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Supplemental Site Investigation Work Plan, Former AST AOI and MES/Pilot Study AOI

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Prepared for

Mendocino Railway
Foot of Laurel Street
Fort Bragg, California 95437

KJ Project No. 1965021*21

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Section 1: Introduction

This Supplemental Site Investigation (SSI) Workplan (Workplan) was prepared by Kennedy Jenks on behalf of Mendocino Railway (MR) for the Former Aboveground Storage Tank (AST) Area of Interest (AOI) and the Former Machine Equipment Shop (MES)/Pilot Study AOI, located in Operable Unit C (OU-C) of the former Georgia-Pacific Wood Products Facility (Site) located at 90 West Redwood Avenue, Fort Bragg, Mendocino County, California (see Figure 1). On 9 June 2022, the Department of Toxic Substances Control (DTSC) issued the First Amendment to Site Investigation and Remediation Order (Docket No. HAS-RAO 06-07-150; Order First Amendment; DTSC 2022). As required by the Order First Amendment, this SSI Workplan proposes activities to further characterize the constituents of concern (COCs) in soil and soil vapor in two AOIs. This report includes a health and safety plan, quality assurance/quality control plan, sampling plan, and implementation schedule.

1.1 Site History

According to historical records, Union Lumber Company began sawmill operations at the Site in 1885. Georgia-Pacific, LLC (Georgia Pacific) acquired the site in 1973 and ceased lumber operations on 8 August 2002. Mendocino Railway purchased approximately 75 acres of OU-C from Georgia Pacific in June 2019, and acquired the remaining portions of OU-C as well as OU-D and OU-E in 2021. Most of the equipment and structures associated with the lumber production have been removed.

The Former AST AOI is located along the Site boundary with the City of Fort Bragg to the north and the California Western Facility (also owned by Mendocino Railway) to the east (Figure 2). The Former MES/Pilot Study AOI is located west of the Former AST AOI, east of Dry Shed #4, and north of former Dry Shed #5 (see Figure 2). Little historical information exists for the tanks in this area; however, it is likely they were removed at or prior to the time the Former MES was demolished in the late 1980s (Arcadis 2015). Historical information indicates that there was one gasoline AST and two diesel-fuel ASTs (Kennedy Jenks 1995). The former Georgia Pacific and Mendocino Railway property boundary ran between the former Georgia Pacific gasoline AST and the existing AST owned and operated by Mendocino Railway (no longer in use and closed in place; Figure 2). Two buildings were in the Former MES/Pilot Study AOI: the lube bay, which included fuel dispensing and equipment washing areas, and an equipment and storage washing building (Arcadis 2015). Degreasers were found to have been used in both equipment wash areas. Both buildings had concrete floors and the foundations of these buildings were removed in 2006 (Arcadis 2015). A pilot study involving excavation and onsite bioremediation of affected soils was completed in 2007 in this area. Affected soils were removed and clean, treated soils, having met screening levels established for the pilot study, were backfilled into this area (Arcadis 2008).

A remedial investigation report (RI Report) was prepared for OU-C and OU-D in 2010, which included data collected from several investigations from 1998 to 2009 (Arcadis 2010). These investigations included a lead-based paint investigation, a Phase 1 Environmental Site Assessment (ESA), a Phase II ESA, additional site assessments, site investigation activities, and quarterly groundwater monitoring (Arcadis 2010). A subsequent report, the OU-C and OU-D

Feasibility Study (OU-C/D FS), recommended remedial alternatives to address COCs within the Former AST and Former MES/Pilot Study AOIs (Arcadis 2012).

After completion of the OU-C/D FS, a supplementary soil and groundwater investigation was conducted in June 2012 to address data gaps identified in the Former AST and Former MES/Pilot Study AOIs. Soil sample results from the supplemental investigation further delineated the extent of petroleum hydrocarbons in the Former AST and Former MES/Pilot Study AOIs. Petroleum hydrocarbons were found to be primarily limited to smear zone soils in the vicinity of the AOIs.

In 2015, a Remedial Action Plan for OU-C and OU-D (OU-C/D RAP) was completed, which identified selected remedial actions for each AOI in OU-C and OU-D. The OU-C/D RAP also presented remedial action goals (RAGs) for COCs in soil, soil vapor, and groundwater (Arcadis 2015). The proposed OU-C/D RAP remedial actions for the Former AST and MES/Pilot Study AOIs included excavation and off-site disposal of TPHd-impacted soil, natural attenuation of groundwater with long-term monitoring, a soil management plan, and land use controls[1]. DTSC approved the OU-C/D RAP in a letter dated 17 December 2015 (DTSC 2015). DTSC provided partial certification of the OU-C remedial action pending completion of the soil remedy at the Former AST and Former MES/Pilot Study AOI. Soil remediation will be coordinated with work anticipated at the adjacent California Western Facility. A land use covenant (LUC) creating a groundwater restricted area and a soil and soil vapor restricted area for a portion of OU-C was recorded with the Mendocino County Recorder on 11 June 2018. The areas under the LUC are shown on Figure 2. DTSC issued the Order First Amendment on 9 June 2022, which included a requirement to submit this SSI Workplan for the Former AST AOI and MES/Pilot Study AOI.

The affected media and COCs for soil and soil vapor in the Former AST and Former MES/Pilot Study AOIs include (Arcadis 2010, 2015):

- Former AST AOI:
    - Soil: lead, total petroleum hydrocarbons in the diesel range (TPHd)
    - Soil vapor: benzene, ethylbenzene, 1,2,4-trimethylbenzene (1,2,4-TMB), and naphthalene
- Former MES/Pilot Study AOI:
    - Soil vapor: benzene, ethylbenzene, 1,2,4-TMB, and naphthalene

1.2 Objectives

This SSI Workplan was prepared in accordance with the Order First Amendment. The objective of the scope of work proposed in this SSI Workplan is to provide an updated data set describing the current presence of TPHd in soil and benzene, ethylbenzene, 1,2,4-TMB, and naphthalene in soil vapor in the Former AST and Former MES/Pilot Study AOIs. Soil excavation and disposal

[1] Proposed remedial action also included soil vapor mitigation if and when future use created an unacceptable risk to potential receptors.

was proposed in the OU-C/D RAP as a remedial action to remove residual TPHd and petroleum-related volatile organic compounds (VOCs) mass from unsaturated zone soil in these AOIs; however, this remedial action was based on information collected between 1998 and 2012. Reductions in mass of petroleum hydrocarbons can occur through natural biodegradation processes, and therefore concentrations of TPH and petroleum-related VOCs may have degraded since 2012. Recent scientific work to characterize and quantify the magnitude of natural source zone depletion (NSZD) of residual hydrocarbons at fuel release sites has shown that measurements of oxygen, carbon dioxide, and methane can be used to accurately quantify the rate of residual petroleum hydrocarbon degradation. This SSI is proposed to understand current conditions and evaluate the rate of NSZD as compared to the remaining concentrations of petroleum hydrocarbons.

These objectives will be met by collection of analytical data for TPHd in soil and benzene, ethylbenzene, 1,2,4-TMB, and naphthalene in soil vapor for comparison to previous results. These analytical data will be used to characterize the current presence of constituents in the AOIs and understand changes in concentrations over the last approximately 10 years. The SSI Workplan also proposes the evaluation of NSZD rates in the AOIs through collection of soil vapor measurements from existing monitoring wells. The NSZD evaluation will evaluate the reduction in mass of residual petroleum hydrocarbons in the vadose zone via naturally occurring biodegradation.

Section 2: Site Conditions

2.1 Geology

2.1.1 Regional

Fort Bragg is located along the northern California coastline within the Coast Range geomorphic province. The regional geology consists of completely folded, faulted, sheared, and altered bedrock. The bedrock of the region is the Franciscan Complex (Complex) of Cretaceous to Tertiary (late Eocene) age (40 to 70 million years old). The Complex comprises a variety of rock types. In the north coast region, the Complex is divided into two units; the Coastal Belt and the Melange. In Mendocino County, the Melange lies inland and is an older portion of the Complex, ranging in age from the Upper Jurassic to the late Cretaceous. The Coastal Belt consists predominantly of greywacke sandstone and shale.

2.1.2 Local

Besides the Coastal Belt, other geologic units present in Fort Bragg and in the vicinity include surficial deposits of beach and dune sands, alluvium, and marine sediments. At the site, the most important of these at the site are the marine sediments, which cut bedrock surfaces along the coast and form much of the coastal bluff material overlying bedrock. Artificial fill (reworked native soil or imported material) is also prevalent at the site.

The site is underlain by Quaternary (less than 1.5 million years old) marine sediments deposited in thicknesses up to 30 feet on wave-cut surfaces parallel to the coast (Blackburn Consulting, Inc. (BCI) 2006). These surfaces were created during the Pleistocene Epoch when sea level fluctuations caused by glaciation created a series of terraces cut into the Franciscan bedrock by wave action (BACE Geotechnical 2004). The marine sediments comprise poorly to moderately consolidated silts, sands, and gravels, and in some locations are overlain by a 3- to 4-foot-thick mantle of topsoil or up to a 20-foot-thick layer of artificial fill (BACE Geotechnical 2004). Both the topsoil and fill are generally relatively coarse in texture, ranging primarily from sandy silts to gravel. The marine sediments are also generally coarse, but appreciable thicknesses of finer materials are also found onsite. Beneath these Pleistocene materials are the Tertiary-Cretaceous rocks (approximately 65 million years old) of the Coastal Belt, composed of well-consolidated sandstone, shale, and conglomerate.

2.2 Hydrogeology

2.2.1 Regional

The regional hydrogeologic setting of the Mendocino County coast has been presented in the Mendocino County Coastal Ground Water Study (California Department of Water Resources, 1982). The site is located in the western coastal area of the county, which was divided into five subunits in the study (Westport, Fort Bragg, Albion, Elk, and Point Arena), separated by the major rivers that discharge to the Pacific Ocean. The site is located within the Fort Bragg subunit, which extends from Big River to the south to Ten Mile River to the north.

2.2.2 Local

Based on 14 years of monitoring, groundwater generally flows radially at the site toward Fort Bragg Landing and the Pacific Ocean under an average horizontal hydraulic gradient ranged from 0.016 foot per foot (ft/ft) to 0.094 ft/ft. Groundwater elevations tend to range from approximately 7 to 91 feet relative to the Northern American Vertical Datum of 1988 (NAVD 88). Depending on the location, seasonal fluctuations in groundwater levels of up to 12 feet have been observed. Groundwater elevations from "Year 3" groundwater monitoring events, completed in accordance with the GW O&M Plan (Kennedy Jenks 2020), are included in Table 1.

Section 3: Historical Sample Results and Proposed Sampling Approach

Soil sampling data from previous investigations were compiled as part of the development of the OU-C/D RI (Arcadis 2010), FS (Arcadis 2012), and RAP (Arcadis 2015). Appendix A includes select figures from previous documents that present previous sample locations and sampling results. Previous soil and soil vapor investigations are summarized in the following sections.

3.1 Soil

3.1.1 Historical Sample Results

Based on existing data, TPHd is present in soil at concentrations above RAGs in the Former AST AOI and is the subject of proposed remedial action in the OU-C/D RAP. Appendix A includes select figures that present previous sample locations and results for TPHd in soil. A summary of the previous soil sampling results for the Former AST and Former MES/Pilot Study AOIs includes:

- TPHd was detected above leaching to groundwater (LGW) screening levels at locations west and downgradient of the ASTs except for one location (OUC-DP-1003). TPHd concentrations were below direct contact and protection of indoor air screening levels.
- TPHd was detected at approximately 10 to 12 ft bgs, where groundwater was first observed, at concentrations between 440 and 9,600 milligrams per kilogram (mg/kg; C10-C24 range). Concentrations in shallower soils were below the LGW screening level, except for OUC-DP-1009 (5,900 mg/kg).
- TPHd concentrations generally decrease with distance south of the ASTs and west of the border between the California Western and Former AST AOI.
- Concentrations of samples immediately cross gradient and upgradient of the ASTs were below screening levels (STF-DP-018, STF-DP-019, and OUC-DP-1013).
- TPHd detected in soil are primarily within the saturated interval and the interval of historical groundwater table fluctuations (in the “smear zone”).

3.1.2 Proposed Sampling Approach

Collection of soil samples is proposed to further characterize TPHd in soil in the Former AST AOI and understand current conditions.

Soil sample locations are selected to target previous locations with elevated TPHd concentrations that were drivers for the soil excavation areas proposed in the OU-C/D RAP. Soil samples will be collected from multiple depth intervals at each location (chosen to repeat previous sampling depth intervals) and analyzed for the constituents identified in Table 2. The proposed approximate sample locations are shown on Figure 3. Soil sampling and analysis methodologies are presented in Section 4.

3.2 Soil Vapor

3.2.1 Historical Sample Results

Based on existing data, benzene, ethylbenzene, 1,2,4-TMB, and naphthalene are COCs in soil vapor in the Former AST and Former MES/Pilot Study AOIs. These are petroleum-related VOCs. Appendix A includes a figure that presents soil vapor sampling locations and select VOC results.

