHMW01 in the Navy's sampling program.

Some Primary Release Detection Wells, such as RHMW08, have only sporadically shown detectable amounts of petroleum-related compounds, generally limited to total petroleum hydrocarbon (TPH) fractions or mixtures, rather than specific compounds. In addition, the fractions observed in these wells are generally older components that can be identified as such in the laboratory with a silica gel cleanup (SGC) process. The SGC process removes older weathered organic compounds that have polar characteristics and leaves fresh fuel components that are non-polar and thus indicative of a new release.

Other Primary Release Detection Wells include RHP07 and RHMW2254-01, which samples the Red Hill Shaft water development tunnel.

Primary Release Detection Well COPCs for action-level evaluation are the polycyclic aromatic hydrocarbon (PAH) compounds naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene; and TPH fractions (TPH-diesel and residual oil range organics [TPH-d and TPH-o]). Action levels are listed in Table 2-2.

Table 2-2: Action Levels for Primary Release Detection Wells

Primary Release Detection Well	Action Level (µg/L)				
	TPH-d	TPH-o	Naphthalene	1-Methylnaphthalene	2-Methylnaphthalene
RHMW01R	597	384	0.3	0.7	0.3
RHMW02	2,617	382	27	16	11
RHMW03	289	409	0.3	0.3	0.3
RHMW05	123	380	0.3	0.3	0.3
RHMW2254-01	111	376	0.28	0.25	0.25
RHMW08 [a]	111	376	0.28	0.25	0.25
RHP07 [a]	111	376	0.28	0.25	0.25

µg/L micrograms per liter
TPH-d total petroleum hydrocarbons - diesel range organics
TPH-o total petroleum hydrocarbons - residual oil range organics
[a] Action levels for RHMW08 and RHP07 are based on the evaluations of RHMW2245-01.

Action levels presented in Table 2-2 are based on evaluation of weekly groundwater sampling results from RHMW01R, RHMW02, RHMW03, RHMW05, and RHMW2254-01 collected between January 4 and August 3, 2023. This data set was chosen to represent the most recent ambient conditions in these wells prior to defueling when no releases of fuels from the Facility were observed. The values in Table 2-2 are calculated from the average and standard deviation of each COPC at each well. The population (P) used to generate the statistics include the detected COPC concentration when available, and the limit of detection (LOD) concentration, when the analyte was not detected. The values (V) presented in Table 2-2 were based on the average of the population (P) plus two standard deviations of P. For the ideal case where P is normally distributed, 95% of P falls below V, thus V represents a reasonable upper limit for the population of results during the period where no releases are observed from the Facility.

$$V = \text{Average (P)} + 2 \times [\text{Standard Deviation (P)}]$$

Appendix A presents the charts of the well-specific action levels, also known as "trigger levels," compared to the analytical results for the COPC for each well. These results are described in detail in the Navy's ongoing series of Quarterly Release Response Reports (DON 2023b).

In addition, a second aliquot of each sample will be processed through SGC and analyzed for TPH-d and TPH-o. The TPH-SGC results will be evaluated for fresh (non-polar) hydrocarbons that could be indicative of a new release. SGC results for TPH-d and TPH-o should be evaluated along with the detected TPH-d and TPH-o results that have not gone through the SGC process to provide a comparison for qualitative analysis of the freshness of the petroleum in the sample. If the associated SGC result is more than 50% of the non-SGC result, this provides additional evidence of a new release. The evidence of a new release becomes stronger as the SGC result approaches 100% of the non-SGC result.

2.4.2.2 SECONDARY RELEASE DETECTION WELLS

Secondary Release Detection Wells located near the Facility boundary will be sampled to identify whether COPCs are migrating beyond the Facility boundaries above regulatory action levels. If groundwater sampled from these Secondary Release Detection Wells does not exceed regulatory action levels, it is assumed that water is not migrating off site above these regulatory limits and that the Facility is in compliance for this objective. Currently, 22 Secondary Release Detection Wells are located near the Facility perimeter, as described in Section 2.4.

In addition to the May 2023 groundwater sampling program consolidation and optimization memorandum (DON 2023a), these wells will be tested for the petroleum-related compounds listed in Table 2-3 and screened against the DOH Environmental Action Levels (EALs) sourced from the DOH-EAL-Surfer-Fall-2017 guidance document, Summary Table A (Soil and Groundwater, for groundwater greater than 150 meters of a surface water body) (DOH 2017). These Secondary Release Detection Wells are screened in basal water that does not empty into any nearby surface water tributary located within 150 meters of the Facility (the tributaries are at least 50 feet vertically above the basal aquifer in these areas).

Table 2-3: Action Levels for Secondary Release Detection Wells and Sentinel Wells – DOH EALs, Groundwater IS Current or Potential Source of Drinking Water

Contaminant	Action Level (µg/L)
TPH (gasolines)	300
TPH (middle distillates)	400
TPH (residual fuels)	500
Benzene	5
Toluene	40
Ethylbenzene	30
Xylenes	20
1-Methylnaphthalene	10
2-Methylnaphthalene	10
Naphthalene	17
1, 2-Dibromoethane[a]	0.04
1,2-Dichloroethane[a]	5
Phenol	300
2-(2-Methoxyethoxy)ethanol [a, b]	800
Acenaphthene	20
Acenaphthylene	236
Anthracene	0.18
Benzo(a)anthracene	0.03
Benzo(a)pyrene	0.20
Benzo(b)fluoranthene	0.22
Benzo(g,h,i)perylene	0.13
Benzo(k)fluoranthene	0.40
Chrysene	1
Dibenzo(a,h)anthracene	0.022
Fluoranthene	13
Fluorene	236
Indeno(1,2,3-cd)pyrene	0.1
Phenanthrene	214
Pyrene	68

Source: Appendix 1, Table D-1a (<150m to Surface Water Body) and Table D-1b (>150m to Surface Water Body) (DOH 2017).
[a] 1,2-Dibromoethane, 1,2-Dichloroethane, and 2-(2-Methoxyethoxy)ethanol are additional compounds that will be included in Secondary Release Detection Monitoring Wells and Sentinel Well analyses associated with the defueling GWPP events.
[b] 2-(2-Methoxyethoxy)ethanol (CAS No. 111-77-3) is a common de-icing additive that the Navy has added to jet fuel (JP-5 and JP-8). It has no established EAL; the action level (800 µg/L) is from EPA (2023) Regional Screening Levels (RSLs) for residential exposure, for noncarcinogenic health risks.

2.4.2.3 SENTINEL WELLS

Sentinel Wells are either already installed, under construction, or are currently planned for installation after the Navy obtains access and completes permitting requirements. Once installed, these wells will be used to assess groundwater conditions between potential releases within the Facility and the potential offsite receptors identified in Section 3.2: BWS Hālawa Shaft; Navy 'Aiea Hālawa Shaft; TAMC-MW-2; and Moanalua-1, Moanalua-2, and Moanalua-3.

