Supplemental Remedial Investigation Work Plan

NuStar Vancouver Main Terminal
2565 NW Harborside Drive
Vancouver, Washington

Prepared for:

NuStar Terminals Services, Inc./Kinder Morgan/Port of Vancouver
December 18, 2020

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1.0 INTRODUCTION

On behalf of the Port of Vancouver, U.S.A. (Port), NuStar Terminals Services, Inc. (NuStar), and Kinder Morgan Bulk Terminals, LLC (KMBT), Antea Group, Parametrix, and Cascadia Associates LLC (Cascadia) have prepared this combined Supplemental Remedial Investigation Work Plan (SRIWP) to describe investigative activities to be conducted in support of a Supplemental Remedial Investigation (RI) at portions of the Port that include the NuStar Leasehold and the KMBT Operations Area (Location Map [Figure 1]).

This SRIWP was prepared in accordance with the Model Toxics Control Act (MTCA) as defined in Washington Administrative Code (WAC) 173-340-350 and pursuant to Agreed Order (AO) No. DE 15806 ("AO DE 15806") between the Washington State Department of Ecology (Ecology) and the Port, NuStar, and KMBT (the "Parties"). AO DE 15806 requires the Parties to conduct a Supplemental RI for certain hazardous substances which may include, but are not limited to, ammonia, nitrate, copper, and other metals.

AO DE 15806 identifies the Site as the "Vancouver Port of NuStar Cadet Swan," Facility Site Identification (FS-ID) 1026. As detailed in AO DE 15806, the Supplemental RI is required on a portion of the Site that is referred to herein as the Project Area. The Project Area includes, but is not limited to, the NuStar Leasehold and KMBT Operations Area. The boundary of the Project Area will encompass the geographic area needed to define the extent of the chemicals of potential concern (COPCs) being assessed in the Supplemental RI. The Supplemental RI will be conducted in phases, as discussed with Ecology in meetings held in July and October 2019. Figure 2 shows the Phase I Investigation Area and identifies the location of the KMBT Operations Area and the NuStar Leasehold.

1.1 OBJECTIVES

The primary objective of this SRIWP is to present the rationale, methods, and scope of work to be conducted to complete the Supplemental RI for portions of the Site, as described in WAC 173-340-350(7). Per AO DE 15806, this investigation includes an evaluation of materials currently and historically used, handled, or stored at the NuStar Leasehold and KMBT Operations Area, including but not limited to copper and related metals, ammonia, and nitrate. The purpose of the Supplemental RI is to collect the data necessary to adequately characterize the Site for the purpose of developing and evaluating cleanup action alternatives.

While the primary objective of the RI activities proposed herein is to evaluate for the presence and/or extent of copper and related metals, ammonia, and nitrate in Project Area media, Ecology has also requested additional volatile organic compound (VOC) delineation to the west of NuStar monitoring well MW-26 as part of the Supplemental RI.

1.2 REGULATORY FRAMEWORK

RIs have been conducted by the Port and NuStar to evaluate the nature and extent of VOCs in various media associated with the historical handling and storage of chlorinated solvents at the Swan Manufacturing/Cadet Manufacturing and NuStar facilities, respectively. Results of the RIs for each of the facilities were presented and summarized in the NuStar (Apex Companies, LLC [Apex], 2013), Swan Manufacturing Company (SMC; Parametrix, 2009), and Cadet (Parametrix, 2010) RI reports. Ecology approved the SMC, Cadet, and NuStar RIs on May 8, 2009; May 26, 2010; and November 6, 2013, respectively. The Port and NuStar worked collaboratively on the Feasibility Study (FS) and submitted an initial draft in 2015 (Apex and Parametrix, 2015). This draft was revised in response to Ecology and other stakeholder comments and was re-submitted to Ecology in December 2016 (Apex and Parametrix, 2016).

In December 2017, copper was detected in groundwater samples collected from the NuStar facility. While NuStar was not handling products with copper at the time of the groundwater sampling, KBMT was handling bulk dry materials in its operations area, including copper concentrate in powdered form. Ecology issued a Potentially Liable Persons (PLP) status letter to KBMT on May 2, 2018, and after receiving and responding to comments, issued a determination of KBMT as a PLP under RCW 70.105D.040 via letter on July 19, 2018.

In early 2018, Ecology announced that they would also be requiring additional investigation at the NuStar Leasehold to evaluate two additional COPCs, ammonia and nitrate, associated with the historical and current handling of fertilizer at the NuStar facility. Ecology rescinded approval of the NuStar RI in a letter dated January 25, 2018.

Preliminary data indicated that ammonia, nitrate, and copper (and other related metals) have commingled with the solvent plume at the Investigation Area. In accordance with MTCA, Ecology prepared AO DE 15806 requiring the Parties to prepare an SRIWP, Supplemental RI report, and FS for hazardous substances, including but not limited to ammonia, nitrate, and copper and related metals. The proposed work scope described herein will be performed pursuant to AO DE 15806 and in accordance with MTCA.

Technical consultants for each PLP have worked collaboratively to develop this SRIWP and will oversee completion of the Supplemental RI. The consultant leads include:

<u>NuStar</u>
Consultant: Cascadia Associates LLC
Technical Leads: Stephanie Bosze Salisbury, L.G.; Amanda Spencer, P.E.

<u>KMBT</u>
Consultant: Antea Group
Technical Leads: Kevin McCarthy, L.G.; Nate Hemphill

Port of Vancouver
Consultant: Parametrix
Technical Leads: Richard Roché, LHG; Rick Malin, LHG

Each PLP is responsible for overseeing the implementation of AO DE 15806. To the maximum extent possible, communications between Ecology and the Subject PLPs, and documents, including reports, approvals, and other correspondence concerning the activities performed pursuant this SRIWP shall be directed through the PLPs.

1.3 SRIWP ORGANIZATION

This report is organized as follows:

Section 1:	Introduction – provides the regulatory context, defines the Project Area, and describes the general content of the report.
Section 2:	Site Background – includes a site description as well as summary of the Investigation Area geology and hydrogeology determined from previous investigations as well as literature review. The background section also describes the fertilizer and bulk materials handling in the Project Area, summarizes previous investigations and relevant data collected to date, evaluates the potential receptors in the Project Area, and defines the COPCs for the Supplemental RI.
Section 3:	Preliminary Conceptual Site Model (CSM) – summarizes the preliminary CSMs for copper and fertilizer constituents which will be evaluated using the data collection proposed in this SRIWP.
Section 4:	Scope of Work for Supplemental RI – describes the approach and procedures for investigation of copper/metals, fertilizer constituents, and VOCs at the Project Area.
Sections 5:	Summary of Phase I Investigation Report – summarizes the general contents of the Phase I Investigation report and provides recommendation for additional investigation, as necessary.
Section 6:	References – lists the references cited in this report.

Appendices are included that provide technical and supporting information.

2.0 BACKGROUND

Section 2.1 provides site description information for the NuStar Leasehold and the KMBT Operations Area, both of which are leased from the Port. The locations of these two areas are shown on Figure 2. For both the NuStar and KMBT facilities, this SRIWP includes a summary of current and historical materials handling activities.

Section 2.2 provides a synopsis of the geology/hydrogeology in the Project Area as well as the regional geology and hydrogeology.

Section 2.3 describes the stormwater management system in the Project Area, and Section 2.4 summarizes relevant analytical data collected to-date.

In Section 2.5, the list of COPCs for the Supplemental RI is developed based on the information presented in Sections 2.1 through 2.4.

2.1 DESCRIPTION OF NUSTAR LEASEHOLD AND KMBT OPERATIONS AREA

This section provides a description of the KMBT and NuStar facilities, including location, physical features, and historical and current operations.

2.1.1 NuStar Facility

The facility was owned/operated by GATX from the early 1960s through 1998 and was acquired in 1998 by Support Terminals (ST) Services, a subsidiary of Kaneb Pipeline Partners L.P. (Kaneb). Kaneb was acquired in 2005 by Valero L.P., and Valero L.P. changed its name to NuStar Energy L.P. in 2007 and changed the name of ST Services to NuStar Terminals Services, Inc. The terminal property is currently leased by NuStar Terminal Operations Partnership, L.P., and operated by NuStar Terminals Services, Inc.

The NuStar facility was developed to receive, store, and handle bulk fuel and chemicals. Typically, these chemicals were not owned by the facility operator. Rather, the operator entered into agreements as a wholesale distributor to handle chemicals for owners.

2.1.1.1 Location

The NuStar facility is located at the Port Terminal No. 2 in Vancouver, Washington, on property owned by the Port and leased by NuStar. The extent of the NuStar Leasehold is shown on Figure 2. The NuStar facility address is 2565 NW Harborside Drive, Port of Vancouver, Vancouver, Washington 98660 (Latitude: N45º 38.26'; Longitude: W122º 42.20').

The NuStar facility is located on Clark County Tax Lot (TL) Nos.: 151979-000, 502010-002, 502010-000, and a portion of 502020-000, as well as a portion of the Washington Department of Natural Resources tideland area managed by the Port. A Site Plan of the NuStar Leasehold is provided as Figure 3.

2.1.1.2 Physical Features

The NuStar Leasehold is approximately 19 acres located on the north shore of the Columbia River. Land adjacent to the NuStar Leasehold is industrial property also owned by the Port.

The NuStar facility includes five buildings (Port Warehouses Nos. 2645, 2655, 2625, 2585, and 2565), a loading dock at Berth 5, three aboveground storage tank (AST) farms, two tank truck loading/unloading racks, a rail tank car loading/unloading area, marine vessel dock (Berth 5) with piping and an office (in Warehouse 2565). The ground surface is nearly flat at an elevation typically between 32 and 34 feet above mean sea level (msl).

The NuStar facility includes extensive underground utilities. Utilities are within about 12 feet of the ground surface, above the groundwater table.

