SECTION E

GROUNDWATER MONITORING

This section provides detailed information on background and site specific geologic and hydrogeologic data, contaminant plume characteristics, and groundwater corrective action. Figures, tables, and other supporting data are provided in the labeled appendices for added clarity.

E-1 Exemption from Groundwater Protection Requirements (40 CFR 270.14(c))

This section is not applicable to this site.

E-2 Interim Status Groundwater Monitoring Data (40 CFR 270.14(c)(1))

This facility is no longer conducting an interim monitoring program. A description of the current monitoring program is provided in Section E-6.

E-3 General Hydrogeologic Information (40 CFR 270.14(c)(2))

This section includes basic hydrogeologic/geologic information included in the following subsections: E-3a) regional geology, E-3b) site-specific geology, E-3c) regional hydrogeology, and E-3d) site-specific hydrogeology. References are provided in Section E-10.

E-3a Regional Geology

East Point and Fulton County are located in the Piedmont Physiographic Province which regionally extends from Alabama to Maine. The Piedmont Province is topographically characterized by rolling hills and dendritic stream drainage. A review of the Physiographic Map of Georgia indicates East Point is located in the southwest portion of the Winder Slope District near the boundary with the Greenville Slope District (Clark and Zisa, 1976). The Winder Slope District is characterized by gently rolling topography which slopes gradually from an elevation of approximately 1,000 feet above sea level in the north to 700 feet at the southern edge. The district is dissected by headwater tributaries of the major streams draining to the Atlantic Ocean. The western boundary follows the drainage divide that separates streams draining to the Atlantic Ocean from those draining to the Gulf of Mexico. A copy of the physiographic map illustrating the site location is provided as **Figure E-1**.

The Piedmont consists of a complex series of greenschist to amphibolite grade metamorphic rocks, meta-igneous, meta-sedimentary rocks, and igneous intrusives of Pre-Cambrian to Paleozoic age. Structural features in the area are generally oriented along a southwest-northeast strike imparted from regional tectonic events (McConnell & Abrams, 1984).

The Georgia Piedmont generally includes geologic rock units north of the Fall Line boundary with the Coastal Plain Province, south of the Blue Ridge Province, and south-southeast of the Valley and Ridge Province. The Brevard Zone, a northeast/southwest trending structural shear zone, has commonly been used to divide the Georgia Piedmont into Northern and Southern segments. However, due to the presence of the same or similar rock units on either side of the Brevard Zone, recent geologic interpretations no longer describe the Georgia Piedmont in terms of segments. In addition, since similar rock formations are common to the Georgia Piedmont and Blue Ridge provinces, recent interpretations describe the Piedmont-Blue Ridge as one combined province (Crawford & Higgins, et.al., 1999). These new interpretations have resulted in the re-classification of many rock formations.

Recent theories into the origin of the Piedmont-Blue Ridge have resulted in the grouping of rock formations into two assemblages: the parautochthonous continental margin assemblage and the allochthonous oceanic assemblage. The allochthonous assemblage (from an unknown origin) was theorized to have been obducted onto the parautochthonous assemblage and later isoclinally folded in the middle to late Ordovician period. Folded thrust faults in the rock assemblages were in turn displaced producing a wrench-fault system similar to the San Andreas fault in California. The parautochthonous assemblage includes Appalachian basement rocks (primarily meta-granites) of Proterozoic age intruded by middle Proterozoic age meta-volcanic and meta-plutonic rock formations. The basement rocks and intrusives are overlain by early Cambrian to early Ordovician age meta-sedimentary rock formations. The allochthonous oceanic assemblage includes late Proterozoic to early Ordovician age rock formations consisting of metabasalts and other meta-intrusives, meta-plutonics, and ultramafics. Many of the formations in this assemblage are interpreted to be of younger age than the continental margin assemblage (Crawford & Higgins, et.al., 1999).

E-3b Site Geology

East Point is located in the southern portion of the Piedmont Province, approximately -10- miles south of the Brevard Zone. A review of prior publications indicates that the site and surrounding properties are underlain by the Clarkston Formation. This formation is described as a sillimanite-garnet-quartz-plagioclase-biotite-muscovite schist interlayered with a hornblende-plagioclase amphibolite (McConnell & Abrams, 1984). **Figure E-2** illustrates the geologic units in and around the site. Recent interpretations group this formation in the allochthonous oceanic assemblage (Crawford & Higgins, et.al., 1999).

Outcrops at the site and surrounding areas are rarely visible due to heavy vegetation and the high degree of chemical weathering. The chemical weathering process generally produces a mantle of residual soils over the bedrock (saprolite) with thicknesses ranging from a few feet below surface to up to 50 feet. Mica schists and granitic gneisses generally weather into yellow, brown, or reddish-brown soils; whereas mafic rocks such as amphibolite, biotite gneiss, and diabase generally weather into a more dark-red soil (Chapman, Crawford, & Tharpe, 1999).

These soils generally consist of micaceous-silt and sand mixtures and clays grading into saprolite and partially weathered rock near the bedrock surface. The saprolite retains most of the original rock structure but is often highly permeable to groundwater flow (Cressler, 1983).

The site geology has been observed during the advancement of soil borings and monitoring wells by Earl Titcomb, P.G. of EFT, Inc. (EFT) and Ken Summerour, P.G. of Envirorisk Consultants, Inc. (Envirorisk). Well construction details are summarized in **Table E-1**. Boring logs were used to create three cross-sections to better display subsurface geologic conditions. A Site Map (**Figure E-3**) followed by a Cross-Section Location Map (**Figure E-4**) is provided in the Figures section. Cross-Sections A-A', B-B', and C-C' are provided as **Figures E-5**, **E-6**, and **E-7**, respectively.

A review of the boring logs and cross-sections indicates that subsurface soils consist of a silty, sandy, clay-rich highly variable fill material extending to depths of approximately 15-30 feet below ground surface (ft-bgs). The fill reportedly contains variable sized debris and organic materials. Residual soils encountered beneath the fill consist predominantly of micaceous sandy-silts and silty-sands with traces of clay and relict foliation (saprolite) derived from in-place weathering. At depths of approximately 35-55 ft-bgs, the saprolite can be characterized as partially weathered rock (PWR), based on higher blow counts observed during drilling (generally 50+) and appearance of less weathered minerals. Weathering in the PWR zone occurs from a combination of mechanical weathering and chemical processes. The PWR zone consists of weathered mica schists, micaceous granitic gneiss, and biotite and hornblende-rich gneiss and schists. Competent bedrock, based on hollow stem auger refusal, was reported at depths of approximately 50-65 ft-bgs. At depths greater than 65 ft-bgs, hard biotite gneiss, granitic gneiss, and amphibolite gneiss was observed (MW-3B, MW-7B, MW-7B2, MW-8B, and MW-8B2) with intermittent fracturing noted at depths of 53 to 200 ft-bgs.

E-3c Regional Hydrogeology

The upper boundary of unconfined groundwater in the Piedmont is formed by the water table. The water table can be loosely defined as the boundary between saturated and unsaturated soil zones. The depth to the water table may range from a few feet below ground surface to up to 50 feet along hilly terrain. The water table in Piedmont regions is usually situated within the soil-saprolite residuum and the upper portion of the fractured crystalline bedrock.

In areas where saprolite thicknesses are minimal, the water table may reside almost entirely in fractured bedrock. The soil-saprolite residuum generally has a relatively large storage capacity with a low to moderate transmissivity. An exception to this is the transition zone between saprolite and bedrock (PWR) where more sandy permeable soils are generally produced from mechanical weathering of the rock unit.

The PWR transition zone is often highly transmissive and depending on its thickness and orientation may act as a major groundwater pathway (Cressler, 1983). In contrast to the saprolite and PWR zone, the bedrock fracture system generally has a relatively low storage capacity with a high transmissivity where fracture systems are interconnected (LeGrand, 1989). If bedrock fracturing is significant, a hydraulic connection between the surficial water bearing zone and deeper groundwater sources may occur at varying depths within the bedrock.

Groundwater flow in the soil-saprolite/fractured bedrock zone (sometimes referred to as the uppermost aquifer) often mimics surface topography except where controlled by preferential pathways. These pathways may be caused by heterogeneities in the soil, weathering patterns of the saprolite, foliated bedding planes, faults, fractures, or other relict bedrock features. Groundwater flow is usually unconfined in the Piedmont with recharge occurring from rainfall penetrating upland areas and discharge occurring as base flow to streams and creeks in low lying areas. These flow regimes are commonly referred to as slope aquifer systems (LeGrand, 1989). Depending on the interconnection of fracture zones, a downward gradient is commonly observed in upland areas with an upward gradient present in lowlands.

Productive groundwater wells in the Georgia Piedmont may be located in the saprolite residuum, fractured crystalline bedrock, or a combination of both. Groundwater in the bedrock is transmitted via connected fractures within the rock unit that vary widely. The quantity, size, and degree of connection between these fractures or discontinuities is generally more significant than lithology in determining the amount of water available for withdrawal. Rates of withdrawal are often higher along contact zones between rock units (Chapman, Crawford, & Tharpe, 1999).

Piedmont rock types with high reported secondary fracturing and groundwater yield include amphibolite, biotite gneiss, quartzites, and some schists. Secondary permeability and fracture size generally decreases with depth due to overburden pressures. In most places in the Piedmont, well yields are insignificant below a depth of 600 feet (Chapman, Crawford, & Tharpe, 1999).

No public water supply wells are located in the East Point area. The site and surrounding area are supplied by a municipal system that utilizes surface water from a reservoir located approximately six miles west of East Point. Observational water wells exist north at the old Fort McPherson and south at O'Neill Brothers. These wells utilize groundwater from deeper bedrock zones. Water well information from available database sources is provided in **Table E-2**.

E-3d Site Hydrogeology

The findings of previous investigations indicate that the water table occurs near the top of the residuum soils and/or at the base of the fill soils. Groundwater depths across most of the site (excluding MW-12/12A) have historically ranged from approximately 11 ft-bgs in MW-4 to 32 ft-bgs in MW-1. Groundwater depths measured in down-gradient wells MW-12 and MW-12A, located along the intermittent stream bank, have ranged from approximately 1.5-3.8 ft-bgs. Groundwater depths/elevations measured at clustered well locations suggest a downward vertical gradient at higher elevations (MW-7/7A/7B and MW-3/3A) and an up-ward vertical gradient at lower elevations near the stream bank (MW-12/12A). This is typical of Piedmont slope-aquifer systems where groundwater in deeper fractured bedrock zones in up-land areas flows downward in order to discharge into a water body. Conversely, groundwater flow near stream beds or in valleys moves upward in deeper zones to discharge in the water body. Groundwater depths and calculated elevations are provided on **Table E-3**.

The vertical extent of the upper aquifer system and degree of hydraulic connection with deeper bedrock units has not been fully determined. Prior investigations (before 2013) performed at this facility were limited to top-of-bedrock wells and one impacted bedrock well, MW-7B, installed to a depth of 121 ft-bgs, with intermittent fracturing noted at depths of 87-118 ft-bgs. Based on the presence of regulated constituents detected in bedrock wells, further discussed in Section E-5, some degree of hydraulic separation from the uppermost unit is likely present in the bedrock at depths greater than 85 ft-bgs.

In 2013, a deeper bedrock well, MW-7B2 was advanced adjacent to the MW-7 well cluster to a final depth of 200 ft-bgs (screened interval 195-200 ft-bgs). Groundwater sampling results indicated the presence of regulated constituents (namely VOCs/SVOCs) in the top of the fractured bedrock, at a depth greater than 85-110 ft-bgs, and possibly extending to 175 ft-bgs prior to termination at some depth shallower than 195 ft-bgs. Regulated constituents were not detected in MW-7B2 following well completion. In 2016-2017, bedrock wells, MW-3B and MW-8B were advanced using rock coring drill methods. Apparent water bearing fracture zones were sampled using inflatable packers, as follows:

- MW-3B – 65-70 ft-bgs, 80-85 ft-bgs, 85-90 ft-bgs, 90-95 ft-bgs, 110-115 ft-bgs, 118.5-123.5 ft-bgs, 142-147 ft-bgs (DRY), 175-180 ft-bgs, and 195-200 ft-bgs (DRY).
- MW-8B – 53-58 ft-bgs, 61-66 ft-bgs, 66-71 ft-bgs, 71-76 ft-bgs, 76-81 ft-bgs (DRY), 91-96 ft-bgs, 131-136 ft-bgs (DRY), and 148-153 ft-bgs.

MW-3B was subsequently converted to an open hole rock well (interval 62.5-200 ft-bgs) and MW-8B was converted to nested wells MW-8B (open interval 55-80 ft-bgs) and MW-8B2 (screen 148-153 ft-bgs) following evaluation of discrete sampling results. Regulated constituents were detected in the completed wells.

The extent of hydraulic connection between the uppermost aquifer and deeper zones in the bedrock has not been fully established and will require further investigation.

The groundwater flow direction in the uppermost aquifer has been evaluated by creating Potentiometric Surface Maps using data from the last three sampling events. These maps are provided as **Figure E-8A** (March 2021), **Figure E-8B** (April 2022), and **Figure E-8C** (April 2023). A review of the maps indicates similar groundwater flow patterns with the flow direction predicted to the northwest toward an unnamed tributary of South Utoy Creek.

The horizontal groundwater flow velocity (Vh) and approximate vertical velocities for deeper aquifer zones were calculated using the April 2023 calculated hydraulic gradients between MW-6R and MW-12, the average hydraulic conductivity from May 1990 recovery tests, and estimated values obtained from published sources. Calculations were performed using Darcy's Law to predict flow through a porous medium.

Using Darcy's Law equation, an average horizontal groundwater flow velocity of 0.0018 feet per day (ft/day) or 0.657 feet per year (ft/year) was calculated between MW-6R and MW-12. A vertical flow velocity (Vv) or seepage velocity was calculated between residuum and PWR (top of bedrock zones) using the gradient distance between 1) MW-7 & MW-7A and 2) MW-8 and MW-8A, taken as the midpoint of each screened interval. The velocity (Vv) was calculated at 0.0019 ft/day or 0.663 ft/year between MW-7 and MW-7A and 0.0024 ft/day or 0.876 ft/year between MW-8 and MW-8A. A deeper seepage velocity (Vvv) was also calculated using the gradient between 1) MW-7A & MW-7B and 2) MW-8A & MW-8B for the fractured bedrock.

The velocity (Vvv) was calculated at 0.00036 ft/day or 0.13 ft/year between MW-7A and MW-7B and 0.00012 ft/day or 0.044 ft/year between MW-8A and MW-8B. In addition, the deepest bedrock seepage velocity (Vvvv) was calculated using the gradient between 1) MW-7B & MW-7B2 and 2) MW-8B & MW-8B2. The velocity (Vvvv) was calculated at 0.0000099 ft/day or 0.0036 ft/year between MW-7B and MW-7B2 and 0.0000020 ft/day or 0.00073 ft/year between MW-8B and MW-8B2. *(Note that these calculations were derived assuming fluid flow through a homogeneous, isotropic porous medium that does not account for flow through secondary pathways (including fracture pathways); therefore, these flow estimates should be considered approximate.)* Calculation data including supporting reference sources is provided in the Aquifer Data labeled appendix.

E-4 Topographic Map Requirements (40 CFR 270.14(c)(2),(3),(4)(i))

A topographic map meeting the requirements of this section is provided as Figure B-1 in Section B of this report. A review of Figure B-1 indicates the property slopes toward the north from an elevation of approximately 1040 feet above mean sea level (msl) at the southern boundary to a low of approximately 980 feet msl at the northwest boundary near Empire Street.

The original topographic surface taken from a 1925 topographic map is shown to illustrate changes in the topography due to filling and grading performed after development. A tributary previously crossed the middle of the property recharged by a spring-fed lake/depression. The tributary was later filled in and re-routed through a 36-inch storm sewer line owned by the City of East Point.

E-5 Contaminant Plume Description (40 CFR 270.14(c)(2),(4),(7))

Groundwater impact at this site includes non-aqueous phase liquids (NAPL) and a mixture of dissolved volatile organic compounds (VOCs), semi-volatile organics (SVOCs), metals, dioxins, and sulfide. Groundwater sampling is currently performed on an annual basis in accordance with the Sampling and Analysis Plan (SAP), revised and approved March 2018. Historical concentration data for VOCs, SVOCs, and metals is provided in **Tables E-4**, **E-5**, and **E-6**, respectively. Concentrations detected are compared to Groundwater Protection Standards (GPS) listed in the tables. Dioxin sampling data for a limited number of wells is provided in **Table E-7**. The most recent Appendix IX sampling data was collected during the April 2021 event and is provided in **Table E-8**. Sulfide sampling data is provided in **Table E-9**.

