Quality Assurance Project Plan Addendum
Remedial Investigation
Former NIKE PR-79 Control Area
Foster, Rhode Island
DERP-FUDS D01RI0063/02

December 23, 2022 (Revised November 21, 2023)

This Quality Assurance Project Plan (QAPP) Addendum provides the protocols for sample collection, handling, and storage, chain-of-custody, laboratory and field analyses, data validation, data evaluation, and reporting that are specific to soil, overburden groundwater, and bedrock groundwater water sampling and testing to be conducted at the Former NIKE PR-79 Control Area in Foster, Rhode Island (”Property”). This document summarizes updates to the Final QAPP dated September 11, 2020 for Remedial Investigation (RI); the first QAPP Addendum, dated January 2021, for residential drinking water sampling at the Property; and the second QAPP Addendum, dated May 2022, for additional RI work. RI investigations were conducted in 2020, 2021, and 2022. The field activities included herein are being conducted for the purpose of evaluating data gaps and bolstering the groundwater data set for risk assessment. Soil sampling described herein is to be considered “biased” for the purposes of filling data gaps in connection with nature and extent. This third addendum was prepared to support the United States Army Corps of Engineers (USACE) New England District with additional soil sampling, and groundwater (overburden and bedrock) sampling. Data validation protocols for soil and groundwater data will be validated to level Stage 2b. Additional soil sampling will be proposed in a future QAPP Addendum to establish an unbiased soil dataset for evaluation in the Phase II risk assessment.

Programmatic and Site-specific decisions for the RI presented in the Final QAPP as well as the first and second QAPP Addendums remain unchanged, including laboratory worksheets for methods that remain unchanged.

The following Summary of Changes for this UFP-QAPP Addendum table (Page 2) briefly outlines which worksheets have been updated from the original RI QAPP (September 2020), Residential Drinking Water QAPP Addendum (January 2021), and/or Additional RI QAPP Addendum (May 2022). The table additionally provides some information and context relative to the change included in this document in comparison to the original QAPP(s). Please refer to the September 2020 RI QAPP, January 2021 Residential Drinking Water QAPP Addendum, and May 2022 Additional RI QAPP Addendum for all other worksheets that did not require updates for the field work included herein.

QAPP Worksheet #10: Conceptual Site Model

10.1 Overview

This worksheet presents general background information and the general updated Conceptual Site Model (CSM) for the Site. A more detailed CSM was provided in the Final QAPP dated September 11, 2020. This updated CSM is subject to change based on the results of this investigation. A more detailed updated CSM will be included in the RI Report.

10.2 Conceptual Site Model Summary

The following subsections briefly summarize the current CSM. It is divided into the specific AOCs identified for investigation, shown in Figure 10-1. Sample locations are depicted on Figures 10-2, 17-1A, 17-1B, 17-1C, 17-1D, and 17-1E.

AOC-1 Radar Area

Study Area: The study area includes a former helicopter pad and former target acquisition and tracking radar equipment located at Radar Pad A, Radar Pad B, Radar Pad C, Radar Control Van, Battery Control Van, Frequency Changer/Generator building (including a floor drain), associated cesspools and a dry well.

The floor drain was previously investigated in the initial phase of the RI. Upon uncovering the floor drain and associated drainage trench. The initial phase of the RI found VOCs (including TCE at an estimated low concentration [0.0009 J mg/L]) in a groundwater. The 2020-2021 RI evaluated VOCs in the underlying overburden and weathered bedrock zones.

Dissolved TCE was identified above Project Action Limits (PALs) during the 2020 RI in groundwater samples collected from newly installed overburden well PR79-MW-003, suggesting that AOC-1 (the former Frequency Changer Generator Building) is a potential source area of TCE. AOC-1 is located near the topographic high point of the Property. Overburden groundwater elevation contours indicate that overburden groundwater flow may be radial away from this topographical high point; however, there are currently no overburden monitoring wells to the north and northeast to confirm this interpretation.

The primary migratory pathway of dissolved TCE in groundwater to downgradient receptors is from the overburden material in the AOC-1 source area to the underlying bedrock and through the major transmissive fracture zones identified to the south and southwest. It is also anticipated that TCE, both as NAPL during original release as well as dissolved phase, migrated over the top of the bedrock, downslope through overburden and weathered bedrock. It is important to understand that only a fraction of the recharge makes it into the transmissive fracture network, which is the primary pathway impacting bedrock drinking water supply wells. Dissolved TCE has been confirmed in bedrock wells in those directions (i.e., wells PR79-BR-002, PR79-BR-001, PR79-BR-003, NIKE-1, ROU-1, ROU-2, ROU-3, and DW-39) and bound by non-detection results in wells DW-41 and DW-37. Bedrock well PR79-BR-002 is the northernmost well on the property and was completed as a multi-level FLUTe well where fractures/fracture zones were encountered. The original location of this well was chosen based on both previous site activities as well as previous geophysical surveys that identified potential thick weathered zones/fracture zones and proximity to historic building activities. This well has some of the highest impacts in fractures that dip to the north/northeast with elevated head as compared to water levels measured in the deeper FLUTe ports (i.e., shallow FLUTe ports show a downward gradient relative to deeper FLUTe ports). Additionally, groundwater elevations measured in the FLUTe ports in BR-002 indicate downward gradients were present in this well on December 15, 2020 and May 24, 2022. The shallowest PR79-BR-002 sample port had low TCE concentrations (0.92 µg/L in December 2020, Non-detect in May 2022), whereas deeper sample ports, two and three, had concentrations of 100 µg/L and 79 µg/L, respectively. Similar concentrations were identified in a sampling event conducted in May 2022. Based on prior borehole geophysics data, the shallowest fractures with low detection of TCE dip to the south/southeast with a strike in the east/west direction. The higher impacted fractures within this well dip to the east/northeast at moderate dip angles with strike of north-south/northwest-southeast. One fracture is sub-horizontal, dipping approximately six degrees to the northwest with northeast-southwest strike. When extrapolated out from the borehole center, the shallow fractures with low TCE impacts in BR-002 would intersect the bottom of MW-003. Extrapolating this fracture out further north/northwest would see it intersect the ground surface in the vicinity of MW-001 (similar to the red dashed line shown in Figure 17-1A).

Although there has been no indication of TCE in drinking water wells to the north (DW-68 and DW-69), northeast (DW-24) and east (DW-21).

AOC-2 Operations and Maintenance Area

Study Area: The study area includes the former Mess Hall, Barracks, and Administration buildings, water pump house, former transformer area, and reported motor pool vehicle maintenance areas located northwest of the former Guard Post along Theodore Foster Drive and northwest of the former water storage tank and pump house. The study area also includes an “unidentified pipe” observed west of former water pump house which is approximately 23 feet deep and is thought to be an abandoned borehole.

The transformers and associated electrical equipment were removed by the Town of Foster after being transferred to the Town of Foster in 1965 for beneficial use. The former transformer area was previously investigated twice, and the results from surficial soil samples indicated PCBs were not present at concentrations exceeding laboratory reporting limits. Based on the findings of these previous investigations, and that the electrical equipment was beneficially used and removed by the Town of Foster, further investigation of the former transformer area was not conducted as part of the 2020-2021 RI.

Soils in the vicinity of the Former Vehicle Maintenance area have indicated concentrations of benzo(a)pyrene and lead at or above their respective PALs in samples collected at PR79-SB-109. Based on the 2020-2021 RI, both benzo(a)pyrene and lead appear to be delineated both vertically and horizontally, isolated to boring PR79-SB-109.

Potential impacts from TCE and other degreasing solvents are related to the maintenance of former buildings and potentially used for motor pool vehicle maintenance. Gasoline, diesel, and motor oil leaks and spills related to former motor pool vehicle maintenance was investigated as part of the 2020-2021 RI with the installation of boring/overburden monitoring well PR79-SB-109/PR79-MW-005 and bedrock monitoring well BR-004. TCE was not reported at concentrations exceeding laboratory detection limits in groundwater samples collected at PR79-MW-005 and/or PR79-BR-004.

The absence of TCE in groundwater and horizontal and vertical delineation of soils in the vicinity of the Former Barracks and Former Vehicle Maintenance area my indicate that these features in AOC-2 are not to be considered potential source areas. As a result, no further investigation is warranted at this time.

AOC-3 Southern Leach Field

Study Area: The study area includes the former southern leach field, former distribution box, and drain line connected to the Western Sewage Disposal Area.

Potential impacts of TCE and other degreasing solvents used as cleaning agents and paint waste disposed through the septic system were investigated during the 2020-2021 RI. Monitoring wells PR79-MW-006 and PR79-MW-007 were installed to target the shallow water bearing unit adjacent to the former Mess Hall for human health risk assessment and assess potential overburden impacts from the former leach field and septic tank, respectively.

Benzo(a)pyrene weas detected at a concentration above its respective PAL in samples collected at boring PR79-SB-113. Benzo(a)pyrene appears to be vertically delineated. Elevated concentrations of benzo(a)pyrene in subsurface soil at PR79-SB-113 may be related to a leaking 2,000-gallon No. 2 heating oil underground storage tank (UST) located approximately 50 ft east of PR79-SB-113. Further evaluation of soils in this area was determined to be warranted.

Nitrite was detected at an estimated concentration (210 µg/L) slightly above the associated PAL, equal to the USEPA Regional Screening Level (RSL) for tapwater based on a target hazard quotient of 0.1 (May 2022), of 200 µg/L in a groundwater sample collected from PR79-MW-006. The estimated nitrite concentration of 210 µg/L in groundwater is less than the USEPA Maximum Contaminant Level (MCL) of 1,000 µg/L. Nitrite was not detected in the background bedrock groundwater well (i.e., Steere well). PR79-MW-006 is located approximately 100 feet from an active septic leach field constructed in the 2000s by the Town of Foster to replace a former septic system; therefore, nitrite is likely associated with that septic leach field. No other analytes were identified at concentrations exceeding laboratory detection limits in groundwater samples collected from PR79-MW-006 and/or PR79-MW-007.

Three heating oil USTs that supplied the Barracks, Administrative, and Mess Hall buildings were transferred to the Town of Foster in 1965 On December 16, 2019. To date, the three USTs have been removed. Upon removal, indication of a release was observed from the UST located adjacent to the former Mess Hall. The Formerly Used Defense Site (FUDS) Program Policy, ER 200-3-1, provides specific criteria for property eligibility. The Program Policy expressly provides that USTs that have been beneficially reused by the Property Owner are ineligible under the FUDS Program.

Currently, RIDEM is requiring the Town of Foster to conduct quarterly groundwater sampling of up to eight shallow overburden monitoring wells installed by Sage Environmental. Groundwater monitoring of SVOCs is to occur during the months of January, April, July, and October of each year until further notice.

AOC-4 Western Sewage Disposal Area

Study Area: The study area includes the former sand filtration beds, former chlorine detection chamber and former utility shed located at the Western Sewage Disposal Area.

The location of the utility shed in the Western Sewage Disposal Area was investigated in the initial phase of the RI (AMEC, 2013) with soil borings SB-023 and SB-026. Additional soil sample locations in this AOC were sampled as part of the 2020-2021 RI (PR79-SB-117, -118, and -119). Compounds were not identified at AOC-4 at concentrations exceeding screening levels, except for arsenic, which was reported in 2 of 5 surface soil samples (at a maximum concentration of 3.29 mg/kg) and 1 of 3 subsurface soil samples (at a maximum concentration of 2.61 mg/kg) at concentrations exceeding the May 2022 Residential Soil Regional Screening Level (RSL) of 0.68 mg/kg and the Site-specific BTVs of 2.6 mg/kg and 1.7 mg/kg for surface soil and subsurface soil, respectively. Arsenic is commonly found in soils in Rhode Island and has not been identified as a chemical used at NIKE missile batteries and is unlikely to be related to former DoD activities (USACE EMCX, 2003). Furthermore, elevated concentrations of arsenic were not identified in borings placed in areas leading into (PR79-SB-116 and -115, collected from 5-6 and 5-7 feet, respectively) or out of (PR-79-SB-119, collected from the surface down to 8-10 feet) the former sand pit area. This further supports that the arsenic identified in this area is likely a background condition.

As part of the 2020-2021 RI soil boring/monitoring well PR79-SB-118/PR79-MW-008 was installed at the downgradient edge of the former Sand Pits to assess whether they affected groundwater quality. Numerous attempts have been made to sample monitoring well PR79-MW-008; however, the well has been dry (i.e., no water column) since its initial installation.

The absence of COPCs in soil samples collected as part of the 2020-2021 RI suggests the area surrounding the former sand filtration beds is not a source for impacts to soil. Attempts will continue to be made to monitor groundwater conditions in well PR79-MW-008. No further investigation of AOC-4 is warranted at this time.

AOC-5 Western Disposal Area

AOC-5 was used for residential and agricultural dumping by the property owner and is not attributable to former DoD activities; therefore, AOC-5 is ineligible for investigation and cleanup under DERP-FUDS.

10.3 Data Gap Analysis

The review of the historic information and working CSM has identified data gaps in the technical understanding of the hydrogeology, migration pathways, and nature and extent of impacts. A detailed data gap analysis was included in the September 2020 RI QAPP. The following briefly outlines data gaps developed following RI activities conducted from 2020 to 2021. Sample locations discussed herein are depicted on Figure 10.2.