The ground surface coverage consists of the following (with approximate aerial extent):

Buildings (35 percent);

Paved areas (45 percent);

Tanks (5 percent); and

Gravel/bare ground (15 percent). The unpaved areas are primarily located along portions of the rail corridor (see Figure 3 for rail locations).

2.1.1.3 Historical and Current Operations

Dry and liquid bulk products are received, stored, and exported from the facility. Previously, dry fertilizer products were also packaged at the facility.

Dry bulk products consist of fertilizers which historically were received, stored, and handled in the western and central portion of the NuStar Leasehold. Fertilizer handling and storage was suspended in July 2020. Liquid products consist of Jet Fuel A, sodium hydroxide, and calcium chloride, and are handled at the tank farm in the eastern portion of the NuStar Leasehold, in a separate area from where dry bulk products are handled.

Liquid wood preservatives, methanol, and chlorinated solvents were previously stored and handled at the facility.

Historical and current chemical handling is described below.

Summary of Dry Bulk (Fertilizer) Storage and Handling

The Port and NuStar have each prepared memoranda summarizing fertilizer handling activities in the Investigation Area. The Port's memorandum, entitled *Summary of Port Records Related to Historical Fertilizer Operations*, focused on the fertilizer operations that occur outside of the NuStar Leasehold and summarized the receipt of fertilizer products via cargo vessels at Port Berths 8 and 9 (and occasionally Berth 3), the offloading by longshoremen, and the transportation of fertilizer products to the NuStar Leasehold (Parametrix, 2019a).

Once the fertilizer product reached the NuStar Leasehold, NuStar assumed control of handling and management. NuStar's memorandum, entitled *Transmittal of NuStar Fertilizer Handling Memorandum and Clarification Items on Port of Vancouver Technical Memorandum – "Summary of Port Records Related to Historical Fertilizer Operations"*, summarized the recent and historical fertilizer products handled on the NuStar Leasehold, offloading of fertilizer products into terminal warehouses for storage, and loading of trucks for distribution (Cascadia, 2020a). The complete fertilizer handling process, from cargo vessel to departing the NuStar Leasehold, is synthesized from the two memoranda in the section below.

Historical records indicate that fertilizer handling was conducted over two time periods on the NuStar Leasehold. The first being from 1968 to 2008, and the second between 2014 and July 2020.

Historical Fertilizer Operations (1968–2008)

Fertilizer Products. The fertilizer products handled at the NuStar Leasehold prior to 2009 consisted of calcium nitrate and Triple 16 (a commercial fertilizer formulation comprised of equal parts phosphorous, nitrogen, and potassium).

Receipt of Product by Vessel and Transport to NuStar Leasehold. Dry bulk fertilizers, in prill and crystal form, have been handled at the Port since approximately 1968. Fertilizer handling was discontinued for periods of time, including from 2008 to 2014. Historically, fertilizer has been offloaded at several berths, depending on ship schedule and berth availability. From 1968 to 2008, fertilizer was handled at Terminal 2 (Berths 1-4). Fertilizer has been handled at Terminal 3 (Berths 8 and 9) starting in approximately 1979 until 2008, then resuming in 2014.

Historically, fertilizer was unloaded from vessels using the ship's cranes and grab buckets and transferred into hoppers at the terminal. Stevedores hired by the product importer/ship owner/charterer then loaded the product to dump trucks for transport to the NuStar Leasehold at one of two concrete-lined dump pits in the A-frame warehouses (buildings 2645 and 2655). Each of the dump pits fed into a bucket elevator system, in which the product was elevated to the top of the warehouse and then dispersed via a conveyor system. The material was also offloaded into pits located inside the warehouses that are still present today. A third pit located on the outside exterior of building 2655 was sealed off at least 16 years ago (the cessation of use/sealing date is unknown, but operations staff recall the pit was no longer in use by 2004). The locations of the warehouses and associated pits are shown on Figure 2.

Product Handling and Packaging and Transport Off-Property. After the bulk fertilizer was delivered to buildings 2645 or 2655, the product was placed into hoppers and relocated into bulk storage piles using a conveyor belt. A shaker sieve, located in the northeast corner of Warehouse 2645, was used to remove oversized material from the bulk fertilizer prior to further handling. Oversized materials were then reworked to a consistent size as the sieved material and added back to the product pile. Conveying and sieving activities were always performed inside warehouses and never outdoors.

Handling of the fertilizer products from the bulk warehouses varied depending upon the packaging of the product to be delivered:

- Some of the products were transferred from bulk storage piles in buildings 2645 or 2655 to trucks for bulk delivery (via truck loading facilities at the east and west ends of building 2645 and east end of building 2655); and some of the products were bagged into end-user sized sacks (which involved the loading of products in warehouses 2645 and 2655 into a dump truck for transport to the bagging area in building 2585), placed on pallets, and stored pending shipment. The palletized bags of fertilizer and the tote sacks were subsequently loaded onto flatbed trucks for off-site transport.
- According to Port records, on rare occasions, the fertilizer was loaded to railcars at the southeastern side of building 2645, for off-site distribution (Parametrix, 2019a).

The location of historical fertilizer loading areas are shown on Figure 2. In 2008, fertilizer operations were discontinued on the NuStar Leasehold until 2014.

Recent Fertilizer Operations (2014 to Mid-2020)

Fertilizer operations were reinstated on the NuStar Leasehold in 2014 and continued until mid-2020.

Fertilizer Products. In the 2014 to 2020 timeframe, the NuStar facility handled three fertilizer products:

- Granulated urea;
- Mono-ammonium phosphate; and
- Ammonium sulfate.

There was not a dedicated building for the individual fertilizer products, but rather, the five warehouses were filled based on availability at the time the cargo was received. Buildings 2645, 2585, 2655, and 2565 were used to store undisturbed product. The smaller warehouse (2625) was generally used to store material scraped from the ship bottom and/or floor bottom of warehouses. This “bottom” material was also sold and distributed. Building 2695 was used a few times per year to store excess fertilizer.

Receipt of Fertilizer Product by Vessel and Transport to NuStar Leasehold. Two Rivers (a fertilizer importer, formulator, and distributor) hired stevedores to unload the fertilizer from vessels docked primarily at Terminal 3, Berth 8, and/or Berth 9 using crane-operated clamshell buckets. According to NuStar shipment records, 25 fertilizer ships docked at Berth 8/9 since the NuStar fertilizer operations resumed in 2014. No fertilizer ships docked at Berth 3 during this time. The stevedores were responsible for hiring the labor (longshoremen) to perform the work. Once the vessel arrived, the stevedores installed steel/wood ramps to cover the gap between the bull rail of the dock and vessel to prevent fertilizer from entering the river. A tarp was attached from the vessel to the terminal, covering the entire ramp. Spilled fertilizer either fell back into the vessel (from the tarp) or onto the dock. Fertilizer was transferred from the buckets into hoppers. A conveyor was used to transfer the fertilizer from the hoppers into dump trucks for transfer to the NuStar facility warehouses. During the unloading operations, the stevedores were responsible for product management including cleanup of spillage. A regenerative air street sweeper was used to clean the pavement. Fertilizer unloading was generally not completed during rain or high wind events.

The Port did not have direct involvement with the unloading or management of the fertilizer. However, in 2015, the Port implemented specific Best Management Practices (BMPs) for Terminal 3 Fertilizer Operations (which include Berths 8 and 9; see Figure 2). The BMPs focused on the protection of stormwater and compliance with air permits. Prior to vessel arrival, the Port maintenance crew plugged the stormwater catch basins on Berths 8 and 9, as well as along the haul route used by trucks on Port property (not on the NuStar Leasehold). Upon completion of the unloading operations, the Port would inspect Berths 8 and 9 and along the route used by trucks on Port property (not on the NuStar Leasehold) with the stevedore. Longshore sweepers performed sweeping along truck routes during the cargo operation. An environmental contractor hired by the Port (most recently West Coast Marine Cleaning) pumped stormwater, if any, that accumulated during the fertilizer unloading. The Port then removed the plugs from the catch basins on Berths 8 and 9 and along the haul route. Water from the trench drain located along the edge of the dock (Figure 4) went to the Port's decant treatment facility at Terminal 3 which uses an oil/water separator and Contech Filter Cartridges with a three-filter cartridge vault for water treatment. Solids were disposed of at Columbia Resource Company. Treated water was discharged to the City of Vancouver (City) wastewater system in accordance with an approval letter from the City. The overall stormwater and wastewater systems at Terminal 3 are discussed in Section 2.3.

Fertilizer Product Handling. Dry bulk materials were stored in five warehouse buildings at the NuStar terminal: buildings 2645, 2585, 2655, 2625, and 2565, and intermittently in building 2695 (see Figure 2 for building locations). In both A-Frame buildings (2645 and 2655), fertilizers were either off-loaded into pits or placed directly onto the warehouse floor via the transport truck. The pit in building 2645 is concrete and completely contained. There was no liquid in the pit during the fertilizer operations, except during maintenance wash downs. In the event water was added for cleaning, the water was collected into a sump at a low point in the pit and pumped out into a storage tank. The material in the tank was pumped out and into a truck and was sold to a customer as liquid fertilizer. In building 2655, the dump pit is comprised of stainless steel and is angled towards a bucket elevator. The pit is encased in a concrete room. Similar to building 2645, the pit area was kept dry with the exception of when equipment in the area was washed down. In that event, liquid was collected into a sump, pumped out to a storage tank, and distributed by truck as liquid fertilizer.

From the pits, the material was moved by a conveyor system (within the building) into large piles. When the material was placed directly on the floor inside the building, the fertilizer was pushed into the main ("high") pile with a backhoe or front loader. Off-loading of the fertilizer product was done inside the warehouse buildings, and movement of the fertilizer was done under the building cover.