Soil vapor samples were collected at 5 bgs and 8 ft bgs as part of RI activities (Arcadis 2010). Concentrations of VOCs were detected above screening levels in limited areas downgradient of previous petroleum storage. VOC concentrations above screening levels included: 1,2,4-TMB (11,000 to 56,000 micrograms per cubic meter ($\mu g/m^3$)), benzene (120 to 7,700 $\mu g/m^3$), ethylbenzene (1,000 to 37,000 $\mu g/m^3$), Methyl tert-Butyl Ether (MTBE; 4,800 $\mu g/m^3$ in one sample), vinyl chloride (16 $\mu g/m^3$), and naphthalene (32 to 1,700 $\mu g/m^3$).

3.2.2 Proposed Sampling Approach

Collection of soil vapor samples is proposed to further characterize benzene, ethylbenzene, 1,2,4-TMB, and naphthalene in soil vapor in the Former AST and Former MES/Pilot Study AOIs.

Soil vapor sample locations were selected to target previous locations with elevated petroleum-related VOC concentrations. Soil vapor samples will be collected from two depths at each location and analyzed for the constituents identified in Table 2. The proposed approximate sample locations are shown on Figure 3. Soil vapor sampling and analysis methodologies are presented in Section 4.

3.3 Natural Source Zone Depletion

At sites with petroleum hydrocarbons in the subsurface, reductions in mass can occur through natural biodegradation processes. The rate of biodegradation is dependent on subsurface conditions and the nature of petroleum hydrocarbons in the soil. Evaluating the byproducts of degradation, in context with the volatilization of hydrocarbons, aerobic biodegradation, and the production of carbon dioxide (CO_2); methanogenesis of petroleum hydrocarbons and the production of methane (CH_4) and CO_2; aerobic oxidation of methane and the production of CO_2; and transport of the gases from the saturated zone, can provide information to estimate the biodegradation rate naturally occurring at the Site.

Select field measurements will be collected using a portable five-gas meter or equivalent at existing monitoring wells and soil vapor sampling locations, and the measurements will be used to complete a NSZD evaluation using the gradient method. The gradient method involves the assessment of changes in the vertical distribution of soil vapor constituents (principally O_2 and CO_2) over the source zone footprint, combined with estimates or measurements of the effective diffusion coefficient for the soil vapor. The targeted air column will be selected at a distance above the potentiometric surface in the selected monitoring wells. The screened intervals of the selected monitoring wells have been reviewed and extend above the high-water table during the wet season (see Table 1). Background locations will be identified, and measurements from background locations will be used to compensate for natural soil respiration. The NSZD evaluation and gradient method will be described in additional detail with the results in subsequent reporting. Sample locations and proposed field measurements (O_2, CO_2, and CH_4) are presented in Table 2 and Figure 3.

Monitoring wells and soil vapor sampling locations are categorized as follows:

- Upgradient: MW-3.17
- Within the estimated extent of petroleum hydrocarbon impacts: MW-3.2, MW-3.13, SSI-1, SSI-2, SSI-5
- Downgradient: MW-3.16R, MW-3.3, SSI-6, and MW-3.18[2]

[2] MW-3.18 is an existing downgradient well. However, the most recent groundwater elevation was above the top of the screened interval. MW-3.18 is included in the proposed sampling locations, but field measurements for the NSZD evaluation will only be collected if the groundwater elevation is below the top of the screened interval.

Section 4: Sampling and Analysis Methodologies

The proposed scope of work will be completed in accordance with the Site Health and Safety Plan (HASP) and the Site Quality Assurance Project Plan (QAPP; Arcadis 2007). Personnel will be HAZWOPER certified and comply with the requirements of the Site HASP. The Site HASP will be reviewed, updated as needed, and maintained onsite.

Sample locations will be recorded using GPS. Photographs will be taken and logged in the field to document findings and Site conditions.

4.1 Fieldwork Preparation

A boring permit will be obtained from the Mendocino County Health and Human Services Agency, Environmental Health, Hazardous Materials prior to mobilization.

Boring locations will be marked in white paint, stakes, or flags and the Underground Service Alert (USA) system will be notified no less than 48 hours prior to drilling. In addition, a subcontractor will be engaged to use non-invasive geophysical means, including a ground-penetrating radar device (GPR), to locate and map underground utilities around the proposed borings. Each soil boring location will also be hand-cleared to 5 feet depth.

When boring locations are marked, planned soil vapor sampling locations will also be marked using stakes or flags. Hand augering at soil vapor sampling locations may disturb nearby soil and increase the stabilization period after installation of the soil vapor point (see Section 4.2.2). Therefore, to evaluate the absence of utilities at soil vapor sampling locations, no less than three hand auger borings will be advanced to 5 feet depth in a pattern around the planned soil vapor point when boring locations are marked (at least 48 hours prior to sampling). The soil will be repacked in each borehole and the hand auger locations will be marked in white paint, stakes, or flags (in a different color or style than used to mark the soil vapor sampling location). If utilities are revealed, the soil vapor sample will be relocated, and a similar process repeated.

4.2 Sampling

To accommodate the required stabilization period for soil vapor sampling, the soil vapor probes will be installed first. If the 2-hour stabilization period has completed for the first soil vapor probe when installation of the last soil vapor probe is complete, the field team will return to the first soil vapor probe and begin the soil vapor sampling. If the 2-hour stabilization period has not completed, soil borings that are not co-located with a soil vapor probe will be completed until the stabilization period is complete. Soil borings that are co-located with a soil vapor sample will be completed last, after the soil vapor sample has been collected. NSZD sampling will be completed after the soil vapor sample has been collected and before the soil vapor probe is decommissioned.

4.2.1 Soil Sampling

4.2.1.1 Soil Boring Drilling

Soil samples will be collected from at the Site from the proposed locations included in Table 2 and shown on Figure 3. Each soil boring will be hand-cleared to 5 feet depth using a hand auger to confirm the absence of utilities. If any utilities are revealed, the soil boring will be relocated, and a similar process repeated. Where co-located soil sample and soil vapor samples are proposed, the soil boring will be completed after the soil vapor sampling and NSZD sampling is complete at that location to avoid disturbing soil vapor prior to sampling.

A hydraulic push-drive device such as a GeoProbe™ or equivalent will be used to continually core each boring below the hand-cleared depth, as described in Appendix B Standard Operating Guideline (SOG) – Hydraulic Push/Drive Sampling Procedures. This type of drilling device advances hollow steel rods, typically 5-feet length and 2-1/4 inches diameter, with the lead rod is fitted with an acetate liner. Upon drilling the length of the steel rod, the core-filled acetate liner is removed and replaced with a new liner, and the rods are advanced another length; this coring process is repeated until the maximum depth is reached. The method allows the borehole to be continuously cased as it is advanced.

Soil borings will be sealed with neat cement grout using the tremie method. Upon reaching the total depth, the tremie pipe will be inserted into the steel rods and grout poured in to fill the steel rods and displace any standing groundwater. The steel rods will be removed and the cement topped off to the ground surface.

Soil will be logged using the United Soil Classification as described in Appendix B SOG – Borehole Logging and recorded on a soil boring log form. Observations will include color, texture, visual staining, and odor of each sample.

Investigation-derived residuals (IDW) is anticipated to consist of soil not retained for analysis and decontamination water. IDW will be placed in DOT-approved 55-gallon drums and held onsite pending profiling and disposal.

4.2.1.2 Soil Sample Collection

Soil samples proposed in the hand-cleared interval in the upper 5 feet will be collected by compiling soil from the hand auger into a metal liner or a 6-inch long portion of new acetate liner, which will be sealed, capped, and labeled as described in Appendix B SOG – Surface and Shallow Soil Sampling. The hand auger will be cleaned between borings using non-phosphate soap, potable water, and a final distilled water rinse and described in the SOG.

To retain a soil sample from the hydraulic push-drive section, the desired portion section of the acetate liner is cut away and is sealed with Teflon tape, capped, and labeled.

It is expected that 4 ounces of soil will be required per sample for analysis. Samples will be entered into the chain of custody and placed in a cooler on ice until shipped or transferred to the laboratory. Sample packaging and shipping procedures are included in Appendix B – SOG Sample Packaging and Shipping.

A portion of soil from each coring interval will be in a plastic bag and tested with a photoionization detector (PID) to screen for VOCs. These headspace readings will be recorded on the boring log.

4.2.2 Soil Vapor Sampling

4.2.2.1 Soil Vapor Probe Construction

As summarized in Table 2 and shown on Figure 3, temporary soil vapor probes will be constructed at SSI-1 (near former location OUC-DP-019), SSI-2 (near former location OUC-DP-1004), SSI-5 (between former locations OUC-SV-012 and OUC-SV-013), and at SSI-6 (east of former location OUC-SV-018).

After completion of the soil boring, a separate boring will be drilled for soil vapor probe construction. Each soil vapor location will be a nested probe, with two gas intakes in a single boring. If groundwater is greater than 8.5 feet depth, the boring will be drilled to 8.5 feet depth with one intake placed at 8 feet and one at 5 feet. If groundwater is less than 8.5 feet depth but greater than 5 feet depth, only the intake at 5 feet will be placed.

Utilities will be cleared at least 48 hours prior to installation of the soil vapor probe (see Section 4.1). The upper 5 feet of the soil vapor borings will not be hand augered. To evaluate the absence of utilities, no less than three hand auger borings will be advanced in a pattern around the soil vapor point. The soil vapor borings will be advanced at cleared locations with the GeoProbe™ or equivalent rods to the total depth.

Probes will be constructed in accordance with the DTSC and Los Angeles and San Francisco Regional Water Quality Control Board *Active Soil Gas Investigation* (DTSC 2015). Each intake will be placed in the middle of a 12-inch section of filter pack sand (8.5 feet to 7.5 feet depth and 5.5 to 4.5 feet depth) with 12 inches of dry bentonite granules above the sand pack. Hydrated bentonite granules will extend from 6.5 feet up to 5.5 feet depth and 3.5 feet to the surface. Each probe will consist of a stainless steel filter intake and the riser will be ¼-inch Nylaflow™ or equivalent tubing. Upon successful sample collection, including both the soil vapor sample and NSZD sampling (see Section 4.2.3), the temporary probes will be decommissioned by removing the tubing and restoring the location with neat cement or similar.

4.2.2.2 Soil Vapor Sample Collection

Soil vapor sample collection will be in accordance with DTSC (2015). Samples will be collected in 1-liter batch certified stainless steel Summa™ canisters provided by the analytical laboratory. The sample train, including the sample canister, regulator, gauges, and valves or fittings to arrange the purging, and sample collection will be provided by the laboratory.

4.2.2.2.1 Shut-in Test

A shut-in test will be conducted at every location prior to purging to check for leaks in the above-ground sampling train. The above-ground valves, fittings, Summa sample canister with its valve closed, and a vacuum gauge are assembled and the system evacuated to at least 100 inches of water. If the vacuum gauge does not change after one minute, the sampling may proceed without altering the sampling train. If any loss of vacuum is observed, the fittings are tightened and adjusted and the test repeated until no loss of vacuum can be observed.

4.2.2.2.2 Leak Testing

Helium will be used for leak testing during sample collection as described in DTSC (2015). The system will consist of a shroud to be placed around the sampling train (which includes the sample canister), a helium source, a detector to measure helium concentration in the shroud, and an in-line helium detector connected to the purge line to test for helium while purging. If helium is detected in the purge line after one to two purge volumes, a leak is likely and corrective action will be taken to resolve the leak. The soil vapor sample analysis will include helium by fixed gas analysis to quantify any leaks. The helium atmosphere in the shroud will be kept between 20% and 40%.

4.2.2.2.3 Purging and Sampling

In accordance with the DTSC (2015), samples will be collected no sooner than two hours after sampling points were installed by push methods. Three purge volumes of soil vapor will be removed prior to sampling to remove stagnant air from the system. One purge volume includes the internal volume of tubing and probe tip; void space of sand pack around the tubing; void space around the dry bentonite around the tubing.

Soil vapor will be purged at a rate between 100 and 200 milliliters per minute (ml/min) and with a vacuum less than 100 inches of water (7.35 inches of mercury) as measured with a vacuum gauge. If the vacuum exceeds 100 inches of water (which can occur if the subsurface is very fine grained), the DTSC Advisory presents alternative methods of purging and sample collection that will be utilized. Purging will be performed with a 60-ml gas-tight syringe or a small vacuum pump. The purge rate will be monitored using either an inline flow meter calibrated using a primary standard or timing the infilling of the syringe. The purging start and end times, volume, and rate will be recorded on a field datasheet.

Once the required purge volume has been removed, the soil vapor sample will be collected. The sample canister will be closed to complete sample collection when approximately 5 inches of mercury is reported by the vacuum gauge. The sample will be delivered to the laboratory under chain-of-custody for analysis of the target compounds. Before decommissioning the soil vapor probe, field measurements will be collected (see Section 4.2.3).

Samples will be delivered or shipped to the analytical laboratory under chain-of-custody. The unique sample identification, date of collection, start and end time of sample collection, starting and ending canister vacuum, and other pertinent information will be filled out on the sample identification label and the chain-of-custody form.