The Sentinel Wells have the potential to detect releases from other sources in their proximity; therefore, not all chemicals detected in these wells should be automatically attributed to the Red Hill Facility:

- If chemicals detected at the Sentinel Wells are not attributable to the Red Hill Facility, they will be attributed to another offsite source and not associated with the Facility, and will not be considered as triggers for the purposes of this GWPP.
- If concentrations of COPCs are detected that exceed those observed at Secondary Release Detection Wells, they will not be completely attributed to the Facility unless other direct evidence is observed, such as evidence of Navy de-icing additives or other forensic data.

If Table 2-3 COPCs are detected in Sentinel Wells in conjunction with action levels triggered in associated Secondary Release Detection Wells, DOH/EPA will be notified, and the data will be evaluated for verification purposes prior to triggering additional response actions. Included in the verification will be an immediate resampling of the Sentinel Well where the COPCs were observed, as well as a review of chromatograms, data quality control (QC) samples, and laboratory QC results.

2.5 CONTINGENCY PFAS MONITORING

PFAS sampling is performed monthly in accordance with the Consolidated Sampling Program (DON 2023a) in response to the 2022 aqueous film-forming foam (AFFF) release. This GWPP Revision specifically addresses monitoring for potential impacts to the environment associated with the Facility's upcoming defueling process. PFAS are not associated with the fuels that are currently stored in the Facility's bulk fuel storage tanks (i.e., JP-5, F-24, and F-76). Accordingly, PFAS are not chemicals of concern for the defueling process, and currently no PFAS sampling requirements are included in this GWPP Revision.

However, if AFFF is inadvertently released or used in the Facility during the defueling process, the Navy will sample the Release Detection Wells weekly for the PFAS compounds listed in Table 2-4 by EPA Draft Method 1633 and screen them against the latest DOH EALs.

Table 2-4: Action Levels for Contingent PFAS Sampling

CAS #	Chemical [a]	DOH Groundwater EAL (Revised May 8, 2023) (µg/L) [b]
45187-15-3	Perfluorobutane sulfonate (PFBS-)	1.69
108427-53-8	Perfluorohexane sulfonate (PFHxS-)	0.08
146689-46-5	Perfluoroheptane sulfonate (PFHpS-)	0.04
45298-90-6	Perfluorooctane sulfonate (PFOS-)	0.01
126105-34-8	Perfluorodecane sulfonate (PFDS-)	0.04
45048-62-2	Perfluoro butanoate (PFBA-)	14.62
45167-47-3	Perfluoro pentanoate (PFPeA-)	1.54
92612-52-7	Perfluoro hexanoate (PFHxA-)	1.92
120885-29-2	Perfluoro heptanoate (PFHpA-)	0.08
45285-51-6	Perfluoro octanoate (PFOA-)	0.01
72007-68-2	Perfluoro nonanoate (PFNA-)	0.01
73829-36-4	Perfluoro decanoate (PFDA-)	0.01
196859-54-8	Perfluoro undecanoate (PFUnDA-)	0.02
171978-95-3	Perfluoro dodecanoate (PFDoDA-)	0.03
862374-87-6	Perfluoro tridecanoate (PFTrDA-)	0.03
365971-87-5	Perfluoro tetradecanoate (PFTeDA-)	0.26
754-91-6	Perfluroroctane sulfonamide (PFOSA)	0.05
122499-17-6	2,3,3,3-tetrafluoro-2-(heptafluoropropoxy) propanoate (HFPO DA-)	0.01
425670-75-3	6:2 Fluorotelomer sulfonate (6:2 FTS-)	1.50
958445-44-8	Ammonium 4,8-Dioxa-3H-perfluoro nonanoate (ADONA-)	1.15

Source: (DOH 2023) (PFASs Surfer [Excel electronic lookup tables] April 2023 Rev 05-08-23) [1]
CAS Chemical Abstracts Service
[a] Abbreviations refer to anion form of compound, assumed to be dominant in environmental samples (noted by "-" sign after abbreviation; refer to Table 1a in November 2020 Technical Memorandum).
[b] Assumes potential impacts to drinking water source and discharge of groundwater into a freshwater, marine or estuary surface water system. Compare to dissolved-phase concentration.

2.6 DRINKING WATER LONG-TERM MONITORING

Drinking water long-term monitoring (DW LTM) will continue to be conducted during defueling in accordance with the DW LTM Plan (DOH, DON, and DA 2022). The DW LTM Plan was developed jointly by representatives of DOH, the Navy, the U.S. Army, and a team of technical and subject matter experts as a "surveillance tool intended to continuously ensure that the water is safe to drink, meets all State and Federal drinking water standards and is free of petroleum and response by-product contamination."

The DW LTM Plan includes a response action to sample groundwater from Well 3-2558-010 Waiawa Shaft if any releases occur prior to or during the defueling process.

[1] https://health.hawaii.gov/heer/guidance/ehe-and-eals/#ehe6

3. Groundwater Protection Responses for Releases and Action Level Exceedances

This section describes the groundwater protection actions that will be taken if soil vapor or groundwater concentrations indicate that a fuel release may have occurred during defueling operations, a fuel release is visually observed during defueling operations, or free product is observed in a groundwater sample during defueling operations. Emergency response actions are described in other related documents (DoD 2022a; 2022b; 2022c; 2023).

Red Hill Shaft will not be reconnected or re-started as a drinking water source during defueling. If fuel is released to the environment during gravity defueling, the Navy will secure Navy 'Aiea Hālawa Shaft (if operational) until the risk of the release is assessed and, to demonstrate confidence that drinking water is safe, will sample Waiawa Shaft. Additionally, the Navy will notify BWS within 4 hours of confirming that a release has occurred and will recommend that BWS Hālawa Shaft should be secured until the further notice.

Surfactants will not be used in any cleanup activities.

3.1 Visual Observation Response Actions

If an active release is visually observed, the individual observing the active release will immediately report it to the Control Room Operator at 808-471-8081 / 808-473-1075 . The Control Room Operator will initiate the spill response by activating the Red Hill Spill Notification Call Tree (DoD 2022c, Enclosure B Spill Exercise Plan, pg. 41). Additional and up-to-date details on spill response planning and activities are available in the defueling plan and associated supplements.[2]

3.2 Soil Vapor Response Actions

Response actions for exceedances of action levels for soil vapor under the fuel storage tanks identified in Section 2.3.2 are described on Figure 3A and Figure 3B.

3.3 Groundwater Contingency Plan and Response Actions

Response actions for exceedances of groundwater action levels or free product in groundwater wells are described on Figure 3A and Figure 3C.