There are no pits at buildings 2585, 2625, and 2565. The trucks placed the fertilizer products directly on the floor and the product was pushed into high piles with a big wheel loader.

Granulated urea will solidify if exposed to significant moisture. Thus, this material was not offloaded while it was raining. Typically, the weather forecast was checked the day before the offloading event, and if rain was predicted, the offloading event was postponed. When urea was inadvertently exposed to water or moisture, mechanical grinders located in the warehouses were used to grind the urea into the small pellets used for industrial distribution.

Packaging and Transport Off-Property. Each of the five fertilizer storage buildings has an attached covered loading station located adjacent to, but outside of, the warehouse. Distribution trucks were driven into the loading areas, and bulk fertilizer was conveyed from the warehouse into a loading chute that pours fertilizer directly into the storage compartment of the truck. The loading chute and trucks were strategically positioned to limit spillage and fugitive dust. The trucks were then covered for transport off the NuStar Leasehold property. Each of the five drive-through loading areas is covered and surrounded by a concrete berm which served to limit the migration of fertilizer material from the loading area.

Summary of Liquid Materials Storage and Handling

Interviews with NuStar terminal staff and reviews of historical product inventories were used to determine what products were handled on the NuStar Leasehold, either historically or currently. Liquid products currently or previously handled by NuStar have included wood preservative (described in more detail in his section), sodium hydroxide, potassium hydroxide, calcium chloride, phenol, ethylene glycol, sodium chlorate, mineral spirits, cyclohexane, methanol, and chlorinated solvents.

Currently Handled Liquid Materials

Liquid products currently handled include:

Liquid sodium hydroxide - Liquid sodium hydroxide is received via ship and transported out by rail and truck.

Calcium chloride - Calcium chloride is received via rail and transported out via truck.

Jet A fuel - Jet A fuel is received via ship and transported out via truck and barge.

Previously Handled Liquid Materials

Two wood preservative products were handled and stored in the liquid phase between February 2000 and March 2010: alkaline copper quaternary (ACQ 2102) and chromated copper arsenate (CCA). These were the only two known wood preservatives handled and stored at the facility. In addition, methanol and chlorinated solvents were historically handled and stored, although chlorinated solvents have not been handled/stored at the terminal for almost 30 years.

Historical Handling and Storage of CCA. CCA is a wood preservative that has been used in the timber industry to treat timber for microbes and insects since the 1930s. Historically, CCA was transported to the NuStar Leasehold via rail tank cars and was offloaded into storage tanks at the facility. The CCA was transported from the Leasehold by truck through the main gate.

Historical Handling and Storage of ACQ 2102. ACQ 2102 is a water-based wood preservative formulation made of soluble copper and a quaternary compound[1]. Like CCA, the product is used to treat wood to make it resistant to fungi and bacteria. ACQ 2102 was transported to the NuStar Leasehold via rail tank cars and was offloaded into storage tanks at the facility. The ACQ was transported from the facility by truck.

Historical Handling of Methanol. At first, methanol was brought in to the terminal by vessel, and was loaded onto railcars for distribution or was shipped to the Vancouver Annex facility (the "Annex"; located at 5420 Fruit Valley Road) by pipeline for distribution at the Annex truck loading rack. After a few years, vessel shipments stopped, and methanol was delivered to the terminal by railcars, pumped into tanks, and then transported to the Annex via pipeline for distribution by truck at the loading rack.

Historical Handling of Chlorinated Solvents. Historical company records identified the following with respect to chlorinated solvent handling at the NuStar facility.

> Tetrachloroethylene (PCE), trichloroethylene (TCE), methylene chloride (MC), and 1,1,1-trichloroethane (1,1,1-TCA) were handled for several companies beginning prior to 1976, but the start date is uncertain. The records suggest that handling of chlorinated solvents may have ended as early as 1990, but the end date is uncertain.
>
> Direct loading (direct transfer from rail tank cars to tank trucks) was the initial method used for transfer of chlorinated solvents. Direct loading occurred near Warehouse 2625. Direct loading ended in 1982. Interviews with long-time employees support the records review.
>
> Indirect transfer (transfer from rail to ASTs, transfer from ASTs to tank trucks) began in 1981 and continued throughout the remainder of chlorinated solvent handling. Indirect transfer occurred in and around the AST farms located east of Warehouse 2565 (see Figure 2).

Solvent handling ended approximately 30 years ago.

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[1] In chemistry, a quaternary compound is a cation consisting of a central positively charged atom with four substituents.

2.1.1.4 Best Management Practices at NuStar Leasehold

NuStar implements BMPs to minimize releases of handled materials at its leasehold. NuStar has filed a NuStar Fertilizer Handling Best Management Practices memorandum with the Port, documenting BMPs utilized by NuStar for handling bulk fertilizer. A copy of the memorandum is provided in Attachment A of NuStar's fertilizer memorandum (Cascadia, 2020a).

In addition to these BMPs, NuStar implemented the following maintenance, cleaning, and handling practices to further reduce the migration of fertilizer products from the handling areas at the NuStar Leasehold:

- The Leasehold property was swept at least daily during shipments to keep the asphalt pavement free of fertilizers. In addition to operating its own street sweeper, NuStar hired a contractor to assist in street sweeping during shipments or other busy transportation times. Distribution trucks and/or hopper trucks did not travel on unpaved areas at (or off) the terminal.

- Twice daily inspections were conducted to visually monitor for the presence of fertilizer material outside of the handling areas, and sweeping was conducted if these inspections identified spilled fertilizer on the NuStar Leasehold; the Port was contacted if spilled fertilizer was identified off the NuStar Leasehold.

- The storm drain manholes in the vicinity of the fertilizer handling areas were sealed during shipment receipt to keep fertilizer out of the stormwater system. The pavement was swept prior to unsealing the manholes. The manholes were periodically pumped out by a third party.

- Asphalt berms are located around each of the five truck loading areas which served to minimize fertilizer from migrating outside of the loading areas. The bermed areas are covered and there was little to no liquid accumulation in these areas. The bermed areas were routinely swept with a street sweeper and any minimal water was removed by sweeper and disposed of off-site.

- Engineered heavy-duty loading area roof covers were added to the loading areas for each of the five buildings.

- Berms were added to the vehicle entrances of each building to help keep product inside while operations equipment was being moved in and out of the buildings.

- Dropdown industrial flaps were installed at each of the five loading areas. These flaps hang down from the roof and were designed to prevent fugitive dust from leaving the bermed areas.

- During loading of the distribution trucks at each of the warehouses, care was taken to position the truck relative to the loading chute to minimize spillage; spilled product was immediately swept up and returned to the storage pile within the building.
- At the large A-Frame (building 2645) a diversion system was installed to aid in the cleaning/maintenance of dust on the roof near the elevator (conveyor system). Dust on the roof periodically needed to be rinsed clean. When rinsing occurred, the system diverted liquid into a storage tank. When no rinsing was occurring, the system diverted any incidental water to a downspout feeding into a Port Grattix box (a large treatment planter used as a filtration system for roof runoff). Liquid fertilizer from the storage tank was periodically pumped out and sold as a separate product.
- Inside building 2645, concrete sumps were installed underneath the large permanent loading equipment and near the equipment pad (which has been paved with asphalt and bermed). The concrete sumps were sealed to collect water; a pump was advanced into the sumps to remove water during cleaning activities. The loading equipment and equipment pad were routinely cleaned, and the rinsate water was collected and pumped into a large horizontal tank. The product-rich water from the tank was periodically pumped out and sold separately as liquid fertilizer.

A regenerative air street sweeper was used by longshoremen to sweep the roads that the trucks used to transport the fertilizer from the off-loading area to the NuStar Leasehold. The paved areas between the berths and the NuStar Leasehold, that are not on Port roadways, were cleaned/swept by longshoremen. The sweeping of roads was conducted during and after offloading operations.

2.1.2 KMBT Operations Area

The Port constructed the Bulk Terminal facility in 1981 to support import of copper concentrate via rail and export via ship. The Port operated the terminal from 1982 to 1995. In May 1995, the Port entered into a Terminal Management Agreement with Hall-Buck Marine, Inc., for the operation of the Bulk Terminal. Hall-Buck Marine, Inc., was acquired by KMBT in July 1998 and, since that time, has operated the terminal as KMBT.

The following provides a summary of the location, description, and history of the KMBT facility.

2.1.2.1 Location

The KMBT facility is located at the Port of Vancouver Terminal in Vancouver, Washington, on property owned by the Port and leased by KMBT. The extent of the KMBT Operations Area is shown on Figure 2. The KMBT facility address is 2735 NW Harborside Drive, Port of Vancouver, Vancouver, Washington 98660 (Latitude: N45º 38.26’; Longitude: W122º 42.20’).

2.1.2.2 Physical Features

Operations at the KMBT facility consist of transportation, storage, maintenance, fueling, and operating pollution-control equipment. Structures at the facility consist of a bulk material warehouse (building 2725), a Coverall Building (building 2745), a pier and loading dock (Port Berth 7), a belt conveyor system a railroad control station, and 2,400 feet of railroad track. Air emission control systems include seven baghouse dust collectors working in conjunction with enclosed building structures, fully and partially enclosed conveyors, and the shiploader spout. Structures are shown on Figure 2. Another building called the Sand Shed (former building 2705; located immediately south of building 2745 and west of building 2695) was also used for bulk materials storage prior to demolition in 2013. The former location of the Sand Shed is depicted on Figure 2.

Important upgrades to the facility completed since KMBT took over the operations in 1998 include the following:

In 1997, as part of Hall-Buck Marine operations, the Port built a new ore storage building located at the north end of current building 2745.

In 2006, the Port constructed the Coverall Building in support of KMBT operations (see building 2745 on Figure 2). The Coverall Building was constructed over the footprint of the storage building built in 1997.