4.2.3 NSZD Sampling

4.2.3.1 Existing Monitoring Wells

The measurements will be in general accordance with the methodology of Jewel and Wilson (2011) for measurement and sampling of soil vapor from monitoring wells, with modifications to exclude analytical samples and include a packer thereby reducing purge volume and minimizing well mixing per the "small purge method" of Sweeney and Ririe (2017).

Soil vapor measurements will be collected using the following steps:

1) Measure depth to groundwater using an interface probe.

2) If a packer is unable to reach the desired depth due to bends in well casing, a modified J-plug cap will be used. The modified J-plug cap is a typical expanding J-plug cap used to seal monitoring wells, modified so it has a central pathway to allow vapor to pass through the cap. The top of the pathway on the outside top of the cap is fitted with a valve or quick-connect air fitting; the inner, bottom end of the cap has a perforated barb so that tubing can be fixed to the end of the barb. The tubing length is adjusted to the desired length so vapors can be drawn from the desired depth, similar to low-flow groundwater purging. Tubing with packers or the modified J-plug will be installed a day prior to monitoring to reduce the potential effects of soil vapor mixing that may occur during installation. Well void volume is calculated from the bottom of the packer or J-plug to the down well fluid surface.

3) A calibrated field portable gas meter is used to pump soil vapor and monitor soil vapor composition (O_2, CO_2, and CH_4). Measurements will be collected at approximately every ¼ void volume (minimum of 12 measurements) for three void volumes. Flow through the gas meter range between 100 milliliters per minute (mL/min) to 500 mL/min. Soil vapor will be purged until measurements stabilize.

The soil vapor composition is recorded at small intervals to observe the compositional change approaching stable conditions. Stabilized readings may occur before the three volumes are removed; however, data will be recorded up to the point where three void volumes have been met. A water trap/particulate filter is used to avoid moisture and dust-affecting measurements. Gas meter measurements will be in percent of volume.

4.2.3.2 Soil Vapor Probes

NSZD measurements will be collected at temporary soil vapor probes after the soil vapor sample is collected and before the temporary soil vapor probe is decommissioned (see Section 4.2.2). After the soil vapor sample is collected, a calibrated field portable gas meter will be connected to the soil vapor tubing to collect field measurements. Measurements will be collected as described in section 4.2.3.1, step #3.

4.3 Sample Handling and Analysis

4.3.1 Sample Labeling, Packaging, Shipment

Prior to shipping to the laboratory, samples will be clearly labeled. A plastic or waterproof paper label will be attached to the sample container and will be filled out using water-resistant ink.

Alternatively, information may be recorded directly onto the sample container using indelible ink. Sample labels will contain the following information:

- Project number or site/project name
- Sample location identification
- Sample depth
- Date and time the sample was collected
- Sampler's name/initials.

Following collection and labeling, soil samples will be immediately placed in a sample cooler with ice for temporary storage. The samples will be placed in sealed plastic bags to restrict contact with moisture in the ice chest. Jars and bottles will be wrapped in plastic bubble wrap or other packing materials to protect against breakage. Each cooler will be shipped under chain-of-custody and will be sealed with a self-adhesive custody seal. Samples will be shipped on a next-day basis. If samples are held for more than 1 day, they will be kept in a secure place on ice in a cooler.

Soil vapor samples in Summa canisters will be kept at room temperature and returned in laboratory-provided shipping boxes.

4.3.2 Analytical Methods

Samples will be analyzed on a standard turn-around time (14 business days) by an accredited analytical laboratory. Samples will be analyzed by the following analytical methods:

- Soil samples will be analyzed for TPHd by EPA Method 8015 with Silica Gel Cleanup by EPA Method 3630C.
- Soil vapor samples will be analyzed for benzene, ethylbenzene, 1,2,4-TMB, and naphthalene by EPA TO-15. Samples will also be analyzed for fixed gases helium (the leak check compound) by ASTM D1946/D1945.

4.4 Quality Assurance/Quality Control

Consistent with the Site QAPP (Arcadis 2007), QA/QC samples will be collected in the field at the following frequency for each type of media:

- Matrix Spikes/Matrix Spike Duplicates (MS/MSD): Collected at a rate of one sample per approximately 20 samples collected for each analytical method.
- Trip Blanks: Included at a rate of one per sample delivery group where VOC analysis is planned.

- Equipment Blanks: Collected when non-disposable equipment is used. One equipment blank per day of sampling activities is expected for this field effort.
- Field Duplicate: Collected at a rate of one sample per approximately 10 samples.

Equipment blanks will be collected following cleaning procedures (see Section 4.7) by carefully pouring distilled water over or through the recently cleaned re-usable equipment and collecting this directly into an appropriate sample container held over a bucket.

QA/QC samples will be labeled and handled in the same manner as other samples and analyzed using the same analytical methods used on the unique soil samples (see Section 4.3).

4.5 Cleaning Procedures

To reduce the likelihood of carryover from one sample to another, equipment that comes into contact with soil or water will be cleaned according to the SOG for Equipment Cleaning (Appendix B). Disposable equipment intended for one-time use will not be cleaned but will be packaged for appropriate disposal. Cleaning will occur prior to and after each use of a piece of equipment. Sampling devices used will either be single-use and pre-cleaned or be cleaned using the following procedures:

- Non-phosphate detergent and tap water wash using a brush if necessary
- Tap water rinse
- Final deionized/distilled water rinse.

4.6 Investigation-Derived Waste

In the process of collecting environmental samples during the proposed field sampling program, different types of investigation-derived waste (IDW) will be generated that include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Cleaning fluids.
- Soil cuttings.

Listed below are the procedures that will be followed for handling the IDW:

- Used PPE and disposable equipment will be double-bagged and placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill. PPE and disposable equipment marked for disposal that can still be reused will be rendered inoperable before disposal in the refuse dumpster.

- Cleaning water will be placed in the onsite tank that holds groundwater purge water. The tank will be sampled and profiled during subsequent waste disposal events.

- Soil cuttings will be placed in a DOT-approved 55-gallon drum, which will be clearly labeled and placed near the onsite groundwater purge water tank. The drum will be sampled and profiled during subsequent waste disposal events.

Section 5: Implementation Schedule and Reporting

The Order First Amendment requires submittal of an RI Report Addendum within 120 days of approval of the Workplan. The RI Report Addendum will include the sampling results from completing the scope of work proposed in this SSI Workplan, the proposed NSZD evaluation, and recommendations related to the soil excavation proposed for the Former AST and MES/Pilot Study AOIs in the OU-C/D RAP.

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Tables

Table 1: Monitoring Well Details

Well ID	Well Construction Details: Top of Casing (ft NAVD88)	Ground Surface Elevation (ft NAVD88)	Total Constructed Depth (ft bgs)	Screen Top (ft toc)	Screen Bottom (ft toc)	3rd Quarter 2020: Depth To Water (ft toc)	Groundwater Elevation (ft NAVD88)	Depth To Product (ft toc)	Product Thickness (ft)	1st Quarter 2021: Depth To Water (ft toc)	Groundwater Elevation (ft NAVD88)	Depth To Product (ft toc)	Product Thickness (ft)
MW-3.2	75.78	76.17	23.5	8.00	23.50	10.56	65.22	ND	0.0	8.57	67.21	ND	0.0
MW-3.3	73.83	74.23	25	5.00	25.00	--	--	--	--	6.64	67.19	ND	0.0
MW-3.13	75.91	76.13	18	8.00	18.00	10.59	65.32	ND	0.0	8.63	67.28	ND	0.0
MW-3.16R	75.06	75.38	14.6	4.60	14.60	9.18	65.88	ND	0.0	7.23	67.83	ND	0.0
MW-3.17 (a)	78.63	79.15	22	12.00	22.00	--	--	--	--	--	--	--	--
MW-3.18	71.91	72.38	15	5.00	15.00	5.67	66.24	ND	0.0	4.07	67.84	ND	0.0

Notes:

ft	foot or feet
NAVD88	North American Vertical Datum of 1988
ND	not detected
toc	(relative to) top of casing
--	Not applicable, not measured, or not analyzed

(a) MW-3.17 is monitored in "Year 5" of the groundwater monitoring program only. Therefore, it was not monitored in third quarter 2020 or first quarter 2021.

Table 2: Proposed Sampling Locations

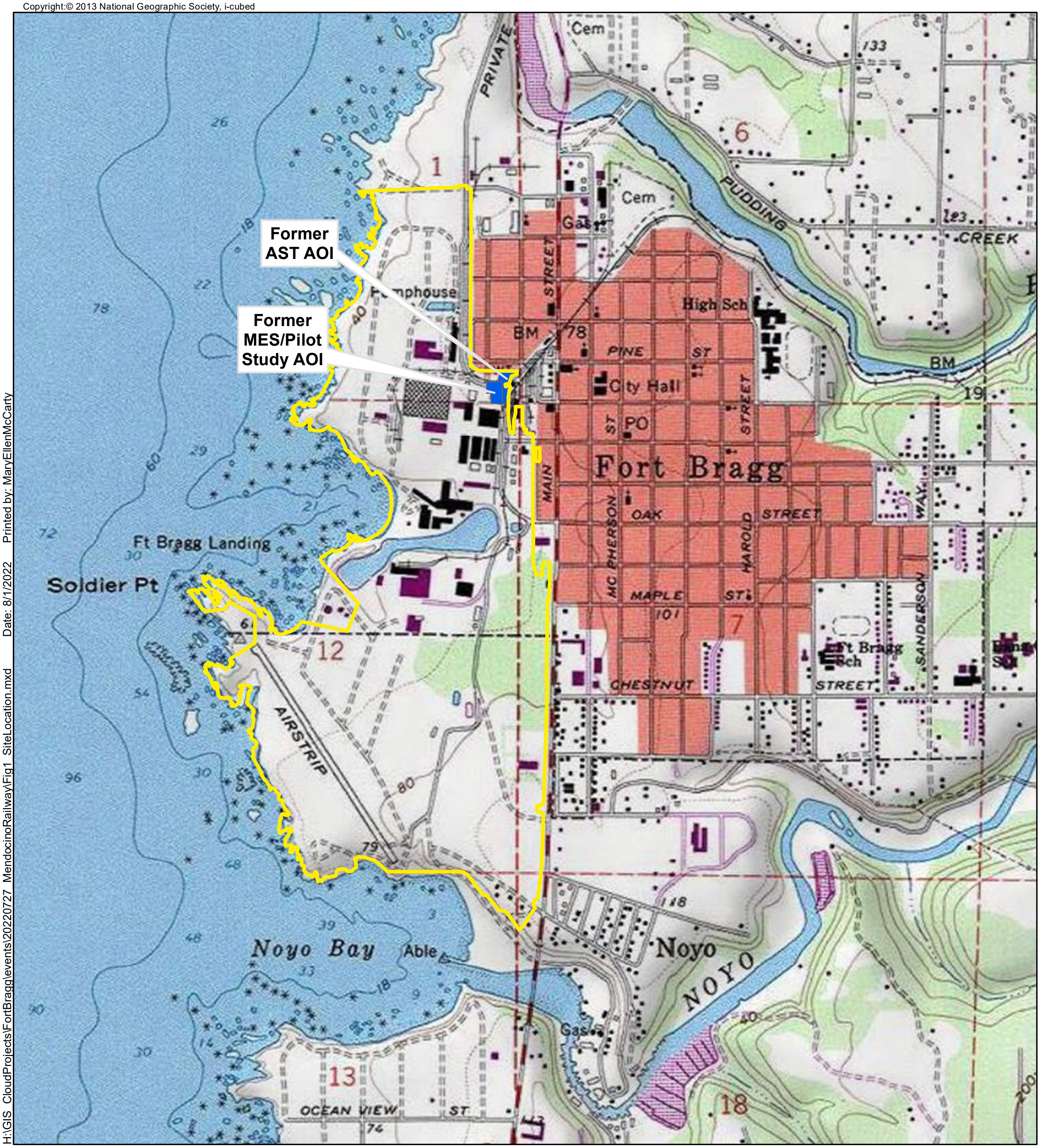
Previous / Existing Location ID	Proposed Location ID	Type	Sample ID	Depth (ft bgs)	Purpose	AOI	Lab: TPHd by USEPA Methods 8015/3630C with Silica Gel Cleanup	Lab: Selected VOCs by USEPA Method TO-15 (Benzene, ethylbenzene, 1,2,4-TMB, naphthalene)	Lab: Helium (tracer gas) by ASTM D1946/D1945	Field: Oxygen, Carbon Dioxide, Methane
OUC-DP-019	SSI-1	Soil	SSI-1-S(X.X-X.X)-DATE	0-2; 6-8; 10-12	Soil characterization	Former AST	●			
		Soil Gas	SSI-1-SG(X.X-X.X)-DATE	5; 8	Soil gas characterization	Former AST		●	●	●
OUC-DP-1004	SSI-2	Soil	SSI-2-S(X.X-X.X)-DATE	6-7; 9.5-10.5; 13.5-14.5	Soil characterization	Former AST	●			
		Soil Gas	SSI-2-SG(X.X-X.X)-DATE	5; 8	Soil gas characterization	Former AST		●	●	●
OUC-DP-1009	SSI-3	Soil	SSI-3-S(X.X-X.X)-DATE	0-0.5; 2.5-3; 6.5-7; 11.5-12	Soil characterization	Former AST	●			
STF-DP-1023	SSI-4	Soil	SSI-4-S(X.X-X.X)-DATE	6-7; 10-11; 16-17	Soil, soil gas characterization	Former MES/Pilot Study	●			
Between OUC-SV-012 and OUC-SV-013	SSI-5	Soil Gas	SSI-SG-3(X.X-X.X)-DATE	5; 8	Soil gas characterization	Former MES/Pilot Study		●	●	●
East of OUC-SV-018	SSI-6	Soil Gas	SSI-SG-4(X.X-X.X)-DATE	5; 8	Soil gas characterization	Former MES/Pilot Study		●	●	●
MW-3.2	--	Soil Gas	SSI-MW-3.2-SG-DATE	According to NSZD Method	NSZD at well [Impacted Area]	Former MES/Pilot Study				●
MW-3.13	--	Soil Gas	SSI-MW-3.13-SG-DATE	According to NSZD Method	NSZD at well [Impacted Area]	Former AST				●
MW-3.3	--	Soil Gas	SSI-MW-3.3-SG-DATE	According to NSZD Method	NSZD at well [Downgradient]	Former MES/Pilot Study				●
MW-3.16R	--	Soil Gas	SSI-MW-3.16R-SG-DATE	According to NSZD Method	NSZD at well [Downgradient]	Dry Sheds #4/#5				●
MW-3.17	--	Soil Gas	SSI-MW-3.17-SG-DATE	According to NSZD Method	NSZD at well [Upgradient]	Former AST				●
MW-3.18	--	Soil Gas(a)	SSI-MW-3.18-SG-DATE	According to NSZD Method	NSZD at well [Downgradient]	Dry Sheds #4/#5				●

Note:
(a) Soil vapor sampling at MW-3.18 will only be conducted if groundwater elevation is below the top of the screened interval.