Hydrogeology and Migration Pathways

Groundwater flow: Overburden groundwater contours indicate that overburden groundwater flow may be radial away from the topographical high point around the former Frequency Changer/Generator Building; however, there are currently no overburden monitoring wells to the north and northeast that would confirm this interpretation. The installation of two additional overburden monitoring wells to better define the extent and potential migration of TCE in overburden groundwater from the probable source area around PR79-MW-003 to the north and northeast. Overburden wells should be screened in the same lithologic units as MW-003 (i.e., into weathered bedrock, assumed depth of wells to be approximately 35 feet).

The primary migratory pathway of dissolved TCE in groundwater to downgradient receptors appears to be from the overburden material at the AOC-1 source area (former Frequency Changer/Generator Building) to the underlying bedrock and through the major transmissive fracture zones identified to the south and southwest. It is an anticipated that TCE, both as NAPL during original release as well as dissolved phase, migrated over the top of the bedrock, downslope through overburden and weathered bedrock. It is important to understand that only a fraction of the recharge makes it into the transmissive fracture network, which is the primary which is the primary pathway impacting bedrock drinking water supply wells. Fractured bedrock groundwater flow may follow discrete fractures based on strike and dip and where fracture intersections occur. Based on the Rose Diagram of potentially hydraulically active fractures derived from bedrock wells PR79-BR-001, PR79-BR-002, PR79-BR-003, PR79-BR-004, PR79-BR-005, NIKE-1, NIKE-2, ROU-1, ROU-2, and ROU-3 the primary strike direction is N/NW to S/SE, with a secondary set that strikes in the E/NE to W/SW direction. Dissolved TCE has been confirmed in bedrock wells in those directions (PR79-BR-002, PR79-BR-001, PR79-BR-003, NIKE-1, ROU-1, ROU-2, ROU-3, and DW-39) and bound by non-detection in wells DW-41 and DW-37. Bedrock well PR79-BR-002 is the northernmost well on the property. This well has some of the highest impacts in fractures that dip to the north/northeast with elevated head (with strike consistent with the secondary set of fractures described above). Although there has been no indication of TCE in drinking water wells to the north (DW-68 and DW-69), northeast (DW-24) and east (DW-21).

<u>Downhole bedrock fracture characterization</u>: An additional bedrock well is needed to intercept and further characterize potential migration pathways via transmissive fractures and measure the vertical component of the hydraulic gradient within bedrock to the south/southwest of residential wells ROU-2 and ROU-3.

Nature and Extent of Impacts in Soil, Overburden, and Bedrock

<u>Plume delineation (horizontal and vertical):</u> The existing dataset for soil and groundwater is not sufficient to adequately assess the horizontal and vertical extent of impacts, particularly in deep overburden, weathered bedrock, and bedrock. The current data is limited with respect

to the media assessed and the likely pathways in which COPCs migrated over time. Previous investigations concluded that TCE, pentachlorophenol, and naphthalene are the only Site-related COPCs identified in overburden groundwater and are isolated to the area surrounding PZ-019 located immediately adjacent to the former Frequency Changer/Generator Building as well as in the area surrounding PR79-MW-003 in the Radar Area (AOC-1). Bedrock well PR79-BR-002 is the northernmost well on the property and was completed as a multi-level FLUTe well where fractures/fracture zones were encountered. The original location of this well was chosen based on both previous site activities as well as previous geophysical surveys that identified potential thick weathered zones/fracture zones and proximity to historic building activities. This well has some of the highest impacts in fractures that dip to the north/northeast (with strike in a general east/west direction) with elevated head as compared to water levels measured in the deeper FLUTe ports (i.e., shallow FLUTe ports show a downward gradient relative to deeper FLUTe ports). Additionally, groundwater elevations measured in the FLUTe ports in BR-002 indicate downward gradients were present in this well on December 15, 2020 and May 24, 2022. The shallowest PR79-BR-002 sample port had low TCE concentrations (0.92 µg/L in December 2020, Non-detect in May 2022), whereas deeper sample ports, two and three, had concentrations of 100 µg/L and 79 µg/L, respectively. Similar concentrations were identified in a sampling event conducted in May 2022. Based on prior borehole geophysics data, the shallowest fractures with low detection of TCE dip to the south/southeast with a strike in the east/west direction. The higher impacted fractures within this well dip to the east/northeast at moderate dip angles with strike of north-south/northwest-southeast. One fracture is sub-horizontal, dipping approximately six degrees to the northwest with northeast-southwest strike. When extrapolated out from the borehole center, the shallow fractures with low TCE impacts in BR-002 would intersect the bottom of MW-003. Extrapolating this fracture out further north/northwest would see it intersect the ground surface in the vicinity of MW-001 (similar to the red dashed line shown in Figure 17-1A). Additional data is needed to assess this potential source area in overburden, identify whether a discrete or diffuse continuing source exists, and assess transport mechanisms in weathered bedrock and bedrock. This will be achieved by installing new monitoring wells screened to target permeable overburden and transmissive bedrock fractures and conducting sampling for COPCs and geochemical parameters to understand the chemical and physical processes impacting the plume.

10.4 Description and Current Use

The Former NIKE PR-79 Control Area (Property) is located in Providence County, in Foster, Rhode Island, as shown on Figure 10-1. The coordinates for the Site obtained from the US Geological Survey (USGS) 7.5-minute Quadrangle for Clayville, Rhode Island are approximately:

- Latitude: N41° 50' 32"
- Longitude: W71° 42' 57"

The Property is located at the end of Theodore Foster Drive. According to the Town of Foster Tax Assessor Online database, the address is 23 Theodore Foster Road and recorded on Lot 10, Map 18. The parcel is 6.62 acres in size[1]. The land is zoned for municipal use.

- The area surrounding the Former NIKE PR-79 Control Area is comprised of northern hardwood forest and rural development. The Property is located on top of Oak Hill and residences, farms, and businesses are located south of the Property. Three residences are located within 300 to 400 ft of the Property with approximately 68 residences located within a one-mile radius with private water supply wells in Foster and North Scituate, Rhode Island. The majority of these homes are located along Maple Rock Road, Winsor Road, and Old Hartford Pike. The nearest residential private water supply well (ROU-1) is located approximately 200 ft east of the Property. Businesses located near the Property include solar panel arrays located to the northeast and southeast of the Property. The location of on-Property supply wells (NIKE-1, NIKE-2), nearby residential water wells (ROU-1, ROU-2, and ROU-3) and solar panel arrays are shown on Figure 10-2.

The Town of Foster has recently converted the former Mess Hall building to be used for residential uses. There is currently one tenant occupying the former Mess Hall building. The former mess hall building, which is the only building on the Former NIKE PR-79 Control Area property, was temporarily declared "unsafe" in July 2020 by the Town of Foster Building Inspector due to potential asbestos containing building materials.

10.5 Topography and Geology

The Former NIKE PR-79 Control Area is located on top of Oak Hill at approximately 620 ft above mean sea level (msl). The surrounding terrain is characterized by low hills and shallow valleys. The elevation of Winsor Brook is approximately 470 ft above msl.

The surficial geology in the vicinity of the Site is made up of glacial-fluvial deposits in the valleys and lodgment and ablation till along the hills. The glacial outwash is composed of sand and gravel interbedded with silt and clay. The units form unconsolidated and generally well sorted and

1 Town of Foster Tax Assessor Online database indicates the parcel is 6.62 acres in size; however, there is conflicting information from other sources regarding the exact acreage. The DERP-FUDS Inventory Project Report indicates the Site is 19.59 acres in size (13.36 acres and a 6.23-acre easement). Historic reports from Camp Dresser & McKee, Inc. (CDM) and CENAE reference 8 acres (CDM, 1994; CENAE, 2003). On September 22, 1995, 1.38 acres was transferred to Lot 11 on Plat 18 (AMEC, 2013).

stratified sequences that reach up to 50 ft thick in the area surrounding the Site. Site-specific geophysical and boring log information indicates a much thinner layer of overburden of between 5 to 35 ft thick. Boulders, sand, silt, and clay are found within the poorly sorted and unstratified glacial materials. As observed during the 2020 RI field events, glacial till forms a thin, discontinuous mantle over the bedrock surface averaging 18 ft in thickness.

Below the overburden material is a layer of weathered bedrock. Surface geophysics performed at the Site indicate the thickness of this layer varies between one and 15 ft beneath the Site. However, the weathered bedrock is sometimes thicker and the bedrock surface elevation lower in areas of highly fractured bedrock. The bedrock beneath the Site is composed of the South Foster Migmatite and Ponaganset Gneiss of the Esmond Igneous Suite. The South Foster Migmatite consists of a heterogeneous composite of quartz-biotite schist and quartzite members. The Ponaganset Gneiss is a coarse grained, porphyritic, pink to gray diorite gneiss. The gneiss is the most predominant rock type across the Site.

A weathered bedrock zone, with possible intersecting fractures that could represent potential migratory pathways and/or storage/source areas for residual TCE, extends to the north from central portions of AOC-1. The weathered bedrock zone was interpreted to extend to the property line based on only a few piezometers. Surface geophysical surveys were completed in this vicinity to evaluate the presence of the weathered bedrock zones to the north and to attempt identification of weathered zones and/or potential fractures that were inferred to extend to this area by others (Johnson Company, 2018) since these areas may continue to hold contaminant mass. Recent surface geophysical data compiled in November 2022 by Hager-Richter and AECOM was integrated with all previously collected geophysical data and evaluated to assess detailed bedrock topography as well as lower velocity zones interpreted as weathered bedrock or thicker intervals of glacial till including cobbles and boulders. AECOM also evaluated geophysical data collected by Hager-Richter relative to TCE concentrations and fracture orientations in BR-002 under separate cover (AECOM, 2023). These features are also included in the Johnson Company's 2018 RI/FS Work Plan (specifically Figures 3-7, 3-7, 3-9, 3-10, and 3-17) and shown with other interpreted bedrock features on Figure 17-1C. Two overburden monitoring wells (screened into weathered bedrock) were proposed for this area to further investigate groundwater flow/hydraulic gradient and groundwater quality within these suspected lateral extending weathered bedrock/fractured zones since TCE was identified in a monitoring well installed to the south MW-003. Recent surface geophysical results confirmed zones of lower velocity bedrock (indicative of weathered bedrock) extending to the northern property boundary. Bedrock structure and weathered zones are depicted on Figure 17-1C, where inferred weathered zones, bedrock lineaments, and potential fractures inferred from previous sources shown. Updated competent bedrock contours are presented in Figure 17-1D for this area from Hager Geosciences seismic refraction data collection effort in 2022. Proposed boring locations are placed in areas where competent bedrock contours show lower elevation, which may correspond with fracture intersections and/or locations of mass storage. Additionally, saturated overburden thickness is depicted on Figure 17-1E, where the two proposed soil boring/well locations are located in areas indicative of thicker saturated overburden/weathered bedrock with possible fracture zones. These two additional locations will aid in evaluating groundwater elevations, flow directions, and quality along the northern property boundary.

Based on borehole geophysics and outcrop field observations, the competent bedrock is characterized by steeply dipping fractures and occasional fracture zones spaced from approximately 4 to greater than 10 ft apart. The orientations of field-measured bedrock fractures are similar to the orientations of topographic lows feeding into Barden Reservoir located south of the Site, suggesting that ground surface topography is sometimes controlled by preferential erosion along zones of closely spaced bedrock fractures.

The steeply dipping fracture orientations in bedrock predominantly strike north-northwest (NNW) to south-southeast (SSE) and north-northeast (NNE) to south-southwest (SSW) on Site, although north to south and east-northeast (ENE) to west-southwest (WSW)-striking fractures are also present. The primary water-bearing fracture sets encountered in Site wells NIKE-1, NIKE-2, ROU-1, ROU-2, and ROU-3 strike NNE to SSW and NW to SE and dip moderately.

South of the Site, NNW to SSE and northwest (NW) to southeast (SE)-striking fractures are more prevalent, reflecting the primary orientation of the Ponaganset River drainage to Barden Reservoir. These fracture strike orientations are reflected in the topographic drainage patterns, suggesting that the bedrock joints and associated fracture sets represent preferential erosional zones.

10.6 Hydrology and Hydrogeology

There are no surface water bodies in the Former NIKE PR-79 Control Area (Site). Surface water runoff from the Site is directed into drainage ditches which flow along the slopes of Oak Hill. Surface water not captured by these ditches infiltrates or flows radially in all directions, since the Former NIKE PR-79 Control Area is located on top of a hill. The nearest surface water bodies include three streams and a 16-acre wetland complex located approximately 0.25 mile to the south; a 0.15-acre wetland followed by Winsor Brook located approximately 0.25 miles to the west; and a 0.07-acre open water body to the north of the Site. The Site is located within the Scituate Reservoir Watershed and is within the Scituate Reservoir Protection Area. The northwestern most portion of the Scituate Reservoir (known as the Barden Reservoir) is located approximately 3 miles southeast of the Site. Winsor Brook is a tributary to the Ponaganset River, which flows into the Barden Reservoir. Local potable water is supplied with private bedrock drinking water supply wells, not municipal water. There are no wellhead protection areas within one mile of the Site. The groundwater beneath the Site is classified as Group GA which is presumed to be suitable for drinking water.

The main source of overburden groundwater at the Site comes from infiltration. Precipitation and melt water infiltrate and likely form a saturated zone in the coarse-grained sand and gravel above the less permeable till and bedrock. Over time, the overburden groundwater slowly drains both horizontally and vertically into the weathered bedrock and competent bedrock fractures below or migrates radially from the top of the hill likely contributing to seeps and wetlands observed at the base of Oak Hill. Groundwater within bedrock likely receives water from a series of fractures which are recharged from the overlying glacial overburden.