In September 2017, the Port completed upgrades to the Bulk Terminal, including replacement of the rail unloading facility, enclosing both the bulk offloading point and conveyors inside, and adding baghouses to control dust emissions. The bag houses create air flow and localized negative pressure at the transfer points such as the unload building hopper, the transfer points to the warehouses, and the shiploader. The upgrades were completed to support the Port’s West Vancouver Freight Access process and as a level 3 corrective action to comply with the Port’s Industrial Stormwater General Permit. The new rail unloading facility, identified as building 2877, includes two options for railcar unloading: belly dumping of railcars or the use of an excavator to remove bulk materials from open top railcars. The unloading operations are operated within the unload building where releases are manually cleaned up by KMBT and placed in the product pile or washed into an onsite wastewater treatment system.

Bulk mineral concentrates are shipped to the facility primarily via rail. The facility is equipped to manage both bottom-dump and top-unloading railcars. Railcars are unloaded by an excavator-type machine onto a covered system for transport into the bulk material warehouse. Heavy mobile equipment, including front-end loaders working inside the warehouse, transfers the ores onto a covered ship-loading conveyor. The conveyor connects directly to the shiploader and loads ore cargo into the ship’s storage compartment.

The KMBT facility includes extensive underground utilities. Utilities are within about 12 feet of the ground surface, above the groundwater table.

The ground surface coverage consists of the following (with approximate aerial extent):

- Buildings (24 percent);
- Paved areas (50 percent); and
- Gravel/bare ground (26 percent).

The bare ground is generally limited to the rail corridors.

2.1.2.3 Historical and Current Operations

Operations have stayed fairly consistent since initiating in 1982, consisting of the import of bulk materials via rail or truck, storage at the facility, and export via ship.

Historical Operations and Materials

In 1981, the Port received permits to construct a copper concentrate shipping facility. The facility was designed to receive copper concentrate from Anaconda Minerals Company from Butte, Montana, via rail, store, and export by vessel. Shortly after construction of the facility was completed, market prices for copper dropped and operations ceased. For several years there were limited shipments of copper through the facility. The Bulk Terminal was renovated in early 1986 to handle a variety of other bulk products. Between 1982 and 1994, the following products were handled at Terminal 2, Berth 7 (Parametrix, 2019e):

Bentonite clay
Talc (in bags)
Beet pulp pellets
Alfalfa pellets
Hay pellets
Copper concentrate
Silica concentrate
Manganese concentrate
Zinc concentrate
Bauxite
Hydrated alumina
Ferrophosphorus

Current Operations and Materials

Most of the products currently handled are mineral concentrates (primarily copper concentrate; see Appendix A for the Safety Data Sheet (SDS) on copper concentrate for more information). At the time of the Hall-Buck purchase in 1998, KMBT was also permitted to handle bentonite clay, talc, fish meal, quartz silica, zircon sand, coal, chalk, agricultural pellets (e.g., beet, alfalfa, hay), and other miscellaneous bulk materials.

Bulk mineral concentrate (primarily copper) and bentonite clay arrive by rail and are offloaded at the rail unloading facility, transferred by a system of conveyor belts to storage buildings, then into oceangoing vessels at Berth 7. Recently, KMBT began exporting tire chips which arrive at the terminal by truck, are stockpiled, then loaded by conveyor belts into ships at Berth 7. The conveyor belts are fitted with upper and lower covers which enclose the belts but are not airtight. Tire chips, bentonite, and copper concentrate are the only products that KMBT has handled in recent years. The same conveyors are used to handle all commodities.

Airborne dust is generated during the offloading, conveyance, and onloading of copper concentrate and bentonite. Operators of the KMBT Operations Area have maintained air discharge permits with regulatory permitting agencies, including the Southwest Air Pollution Control Authority (SWAPCA) which was re-named Southwest Clean Air Agency (SWCAA) in the year 2000. Discharge limits for the following contaminants are included in air discharge permits: arsenic, cadmium, chlorine, chromium, copper, lead, manganese, molybdenum, and silver.

2.1.2.4 Best Management Practices at KMBT Operations Area

KMBT implements BMPs to minimize releases of handled materials at its operations area. These management practices are selected to reduce the release of cargo and to ensure that spilled cargo is cleaned up appropriately. The BMPs were last revised on January 31, 2019, and are split into four categories (operational, structural, cleaning, and inspection) as detailed below:

1. Operational BMPs are a set of work practices that maintain a clean facility and ensure that cargo reaches its final destination in good condition without loss:
    - Rail Unload Building (Building 2877 on Figure 2): Excavator door is to be closed during unloading operations. Coupled with the “Freezer curtain” style flap closures, wind through the building is limited.
    - Baghouses and air emissions controls are operated during bulk cargo handling: These control devices are maintained to achieve the control efficiency required by the air permit. Air pollution control equipment includes seven baghouse dust collectors, enclosed building structures, fully and partially enclosed conveyors, and the shiploader spout. Routine maintenance and regular operation of the air pollution control equipment is a key part of KMBT’s BMPs.
    - Storage buildings: Doors are to remain closed when reclaiming cargo from the storage buildings to the vessel. This practice keeps airborne cargo inside the structures.
    - Limiting copper storage time: KMBT has notified customers that the length of time copper concentrate may be stored at the facility is limited. The copper concentrate (cargo) is shipped in damp form and must be kept damp, as dry copper concentrate potentially forms a dustier cargo. If dry cargo is noted, customers are notified, and effort is made to mix the new and old cargo to moisten the dry cargo to limit dusting.
2. Structural BMPs are constructed to control or contain cargo:

- Mesh fabric wind screen panels are attached around the shiploader structure to prevent material from becoming airborne. The fabric panels resemble tarps and enclose large open areas of the shiploader. Mesh fabric screens are inspected and repaired or replaced as needed. Separate screens are used to control dusting at the shiploader spout. These screens limit air movement around the shiploader spout and extend into the ship's hold; this reduces the chance of cargo (especially bentonite) from being blown from the ship's hold.

- Stormwater containment and segregation: The northern portion of the KMBT Operations Area consists of the rail track area, building 2877, and an asphalt paved area on the river side of Building 2877. The rail tracks and the paved area are separated by a concrete retaining wall. Building 2877 is on the track side of the retaining wall. The track area is gravel ballast and rainfall infiltrates there. Stormwater from active handling areas and process water from cleaning and system wash downs in the paved area are diverted by asphalt berms and grading to the wastewater treatment system that is operated and maintained by the Port, which discharges to the City sanitary sewer under permit. The wastewater treatment system includes tankage to provide surge capacity for rain events. Stormwater river side of the berm is diverted to the Port's stormwater system which flows to the Terminal 4 stormwater pond that discharges to the Columbia River under permit. See the drainage layout on Figure 4 and on Figure 1 of the July 2, 2019 Parametrix Bulk Terminal (Copper) Tech Memo (Parametrix 2019e).

- Contained conveyor system: Conveyor hoods and bottom pans are designed to reduce dust and the release of cargo. Hoods are inspected monthly and pans are inspected in sections approximately every 2 months and cleaned as needed; transfer points are cleaned at a higher frequency.

- "Freezer curtain" style flap closures have been installed at east and west ends of the unload building. These flap barriers limit wind through the structure when railcars are being unloaded and limit fugitive dust from leaving the building.

3. Cleaning activities are performed regularly to collect and reclaim cargo at the facility. Recovered copper concentrate is screened and returned to the storage buildings for later shipment.

   - Pavement sweeping and cleaning: Sweeping is done across the KMBT Operations Area as needed. All site cleaning efforts are logged. Spilled cargo within the KMBT Operations Area is cleaned up as needed by sweeping or washdown to the wastewater treatment system.

   - Shiploader area cleaning: The shiploader and adjacent paved areas are washed down every 1 to 2 months or when needed as determined during inspections. Wash water flow is directed to the wastewater treatment system that is managed and maintained by the

Port. These washdowns limit the volume of copper concentrate that can be tracked outside the wastewater capture area.

- Drain cleaning: Drains located behind the shiploader are cleaned out on an annual basis. These drains also feed to the wastewater collection and treatment system operated by the Port.
- Conveyor cleaning: Terminal conveyors are scheduled for cleanings as determined by inspections. The shiploader transfer points are cleaned 2 to 3 times per shift when loading vessels.

4. KMBT ensures compliance with these BMPs by conducting inspections:
    - Periodic inspections of the general KMBT management area are completed to ensure that correct practices are being followed and equipment is operating correctly. Inspections of the shiploader and dock areas are completed during ship loading operations to ensure compliance with the above BMPs.
    - Monthly spill prevention, control, and countermeasure (SPCC) inspections include inspection of storage and containment areas. Inspection of the operating area is performed monthly to confirm stormwater BMPs are in place. Emphasis is placed on locations outside the capture area of the wastewater treatment system.
    - The crossover conveyor between the storage buildings (buildings 2725 and 2745 on Figure 2) are inspected monthly to note the condition of the tarps enclosing the crossover conveyors between the storage buildings.
    - Opacity readings are taken at least twice per vessel with special attention given to the first pour and topping off hatches.
    - When loading vessels, KMBT management walks the length of the main overhead conveyor (Figure 2) between the storage buildings and shiploader at least once per shift as part of operational rounds.

2.2 GEOLOGY AND HYDROGEOLOGY

The following sections summarize the geology and hydrogeology of the Investigation Area and are obtained from the Draft FS (Apex and Parametrix, 2016). Geologic and hydrogeologic conditions in the areas of the SMC, Cadet, and NuStar sites are detailed in their respective RI Reports (Parametrix, 2009 and 2010; Apex, 2013). Approximately 48 monitoring wells have been installed by NuStar (or the Port) in or near the KMBT Operations Area and NuStar Leasehold and are used to interpret the geology of the Project Area (see Figure 3). A detailed description of regional geologic and hydrogeologic conditions is also presented in the Vancouver Lake Lowlands Groundwater Model Summary Report (Parametrix, 2008).