Abbreviations:

--	not applicable
AOI	area of interest
AST	aboveground storage tank
DATE	sample date. For example, for a sample collected on 26 July 2022, "20220726" would be included in the sample ID
ft bgs	feet below ground surface
MES	Mobile Equipment Shop
MW	monitoring well
X.X-X.X	Sample depth range. For example, if a soil sample is collected from 0 to 2 ft bgs, "(0.0-2.0)" would be included in the sample ID

Figures



H:\GIS_CloudProjects\FortBragg\events\20220727_MendocinoRailway\Fig1_SiteLocation.mxd Date: 8/1/2022 Printed by: MaryEllenMcCarty

Legend

Site Boundary

Area of Interest (AOI)

N

0 800 1,600

Scale: Feet

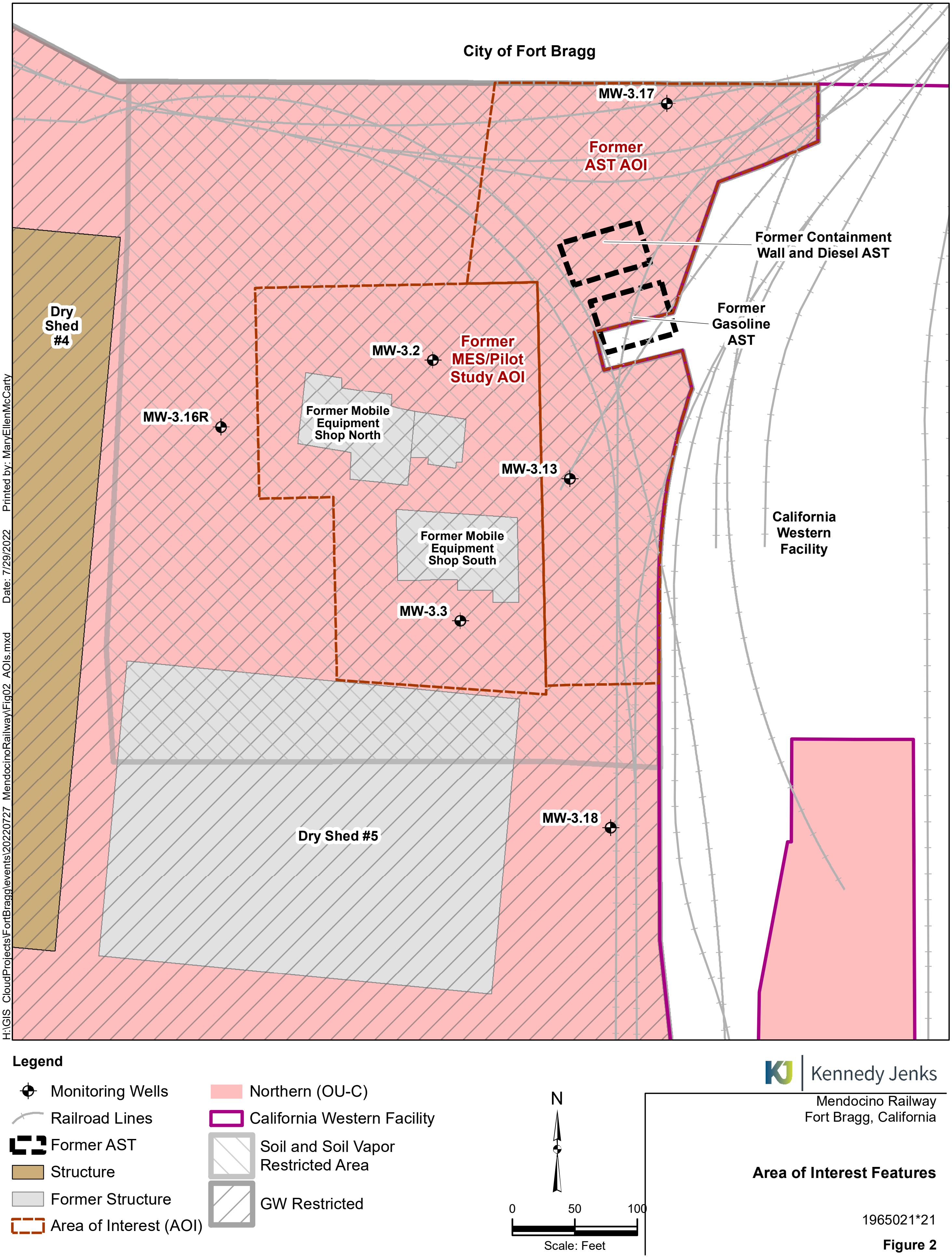
Kennedy Jenks

Mendocino Railway
Fort Bragg, California

Site Location Map

1965021*21

Figure 1



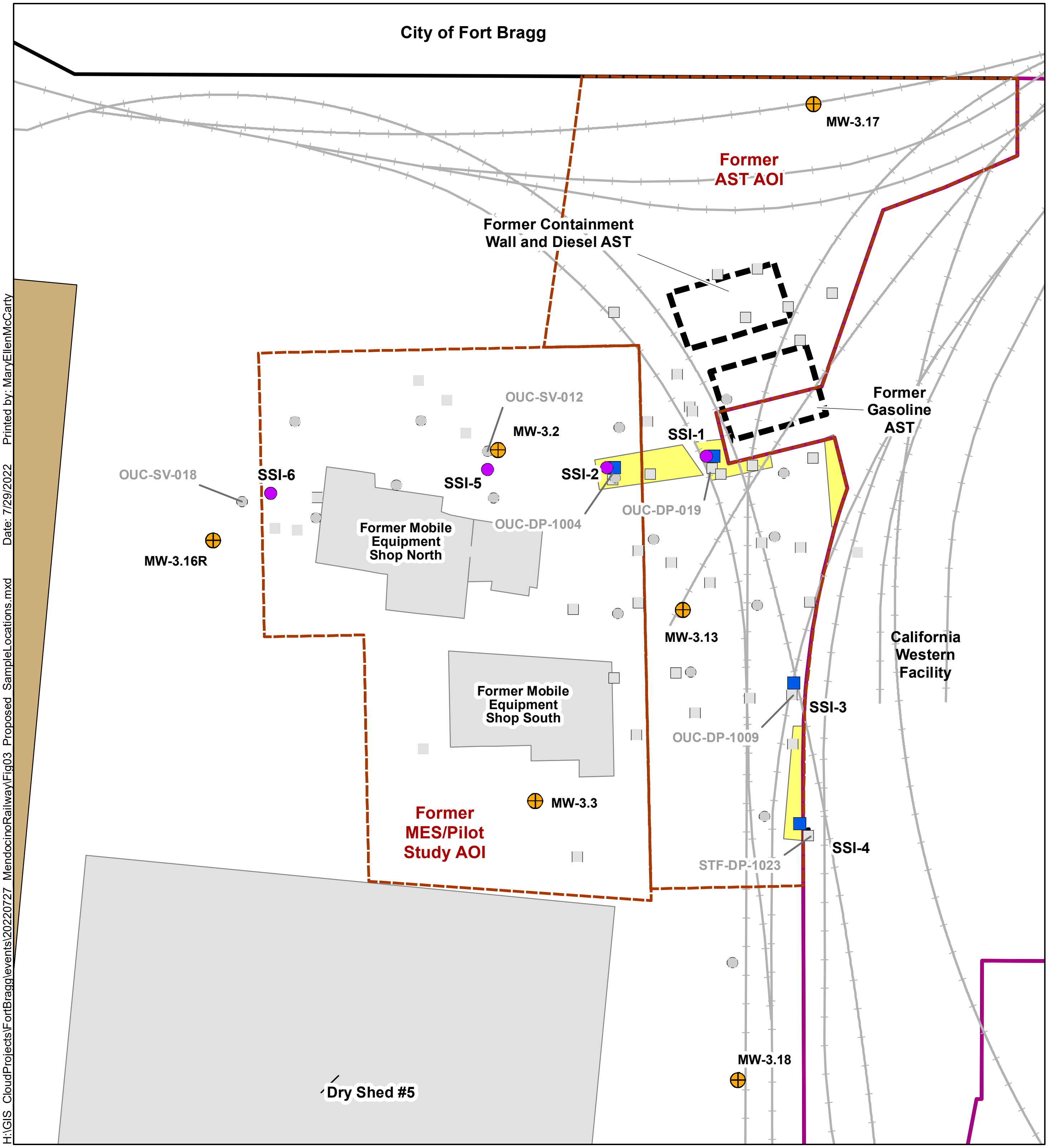
Kennedy Jenks

Mendocino Railway
Fort Bragg, California

Area of Interest Features

1965021*21

Figure 2



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Legend

- Proposed Soil Gas Sample
- Proposed Soil Sample
- Monitoring Well
- Previous Soil Gas Samples
- Historical Soil Samples Analyzed for TPHd
- Soil Excavation Areas Proposed in OU-C/D RAP
- Railroad Lines
- Area of Interest (AOI)
- Former AST
- California Western Facility
- Structure
- Former Structure
- Mill Site Boundary

N

0 50 100
Scale: Feet

Kennedy Jenks

Mendocino Railway
Fort Bragg, California

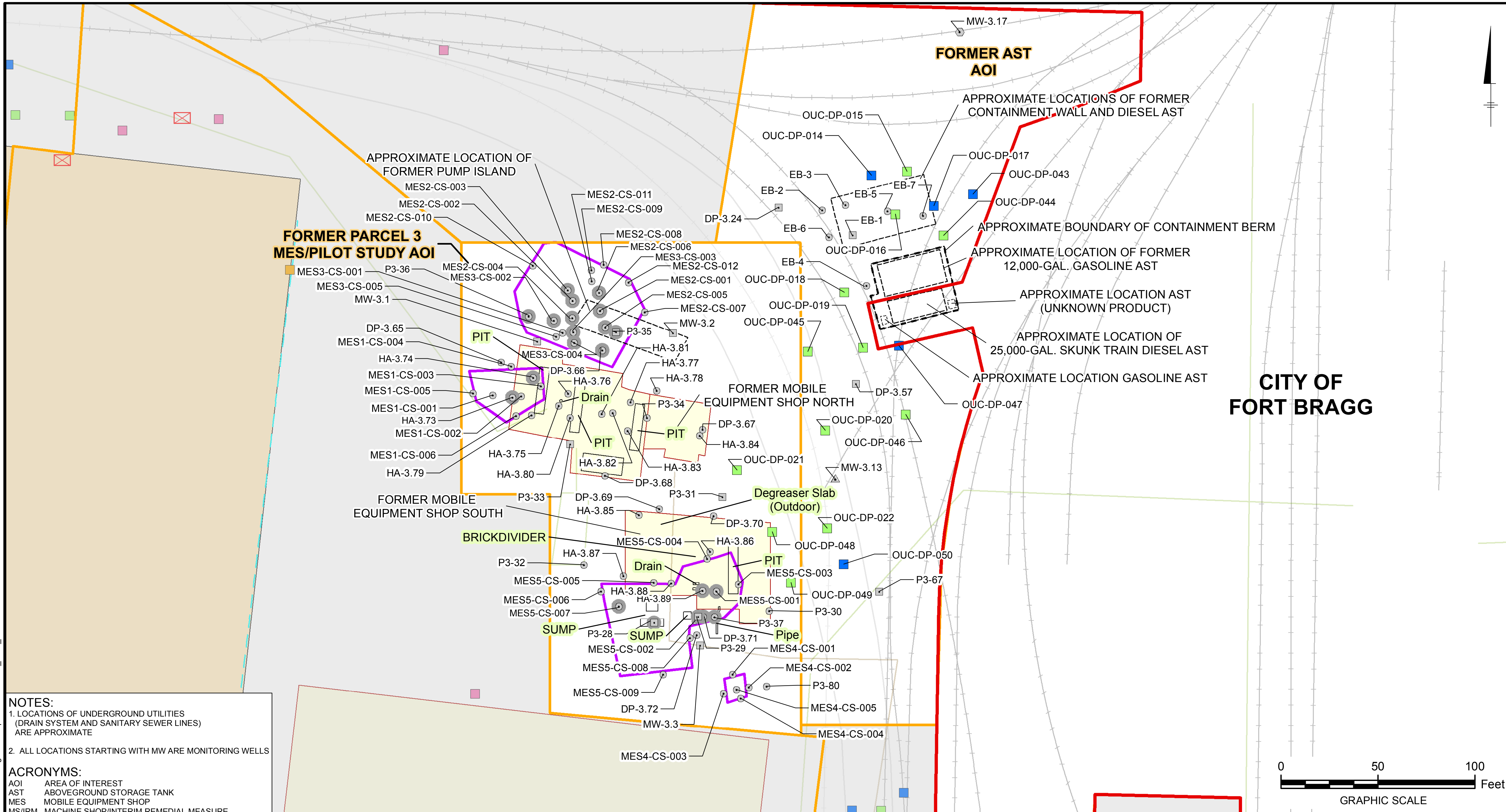
Proposed Sample Locations

1965021*21

Figure 3

Appendix A

Figures from Previous Reports



NOTES:
1. LOCATIONS OF UNDERGROUND UTILITIES (DRAIN SYSTEM AND SANITARY SEWER LINES) ARE APPROXIMATE
2. ALL LOCATIONS STARTING WITH MW ARE MONITORING WELLS