A description of NAPL and detected constituents summarized in compound groups is provided in the section below followed by a discussion of the horizontal and vertical extent of regulated constituents and relevant concentration trends in subsequent sections.

E-5a NAPL Detection

Historically, NAPL has been measured in the three Point of Compliance (POC) wells MW-5R, MW-6R, and MW-11, located down-gradient of the HWMU (refer to Figure E-3). Based on odor and appearance, the NAPL appears to consist predominantly of creosote product that “sinks” due to specific gravity. NAPL thicknesses have historically ranged from an estimated 0.01 to 1.0 feet in MW-5R, 0.01 to 0.75 feet in MW-6R, and 0.01 to 1.0 feet in MW-11. Historically, product thicknesses were estimated using a graduated cord and steel plumb bob. In 2011, Envirorisk began using product-water interface probes which are generally more sensitive to lower specific gravity light end NAPL (LNAPL). The interface probes have not yielded reliable tone readings and have been used, along with disposable bailers, more as a graduated tape to approximate thicknesses. Based on odor and appearance, the NAPL appears to consist predominantly of creosote product that “sinks” due to specific gravity.

In March-July 2017, an additional NAPL assessment was performed inside the impoundment (HWMU) to evaluate potential NAPL sources from the wood preserving area (SWMUs 1-4, 6, 7). Three monitoring wells (HWMU-1, HWMU-2, and HWMU-3) were installed at the southern edge of the impoundment (Figure E-3). Gauging performed with a product-water interface probe indicated the presence of a lower specific gravity LNAPL that differed in odor and appearance from NAPL detected in the POC wells.

LNAPL thicknesses were detected at approximately 4 to 8 feet in thickness in HWMU-2 and HWMU-3.

During the March 2019 sampling event, NAPL thicknesses were estimated based on approximate measurements taken using an interface probe and disposable bailers. (A reliable tone was not obtained with the interface probe for MW-5R, MW-6R, and MW-11.) NAPL was detected in MW-5R (1.0'), MW-6R (0.50'), and MW-11 (0.50'). LNAPL was also detected using the interface probe in HWMU-2 (5.24') and HWMU-3 (4.50').

NAPL extent was delineated following the installation of temporary wells installed during Phase 1 implementation of the 2011 Revised Corrective Action Plan. The NAPL plume was determined to cover an area of approximately 39,000 square feet. The estimated volume of NAPL is approximately 3,900 cubic feet (or 29,172 gallons), conservatively assuming a maximum thickness of 0.1 foot. It should be noted that this calculation assumes a continuous zone of NAPL underlying the closed HWMU and a portion of the wood treatment area. Field evaluation suggests that NAPL occurs in discrete and intermittent zones within the saprolite; therefore, this NAPL estimate may be overly conservative. The May 2011 Revised Corrective Action Plan and subsequent progress reports (further discussed in Section E-9d) are included electronically in CD format as noted in the table of contents.

E-5b Description of Detected Constituents

From 1982 to 1989, a series of groundwater monitoring wells (MW-1 through MW-11, including MW-5R and 6R replacement wells) were installed to delineate the extent of groundwater contamination from the former impoundment. Groundwater samples collected on a quarterly basis from 1989 to 1992, semiannual basis in 1993 and 1995, and annually in 1996 and 1997. (Groundwater sampling was not conducted in 1994 and 1998). Analytical results from these initial groundwater monitoring events indicated the highest concentrations of regulated constituents, including non-aqueous phase liquids (NAPL), were detected in MW-5R, MW-6R, and MW-11. From 1989 to 1997, a total of six (6) VOCs and 24 SVOCs were detected above GPS limits, currently defined as background at the site, as follows:

- Acetone, 2-Butanone, Toluene, Xylenes, Ethylbenzene, and Styrene
- 2,3,4,6-Tetrachlorophenol, 2,4,6-Trichlorophenol, 2,4-Dimethylphenol, 2,4-Dinitrophenol, 2-Chlorophenol, 2-Methylnaphthalene, 2-Methylphenol (o-Cresol), Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Carbazole, Chrysene, Dibenzofuran, Fluoranthene, Fluorene, Naphthalene, Pentachlorophenol, Phenanthrene, Phenol, and Pyrene

Monitoring wells MW-5R, MW-6R, and MW-11 were later designated as Point of Compliance (POC) wells. A program of semi-annual groundwater sampling and monitoring was initiated in 1999 to evaluate contamination associated with the HWMU. Groundwater monitoring was conducted on a semi-annual basis from 1999 to 2016. The sampling plan was revised in November 2017 to allow for annual sampling of select monitoring wells. Annual groundwater monitoring events have been conducted at the facility from 2017 to the most recent event in April 2023. Current and historic detections of VOCs, SVOCs, and metals are listed on **Tables E-4 – E-6**. All or most of the VOCs and SVOCs detected are assumed to be attributed to the former HWMU with the exception of chlorinated VOCs that have not been detected in POC wells. Compound detections are compared to GPS values, which have specified limits for select metals and are equivalent to practical quantitation levels (PQLs) assigned by the laboratory for VOCs and SVOCs. A description of constituents detected during monitoring events conducted in January-February and July 1999, July 2009, April 2018, March 2019, and April 2023, is provided below. Laboratory reports for the July 2009, April 2018, March 2019, and April 2023 events have been provided electronically in CD format as noted in the table of contents.

<u>January-February and July 1999</u>

During the January-February 1999 and July 1999 semiannual sampling events, a total of 11 VOCs and 14 SVOCs were detected above GPS limits, currently defined as background at the site, as follows:

- 1,1-Dichloroethene, 1,2-Dichloroethane, 1,1,1-Trichloroethane, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, 2-Butanone, Acetone, Benzene, Toluene, Xylenes (total), and Tetrachloroethene

- 2,3,4,6-Tetrachlorophenol, 2,4-Dimethylphenol, 2,4-Dinitrophenol, 2-Methylnaphthalene, 2-Methylphenol (o-Cresol), 3,4-Methylphenol, Acenaphthene, Dibenzofuran, Fluoranthene, Fluorene, Naphthalene, Pentachlorophenol, Phenanthrene, and Phenol

VOCs were detected in all wells sampled except MW-2, MW-3, MW-4, MW-6R (July 1999 only), MW-7A, and MW-11 (July 1999 only). Only non-chlorinated VOCs (1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene, 2-Butanone, Acetone, Benzene, Toluene, Xylenes) were detected at MW-5R, MW-6R, MW-7, MW-7B, MW-9, and MW-11; while only chlorinated VOCs (1,1-Dichloroethene, 1,2-Dichloroethane, 1,1,1-Trichloroethane, and Tetrachloroethene) were detected at MW-8 and MW-10. Total VOCs concentrations (non-chlorinated VOCs) ranged from 24 micrograms per liter (µg/L) in MW-7 (July 1999) to 3,294 µg/L in MW-5R (January 1999). Total chlorinated VOCs concentrations ranged from 49.1 µg/L in MW-8 (July 1999) to 71 µg/L in MW-10 and MW-8 (February 1999). The highest detected non-chlorinated VOC was Acetone at a concentration of 2,700 µg/L in MW-5R. The highest detected chlorinated VOC was 1,2-Dichloroethane at a concentration of 35 µg/L in MW-8.

SVOCs were detected in all wells except MW-2, MW-4, and MW-10. Total SVOCs concentrations ranged from 36 µg/L in MW-3 (February 1999) to 134,500 µg/L in MW-5R (July 1999). The highest detected SVOCs was 3,4-Methylphenol at a concentration of 49,000 µg/L in MW-5R.

July 2009

The analytical results from the July 2009 groundwater sampling event detected a total of 13 VOCs, 17 SVOCs, and 5 Metals. Dioxins were also detected in MW-11. The POC wells were not sampled in 2009 due to the presence of NAPL, with the exception of MW-11, which was sampled for Appendix IX parameters. Detected constituents are listed below.

- Acetone, 2-Butanone (MEK), Benzene, Ethylbenzene, Toluene, Total Xylenes (m,p, & o), Styrene, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,1-Dichloroethene, 1,2-Dichloroethane, Tetrachloroethene, and Trichloroethene

- 2,3,4,6-Tetrachlorophenol, 2,4-Dimethylphenol, 2-Methylnaphthalene, 2-Methylphenol, 3,4-Methylphenol, Acenaphthene, Anthracene, Benzo(a)anthracene, Carbazole, Dibenzofuran, Fluorene, Naphthalene, Pentachlorophenol, Phenol, Fluoranthene, Phenanthrene, and Pyrene

- Barium, Chromium, Cobalt, Copper, and Zinc

Non-Chlorinated VOCs

In July 2009, VOCs were detected in all wells except MW-1, MW-2, MW-3, and MW-7A. Total non-chlorinated VOCs concentrations ranged from 3.9 µg/L in MW-4 to 573.2 µg/L in MW-11. The highest detected non-chlorinated VOC was Acetone at a concentration of 270 µg/L in MW-11. The July 2009 non-chlorinated VOC detections are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *Acetone* was detected in MW-11 at 270 µg/l. Prior detections of similar magnitude were reported for this well. Acetone has historically been detected in MW-5R and MW-6R in addition to MW-11.
- *2-Butanone (MEK)* was detected at 83 µg/l in MW-11 of similar magnitude to prior detections. MEK has historically been detected in MW-5R and MW-6R in addition to MW-11.
- *Benzene* was detected in -8- wells in 2009 at concentrations ranging from 1.2 µg/l in MW-8 to 39 µg/l in MW-11.
- *Ethylbenzene* was detected in MW-7 at 2.2 µg/l, in MW-7B at 11 µg/l, and at 44 µg/l in MW-11.
- *Toluene* was detected at 1.3 µg/l in MW-7, at 16 µg/l in MW-7B, and at 42 µg/l in MW-11.

- *Total xylenes (m,p, & o)* were detected in -9- wells at concentrations ranging from 2.3 µg/l in MW-3A to 74 µg/l in MW-11.
- *Styrene* was detected in MW-11 only at 12 µg/l. This compound has historically been detected in MW-5R, MW-6R, and MW-7B.
- *1,3,5-Trimethylbenzene* was detected in MW-7 at 2.7 µg/l, MW-7B at 7.7 µg/l, and in MW-11 at 2.7 µg/l.
- *1,2,4-Trimethylbenzene* was detected in -7- wells at concentrations ranging from 2.6 µg/l in MW-12 to 20 µg/l in MW-7B.

Chlorinated VOCs

Chlorinated VOCs have historically been detected in MW-8, MW-10, MW-12, MW-12A, MW-13, and MW-14. With the exception of MW-12/12A, none of these wells are located in a direct down-gradient flow path from the HWMU. Based on the well distribution and due to the fact that chlorinated VOCs historically were not utilized at this facility and have not been detected in the POC wells, an off-site source is suspected. In July 2009, total chlorinated VOCs concentrations ranged from 6.0 µg/L at MW-8 to 71 µg/L at MW-13. The highest detected chlorinated VOC was 1,2-Dichloroethane at a concentration of 53 µg/L at MW-13. The chlorinated VOCs detected, and concentration ranges are described below.

- *1,1-Dichloroethene* was detected in -5- wells at concentrations ranging from 4.2 µg/l in MW-10 to 12 µg/l in MW-12 and MW-13.
- *1,2-Dichloroethane* was detected in -5- wells at concentrations ranging from 27 µg/l for MW-10 to 53 µg/l in MW-13.
- *Tetrachloroethene* was detected in -6- wells at concentrations ranging from 2.3 µg/l in MW-14 to 15 µg/l for MW-13.
- *Trichloroethene* was detected in -5- wells, MW-8 at 2.8 µg/l, MW-10 at 2.0 µg/l, MW-12 at 1.7 µg/l, MW-12A at 1.6 µg/l, and MW-13 at 2.8 µg/l.

SVOCs

In July 2009, SVOCs were detected in all wells except MW-1, MW-2, MW-3, MW-7A, MW-13, and MW-14. Total SVOCs concentrations ranged from 11 µg/L at MW-10 to 29,208 µg/L at MW-11. The highest detected SVOC was 3,4-Methylphenol at a concentration of 7,800 µg/L at MW-11. Individual SVOCs detected in the sampling event are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *2,3,4,6-Tetrachlorophenol* was detected in MW-7B only at 300 µg/l.
- *2,4-Dimethylphenol* was detected at 84 µg/l in MW-7B and at 4,200 µg/l in MW-11.
- *2-Methylnaphthalene* was detected in -4- monitoring wells in concentrations ranging from 12 µg/l in MW-3A to 1,100 µg/l in MW-11.

- *2-Methylphenol* was detected in MW-7B at 17 µg/l and 2,900 µg/l for MW-11.
- *3,4-Methylphenol* was detected in MW-7B at 36 µg/l and 7,800 µg/l in MW-11.
- *Acenaphthene* was detected at 19 µg/l in MW-7, at 150 µg/l in MW-7B, and 620 µg/l in MW-11.
- *Anthracene* was detected at 29 µg/l in MW-8, at 97 µg/l in MW-11, and at 19 µg/l in MW-12A.
- *Benzo(a)anthracene* was detected in MW-11 only at 51 µg/l.
- *Carbazole* was detected in MW-7B only at 130 µg/l.
- *Dibenzofuran* was detected in -6- monitoring wells at concentrations ranging from 43 µg/l in MW-8 to 450 µg/l in MW-11.
- *Fluorene* was detected in -4- monitoring wells at concentrations ranging from 11 µg/l in MW-8 to 430 µg/l in MW-11.
- *Naphthalene* was detected in -9- monitoring wells at concentrations ranging from 11 µg/l in MW-10 to 6,600 µg/l in MW-11
- *Pentachlorophenol* was detected in -5- monitoring wells at concentrations ranging from 78 µg/l in MW-7 to 2,100 µg/l in MW-7B.
- *Phenanthrene* was detected in -6- monitoring wells at concentrations ranging from 20 µg/l for MW-12A to 950 µg/l in MW-11.
- *Pyrene* was detected at 200 µg/l in MW-11 only.

Metals

A total of five dissolved metals: barium, chromium, cobalt, copper, and zinc were detected in the July 2009 sampling event. Laboratory data was converted from milligrams per liter (mg/L) to µg/l for comparison with historic data. The dissolved metals detected may be from sources other than the HWMU. Concentrations and ranges detected for each of the metals are described below.

- *Barium* was detected in -15- wells sampled at concentrations ranging from 10.9 µg/l in MW-3 to 185 µg/l in MW-7. All detections were significantly lower than the GPS of 1,000 µg/l.
- *Chromium* was detected in MW-3A only at 26.5 µg/l, below the GPS of 50 µg/l.
- Cobalt was detected in -3- wells at 26 µg/l in MW-4, at 93.2 µg/l in MW-7, and at 108 µg/l in MW-11. These concentrations are above the GPS which is equivalent to background for this compound. Statistically derived background metals concentrations have not been determined for this site.
- *Copper* was detected in MW-3A at 16.4 µg/l which is above the GPS that is equivalent to statistically derived background concentrations, which have yet to be determined.
- *Zinc* was detected in -2- wells at 51.1 µg/l in MW-7 and at 345 µg/l in MW-11. These concentrations are above the GPS which is equivalent to statistically derived background concentrations for this metal, which haven’t been calculated.

The higher detections observed in MW-11 may be attributed to the presence of NAPL and high turbidity in this well. Some metals detected may be attributed to trace debris in fill materials used to backfill a large portion of the site.

Dioxins

Dioxins have historically been sampled annually in conjunction with Appendix IX analysis collected for one of the POC wells on a rotating basis. In addition, dioxin samples have been collected from MW-7B. During the July 2009 sample event, dioxins analysis was performed on samples collected from MW-7B and MW-11. The results indicated no detections above the reporting limit for MW-7B consistent with historic data. Several dioxin isomers were detected in the sample collected from MW-11 as follows:

- *1,2,3,7,8-Pentachlorodibenzo-p-dioxin (Penta CDD)* was detected at a concentration of 0.16 nanograms per liter (ng/L).
- *1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (Hexa CDD)* was detected at a concentration of 40.0 ng/L.
- *2,3,4,6,7,8-Hexachlorodibenzofuran (Hexa CDF)* was detected at a concentration of 36.0 ng/L.
- *1,2,3,7,8-Pentachlorodibenzofuran (Penta CDF)* was detected at a concentration of 4.8 ng/L.
- *2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)* was detected at a concentration of 0.15 ng/L.
- *2,3,7,8-Tetrachlorodibenzofuran (TCDF)* was detected at a concentration of 0.79 ng/L.

Appendix IX Sampling

A full round of Appendix IX sampling data was collected from MW-11 during the July 2009 event. In accordance with Permit requirements, Appendix IX sampling is performed annually on a rotating basis using different POC wells. The purpose of the Appendix IX sampling is to identify any new constituents that need to be added to the facility Permit.