2.2.1 Geologic Units

The regional geologic framework and associated groundwater system detailed in the Swan/Cadet and NuStar RI Reports are based on the geologic setting described and the nomenclature used in the United States Geological Survey (USGS) water resources investigation report, *A Description of Hydrogeological Units in the Portland Basin, Oregon and Washington* (Swanson et al., 1993). The *Vancouver Lake Lowlands Groundwater Model Summary Report* (Parametrix, 2008) presents a regional conceptual model and detailed discussion of geologic and hydrogeologic units in the region and their presence in the Project Area. The groundwater model was developed using site-specific geologic and hydrogeologic data collected throughout the Vancouver Lake Lowlands.

There are three regional geologic units (Quaternary alluvium, catastrophic flood deposits, Troutdale formation) in the Project Area. Groundwater in the Quaternary alluvium and catastrophic flood deposits is associated with the Unconsolidated Sedimentary Aquifer (USA), while groundwater in the upper section of the Troutdale formation is associated with the Troutdale gravel aquifer (TGA).

The three geologic units are described in the following sections.

2.2.1.1 Alluvial Deposits

The Quaternary alluvial deposits in the Project Area primarily consist of two main subunits: a lower sand and an upper silt. In the area adjacent to the Columbia River, two localized subunits have been identified; these represent overbank flood deposits and dredge fill. The variability in fines present in the Quaternary alluvial deposits can notably influence the rate at which groundwater passes through the material. Three alluvial subunits are present in the Project Area and are described below.

Dredge Fill (Sand 2) – Dredge fill deposits are present in the southern portion of the Project Area and generally within 1,500 feet of the Columbia River. Dredge fill consists predominantly of sand but can include lenses of silt and gravel. Extensive dredge filling has occurred in the southern portion of the NuStar Leasehold particularly adjacent to the river where the thickness of the fill can reach up to 50 feet. Depending upon location, dredge fill can be saturated or situated above the water table.

Overbank Deposits (Silt 2) – This alluvial subunit is present along the Columbia River and is associated with the historical riverbank. The overbank deposits represent the historical riverbank and seasonal overbank flood deposits, consist of silt and clay material, and are thickest adjacent to the historical river channel. The overbank deposits are thicker and contain more clayey material than the lowland area silt subunit (Silt 1). The water table is generally found within the basal portion of the overbank deposits. Consequently, its lower section is usually saturated and its upper section is within the vadose zone. Beginning in the mid-1930s, filling was completed along the historical riverbank in the Project Area as part of the Port’s terminal developments that resulted in the river being displaced approximately 500 feet south of its historical river channel.

Lowland Area Sand (Sand 1) – The lowland area sand is present throughout the Project Area. The lowland area sand contains variable amounts of fines and is described in places as silty sand. This subunit overlies the catastrophic flood deposits and, in the area of the Swan site, appears to be contemporaneous with lowland area silt deposits. The lowland area sand can be differentiated from catastrophic flood deposits by its lack of gravel. The lowland area sand is present under the overbank deposits on the north side of the historical riverbank. The water table is usually situated within the lowland area sand and silt subunit where overbank deposits are not present. Under these conditions, its lower section is saturated and its upper section is in the vadose zone.

2.2.1.2 Catastrophic Flood Deposits

This unit consists predominantly of medium- to coarse-grained sand with gravel. The gravel can be coarse, ranging up to cobbles 6 inches or greater in diameter. These deposits are associated with the Late Pleistocene catastrophic floods of the Columbia River. This material was deposited throughout the Investigation Area and underlies the Quaternary alluvium. Due to the generally coarse nature of these deposits and the general lack of fines, these deposits are highly transmissive.

2.2.1.3 Troutdale Formation

The Troutdale formation encountered at the Investigation Area consists of well-graded, cemented to semi-consolidated sandy gravel with varying amounts of sand, silt, and clay. The gravel clasts range up to 8 inches (i.e., cobble) in diameter and generally consist of basalt and quartzite. The matrix usually consists of brown to green fine-grained silty sand with varying amounts of silt and clay and is usually abundant with mica. The Troutdale formation underlies the catastrophic flood deposits throughout the Project Area. It is distinguished from the catastrophic flood deposits by the presence of cementation, consolidation, quartzite clasts, and a silty matrix containing mica. In certain places, it can be difficult to distinguish the Troutdale formation from the reworked Troutdale formation material subunit. A noticeable reduction in water production is another characteristic that can be used to distinguish the Troutdale formation from the overlying catastrophic flood deposits.

2.2.2 Hydrogeologic Units

Consistent with the USGS Portland Basin (Swanson et al., 1993) nomenclature, there are two regional hydrogeologic units at the Investigation Area; the USA and the underlying TGA. The USA occurs in the Quaternary alluvium and catastrophic flood deposits, while the TGA occurs in the Pleistocene-aged Troutdale formation.

The distinction between the USA and the TGA is based on differences in the geologic units and resulting hydrogeologic conditions. The overall permeability of the USA is at least one order of magnitude greater than the permeability of the TGA (McFarland and Morgan, 1996). Consequently, primarily due to pumping, groundwater flow conditions in the USA differ from conditions in the TGA. In addition, groundwater flow conditions within the three zones of the USA differ due to permeability contrasts between the alluvium and the catastrophic flood deposits.

The following sections describe the hydrogeologic conditions of the three USA groundwater zones and the TGA at the Investigation Area.

2.2.2.1 Unconsolidated Sedimentary Aquifer

Regionally, the USA receives recharge primarily from precipitation. Within the Investigation Area, the USA also receives recharge from the Columbia River or discharges to the river, depending upon relative river stage conditions and pumping stresses. The flow of groundwater in the USA has historically been dominated by pumping at the Great Western Malting (GWM) site. Water levels in the USA respond quickly to changes in the Columbia River stage, indicating that the river is in direct hydraulic connection with the USA. This rapid response is attributed to the proximity of the river and the high hydraulic conductivity of the USA. These dynamic conditions make it difficult to define groundwater flow direction based on water level measurements collected during short periods of time. Water level measurements indicate very low hydraulic gradients with small-scale and local variations in apparent groundwater flow direction due in part to river stage changes. Groundwater flow model results indicate that the operation of high volume continuous-rate pumping of production wells in the USA is possible and sustainable due to high hydraulic conductivity and relative thickness (i.e., high transmissivity) and the presence of a substantial recharge source (i.e., the Columbia River). Groundwater recharge from the Columbia River due to high volume production well pumping primarily occurs in the intermediate zone.

Three groundwater zones have been established for the USA based on observed geologic and hydrogeologic conditions. Groundwater zones were adopted during the course of the SMC, NuStar, and Cadet RI efforts to evaluate and describe groundwater quality and groundwater flow trends. These zones are used to facilitate understanding of the hydrogeologic system and were originally defined by groundwater quality conditions observed during early phases of the SMC RI. Based on the presence and distribution of the alluvial and catastrophic flood deposits in the Project Area, the groundwater zone classification system has been retained, but has been modified and is now applied only to the USA. The zones for the USA are as follows:

<u>Shallow USA groundwater zone:</u> Regionally, this zone typically extends from the ground surface to -10 feet msl (approximately 40 feet below the ground surface [bgs]); however, the bottom depth of the zone is variable. The shallow groundwater zone of the USA primarily corresponds to the alluvial deposits. At the NuStar Leasehold, the bottom of the shallow zone is about -10 to -25 feet msl and is located in the fill deposit, historical river channel deposits, and overbank deposits.

<u>Intermediate USA groundwater zone:</u> This zone extends from the bottom of the shallow zone (-10 feet msl to -25 msl, depending upon location within the Project Area) to -100 feet msl (approximately 130 feet bgs). The intermediate groundwater zone of the USA primarily corresponds with the catastrophic flood sand and gravel deposits. This zone can also include a portion of the channel fill deposits and reworked Troutdale formation material. At the NuStar Leasehold, the intermediate zone lies between approximately -15

and -100 feet msl and is located under the historical river channel deposits and the overbank deposits.

<u>Deep USA groundwater zone:</u> This zone extends below -100 feet msl. The deep groundwater zone of the USA primarily corresponds with the channel fill deposits and reworked Troutdale formation material. The deep zone generally corresponds to those portions of the aquifer that are less influenced by groundwater pumping. At the NuStar Leasehold, the deep zone is not present and the hydrogeologic units grade from intermediate groundwater to the TGA.

The elevations of these zones continue to serve as general guidelines and have been adjusted slightly in certain areas based on encountered geologic conditions or other hydrogeologic observations. Characteristics of the three groundwater flow zones within the USA are described below. A cross-section depicting the shallow and intermediate lithological units and groundwater zones in the Project Area is provided in Appendix B.

2.2.2.2 Shallow USA Zone

The shallow USA zone consists primarily of the alluvial deposits. Depending on the thickness of the alluvial deposits, the shallow USA zone can extend into the upper part of the sand and gravel subunit of the catastrophic flood deposits. The alluvial deposits contain greater amounts of finer material than the underlying catastrophic flood deposits. Consequently, the transmissivity of the alluvial deposits is notably lower than the underlying sand and gravel deposits. Due to the overall presence of finer material with notably lower permeability, the distribution of contaminants in the shallow USA zone can differ from the distribution of contaminants in the underlying catastrophic flood deposits.