ACRONYMS:

AOI	AREA OF INTEREST
AST	ABOVEGROUND STORAGE TANK
MES	MOBILE EQUIPMENT SHOP
MS/IRM	MACHINE SHOP/INTERIM REMEDIAL MEASURE

LEGEND:

HISTORICAL SAMPLE LOCATIONS
- SOIL/SEDIMENT
- SURFACE WATER/GROUNDWATER
- SOIL/SEDIMENT & SURFACE WATER/GROUNDWATER
- OTHER
- EXCAVATED OR PARTIALLY-EXCAVATED SAMPLE LOCATION

2008/2009 SAMPLE LOCATIONS
- SURFACE/SUBSURFACE SOIL
- SURFACE SOIL (LEAD ONLY)
- SURFACE SOIL
- SURFACE/SUBSURFACE SOIL & GRAB GROUNDWATER
- DISCRETE SOIL SAMPLE FOR COMPOSITE

- SITE BOUNDARY
- AOI BOUNDARY
- OTHER OPERABLE UNITS/AOIs
- STRUCTURE
- FORMER STRUCTURE
- HISTORICAL GEOPHYSICAL SURVEY AREA
- EXCAVATION BOUNDARY
- PLANT DRAIN SYSTEM LINE
- SANITARY SEWER LINE
- UNPAVED ROADWAY
- PAVED ROADWAY
- RAIL LINES
- FORMER RAIL LINES
- COMBINATION STORMWATER/ PROCESS WATER DITCH
- TRANSFORMER

FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA

OPERABLE UNITS C AND D REMEDIAL ACTION PLAN

SAMPLE LOCATIONS AND FEATURES: FORMER PARCEL 3 MES/PILOT STUDY AND FORMER ABOVE GROUND STORAGE TANK AOIs

ARCADIS

FIGURE
2-4

CITY: HR DIV/GROUP: AIT GIS DB:BCG
Project # B0066128.0001.00010
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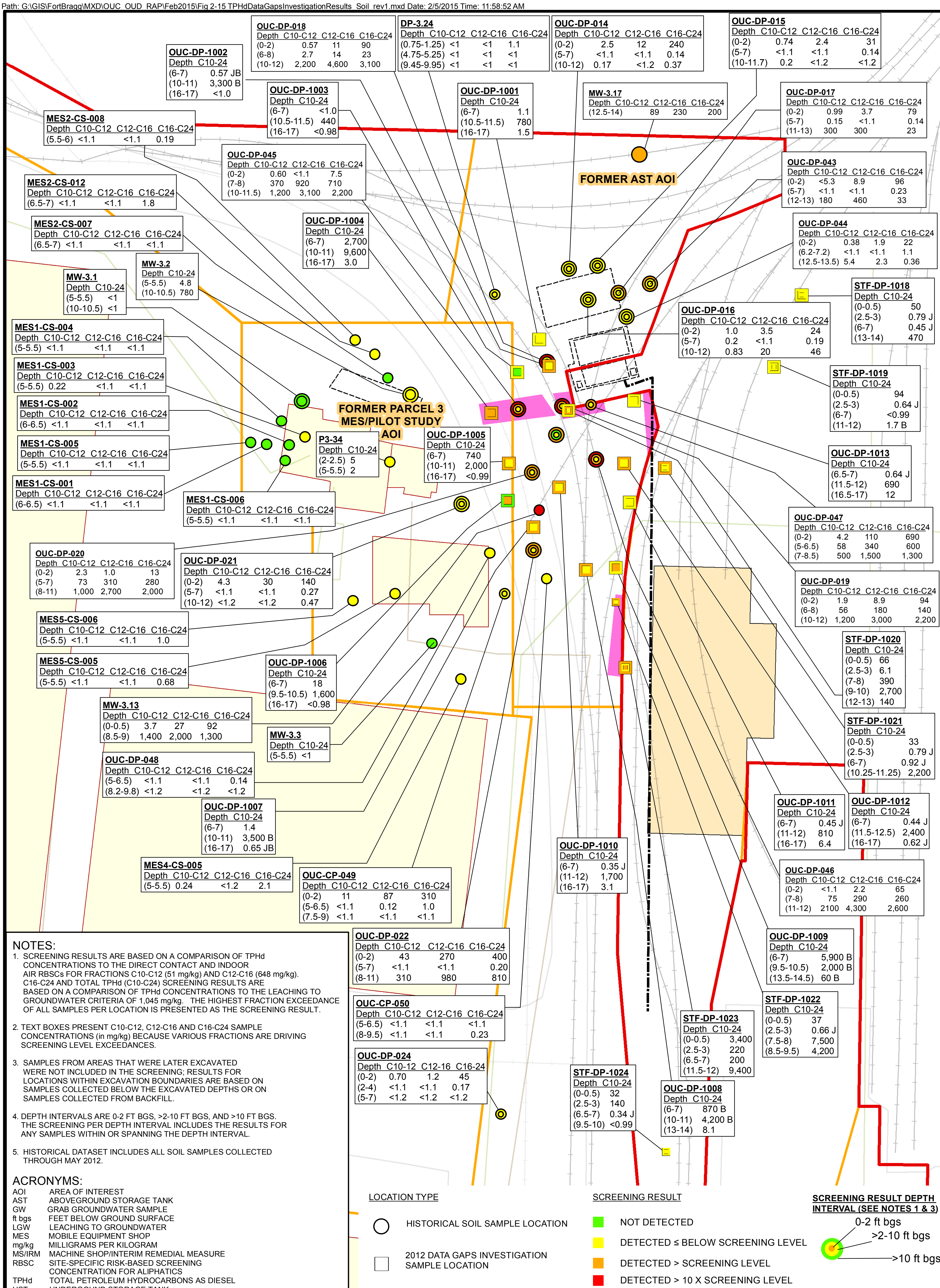


NOTES:

1. SCREENING RESULTS ARE BASED ON A COMPARISON OF TPHd CONCENTRATIONS TO THE DIRECT CONTACT AND INDOOR AIR RBSCs FOR FRACTIONS C10-C12 (51 mg/kg) AND C12-C16 (648 mg/kg). C16-C24 AND TOTAL TPHd (C10-C24) SCREENING RESULTS ARE BASED ON A COMPARISON OF TPHd CONCENTRATIONS TO THE LEACHING TO GROUNDWATER CRITERIA OF 1,045 mg/kg. THE HIGHEST FRACTION EXCEEDANCE OF ALL SAMPLES PER LOCATION IS PRESENTED AS THE SCREENING RESULT.
2. TEXT BOXES PRESENT C10-C12, C12-C16 AND C16-C24 SAMPLE CONCENTRATIONS (in mg/kg) BECAUSE VARIOUS FRACTIONS ARE DRIVING SCREENING LEVEL EXCEEDANCES.
3. SAMPLES FROM AREAS THAT WERE LATER EXCAVATED WERE NOT INCLUDED IN THE SCREENING; RESULTS FOR LOCATIONS WITHIN EXCAVATION BOUNDARIES ARE BASED ON SAMPLES COLLECTED BELOW THE EXCAVATED DEPTHS OR ON SAMPLES COLLECTED FROM BACKFILL.
4. DEPTH INTERVALS ARE 0-2 FT BGS, >2-10 FT BGS, AND >10 FT BGS. THE SCREENING PER DEPTH INTERVAL INCLUDES THE RESULTS FOR ANY SAMPLES WITHIN OR SPANNING THE DEPTH INTERVAL.
5. HISTORICAL DATASET INCLUDES ALL SOIL SAMPLES COLLECTED THROUGH MAY 2012.

ACRONYMS:

AOI	AREA OF INTEREST
AST	ABOVEGROUND STORAGE TANK
GW	GRAB GROUNDWATER SAMPLE
ft bgs	FEET BELOW GROUND SURFACE
LGW	LEACHING TO GROUNDWATER
MES	MOBILE EQUIPMENT SHOP
mg/kg	MILLIGRAMS PER KILOGRAM
MS/IRM	MACHINE SHOP/INTERIM REMEDIAL MEASURE
RBSC	SITE-SPECIFIC RISK-BASED SCREENING CONCENTRATION FOR ALIPHATICS
TPHd	TOTAL PETROLEUM HYDROCARBONS AS DIESEL
UST	UNDERGOUND STORAGE TANK

LEGEND:

SITE BOUNDARY
AOI BOUNDARY
STRUCTURE
FORMER STRUCTURE
(FORMER) INDUSTRIAL USE
PROPOSED SOIL EXCAVATION AREA
PAVED ROADWAY
UNPAVED ROADWAY
FORMER RAIL LINE
RAIL LINE
PLANT DRAIN SYSTEM LINE
SANITARY SEWER LINE

SAMPLE ID
OUC-DP-017
Depth C10-C12 C12-C16 C16-C24
(5-7) 0.15 <1 0.14
Depth in ft bgs
TPHd Concentration in (mg/kg)