A review of the results indicates that all constituents were non-detect for Micro-extractable Volatile Organics, Chlorinated Pesticides, Polychlorinated Biphenyls (PCBs), Chlorinated Herbicides, Mercury, Cyanide, and Sulfide. Detections of VOCs, SVOCs, Metals, and Dioxins were previously discussed in the sections above. Based on the findings no new constituents were detected requiring any additions to the Permit list.

April 2018 - March 2019

The analytical results from the April 2018 and March 2019 groundwater sampling events detected a total of 11 VOCs, 19 SVOCs, sulfide, five (5) metals, and various dioxin/furans. The POC wells were not sampled in 2018 or 2019 due to the presence of NAPL, with the exception of MW-6R, sampled in March 2019 to satisfy Appendix IX requirements.

All or most of the VOCs and SVOCs detected are assumed to be attributed to the former HWMU with the exception of chlorinated VOCs that have not been detected in POC wells. The dissolved metals detected have been attributed to either fill materials or naturally occurring mineral sources from weathered Piedmont soils. In addition to sulfide, the following VOCs, SVOCs, and metals were detected during the April 2018 - March 2019 sampling events:

- Benzene, Ethylbenzene, Toluene, Total xylenes (o-Xylene and m,p-Xylene), Styrene, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,1-Dichloroethene, 1,2-Dichloroethane, Trichloroethene, and Tetrachloroethene.

- 2,3,4,6-Tetrachlorophenol, 2,4,6-Trichlorophenol, 2,4-Dimethylphenol, 2-Methylnaphthalene, 2-Methylphenol (o-Cresol), 3,4-Methylphenol, Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)pyrene, Carbazole, Dibenzofuran, Fluoranthene, Fluorene, Naphthalene, Pentachlorophenol, Phenanthrene, Phenol, and Pyrene.

- Arsenic, Barium, Cobalt, Nickel, and Lead.

Non-Chlorinated VOCs

VOCs have historically been detected in trace to low concentrations as compared to the more predominant SVOCs contained in creosote and pentachlorophenol. In April 2018, VOCs were detected in all wells sampled except MW-1, MW-2, MW-3, MW-3A, MW-4, MW-7B2, MW-9, and MW-14. In March 2019, VOCs were detected in all wells sampled except MW-3A and MW-9. Total non-chlorinated VOCs concentrations in April 2018 ranged from 1.1 µg/L in MW-7A to 338.3 µg/L in MW-5A and the highest detected non-chlorinated VOC were Total Xylenes at a concentration of 124.2 µg/L in MW-8B. In March 2019, total non-chlorinated VOCs concentrations ranged from 31.1 µg/L in MW-7A to 575.7 µg/L in MW-8B and the highest detected non-chlorinated VOC was Total Xylenes at a concentration of 220.4 µg/L in MW-8B. The April 2018 and March 2019 non-chlorinated VOC detections are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *Benzene* was detected in 9 wells in 2018 at concentrations ranging from 1.5 µg/l in MW-3B (discrete sample at 120 ft-bgs) to 65.2 µg/l in MW-5A. In 2019, Benzene was detected in 9 wells at concentrations ranging from 1.5 µg/l in MW-7A to 65.1 µg/l in MW-5A.

- *Ethylbenzene* was detected in 10 wells in 2018 at concentrations ranging from 1.1 µg/l in MW-3B (discrete sample at 90 ft-bgs) to 59.2 µg/l in MW-5A. In 2019, Ethylbenzene was detected in 8 wells at concentrations ranging from 2.1 µg/l in MW-7A to 80.5 µg/l in MW-5A.

- *Toluene* was detected in 9 wells in 2018 at concentrations ranging from 1.4 µg/l in MW-7 to 65.5 µg/l in MW-5A. In 2019, Toluene was detected in 6 wells at concentrations ranging from 2.9 µg/l in MW-7B to 118 µg/l in MW-8B.

- *Total xylenes (m,p, & o)* were detected in 11 wells in 2018 at concentrations ranging from 3.3 µg/l in MW-3B (at 90 ft-bgs) to 124.2 µg/l in MW-8B. In 2019, Total xylenes were detected in 10 wells at concentrations ranging from 15.7 µg/l in MW-12 to 220.4 µg/l in MW-8B.

- *Styrene* was detected in 4 wells in 2018 at concentrations ranging from 1.5 µg/l in MW-3B (at 180 ft-bgs) to 9.5 µg/l in MW-8B. In 2019, Styrene was detected in 4 wells at concentrations ranging from 4.5 µg/l in MW-5A to 12.2 µg/l in MW-8B2.

- *1,3,5-Trimethylbenzene* was detected in 10 wells in 2018 at concentrations ranging from 1.0 µg/l in MW-12 to 21.6 µg/l in MW-6R. In 2019, 1,3,5-Trimethylbenzene was detected in 8 wells at concentrations ranging from 2.1 µg/l in MW-7A to 35.4 µg/l in MW-8B.

- *1,2,4-Trimethylbenzene* was detected in 11 wells in 2018 at concentrations ranging from 1.1 µg/l in MW-7A to 58.6 µg/l in MW-6R. In 2019, 1,2,4-Trimethylbenzene was detected in 10 wells at concentrations ranging from 2.1 µg/l in MW-12A to 97.1 µg/l in MW-8B.

Chlorinated VOCs

Chlorinated VOCs have historically been detected in MW-8, MW-10, MW-12, MW-12A, MW-13, and MW-14. With the exception of MW-12/12A, none of these wells are located in a direct down-gradient flow path from the HWMU. As previously mentioned, an off-site source is suspected for the chlorinated VOCs. Chlorinated VOC detections in vertical delineation wells MW-8A, MW-8B, and MW-8B2 suggest vertical migration has occurred from the off-site source into deeper fractured bedrock zones.

Chlorinated VOCs concentrations in April 2018 ranged from 11.6 µg/L at MW-12 to 42.6 µg/L at MW-13 and the highest detected chlorinated VOC was 1,2-Dichloroethane at a concentration of 39.4 µg/L at MW-12. In March 2019, chlorinated VOCs concentrations ranged from 5.6 µg/L at MW-8B2 to 32.5 µg/L at MW-12 and the highest detected chlorinated VOC was 1,2-Dichloroethane at a concentration of 35.5 µg/L at MW-12. The compounds detected and concentration ranges are described below.

- *1,1-Dichloroethene* was detected in 8 wells in 2018 at concentrations ranging from 1.2 µg/l in MW-10 to 3.4 µg/l in MW-12. In 2019, 1,1-Dichloroethene was detected in 7 wells at concentrations ranging from 1.3 µg/l in MW-8B2 to 2.4 µg/l in MW-8A.

- *1,2-Dichloroethane* was detected in 11 wells in 2018 at concentrations ranging from 11.6 µg/l for MW-10 to 39.4 µg/l in MW-12. In 2019, 1,2-Dichloroethane was detected in 7 wells at concentrations ranging from 4.3 µg/l for MW-8B2 to 35.5 µg/l in MW-12.

- *Tetrachloroethene* was detected in 6 wells in 2018 at concentrations ranging from 3.5 µg/l in MW-12A to 7.4 µg/l for MW-12. Tetrachloroethene was detected in 6 wells in 2018 at concentrations ranging from 1.1 µg/l in MW-8B to 8.6 µg/l in MW-8A.

- *Trichloroethene* was detected in 7 wells in 2018 at concentrations ranging from 1.1 µg/l in MW-12A to 2.3 µg/l for MW-12. In 2019, Trichloroethene was detected in 6 wells at concentrations ranging from 1.0 µg/l in MW-12A to 2.4 µg/l in MW-12.

SVOCs

In April 2018, SVOCs were detected in all wells except MW-1, MW-2, MW-3, MW-3A, MW-4, MW-7B2, MW-8, MW-9, MW-10, MW-13, and MW-14. (MW-3B was initially non detect for SVOCs during April 2018 monitoring event. Results from the May 2018 resampling at depths of 90 ft-bgs, 120 ft-bgs, 180 ft-bgs indicated detections of SVOCs over laboratory reporting limits.) In March 2019, SVOCs were detected in all wells except MW-3A, MW-8, MW-9, and MW-10. Total SVOCs concentrations in 2018 ranged from 210 µg/L in MW-3B at 90 ft-bgs (May 2018) to 40,915.5 µg/L in MW-6R and the highest detected SVOC was Naphthalene at a concentration of 14,700 µg/L in MW-6R. In March 2019, total SVOCs ranged from 112.7 µg/L at MW-7B to 24,190.3 µg/L in MW-8B and the highest detected SVOC was Naphthalene at a concentration of 15,800 µg/L in MW-8B. Individual SVOCs detected in the 2018 and 2019 sampling events are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *2,3,4,6-Tetrachlorophenol* was detected in 4 wells in 2018 at concentrations ranging from 69.9 µg/l in MW-7B to 362 µg/l in MW-8B. In 2019, *2,3,4,6-Tetrachlorophenol* was detected in 3 wells at concentrations ranging from 294 µg/l in MW-8B to 1,170 µg/l in MW-8B2.

- *2,4,6-Trichlorophenol* was detected in 2018 at a concentration of 12.4 µg/l in MW-7B and 21.2 µg/l in MW-8A. In 2019, 2,4,6-Trichlorophenol was detected only in MW-5A at a concentration of 11.2 µg/l.

- *2,4-Dimethylphenol* was detected in 5 wells in 2018 at concentrations ranging from 11.0 µg/l in MW-8A to 2,320 µg/l in MW-6R. In 2019, 2,4-Dimethylphenol was detected in 4 wells at concentrations ranging from 137 µg/l in MW-3B to 507 µg/l in MW-5A.

- *2-Methylnaphthalene* was detected in 9 wells in 2018 at concentrations ranging from 29.2 µg/l in MW-7A to 2,370 µg/l in MW-6R. In 2019, 2-Methylnaphthalene was detected in 6 wells at concentrations ranging from 156 µg/l in MW-7A to 848 µg/l in MW-8B.

- *2-Methylphenol (o-Cresol)* was detected in 3 wells in 2018 at concentrations ranging from 78.8 µg/l in MW-8B to 1,210 µg/l in MW-6R. In 2019, 2-Methylphenol was detected in 4 wells at concentrations ranging from 26.1 µg/l in MW-3B to 319 µg/l in MW-5A.

- *3,4-Methylphenol* was detected in 4 wells in 2018 at concentrations ranging from 69.5 µg/l in MW-8B to 2,770 µg/l in MW-6R. In 2019, 3,4-Methylphenol was detected in 4 wells at concentrations ranging from 27.8 µg/l in MW-8B to 218 µg/l in MW-5A.

- *Acenaphthene* was detected in 10 wells in 2018 at concentrations ranging from 14.2 µg/l in MW-7 to 2,320 µg/l in MW-6R. In 2019, Acenaphthene was detected in 8 wells at concentrations ranging from 25.2 µg/l in MW-12A to 481 µg/l in MW-8B.

- *Acenaphthylene* was detected in 2018 at a concentration of 12.8 µg/l in MW-8B only. In 2019, Acenaphthylene was detected only in MW-8B at a concentration of 19.0 µg/l.

- *Anthracene* was detected in 5 wells in 2018 at concentrations ranging from 11.5 µg/l in MW-5A to 603 µg/l in MW-6R. In 2019, Anthracene was detected in 3 wells at concentrations ranging from 10.7 µg/l in MW-5A to 24.9 µg/l in MW-8B.

- *Benzo(a)pyrene* was detected in 2018 at a concentration of 79.5 µg/l in MW-6R only. In 2019, *Benzo(a)pyrene* was not detected above laboratory reporting limits.

- *Carbazole* was detected in 9 wells in 2018 at concentrations ranging from 14.5 µg/l in MW-7 to 717 µg/l in MW-6R. In 2019, Carbazole was detected in 8 wells at concentrations ranging from 10.8 µg/l in MW-7 to 607 µg/l in MW-8B.

- *Dibenzofuran* was detected in 11 wells in 2018 at concentrations ranging from 11.8 µg/l in MW-7A to 1,730 µg/l in MW-6R. In 2019, Dibenzofuran was detected in 9 wells at concentrations ranging from 37.1 µg/l in MW-12A to 351 µg/l in MW-8B.

- *Fluoranthene* was detected in 2 wells in 2018 at concentrations of 120 µg/l in MW-8B and 2,300 µg/l in MW-6R. In 2019, Fluoranthene was detected only in MW-8B at a concentration of 44.8 µg/l.

- *Fluorene* was detected in 9 wells in 2018 at concentrations ranging from 17.6 µg/l in MW-3B (at 120 ft-bgs) to 2,090 µg/l in MW-6R. In 2019, Fluorene was detected in 5 wells at concentrations ranging from 19.6 µg/l in MW-7B to 246 µg/l in MW-8B.

- *Naphthalene* was detected in 12 wells in 2018 at concentrations ranging from 86.1 µg/l in MW-7A to 14,200 µg/l in MW-6R. In 2019, Naphthalene was detected in 8 wells at concentrations ranging from 1,160 µg/l in MW-12A to 15,800 µg/l in MW-8B.

- *Pentachlorophenol* was detected in 11 wells in 2018 at concentrations ranging from 23.6 µg/l in MW-8A to 3,110 µg/l in MW-8B2. In 2019, Pentachlorophenol was detected in 5 wells at concentrations ranging from 25.5 µg/l in MW-7 to 4,870 µg/l in MW-6R.

- *Phenanthrene* was detected in 9 wells in 2018 at concentrations ranging from 14.2 µg/l in MW-3B (at 180 ft-bgs) to 5,740 µg/l in MW-6R. In 2019, Phenanthrene was detected in 7 wells at concentrations ranging from 13.4 µg/l in MW-12 to 301 µg/l in MW-8B.

- *Phenol* was detected in 2 wells in 2018 at concentrations of 27.2 µg/l in MW-5A and 641 µg/l in MW-6R. In 2019, Phenol was not detected above laboratory reporting limits.

- *Pyrene* was detected in 2 wells in 2018 at concentrations of 48.3 µg/l in MW-8B and 1,160 µg/l in MW-6R. In 2019, *Pyrene* was detected only in MW-8B at a concentration of 22.6 µg/l.

Metals

A total of 5 dissolved metals: arsenic, barium, cobalt, nickel, and lead were detected in the April 2018 sampling event. (Total metals were not analyzed in any of the wells in March 2019 per the updated SAP, approved March 2018). In April 2018, monitoring wells MW-2, MW-3, MW-8, and MW-12 were analyzed for site-specific metals Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Nickel, Selenium, Thallium, Vanadium, and Zinc. MW-5R and MW-11 were not analyzed due to the presence of NAPL. MW-6R was analyzed for metals (including Mercury) as part of the Appendix IX analysis. A total of 5 metals (Arsenic, Barium, Cobalt, Lead, and Nickel) were detected in the April 2018 sampling event, as follows:

- *Arsenic* was detected at a concentration of 9.8 µg/l in MW-3 only. This detection is lower than the GWPS of 50 µg/l.

- *Barium* was detected at a concentration of 84.4 µg/l in MW-2, 133 µg/l in MW-3, 44.8 µg/l in MW-6R, 33.7 µg/l in MW-8, and 38.9 µg/l in MW-12. This detection is lower than the GWPS of 1,000 µg/l

- *Cobalt* was detected at a concentration of 91.5 µg/l in MW-6R only. *Due to the presence of NAPL and high turbidity in this POC well, this detection likely represents a combination of dissolved and sorbed cobalt on sediment particles*. The GWPS for this compound is equivalent to statistically derived background concentrations, which have yet to be determined.

- *Lead* was detected at a concentration of 3.0 µg/l in MW-3 only. This detection is lower than the GWPS of 50 µg/l

- *Nickel* was detected at a concentration of 54.9 µg/l in MW-6R only. *Due to the presence of NAPL and high turbidity in this POC well, this detection likely represents a combination of dissolved and sorbed nickel on sediment particles*. The GWPS for this compound is equivalent to statistically derived background concentrations, which have yet to be determined.

The higher detections observed in MW-6R may be attributed to the presence of NAPL and high turbidity in this well. As previously noted, some metals detected may be attributed to trace debris in fill materials used to backfill a large portion of the site.

Dioxins

Dioxins have historically been sampled annually in conjunction with Appendix IX analysis on one of the POC wells on a rotating basis. In addition, dioxin samples have been historically collected from MW-7B. During the April 2018 sampling event, dioxins analysis was performed on samples collected from MW-7B and MW-6R. Dioxin isomers detected in MW-7B include the following:

- *Penta CDD* was detected at a concentration of 0.0040 ng/L.
- *Hexa CDD* was detected at a concentration of 0.083 ng/L.
- *1,2,3,4,6,7,8-heptachloro dibenzo-p-dioxin (Total HpCDD)* was detected at a concentration of 0.470 ng/L.
- *1,2,3,4,6,7,8-heptachlorodibenzofuran (Total HpCDF)* was detected at a concentration of 0.017 ng/L.
- *1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)* was detected at a concentration of 0.700 ng/L.
- *1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)* was detected at a concentration of 0.017 ng/L.