Prior to operation of the SMC groundwater pump and treat interim action (GPTIA), groundwater flow in the shallow USA zone at the SMC and Cadet sites was toward the southeast. This flow direction was reflected by contaminant distribution where high concentrations of solvents in groundwater at the two source areas decreased with distance southeast of the source area. Before groundwater pumping at SMC, potentiometric contour maps based on water level measurements from shallow monitoring wells also suggested a southeastern flow direction in the shallow USA zone in the SMC and Cadet areas. Groundwater flow model results indicated that, prior to starting the Port's GPTIA, flow in the shallow USA zone was primarily influenced by pumping occurring at the GWM site but also appeared to be influenced by City water station pumping. The flow direction at the Cadet site was similar, based on the distribution of contaminants, potentiometric contour maps, and modeling. Groundwater elevation data collected since 2009 indicate flow in the shallow zone beneath the Cadet site remains to the southeast.

The direction of shallow zone groundwater flow beneath the NuStar Leasehold has not been affected by the GPTIA due to the presence of a silty layer at the bottom of the shallow zone that extends to the northern extent of the leasehold and the presence of a "silt ridge" in the shallow zone beneath the northern 2006 leasehold boundary (see Figure 2-6 in Appendix B). Groundwater flow in the shallow USA zone in the area of the NuStar Leasehold has been observed to fluctuate toward or away from the river in response to river stage changes. A groundwater divide in the shallow zone is present in the central portion of the NuStar Leasehold generally corresponding to the southern edge of the “silt ridge” along the northern side of the NuStar Leasehold (see Figure 2-6 in Appendix B). The presence of the silt layer associated with the pre-fill Columbia River channel (former natural riverbank) results in a low-permeability zone in the shallow zone along the northern boundary of the NuStar facility. The pre-fill river channel silty gravel layer beneath the NuStar Leasehold also greatly impedes hydrogeologic communication between the shallow and intermediate zones (Apex, 2013). These pre-fill river channel features also serve to isolate the shallow zone at the NuStar site from the shallow zone north of the Site.

Based on stable oxygen isotope data, recharge of the shallow USA zone appears to be primarily from precipitation along with indications of some recharge from the river. Oxygen isotope data indicate that the shallow USA zone at the NuStar Leasehold is recharged from precipitation. Due to the presence of overbank deposits (former natural riverbank) just north of the NuStar Leasehold, northerly flow in the shallow USA tends to be restricted.

2.2.2.3 Intermediate USA Zone

The intermediate USA zone corresponds to the catastrophic flood deposits. The catastrophic flood deposits are more permeable than the overlying alluvial deposits or the underlying TGA. Based on well log descriptions, the sand and gravel subunit is the most permeable sedimentary unit in the USA (Mundorff, 1964). Consequently, the rate of groundwater movement is highest in the intermediate USA zone where it is greatly influenced by pumping at high-volume production wells located in the lower terrace and Vancouver Lake Lowlands area, including wells operated by the City, Clark Public Utilities (CPU), GWM, and the Port. In response to high-volume pumping, recharge of the intermediate USA zone is primarily from the river.

Prior to operation of the GPTIA, groundwater flow in the intermediate zone near the SMC, Cadet, and NuStar sites was to the north/northeast (from the river) and curving to the east, and then toward the GWM production wells, which have been in operation since the 1940s. These flow patterns are supported by the distribution of contaminants from the SMC, Cadet, and NuStar sites, isotope data, and groundwater flow model results. After startup of the GPTIA, overall flow in the intermediate zone is towards the GPTIA. The gradient in the area between the SMC/Cadet and NuStar properties (former Carborundum pond area) is typically flat, although it does vary during periods of rapid river stage change.

2.2.2.4 Deep USA Zone

This zone of the USA includes the deeper area of the USA where the rate of groundwater flow is lower, less influenced by groundwater pumping, and more regionally influenced. Overall assessment of the contaminant plume, completed using analytical data collected since June 2009 and included in annual monitoring reports, indicates groundwater flow in the deep USA zone has not substantially changed due to operation of the GPTIA. At the NuStar Leasehold, the deep USA appears to contain re-worked Troutdale formation material that is situated on top of the Troutdale formation. The channel fill deposit and the reworked Troutdale formation material are permeable, but not as permeable as the sand and gravel subunit of the intermediate USA zone. Both the channel fill deposits and the reworked Troutdale formation material are more permeable than the underlying consolidated to semi-consolidated Troutdale formation that makes up the TGA.

2.2.2.5 Troutdale Gravel Aquifer

The TGA is associated with the Troutdale formation, which underlies the catastrophic flood deposits and alluvial deposits that make up the USA at the Project Area. The top of the Troutdale formation varies noticeably, and the presence of an erosional trough has been identified. The permeability of the TGA is at least one order of magnitude lower than the USA (McFarland and Morgan, 1996). This is due to the presence of more fines in the Troutdale formation and the extent of its lithification/cementation, which ranges from consolidated to semi-consolidated. The combination of lower permeability and lack of groundwater extraction from the TGA at the Project Area produces much lower flow rates in the aquifer than in the overlying USA. There is hydraulic connection with the USA due to a lack of a confining layer. It is anticipated that the TGA would exhibit similar river response behavior as the USA, but would be more attenuated due to its lower permeability and the fact that it appears not to be in direct contact with the river (i.e., the USA is situated between the river and the TGA).

2.3 STORMWATER/WASTEWATER MANAGEMENT

In general, stormwater in the Project Area is conveyed to a Port stormwater treatment pond prior to discharge to the Columbia River (Figure 4). There are specific areas, including portions of the KMBT Operations Area, where stormwater is directed to a Port-managed wastewater treatment system located in building 2715, prior to discharge to the City wastewater treatment system. Areas where stormwater is captured and directed to the wastewater treatment system are shaded green on Figure 4. In addition, there are several small areas within the Project Area, primarily in rail corridors, where stormwater infiltrates.

The details of stormwater management in the Project Area are provided in the subsections below.

2.3.1 Port of Vancouver Stormwater System

Stormwater infrastructure was initially installed at Terminals 2 and 3 in the 1960s during the terminal development and included catch basins and drainage pipes that discharged stormwater to the river as allowed by regulatory codes of the time. Terminals 2 and 3 were redeveloped by the Port from 1998 to 2003 and included the installation of a new stormwater system that collects stormwater and conveys it to a stormwater treatment pond at Terminal 4. Stormwater from the pond is discharged to the Columbia River under the Port’s Industrial Stormwater General Permit (ISGP) WAR000424. The stormwater infrastructure for Terminals 2 and 3, including the Terminal 4

Outfall, are shown on Figure 4. The historical outfalls adjacent to the operational areas are shown on Figure 20.

From 2003 to 2012, NuStar operated under two ISGPs (ISGP S03002510 and WAR002510) to discharge stormwater from the NuStar Leasehold into the Port's stormwater system discussed above. Under NuStar's ISGP, NuStar was required to sample quarterly at select storm drains for pH, turbidity, zinc, copper, and nitrate and report the results to Ecology. Historical records indicate that the samples were collected from storm drains at three locations: the northwest end of building 2585, the southwest end of building 2655, and the southwest end of building 2565. The buildings are labeled on Figure 2. NuStar's records were queried along with Ecology's Permitting and Reporting Information System (PARIS) database for historical stormwater data from that time period. A summary of the available stormwater analytical data and a comparison to permit action levels are provided in Table 1.

NuStar discontinued the storage of fertilizer products at the facility in 2009 and applied for a Conditional No Exposure (CNE) Exemption with the Ecology Water Quality program on June 7, 2013. On December 19, 2013, NuStar received a letter from the Ecology Water Quality program granting the exemption from the ISGP.

2.3.2 Wastewater Treatment Facility

Stormwater in the unpaved rail area of the KMBT Operations Area infiltrates through the railroad ballast; the stormwater in the remaining paved areas is directed to an onsite wastewater treatment plant located in building 2715 (see Figure 4). The wastewater treatment plant is owned and operated by the Port. The KMBT Operations Area includes four drainage basins and encompasses approximately 8.8 acres of impervious area. Wastewater (i.e., runoff) generated in the drainage basins is contained using a combination of asphalt/concrete berms and pavement grading and conveyed via sumps that include lift stations to the onsite wastewater treatment plant (building 2715), which was upgraded in 2010 and provides pretreatment prior to discharging to the City wastewater treatment facility. The onsite treatment system includes detention tanks and two coagulation treatment trains with a total capacity of 100 gallons per minute. The drainage basins and locations of the sumps/lift stations, conveyance piping, and treatment plant are shown on Figures 1 and 2 of the Port's memorandum *Kinder Morgan Operating Area - Wastewater Line Inspection and Testing* (Parametrix, 2018a). The discharge permit for the City wastewater treatment facility includes limits for the following metals: arsenic, cadmium, copper, lead, silver, nickel, and zinc.

2.3.3 Recent Inspection of Stormwater and Wastewater Systems

Two recent studies were completed by the Port to evaluate the conditions and to assess the potential of the storm system as a potential contaminant pathway. Both show that the stormwater systems and wastewater conveyance systems are not a potential contaminant pathway to the subsurface.

1. In August and September 2018, the Port managed the cleaning and video inspection of the Terminal 2 stormwater system. Details can be found in a March 18, 2019 Parametrix memorandum (Parametrix, 2019b). Stormwater system cleaning included Terminal 2 pipelines, catch basins, manholes, and other associated infrastructure. The cleaning was completed using a jet pressure washer to remove sediment, oil, grease, and other debris. Wash water, sediment, and debris were vacuum extracted and disposed of at the Port decant facility located at Terminal 3.

   After the stormwater system was cleaned, a video inspection of accessible stormwater lines was conducted. Several short sections of small diameter piping had blockages and could not be video inspected. The small pipes with blockages were on the opposite end of the terminal near United Grain and no discharge from NuStar or KMBT went to these pipes. The video was used to inspect the integrity of the stormwater lines, looking for evidence of breaks, leaks, separated joints, or other damage that could result in releasing stormwater to the subsurface. The results from the Terminal 2 stormwater system cleaning and video inspection show that the system is intact and is operating as designed. No evidence of the system as a source of contaminants to the subsurface was identified (Parametrix, 2019b).