[2] https://cnrh.cnic.navy.mil/Operations-and-Management/Red-Hill/DoD-RHBFSF-Defuel-Plan/

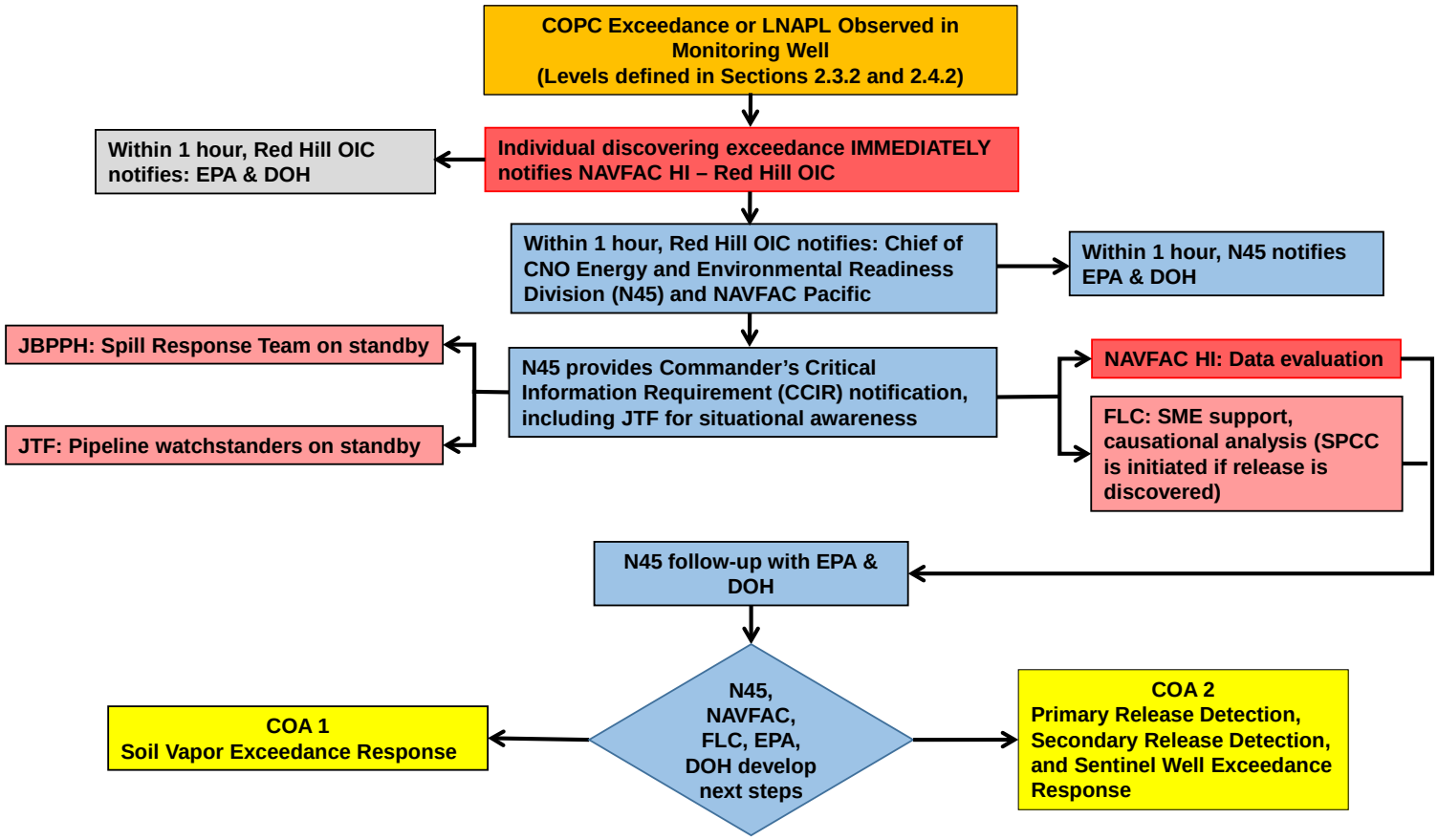

Figure 3A: Response Actions for Exceedance During Defueling

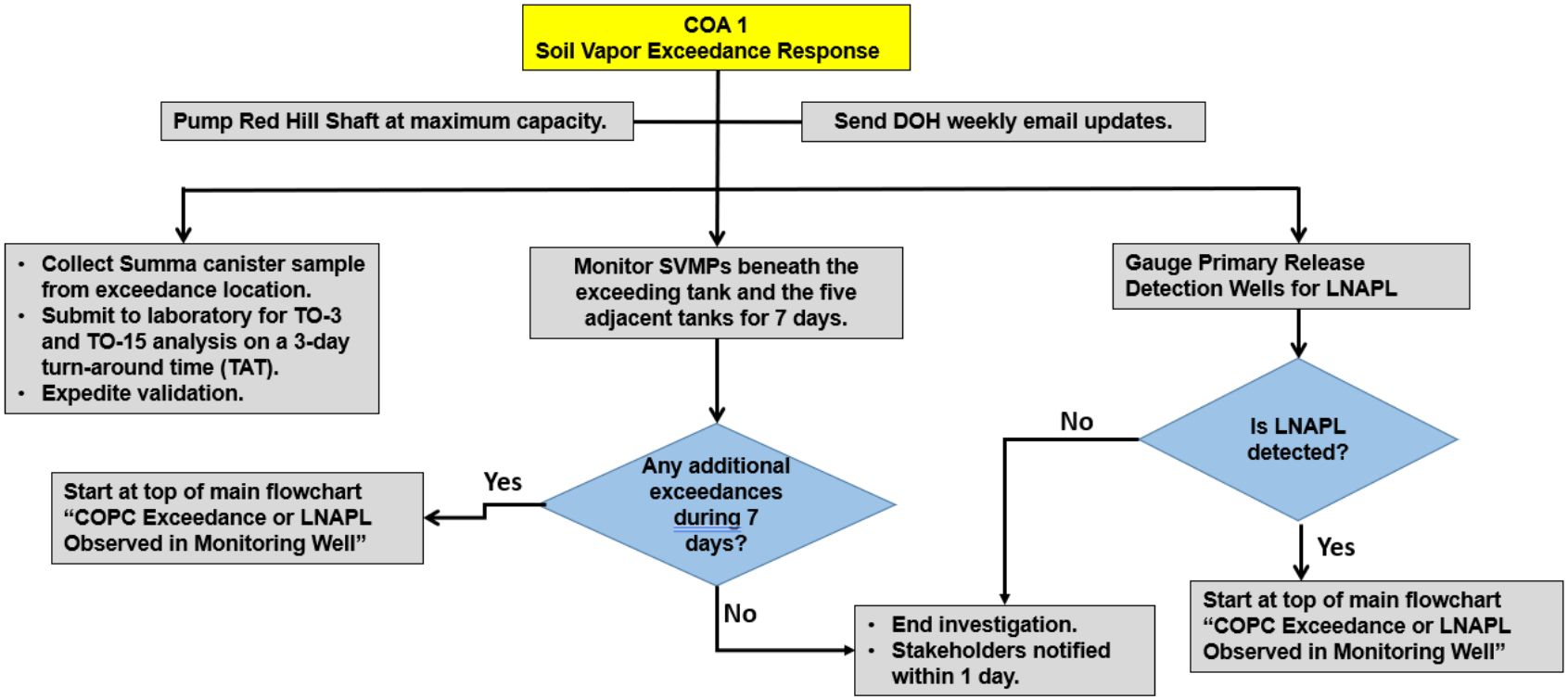

Figure 3B: Response Actions for Exceedance During Defueling – COA 1