Surface geophysics, fracture trace analysis, and borehole geophysics investigations have been completed at the Site. The integration of these data indicates that fracture strikes trend primarily north to south and dip steeply to the southwest and southeast. Large low-velocity anomalies indicating fracture zones at the Site were identified along seismic and GPR geophysical lines. The orientation of fractures observed at outcrops and identified in fracture domain analysis provide evidence that a fracture zone could connect supply wells NIKE-1 and ROU-1. Borehole geophysical logging at supply wells NIKE-1, NIKE-2, ROU-1, ROU-2, ROU-3, and bedrock monitoring wells PR79-BR-001 through PR79-BR-005 identified 25 water producing fracture sets dipping to the southwest and southeast that intersect two or more supply wells. The deepest three fracture sets were identified as primary water producing fractures. During 2013, AMEC performed a four-hour pump test in NIKE-2 to assess hydraulic connectivity between NIKE-1, ROU-1, ROU-2, and ROU-3. AMEC concluded that NIKE-1 and ROU-1 are hydraulically connected and there is evidence of weak influence and connectivity between NIKE-1 and NIKE-2.

Groundwater flow from the Site has a radial character, reflecting the elevated topography of the Site with components of flow ranging from the west to southeast. With the identification of thick weathered bedrock zones extending to the north of the central portions of the site and impacts of TCE located in the vicinity of the former frequency changer/generator building, additional monitoring wells are proposed to confirm overburden groundwater flow near the northern property boundary to identify if there is a component of flow that extends in that direction. There is an ENE drainage from Oak Hill, as well, but that is located over 1,000 feet northeast of the previously active portions of the Site and therefore likely has less potential for influencing contaminant transport. The predominant topographic drainage patterns in near-Site area are generally SSW to the west of the Site and SSE to the south and east of the Site. The westerly and south-southeasterly drainage features converge south of the Site and converge with the Ponaganset River in close proximity to one another approximately 0.7 miles SSW of the Site.

10.7 Operational History and Environmental Areas of Concern

The Property was originally developed for agricultural use, namely as an apple and peach orchard. The US Government acquired the subject property between 1955 and 1957 and developed it for radar missile tracking as part of the NIKE Missile Defense System. NIKE sites were constructed throughout the continental US in the mid-1950s during the Cold War era to defend major industrial and urban areas. The location of NIKE PR-79 was selected for defense of Providence, Rhode Island. NIKE sites generally consisted of a missile launcher area and a separate integrated fire control and radar missile tracking area (NIKE control area) which typically operated less than two miles apart. The launcher area is where missiles were stored, maintained, and if necessary, launched. The NIKE control area is where radar and communication equipment needed to detect potential targets and guide launched missiles were maintained and stored. The former launcher area for NIKE PR-79 is a separate property located on Winsor Road in Foster, Rhode Island designated FUDS Property/Site Number D01RI0063/01 and is not the subject of this document.

The Former NIKE PR-79 Control Area was reported as excess property by the General Services Administration (GSA) in 1964. In July 1965, the Site was closed and the Property was transferred to the Town of Foster. The Town of Foster used the former Mess Hall, Barracks, and administrative buildings as the Fogarty Elementary School until 1989 (RIDEM, 1992). The Town of Foster recently retrofitted the Site building to utilized as residential. A residential tenant currently occupies the former Mess Hall building.

The following structures were transferred to the Town of Foster in good condition for beneficial reuse:

- Mess Hall, Barracks, and Administrative buildings
- Heating Oil USTs supplying the Mess Hall, Barracks, and Administrative buildings
- Utility Lines
- Southern Leach Field

The locations of the above referenced structures are shown on Figure 17-1B.

In 1988, the Foster Board of Education requested that CENAE investigate groundwater at the Former NIKE PR-79 Control Area to determine whether TCE detected by RIDEM in water supply wells was related to former DoD activities. CENAE conducted a field survey and Inventory Project Report (INPR) that same year, which concluded that former DoD activities may have resulted in the release of TCE to the environment. Based on the findings of the INPR, the Former NIKE PR-79 Control Area entered DERP and was designated FUDS Property/Site Number D01RI0063/02 (CENAE, 1988).

The INPR field survey identified a 6,000-gallon diesel fuel UST (originally assumed to be a 1,000-gallon UST) in the northeast corner of the Former NIKE PR-79 Control Area, next to the former Frequency Changer/Generator Building shown in Figure 10-1. The UST was removed in June 1994. There is limited documentation beyond that the UST was closed under RIDEM UST regulations and no additional UST investigation was recommended.

In March 1992, USEPA designated the Former NIKE PR-79 Control Area as Site Number RID987492485 in Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS). CERCLIS is a management system used by the USEPA to track activities at hazardous waste sites considered for cleanup under CERCLA. The Site is not included on the National Priorities List (NPL).

On August 24, 2000, RIDEM issued a Letter of Responsibility (LOR) to the US Army 94th Regional Support Command at Fort Devens, Massachusetts, indicating that a potential release of hazardous materials occurred at the Site and identified DoD as the potentially responsible party. The LOR requested the US Army conduct a site investigation of the source area in accordance with Rhode Island Remediation Regulations 250-RICR-140-30-1. On September 5, 2000, the US Army 94th Regional Support Command sent a response letter to RIDEM refuting ownership of the Site.

Beginning in 2001, CENAE conducted a series of residential water supply well sampling events, which targeted two on-Property water supply wells (NIKE-1, NIKE-2) and three off-Property residential water supply wells located at 23A Theodore Foster Drive (ROU-1, ROU-2 and ROU-3) that are in close proximity to the Former NIKE PR-79 Control Area. Based on the analytical results for the residential sampling, in 2002, a Time Critical Removal Action (TCRA) was initiated as a temporary remedy for groundwater impacts in drinking water. The TCRA included installation of point of use dual carbon filtration systems at one on-Property water supply well (NIKE-1) and three off-Property residential water supply wells (ROU-1, ROU-2, and ROU-3). CENAE continues to monitor these four carbon filtration systems.

Five AOCs have been identified based on previous investigations:

- AOC-1: Radar Area
- AOC-2: O&M Area
- AOC-3: Southern Leach Field
- AOC-4: Western Sewage Disposal Area

- AOC-5: Western Disposal Area (ineligible for investigation and cleanup under DERP-FUDS)

Based on a review of historic aerial photographic analysis, historical maps, and other documents regarding historical operations, there is no evidence to suggest fire training activities or other activities using per- and polyfluoroalkyl substances (PFAS) occurred at the Former NIKE PR-79 Control Area. Additionally, DoD activities at the Former NIKE PR-79 Control Area precedes dates of common PFAS use as aqueous film forming foam (AFFF). Therefore, PFAS is not a Site-specific COPC.

10.8 Previous Site Investigations and Available Dataset

A detailed discussion of previous investigations at the Former NIKE PR-79 Control Area including a Preliminary Assessment (PA) and Site Inspection (SI), off-Property residential and on-Property water supply well sampling, soil, groundwater, and soil vapor studies, and surface and geophysical investigations was provided in the September 2020 RI QAPP. Site investigation activities that occurred as part of recent RI activities between 2020 and 2021 are summarized below.

2020-2021 Remedial Investigation

RI activities conducted were presented in the Draft RI Field Report dated April 22, 2021 and revised August 19, 2021. The Field Report presented the data collected during RI field activities occurring between April 2020 and February 2021. RI field activities were conducted in accordance with the QAPP (original final dated April 10, 2020 and updated September 11, 2020) and consisted of the following:

- Background Soil Sampling;
- Surficial and Subsurface Soil Sampling;
- Monitoring Well Installation and Development;
- Hydraulic Conductivity Testing;
- Piezometer Abandonment;
- Borehole Geophysical Testing;
- Flexible Liner Underground Technologies, LLC (FLUTe) Activated Carbon Technique (FACT) Testing;
- Bedrock Fracture Connection Testing;
- Water FLUTe Multi-Level Sampler (MLS) Installation and Development;
- Background Groundwater Sampling;
- Groundwater Sampling;
- Background Surface Water, Porewater, and Sediment Sampling;

- Surface Water, Porewater, and Sediment Sampling;
- Water Supply Sampling;
- Land Surveying;
- Laboratory Data Validation; and
- Data Evaluation.

Analytical results were compared to PALs, and a Phase I risk screening assessment was performed in accordance with Section 2 of the risk assessment work plan (included as Appendix G of the QAPP) to identify additional data gaps and sampling needs to support completion of the RI Report.

Based on the 2020 RI phase field activity findings, the following data gaps were identified:

- Several monitoring wells were dry when water levels were measured in Summer 2020 and Fall 2020. To further evaluate seasonal fluctuation in water levels and potential for migration through overburden materials, collection of synchronous water level measurements seasonally was recommended.
- Overburden monitoring well PR79-MW-008 was dry when groundwater sampling was attempted in Fall 2020 and Winter 2021. PR79-MW-008 is currently the only overburden monitoring well located in AOC-4 to evaluate groundwater conditions in that AOC. Another groundwater sampling attempt at PR79-MW-008 was recommended during a period of elevated water elevations. If a groundwater sample cannot be collected, then alternatively, a surface water and porewater sample was recommended at the base of the slope immediately west of PR79-MW-008 to assess water quality emanating from AOC-4.
- Confirmatory sampling of the five existing piezometers, eight overburden wells that were installed during the RI, and five bedrock wells that were installed during the RI was recommended to supplement the RI risk assessment data set.
- The RI Report will further evaluate the saturated thickness of overburden, stratigraphy, and hydrogeology of the hilltop to determine the extent and possible migration pathways for TCE detected in overburden groundwater at AOC-1. Seasonal water level information will support this evaluation. Additional exploratory soil borings may be necessary to better define the extent and potential migration of TCE in overburden groundwater and into bedrock from the probable source area around PR79-MW-003.
- The RI Report will further evaluate in more detail potential transport pathways in transmissive fracture zones for TCE from the probable source area around PR79-BR-002 to NIKE-1, ROU-1, ROU-2, and ROU-3.

- Additional soil, sediment, porewater and surface water sampling was required to supplement the RI risk assessment and background evaluation.

Supplemental sampling of residential wells, overburden groundwater wells, bedrock groundwater wells, and surface water/pore water locations has been completed through June 2022. Results of this sampling will be described in a future Field Report deliverable. Additional soil sampling will be proposed in a future QAPP Addendum to establish an unbiased soil dataset for evaluation in the Phase II risk assessment.

10.9 Receptors and Exposure Pathways

The human health and ecological receptors and potentially complete exposure pathways under current and reasonably anticipated future land use scenarios to be considered for the Site are summarized below. The Former NIKE PR-79 Control Area FUDS property is currently zoned as "municipal". However, the Town of Foster recently retrofitted the current on-Site building (former Mess Hall building) for residential use. The area to the south of the FUDS property is currently residential use. The DoD is implementing a Time Critical Removal Action (TRCA) to treat residential drinking water wells, in which Site-related VOCs have been identified, in this off-Property residential area. Future use of the FUDS property and the surrounding area is anticipated to remain consistent with current use. However, recreational use of the FUDS property is also considered a reasonable future use scenario. An unlimited use and unrestricted exposure (UU/UE) scenario will be evaluated to provide information for making risk-management decisions.

<u>Human Health</u>

Current/future human receptors at the Site are as follows:

- Current/Future On-Property Resident (Adult/Child)
- Current/Future On-Property Trespasser (Adolescent);
- Current/Future On-Property Commercial/Industrial Worker;
- Current/Future On-Property Construction/Utility Worker;
- Current/Future Off-Property Resident (Adult/Child); and
- Future Recreational User (Adult/Child).

The potentially complete exposure scenarios for the above receptors and Site media are as follows:

- Exposure to surface soil may occur by current/future on-Property residents, trespassers, and commercial/industrial workers, and future recreational users. Surface soil exposure pathways include incidental ingestion, dermal contact, and inhalation of particulates and/or volatiles.

- Exposure to the combined surface and subsurface soil interval (to a maximum depth of 10 ft) may occur by current/future on-Property construction/utility workers and by future on-Property residents, trespassers, commercial/industrial workers, and recreational users, assuming soils become mixed during potential future redevelopment activities. Soil exposure pathways include incidental ingestion, dermal contact, and inhalation of particulates and/or volatiles.
- Exposure to shallow groundwater may occur by:
  - current/future on-Property construction/utility workers via incidental ingestion, dermal contact, and inhalation of volatiles in an excavation trench.
  - current/future on-Property residents and commercial/industrial workers via inhalation of indoor air within the current on-Property building and hypothetical on-Property buildings that may be constructed in the future (i.e., potential vapor intrusion pathway).
  - current off-Property residents via inhalation of volatiles in indoor air (i.e., potential vapor intrusion pathway).
- Exposure to groundwater (from on-Property monitoring wells [overburden and bedrock], piezometers, and water supply wells [using groundwater collected prior to carbon filtration]) may occur by:
  - future on-Property commercial/industrial workers via ingestion of drinking water. (This exposure pathway is not complete under a current scenario due to the presence of a carbon filtration system on existing on-Property water supply well NIKE-1 and NIKE-2 is inactive. Evaluation of the future scenario will also provide information on a hypothetical scenario in which the carbon filtration system on NIKE-1 fails)
  - current/future on- and off-Property residents via ingestion of drinking water, dermal contact and inhalation while bathing/showering. (This exposure pathway is not complete under a current scenario due to the presence of a carbon filtration system on existing water supply wells in closest proximity to the Property. Off-Property residential water supply wells located further away from the Property ("DW-wells") do not all have carbon filtration systems installed. These wells will not be evaluated within the scope of the risk assessment. However,

recommendations for further assessment of these wells during a later RI phase may be made following assessment of groundwater results from the on-Property area and adjacent off-Property area.)