2. In late September 2018, the Port managed a cleaning, inspection, and pressure testing of the wastewater conveyance system associated with the KMBT Operations Area. Details can be found in a December 17, 2018 Parametrix memorandum (Parametrix, 2018a). The portions of the conveyance system included in the cleaning are shown on Figure 2 of the December 2018 memorandum (Parametrix, 2018a). Conveyance facilities, including catch basins, sumps, and lift stations, were cleaned using a vacuum truck and pressure washer. Lift stations operate in Sumps 1, 2, 3, 5, 7, and 8. Sumps 7 and 8 are located inside buildings 2875 and 2877, respectively. These two sumps were tested during construction of these buildings in 2017; therefore, they were not included in the Port's 2018 work.

   After cleaning, the conveyance facilities were visually inspected. Based on a review of inspection forms completed by Port staff, other than a few minor cracks in catch basins and sumps, no damage, breaks, or leaks were observed. As part of the inspection process, a static water test was conducted in each sump. The tests included filling the sumps with water and measuring the water level over a 24-hour period. None of the sumps showed evidence of water loss or leakage (Parametrix, 2018a).

   Pressure testing was completed on the primary treatment system conveyance piping to evaluate potential leaks, breaks, or other evidence of damage. The following three main lines were pressure tested: Sump 1 to Old Sump 2, Sump 5 to Water Treatment Facility, and Sump 3 to Water Treatment Facility. The main line from Sumps 7 and 8 to Sump 3 was tested during construction of buildings 2875 and 2877 in 2017; therefore, it was not included in the current testing. These features are shown on Figure 2 of the above-referenced memorandum. Pressure testing found no loss of pressure in the tested lines, and, as such, no evidence of leaks or breaks in the lines were identified (Parametrix, 2018a).

Overall, results show that other than a few cracks in the catch basins and sumps, no damage, breaks, or leaks were observed. None of the sumps showed evidence of water loss or leakage. Pressure testing did not identify any loss of pressure or evidence of leaks or breaks. There was no evidence that the wastewater treatment sumps and piping are a potential pathway for contaminants to the subsurface (Parametrix, 2018a).

2.4 PORT BERTH SEDIMENT MAINTENANCE PROGRAM

2.4.1 Berth Dredging

The Port's current berth dredge program includes authorized maintenance dredging to remove accumulated river sediment deposited in Berths 1 through 14 to authorized depths, and deepening of Berths 1, 5, 10, 13, and 14 to accommodate the authorized navigation depth of -43 feet +2 feet Columbia River Datum (CRD) consistent with the depth of the federal navigation channel. Maintenance dredging within the berths, including Berths 5, 7, 8, and 9, is typically focused in front of the dock structure fender piles where the majority of sediment accumulates. A nominal amount of sloughing typically occurs during dredging in the established vessel berths, as sloughing within the dredge footprint is inherent to dredging. Historically, the Port's maintenance dredging requirements have ranged from 0 to 25,000 cubic yards (CY) annually, with dredging activities occurring every few years. In typical years, approximately 6,000 to 8,000 CY of sediment are removed from the established vessel berths. Dredging frequency depends on the rate of sediment accumulation, as identified by an annual hydrographic conditions survey and on operational needs. Over the past decade, maintenance dredging of Berths 5 and 7 has occurred in 2011, 2012, 2015, 2017, and 2018. The dredge quantity from each berth throughout these events has ranged from approximately 300 to 1,000 CY. Maintenance dredging of Berths 8 and 9 also occurred in 2011, 2015, and 2017, with annual dredge quantities throughout these events ranging from just under 1,000 CY to approximately 1,500 CY. In 2018, Berths 8 and 9 were deepened to -43 feet +2 feet CRD with an approximate dredge quantity of 5,200 CY.

The Port conducted a multi-beam bathymetric survey of the shoreline area in March 2020; copies of maps developed from the survey are contained in Appendix B. The shoreline adjacent to the NuStar and KMBT upland facility operations consists of sloping banks from the top of the shoreline at an approximate elevation of 30 feet CRD, to the toe of the slope at the face of the in-water structures and berth maintenance dredging areas. The adjacent berths, Berths 5 and 7, and Berths 8 and 9 are flat bottomed. Berth 5 is maintained at elevation -41 feet CRD and Berths, 7, 8, and 9 are maintained at elevation -43 feet CRD. The berth depth is maintained by the Port based on the terminal operational use needs and commensurate with the elevation as the navigation channel of approximately -43 feet CRD. The majority of the shoreline along Berths 5, 7, 8, and 9 slopes from 5:1 to approximately 1.5:1. The steepest slopes (1.5:1) occur mainly in underpier areas armored with riprap beneath the dock structures.

The shoreline adjacent to the NuStar and KMBT upland facility operations consists of riprap armoring, which is sparsely vegetated at the top of the slope and transitions to sand, gravel, and native rocky alluvial deposits, consistent with the river bottom substrates, at the lower portion of the slope.

2.4.2 Sediment Sampling and Chemical Analysis

The Port conducts testing of sediment within the berths as part of their dredging program in accordance with the guidelines established in the sediment evaluation framework (SEF). Suitability Determinations are issued by the Portland Sediment Evaluation Team (PSET) that summarize the testing results, berth ranking, sediment data recency durations, and decisions regarding the suitability for in-water placement. Testing of sediment removed during previous Port maintenance dredging of berths has shown that sediment removed has met the SEF freshwater screening levels (SLs) (equivalent to the freshwater Sediment Management Standards [SMS] levels), with the exception of Berths 8 and 9 as described in Section 2.4.2.1. In addition to in-water placement, dredged material can be placed at the Port's Gateway 3 site for upland dredge material placement, based on chemical testing.

In 2007, the Port conducted sediment sampling of Berths 2, 4, 5, 7, 8, 9, 10, 13, and 14 and the United Grain Terminal (Grain Terminal) in order to characterize dredge material as part of the Port's berth deepening and berth maintenance dredging. Sediment sampling was performed in accordance with the 2006 SEF. There were no exceedances of the SEF SLs in samples from the Grain Terminal or Berths 2, 4, 5, 10, 13, or 14. At Berth 7 there was a slight exceedance of copper in one sample. Based on the low SEF ranking of nearly all the berths, including Berths 5 and 7, sediment sampling was not required to be performed for a seven-year period.

2.4.2.1 November 2015 Sediment Sampling and Chemical Analysis

In November 2015, following the end of the low-ranking recency period, the Port conducted post-dredge grab sampling of Berths 2, 3, 4, 5, 7, 8, 9, 13, and 14, and the Grain Terminal. Samples were generally collected in accordance with a July 2015 Sampling and Analysis Plan (SAP) memorandum (Floyd Snyder, 2015a) and an October 2015 SAP addendum (Floyd Snyder, 2015b). Details of the November 2015 field activities and sediment characterization results are presented in a January 27, 2016 Memorandum by Floyd Snider (Floyd Snider, 2016).

As described in the 2016 memorandum, the sediment sampling was intended to accomplish the following four objectives:

1. Characterize sediments (dredged material sampling from the receiving barge) in support of a PSET anti-degradation evaluation (Berths 7, 8, and 9).
2. Characterize post-dredge surface sediments via sediment grab sampling to assess the chemical quality of the new sediment surface and support the PSET anti-degradation evaluation by comparing post-dredge data to the SMS Freshwater Sediment Cleanup Objective (SCO) and Cleanup Screening Level (CSL) criteria (Berths 2, 3, 4, 5, 7, 8, and 9, and the Grain Terminal).

3. Characterize surface sediments via sediment grab sampling in berths that were not dredged (Berths 1, 10, 13, and 14) to provide chemical characterization of all berths at the same time.
4. Characterize sediment vertically in Berths 8 and 9 via sediment core sampling to obtain a better understanding of both the vertical extent of sediment containing tributyltin (TBT; identified during the 2007 sampling event) and to inform future maintenance dredging efforts.

Sediment samples were analyzed for the following constituents:

- Total petroleum hydrocarbons (TPH)
- Metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc)
- Butyltin
- Semi volatile organic compound (SVOCs)
- Pesticides
- Polychlorinated biphenyls (PCBs) as Aroclors
- Total organic carbon
- Total sulfides
- Ammonia
- Total solids

Tables 2, 3, and 4 of the January 27, 2016 Memorandum by Floyd Snider (Floyd Snider, 2016) provide a summary of the analytical results.

Both post-dredge and non-dredged sample data were compared to SMS Freshwater SCOs and CSLs. Results indicated that no analytes exceeded either their respective freshwater SCO or SCL criteria, with the exception of TBT. TBT exceeded the TBT SCO in the upper interval of the composite core sampling conducted in Berths 8 and 9. In Berth 8, samples were collected in intervals of 0 to 1.5 feet, 1.5 to 3 feet, and 3.6 to 5 feet. The TBT concentration detected in the A-interval of the Berth 8 composite core (0 to 1.5 feet below the mudline) was approximately two times the SCO. Although the detected TBT concentration was greater than the SCO, it was less than the results of 2007 composite sediment samples collected from Berths 8 and 9.

Ammonia concentrations ranged from <0.11 to 1.36 milligrams per kilogram (mg/kg) in the post-dredge and non-dredged samples, well below the SCO (per the SMS Freshwater Criteria) for ammonia of 230 mg/kg. Sediment cores extending to depths of 5 feet below the mudline were advanced at Berths 8 and 9. Ammonia concentrations in the core samples ranged between 10 and 19 mg/kg, more than an order of magnitude below the SCO concentration (230 mg/kg).

As previously discussed, fertilizer has been offloaded from ships at Berths 8 and 9 since 2014, but it has not been offloaded at Berths 2, 4, 5, or 7. Therefore, it would be anticipated that sediment adjacent to Berths 8 and 9 would have the highest potential for the presence of ammonia. However, the sediment sampling conducted at all of the berths had similar ammonia concentrations and all were well below the ammonia SCO.