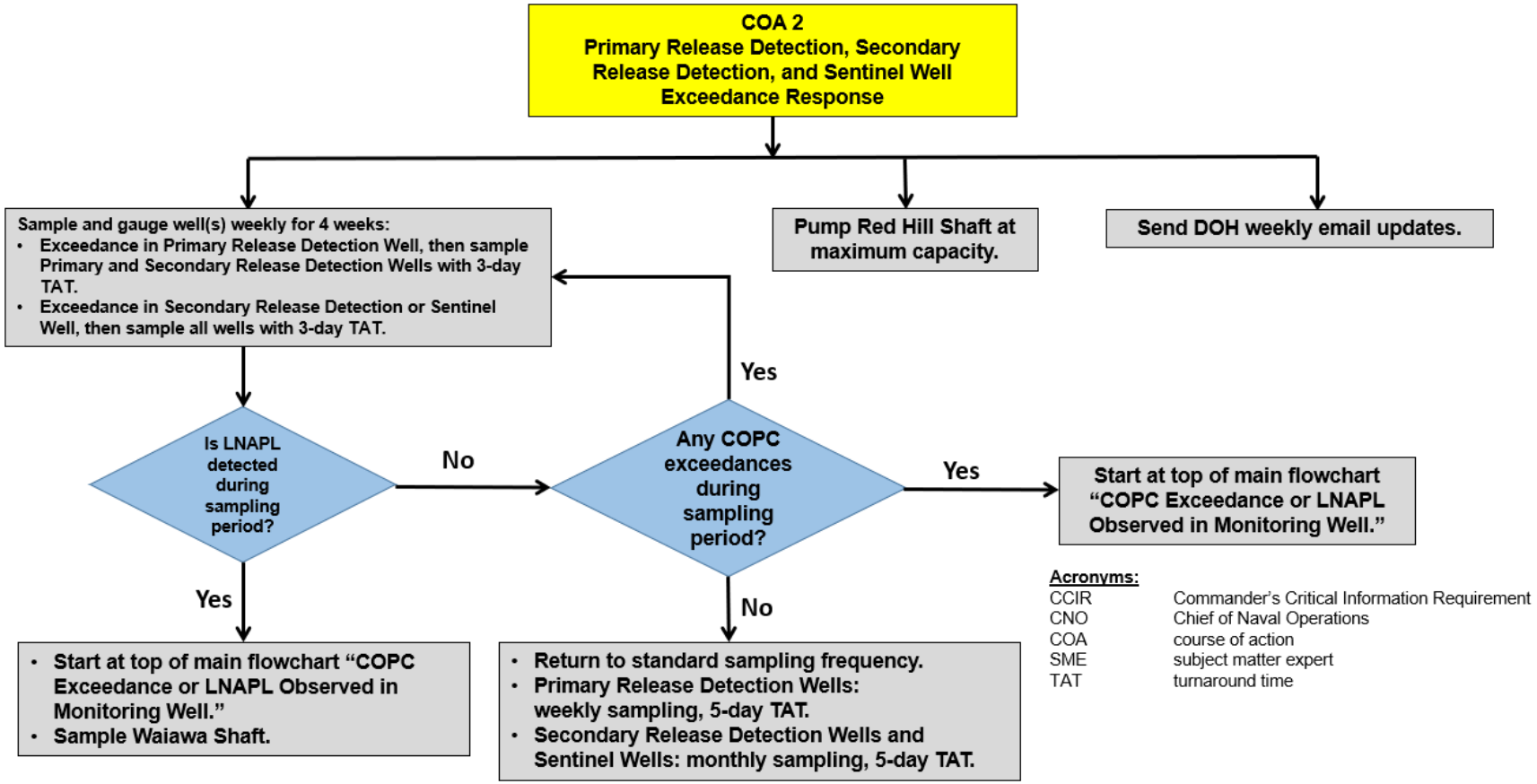

Figure 3C: Response Actions for Exceedance During Defueling – COA 2

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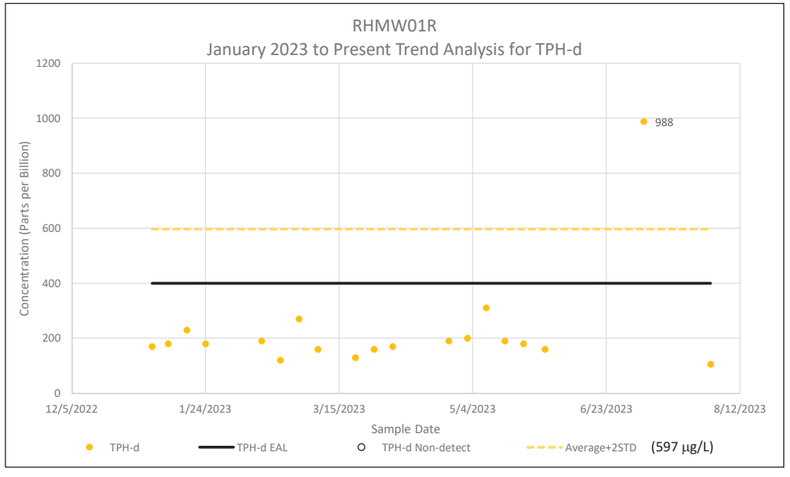
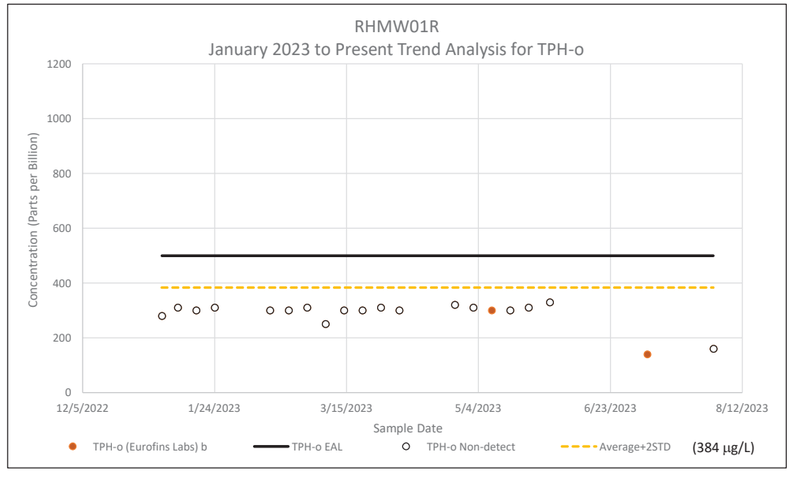
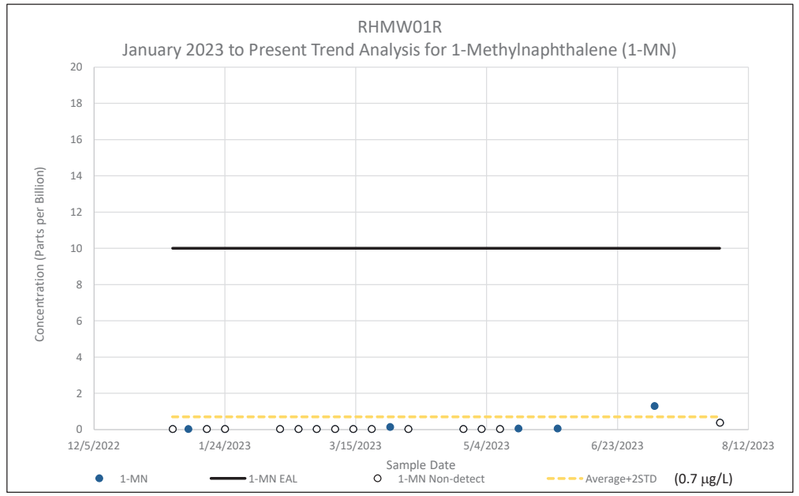