Historically, Total HpCDD, Total HpCDF, and OCDF have not been detected in MW-7B. Hexa CDF, Penta CDF, and TCDF (detected in July 2016) were not detected during the April 2018 sampling event. In addition, the following dioxin isomers were detected in the sample collected from MW-6R:

- *Penta CDD* was detected at a concentration of 6.40 ng/L.
- *Hexa CDD* was detected at a concentration of 920 ng/L.
- *Hexa CDF* was detected at a concentration of 1,100 ng/L.
- *Penta CDF* was detected at a concentration of 97.0 ng/L.
- *TCDD* was detected at a concentration of 3.0 ng/L.
- *TCDF* was detected at a concentration of 6.20 ng/L.
- *Total HpCDD* was detected at a concentration of 21,000 ng/L.
- *Total HpCDF* was detected at a concentration of 5,700 ng/L.
- *OCDD* was detected at a concentration of 110,000 ng/L.
- *OCDF* was detected at a concentration of 5,600 ng/L.

Due to the presence of NAPL and/or sediment content in MW-6R, and an understanding of the low solubility of dioxins, some or all of the isomers reported *may not* be attributed to dissolved phase contamination. Future evaluation will be required to determine the significance of the dioxin detections relative to laboratory quantitative reporting limits.

Sulfide

Sulfide was added to the facility permit in March 2018 and was analyzed in all the monitoring wells sampled during the April 2018 sampling event. The predominant source is suspected to be natural microbial biodegradation via sulfate reduction. Sulfide detections above the laboratory reporting limit of 1.0 mg/l were observed in the following 4 monitoring wells:

- MW-3A - 1.3 mg/L
- MW-3B (at 180 ft-bgs) - 1.1 mg/L
- MW-7A - 1.4 mg/L
- MW-7B2 - 1.6 mg/L

Sulfide was not detected above laboratory reporting limits in any of the remaining monitoring wells. In March 2019, sulfide was analyzed in select wells, in accordance with the SAP with no detections above laboratory reporting limits.

April 2023

The analytical results from the April 2023 groundwater sampling event detected a total of 10 VOCs and 19 SVOCs. Sulfide was analyzed but was not detected in any of the samples. The POC wells were not sampled in 2023 due to the presence of NAPL. The following VOCs and SVOCs were detected during the April 2023 sampling event:

- Benzene, Ethylbenzene, Toluene, Total Xylenes, Styrene, 1,3,5-Trimethylbenzene, 1,2,4-Trimethylbenzene, 1,2-Dichloroethane, Trichloroethene, and Tetrachloroethene.

- 2,3,4,6-Tetrachlorophenol, 2,4,5-Trichlorophenol, 2,4-Dimethylphenol, 2-Methylnaphthalene, 2-Methylphenol (o-Cresol), 3,4-Methylphenol, Acenaphthene, Acenaphthylene, Anthracene, Carbazole, Dibenzofuran, Fluoranthene, Fluorene, Naphthalene, Pentachlorophenol, Phenanthrene, Phenol, Pyrene, and 2-Picoline.

Non-Chlorinated VOCs

In April 2023, VOCs were detected in all wells sampled except MW-3A, MW-7A, and MW-9. (Note that MW-1, MW-2, MW-3, MW-4, MW-7B2, MW-13, and MW-14 were not sampled in April 2023.) Selected stormwater outfalls were also sampled along with the monitoring wells. Total non-chlorinated VOC concentrations in April 2023 ranged from 17.6 µg/L in MW-12 to 275 µg/L in MW-5A and the highest detected non-chlorinated VOC was Total Xylenes at a concentration of 84 µg/L in MW-8B2. The April 2023 non-chlorinated VOC detections are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *Benzene* was detected in 6 monitoring wells and stormwater Outfall-2 at concentrations ranging from 3.2 µg/l in MW-12A to 54 µg/l in MW-5A (58 µg/l in DUP-1).

- *Ethylbenzene* was detected in 5 monitoring wells and Outfall-2 at concentrations ranging from 2.1 µg/l in MW-7B to 46 µg/l in MW-5A (54 µg/l in DUP-1).

- *Toluene* was detected in 5 monitoring wells and Outfall-2 at concentrations ranging from 1.1 µg/l in MW-12A to 49 µg/l in MW-5A (58 µg/l in DUP-1).

- *Total Xylenes* were detected in 7 monitoring wells and Outall-2 at concentrations ranging from 7.2 µg/l in MW-12 to 84 µg/l in MW-8B2.

- *Styrene* was detected in MW-3B at 2.4 µg/l and MW-8B2 at 6.7 µg/l.

- *1,3,5-Trimethylbenzene* was detected in 5 monitoring wells and Outfall-2 at concentrations ranging from 4.6 µg/l in MW-7B to 16 µg/l in MW-8B2.

- *1,2,4-Trimethylbenzene* was detected in 9 monitoring wells and Outfall-2 at concentrations ranging from 1.2 µg/l in MW-12 and MW-12A to 40 µg/l in MW-5A.

Chlorinated VOCs

Chlorinated VOCs concentrations in April 2023 ranged from 1.8 µg/L in MW-8B2 to 26.3 µg/L in MW-12 and the highest detected chlorinated VOC was 1,2-Dichloroethane at a concentration of 20 µg/L in MW-12. The compounds detected and concentration ranges are described below.

- *1,2-Dichloroethane* was detected in 6 monitoring wells at concentrations ranging from 1.8 µg/l in MW-8B2 to 20 µg/l in MW-12.
- *Tetrachloroethene* was detected in 5 monitoring wells at concentrations ranging from 1.2 µg/l in MW-8A to 4.9 µg/l in MW-12.
- *Trichloroethene* was detected in MW-8 at 1.1 µg/l and MW-12 at 1.4 µg/l.

SVOCs

In April 2023, SVOCs were detected in all wells sampled except MW-3A, MW-7A, MW-8, MW-8A, and MW-9. Total SVOCs concentrations in April 2023 ranged from 195 µg/L in MW-7B to 13,219 µg/L in MW-8B2 and the highest detected SVOC was Naphthalene at a concentration of 6,600 µg/L in MW-6R. Individual SVOCs detected during the 2023 sampling events are discussed below. Constituents identified in more than three monitoring wells are generally discussed in terms of concentration ranges.

- *2,3,4,6-Tetrachlorophenol* was detected in 4 monitoring wells and Outfall-2 at concentrations ranging from 18 µg/l in Outfall-2 to 500 µg/l in MW-8B2.
- *2,4,5-Trichlorophenol* was detected in MW-8B2 at 33 µg/l and in MW-8B at 100 µg/l.
- *2,4-Dimethylphenol* was detected in 4 monitoring wells and Outfall-2 at concentrations ranging from 33 µg/l in MW-8B2 to 280 µg/l in MW-5A (300 µg/l in DUP-1).
- *2-Methylnaphthalene* was detected in 6 monitoring wells and Outfall-2 at concentrations ranging from 10 µg/l in MW-12A to 530 µg/l in MW-8B2.
- *2-Methylphenol (o-Cresol)* was detected in 3 monitoring wells and Outfall-2 at concentrations ranging from 18 µg/l in MW-8B to 100 µg/l in Outfall-2.
- *3,4-Methylphenol* was detected in 4 monitoring wells and Outfall-2 at concentrations ranging from 19 µg/l in MW-3B to 160 µg/l in Outfall-2.

- *Acenaphthene* was detected in 5 monitoring wells and Outfall-2 at concentrations ranging from 29 µg/l in MW-7B to 260 µg/l in MW-8B2.

- *Acenaphthylene* was detected in MW-5A at 9.9 µg/l and in MW-8B2 at 11 µg/l.

- *Anthracene* was detected in Outfall-2 at 12 µg/l and in MW-8B at 15 µg/l.

- *Carbazole* was detected in 8 monitoring wells and Outfall-2 at concentrations ranging from 11 µg/l in MW-7 to 370 µg/l in MW-8B2.

- *Dibenzofuran* was detected in 8 monitoring wells and Outfall-2 at concentrations ranging from 23 µg/l in MW-7B to 140 µg/l in MW-5A (150 µg/l in DUP-1).

- *Fluoranthene* was detected in MW-8B at 19 µg/l and 22 µg/l in Outfall-2.

- *Fluorene* was detected in 6 monitoring wells and Outfall-2 at concentrations ranging from 23 µg/l in MW-7B to 120 µg/l in MW-8B and MW-8B2 and DUP-1 (MW-5).

- *Naphthalene* was detected in 8 monitoring wells and Outfall-2 at concentrations ranging from 74 µg/l in MW-7B to 6,600 µg/l in MW-8B2 (8,800 µg/l in DUP-1 (MW-5)).

- *Pentachlorophenol* was detected in 7 monitoring wells and Outfall-2 at concentrations ranging from 88 µg/l in MW-7 to 4,300 µg/l in MW-8B2.

- *Phenanthrene* was detected in 8 monitoring wells and Outfall-2 at concentrations ranging from 9.8 µg/l in MW-12A to 130 µg/l in MW-8B and Outfall-2.

- *Phenol* was detected in MW-8B at 10 µg/l and at 26 µg/l at Outfall-2.

- *Pyrene* was detected at Outfall-2 at 10 µg/l only.

- *2-Picoline* was detected at Outfall-2 at 15 µg/l only.

E-5c Trend Analysis

Concentration versus time graphs were prepared for VOCs, SVOCs, and metals for selected wells with one or more constituents exceeding a GPS limit. The graphs are provided in the Graphical Data labeled appendix. Trends for each compound group are discussed in the following italicized sections.

VOCs

VOC concentrations versus time graphs were prepared for wells MW-3A, MW-3B, MW-5A, MW-6R, MW-7, MW-7B, MW-8, MW-8A, MW-8B, MW-8B2, MW-9, MW-10, MW-12, MW-12A, MW-13, and MW-14. The graphs were reviewed for fluctuations in peak concentrations over time to evaluate up-ward or downward trends in contaminant migration. Concentration changes over time are often caused by vertical water table fluctuations “washing” sorbed constituents into the dissolved phase versus actual plume migration. A review of the VOC graphs indicated decreasing trends or slightly decreasing trends for MW-3B, MW-5A, MW-6R, MW-7, MW-7B, MW-8, MW-8A, MW-8B, MW-8B2, MW-10, and MW-12A. Stable trends were observed for MW-3A, MW-9, and MW-14 (non-detect, same as previous sampling event). Increasing (or slightly increasing) trends were observed for MW-12, MW-12A, and MW-13. All of the graphs reveal concentration trends consistent with historic data. The other wells sampled had non-detect concentrations, the same as recent sampling events, therefore trend graphs were not included. Likewise, trend graphs were not prepared for wells with limited historic data.

SVOCs

SVOC concentration versus time graphs were prepared for the following wells: MW-3A (non-detect and stable trend), MW-3B (downward trend), MW-5A (downward trend), MW-7 (downward trend), MW-7A (downward trend), MW-7B (stable trend), MW-8 (non-detect and stable), MW-8A (non-detect, downward), MW-8B (slightly downward), MW-8B2 (slightly upward trend), MW-10 (non-detect and stable), MW-12 (downward trend), and MW-12A (upward trend). In March 2019, MW-7A had a record high total SVOC concentration of 2,187.1 µg/L. MW-3A, MW-8, MW-9 and MW-10 indicated non-detect concentrations, the same as recent sampling events. The other wells sampled had non-detect concentrations, therefore trend graphs were not included. All increases and decreases appear consistent with historic trends.

Carbazole was detected in MW-12 and MW-12A for the first time in March 2019 at low concentrations of 12.3 and 17.2 µg/L, respectively. Acenaphthene was detected in MW-7A for the first time at a concentration of 32.6 µg/L. Carbazole and Acenaphthene have both been detected in other wells on site.

Metals

Historically, metals concentrations versus time graphs have been prepared for wells MW-1, MW-2, MW-3, MW-3A, MW-4, MW-5R, MW-6R, MW-7, MW-7A, MW-7B, MW-8, MW-9, MW-10, MW-11, MW-12, MW-12A, MW-13, and MW-14. A review of the graphs have generally indicated declining or stable trends over time for MW-2, MW-3, MW-7, MW-7A, MW-7B, MW-8, MW-9, MW-10, MW-12, MW-12A, MW-13, and MW-14. In April 2018, dissolved metals were evaluated in a reduced number of wells including MW-2, MW-3, MW-6R, MW-8, and MW-12. The concentration trends were similar with mostly declining, stable trends and a slight increase observed in MW-3, consistent with historic fluctuations.

The trends in metals concentrations over time is attributed to natural fluctuations in background metals concentrations in the groundwater or fluctuating turbidity levels in the samples collected.

E-5d Appendix IX Sampling Results

A full round of Appendix IX sampling data was collected from MW-6R in April 2018 and from MW-11 during the April 2021 event. In accordance with the revised Sampling and Analysis Plan (SAP), Appendix IX sampling is performed triennially on a rotating basis using one of the three POC wells, such that each well is sampled every nine years. The purpose of the Appendix IX sampling is to identify any new constituents that need to be added to the facility Permit. The samples are collected from the dissolved phase only to assess the presence of constituents that have leached out from the NAPL phase or migrated down-gradient. The complete Appendix IX analysis included the following analytical methods:

- Micro-Extractable Volatile Organics (SW8011)
- Chlorinated Pesticides (SW8081B)
- Polychlorinated Biphenyls (SW8082A)
- Chlorinated Herbicides (SW8151A)
- Appendix IX Metals (SW6020A/B)
- Total Mercury (SW7470A)
- Appendix IX Semi-Volatile Organics [SW8270D (2018) & SW8270E (2021)]
- Appendix IX Volatile Organics [SW8260B (2018) & SW8260D (2021)]
- Cyanide (SW9014)
- Sulfide (SW9030/9034)
- Dioxins/Furans (Method 8290)

All constituents were non-detect for Micro-extractable Volatile Organics, Chlorinated Pesticides, Polychlorinated Biphenyls (PCBs), Chlorinated Herbicides, Mercury, Cyanide, and Sulfide. VOCs, SVOCs, Metals, and Dioxins detected are discussed above in Section E-5b. Based on the April 2021 analytical results, 2,4,5-Trichlorophenol was detected at a concentration of 26.0 µg/L at MW-11. On December 28, 2021, MW-11 was resampled and 2,4,5-Trichlorophenol was detected at a concentration of 67 µg/L. Based on the 2021 analytical results, the Permit was modified to include 2,4,5-Trichlorophenol. The April 2021 Appendix IX sampling results are provided in **Table E-8**.

E-5e Horizontal Extent of Contaminant Plumes

Isoconcentration maps depicting the horizontal extent of non-chlorinated VOCs, chlorinated VOCs, and SVOCs are provided as **Figures E-9A-D** through **E-11A-D**. These maps were prepared using data from the January-February 1999, April 2009, April 2019, and April 2023 sampling events. The horizontal extent of metals using data from April 2021 is depicted on **Figure E-12**. The horizontal extent of total VOCs was divided into non-chlorinated and chlorinated VOCs due to distinct differences in the distribution of these regulated constituents.

The horizontal extent of total non-chlorinated VOCs is depicted on **Figures E-9A, E-9B, E-9C**, and **E-9D**. A review of these figures indicates that two plumes are depicted associated with the HWMU and SWMU#s 9 and 10. The main plume is associated with the HWMU with higher concentrations observed in the POC wells and lower concentrations terminating at or slightly north of MW-3 and MW-8. The smaller plume is located around the MW-12 well cluster and appears to be the result of cumulative discharges originating at the storm drain outlet (SWMU #10). The extent of this plume has not been determined.

The horizontal extent of chlorinated VOCs currently includes the following compounds: Tetrachloroethene, Trichloroethene, 1,1-Dichloroethene, and 1,2-Dichloroethane, depicted in **Figures E-10A, E-10B, E-10C**, and **E-10C**. These compounds have historically been detected in low level concentrations in wells MW-8, MW-10, MW-12/12A, MW-13, and MW-14 only but were also detected in wells MW-8A, MW-8B, and MW-8B2, installed during more recent Phase 3 vertical delineation efforts. A source for these compounds has not been detected in the POC wells and no historical records exist to support their use at this facility. Based on detections in up-gradient/cross-gradient well MW-14, the source for the chlorinated compounds is likely located off-site. A review of the figures indicates the horizontal extent of the dissolved chlorinated VOCs has been delineated to the south only.