- Exposure to sediment and surface water in water bodies potentially impacted by Site groundwater may occur by future recreational users via incidental ingestion (sediment only) and dermal contact (sediment and surface water) while wading.

Ecological

The undeveloped, wooded portions of the Site are expected to provide habitat for ecological receptors such as plants, soil invertebrates, small birds and mammals, and reptiles and amphibians. These receptors may be directly exposed to Site-related constituents released to the surface soil (e.g., terrestrial plants, earthworms) or via ingestion of impacted food items (e.g., birds or mammals consuming impacted earthworms).

Ecological receptors are typically not directly exposed to groundwater. However, exposure to constituents present in groundwater may occur when groundwater discharges into a water body such as Winsor Brook, or contributes to seeps and the forested swamp located to the south of the Property. Ecological receptors in the brook, the seeps, and the forested wetlands may be exposed to Site-related groundwater constituents as groundwater is discharged into porewater, sediment, and eventually surface water in these areas. Aquatic receptors such as invertebrates, fish, or amphibians may be directly exposed to constituents in the water column and benthic (sediment-dwelling) invertebrates may be directly exposed to constituents in the sediment or porewater (as groundwater discharges through the sediment into the water body). Birds and mammals may be exposed to constituents in water bodies through the incidental ingestion of sediment, ingestion of drinking water, or ingestion of impacted food items.

Therefore, the ecological exposure scenarios most likely to be complete at the Site include the following:

- Direct contact with surface soil by terrestrial plants and invertebrates;
- Incidental ingestion of surface soil and ingestion of impacted food items by terrestrial birds and mammals in terrestrial areas which provide habitat for wildlife;
- Direct contact with sediment by benthic/wetland invertebrates in water bodies potentially impacted by Site groundwater;
- Direct contact with pore water (i.e., Site groundwater discharging into water bodies) by benthic invertebrates;

- Direct contact of surface water by amphibians, aquatic invertebrates and/or fish in water bodies potentially impacted by Site groundwater; and,
- Ingestion of sediment, surface water, and impacted food items by semi-aquatic birds and mammals foraging in water bodies potentially impacted by Site groundwater.

QAPP Worksheets #14 /16: Project Tasks & Schedule

The following project tasks will be performed as part of the Addendum (refer to WS18 and 20 for specific VOC and SVOC method for each matrix as bottleware, preservation, etc. may differ):

- Advancement of two (2) soil borings north of AOC-1 along the property boundary (to be completed as overburden/bedrock interface wells)
- Advancement of one (1) soil boring between the former heating oil UST and septic tank at AOC-3
- Advancement of one (1) soil boring north of the seep near porewater sample WT-007. Boring will be placed south of the clay drainage pipe that runs from the former septic tank at AOC-3 to AOC-4 (to be completed as an overburden/bedrock interface well)
- Advancement of one (1) replacement soil boring, formerly SB112, that will be moved away from the existing septic tank to a location between the septic tank and the property boundary at AOC-3 (to be completed as a well).
- Advancement of one (1) soil boring to be completed as an interceptor bedrock well downgradient of the FUDS and drinking water wells ROU2 and ROU3, but upgradient of the Winsor Road residences.
- Collect one (1) surficial and one (1) subsurface sample from each of the soil borings. The soil samples will be submitted for analysis of VOCs (full scan), SVOCs SIM (including 1,4-dioxane and pentachlorophenol), and total metals.
- Two (2) rounds of overburden groundwater monitoring well sampling at four (4) newly installed monitoring wells, for VOCs (full scan and SIM), SVOCs SIM including pentachlorophenol, 1,4-dioxane via SVOC SIM with isotope dilution, total and dissolved metals.
- Two (2) rounds of sampling of bedrock groundwater at newly installed bedrock well (3 ports) VOCs (full scan and SIM), SVOCs SIM including pentachlorophenol, 1,4-dioxane via SVOC SIM with isotope dilution, total and dissolved metals

The project task is described in the schedule and text below. The rationale for the specific sampling design and approach is presented in Worksheet #17.

Brush Clearing

Portions of the Site are significantly overgrown with vegetation which will have to be removed to access sample locations for the safe installation of soil borings and permanent monitoring wells.

Brush clearing will also be conducted to facilitate access for a geophysical survey consisting of seismic refraction transects along the northern fence line of the site as well as borehole utility clearance. Hand tools and mechanized equipment will be used to trim the overgrowth along the Site access road and clear paths to the sampling and geophysical locations. Brush clearing for seismic lines will be wide enough to allow personnel to walk equipment (minimum 4 feet width). Brush clearing for borehole clearance will an approximate 30 square foot area (to the extent practical) centered over the borehole. Stumps will be less than 2 to 3-inches in height to allow ground penetrating radar (GPR) equipment to have significant coupling to the ground surface. Only small shrubs, brush, and saplings will be cleared. No hardwood trees will be removed. To protect the habitat of federally threatened Northern Long-Eared Bat (*Myotis septentrionalis*), no trees or sapling with a diameter 3-inches or larger will be removed. Cut brush will be left on-Site in the general vicinity of its generation. The vegetation will be cleared prior to the initiation of field activities.

<u>Utility Survey</u>

Per CENAE policies, utility clearance is required for intrusive work, regardless of planned intrusive depth. Prior to intrusive activities, the FTL is responsible for marking-out planned intrusive locations and opening a ticket with the DigSafe one-call utility clearance contractor. Coordination with the Town of Foster and representatives familiar with the Site will performed to obtain information on replacement water lines and other infrastructure. Precautionary measures (e.g., geophysical survey, air knifing methods, hand-digging to 5 ft, etc.) are required if utility clearance is not confirmed. Lack of confirmation can include urban locations, areas adjacent to roadways, areas not previously assessed, areas with insufficient utility information, or areas with multiple lines. The location of utilities will be noted and recorded during the Site visits and referenced when selecting investigation locations. Utility Clearance will be conducted in accordance with AECOM *SOP 3-01: Utility Clearance* (updated SOP included in Appendix A).

<u>Field Instrument Calibration and Quality Control</u>

Equipment will be checked to ensure its completeness and operational readiness. Equipment found to be damaged or defective will be returned to the point of origin, and a replacement will be secured. Instruments and equipment that require route maintenance and/or calibration will be checked initially upon arrival and then prior to use each day, if needed to support the field activities scheduled for that day. Equipment calibration will be conducted in accordance with AECOM *SOP 3-20: Operational and Calibration of a PID* and AECOM *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling* (updated SOPs included in Appendix A).

This system of checks ensures that the equipment is functioning properly. If an equipment check indicates that a piece of equipment is not operating correctly and field repair cannot be made, the equipment will be tagged and removed from service, and a request for replacement equipment will be placed immediately. Replacement equipment will meet the same specifications for accuracy and precision as the equipment removed from service.

Geophysical Survey

The existing geological dataset will be supplemented for overburden thickness, weathered bedrock zone identification/depth/thickness, competent bedrock depth, and potential fracture orientation. Borehole locations will also be cleared for subsurface utilities using geophysical methods. Noted that previous subsurface utility clearance efforts conducted on the site has been deemed as suspect and shall not be relied upon for the purposes of these efforts.

Utility Clearance

For the utility clearance, three complementary geophysical methods will be utilized including time domain electromagnetic induction metal detection (EM61), ground penetrating radar (GPR), and precision utility location (PUL). The EM61 data will be acquired at approximately 8-inch intervals along lines spaced five feet apart across the accessible portions of the area of interest (AOI) where they are clear of surface metal obstructions. The EM61 survey will detect and outline areas containing buried metal. However, the EM method cannot provide information on the type of objects causing an EM anomaly. GPR data will be acquired along traverses spaced five feet apart in a grided fashion surveying a 30 square foot area centered over each boring location. The PUL method will be used to search for subsurface utilities in the accessible portions of the area of interest by passively searching for signals from active electric lines and by tracing utilities from direct connections to surface features such as valves and conduits.

For the EM61 survey, a Geonics EM61-MK2 time domain electromagnetic induction metal detector will be used. The EM61 is a time-domain electromagnetic induction type instrument designed specifically for detecting buried metal objects. An air-cored 1-meter by ½-meter transmitter coil generates a pulsed primary magnetic field in the earth, thereby inducing eddy currents in nearby metal objects. The decay of the eddy current produces a secondary magnetic field that is sensed by two receiver coils, one coincident with the transmitter and one positioned 40 cm above the main coil. By measuring the secondary magnetic field after the current in the ground has dissipated but before the current in metal objects has dissipated, the instrument responds only to the secondary magnetic field produced by metal objects. Four channels of secondary response are measured in mV and are recorded on a digital data logger. The system is generally operated by pulling the coils as a trailer with an odometer mounted on the axle to trigger the data logger automatically at approximately 8-inch intervals. EM61 method generally penetrates up to 10 feet below ground surface.

Electromagnetic and magnetic geophysical methods, including the methods proposed here, are affected by the presence of power lines and surface metal objects (steel sided buildings, dumpsters, vehicles, reinforced concrete, etc.). Where such are present, the effects of materials in the subsurface may be masked, and firm conclusions about subsurface conditions cannot be made.

Detection and identification should be clearly differentiated. Detection is the recognition of the presence of a metal object, and the EM method is excellent for such purposes. Identification is determination of the nature of the causative body (i.e., what is the body - a drum, UST, automobile, etc.?), and EM cannot identify the buried metal object.

For the GPR survey, either a GSSI UtilityScan DF subsurface imaging radar system or GSSI SIR 4000 subsurface imaging radar system will be utilized. Data are recorded digitally, and the GPR data can be reviewed in the field. The systems include survey wheels that trigger the recording of the data at fixed intervals, thereby increasing the accuracy of the locations of features detected along the survey lines.

To clear borehole locations of utilities, the UtilityScan DF will be used to acquire data simultaneously from 800 MHz and 300 MHz antennas, or the SIR 4000 system will be used to acquire data using a 350 MHz hyperstacking antenna. To map bedrock, surface the UtilityScan DF 800 MHz and 300MHz or the 150 MHz antennas will be used. Please note that GPR penetration depends greatly on the site soil conditions.

There are limitations of the GPR technique as used to detect and/or locate targets such as those of the objectives of this survey: (1) surface conditions, (2) electrical conductivity of the ground, (3) contrast of the electrical properties of the target and the surrounding soil, and (4) spacing of the traverses. The condition of the ground surface can affect the quality of the GPR data and the depth of penetration of the GPR signal. Sites covered with high grass, bushes, landscape structures, debris, obstacles, soil mounds, etc. limit the survey access and the coupling of the GPR antenna with the ground. Boring/well locations and traverse lines will be cleared of brush and debris. Tree/bush stumps will not protrude greater than 3 inches above the surface.

The electrical conductivity of the ground determines the attenuation of the GPR signals and thereby limits the maximum depth of exploration. For example, the GPR signal does not penetrate clay-rich soils and targets buried in clay might not be detected.

A definite contrast in the electrical conductivities of the surrounding ground and the target material is required to obtain a reflection of the GPR signal. If the contrast is too small, then the reflection may be too weak to recognize, and the target can be missed. Typically, in New England the electrical conductivity contrast between soil and bedrock surface is not large enough to clearly identify bedrock surface.

The PUL survey, will use a Radiodetection RD8000 precision pipe and cable location system. The RD8000 is an electromagnetic instrument that consists of a separate transmitter and receiver. The receiver can detect subsurface utilities and cables in three modes by detecting a signal on the utility sent from the transmitter, by passively detecting signals from nearby power lines, or by passively detecting signals from distant radio transmitters.

The PUL equipment cannot detect non-metallic utilities, such as pipes constructed of unreinforced concrete, clay, ceramic, plastic, PVC when used in passive mode alone. Such pipes can be detected with the RD8000, however, where surface access permits insertion of a device on which the signal can be transmitted.

The instrument also generally cannot be used to locate metal utilities located under reinforced concrete because the signal couples onto the metal rebar and mesh in the concrete, and the signal on a particular utility cannot then be traced reliably. Similarly, the method commonly cannot be used adjacent to grounded metal structures such as chain link fences and metal guardrails.

Positively identified utilities in the vicinity of work areas will be marked out by the Subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). White or pink will be used for anomalies.

The location of utilities will be recorded by the Subcontractor using a global positioning system (GPS) unit with sub-meter accuracy combined with measurements to Site features recorded to tenths of a foot with survey tapes. Within one (1) week of completing fieldwork, the Subcontractor shall submit the raw data files and a map showing the locations of utilities, subsurface structures, and anomalies identified. The buried utility map will be submitted in draft and final versions.

Supplemental Geophysical Survey

The purpose of the supplemental geophysical survey was to identify overburden thickness, weathered bedrock zone identification/depth/thickness, competent bedrock depth, and potential fracture orientation along the northern property boundary of AOC-1 to aid in identifying suitable locations for two new overburden wells. The newly collected geophysical survey data was incorporated into the previously collected geophysical data set to further evaluate soil boring/monitoring well placement. This supplemental geophysical survey data was used to locate the two proposed overburden soil boring/monitoring wells to be installed such that they intersect the supposed weather bedrock zone(s) and/or fracture(s). Geophysical survey line locations were chosen to intersect potential weathered bedrock zones and other potential bedrock features extending to the north from central portions of the Site as described in Sections 10.3 and 10.5 and depicted on Figure 17-1C.