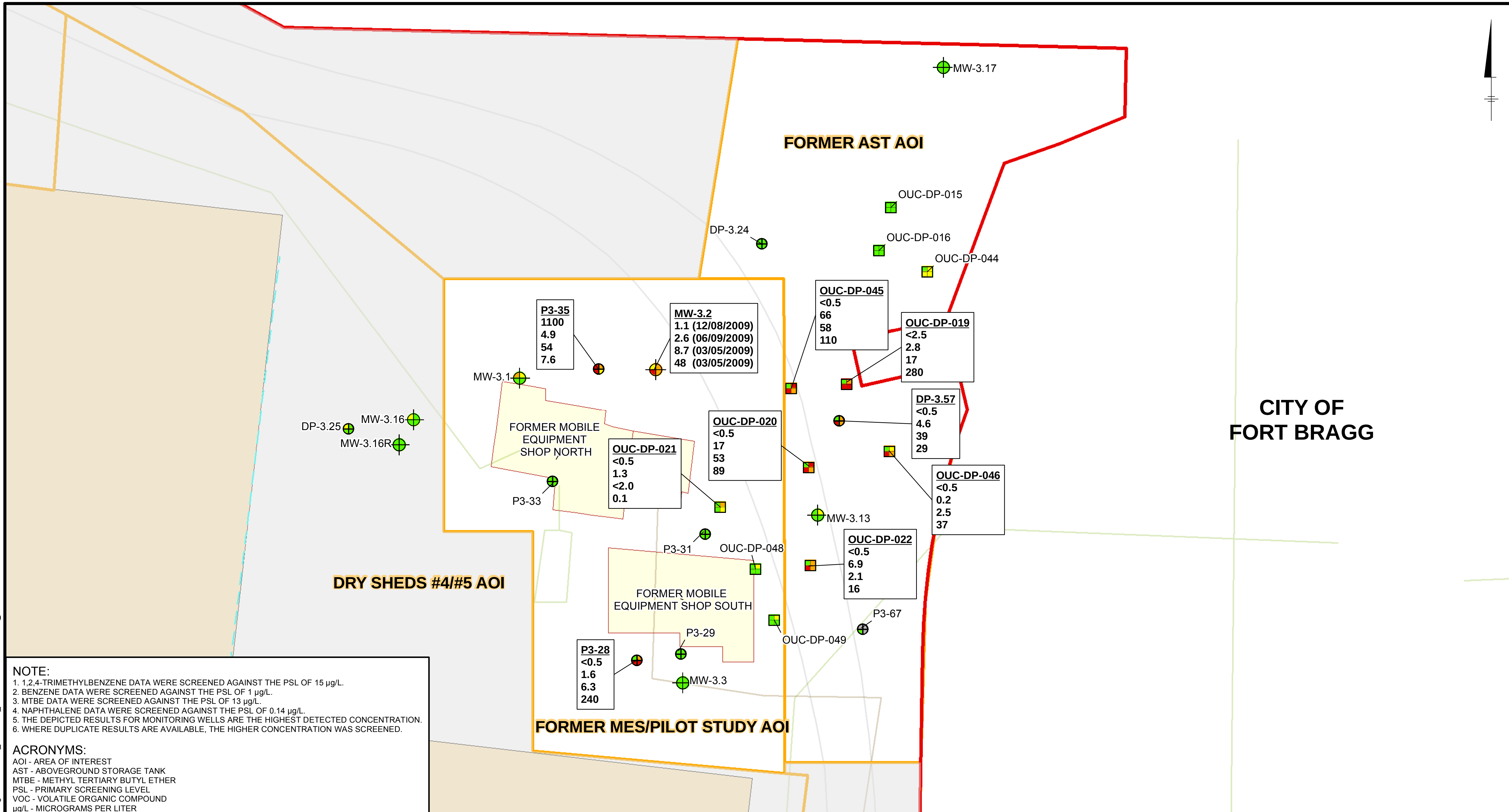
0 60 120 Feet
GRAPHIC SCALE

FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA
OPERABLE UNITS C AND D REMEDIAL ACTION PLAN

DATA GAPS INVESTIGATION RESULTS - TPHd IN SOIL

ARCADIS

FIGURE
2-15



NOTE:
1. 1,2,4-TRIMETHYLBENZENE DATA WERE SCREENED AGAINST THE PSL OF 15 µg/L.
2. BENZENE DATA WERE SCREENED AGAINST THE PSL OF 1 µg/L.
3. MTBE DATA WERE SCREENED AGAINST THE PSL OF 13 µg/L.
4. NAPHTHALENE DATA WERE SCREENED AGAINST THE PSL OF 0.14 µg/L.
5. THE DEPICTED RESULTS FOR MONITORING WELLS ARE THE HIGHEST DETECTED CONCENTRATION.
6. WHERE DUPLICATE RESULTS ARE AVAILABLE, THE HIGHER CONCENTRATION WAS SCREENED.

ACRONYMS:
AOI - AREA OF INTEREST
AST - ABOVEGROUND STORAGE TANK
MTBE - METHYL TERTIARY BUTYL ETHER
PSL - PRIMARY SCREENING LEVEL
VOC - VOLATILE ORGANIC COMPOUND
µg/L - MICROGRAMS PER LITER

LEGEND:
NOT DETECTED
DETECTED ≤ SCREENING LEVEL
DETECTED > SCREENING LEVEL
DETECTED > 10 X SCREENING LEVEL

HISTORICAL GRAB SAMPLE LOCATION
MONITORING WELL SAMPLE LOCATION
2008/2009 GRAB GROUNDWATER LOCATION

MTBE, BENZENE, NAPHTHALENE, 1,2,4-TRIMETHYLBENZENE

SITE BOUNDARY
AOI BOUNDARY
OTHER OPERABLE UNITS/AOIs
STRUCTURE
FORMER STRUCTURE
DRAINAGE

PLANT DRAIN SYSTEM LINE
SANITARY SEWER LINE
UNPAVED ROADWAY
PAVED ROADWAY

P3-28 LOCATION ID
<0.5 MTBE µg/L
1.6 BENZENE µg/L
6.3 NAPHTHALENE µg/L
240 1,2,4-TRIMETHYLBENZENE µg/L

0 50 100 Feet
GRAPHIC SCALE

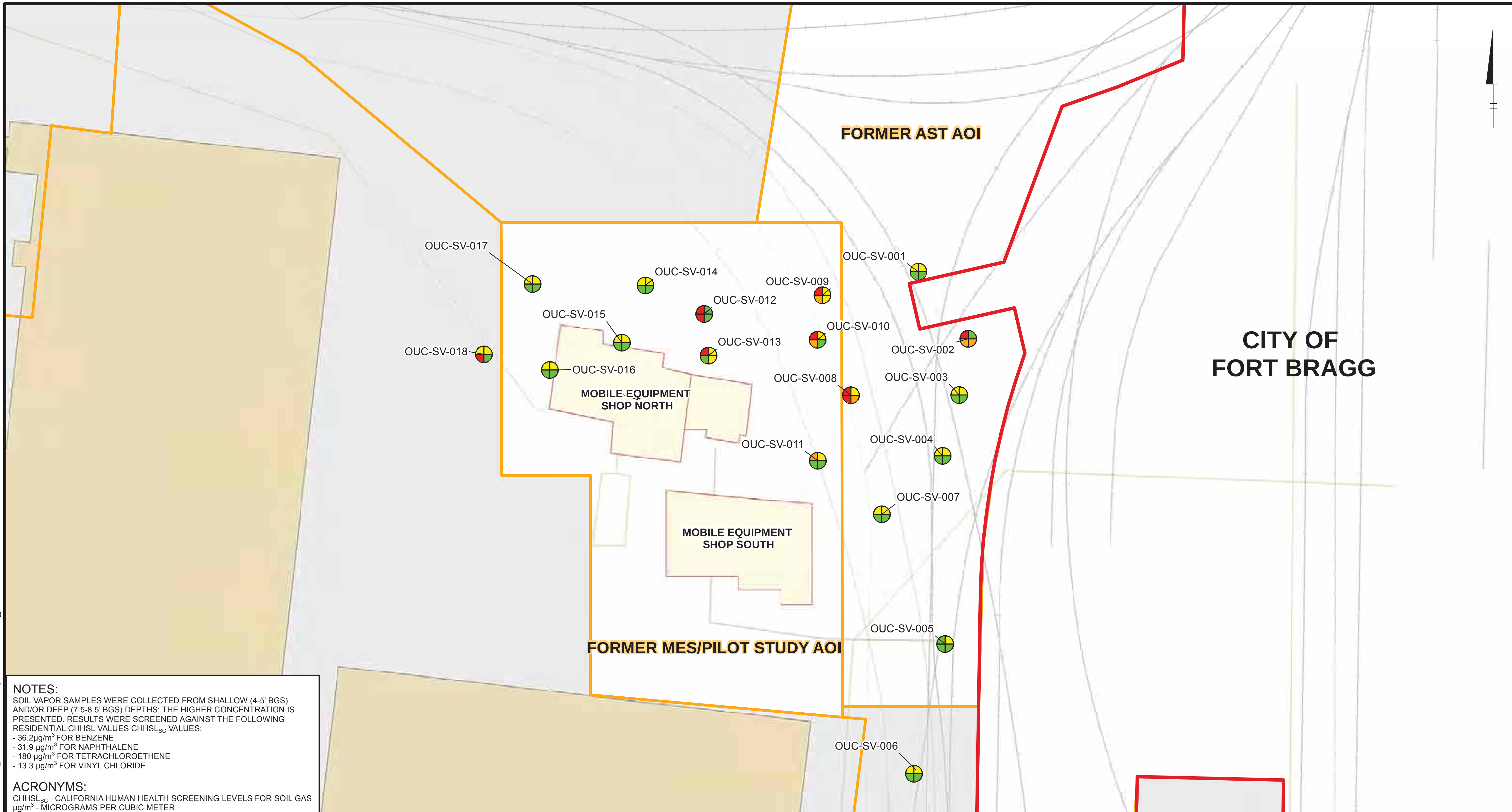
FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA
REMEDIAL INVESTIGATION OPERABLE UNITS C AND D

FUEL-RELATED VOCs IN GROUNDWATER
IN FORMER AST/PARCEL 3 MES AOIs

ARCADIS

FIGURE
6-28

CITY: HR DIV/GROUP: AIT GIS DB:BCG
Project # B0066128.0001.00010
I:\FortBragg\MXD\OUC_OUD_RI\Updates_011711\Fig 6-28 Parcel3_FuelVOC_Skittle.mxd - 1/20/2011 @ 2:06:03 PM



NOTES:
SOIL VAPOR SAMPLES WERE COLLECTED FROM SHALLOW (4-5' BGS) AND/OR DEEP (7.5-8.5' BGS) DEPTHS; THE HIGHER CONCENTRATION IS PRESENTED. RESULTS WERE SCREENED AGAINST THE FOLLOWING RESIDENTIAL CHHSL VALUES $CHHSL_{SG}$ VALUES:
- 36.2µg/m³ FOR BENZENE
- 31.9 µg/m³ FOR NAPHTHALENE
- 180 µg/m³ FOR TETRACHLOROETHENE
- 13.3 µg/m³ FOR VINYL CHLORIDE

ACRONYMS:
$CHHSL_{SG}$ - CALIFORNIA HUMAN HEALTH SCREENING LEVELS FOR SOIL GAS
µg/m³ - MICROGRAMS PER CUBIC METER

LEGEND:
- NOT DETECTED
- DETECTED BELOW SCREENING LEVEL
- DETECTED ABOVE SCREENING LEVEL
- DETECTED ABOVE 10X SCREENING LEVEL
- NOT ANALYZED

BENZENE | TETRACHLOROETHENE | NAPHTHALENE | VINYL CHLORIDE

- PLANT DRAIN SYSTEM LINE
- SANITARY SEWER LINE
- UNPAVED ROADWAY
- PAVED ROADWAY
- RAIL LINES
- FORMER RAIL LINES
- SITE BOUNDARY
- AOI BOUNDARY
- STRUCTURE
- FORMER STRUCTURE
- OTHER OPERABLE UNITS/AOIs

0 50 100 Feet
GRAPHIC SCALE

FORMER GEORGIA-PACIFIC WOOD PRODUCTS FACILITY
FORT BRAGG, CALIFORNIA
FEASIBILITY STUDY OPERABLE UNITS C AND D

SOIL VAPOR CONCENTRATIONS IN FORMER AST AND FORMER MES/PILOT STUDY AOIs

ARCADIS

FIGURE
2-13

CITY: HR DIV/GROUP: AIT GIS DB:BCG
Project # B0066138.0005.00002
I:\FortBragg\MXD\OUC_OUD_FS101911\Fig 2-13 FormerAST_FormerMESPilotStudy.mxd - 1/13/2012 @ 5:04:48 PM

Appendix B

Standard Operating Guidelines

Appendix B: B001 Standard Operating Guideline Surface and Shallow Soil Sampling

B.1 Introduction

This guideline describes the equipment and procedures that are used by Kennedy Jenks personnel for collecting surface and shallow soil samples.

B.2 Equipment

- Stainless steel or plastic scoops
- Hand auger
- Split-spoon drive sampler (2.5-inch or 2.0-inch I.D.) and associated drill rods, wrench and other tools needed to break down equipment
- Slide hammer
- 2.5-inch or 2.0-inch metal liners, or acetate liners, and sealing materials (plastic end caps, Teflon seals, silicon tape, zip-lock plastic bags)
- Photoionization detector and calibration gas
- Shovel
- Post hole digger
- Pick
- Breaker bar
- Measuring tape or measuring wheel
- Stakes or spray paint for sampling grid
- Sampler cleaning equipment
    1. Stiff-bristle brushes
    2. Buckets
    3. High priority phosphate-free liquid soap, such as Liquinox
    4. Trisodium phosphate (TSD) for use if samples are oily
    5. Distilled water
    6. Potable water
- Insulated sample storage and shipping containers
- Personal protective equipment (as specified in site safety plan)

B.3 Typical Procedure

1. Obtain applicable drilling and well construction permits, prior to mobilization, if necessary.

2. Clear locations for underground utilities and structures by Underground Service Alert (USA) and subcontractors, if necessary.

3. Measure and mark sampling locations prior to initiation of the sampling program, as specified in the sampling and analysis plan. If sampling locations are based on a grid pattern, stakes can be used to define the grid layout.

4. Collect soil samples for chemical analysis by using precleaned scoops or a hand auger, or by driving a split-spoon drive sampler or hand auger.

5. If overlying soil is to be removed (as specified in the sampling and analysis plan), use shovels, picks, or post-hole diggers, as needed.

6. Collect soil samples for lithologic logging purposes.

7. If applicable, as described in the site safety plan, use an PID to analyze *in situ* air samples from the breathing zone and other locations as necessary.

8. Have the soils classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D 2488-90) and the Munsell Color Classification (refer to SOG 21).

9. Prior to each sampling event, wash sampling equipment (scoops, hand auger, split-spoon drive sampler, and brass liners) with high purity phosphate-free soap. Double-rinse it with deionized water.

10. At each sampling interval, collect soil and place it in the appropriate sampling container. Fill the sample container and compact the soil to minimize air space. Minimize handling of the soil, especially if it is being collected for analysis of volatile compounds.

11. If a split-spoon drive sampler is being used, select one brass liner for potential laboratory analysis. Cover the ends of this sample in Teflon sheets, seal it with plastic caps, and wrap it with silicon or Teflon tape. Place a completed sample label on the brass liner.