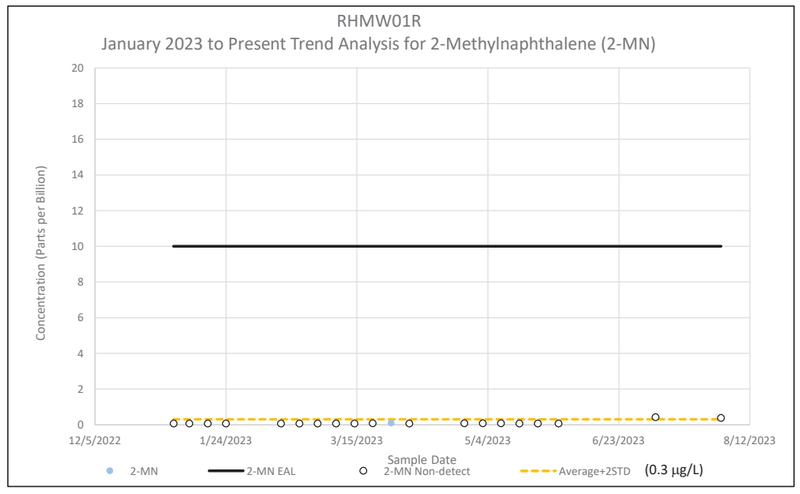
Appendix A: Tunnel Well COPC Trends









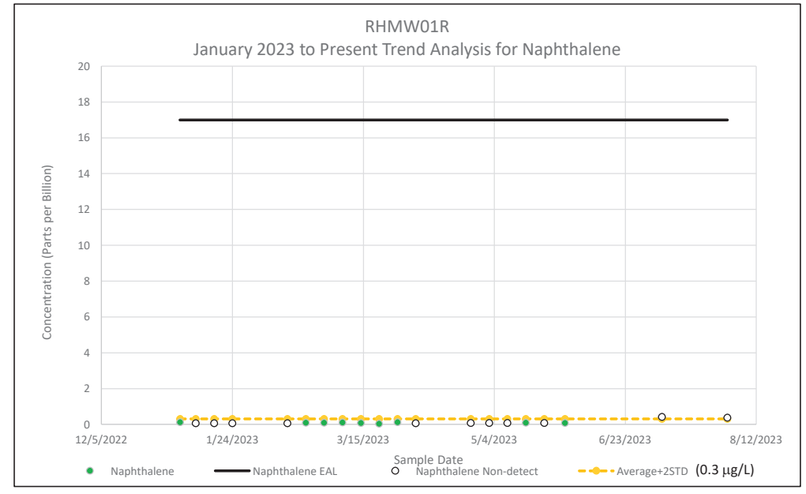
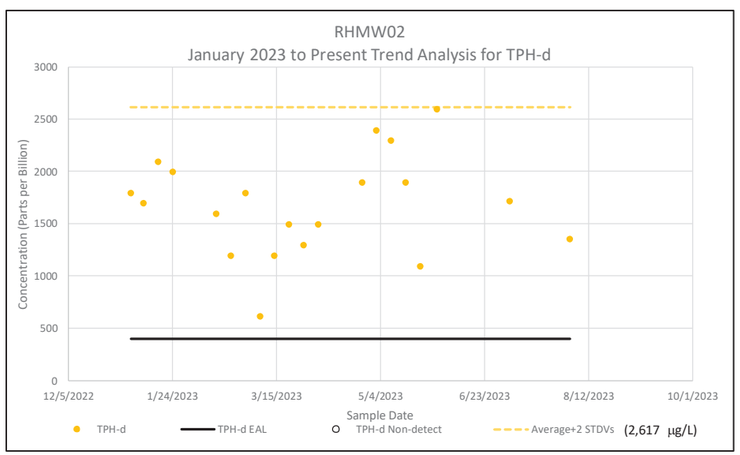
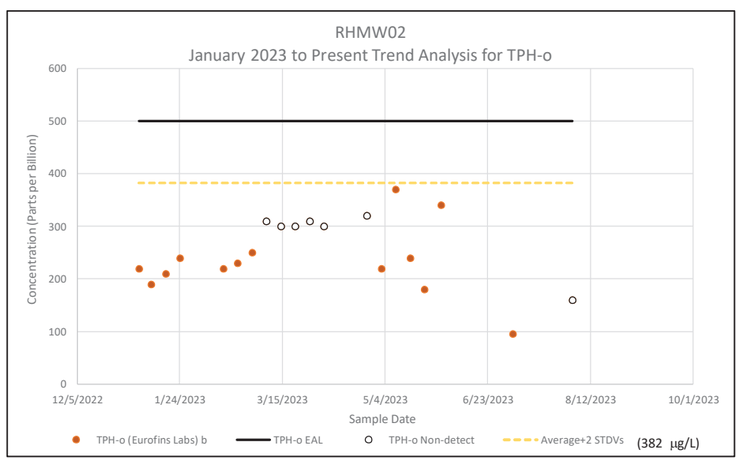
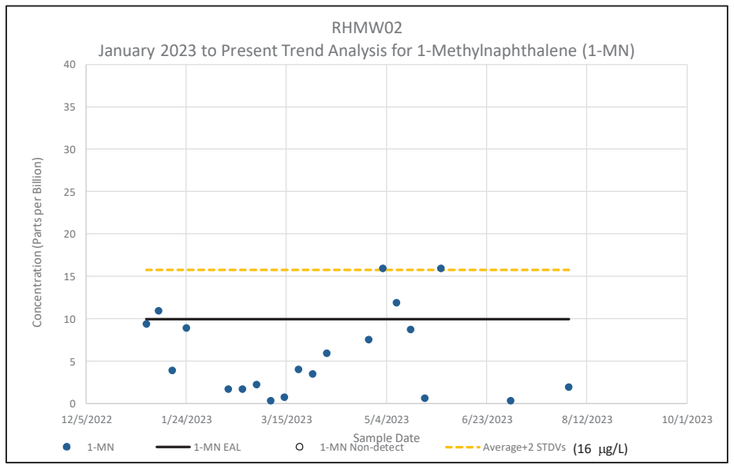
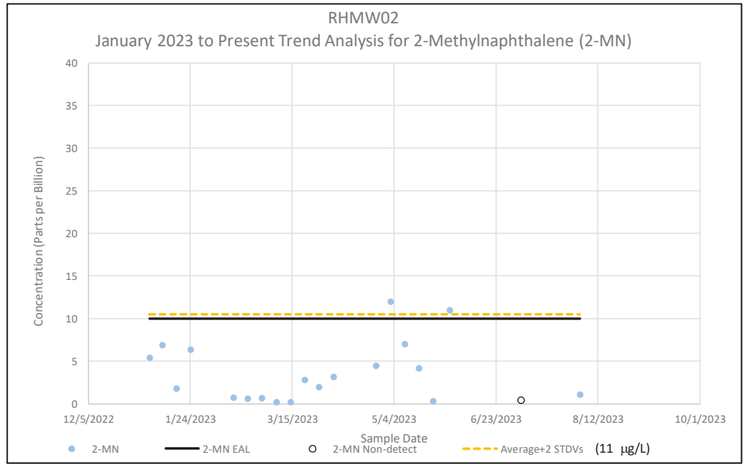