For mapping geological subsurface layering, a seismic refraction survey along the two 300 to 500-foot transects oriented east to west will be completed along the northern fence line of the Site. A GPR survey along the transects will also be completed. (Note: historical geophysical reports and data will be share with the geophysical subcontractor prior to commencement of the work.)

For seismic refraction, a 48-channel seismograph (two 24-channel Geometrics Geodes) coupled to up to 48 14-Hz geophones will be used with geophone spacing at 5 feet for this survey. This survey will be used to evaluate weathered bedrock zone identification/depth/thickness, competent bedrock depth, and potential fracture orientation. The seismograph is connected to, and controlled by, a notebook PC computer. The software provides for the acquisition, display, plotting, filtering, and storage of seismic data. A 12-pound sledgehammer or an accelerated weight drop will be used as an energy source. Generally, five to seven "shots" per cable spread consisting of one shot off each end of the cable, one shot at each end of the cable, and one to three shots interior to the cable. This configuration provides reversed profiles. The number of stacks per shot point is variable, and the quality of the stacked seismic signal for each shot point will be verified in the field. The data will be recorded digitally.

The seismic data will be interpreted with the Generalized Reciprocal Method, commonly referred to as GRM. GRM allows the depth to bedrock to be determined for each geophone location, rather than only at the shot points as for most other methods, and it is less sensitive to the presence of dipping interfaces and hidden layers. Fracture identification/orientation can be determined if a significant drop in seismic velocity is observed within the data set.

Similar to the utility locating task, the Subcontractor will survey the locations of the transects using a Trimble GeoX7 CM PS system coupled with a Zephyr-2 external antenna. A report summarizing the geophysical methods used and results will be provided by the Subcontractor. The Subcontractor will submit annotated/interpreted 2D models of the subsurface from the geophysical data collected. A map summarizing interpreted fracture orientations, weathered zone locations, and thicknesses will be provided. Raw data and field notes will also be submitted, in addition to processed and presented data.

The seismic refraction method assumes that the local geology is uncomplicated. In particular, the seismic refraction method assumes that interfaces between geologic materials correlate with sharp increases in seismic velocity and that the interfaces between geologic units are flat lying. The method is not extremely sensitive to lateral variations within layers, and subtle features such as fracture zones within bedrock cannot be detected unless there is a topographic expression of the feature and/or a significant drop in bedrock velocity. The accuracy of the method is degraded in areas with strong topographic relief and/or where the interfaces have apparent dips greater than about 20 degrees. In general, the accuracy of depths determined is stated to be about 10% or 2 feet, whichever is greater.

Where two materials do not exhibit contrasting velocities, or where velocities gradually increase

with depth, a clear refracted signal is not generated, and the seismic refraction method cannot be used to distinguish the two materials. In some cases, the "geophysical contact" between materials with contrasting velocities does not correlate exactly with the "geologic contact." For example, where a highly weathered bedrock is overlain by a dense material such as till, the velocity range of the weathered bedrock might overlap or approach the velocity range of the till, and the two materials cannot be distinguished seismically. In such cases, the depth determined by seismic refraction is the depth of competent bedrock, which might be located at some depth below the geologic contact.

The depth relations of the water table and bedrock may constitute a significant problem for the seismic refraction technique. This problem is that of a "blind layer." A blind layer occurs where the thickness of the saturated overburden is less than about half the depth of bedrock. In such cases, the water-saturated material immediately above bedrock is "blind" in the sense that no refracted seismic energy from it will be received as a first arrival of seismic energy, and all methods used to reduce the seismic data to determine the depth of bedrock, the objective of this survey, use only first arrivals. Thus, the saturated layer will not be detected where it is close to bedrock, and most methods of seismic data reduction will indicate that bedrock is shallower than it is. Although GRM, the method used by Hager-Richter to reduce the seismic refraction data, does not use first arrivals through the water saturated zone (because there is none to use) in such cases, GRM determines the depth of bedrock correctly by using the average velocity of the saturated and unsaturated zones.

A "hidden layer" occurs where a lower velocity material underlies a higher velocity material, a common situation in stratified sediments. An example is where sands are present under layers of clay or till. As in the case of a "blind layer," most methods of seismic refraction data reduction will indicate that bedrock is deeper than it is if a hidden layer is present but not detected. Internal tests in the seismic refraction data reduction software (IXRefraX by Interpex) indicate that such layers might be present and an average velocity of the two layers is used to determine the depth of bedrock.

<u>Soil Boring Advancement and Surface/Subsurface Soil Sampling</u>

As part of this RI, Optional Task 14 will be executed once. The Optional Task 14 execution includes the advancement of five (5) soil borings to 20 feet below ground surface (bgs) totaling up to 100 linear feet (Note: that actual depths in the field may vary per location). The advancement of a sixth overburden soil boring using rotosonic drilling to an estimated depth of up to 35 feet below ground surface (bgs) will also be performed to facilitate the installation of a bedrock well. Up to two (2) soil samples will be collected from each of the advanced borings. The target depth is specified for each location in Worksheet #17 of this QAPP. The recovered soil core will be screened for VOCs with a PID immediately upon opening the sleeve. The soil core will be logged for descriptions by an experienced and qualified field geologist. Observations and measurements will be recorded on a soil boring log. At a minimum, depth interval, recovery, PID concentrations, moisture, and texture using the Unified Soil Classification System (USCS) will be recorded. Additional observations to be recorded may include detectable odors, groundwater depth, organic materials, cultural debris, or color changes indicative of oxidation changes or staining. See AECOM *SOP 3-16: Soil and Rock Classification* (updated SOP included in Appendix A) and AECOM *SOP 3-21: Surface and Subsurface Soil Sampling Procedures*.

Two soil samples will be collected from each boring location unless otherwise specified in field modification documentation. One (1) soil sample will be collected from surface soil (0-2 feet) and one from the area(s) with highest PID detections, visible contamination, or most likely depth for impacts. Surface soil samples are considered to be 0 to 2 ft bgs and subsurface soil samples are considered deeper samples that indicating evidence of impacts or at the bedrock interface. VOC samples will be collected directly from the soil core using a sampling corer (e.g., Terra Core, plastic syringe with tip removed, or similar) and in accordance with AECOM SOP: 3-21. For other analyses, soil will be removed and transferred to a disposable, re-sealable plastic bag. The sample will then be mixed until the sample is a uniform color, texture, and particle size. Non-mixed particles, organic matter, or other non-soil debris will be removed. After mixing, the sample will be transferred to the appropriate sample containers for laboratory analysis. Sample jars will be labeled with the appropriate information, placed in a Ziploc bag, and stored in a cooler containing bagged ice to maintain preservation, as appropriate. The required samples containers, preservatives, and holding times are specified in Worksheet #19 & 30. Sample locations will be marked with a pin flag labeled with the sample identification number. The locations will also be photo-documented and recorded with a hand-held GPS.

Soil sampling described above is to be considered “biased” for the purposes of filling data gaps in connection with nature and extent. Unbiased soil sampling will be included as part of a future QAPP Addendum to establish the soil dataset for risk assessment purposes.

<u>Overburden/Weathered Bedrock Monitoring Installation and Development</u>

Four (4) permanent overburden and/or weathered bedrock monitoring wells will be installed during the additional RI field investigation. Overburden drilling procedures are detailed above in the *Soil Boring Advancement and Surface and Subsurface Soil Sampling* section. The rationale for the selected overburden monitoring well locations is provided in Worksheet #17. The exact depth and monitoring well construction details will depend on field observations of the geology and observation of potential impacts.

An unused 2-inch diameter milled slot PVC screen and casing will be installed to the bottom of the borehole. The sand pack material will be selected based on the grain size distribution of the surrounding aquifer and placed in lifts as the drilling crew pulls the casing back to expose the well screen. The screen slot size and length will be determined in the field based on the field observations and screening. The borehole above the sand pack will be sealed with 2 ft of hydrated bentonite chips. Water will be added if the seal is not placed within saturated material. Bentonite chips will be allowed to hydrate for one-hour prior to grouting. The remaining annular space between the well casing and the 6-inch override casing from the top of the bentonite seal to the ground surface will be pressure grouted with a bentonite/cement grout using a tremie pipe. The remaining 6-inch diameter sonic casing will be pulled from the ground. Vibration will be applied to the casing as it is pulled to densify and degas the grout, as well as knit the grout into the borehole wall, creating a superior seal.

Permanent overburden monitoring wells will be developed no sooner than 24 hours after completion of well installation. Development will be completed by a combination of surging with a surge block and over-pumping with a submersible monsoon pump or Wattera pump and associated HDPE tubing, in accordance with AECOM *SOP 3-13: Monitoring Well Development* (updated SOP included in Appendix A).

Low-flow sampling will be performed following the USEPA Guidance on low stress purging and sampling (USEPA, 2017). Water clarity will be visually monitored and water quality parameters, including dissolved oxygen (DO), specific conductance (SC), oxidation-reduction potential (ORP), pH, temperature, and turbidity will be measured using a flow-through cell every 5 minutes during purging to determine progress of development per the AECOM *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling*. The multi-parameter water quality meter will be calibrated at the beginning of each day. A calibration check[2] will be performed at the end of each day and anytime anomalous readings are observed. Each well will be developed until the well produces clear (silt-free) water with a minimum of 3 successive stable water quality readings as outlined below:

- pH – within ± 0.2 units.
- DO – within ± 10%
- SC – within ± 3 percent (%).
- ORP – within ± 10 millivolts (mV).
- Temperature – within ±1 degree Celsius.
- Turbidity – at or below 10 nephelometric turbidity unit (NTU) or within ± 10% if above 10 NTU.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry a minimum of three times in succession and the turbidity has decreased. If water is added to the well's borehole during development or drilling, three times the volume of water added will also be removed during well development.

Reusable sampling equipment will be properly decontaminated after each use in accordance with AECOM SOP 3-06. Excess soil or groundwater generated will be containerized, managed, and disposed of as IDW.

<u>Bedrock Monitoring Well Installation and Development</u>

One (1) permanent bedrock monitoring well will be installed during the additional RI field investigation. The rationale for the selected bedrock monitoring well location and target depth is provided in Worksheet #17. Drilling activities will be performed by a driller licensed by the Rhode Island and have experience using water hammer drilling methods. Health and safety consideration for this drilling technique are provided in an update to AECOM's Accident Prevention Plan. Prior to starting, the overburden and weathered bedrock units should be sealed off (this should be done by the roto-sonic drill rig team). To seal off the overburden and weathered bedrock, 5-inch permanent steel casing will be advanced 5 ft into competent rock and tremie-grouted to the surface as 8-inch temporary casing is withdrawn. The top of the 5-inch casing will

[2] An anomalous reading is an unexpected measurement that is often accompanied with an instrument error message. For example, a creeping reading, elevated readings in ambient air, etc. that would necessitate a calibration check

be threaded to allow future attachment of a temporary casing extension at the surface, if needed during FLUTe installation. Hydraulic/water hammer drilling may proceed after a minimum 24-hour curing period.

Drilling will advance to the target depth listed in Worksheet #17. The recovered rock chips/fragments will be logged (as best as possible) for descriptions by an experienced and qualified field geologist. Where water hammer drilling techniques are being conducted, the field geologist will also observe and record water gain and/or water loss as these can be indicators of likely fracture zone(s). Water utilized for this drilling event will be provided by the drilling contractor. Unlike the USCS for soils, there is no single standard rock classification system; however, the field geologist will describe the essential items. At a minimum, depth interval, rock classification name, color, mineralogical composition and percentage, and texture/grain size should be recorded. See AECOM *SOP 3-16: Soil and Rock Classification* and EM-1110-1-1804.

The permanent bedrock borehole will be developed at least 24 hours after completion of well installation. Development will be completed by a combination of surging with a surge block and a venturi air lift pump. Sufficient development of the newly installed bedrock well will be completed to account for the volume of water introduced to the well via water hammer drilling technique to facilitate additional follow up data collection (i.e., borehole geophysics, FLUTe testing, groundwater monitoring). The construction of the surge block will be appropriate for the 4-inch diameter borehole and be mounted on rods for downhole advancement. The borehole will be surged in 10-foot intervals followed by purging. Bedrock borehole development will be performed by the drilling subcontractor with oversight from the field geologist.

Similar to the overburden well development, water clarity will be visually monitored and water quality parameters measured using a flow-through cell every 5 minutes during purging to determine progress of development per the AECOM *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling*. Groundwater generated will be containerized, managed, and disposed of as IDW (see section regarding IDW management).

<u>Bedrock Borehole Geophysics</u>

After completion of the bedrock well development, borehole geophysical logging will be performed on the bedrock borehole. If a significant period of time is scheduled between the borehole development and geophysical logging, a blank FLUTe liner will be installed within the borehole to act as a seal and prevent intra-borehole flow. Once geophysical logging is scheduled, testing will be performed include using the following tools:

- Acoustic caliper

- Fluid temperature
- Fluid conductivity/resistivity
- Optical televiewer (OTV)
- Acoustic televiewer (ATV)
- Natural gamma ray
- Spontaneous potential/resistivity
- Heat pulse flow meter (HPFM) under ambient conditions
- HPFM under pumping conditions

The results of the geophysical logging will be one line of support evidence in the development of the final FLUTe Multi-Level Sampler (MLS) liners.