The horizontal extent of SVOCs is depicted on **Figures E-11A**, **E-11B**, **E-11C**, and **E-11D**. Total SVOCs have generally been detected at this site in concentrations an order of magnitude higher than VOCs. A review of these figures indicates that two plumes are depicted associated with the HWMU and SWMUs 9 and 10, similar to the non-chlorinated VOCs. The horizontal extent of the larger SVOC plume has been delineated to the south by MW-1, to the west by MW-4 and MW-2, to the north by MW-3, and to the east by MW-14.

The horizontal extent of dissolved metals is depicted in **Figure E-12** for the April 2021 sampling event. As observed in the figure, metals detections (particularly barium) appear to be sporadic and are largely attributed to naturally occurring metals in the soil. Dissolved barium, chromium, copper, and zinc have historically been detected in background well MW-1. Due to the lack of a defined source and sporadic distribution, contour lines were not drawn on **Figure E-12**.

E-5f Vertical Extent of Contaminant Plumes

Utilizing the April 2023 analytical results, the vertical extent of VOCs and SVOCs is illustrated on cross-sections A-A’, B-B’, and C-C’ and presented as **Figures E-13A-C** through **E-14A-C**. Due to limited data, the lack of a defined source, and metals distribution; cross-sections were not generated for dissolved metals. Vertical extent data was previously limited to MW-7A/7B, MW-3A, and MW-12A. Monitoring wells MW-8A, MW-8B, and MW-8B2, installed during the 2016-2017 Phase 3 supplemental investigations, were added to geologic cross-sections A-A'. Likewise, MW-3B, also installed during the 2016-2017 Phase 3 supplemental investigation, was added to cross-sections B-B' and C-C' for additional clarification of geologic conditions and vertical distribution of regulated constituents.

A review of **Figures E-13A-C** for VOCs indicates that the vertical extent of the dissolved plume in the shallow saprolite-PWR zone, emanating from the HWMU, extends into the partially weathered rock at MW-7A and MW-8A. The plume also extends vertically into the fractured bedrock, based on VOC concentrations observed in MW-7B, MW-8B, and MW-8B2. At the MW-7 well cluster, VOCs are delineated vertically by MW-7B2 (historically non-detect for all VOCs at a screened interval of 195-200 ft-bgs). VOC concentrations at MW-8 well cluster extend to the deepest vertical fracture zone at MW-8B2 (153 ft-bgs) and have not been vertically delineated. Similarly, VOCs at the MW-3 well cluster extend into the fractured bedrock and have not been vertically delineated. As detailed above, MW-3B was installed to a depth of 200 ft-bgs and was constructed as an open-rock well with the deepest fracture zone observed at 175 to 180 ft-bgs. It is conceivable that the fracture zones observed at MW-3B and MW-8B2 are hydraulically connected; however, additional investigations (i.e. aquifer tests, fracture zone analysis, tracer tests, etc.) would be required to investigate hydraulic pathways in the bedrock. While VOCs at the MW-3, MW-8, and MW-12 well clusters have not been vertically delineated, the deepest bedrock screened zone at the site in MW-7B2 (screened interval of 195-200 ft-bgs) has historically been non-detect for VOCs.

A review of **Figure E-13C** indicates that the vertical extent of the dissolved VOC plume detected in MW-12 and MW-12A and associated with SWMU#10 has not been delineated. VOC concentrations in both wells are similar. MW-12A was advanced into the top of the PWR in weathered schist bedrock but not to auger refusal. Additional vertical delineation will be required to delineate the extent of dissolved VOCs in this area.

A review of **Figures E-14A-C** for SVOCs indicates that the vertical extent of the dissolved plume in the shallow saprolite-PWR zone extends into the PWR at MW-7A and MW-8A, and then vertically into the fractured bedrock at MW-7B, MW-8B, and MW-8B2. At the MW-7 well cluster, SVOCs are vertically delineated by MW-7B2 (non-detect for all SVOCs). As observed with VOCs, while SVOCs at the MW-3, MW-8, and MW-12 well clusters have not been vertically delineated, the deepest screened bedrock zone observed at the site in MW-7B2 (screened interval of 195-200 ft-bgs) remains non-detect for SVOCs.

E-6 General Monitoring Program Requirements (40 CFR 270.14(c)(5);264.90(b)(4); 264.97)

The general monitoring program requirements are described in the subsections below.

E-6a Description of Wells (40 CFR 270.14(c)(5); 264.97(a),(b),(c))

A total of -27- monitoring wells are currently located at the facility. Most of the wells are installed in the shallow residuum saprolite-fill with the exception of intermediate depth (top-of-rock) wells, designated by an “A” after the number (MW-3A, MW-5A, MW-7A, MW-8A, and MW-12A) and deep bedrock wells, designated by a “B” or “B2” after the well number (MW-3B, MW-7B, MW-7B2, MW-8B, and MW-8B2). Wells MW-5R, MW-6R, and MW-11 are designated as POC wells. MW-5R and MW-6R were installed as replacement wells following closure of the HWMU which resulted in the subsequent abandonment of MW-5 and MW-6. Monitoring wells HWMU-1, HWMU-2, and HWMU-3 were installed to assist in determining if the wood preserving area, which includes Solid Waste Management Units (SWMUs) 1, 2, 3, 4, 6, and 7 are a source of NAPL detected down-gradient/cross-gradient of the HWMU. Monitoring well descriptions are provided in **Table E-1**.

E-6b Description of Sampling and Analysis Procedures (270.14(c)(5); 264.97(d),(e),(f))

Post-closure monitoring is currently conducted on an annual basis during the month of March of the calendar year. Sampling procedures followed are described in the Quality System and Technical Procedures for LSASD Field Branches US-EPA, Region 4, LSASD, Athens, Georgia (https://www.epa.gov/quality/quality-system-and-technical-procedures-lsasd-field-branches). Specifics of the sampling and analysis procedures are described below in the italicized sections.

Groundwater Depth Gauging

Prior to collecting samples, the total depth of each well and depth to groundwater is measured in all of the monitoring wells. Water level measurements are taken from the marked surveyed side of each well casing using an electronic water level indicator/interface probe with a 0.01-foot accuracy. The top of casing survey was performed by a licensed surveyor using site benchmarks. Historically wells containing NAPL (MW-5R, MW-6R, MW-11, HWMU-2 and HWMU-3) are gauged using an electronic interface probe. Due to the high specific gravity of the creosote based NAPL, the interface probe often does not provide a reliable tone reading but acts more as a graduated measuring tape.

To limit cross-contamination, measurements are taken starting with wells historically containing non-detect levels of regulated constituents and progressing to wells with higher constituent levels. All measurements are recorded in a field notebook for use in calculating purge volumes and groundwater elevations. The water level indicator is decontaminated between each well by rinsing with a phosphate-free detergent, potable water, and de-ionized water in accordance with procedures described in Region 4 LSASD protocols. Calculated groundwater elevations are added to the Groundwater Elevation Table (**Table E-3**) along with historic data.

Groundwater Purging Procedure

After the collection of static water levels from the wells, the standing water column or well volume is calculated for each well to determine purge volumes. The calculation used for determining the volume of water in each well is as follows (based on a 2-inch diameter well):

$$\mathbf{V = 0.163 * h}$$

Where:

V = Volume of water in gallons
0.163 = gallons/foot conversion (2" well)
h = height of water column in feet

Prior to well purging, the ground surface around each well is prepared by placing disposable polyethylene sheeting around the well heads. Field purging is performed under "low flow" conditions using a peristaltic or submersible pump (RediFlo2-type) with dedicated disposable tubing. The quantity of water removed from each well is gauged using graduated buckets. During purging, the sampling technician measures and records pH, conductivity, temperature, dissolved oxygen (DO), and turbidity on a continuous basis using a multi-parameter meter equipped with a "Flow-Through" Cell. This meter is calibrated prior to use in the field to ensure accurate data collection. Parameter stabilization is evaluated in accordance with Region 4 LSASD sampling protocols. Stabilization generally occurs after removal of one to three well volumes when pH, conductivity, temperature, and turbidity readings agree within 10% and turbidity values are <10 NTUs. When stabilization of the parameters occurs, purging is halted. In the event that stabilization does not occur after three volumes are removed, purging is continued up to the removal of five well volumes or parameter stabilization, whichever occurs first. The parameter measurements, purge volume data, and other general field sampling observations are recorded on well sampling logs and/or in a field book.

Sample Collection

Groundwater samples are collected in a specific order to reduce the potential for cross contamination between wells. In general, the sampling is conducted from least contaminated to most contaminated based upon a review of the prior sampling event results or historic trends. POC wells containing measured or observed NAPL are not sampled with the exception of one well-chosen every three years for Appendix IX sampling.

Samples are collected after purging is complete using dedicated disposable tubing carefully lowered into the top of the well screen interval to minimize disturbance of the water column. Laboratory supplied containers are utilized for sample collection. Special care is taken when filling sample vials for VOC analyses to ensure minimal disturbance of the sample and zero head space conditions. Each vial is individually checked for the possible entrapment of air bubbles immediately after sample collection. Upon collection, each sample container is assigned a unique sample identification number and is placed in an insulated cooler on ice. A laboratory Chain-of-Custody form is completed for each cooler. The Chain-of-Custody form is provided by the analytical laboratory and includes the sample date, sample time, sample identification, type of sample, and the requested analytical method. Sample coolers are hand delivered to a local EPD approved laboratory for analysis.

Sampling Plan and Analytical Methods

On March 29, 2018, a Class III Permit Modification was approved for the WCM facility. The revised permit reduced the sampling frequency from semi-annual to annual monitoring events. The previous sampling program consisted of the collection of groundwater samples in January and July of the calendar year, with the January event consisting of an abbreviated network. The current sampling program consists of annual sampling (March of each year) and analysis of VOCs, SVOCs, Metals (every three years) and Sulfide, with select wells sampled every other year. POC wells are sampled once every nine (9) years (one well every three (3) years) on a rotating basis for Appendix IX and Dioxin analysis. Monitoring well MW-7B is sampled once every three years for Dioxin analysis. Monitoring wells MW-2, MW-3, MW-5R, MW-8, and MW-12 are sampled once every three years for site-specific metals analysis. POC wells are sampled annually if NAPL is not present. Wells installed as part of corrective action activities/SWMU investigations (HWMU-1, HWMU-2, and HWMU-3) are gauged but not sampled during an annual event.

The April 2018 sampling event served as the baseline event for the sampling plan schedule and required the collection of samples from the following 24 onsite monitoring wells:

MW-1, MW-2, MW-3, MW-3A, MW-3B, MW-4, MW-5R (NAPL – No Sample), MW-5A, MW-6R (NAPL – Appendix IX), MW-7, MW-7A, MW-7B, MW-7B2, MW-8, MW-8A, MW-8B, MW-8B2, MW-9, MW-10, MW-11 (NAPL – No Sample), MW-12, MW-12A, MW-13, and MW-14.

All samples were analyzed for VOCs using EPA Method SW8260B, SVOCs using EPA Method SW8270D, and Sulfide using EPA Method SW9034. Monitoring wells MW-2, MW-3, MW-8, and MW-12 are analyzed for metals using EPA Method SW6020B. The POC wells, MW-5R and MW-11 were excluded from sampling due to measurable NAPL. POC well MW-6R also contained NAPL but was sampled for Appendix IX constituents to satisfy permit requirements.

Under the current sampling program, the following 17 monitoring wells are sampled on an annual basis:

MW-3A, MW-3B, MW-5R, MW-5A, MW-6R, MW-7, MW-7A, MW-7B, MW-8, MW-8A, MW-8B, MW-8B2, MW-9, MW-10, MW-11, MW-12, and MW-12A.

All samples are analyzed for VOCs using EPA Method SW8260D, SVOCs using EPA Method SW8270E, and Sulfide using EPA Method 9034. The POC wells, MW-5R, MW-6R and MW-11 are excluded when measurable NAPL is present.

Under the current sampling program, the following seven (7) monitoring wells are sampled every two (2) years:

MW-1, MW-2, MW-3, MW-4, MW-7B2, MW-13, and MW-14.

All samples from these wells will be analyzed using the methods described above. As discussed above, monitoring wells MW-2, MW-3, MW-5R, MW-8, and MW-12 are sampled once every three years for site-specific metals analysis, MW-7B is analyzed for Dioxins every three years, and one POC well is selected on a rotating basis every three years for Appendix IX parameter analysis. The Appendix IX sampling protocol includes the following analytical methods:

- Micro-Extractable Volatile Organics (SW8011)
- Chlorinated Pesticides (SW8081B)
- Polychlorinated Biphenyls (SW8082A)
- Chlorinated Herbicides (SW8151A)
- Appendix IX Metals (SW6020A)
- Total Mercury (SW7470A)
- Appendix IX Semi-Volatile Organics (SW8270E)
- Appendix IX Volatile Organics (SW8260D)
- Cyanide (SW9014)
- Sulfide (SW9030/9034)
- Dioxins/Furans (Method 8290)

In prior correspondence, EPD requested analysis of pentachlorophenol using EPA Method 8151A in order to achieve a lower detection limit. Since lower detection limits can now be obtained using EPA Method 8270E, especially if the SIMs Method is utilized, it was agreed that pentachlorophenol analysis will continue using Method 8270E until such time as a Corrective Action/Remedy or NFA determination is proposed. Final confirmatory sampling will include a minimum of two semiannual sampling events utilizing Method 8151A for confirmation of acceptable levels of pentachlorophenol.

The current sampling plan is described in Section E-9(e) and detailed on **Table E-10**.

Quality Assurance and Quality Control

An internal Quality Assurance/Quality Control (QA/QC) Plan is followed by Envirorisk personnel to ensure the integrity of the data obtained during each sampling event. The QA/QC Plan includes requirements for experience of field personnel, record keeping, chain-of-custody documentation, sample equipment, sample preservation, and sample shipping and handling.

Quality control samples collected during each sampling event include trip blanks, equipment rinse blanks, and field duplicates. Trip blanks are created and sealed by the laboratory using de-ionized water and accompany each cooler in the field. Based on the number of coolers required per sampling event, 3-to-4 trip blanks will be stored and analyzed per event. The trip blank samples will be analyzed for VOCs only. One equipment rinse blank (referred to as sample ERB) will be collected per sampling event to document the effectiveness of decontamination procedures when a submersible pump is utilized. This sample will be analyzed for VOCs only due to the higher solubility and volatility of these compounds. One field duplicate will be collected from a well with historic detections randomly chosen during the sampling event. Duplicate samples are collected and analyzed to assist in validating the laboratory's ability to reproduce data and to ensure that field conditions did not compromise sample integrity. The duplicate will be assigned a unique sample identification number such that the receiving laboratory will not be able to recognize the sample as a duplicate. The duplicate samples will be analyzed for all of the constituents required for the well sample that is being duplicated.

Prior to reporting the data to the EPD, a review and evaluation of the quality control sample results will be performed. If significant concentration variances are noted between the duplicate sample and original well sample, the laboratory will be required to re-analyze both samples. If continued discrepancies are noted, additional samples will be collected from the wells and re-analyzed. In the event that detected constituents are observed in the field equipment blank or trip blanks, re-analysis of the blank samples will be required. If the presence of the detected constituents is confirmed, re-sampling of selected wells will be performed, as needed.

Disposal of Purge Water

All purge water generated during well sampling is temporarily stored in containers/drums prior to being transferred into the on-site wastewater treatment system for disposal/recycling.

E-6c Procedures for Establishing Background Quality (40 CFR 270.14(c)(5); 264.97(a)(1),(g)

Groundwater background quality will be determined using the up-gradient well MW-1. The statistical procedures for determining background concentrations are discussed in Section E-9e(3).

E-6d Statistical Procedures (40 CFR 270.14(c)(5); 264.97(h)(i)(1),(5),(6)

Statistical analysis will be deferred until concentrations of regulated constituents have declined sufficiently such that the facility desires to terminate corrective action. A permit modification will be requested at that time. Concentration versus time graphs have been prepared for wells exceeding GPS concentrations in order to establish reduction trends over time.

E-7 Detection Monitoring Program (40 CFR 270.14(c)(6); 264.91(a)(4);264.98)

This section is not applicable due to prior knowledge of hazardous constituents detected in the groundwater at this facility. In lieu of a Detection Monitoring Program, a Correction Action Program is in place as described in Section E-9.

E-8 Compliance Monitoring Program (40 CFR 270.14(c)(7); 264.99)

This section is not applicable since a Correction Action Program is in place as described in Section E-9.

E-9 Corrective Action Program (40 CFR 270.14(c)(8); 264.99(j);264.100)

Corrective action conducted at this facility has included the in-place closure of the former surface impoundment (HWMU) followed by the installation of a groundwater extraction and treatment system. A characterization of regulated constituents in groundwater followed by a description of the corrective action plan and on-going monitoring and reporting requirements is provided in this section.