Table APPA -1. Trigger Levels for Compounds of Potential Concern during Defueling for RHMW01R









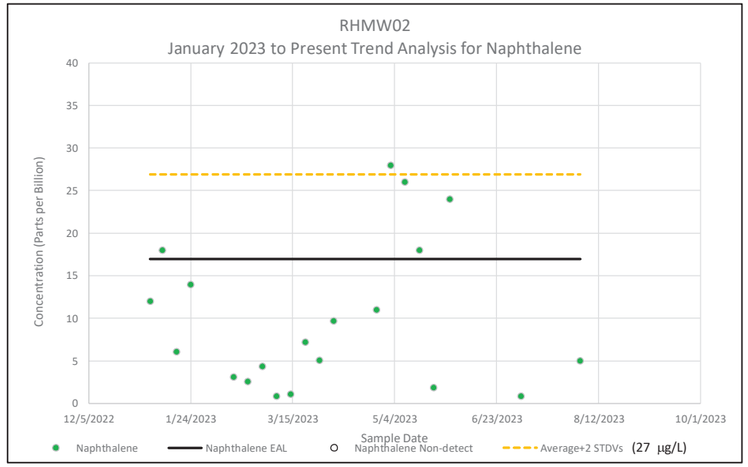
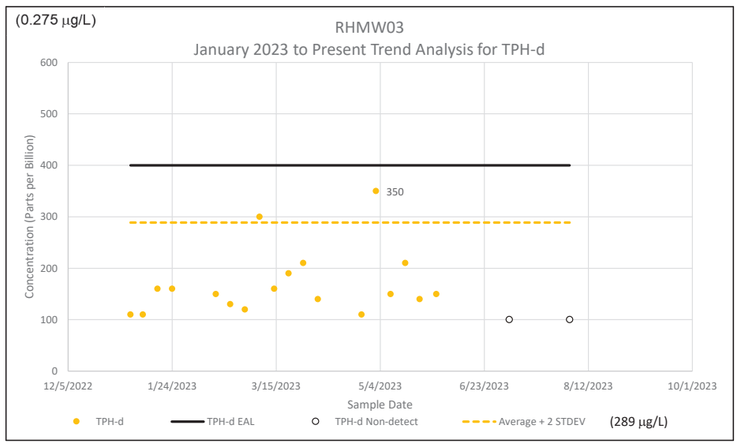
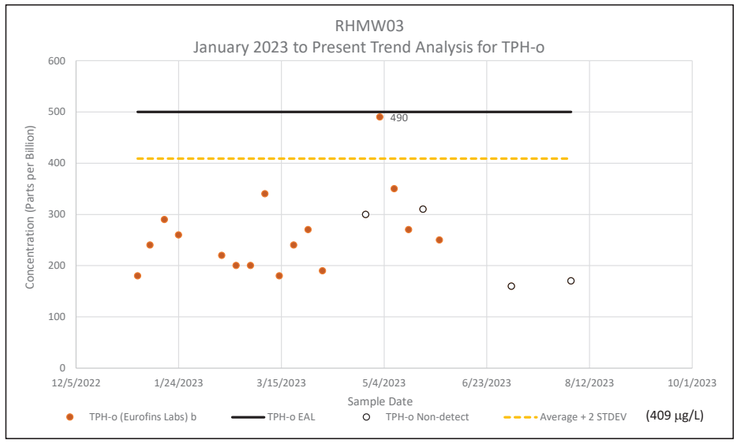


Table APPA -2. Trigger Levels for Compounds of Potential Concern during Defueling for RHMW02

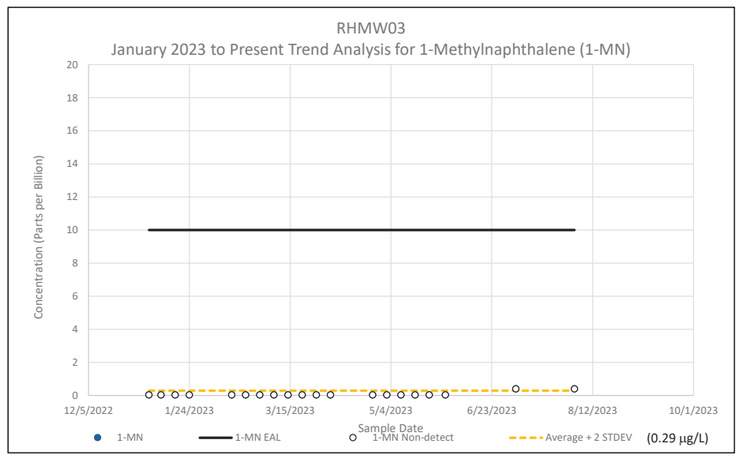
(0.275 µg/L)