<u>FLUTe Installation</u>

Following completion of the geophysical logging, a blank FLUTe liner will be installed in the bedrock borehole. The blank FLUTe liner will be equipped with FLUTe Activated Carbon Technique (FACT) covered with felt strips. The FACT strips will remain in the borehole for a minimum period of two weeks. After this wait period, the FACT strips will be removed and visually inspected and screened with a PID. The FACT strip will be cut into three-foot segments, bottled, and shipped to a laboratory subcontracted by FLUTe for analysis. The FACT strip will be labeled with the borehole identification and placed in a clean trash bag for on-Site storage.

A piece of the FACT liner will be used as a field blank. This sample will be collected from a FACT liner that does not contact groundwater to provide a check on liner handling and potential cross-contamination. Two such blanks will be collected - one prior to liner deployment and another at the time of sample retrieval, collected from a depth above the water table.

As a final test, the FLUTe blank liner will be reused to conduct a transmissivity and reverse head profile in the bedrock borehole. Upon completion of the transmissivity and reverse profiling, the blank FLUTe liner will remain in the borehole to act as a seal and prevent intra-borehole flow until the blank FLUTe liner can be replaced. Borehole information obtained during the FLUTe testing will be compiled and processed by FLUTe. The specific procedure for the FLUTe transmissivity testing was provided in the FLUTe SOPs included in the 2020 QAPP.

Results of the borehole geophysical logging will be combined with FLUTe transmissivity and reverse head profiles, and FLUTe FACT strip analytical results. The objectives of the geophysical logging will be to identify potential water-bearing fracture zones in the bedrock along the length of each open hole, to define fracture depths, strikes, and dips, and to assess the actual and potential inflow/outflow of a subset of those fractures. A secondary goal is identifying changes in bedrock lithology. The FLUTe testing will provide information regarding the transmissivity of the borehole every foot and the relative distribution of dissolved phase VOCs in the borehole.

The team will review the integrated geophysical and FLUTe borehole data and determine the FLUTe MLS liner construction details for the bedrock monitoring well. FLUTe will then construct the MLS liner in accordance with the specifications provided. The FLUTe MLS liner will include three (3) sampling ports. If warranted and based on the review of the integrated well logs, additional ports may be included in the design and construction of the MLS liner. FLUTe work will be performed by qualified personnel trained by FLUTe in the installation and operation of their equipment.

Synoptic Groundwater Gauging

Groundwater levels will be used to monitor Site-wide groundwater elevations and assess groundwater flow in the overburden and bedrock groundwater zones. Synoptic groundwater gauging rounds are anticipated to take place in spring and fall at site wells prior to purging and sampling. Synoptic water level elevation measurements will be collected from the overburden monitoring wells, piezometers, and bedrock FLUTe ports from the survey measurement point using a water level meter (Solonist 101 or equivalent). Synoptic gauging will include stream gauging station PR79-STATION-001. Previous stream gauge location PR79-STATION-002 was lost to potential storm damage. An alternate stream gauging location has been identified as the United States Geological Survey (USGS) stream gauge on Windsor Brook located at Windsor Road (USGS monitoring location 01115185). Steam gauge location 01115185 was established in 1993 located at latitude/longitude 41.83621005, -71.72256829 (NAD83) within the Narragansett subbasin. The measured elevation is 397.5 ft amsl (NAVD88).

New Overburden Groundwater Sampling

Overburden and weathered bedrock groundwater samples will be collected from the four (4) newly installed monitoring wells. The complete list of monitoring wells is provided in Worksheet #17 and shown on Figures 17-1A and 1B.

Prior to sampling, groundwater levels will be measured in each well using a water level meter (Solonist 101 or equivalent). The monitoring wells will be purged following low-flow sampling techniques using a bladder or peristaltic pump and disposable tubing in accordance with AECOM *SOP 3-14: Monitoring Well Sampling* (updated SOP included in Appendix A). Water clarity will be visually monitored and water quality parameters, including dissolved oxygen (DO), specific conductivity (SC), oxidation-reduction potential (ORP), pH, and temperature will be measured using a flow-through cell per the AECOM *SOP 3-24: Water Quality Parameter Testing for Groundwater Sampling*. Turbidity measurements will be collected using a separate turbidity meter. Turbidity samples are collected before the flow-through-cell. A "T" connector (or equivalent) coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed, and the container sample is then placed in the turbidity meter. Readings will be collected every 5 minutes until the well produces clear (silt-free) water for a minimum of 3 stable water quality readings, as outlined above in SOP 3-14. The stabilization requirements are provided in SOP 3-14. The multi-parameter water quality meter and turbidity meter will be calibrated at the beginning of each day. A calibration check will be performed at the end of each day and anytime anomalous readings are encountered. Non-disposable sampling equipment will be decontaminated between each well per AECOM *SOP 3-14: Monitoring Well Sampling*.

Once the water quality parameters reach stabilization, field samples will be collected into laboratory-supplied bottleware for the methods listed in Worksheets #18 and #20 as (refer to Worksheet #19 & 30 for preservation, holding time, and bottleware requirements). Samples requiring filtering will be field filtered. In addition to the normal samples, quality control samples consisting of field duplicates, matrix spike (MS), and matrix spike duplicate (MSD) will be collected as outlined in Worksheet #20. One trip blank (TB) will be submitted each day if normal VOC samples are collected. Sample jars will be labeled with the appropriate information, placed in a Ziploc bag, and stored in a cooler containing bagged ice to maintain a preservation, as appropriate. Samples will be quality-control checked by the field team (label correctness, completeness, etc.) and recorded on Chain-of-Custody (CoC) forms. Samples will be packaged on ice and transported via overnight commercial carrier or a laboratory courier under standard chain-of-custody procedures to the laboratory.

<u>New Bedrock Groundwater Sampling</u>

Bedrock groundwater samples will be collected from the newly installed FLUTe bedrock well (3 sampling ports). The monitoring well and sampling ports are provided in Worksheet #17 and shown on Figure 17-1B.

Groundwater sampling procedures have been developed by FLUTe based on the transmissivity testing performed during the FLUTe installation. Prior to sampling, the water level inside the FLUTe liner will be gauged to ensure water has not been lost since the previous sampling round. Water will be added, if needed, to raise the water level to the specified head (as per FLUTe guidance). Next, the water level within each sampling port will be gauged using a Solinst 102 P10 (or similar). After completion, the nitrogen gas will be connected via a regulator to the FLUTe sampling manifold. The specific sampling gas pressure (determined by FLUTe) will be used during the purge and sampling cycles. Per FLUTe guidance, the pump and sample tube should be purged at the specific purge pressure four times prior to sampling. After this, sampling at the designated sample pressure can begin on the fifth cycle. The specific sampling procedures for the FLUTe bedrock well is included in the FLUTe SOP in Appendix D of the original QAPP March 2020). Samples will be collected into laboratory-supplied bottleware for the methods listed in Worksheets #18 and #20 as (refer to Worksheet #19 & 30 for preservation, holding time, and bottleware requirements). Samples requiring filtering will be field filtered. In addition to the normal samples, quality control samples consisting of field duplicates, MS, and MSD will be collected as outlined in Worksheet #20. One TB will be submitted each day if normal VOC samples are collected. Sample jars will be labeled with the appropriate information, placed in a Ziploc bag, and stored in a cooler containing bagged ice to maintain preservation, as appropriate. Samples will be quality-control checked by the field team (label correctness, completeness, etc.) and recorded on CoC forms. Samples will be packaged on ice and transported via overnight commercial carrier or a laboratory courier under standard chain-of-custody procedures to the laboratory.

<u>Investigation Derived Waste (IDW) Management</u>

IDW generated during field activities will be managed pursuant to applicable Federal, State, and local regulations and guidance, including USACE guidance (2013) and RIDEM Policy Memo 95-01 Guidelines for the Management of Investigative Derived Waste (RIDEM, 1995). Refer to AECOM *SOP 3-05: Investigation-Derived Waste Management* for procedures related to IDW management. Department of Transportation (DOT) compliant shipping containers will be used to stage IDW prior to off-Site transport. Solid IDW (e.g., drill cuttings from boring/monitoring well installation that cannot be returned to the borehole of origin) will be stored in 55-gallon metal drums and/or a 20 cubic yard closed-top roll-off bin; liquid IDW (e.g., monitoring well development water, purge water, decontamination water, drilling water) will be stored in frac tanks (or equivalent) and/or 55-gallon metal drums.

The IDW containers will be properly labeled, sampled for waste characterization, and temporarily staged on Site at a designated secure location until waste characterization is completed in accordance with applicable Federal and State guidance and regulations. The IDW containers will subsequently be transported to the approved off-Site disposal facility; the intended facility will confirm their acceptance of the waste prior to transport. IDW removal from the Property will be documented by manifest or bill of lading prepared by the waste disposal subcontractor.

QAPP Worksheet #17: Sampling Design and Rationale

This worksheet describes the sampling design and basis for selection for the soil, overburden groundwater, and bedrock groundwater sample locations.

17.1 Soil Sampling

Discrete surface and subsurface soil samples will be collected in areas with identified data gaps within the established AOCs. The analytical methods for soils are shown in Worksheet #18 and include VOCs (full scan), SVOCs SIM, and total metals. The locations of the proposed soil borings were determined after evaluating sampling results from previous investigations. A total of six (6) soil borings will be advanced as indicated below. The soil boring locations are shown on Figures 17-1A, 17-1B, 17-1C, 17-1D, and 17-1E. Two soil samples will be collected from each soil boring: one surface soil sample (collected from the 0-2 ft bgs interval) and one subsurface soil sample (collected no deeper than 10 ft bgs). The sample intervals were specifically selected for several reasons:

- Surface soils collected during the Phase I Site investigation were collected from the 0-2 ft bgs interval. For consistency and to combine the results of both datasets, the RI surface soil samples will be collected from 0-2 ft bgs (see Table 17-1 for rationale).
- Due to the Site history (construction, activities, and demolition), it was agreed that sampling 0-1 ft bgs interval would likely only target reworked soils and not reach native material.
- Surface soils will be collected from the 0-2 ft bgs interval to allow for comparisons to historic datasets.
- Subsurface soil samples will not be collected from depths greater than 10 ft bgs, which is the maximum depth to which human receptors may be exposed. Field screening will be performed to determine the exact sampling depth (highest PID, water table elevation, or lithologic interface) within the 2-10 ft bgs interval.
- Soil borings will be field screened for the entire length of the boring (to a maximum depth of boring). Additional subsurface samples will be collected if an interval of interest is observed (non-aqueous phase liquid [NAPL] present, elevated PID reading, or lithologic interface).

The proposed soil boring samples are listed in Table 17-1 along with the rationale for the selected location. Soil sampling procedures are summarized in Worksheet #14. Specific sample analyses are provided in Worksheet #18.

Table 17-1: Sampling Design and Location Rationale for Soil Borings

AOC	Location ID	Depth	Rationale
AOC-1	PR79-SB-141 (Figure 17-1A, 17-1C, 17-1D, 17-1E)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Located along the northern property/FUDS boundary. Additional sampling is required for horizontal and vertical data coverage along the northern property boundary. Soil boring location was selected using newly acquired geophysical survey data incorporated into the current geophysical data set. Survey data indicates an area of weathered bedrock and/or fracture zone with significant saturated zone thickness. This area corresponds with previously interpreted western fork of weathered bedrock zone. Previous geophysical efforts extrapolated a potential north/south trending fracture zone. H-R geophysics (collected in 2022) identifies a potential low spot in bedrock contours at this location. Proposed overburden soil boring/monitoring well to be installed such that they intersect the weather bedrock zone(s) and/or fracture(s) to better define groundwater flow and the upgradient edge of TCE encountered with in the weathered bedrock zone(s).
AOC-1	PR79-SB-142 (Figure 17-1A 17-1C, and 17-1D, 17-1E)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Located along the northern property/FUDS boundary. Additional sampling is required for horizontal and vertical data coverage along the northern property boundary. Soil boring location was selected using newly acquired geophysical survey data incorporated into the current geophysical data set. Survey data indicates an area of weathered bedrock and/or fracture zone with significant saturated zone thickness. This area corresponds with previously interpreted eastern fork of weathered bedrock zone. H-R geophysics (collected in 2022) identifies a potential low spot in bedrock contours at this location. Proposed overburden soil boring/monitoring well to be installed such that they intersect the weather bedrock zone(s) and/or fracture(s) to better define groundwater flow and the upgradient edge of TCE encountered with in the weathered bedrock zone(s).
AOC-3	PR79-SB-143 (Figure 17-1B)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Located between the former heating oil UST and former septic tank. Limited soil data exists in this area from previous investigations. Additional sampling is required for horizontal and vertical data coverage.
AOC-3	PR79-SB-144 (Figure 17-1B)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Replacement soil boring, formerly SB112, that will be moved away from the existing septic tank to a location between the septic tank and the property boundary at AOC-3.
AOC-3	PR79-SB-145 (Figure 17-1B)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Located north of the seep near porewater sample location WT-007 along the Pipeline and Service Pathway from the Distribution Box to the Sand Pits and Chlorine Chamber. Intercept midpoint for COPCs migrating from the hilltop to Winsor Brook. Additionally, sewage leaking from the pipeline could potentially impact underlying soil and the pipeline bed could act as a preferential pathway for COPCs to flow. Further investigation is warranted to investigate this identified data gap.
23B Theodore Foster Road	PR79-SB-146 (Figure 17-1B)	Surface: 0-2 ft bgs Subsurface: up to 10 ft bgs	Located downgradient of drinking water wells ROU-2 and ROU-3. Soil boring will be advanced to facilitate the installation of an interceptor bedrock well.