E-9a Characterization of Contaminated Groundwater (40 CFR 270.14(c)(8)(i))

Characteristics of regulated constituents in groundwater are described in detail in Section E-5. The hazardous constituents detected in the groundwater beneath and down-gradient of the HWMU has included a mixture of dissolved VOCs, SVOCs, metals, and dioxins. NAPL has been detected in POC wells and HWMU-2 and HWMU-3 located on the southern end of the impoundment. During the most recent April 2023 sampling event, detections included a total of 10 VOCs and 19 SVOCs. Metals samples were most recently collected during the April 2021 sampling event with a total of 12 metals detected. Current and historic compounds detected along with their GPS limits are shown on **Tables E-4** through **E-6**.

VOCs have historically been detected in trace to low concentrations as compared to the more predominant SVOCs contained in creosote and pentachlorophenol. The distribution of non-chlorinated VOCs and SVOCs indicate the presence of two dissolved plumes. The larger plume is located immediately down-gradient of the HWMU; while the smaller plume appears to be associated with releases at SWMUs 9 and 10. Chlorinated VOCs have historically been detected in wells down-gradient and cross-gradient to the east-northeast of the HWMU. The source of the chlorinated VOCs appears to be from an off-site source. Dissolved metals detected at the site are not commonly associated with creosote and pentachlorophenol wood treatment wastes. Historically, metals concentrations have varied presumably due to naturally occurring concentrations in the groundwater and/or turbidity. Dioxins have been reported in POC wells; however, the detections are likely attributed to the presence of NAPL and/or entrained sediment in the wells. Dioxins were detected in MW-7B (located down-gradient of the HWMU) during July 2015, July 2016, April 2018, and April 2021 sampling events. Prior to these events, Dioxins had not been detected in MW-7B.

E-9b Concentration Limits (40 CFR 270.14(c)(8)(ii); 264.94;264.100(a)(2))

The maximum concentration limits for constituents in the dissolved plume associated with releases from the HWMU are listed in Table 1 of 40 CFR 264.94 or are defined by background concentrations if not listed. Concentration limits (GPS limits) are shown on **Tables E-4** through **E-6**. Note that for regulated constituents associated with SWMUs or sources other than the HWMU, alternative concentration limits may be sought at a future date.

E-9c Alternative Concentration Limits (40 CFR 270.14(c)(8)(ii); 64.94(b); 264.100(a)(2))

This section is not applicable at this time.

E-9d Corrective Action Plan (40 CFR 270.14(c)(8)(iii);264.100(b))

The first remedial action at the facility was started in 1986 and completed in 1989 with the permitted closure of the surface impoundment. The surface impoundment clean-up was accomplished by constructing three PVC lined aeration treating lagoons inside the north end of the former pond area. During the closure period, impacted wastes were pumped into the aeration lagoons and treated biologically to reduce levels of hazardous constituents. After two years of treatment, the surface impoundment liquids and sludges that had been treated and the remaining contaminated solids were encapsulated with quick lime to solidify the remaining constituents to prevent leaching into the groundwater. Detoxified residues were left in-place in the surface impoundment for final capping via placement of a polyethylene synthetic impervious liner, two-feet of soil cover, and Bermuda grass cover. Further details on the impoundment closure are provided in Section I.

Since the impoundment was not “clean closed”, a Post-Closure Care monitoring system followed by subsequent groundwater corrective action was required. From 1982 to 1989, a series of groundwater monitoring wells (MW-1 through MW-11, including MW-5R and 6R replacement wells) were installed to delineate the extent of groundwater contamination from the former impoundment.

The highest concentrations of regulated constituents (including NAPL) were detected in MW-5R, MW-6R, and MW-11 which were later designated as POC wells. In 2004, five additional monitoring wells (MW-3A, MW-12, MW-12A, MW-13, and MW-14) were installed to better delineate the down-gradient extent of dissolved constituents. In 2013, top of bedrock monitoring well MW-5A and deep bedrock monitoring well MW-7B2 were installed during Phase 3 corrective action efforts to better delineate the vertical extent of dissolved constituents. In November 2016–August 2017, top of bedrock monitoring well MW-8A and deep bedrock monitoring wells MW-3B, MW-8B, and MW-8B2 were installed and discrete sampled in various bedrock fracture zones during supplemental Phase 3 activities.

These wells were installed to further delineate the horizontal and vertical extent of regulated constituents in bedrock. In April 2017, Monitoring wells HWMU-1, HWMU-2, and HWMU-3 were installed to determine if SWMUs 1, 2, 3, 4, 6, and 7 in the wood preserving area are a source of NAPL (LNAPL) detected down-gradient/cross-gradient of the HWMU.

In 1989, a four-inch diameter groundwater extraction well, PW-1, was installed for product removal and hydraulic control along the down-gradient end of the former impoundment. In May 1990, a 24-hour aquifer test was performed by EFT, Inc. under the direction of Earl Titcomb, P.G. to evaluate drawdown and an optimum pumping rate for PW-1. During the aquifer test, groundwater depth readings were collected from surrounding monitoring wells to evaluate the extent of groundwater drawdown. The test results indicated a sustained groundwater flow rate of 2.84 gallons per minute (gpm). Significant drawdown greater than 0.1 feet was measured as far away as MW-4 (west) and MW-10 (north). The findings suggested that continuous extraction from PW-1 would aid in the hydraulic control of the dissolved plume. Drawdown curves are provided in the Aquifer Data appendix. The well capture zone for PW-1 is depicted on **Figure E-15**.

Later in 1990, groundwater extraction was initiated using PW-1. Groundwater was pumped from PW-1 into the existing wastewater treatment system prior to discharge into the City sewer system under a sanitary discharge permit. In 1993 and later in the mid-late 1990s, EFT excavated a groundwater interceptor trench along the northern end of the impoundment to provide an additional means of hydraulic control. The trench was reportedly excavated to a depth of approximately 24-26 ft-bgs beneath the top of the water table. Deeper trench depths could not be achieved due to cave-in. The trench was lined with crushed stone along the base and three 30" diameter vertical extraction points (TA, TB, and TC) were constructed using steel corrugated pipe, slotted in the lower five feet. Due to the subsequent decline in the water table, the trench has not been utilized for product recovery and groundwater extraction.

In November 1995, the treatment system was upgraded by adding a filter press to treat sludge from the wood treating operations as well as the groundwater extraction system. In September 1996, chemical flocculant tanks were added to remove high levels of constituents from the wastewater prior to biological treatment using an Allied Signal Immobilized Cell Biotreater (ICB) system. The Allied ICB system has four aerated biological compartments packed with carbon impregnated foam cubes and plastic air rings. The carbon foam cubes were designed to uptake the organic compounds from the wastewater and allow biological enzyme growth to degrade the organics to non-hazardous carbon and water. A sand filter was also added to remove the biological solids prior to activated carbon treatment before discharge into the city sewer system.

In December 1998, an oil/water separator tank was installed to remove creosote DNAPL extracted from PW-1 prior to wastewater treatment. The DNAPL pump system in PW-1 operated at a flow rate of approximately 36 gallons per day (gpd). Attempts to operate the system at higher flow rates were unsuccessful due to iron or sludge fouling in the treatment system components.

The system operated continuously until September 2004 when a lightning strike damaged the pump control cabinet and interrupted operations. The system was repaired, and extraction was resumed in October 2004.

In June 2006, the DNAPL pump was shut down again due to a lightning strike. In June 2007, after receiving approval from a Work Plan submitted to the EPD, a new Blackhawk® DNAPL piston pump was installed in PW-1, along with additional tanks and transfer pumps. The extraction system was operated at a flow rate of 1 gpm or 1440 gpd until the system was shut-down due to excessive iron fouling.

To supplement DNAPL recovery, a two-inch diameter Abanaki Petro Xtractor® (loop skimmer) was installed in the POC wells to allow DNAPL skimming using a rotating belt system. Due to a decline in DNAPL thicknesses to quantities below 3 inches, this skimmer could not be successfully utilized. In December 2008, a new gravity separator outflow was added to the treatment system along with a new collection tank and transfer pump to the plant wastewater treatment system. Continuous groundwater withdrawal has occurred since late December 2008 at approximately -288- gpd, with the exception of minor stoppages due to freezing weather. Sufficient DNAPL is not present in the POC wells to allow operation of the loop skimmer. A schematic showing the treatment system components and operation is provided as **Figure E-16**.

In May 2011, a revised Corrective Action Plan (RCAP) was developed and approved concurrent with the Part B Permit renewal. The RCAP included plans for expanded source area assessments, SWMU evaluations, vertical delineation, remedial pilots, and corrective action divided into separate phases (Phases 1-8). Each RCAP phase of work was provided in a separate progress report with detailed maps, tables, and other supporting data. A summary of the RCAP phases of work is provided in the italicized sections to follow.

Phase 1 - HWMU Source Area Assessment & NAPL Delineation

Phase 1 was initiated in October 2011 and included the installation of twelve (-12-) temporary wells (TW-1 through TW-12) to depths of approximately 32-34 ft-bgs. The temporary wells were located to the north, east, and west of the HWMU fenced area (refer to **Figure E-17**). The primary focus of this investigation was to fill data gaps regarding the extent of NAPL, impacted soils, and dissolved VOC/SVOCs requiring corrective action. The results indicated an expanded area of NAPL was detected in TW-3, TW-6, TW-10, TW-11, and TW-12, down-gradient or cross-gradient of the POC wells. VOCs/SVOCs were detected in shallow fill soils and deeper saturated soil zones above and below the water table. Additional NAPL delineation was recommended for completion in conjunction with Phase 2 investigations.

Phase 2 - SWMU Delineation at the Treatment Area

Phase 2 was conducted in July 2012 and included the installation of thirteen (-13-) soil borings at SWMU areas 1, 4, 6, and 8 and three (-3-) background borings. Additional delineation associated with Phase 1 included the installation of ten (-10-) temporary wells (TW-13-TW-21, TW-23, and SB-22) for NAPL gauging. The soil analytical results indicated the presence of similar VOCs/SVOCs/metals in the temporary wells and SWMU soil samples as detected in previous investigations. NAPL was detected in temporary wells TW-3, TW-6, TW-7, TW-10, TW-11, TW-12, TW-13, TW-15, TW-16, TW-19, TW-20, and SB-22.

The findings indicated the extent of NAPL covered an area of approximately 39,000 square feet (SF) to the north, west, east, and southeast of the HWMU (refer to **Figure E-18**). The estimated volume of NAPL in this area is approximately 3,900 cubic feet (or 29,172 gallons), conservatively assuming a continuous zone of NAPL (versus discrete pockets) with an average thickness of 0.1 foot. In addition, the VOC plume in saturated soils (16-36 ft-bgs), not counting SWMU areas, was estimated at 40,274 SF or 29,833 cubic yards (CY) and the SVOC extent in saturated soils 64,346 SF and 47,664 CY.

Phase 3 - Vertical Bedrock Delineation

Phase 3 investigations were performed January–March 2013 and included the installation of top-of-rock well MW-5A, adjacent to MW-5R, and MW-7B2 in the MW-7 well cluster for deeper bedrock delineation. In addition, soil sampling for metals and dioxins/furans and additional groundwater delineation was performed to satisfy EPD comments. The vertical soil sampling and logging evaluation for MW-5A identified “creosote-like” product zones from 22-23 ft-bgs and “pockets” of product from 23-31 ft-bgs in fill materials. MW-7B2 was advanced through fractured and competent bedrock and was set at 200 ft-bgs. Discrete samples collected from 148-150 ft-bgs and 173-175 ft-bgs indicated detectable concentrations of VOCs/SVOCs with higher concentrations of SVOCs observed (namely naphthalene and pentachlorophenol). The sample collected from MW-7B2 at a screened interval of 195-200’ was non-detect for target constituents.

The additional metals analysis from background borings aided in the determination that the source of metals is native minerals in the soil resulting from the in-place weathering of bedrock. Additional groundwater data from Phase 3 investigations was used to update estimates of the total dissolved VOC and SVOC plume extent. The estimated total area of the main non-chlorinated VOC plume in the upper aquifer is approximately 92,870 SF. A review of the horizontal extent of SVOCs indicates concentrations generally an order of magnitude higher than VOCs, with the main SVOC plume in the upper aquifer estimated at 136,734 SF.

Phase 4 - SWMU 9 & 10 investigations

In 2014-2017, a series of Phase 4 investigations were conducted in the drainage area behind the office and included the intermittent creek, main storm sewer utility line cross cutting the property, and the storm drainage culvert. The investigations included several iterations of temporary well installation (including shallow/intermediate depth wells), soil, sediment, and surface water sampling, and collection of surface water/sediment from outfall locations utilized as part of the facility's storm water monitoring program. The findings of the investigations indicated the presence of regulated constituents from multiple potential sources including shallow and intermediate groundwater baseflow, surface water/sediment migration/desorption, and discharge points for the City of East Point storm sewer line and collection system located on WCM property.

Based on the findings, an Interim Corrective Measures Work Plan was prepared in 2018 in an effort to treat and prevent off-site migration. This work plan provided plans for inventory relocation and the implementation of best management practices to control/mitigate storm water runoff.

Proposed corrective action included construction of a wetland cell(s) in the intermittent creek bed and placement of a phytoremediation (tree buffer) along the banks of the creek. After further discussion, implementation of the interim corrective action measures was delayed allowing time to collect additional data for evaluation of the complex network of pathways (i.e. surface water, sediment, groundwater, storm water, etc.). In November 2019, an Interim Measures Work Plan was prepared providing a plan to reduce erosion (including additional grading and installation of check dams), relocate inventory, reconstruct outfall locations, and implement quarterly sampling of select temporary well, surface water, and storm water outfall locations. The plan was approved in December 2019 and has been implemented.

Phase 5 - Treatability Evaluation

The Phase 5 Treatability Evaluation was performed from March-June 2014 to evaluate the use of various oxidants for potential injection and soil blending applications. The study included the collection of background soil and groundwater for soil oxidant demand (SOD) testing and preparation of a series of batch reactors for oxidant degradation testing. The batch reactors were constructed to evaluate catalyzed hydrogen peroxide (CHP), hydrogen peroxide combined with calcium peroxide, sodium percarbonate, sodium persulfate combined with Portland cement, sodium permanganate, and ozone. The laboratory results indicated that the most effective contaminant reduction was observed for the ozone reactor followed by sodium percarbonate, CHP/calcium peroxide, and sodium permanganate. Based on the findings, the following pilot tests were recommended:

- A source area large diameter auger (LDA) soil blending pilot utilizing sodium percarbonate, CHP combined with a catalyst/stabilizer (iron chelator), and un-catalyzed CHP;
- An ISCO pilot injection using sodium permanganate to evaluate use as a solid phase PRB; and
- An ozone pilot injection to evaluate for possible use as a source area or barrier treatment.

Phase 6 – ISCO Pilot Injection

An ISCO pilot injection was conducted from July - October 2014. The pilot included the installation of four observation wells OW-1, OW-2, OW-3, and OW-4 around the MW-7 well cluster followed by injection of approximately 1,500 gallons of a 10% solution of sodium permanganate. Injection was performed using four direct push injection points (ISCO-1 through ISCO-4). During the ISCO pilot, oxidant movement into target treatment areas was observed as well as initial oxidation of regulated constituents. The locations of ISCO injection pts and observation wells are depicted on **Figure E-19**. Additional ISCO evaluation and solid phase oxidant testing was recommended for future evaluation.

Phase 6A/6B – Soil Blending Pilot/Ozone Pilot

The soil blending pilot and ozone pilot were conducted from August 2014 - February 2015. The soil blending pilot involved limited soil removal for "ex-situ" oxidant treatment from four LDA pilot borings (PB-1, PB-2, PB-3, and PB-4) advanced to 30-35 ft-bgs using a "bucket" auger rig. Borings were located along the down-gradient end of the impoundment (see **Figure E-20**). Soils were blended using 1) hydrogen peroxide mixed with sodium citrate (an iron chelator) and iron sulfate, 2) sodium percarbonate and ferrous sulfate, 3) un-catalyzed hydrogen peroxide, and 4) sodium percarbonate mixed with ferrous sulfate and hydrogen peroxide. The results indicated successful NAPL removal and/or contaminant destruction using all four oxidant combinations. Due to an understanding of the current size of the NAPL plume, a decision was made to utilize soil oxidant blending in the future for localized area treatments, if needed, versus full scale application.

The ozone pilot consisted of the advancement of three ozone injection wells (OZTW-1A, OZTW-1B, and OZTW-3) along with five observation wells (OZOW-1 to OZOW-5) in the SWMU #6 area (refer to **Figure E-21**). The original scope proposed ozone well locations to the northeast; however, due to drilling refusal in this area and in an effort to treat the area around SWMU#6 prior to the installation of a new cylinder, the ozone pilot was relocated to the southeast, adjacent to the treatment area. Creosote NAPL and elevated dissolved SVOCs were observed in the pilot wells during baseline evaluation. The study was conducted using an ozone trailer connected to the three ozone injection wells using surface piping.