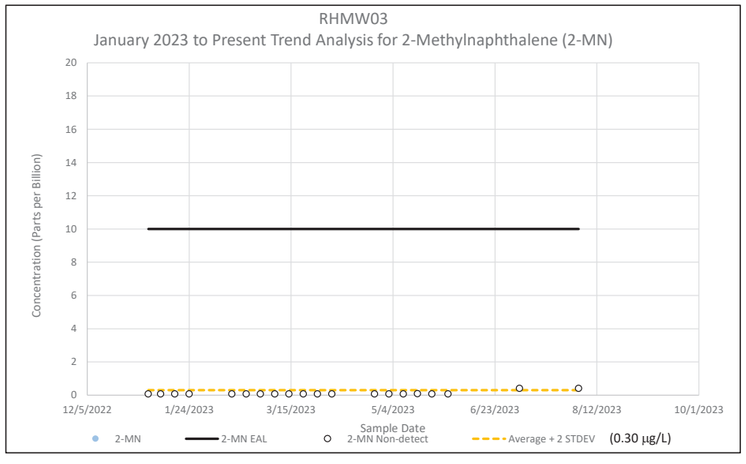
(289 µg/L)



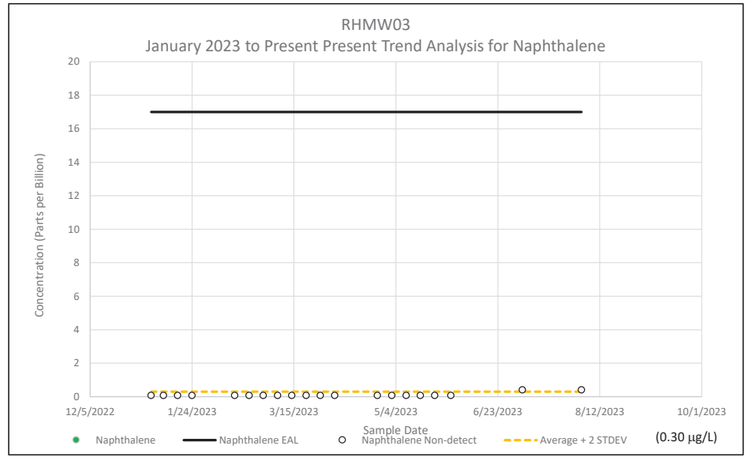
(409 µg/L)



(0.29 µg/L)

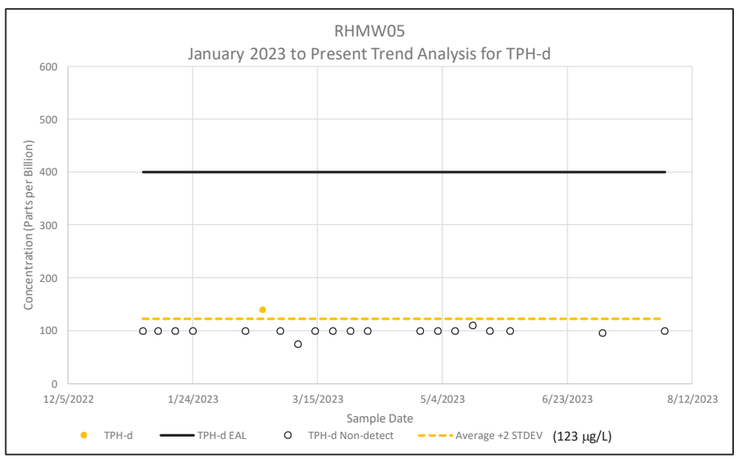


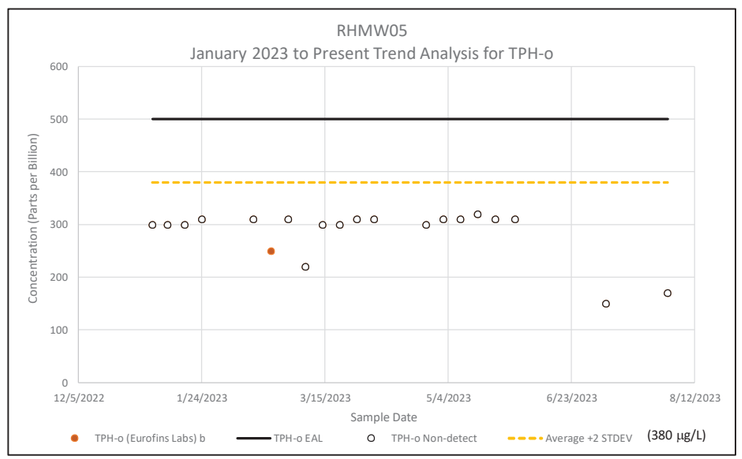
(0.30 µg/L)

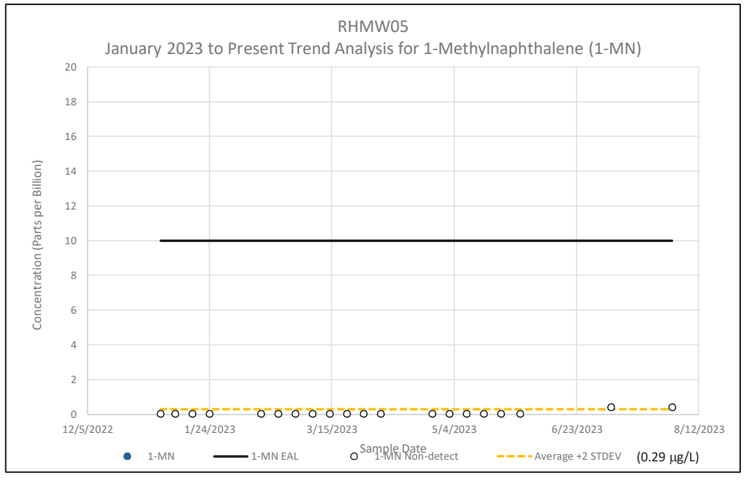


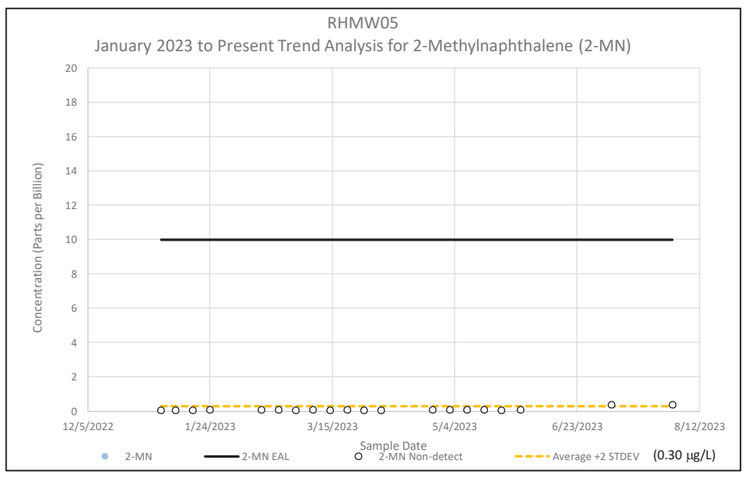
(0.30 µg/L)

Table APPA -3. Trigger Levels for Compounds of Potential Concern during Defueling for RHMW03