12. Place the selected samples in appropriate containers and store them at approximately 4 °C.

13. As a field screening procedure (if applicable), for each sampling interval, place soil not selected for chemical analysis in an airtight container (e.g., plastic bag or jar) and allow it to equilibrate. After this, monitor the headspace in the container using either an HNU, OVM or OVA. Record the headspace concentration in the field notes (refer to SOGs 4 and 5).

14. Complete chain-of-custody forms in the field and transport the selected samples in insulated containers, at an internal temperature of approximately 4°C, to the analytical laboratory (refer to SOGs 3).

B.4 Equipment Cleaning

Prior to collection of each soil sample, the sampling equipment should be either steam cleaned or hand washed. If the sampling equipment is hand washed, wash excavation equipment with a brush, in a solution of high purity phosphate-free soap and potable water. Rinse the equipment with potable water. Follow this with double-rinsing using distilled water.

B.5 Investigation-Derived Residuals

If sufficient volumes of soil cuttings and other residuals are generated, contain the material in appropriately labeled containers for disposition by the client. All soil samples transported to the laboratory must be returned to the client for disposition if required by the laboratory. Kennedy Jenks is available to assist the client with options for disposition of residuals.

Appendix B: B002 Standard Operating Guideline Typical Hydraulic Push/Drive Sampling Procedures

B.1 Introduction

This guideline describes the equipment and procedures typically used by Kennedy Jenks personnel for collecting soil and reconnaissance groundwater samples with a hydraulic push/drive system.

B.2 Equipment

- Portable, hydraulic push/drive sampling system
- 6-inch long, 1.75-inch O.D. stainless steel or brass liners and liner sealing materials (Teflon sheets, plastic end caps, Ziploc plastic bags)
- Type II Portland cement
- ¾ or 1-inch O.D. Schedule 40 PVC screen (0.010-inch slot size)
- ¾ or 1-inch O.D. Schedule 40 PVC blank casing
- 0.75-inch diameter stainless steel or Teflon bailer
- PID organic vapor analyzer
- Water level indicator
- Temperature, specific conductivity and pH meters
- Equipment cleaning materials
    1. Steam cleaner
    2. Generator
    3. Stiff-bristle brushes
    4. Buckets
    5. High-purity phosphate-free liquid soap
    6. Deionized water
    7. Rinsate collection system
- Personal protective equipment
- Appropriate groundwater sample containers
- Chain-of-custody forms
- Insulated sample storage container and ice substitute

B.3 Typical Procedures

1. Applicable drilling permits will be obtained prior to mobilization.

2. Sample locations will be cleared for underground utilities.

3. All downhole equipment will be steam cleaned prior to use at each location.

4. Soil borings will be advanced using a portable, hydraulic push/drive sampling system that simultaneously drives two nested, steel sampling rods into the ground to collect continuous soil cores.

5. As the sampling rods are advanced, the soil core will be collected in an inner acetate liner, which is inserted and fixed in the lead steel drive rod. After being advanced the length of one steel drive rod, the inner liner will be removed from the steel drive rod. A new liner will then be

lowered back into the borehole to the previous depth and the rods are driven another rod length. This process will be repeated until the desired depth is reached.

6. The soil samples will be retained for lithologic logging and chemical analyses, if appropriate.

7. The soils will be classified in the field in approximate accordance with the visual-manual procedure of the Unified Soil Classification System (ASTM D-2488-93), and the Munsell Color Classification.

8. If required, soil samples will be collected at selected intervals for laboratory analysis. At these intervals, the ends of one or more of the soil sample liners will be covered with Teflon end sheets and plastic end caps, and labeled. Labels will document the sample designation, type, date and time of collection, collector(s), location, and any additional information.

9. If groundwater samples will not be collected, the soil borings will be grouted to the ground surface with a neat cement grout (Type II Portland cement) using the tremie method.

10. Upon encountering the uppermost groundwater surface during sampling, the sample barrel and inner rods will be removed, and the well screen and casing will be installed within the outer drive casing to facilitate collection of a groundwater sample. The drive casing will be pulled up approximately 3 feet to expose the slotted PVC casing. Groundwater samples will then be collected from within the PVC casing with a 0.75-inch diameter Teflon or stainless steel bailer.

11. The depth to groundwater will be measured prior to groundwater sampling.

12. The sample will be drained directly from the bailer into sample containers. The containers will be labeled to document the sample designation, type, date and time of collection, collector(s), location, and any additional information.

13. After collecting the reconnaissance groundwater sample, decant groundwater into a clean container and record the Depth to water, color, and other observations (odors, free-phase product, etc)

14. After sample collection, the boring will be grouted to ground surface with a neat cement grout (Type II Portland cement) using the tremie method.

B.4 Equipment Cleaning

1. Downhole equipment (rods, sampler) will be steam cleaned or washed prior to each borehole.

2. Sampling equipment (sampler) will be steam cleaned or washed with a brush in a solution of high-purity phosphate-free soap and potable water, then rinsed with potable water followed by double rinsing with deionized water prior to each sampling run.

3. Downhole equipment and vehicles which warrant it, will be steam cleaned prior to leaving site at completion of sampling.

B.5 Investigation-Derived Residuals

Soil cuttings will be placed in labeled 5-gallon DOT-approved pails with bolt-on covers. Decontamination water and groundwater residuals will be contained in labeled 55-gallon DOT-approved drums with bolt-on covers. All residuals generated during sampling activities will be stored at the site.

Appendix B: B003 Standard Operating Guideline Borehole Logging

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy Jenks personnel for classifying soils and preparing boring logs and other types of soil reports. The purpose of this SOG is to facilitate the acquisition of uniform descriptions of soils encountered during borehole programs and to promote consistency in the logging practices used by Kennedy Jenks personnel. This SOG provides guidance on procedures that are generally consistent with standard practices used to classify soils. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of subsurface exploration activities.

Borehole logging is the systematic observation and recording of geologic and hydrogeologic information from subsurface borings and excavations. The Unified Soil Classification System (USCS) (ASTM D2487-00) is used to identify, classify, and describe soils principally for engineering purposes, and is based on laboratory tests.

For field applications, ASTM D2488-06 (Visual-Manual Procedure) is used as the general guide adopted under this SOG.

Both ASTM D2487 and ASTM D2488 utilize the same group names and symbols. However, soil reports should state that boring logs are not formal USCS laboratory determinations but are based on the visual-manual procedures described in ASTM D2488.

This SOG contains the following sections:

- Field Equipment/Materials
- Typical Procedures
  - Soil Classification
  - Classification of Coarse-Grained Soil
  - Classification of Fine-Grained Soil including Organic Soils
- Other Logging Parameters
- References.

Field Equipment/Materials

Material/equipment typically required for classifying soils and preparing boring logs may include:

- Pens, pencils, waterproof pens, and field logbook or other appropriate field forms (e.g., boring log forms), water-tight field case.

- Daily inspection report forms

- USCS (ASTM D 2488-06) table and classification chart
- Soil color chart (i.e., Munsell) If used, the edition of the Munsell chart should be specified on each borehole log as the color descriptions and hue, color values and chromas have changed between editions. Also, whenever possible, the newest version of Munsell's color charts should be used due to fading of color chips over time.
- American Geological Institute (AGI) Data Sheets
- Graph paper
- Engineer's scale
- Previous project reports and boring logs (if available)
- Pocket knife or putty knife
- Hand lens
- Supply of clean water
- Dilute hydrochloric acid (HCl) (make sure and MSDS for HCl is included in the project HASP)
- Aluminum foil, Teflon® sheets, and paper towels
- Sample containers (brass, stainless steel or aluminum liners, plastic or glass jars)
- Clean rags or paper towels
- Sample shipping and packaging supplies
- Personnel and equipment decontamination supplies
- Personal protective equipment as described in the Health and Safety Plan (HASP).

Typical Procedures

Soil classification and borehole logging should be conducted by a qualified geologist, engineer; or other personnel trained and experienced in the classification of soils.

Soils are typically logged in conjunction with advancing boreholes and sampling subsurface soils. Although the guideline focuses on classifying soil samples obtained from boreholes, this particular procedure also applies to soils and sediments collected using other techniques (e.g., post hole digger, scoop, Ekman, Ponar, or Van Veen grab samplers, and backhoe).

The USCS as described in ASTM D2488-06 categorizes soils into 15 basic group names, each with distinct geologic and engineering properties. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain-size grading and distribution and influence of moisture on fine-grained soil.

2. Assign the soil a USCS classification and denote it by the standard group name and symbol.

3. Provide a written description to differentiate between soils in the same group, if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on either grain-size grading and distribution, or plasticity characteristics. In this case, assigning dual group names and symbols might be appropriate (e.g., GW-GC or ML-CL).

The two basic soil groups are:

1. **Coarse-Grained Soils –** For soils in this group, more than half of the material is larger than No. 200 sieve (0.074 mm).

2. **Fine-Grained Soils (including Organic Soils) –** For soils in this group, one half or more of the material is smaller than No. 200 sieve (0.074 mm).

Note: No. 200 sieve is the smallest size that can be seen with the naked eye.

Classification of Coarse-Grained Soils

Coarse-grained soils are classified on the basis of:

1. Grain size and distribution

2. Quantity of fine-grained material (i.e., silt and clay)

3. Character of fine-grained material

Classification uses the following symbols:

Basic Symbols	**Modifying Symbols**
G - gravel	W - well graded
S - sand	P - poorly graded
	M - with silt fines
	C - with clay fines

The following are basic facts about coarse-grained soil classification:

- The basic symbol G is used if the estimated volume percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated volume percentage of sand is greater than the percentage of gravel.

- Gravels include material in the size range from 3 inches to 0.2 inch (i.e., retained on No. 4 sieve). Sand includes material in the size range from 0.2 inches to 0.003 inches. Use the grain size scale used by engineers (ASTM Standards D422-63 and D643-78) to further classify grain size as specified by the USCS.

- Although not specifically treated in ASTM D2488-06, cobbles range in size from 3 inches to 10 inches and boulders refer to particles with a single dimension greater than 10 inches. They are included here for the purpose of completeness and for their hydrogeologic significance.

  Note: The ASTM grain size scale differs from the Modified Wentworth Scale used in teaching most geologists. Also, it introduces a distinction between sorting and grading (i.e., well graded equals poorly sorted and poorly graded equals well sorted.)

- The modifying symbol W indicates good representation of a range of particle sizes in a soil.

- The modifying symbol P indicates that there is a predominant excess or absence of particle sizes.

- The symbol W or P is only used when a sample contains less than 15 percent fines.

- Modifying symbol M is used if fines have little or no plasticity.

- Modifying symbol C is used if fines have low to high plasticity (clayey)

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Sands and gravels (clean)	Less than 5 percent fines
Sands (or gravels) with fines	5 to 15 percent fines
Silty (or clayey) sands or gravels	Greater than 15 percent fines

- Other descriptive information may include:

  - Color (e.g., Munsell Soil Color chart, specify edition). Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, "dk brn (7.5 YR, 3/4)."
  - Relative Density/Penetration Resistance. For cohesionless materials use very loose, loose, medium, dense, or very dense estimated from drive sample hammer blows or other field tests. Blow counts may be used, if reliable.
  - Maximum grain size (fine, medium, coarse, as described in AGI data sheets or USCS). Note the largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.
  - Composition of grains (mineralogy)
  - Approximate percentage of gravel, sand, and fines (use a percentage estimation chart as provided in the AGI data sheets)

Modifiers	Description
– Trace	Less than 5 percent
Few	5 to 10 percent
Little	15 to 25 percent
Some	30 to 45 percent
Mostly	50 to 100 percent

- Angularity (round, subround, angular, subangular)
- Shape (flat or elongated)
- Moisture Condition (dry, moist, wet)
  - Dry - Absence of moisture to the touch.
  - Damp - Contains enough water to keep the sample from being brittle, dusty or cohesionless; is darker in color than the same material in the dry state.
  - Moist - Leaves moisture on your hand, but displays no visible free water.
  - Wet - Displays visible free water.
- HCl Reaction (none, weak, strong)
- Cementation (Crumbles under finger pressure: weak, moderate, or strong)
- Range of Particle Sizes (sand, gravel, cobble, boulder)
- Maximum Particle Size (fine, medium, coarse)
- Cementation (weak, moderate, or strong)
- Hardness (breaks with hammer blow)
- Structure (stratified, laminated, fissured, slickensided, blocky, lensed, homogeneous)
- Organic material
- Odor
- Iridescent sheen (based on sheen test)
- Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
  - Additional Comments (e.g., roots or rootholes, difficult drilling, borehole caving, presence of mica, contact and/or bedding dip, bedding features, sorting, structures, fossils, cementation, geologic origin, formation name, minerals, oxidation, etc.