The ozone trailer was designed for delivery of approximately 16 grams/hour of ozone and was operated intermittently for -4- months, due to mechanical issues. The findings of the pilot determined that ozone appears suitable only for areas with little to no creosote NAPL and/or moderate dissolved concentrations.

The 2011 RCAP Phase investigations indicated a larger NAPL zone, thus the source zone remedial strategy was modified to include construction of a surfactant injection and recovery system. In addition, a permanganate oxidant permeable reactive barrier (PRB) was proposed for down-gradient plume control. This corrective action strategy was presented in the 2021 Part B Permit Application. EPD provided comments following their review of the 2021 Permit Application in a letter dated February 1, 2023. Specifically, comments #22 and #23 requested an updated phased corrective action plan. As such, in conjunction with this Permit Application, an updated RCAP was developed and is provided in the labeled appendix. A summary of proposed RCAP phases is provided below.

2024 Updated Corrective Action Plan

Based on the findings of prior remedial pilot testing, the goal of the updated corrective action plan is to collect data needed to upgrade the existing groundwater extraction and treatment system to provide a more effective means of site wide corrective action. Future supplemental remedial treatment may also be employed using one or more of the technologies previously evaluated during 2011 RCAP phases or a similar technology.

The updated corrective action work plan will be conducted in "phases" and is intended to be flexible enough to allow re-evaluation of the plan both from a cost and feasibility standpoint after each phase of work is complete. Some phases may be combined, all or in part, as a cost-saving measure.

The proposed phases of work are described below and detailed in the subsections. Further details including a milestone schedule for completion of RCAP phases and cost projection are included in the 2024 Updated RCAP, provided in the labeled appendix.

Phase 1 - Vertical Delineation and Recovery Well Installations
Phase 2 - Short-term Yield Testing and Aquifer Testing
Phase 3 - Source Area Recovery Well Installations and Treatment System Upgrade
Phase 4 - Supplemental Vertical Delineation Well Installations
Phase 5 - SWMU #9 and #10 Surface Water and Sediment Sampling Plan
Phase 6 - Soil and Groundwater Delineation at Storm Drain and Preserving Area
Phase 7 - Additional Recovery Wells for Cross-gradient/Down-gradient Plume Control
Phase 8 - Remediation of Vadose Zone Soils
Phase 9 - Supplemental Corrective Action Alternatives

Progress Reports detailing the results of each phase listed above will be submitted to the EPD for review. Each report will summarize the data collected in a comprehensive manner and describe any significant findings relevant to the need for corrective action modification and/or future CAP phase investigations along with an updated schedule.

Vertical Delineation and Recovery Well Installations (Phase 1)

In order to assess the migration of dissolved constituents in bedrock and expedite groundwater recovery system upgrades, additional intermediate (top-of-bedrock) and/or deep (bedrock) wells are proposed, as described below.

- MW-5B (air rotary), convert into bedrock recovery well;
- MW-12B/PRW-11(MW-12B (top-of-rock-auger install/air rotary); PRW-11 (auger))

Supplemental Vertical Delineation (Phase 4):
- MW-2A (top-of-bedrock-auger install) and MW-2B (bedrock-rock coring)
- MW-4A (top-of-bedrock-auger install) and MW-4B (bedrock-rock coring)
- MW-10A (top-of-bedrock-auger install) and MW-10B (bedrock-rock coring)
- MW-13A (top-of-bedrock-auger install) and MW-13B (bedrock-rock coring)
- MW-14A (top-of-bedrock-auger install) and MW-14B (bedrock-rock coring)

Note that the location and/or need for installation of the top-of-rock/bedrock well pairs will be determined after additional data evaluation (Phase 4).

In an effort to expedite source area recovery well installations/treatment system modification, vertical bedrock delineation in Phase 1 will be limited to MW-5B (PMW-5B), MW-12B (PMW-12B), and PRW-11. Proposed vertical delineation/bedrock monitoring wells are depicted on **Figure E-22.** MW-5B has been partially completed with a five to six-inch diameter outer casing installed into the top of bedrock at a depth of approximately 50 ft-bgs. Prior to air rotary drilling, installation of a larger diameter outer casing (8” to 10” stainless steel) may be required. The new outer casing, if needed, will be pressure grouted in-place on the exterior and interior casing surfaces, using Portland cement or equivalent, to provide a seal protecting against down-hole migration of groundwater. The outer casing will require one to two days to install with one or more additional days for concrete curing. MW-5B will be advanced to a depth of 150-200 feet inside the cured outer casing using a compressed air driven air rotary hammer, connected to 5 to 10’ threaded drill rods.

Discrete sampling will be performed using inflatable packers prior to well completion to evaluate the vertical extent of regulated VOC/SVOC constituents. The packer system consists of one or two-inch diameter stainless steel or PVC screened pipe sections located between polybutylene inflatable bladders. After lowering to the desired depth, the packers are inflated using compressed air or nitrogen to seal off the sampling zone. Based on prior bedrock drilling, it is anticipated that a total of four (4) discrete samples will be collected at depth intervals of approximately 80', 100', 125', and 175'; however, sample intervals will be adjusted based on drilling observations. Groundwater samples will be collected after properly purging the sampling interval for analysis on an expedited turnaround in order to limit delay of the drilling effort.

In addition to discrete sampling, several optional borehole geophysical logging tools may be selected, as described further in Section 5.1 of the 2024 RCAP. After evaluating bedrock fracture zones, a 4” or greater Schedule 40 or 80 PVC well screen or stainless steel will be installed inside the outer casing for groundwater recovery. Alternatively, MW-5B may be completed as an open hole rock well after conferring with the EPD project geologist.

Due to access difficulties and the need for significant potable water to facilitate rock coring, air rotary drilling is also planned for bedrock drilling of MW-12B. The purpose of this well is to evaluate the down-gradient extent of VOCs/SVOCs in bedrock as well as hydraulic flow properties in a “down-slope” hydraulic location, where an upward vertical gradient may be present in deeper bedrock. A Geoprobe 7822DT track mounted probe/auger/rotary rig will be utilized for MW-12B advancement and installation after land clearing and limited grading to allow access. Prior to auger drilling for the outer casing, continuous probing will be performed using two-inch diameter, four- to five-foot-long sample core barrels fitted with acetate liners and advanced with threaded carbon-steel drive rods. Soils will be logged by a trained geologist/field scientist and field screened using a photoionization detector (PID) to identify soil sample locations. Based on PID readings and olfactory indicators, one or two soil samples will be collected for target VOC/SVOC laboratory analysis.

It is anticipated that the outer casing for MW-12B will be installed to auger refusal depths of 35-40 ft-bgs and will consist of 4” to 6” diameter Schedule 40 or Schedule 80 threaded PVC riser pipe. The outer casing will be pressure grouted in-place using Portland cement or equivalent, to provide a seal protecting against down-hole migration of groundwater. The outer casing will require one to two days to install with one or more additional days for concrete curing prior to air rotary borehole advancement. Air rotary drilling will be performed to depths ranging from 100-200 feet. Final well completion depths will be determined by discrete sampling for regulated VOC/SVOC constituents as described above for MW-5B. Optional borehole geophysical tools may be selected to assess productive fracture zones in the bedrock. After evaluation, a 2” Schedule 40 PVC well will be installed in the borehole or alternatively, MW-12B will be completed as an open hole rock well. If a well is installed, a washed silica sand pack will be installed in the borehole annulus using a tremie pipe followed by a two-foot thick (minimum) hydrated bentonite seal, and final grout seal. Surface completion will likely be an above grade manhole cover secured with a 2’x 2’ or 4’x 4’ concrete pad installed at ground surface.

In conjunction with MW-12B outer casing installation, PRW-11, a top-of-rock intermediate depth recovery well will be auger drilled and installed adjacent to MW-12B to a depth of 35’-40’ or refusal. No soil core samples will be collected due to the close proximity to MW-12B. PRW-11 will be utilized in a later phase upgrade to the groundwater extraction system; however, due to access difficulties, the well will be installed during the same rig mobilization. PRW-11 will be installed using 4” diameter Schedule 40 PVC with a slotted screen (0.010" slotted) interval ranging from 15'-25', based on water table measurements and other considerations. Recovery well completion will include adding a washed silica sand pack to the borehole annulus using a tremie pipe followed by a two-foot thick (minimum) hydrated bentonite seal, and final grout seal. Surface completion will likely be flush grade using a larger 2'x 2' square manhole cover or alternatively, may be an above ground completion. The proposed location of PRW-11 is depicted on **Figure E-23**.

Auger cuttings and pulverized rock fragments from air rotary drilling of MW-5B will be placed in the facility's treatment waste roll-off for incineration. Auger cuttings and air rotary fragments from drilling MW-12B and PRW-11 will be temporarily stored on-site for testing and potential off-site landfill disposal. Fluids generated from drilling and decontamination will be containerized and pumped into the facility's treatment system.

Phase 1 Installation of MW-5B, MW-12B, and PRW-11 is anticipated to require 5 to 6 weeks for field completion and preliminary evaluation.

Short-term Yield Testing and Aquifer Testing (Phase 2)

To aid in determination of recovery well spacing, short-term yield testing followed by more extended aquifer testing, if needed, is proposed using existing pumping well PW-1. The purpose of the short-term yield testing (or step-drawdown testing) is to determine the optimal well flow rate achievable in order to maximize hydraulic control without drawing the water level below the pump intake. Yield testing will also aid in calculating the total influent load expected for the treatment system. Ideally, this testing will be performed using PW-1 with gauging conducted in nearby MW-5A and newly installed MW-5B along with expanded measurements using the surrounding well network. Additional testing may be required using one or more existing monitoring wells, based on the findings.

Prior to yield testing, the Blackhawk® pump assembly will be temporarily removed from PW-1 and the well depth will be gauged and compared to the total depth recorded at completion. If observed well conditions suggest the need for inspection, a down-hole camera will be utilized to inspect the well interior for fouling. After the optional camera inspection, PW-1 will be redeveloped using a Waterra-style pump with surge blocks. Re-development will be performed to remove fines/sediment collected over time in the well casing and in an effort to improve hydraulic communication between the sand pack and surrounding formation. Well development fluid will be temporarily containerized in tanks located adjacent to PW-1 prior to pumping into the treatment system.

Approximately one to two days following development, after groundwater recharge, yield testing will be performed using a variable speed Grundfos submersible pump. The pump will be operated at various flow rates while drawdown extent is monitored using the surrounding monitoring well network. Prior to testing, a full round of groundwater depths will be gauged using a downhole interface probe. A programmable multi-channel datalogger will likely be utilized to capture initial drawdown data in PW-1 and likely MW-5R, MW-5A, and MW-5B. In order to determine the vertical extent of hydraulic communication, inflatable packers will be utilized to initially isolate deeper zones in MW-5B during yield testing.

Yield testing is expected to require 12 to 16 hours to complete. After determining an optimal pumping rate, a longer term aquifer test may be conducted for 24 to 48 hours. Aquifer test results will be used to gain a better understanding of long-term drawdown and aquifer recovery as well as allowing calculation of hydraulic conductivity and transmissivity for more accurate flow rate determinations.

Phase 2 testing is expected to require 4 to 5 weeks for completion of field work and preliminary evaluation.

Source Area Recovery Well Installations and Treatment System Upgrade (Phase 3)

After completion of Phase 2 assessment activities, recovery wells surrounding the impoundment will be installed for initial source area treatment and hydraulic control (see **Figures E-23** and **E-24**). The exact number of recovery wells and spacing will be determined following yield and aquifer testing. Currently, an approximate 100-foot capture zone is estimated for shallow and intermediate depth recovery wells. This capture zone was derived based on the drawdown observed in the original aquifer test performed in May 1990. Closer spacings may be chosen for shallow recovery wells based on field logging and NAPL observations, or the Phase 2 findings, in order to enhance recovery. The proposed recovery well/treatment system layout (with 100-foot capture zones) is depicted on **Figure E-25**.

Proposed source area recovery wells currently include (seven) 7 shallow recovery wells (PSRW-1 – PSRW-7) installed to depths of 35-40 ft-bgs, (two) 2 intermediate recovery wells (PRW-1 and PRW-2) installed to depths of 50-60 ft-bgs and located east and west of existing PW-1, also of intermediate depth, and (one) 1 deep bedrock recovery well (MW-5B) installed to 125-200 ft-bgs. In an attempt to utilize recovery trench wells TA, TB, and TC (PSRW-A, B, and C) the wells will be drilled deeper to depths of 35-40 ft-bgs, if feasible.

Following installation of shallow recovery wells, a 24-hour mobile multi-phase extraction (MPE) event will be performed using a suitably sized vacuum truck/trailer for initial LNAPL recovery. Extraction will be performed using the HWMU wells and one or more of the newly installed shallow recovery wells (PSRW-1, PSRW-2, and PSRW-3) containing LNAPL. Extraction will be enhanced by placement of an interior “stinger” pipe inside the wells with a temporary vacuum seal. Extracted fluids will be stored in a temporary trailer mounted storage tank prior to being pumped into the treatment system. Similar to yield testing, groundwater/NAPL gauging will be performed prior to and during the mobile MPE event to gauge the effective drawdown. Vacuum influence will also be determined using vacuum gauges attached to PVC well heads.

Intermediate and deep recovery wells will be installed, as described for Phase 1, using air rotary methods rather than rock coring to expedite installations. Intermediate and deep recovery wells will be constructed using a 4-, 6-, or 10-inch diameter stainless steel casing and screen lengths determined based on packer testing results. Shallow recovery wells will be installed using hollow stem auger drilling methods after direct push continuous soil coring, and will also be constructed using a 4-, 6-, or 10-inch diameter stainless steel casing (or Schedule 40 or 80 PVC, if NAPL is not observed). Larger diameter recovery wells will be considered in locations where it is anticipated creosote DNAPL will be recovered. Shallow recovery wells that contain little or no recoverable NAPL may be either re-located or drilled deeper for use as an intermediate depth recovery well for hydraulic control.

It is anticipated that shallow recovery wells will generally be utilized to remove NAPL/impacted groundwater with NAPL droplets/sheens at lower flow rates [i.e. <1 gallons per minute (gpm)]; while, intermediate depth recovery wells will be utilized for both recovery of impacted groundwater and hydraulic control. After determining anticipated well flow rates and target NAPL recovery areas around the impoundment, groundwater recovery extraction pumps will be selected. Ideally, above ground low flow, air lift piston pumps such as the Blackhawk® brand pump currently in use in PW-1, will be placed in shallow recovery wells for NAPL recovery. Intermediate depth recovery wells, that do not contain appreciable NAPL, will be fitted with down-hole submersible pumps to create more drawdown for hydraulic control. All well pumps will be pneumatically driven consistent with the current recovery operation. Recovery wells fitted with above ground piston pumps will be completed above grade with protected bollards. Recovery wells with submersible pumps will be completed with flush grade vaults. All recovery wells will be connected with sub-grade piping for influent water flow and compressed air for pump operation.

The up-graded groundwater treatment system is anticipated to consist of up to 10 shallow recovery wells (PSRW-1 – PSRW-7 and PSRW-A, B, and C), 3 - intermediate depth recovery wells (PRW-1 – PRW-4 and PW-1) and 1– deep bedrock recovery well (MW-5B). Influent flow is expected to range from roughly 3,000 to 6,000 gallons per day after adding the additional recovery wells. Since the majority of the regulated substances extracted are SVOCs with minimal volatility and “stripability” based on Henry’s constants, treatment will primarily consist of NAPL separation (LNAPLs will require an oil-water separator) and carbon absorption. The current treatment system utilizes an Allied Signal Immobilized Cell Biotreater (ICB) system followed by up to four 2,000 pound carbon tanks for combined treatment of groundwater influent and process water prior to discharge to the City of East Point wastewater treatment plant. The Allied ICB system has four aerated biological compartments packed with carbon impregnated foam cubes designed to absorb and treat VOCs/SVOCs in the wastewater through biological enzyme growth. A generic treatment system schematic is depicted on Figure E-24.

It is anticipated that the current ICB system can be utilized along with additional activated carbon treatment. Preliminary calculations based on a 4 gpm influent stream, without pre-treatment with the ICB, indicate that 15 to 20 pounds of activated carbon may be consumed per day. Assuming 20 pounds per day usage, up to 400 days (approximately 13 months) of total treatment is achievable if all four 2,000 pound carbon tanks were used in series. Actual activated carbon usage should be much lower through continued use of the ICB system. Other pre-treatment options include chemical oxidation which is commonly used in public operated treatment works prior to biological treatment. Pre-treatment using chemical oxidation may be accomplished through use of a series of mix tanks preferably prior to ICB treatment. Common oxidants include hydrogen peroxide, sodium persulfate, and sodium/potassium permanganate; all of which were previously investigated through a treatability study and subsequent pilot testing.