17.2 Overburden and Bedrock Groundwater Sampling

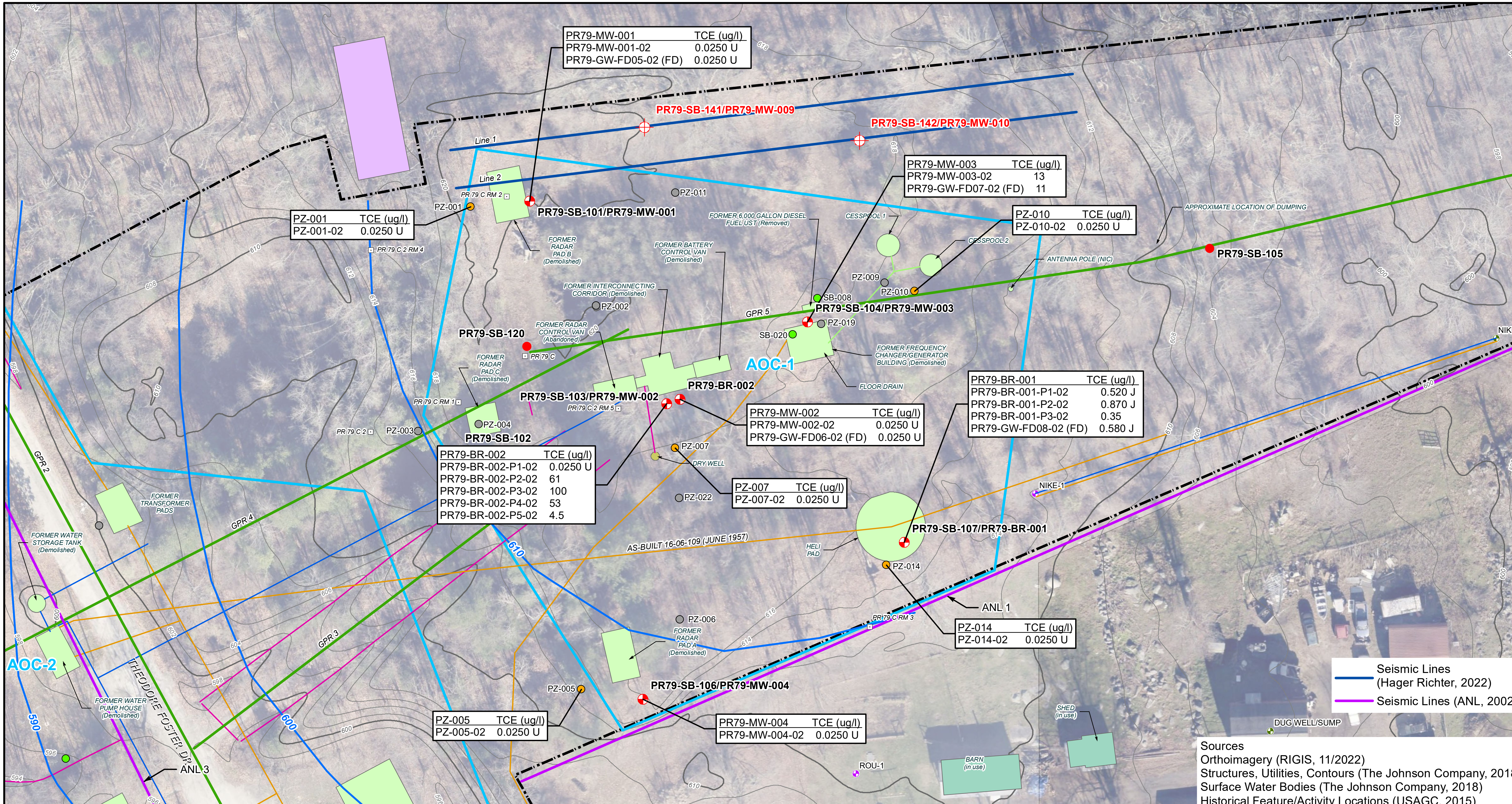
The primary goal for the monitoring well sampling is to select locations that targeted data gaps in the overburden, weathered bedrock, and bedrock where potential constituents of potential concern (COPCs) could be acting as a continuing source to the dissolved concentrations observed in downgradient water supply wells. Two rounds of sampling of the newly installed monitoring wells is being conducted for VOCs (full scan and SIM), SVOCs including pentachlorophenol (SIM), 1,4-dioxane[3] (SIM via isotope dilution), and total metals, and dissolved metals (field filtered) analysis to bolster the data set for the risk assessment. Table 17-2 provides the rational for the locations included in the groundwater sampling program. Sample locations are shown on Figures 17-1A and 1B.

Table 17-2: Sampling Design and Rationale for Overburden and Bedrock Groundwater

AOC	Location ID	Screen Interval	Rationale
Overburden and Weathered Bedrock Monitoring Wells			
AOC-1	PR79-MW-009	TBD	Assess groundwater flow (horizontal gradient) north of AOC-1 (Former Radar Pad B) and evaluate if TCE is migrating to the north in overburden groundwater. Additional groundwater chemistry and MNA parameters will also be evaluated.
AOC-1	PR79-MW-010	TBD	Assess groundwater flow (horizontal gradient) north of AOC-1 (Former Radar Pad B) and evaluate if TCE is migrating to the north in overburden groundwater. Additional groundwater chemistry and MNA parameters will also be evaluated.
AOC-3	PR79-MW-011	TBD	Assess the potential source of TCE detected at the seep at sampling location WT007, located southwest of AOC-3.
AOC-3	PR79-MW-012	TBD	Assess overburden groundwater between the former septic tank and the southwestern property boundary.
Bedrock Monitoring Wells			
AOC-1	PR79-BR-006	3 sample ports (depths TBD)	Assess bedrock groundwater downgradient from drinking water wells ROU-2 and ROU-3, south of the Site.

[3] Based on the Phase I Risk Screening results, 1,4-Dioxane was detected in groundwater wells sampled during the December 2020 sampling event at concentrations greater than the USEPA RSL for tapwater, including BR-001, BR-002, BR-003, BR-004, and BR-005.

Figures



AECOM

Drawn: JB 09/05/2023

Approved: KK 09/05/2023

Project #: 60608703

Legend

- Proposed Boring/Well Location
- Monitoring Well
- Soil Boring
- Historic Soil Boring/Piezometer (AMEC, 2013)
- Abandoned Historic Soil Boring/ Piezometer (AMEC, 2013)
- Historic Soil Boring (AMEC, 2013)
- Drinking Water - Individual
- Drinking Water - Not in Use
- Geodetic Control Station (National Geodetic Survey)
- Perimeter Fence
- Former Government Property
- Non-Government Property
- Area of Concern (AOC)
- Extent of Former NIKE PR-79 Control Area (USAGC, 2015)
- Cemetery
- Index Contour
- Intermediate Contour
- Electrical Line
- Sewer Line
- Water Line
- Drainage
- Geophysical Lines (Hager Geosciences, Inc (HGI), 2017)
- Overburden Groundwater Contour (5/2021)

0 25 50

Scale in Feet

N

FIGURE 17-1A
AOC-1 SAMPLING PLAN & TCE (2022)

FORMER NIKE PR-79 CONTROL AREA
FOSTER, RHODE ISLAND

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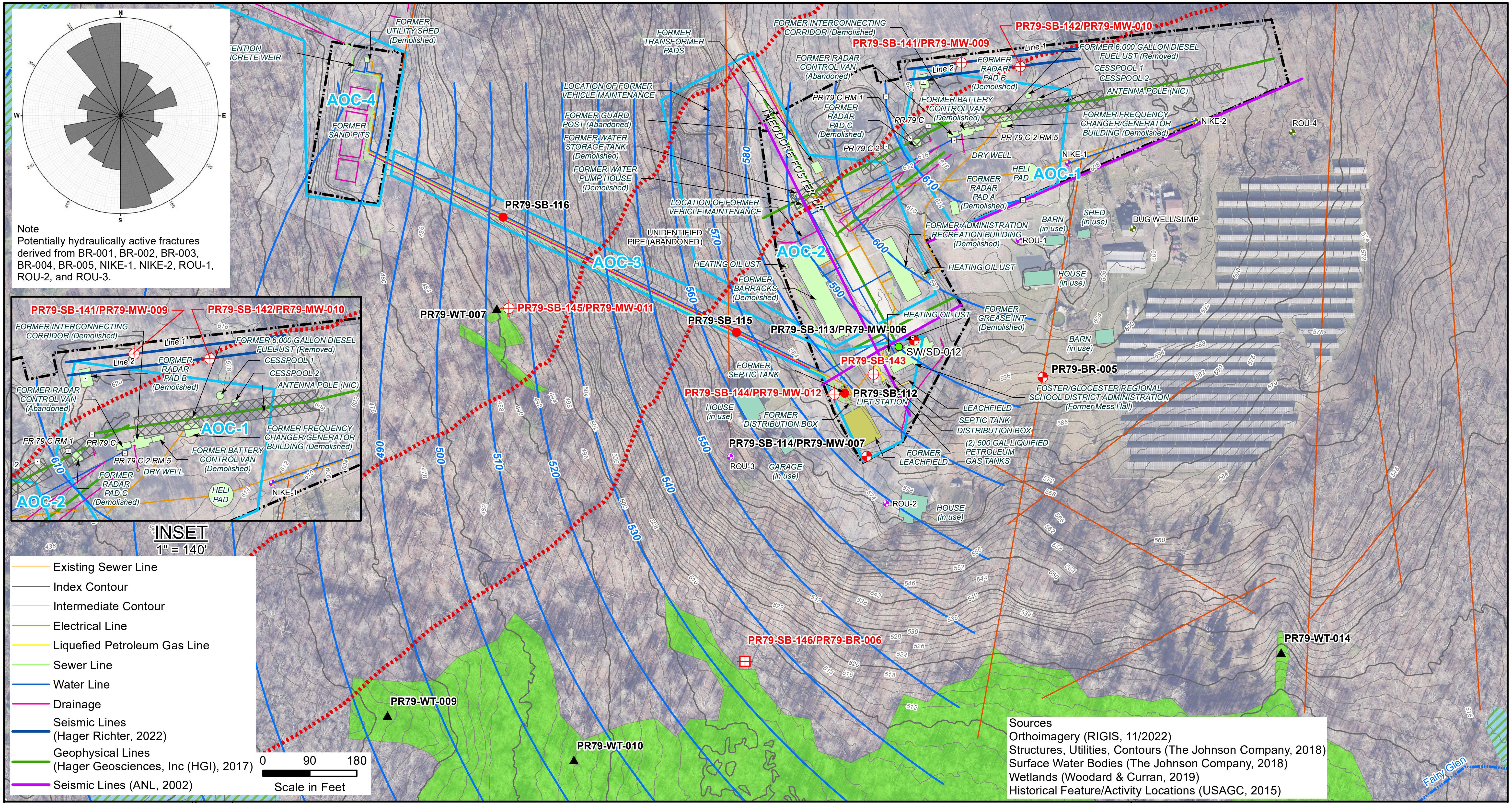

AECOM

Drawn: JB 08/31/2023

Approved: KK 08/31/2023

Project #: 60608703

Legend

- Proposed Boring/Bedrock Well Location
- Proposed Boring/Well Location
- Monitoring Well
- Soil Boring
- Historic Soil Boring (AMEC, 2013)
- Surface Water/Porewater/Sediment
- Drinking Water - Individual
- Drinking Water - Not in Use
- Unidentified Pipe
- Geodetic Control Station (National Geodetic Survey)
- Stream
- Perimeter Fence
- Former Government Property
- Non-Government Property
- Area of Concern (AOC)
- Wetland (Woodard & Curran, 2019)
- Extent of Former NIKE PR-79 Control Area (USAGC, 2015)
- Former Sewer and Stormwater Structures
- Existing Sewer Structures
- Bedrock Lineament
- Overburden Groundwater Contour (5/2021)
- Fractured Bedrock
- Fracture - Ground Surface Intersects