Classification of Fine-Grained Soils

Fine-grained soils are classified on the basis of:

1. Liquid limit
2. Plasticity

Classification uses the following symbols:

Basic Symbols	**Modifying Symbols**
M - silt	L - low liquid limit
C - clay	H - high liquid limit
O - organic	
Pt - peat	

The following rules apply for the written description of the soil group name:

Types of Soil	**Rule**
Silts and clays with sand and/or gravel	5 to 15 percent sand and/or gravel
Sandy or gravelly silts or clays	Greater than 15 percent sand and/or gravel

The following are basic facts about fine-grained soil classification:

- The basic symbol M is used if the soil is mostly silt, while symbol C applies if it consists mostly of clay. Use of symbol O indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.
- Modifying symbols are based on the following hand tests conducted on a soil sample:
  - Dry strength (crushing resistance : none, low, medium, high, very high)
  - Dilatancy (molded ball reaction to shaking: none, slow, rapid)
  - Toughness (resistance to rolling or kneading near plastic limit : low, medium, high)
  - Plasticity (nonplastic, low, medium, high).
- Soil designated ML has little or no plasticity and can be recognized by none to low dry strength, slow to rapid dilatency, and low toughness.
- CL (lean clay) indicates soil with medium plasticity, which can be recognized by medium to high dry strength, no or slow dilatency, and medium toughness.
- OL is used to describe an organic, fine-grained soil that is less plastic than CL soil and can be recognized by low to medium dry strength, medium to slow dilatency, and low toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.
- MH soil has low to medium plasticity and can be recognized by low to medium dry strength, no to slow dilatancy, and low to medium toughness.
- Soil designated CH (fat clay) has high plasticity and is recognizable by its high to very high dry strength, no dilatency, and high toughness.
- OH is used to describe an organic fine-grained soil that is less plastic than CH soil and can be recognized by medium to high dry strength, slow dilatency, and low to medium toughness. In some cases, it may be possible to differentiate organic silts (OL) from organic clays (OH), based on correlations between dilatancy, dry strength, toughness, or laboratory tests.

Note: PT (peat) is used to describe a highly organic soil composed primarily of vegetable tissue with a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor.

- Other descriptive information includes:
  - Color (e.g., Munsell) Soil color is named and coded using the Munsell Soil Color chart if required for the project. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “reddish brn (5YR, 4/4).”
    - Moisture condition,
  - Omit moisture terms below the regional water table and when drilling with mud or air-mist rotary systems.
  - Consistency (thumb penetration test: very soft, soft, firm, hard, very hard . For fine sediments use very soft, soft, medium, stiff, very stiff, and hard.) These are estimated from drive sample hammer blows or other field tests. Blow counts may also be used, if reliable.
    - Structure (same descriptors as coarse grain)
    - Compactness (loose, dense) for silts
    - Odor
    - Iridescent sheen (based on sheen test)
    - Debris (e.g., paper, wood, plastic, cloth, concrete, construction materials, etc.).
    - HCl Reaction (none, weak, strong).
  - Additional Comments (e.g. roots or rootholes, difficult drilling, borehole caving, presence of mica, , contact and/or bedding dip, bedding features, cementation, structures, fractures, fracture fillings, fossils, formation name, minerals, oxidation).

Fine-Grained Rock Description

- Textural Classification
- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding is also recorded. For example, “gry grn (5G, 5/2).”
- Hardness. Very hard, hard, medium, soft, very soft..
- Moisture Content. Dry, damp, moist, wet (saturated).
- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).
- Estimated Permeability. Very low, low, moderate, or high. This is based primarily on grain size, sorting, and cementation. Estimate secondary permeability due to natural rock fractures when applicable.
- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]) should be stated. For example, "NF @90.8', 25 deg to axis, 0.1" wide, minor calcite."

- Coarse-Grained Rock Description

- Textural Classification.

- Color. Rock color is named and coded using the Geological Society of America rock color chart. The code should be in parentheses immediately following the written description. Presence of mottling and banding also is recorded. For example, "gry olive grn (5GY, 3/2)."Hardness. Very hard, hard, medium, soft, very soft.

- Moisture Content. Dry, damp, moist, and wet (saturated).

- Size Distribution. Approximate percentage of gravel, sand, and fines (silt and clay).

- Grain Shape. Angular, subangular, subrounded, rounded, or well-rounded, for grains larger than sand size.

- Grain Size. The largest cross-sectional dimension measured in tenths of an inch for grains larger than sand size.

- Miscellaneous. Odor, contact and/or bedding dip, cementation, bedding, inclusions, secondary mineralization, fossils, structures, formation name, and fractures.

- Fractures are identified by depth, angle, width, and associated mineralization, if applicable. The interpretation of the fracture type (i.e., as natural [N], coring induced [CI], or handling induced [HI]), should be stated. For example, "NF @126.1', 35 deg to axis, 0.1" wide, minor calcite."

Other Logging Parameters

Rock Quality Designation

This designation generally follows ASTM D6032-08 Standard Test Method for Determining Rock (RQD) of Rock Core.

The RQD denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. This method is generally applied to core barrel samples.

Standard Penetration Tests

This method generally follows ASTM D1586-08A Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. This method provides a means of assigning a relative density to the soil by counting the number of hammer blows (blow counts) required to advance a split-barrel sampler a specified distance into the undisturbed soil ahead of the lead auger. This method is not applicable to boreholes advanced with direct-push sampling equipment. It is used primarily in conjunction with hollow stem auger drilling apparatus as the test can be performed through the auger string without removal of the augers thereby allowing the borehole to remain open to the bottom of the drill string without risk of caving. As the sampler is advanced by the repeated drop of a hammer of known weight, the blow counts are recorded on the log and used to provide a relative density descriptor to the soil penetrated during the test.

The number of blows required to drive the sampler 6 inches by a 140-lb hammer falling 30 inches. Fifty blow counts per 6-inch drive is considered “refusal,” and sampling at this depth is usually terminated. In addition, a total of 100 blow counts per 18-in. drive, or no observed advance of the sampler during ten successive hammer blows, is also considered “refusal.” During coring, leave this section blank. Normally, the second and third 6-inch intervals are recorded and added as the number of blows per feet.

Sampler Type/Depth. Give sampler type by the letter code listed below and identify the depth at the top of the sampling interval in feet below ground surface (bgs).

Sampler type	Inside diameter(in.)	Code
Standard penetrometer	1.38	SP
Split-barrel (small)	2.0	SBS
Split-barrel (large)	2.5	SBL
HQ wireline core	2.3	PC

Those descriptors are as follows for coarse grained soils:

Very Loose	0 to 3 SPT Sampler	0 to 4 Mod CA Sampler
Loose	4 to 7 SPT Sampler	5 to 10 Mod CA Sampler
Medium Dense	8 to 23 SPT Sampler	11 to 30 Mod CA Sampler
Dense	24 to 38 SPT Sampler	31 to 50 Mod CA Sampler
Very Dense	> 38 SPT Sampler	>50 Mod CA Sampler

Relative Density Descriptors for fine grained soils are as follows:

Very Soft	<1 SPT Sampler	0 to 1 Mod CA Sampler
Soft	1 to 3 SPT Sampler	2 to 4 Mod CA Sampler
Firm	4 to 6 SPT Sampler	4 to 8 Mod CA Sampler
Stiff	7 to 12 SPT Sampler	8 to 15 Mod CA Sampler
Very Stiff	13 to 23 SPT Sampler	15 to 30 Mod CA Sampler
Hard	> 23 SPT Sampler	>30 Mod CA Sampler

Regardless of the degree of adherence to the ASTM Standard Method, split barrel samplers are used as the preferred method of undisturbed sample acquisition in a hollow stem auger drilling. Upon retrieval of the sampler from the borehole, the sampler should be opened without making contact with its interior contents and the logging personnel should record the percent recovery or length of the sample recovered. Sample containers should be removed with a clean gloved (gloves may not be needed, depending upon requirements of HASP) hand and placed in a clean, dry area for examination and logging. The sample will be described per the above. Any lithologic changes that may be observable in the exposed ends of the intact core over the sampled interval should be recorded on the log before any disturbance thereof. The depth of the lithologic changes should be estimated and recorded on the boring log. The least disturbed sample container of the two deeper six-inch sample increments should be secured with Teflon® or aluminum end sheets and snug fitting plastic end caps, sealed with silicon tape, depending upon testing, sampler may be filled with one inch rings instead of 6 inch. Sealing material should also be compatible with subsequent testing requirements.

Ambient Temperature Head-Space:

Organic vapor analyzers such as photoionization detectors (PIDs) or flame ionization detectors (FIDs) are generally used to assess the relative concentration of volatile hydrocarbons in the soil as the borehole is advanced and recorded as a value in parts per million on the boring log. This can be done by placing a uniform amount of soil in a Ziploc® bag, glass jar or other clean container, allowing the soil in the container to equilibrate to the ambient temperature, then inserting the probe of the PID or FID into the sealed container and recording the maximum PID or FID reading.

Non-Aqueous Phase Liquid (NAPL) Containing Soil

Appropriate observations of NAPL containing soil should include the following:

Appearance: If a separate phase liquid appears to be present, it might be described as “dark brown viscous fluid or liquid observed in the soil matrix.” This remark should follow the lithologic description in the borehole log. Observations of color should be made such as “black streaks” or “mottled gray to “olive brown”, however, it should not be inferred or remarked that the color is a necessary consequence of petroleum staining.

Odor: If the soil smells like petroleum it might be remarked that it has a “petroleum like” or “solvent like” odor. The use of terms like “strong” or “slight” should be avoided because there is no way to ensure that these terms can be applied uniformly in the field between various persons performing the logging (i.e., each person’s olfactory sense is different). The use of terms like “chemical odor” should also be avoided as there is no common reference point. Notations regarding the type of petroleum distillate present (e.g., “diesel-like odor” or “gasoline odor”) are inappropriate as these are determination s that can only be accurately made by laboratory analysis.

References

Grain Size Scale Used by Engineers. ASTM D422-63 and ASTM D643-78.

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Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. ASTM D1586-08A

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). ASTM D2488-06.

Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System. ASTM D2487-00

Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core. ASTM D6032-08.

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Appendix B: B004 Standard Operating Guideline Sample Packaging and Shipping

B.1 Introduction

This guideline presents methods for shipping non-hazardous materials, including most environmental samples via United Parcel Service (UPS), Federal Express. Many local laboratories offer courier service as well.

B.2 Equipment

- Coolers or ice chests
- Sorbent material
- Bubble-wrap
- Strapping tape
- Labels and pens
- Chain-of-Custody forms
- Chain-of-Custody seals
- UPS, Federal Express Shipping Labels

Samples shipped to each analytical laboratory can be sent by UPS or Federal Express on a next-day basis unless other arrangements are made. Greyhound bus service should only be used if there is direct service (e.g., Sacramento or Bakersfield to San Francisco). Ice chests, used to refrigerate perishable items, can be used to convey non-hazardous samples to the analytical laboratory.

Absorbent pads should be placed in the bottom of the shipping container to absorb liquids in the event of sample container breakage. Transportation regulations require absorbent capacity of the material to equal the amount of liquid being shipped; each pad absorbs approximately 1 quart of liquid. Liquid samples in glass jars or bottles should also be wrapped in plastic bubble wrap. A small amount of air space is desirable in filled plastic containers. This often prevents the cap of the container from coming off should the container undergo compression. Volatile organics analysis (VOA) vials should be packed in sponge holders. Additionally, exposure of filled VOA vials to other types of sample containers, by placement in the same shipping container, is not recommended. Various non-VOA sample containers are solvent-rinsed which may contaminate the VOA vials before or after sample collection. Therefore, a separate shipping container for VOA vials is recommended. An equal weight of ice substitute should be used to keep the samples below 4 degrees Centigrade for the duration of the shipment (up to 48 hours). Care in choosing a method of sample chilling should be observed so that the collected samples are not physically or chemically damaged. Re-usable blue ice blocks, block ice, ice cubes, or dry-ice are suitable for keeping samples chilled. Labels of samples may get wet. Use of waterproof pens and labels is desirable for identification of sample containers. Use of clear tape to cover each affixed sample label is helpful in ensuring sample identification. Strong adhesive tape should be used to band the coolers closed. Additionally, it is recommended that the drain plug be covered with adhesive tape to prevent any liquid from escaping.

Specific requirements for packaging materials may apply if the samples being shipped are known to be hazardous materials as defined in 49 CFR 171.8 (samples are not considered hazardous waste and therefore manifest requirements do not apply). UPS holds shippers responsible for damage occurring in the event of accidents when a hazardous material is shipped as a non-hazardous material. Samples which obviously are hazardous materials should therefore be shipped as such, and samples which most likely are not hazardous materials should be shipped in coolers. Guidelines for shipping hazardous materials by UPS are provided in the *Guide for Shipping Hazardous Materials* available from UPS. Specific labels for shipping of hazardous materials are available.

Chain-of-custody documentation should accompany shipments of samples to the analytical laboratory. Often, the chain-of-custody document contains an analytical request section which may be completed following sample collection. Chronological listing of collected samples is desirable. A copy of the completed chain-of-custody form should be retained in the event that the original form is lost or destroyed.

It should be noted that samples retained by the analytical laboratory which are not chosen for analysis may be assessed a fee for disposal. Often a disposal fee is assigned to a sample, typically soil, that has been retained beyond standard analytical holding periods. Therefore, consultation with project management is recommended to determine which samples may be of interest. Contacting the selected analytical laboratory regarding disposal policies is also recommended. Arrangements may be made with the analytical laboratory for return of the unanalyzed samples for later disposal to the area of origin.