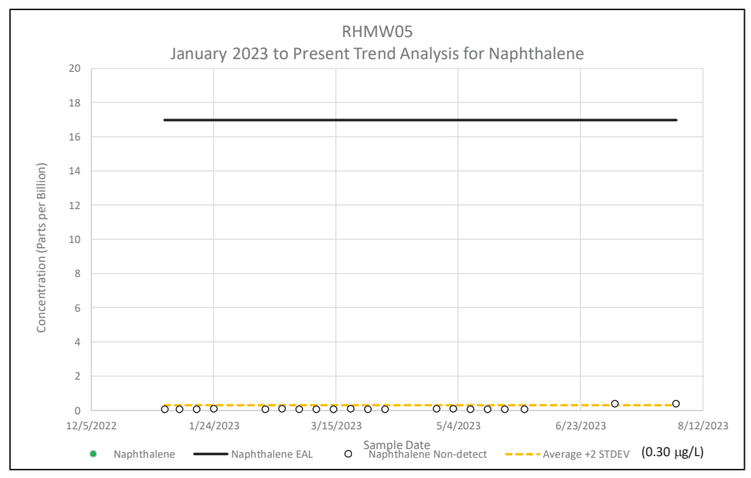
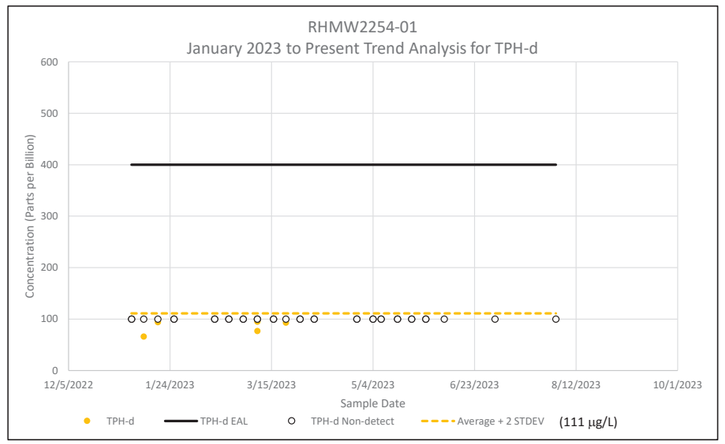
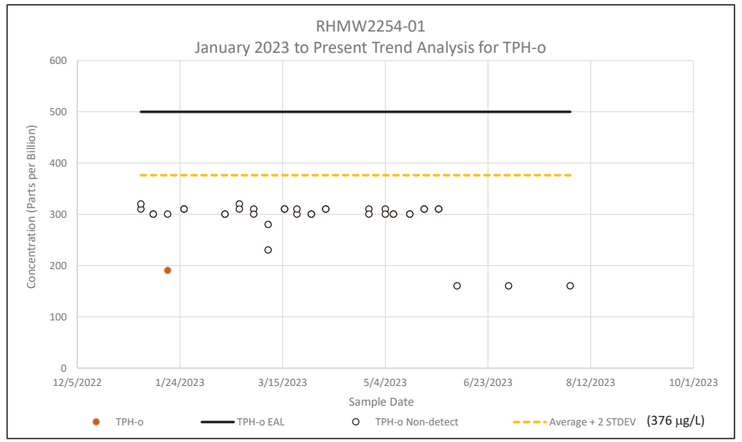
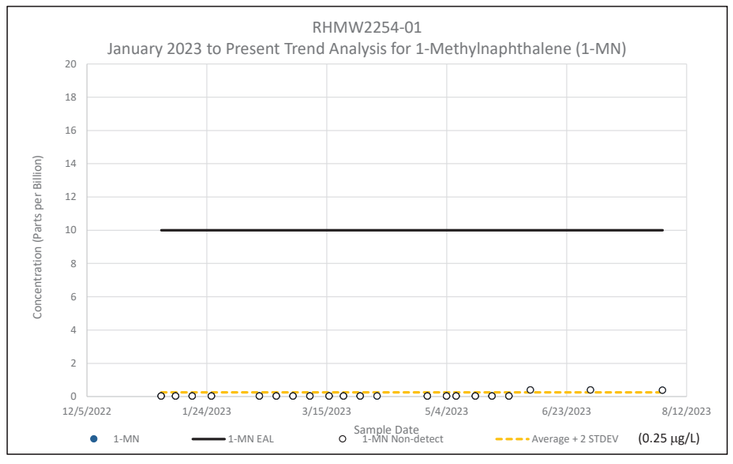
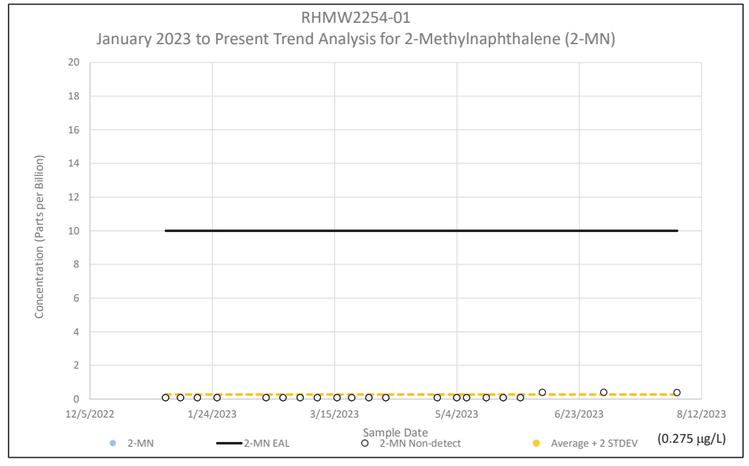


Table APPA -4. Trigger Levels for Compounds of Potential Concern during Defueling for RHMW05









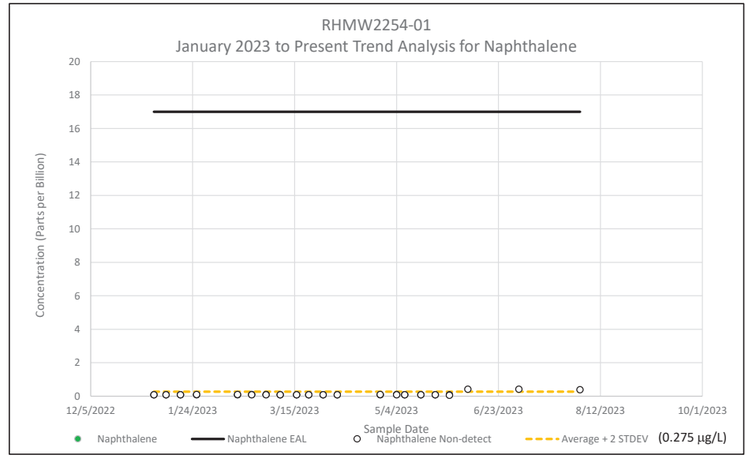


Table APPA -5. Trigger Levels for Compounds of Potential Concern during Defueling for RHMW2254-01