N

FIGURE 17-1B
AOC-3 SAMPLING PLAN

FORMER NIKE PR-79 CONTROL AREA FOSTER, RHODE ISLAND

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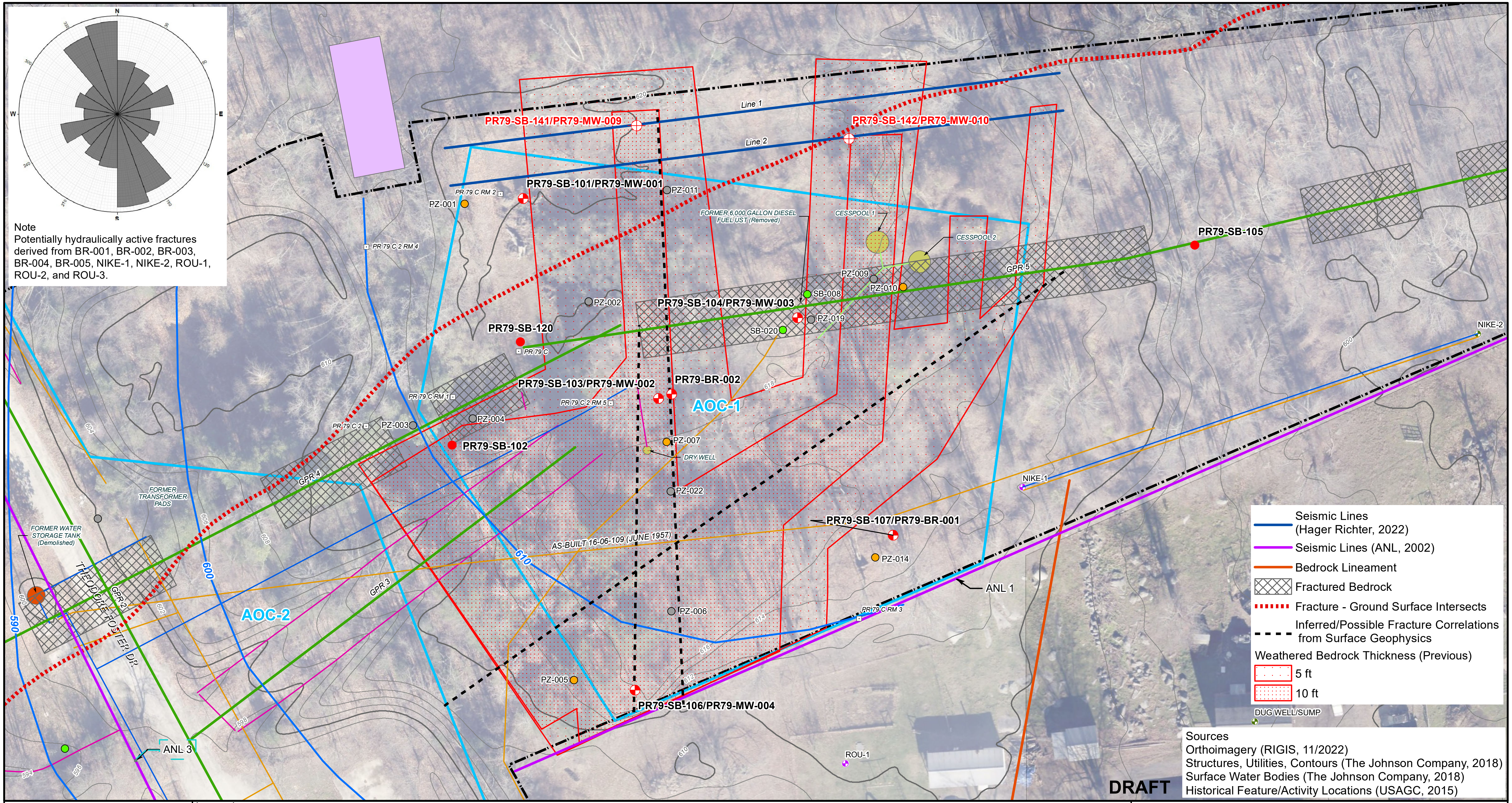

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Drawn: JB 08/31/2023
Approved: KK 08/31/2023
Project #: 60608703

Legend

- Proposed Boring/Well Location
- Monitoring Well
- Soil Boring
- Historic Soil Boring/Piezometer (AMEC, 2013)
- Abandoned Historic Soil Boring/ Piezometer (AMEC, 2013)
- Historic Soil Boring (AMEC, 2013)
- Drinking Water - Individual
- Drinking Water - Not in Use
- Geodetic Control Station (National Geodetic Survey)
- Perimeter Fence
- Area of Concern (AOC)
- Extent of Former NIKE PR-79 Control Area (USAGC, 2015)
- Cemetery
- Index Contour
- Intermediate Contour
- Electrical Line
- Sewer Line
- Water Line
- Drainage
- Seismic Lines (Hager Geosciences, Inc (HGI), 2017)
- Overburden Groundwater Contour (5/2021)

0 25 50
Scale in Feet
N

FIGURE 17-1C
INTERPRETED BEDROCK STRUCTURE
PROPOSED NEW MONITORING WELL LOCATIONS
FORMER NIKE PR-79 CONTROL AREA
FOSTER, RHODE ISLAND

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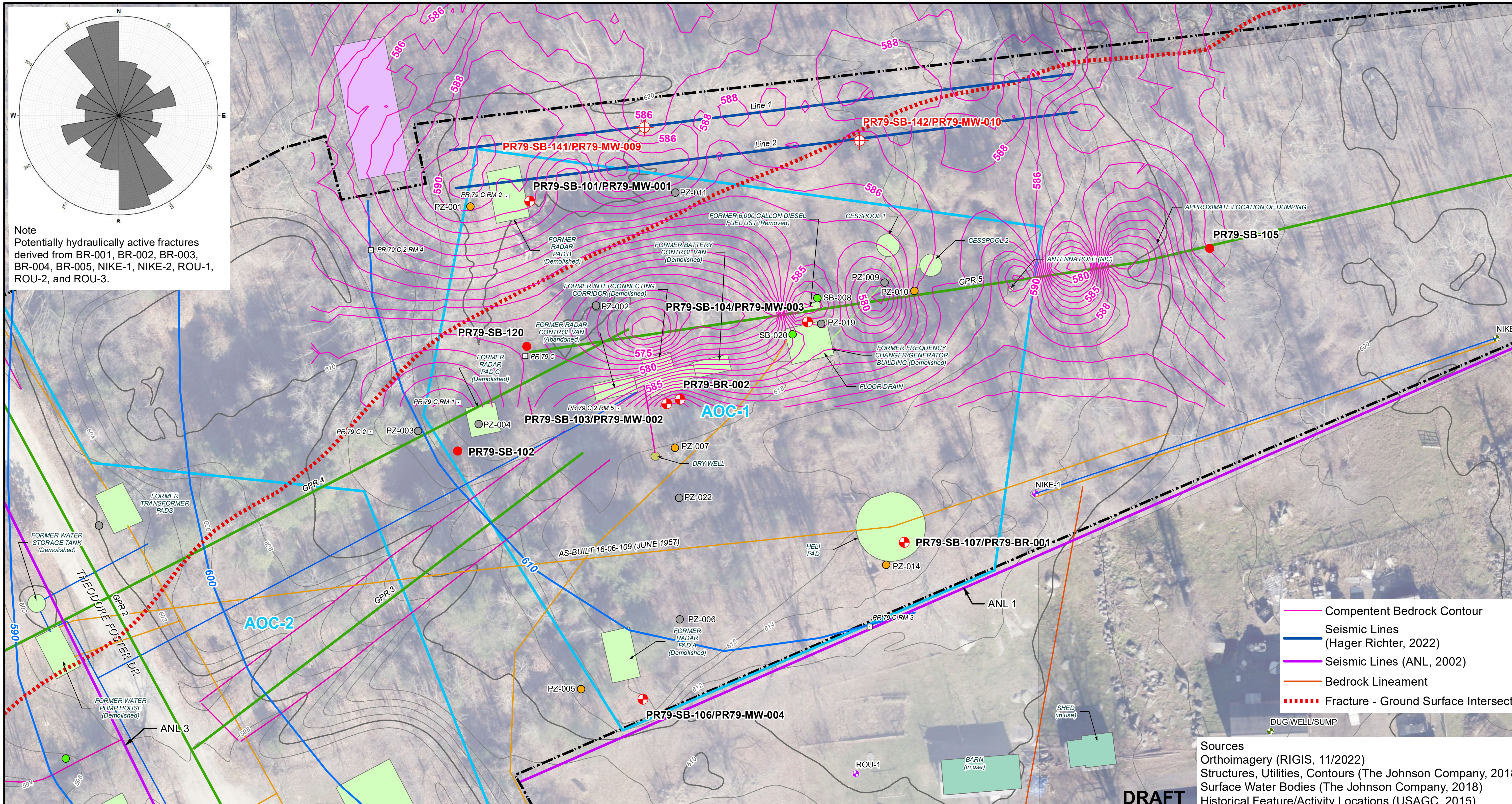

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Drawn: JB 09/01/2023

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Project #: 60608703

Legend

- Proposed Boring/Well Location
- Monitoring Well
- Soil Boring
- Historic Soil Boring/Piezometer (AMEC, 2013)
- Abandoned Historic Soil Boring/ Piezometer (AMEC, 2013)
- Historic Soil Boring (AMEC, 2013)
- Drinking Water - Individual
- Drinking Water - Not in Use
- Geodetic Control Station (National Geodetic Survey)
- Perimeter Fence
- Former Government Property
- Non-Government Property
- Area of Concern (AOC)
- Extent of Former NIKE PR-79 Control Area (USAGC, 2015)
- Cemetery
- Index Contour
- Intermediate Contour
- Electrical Line
- Sewer Line
- Water Line
- Drainage
- Geophysical Lines (Hager Geosciences, Inc (HGI), 2017)
- Overburden Groundwater Contour (5/2021)

0 25 50
Scale in Feet
N

FIGURE 17-1D
COMPETENT BEDROCK CONTOURS
PROPOSED NEW MONITORING
WELL LOCATIONS
FORMER NIKE PR-79 CONTROL AREA
FOSTER, RHODE ISLAND

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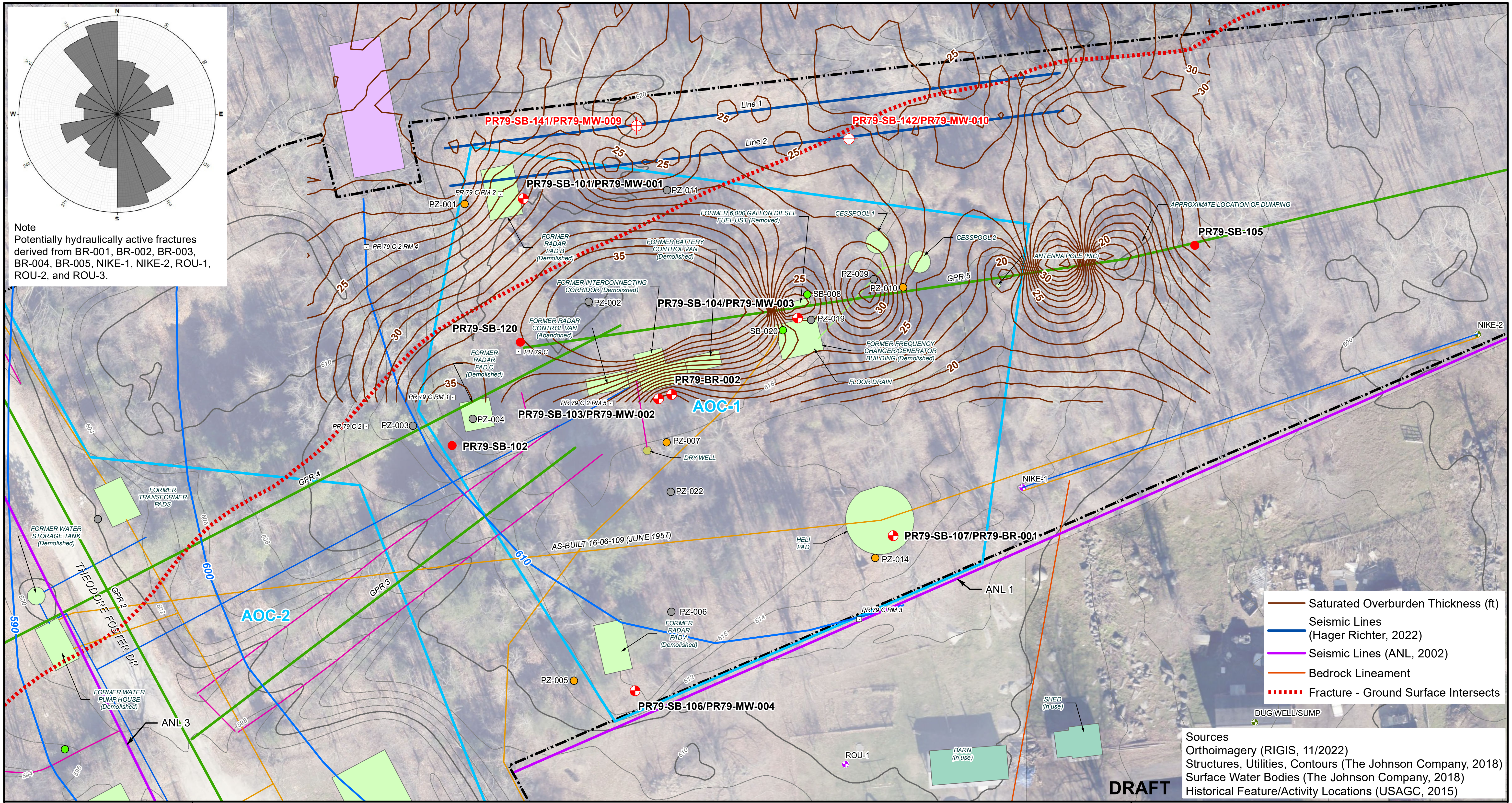

AECOM

Drawn:	JB	09/01/2023
Approved:	KK	09/01/2023
Project #:	60608703	

Legend

- Proposed Boring/Well Location
- Monitoring Well
- Soil Boring
- Historic Soil Boring/Piezometer (AMEC, 2013)
- Abandoned Historic Soil Boring/ Piezometer (AMEC, 2013)
- Historic Soil Boring (AMEC, 2013)
- Drinking Water - Individual
- Drinking Water - Not in Use
- Geodetic Control Station (National Geodetic Survey)
- Perimeter Fence
- Former Government Property
- Non-Government Property
- Area of Concern (AOC)
- Extent of Former NIKE PR-79 Control Area (USAGC, 2015)
- Cemetery
- Index Contour
- Intermediate Contour
- Electrical Line
- Sewer Line
- Water Line
- Drainage
- Geophysical Lines (Hager Geosciences, Inc (HGI), 2017)
- Overburden Groundwater Contour (5/2021)

0 25 50
Scale in Feet

N

FIGURE 17-1E
SATURATED OVERBURDEN THICKNESS PROPOSED NEW MONITORING WELL LOCATIONS
FORMER NIKE PR-79 CONTROL AREA FOSTER, RHODE ISLAND

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