Ideally, up-grades to the existing treatment system will include the flexibility of accommodating a higher volume influent stream in the future as additional recovery wells are added. Process wastewater treatment should be greatly reduced as PCP is phased out and replaced with the non-hazardous DCOI wood treatment chemical currently in use. This will likely necessitate a separation of groundwater influent from the non-hazardous waste stream generated from DCOI wastewater. Influent treatment requirements and waste stream separation considerations will be determined at a future date after the elimination of PCP and follow-up discussions with East Point personnel.

Supplemental Vertical Delineation Well Installations (Phase 4)

Additional vertical delineation monitoring wells may include the following:

- MW-2A/MW-2B
- MW-4A/MW-4B
- MW-10A/MW-10B
- MW-13A/MW-13B
- MW-14A/MW-14B

These wells will be installed in an effort to complete the horizontal and vertical delineation on-site of deeper bedrock zones previously investigated. All top-of-rock intermediate depth monitoring wells (MW-2A, MW-10A, MW-13A, and MW-14A) will be installed using a hollow stem auger rig through the softer schist bedrock until auger refusal is observed in harder gneiss bedrock (50-65 ft-bgs). Monitoring wells MW-2B, MW-4B, MW-10B, MW-13B, and MW-14B will be advanced by rock coring methods to target depths up to 200 ft-bgs. The exact depths drilled will be determined by the on-site geologist based on core evaluation and discrete sample collection, using similar procedures as followed during construction of MW-3B and MW-8B. Additional details are provided in Section 5.4 of the 2024 RCAP. Note that one or more of these well pairs may be eliminated based on initial delineation and further evaluation. Proposed locations are depicted on Figure E-22.

SMWU #9 and #10 Surface Water and Sediment Sample Plan (Phase 5)

The facility is currently required to perform annual groundwater sampling in March as part of the Permit requirements. In order to assess current sediment and surface water conditions at the stream, it is recommended annual sampling of historic sediment and surface water locations (SED/SW-5, SED/SW-6, SED/SW-7, SED/SW-8, SED/SW-9, and SED/SW-10) be conducted during annual groundwater monitoring events. It is also recommended that Interim Measures sampling events continue on a semi-annual basis. This includes sampling at stormwater locations Outfall-1, Outfall-2, Outfall-3, Outfall-4, and Outfall-5, PB-1, and PB-2; surface water location SW-9; and groundwater at TMW-25. (Note: These samples may be collected apart from a storm event).

After upgrading the groundwater extraction system, these sampling events will also serve as performance monitoring events to evaluate treatment effectiveness. In addition, newly constructed permanent monitoring wells (described in preceding sections) will be added to the Sampling and Analysis Plan shown on **Table E-10**. Surface water, stormwater, groundwater, and sediment samples will be analyzed for site specific VOCs, SVOCs, and metals. Surface water and sediment sample locations are depicted on **Figure E-26**. The stormwater, groundwater, and surface water sample locations associated with Interim Measures events are depicted on **Figure E-27**.

In addition to SWMUs #9 and #10, site wide surface soil/sediment sampling will be performed. Prior to selecting sample locations, a site meeting is recommended with the Facility owner and the EPD geologist to better ascertain sampling locations. Surface soil/sediment samples will be collected using a stainless-steel scoop/spoon or directly from soils exposed beneath the gravel cover at depths of 0-2" (disposable nitrile gloves will be utilized). Recommended sample analysis includes target VOCs and SVOCs. This sampling will be conducted in conjunction with other phases of work to reduce costs.

Supplemental Soil and Groundwater Delineation (Phase 6)

The following data gaps have been identified:

- Soils east, west, and south of the preserving area (SWMU #1, #4, and #6 areas) have not been delineated;
- SVOCs were detected in SWMU 10-1B, SWMU 10-2, and SWMU 10-3 at depths ranging from 8-12 ft-bgs which may indicate migration of impacted sediments in or around the storm drain that have not been delineated; and
- Soils west and northwest of TW-9 (@ 9.5 ft) have not been delineated.

The extent of regulated constituents in soil (surface and subsurface) and shallow groundwater has not been delineated east, west, and south of the preserving area (SWMU #1, #4, and #6). In addition, the extent of soil impact along the storm drain line (associated with SWMU #10) and west/northwest of TW-9 has not been delineated. Envirorisk recommends the advancement of eight (8) additional borings in the locations shown on **Figure E-28** for horizontal and vertical delineation purposes. Four (4) borings will be converted into temporary monitoring wells to delineate shallow groundwater impacts. It is recognized that additional soil borings will likely be required prior to soil remediation after calculated risk based target clean-up values are developed and approved.

Soil borings will be advanced using a direct push drill rig. Discrete soil samples will be collected using four-foot or five-foot long, one to two-inch diameter core sample tubes with clear, sterile, disposable acetate liners. Soil core samples will be collected continuously for visual classification and field screening (PID/olfactory) for selection of sample depths for laboratory analysis. Based on the PID readings, olfactory indications, and relative depth, a minimum of one (1) subsurface soil samples (depth >2 ft-bgs) and one (1) surface soil sample (depth 0 to 1 ft-bgs) will be collected from each of the soil borings and submitted for laboratory analysis of VOCs and SVOCs.

At four (4) soil boring locations, temporary wells will be constructed using 2” Schedule 40 PVC riser pipe with 10-15 foot screened intervals (0.010” slotted) and secured with a silica sand pack and bentonite seal. The temporary wells will be completed with expandable caps and will be left extending 2-3 feet above grade. The newly installed temporary wells will be developed using a peristaltic pump to ensure the sand pack was properly “seated” and improve hydraulic communication with the shallow aquifer. Temporary wells will be sampled for site-specific VOCs and SVOCs.

In conjunction with temporary well construction, all prior temporary wells, injection wells, and observation wells from previous corrective action phases will be properly closed and abandoned in accordance with applicable EPA Region 4 LSASD procedures.

Recovery Wells for Cross-gradient/Down-gradient Plume Control (Phase 7)

It is anticipated that additional cross-gradient and down-gradient recovery wells will be required for treatment and hydraulic control. The exact number of recovery wells and spacing will be determined based on follow-up evaluation; however, using an approximate 100-foot spacing a total of 2 additional PSRWs, 9 intermediate depth recovery wells, and 4 deep bedrock recovery wells are proposed (see Figure E-23). The additional recovery wells will be installed using a combination of auger, air rotary, and/or rock coring, as determined by the site geologist.

Remediation of Vadose Zone Soils (Phase 8)

Prior soil assessments have identified impacted soils in the vadose zone particularly at depths shallower than 16 ft-bgs, that may require remediation. These impacted soils predominantly consist of fill materials to depths of >30 ft-bgs which contain “pockets” of creosote-like NAPL from unknown sources. In order to determine a calculated leaching potential, risk-based target values for vadose zone soils will need to be developed. Following approval, limited source removal may be performed to remove impacted soils above the water table in accessible areas. Deeper soil impacts, in inaccessible areas close to above ground or underground structures, may require supplemental treatment using a combination of limited bulk removal, in-situ chemical oxidation (ISCO), surfactant injection and extraction, or ex-situ/in-situ soil oxidant blending.

Supplemental Corrective Action Alternatives (Phase 9)

Prior RCAP pilot testing indicated that in-situ/ex-situ chemical oxidant applications and/or PRB applications would successfully reduce regulated substances in the saturated soil and groundwater as well as NAPL phases. Due to the extent of NAPL, in particular LNAPL under the southern end of the impoundment, discovery of regulated substances in deep fractured bedrock, and impoundment access; implementation of these technologies is cost prohibitive. Future treatment in smaller areas or NAPL “pockets” using chemical oxidation applied via large diameter augers (soil blending) or injection-based delivery methods may be a useful alternative. In-situ stabilization and solidification (ISS) which involves mixing or blending impacted soils with Portland cement, lime, fly ash, or similar substance; offers another remedial alternative. ISS may be combined with sodium persulfate or other oxidants to provide a combined remedial remedy known as ISCO-ISS. ISCO-ISS is typically more effective than ISS alone due to the contaminant destruction that occurs as a result of ISCO oxidation followed by a reduction in soil leachability caused by ISS. Potential long-term biodegradation is also achievable through cycling of residual sulfates by native sulfate reducing bacteria.

Other supplemental remedial alternatives include surfactant injection and subsequent extraction using the upgraded groundwater extraction system. Surfactants are compounds that are partially soluble in both oil-based (hydrophobic) and water-based (hydrophilic) solutions and are utilized to create emulsions for enhanced removal of NAPL and regulated substances sorbed to soil particles. Surfactant applications in the field would typically involve injection either through direct push rod tooling or injection wells installed for multiple delivery events. Treatment beneath the impoundment may be facilitated possibly using low angle sonic delivery or horizontal wells.

Prior to initiating supplemental remediation, additional vertical NAPL delineation beneath the impoundment and in surrounding source areas is recommended using High Resolution Site Characterization tools such as Laser Induced Fluorescence (LIF). LIF methods available for heavier oils and creosote include the Geoprobe Optical Interface Probe (OIP)–G and the TarGOST® from Dakota Technologies.

E-9e Groundwater Monitoring Program (40 CFR 270.14(c)(8)(iv);264.100(d))

The Post-closure groundwater monitoring program consists of annual sampling of selected monitoring wells to evaluate current conditions and the status of corrective action efforts. During each sampling event, all of the monitoring wells are gauged to determine groundwater depth for calculation of elevations. This data is added to a table with historic elevation measurements to observe trends over time.

The POC wells and the three interceptor trench manholes are gauged for NAPL thicknesses and this data is added to the tables. Groundwater elevations are used to prepare updated potentiometric surface maps to predict flow direction and calculate groundwater flow velocities.

In March 2018, a Permit Modification was approved which made changes to the frequency of sampling, included newly installed wells, and added additional analytes (sulfide, beryllium, thallium, isobutyl alcohol, 2-hexanone, 4-methyl-2-pentanone, 2-

picoline, and benzo(g,h,i)perylene). The current sampling program consists of annual sampling (March of each year) and analysis of VOCs, SVOCs, and Sulfides, with select wells sampled every other year.

Under the current sampling program, the following 17 monitoring wells are sampled on an annual basis:

MW-3A, MW-3B, MW-5R, MW-5A, MW-6R, MW-7, MW-7A, MW-7B, MW-8, MW-8A, MW-8B, MW-8B2, MW-9, MW-10, MW-11, MW-12, and MW-12A

All samples are analyzed for VOCs using EPA Method SW8260D, SVOCs using EPA Method SW8270E, and Sulfide using EPA Method 9034. The POC wells, MW-5R, MW-6R and MW-11 are excluded when measurable NAPL is present.

Under the current sampling program, the following 7 monitoring wells are sampled every two years:

MW-1, MW-2, MW-3, MW-4, MW-7B2, MW-13, and MW-14

All samples from these wells are analyzed for the parameters described above. Monitoring wells MW-2, MW-3, MW-5R, MW-8, and MW-12 are sampled once every three years for site-specific metals analysis, MW-7B is analyzed for Dioxins every three years, and one POC well is selected on a rotating basis every three years for Appendix IX parameter analysis. Sampling and analysis procedures are further described in Section E-6(b).

E-9e(1) Description of Groundwater Monitoring System (40 CFR 270.14(c)(7)(v),(8)

The monitoring well network utilized in evaluating the effectiveness of the corrective action system is described in Section E-9e and in Section E-6b. The wells included in the monitoring network are used for the following purposes:

- MW-1 for up-gradient plume delineation (south) and background metals determination;
- POC wells (MW-5R, MW-6R, and MW-11) for source area evaluation;
- MW-7, 7A, 7B well cluster for down-gradient delineation, northwest of HWMU;
- MW-7B2 (deep bedrock) for down-gradient vertical plume evaluation;
- MW-3, 3A well cluster for delineation of down-gradient HWMU plume boundary, northwest of MW-7 well cluster;
- MW-3B (deep bedrock) for down-gradient vertical plume evaluation;
- MW-5A (top of bedrock) for source area vertical plume evaluation;
- MW-8 for down-gradient/cross-gradient plume control to northeast;
- MW-8A (top of bedrock) for down-gradient/cross-gradient vertical plume evaluation;

- MW-8B, 8B2 (deep bedrock) for down-gradient/cross-gradient vertical plume evaluation;
- MW-10 for down-gradient/cross-gradient plume evaluation and hydraulic control north of MW-8;
- MW-2, MW-4, and MW-9 for cross-gradient plume evaluation and hydraulic control to west-northwest;
- MW-12/12A well cluster for evaluation of separate contaminant plume associated with the intermittent stream (SWMU #10);
- MW-13 for down-gradient plume evaluation/hydraulic control northwest of MW-10 and cross-gradient of MW-12 cluster;
- MW-14 for cross-gradient evaluation/hydraulic control northeast of HWMU.

The locations of the monitoring wells are shown on **Figure E-3**. Well descriptions are provided in **Table E-1**. (Recovery and monitoring wells proposed as part of RCAP activities will be added to Table E-1 upon completion.)

E-9e(2) Description of Sampling & Analysis Procedures (40 CFR 270.14(c)(7)(v),(8)

The current sampling program consists of annual sampling (March of each year) and analysis of VOCs, SVOCs, and Sulfides, with select wells sampled every other year. Monitoring well MW-7B is sampled once every three years for Dioxin analysis. Monitoring wells MW-2, MW-3, MW-5R, MW-8, and MW-12 are sampled once every three years for site-specific metals analysis. POC wells are sampled annually if NAPL is not present. The list of constituents included on the facility's permit along with their GPS limits are shown on **Tables E-4** through **E-6**. Note monitoring wells installed as part of corrective action activities (HWMU-1, HWMU-2, and HWMU-3) are gauged but not sampled during an annual event. Monitoring wells selected for sampling are described in Section E-9e. Appendix IX sampling is performed every three years to update the constituent list using one of the POC wells selected on a 9-year rotating basis. Groundwater monitoring procedures are provided in Section E-6b.

E-9e(3) Monitoring Data & Statistical Analysis Procedures (40 CFR 270.14(c)(7)(v),(8)

Monitoring data for all wells will be reviewed in accordance with the Quality Assurance/Quality Control (QA/QC) procedures described in Section E-6b. These procedures include the implementation of an internal QA/QC Plan followed by Envirorisk personnel to ensure the integrity of the data collected during each sampling event. The QA/QC Plan includes requirements for experience of field personnel, record keeping, chain-of-custody documentation, sample equipment, sample preservation, sample shipping and handling, and evaluation of quality control data. Quality control samples collected during each sampling event include trip blanks, equipment rinse blanks, and field duplicates. A QA/QC review including an evaluation of the quality control samples is performed prior to reporting the sample data to the EPD. If necessary, based on the QA/QC review, re-sampling and analysis will be performed.

Until corrective action objectives are achieved, background concentrations of regulated constituents are assumed to be equivalent to PQLs reported by the laboratory. A determination of statistically significant background metals concentrations has not been performed. Statistical analysis will be deferred until contaminant concentrations have declined sufficiently such that the facility desires to terminate corrective action.

E-9e(4) Reporting Requirements (40 CFR 270.14(c)(7);264.100(g))

Annual monitoring reports will be submitted to EPD during corrective action within -60-days of the facility's receipt of laboratory analytical results. These reports will describe the field and analytical results of the sampling events and the effectiveness of the corrective action program. The following information will be provided as shown in the italicized sections:

- *Introduction*: provides a description of the facility and relevant background information along with a summary of activities performed for the reporting period.
- *Sampling Methods*: provides a description of groundwater depth measurements and field sampling and analysis procedures along with QA/QC sampling performed.
- *Recovery System Inspections and Routine Maintenance*: provides a description of recovery system operations including total quantities of groundwater and NAPL removed and other routine maintenance operations associated with the HWMU.
- *Site Hydrogeological Conditions*: includes a description of recent groundwater depths, NAPL thicknesses, and calculated elevations shown in updated tables. Potentiometric surface maps will be prepared using the new data and used to determine flow direction, hydraulic gradients, and flow velocities.
- *Analytical Results*: includes a tabulated summary of VOCs, SVOCs, and Sulfides detected along with supporting iso-concentration maps and concentration versus time graphs. Metals, Dioxins, and Appendix IX sampling results is also provided, as dictated by the SAP schedule. Laboratory reports and field sampling sheets are provided as appendices.
- *Conclusions*: includes a summary of hydrogeological findings, groundwater sampling data and trends, corrective action effectiveness, updated estimate of time to complete sitewide corrective action, and recommendations for any improvements needed.

E-10 References

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