2.4.2.2 2017 Berth 9 Post-Dredge Sampling

In 2017, the Port conducted post-dredge grab sampling of Berth 9 in order to confirm that the post-dredge sediment surface meets anti-degradation requirements and to re-evaluate PSET's ranking of Berth 9 by providing a second round of sampling to support down-ranking of the berth. The recency of Port's existing berth sediment characterization data expires in 2022 (seven years after the 2015 post-dredge sampling event). In coordination with PSET, additional sediment sampling will be conducted to confirm that the sediment quality is consistent with past testing results.

2.4.2.3 2018 TBT-Impacted Sediment Removal at Berths 8 and 9

The subsurface TBT impacted sediments were removed from Berths 8 and 9 in 2018 when these berths were deepened to -45+1 feet CRD.

2.5 PRELIMINARY INVESTIGATION ACTIVITIES

Several investigations of copper (and other related metals) and/or nitrates/ammonia in various media in the Project Area have been conducted. A description of the preliminary investigation activities and results are provided in the subsections below.

2.5.1 Blue Water in Soil Vapor Extraction System

Interim remedial activities are ongoing on the NuStar Leasehold to address chlorinated solvents in the vadose-zone soil and groundwater. A soil vapor extraction (SVE) system is currently operating at the Facility. The extent of the SVE system is shown on Figure 14 in Appendix D.

During the November 2017 monthly SVE monitoring event, approximately 16 gallons of water were observed in the condensate knock-out drum, and the water was bright blue rather than colorless, as is typical when water is present. The knockout drum is designed to separate liquid from vapors that have been removed from the SVE wells, by allowing the liquid to precipitate into a drum before the vapors are drawn into the vacuum system (blower). A sample of the "condensate" was collected and shipped to a local laboratory for analysis of constituents that were known to be historically or currently handled at or in the vicinity of the NuStar Leasehold and the KMBT Operations Area, including chlorinated VOCs, fertilizer compounds (sulfate, nitrate, nitrite, and phosphorous), and metals (copper). The analytical results are provided in Table 1 of the *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* report (Cascadia, 2018a). As reported in the additional investigation report, the results indicated that the knockout tank sample had elevated concentrations of copper, iron, ammonia, and nitrate, while the chlorinated VOC concentrations were at or below method reporting limits (Cascadia, 2018a).

After the blue water was discovered, the SVE system blower, knockout drum, piping manifold, and immediate area were inspected for obvious sources of surface water infiltration. However, nothing was observed. SVE system operating parameters remained consistent with historical results, suggesting that the piping remained intact and that there were no significant leaks in the system. During a site visit in April 2018, a gurgling sound was noted outside of SVE well vault VE-1-2, located between NuStar warehouses 2625 and 2655. When the vault to well VE-1-2 was opened, horizontal piping inside the vault was observed to have separated at a coupling. The inspection indicated that surface water was accessing the vault through a small pryhole located on the surface of the vault, at which point, water would accumulate in the vault until reaching the separating coupling, which could then allow stormwater to enter the SVE system and end up in the condensate drum.

The well coupling was repaired and the well was returned to service in September 2018. After repairing the well, blue water was still observed in the knockout drum. In general, water is observed in the knockout drum from November/December through May. During the drier summer/fall months, little to no water has been observed in the drum. From June through November 2018, water was not observed in the knockout drum, which is generally consistent with the drier season in Vancouver, Washington.

To date, the source of the blue water in the SVE system has not been confirmed. During the winter of 2018, all SVE wells were closed (not drawing a vacuum), except those under building 2625, and blue water still collected in the knockout drum. Throughout the 2019/2020 rainy season, NuStar continued to isolate (open) small groups of wells, in an attempt to identify the location in which ground surface water (stormwater) was entering the SVE system.

2.5.2 Initial Groundwater Sampling for Copper – November 2017

To better assess the source of metals in the SVE knockout drum water, total copper analysis was ordered on groundwater samples collected during the fourth quarter 2017 groundwater monitoring event for the NuStar Leasehold. The copper analytical results from the fourth quarter 2017 groundwater monitoring event are shown on Figure 2 of the NuStar *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a). Copper concentrations were detected in 25 of the 41 samples, with the highest concentrations located closer to the copper handling areas at the KMBT Operations Area (Cascadia, 2018a).

2.5.3 Wellhead Assessment

During fieldwork in November 2017, three groundwater monitoring wells (monitoring wells S-1, S-2, and MW-13) were identified as needing repair and redevelopment which was completed in 2018.

To further evaluate potential sources and pathways for metals in groundwater, Ecology requested a monitoring well monument assessment be conducted on the NuStar monitoring well network. The results of the monitoring well repair and redevelopment, and the monitoring wellhead assessment work is documented in the *Summary of Additional Field Activities at the NuStar Facility – March* *through June 2018* report (Cascadia, 2018a). The following paragraphs provide a summary of the scope and results of the wellhead assessment work.

On March 27, 2018, a representative from Ecology assessed 19 monitoring wells owned by NuStar. These wells consisted of wells EW-1, EX-1, MW-1, MW-6, MW-7, MW-8, MW-10, MW-12, MW-13, MW-14, MW-17, MW-23i, MW-2, MW-3, MW-9, MW-16, MW-19, MW-25i, and MW-26. Field representatives from Apex (on behalf of NuStar) and Parametrix (on behalf of the Port) were also onsite for the assessment.

During the wellhead assessment, Ecology took photos of monitoring wells and recorded information about the presence or absence of sediment in the well monuments above the well surface seal and around the upper portion of the well casing. Of the 19 wells assessed, 12 well monuments contained sufficient sediment volume for sample collection and analysis, including monitoring wells EW-1, EX-1, MW-1, MW-6, MW-7, MW-8, MW-10, MW-12, MW-13, MW-14, MW-17, and MW-23i. Ecology collected sediment samples from each of these well monuments. The well monuments for monitoring wells MW-2, MW-3, MW-9, MW-16, MW-19, MW-25i, and MW-26 did not contain enough sediment in the monument for sample collection.

A weighted tape was used to probe the bottom of the 19 wells to determine if sediment had accumulated. Sediment in wells S-1 and S-2 was assessed and sampled by Apex prior to Ecology's visit as summarized in the following paragraph. The only well with a notable amount of bottom sediment during the March 27, 2018 assessment conducted by Ecology was well MW-13. The sediment was present as murky or grainy dark water rather than a distinctly separate solid material. Ecology collected a sample of the murky water for laboratory analysis.

During a field event conducted a week earlier in conjunction with well monument repair work, Apex collected sediment from the monuments of wells S-1 and S-2 (on March 22, 2018) and sediment-containing water samples from the bottom of wells S-1 and S-2 (on March 26, 2018).

At the request of Ecology, well monument and sediment-containing well bottom samples that were collected by Ecology on March 27, 2018, and by Apex on March 22 and 26, 2018, were combined under one chain-of-custody and were submitted by Ecology for laboratory analysis of metals aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, molybdenum, selenium, silver, and zinc. Analytical results are provided are included in Table 3 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a). Copper concentrations in the well bottom "sediment" samples ranged from 612 mg/kg in well S-2 to 20,300 mg/kg in well MW-13. Copper concentrations in sediment samples collected from the well monuments ranged from 2,060 mg/kg in well MW-1 to 23,800 mg/kg in well S-1.

2.5.4 Monitoring Well Development

Because sediment was identified at the bottom of wells S-1, S-2, and MW-13 during the wellhead assessment event, Ecology requested that the wells be redeveloped to remove sediment. The wells were developed on March 26, 2018 (S-1 and S-2) and on April 10, 2018 (MW-13) as summarized in

Summary of Additional Field Activities at the NuStar Facility – March through June 2018 (Cascadia, 2018a). The location of the monitoring wells is shown on Figure 3. Development activities included first removing the bottom sediment with peristaltic tubing and a bailer. Once the sediment laden water was removed from the well, the well was surged using a surge block, to displace fine material from the well pack and/or adjacent formation while simultaneously removing water from the well with a downhole pump. Wells S-1 and S-2 were surged and pumped until the water turned from cloudy to clear, removing approximately three casing volumes from each well (i.e., approximately 25 gallons from well S-1 and 15 gallons from well S-2). At well MW-13, ten well volumes of water were removed equating to approximately 87 gallons of water. The groundwater clarity improved from cloudy at the initiation of development of well MW-13 to slightly cloudy at the end of development.

As previously discussed, groundwater samples from the fourth quarter 2017 monitoring event were analyzed for copper and were considered “pre-development” samples. In addition, wells S-1 and S-2 were sampled for copper during the first quarterly 2018 groundwater monitoring event on March 20, 2018, and are also considered pre-development samples. Groundwater samples were then collected after the development of the wells: post-development samples from wells S-1 and S-2 were collected on April 2, 2018, and from well MW-13 on April 10, 2018. Wells S-1 and S-2 were sampled seven days after well development and well MW-13 was sampled immediately a couple hours after well development.

The pre- and post-development analytical results are presented in Table 3 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a). The sample results for total copper in intermediate zone well S-1 decreased from a concentration of 20,900 micrograms per liter (µg/L) during fourth quarter 2017 to 370 µg/L and 829 µg/L, respectively during the pre- and post-development monitoring events on March 20 and April 20, 2018, respectively. The post-development total copper results decreased in wells S-1 and S-2, compared to the fourth quarter 2017 result, but increased in well MW-13.

2.5.5 Surface Sediment and Gutter Sampling on NuStar Leasehold

On March 29, 2018, Apex collected a ground surface sample for analysis of copper. The sample was collected on the pavement surface where a layer of mud had accumulated adjacent to the seawall. NuStar terminal operations staff had collected a similar surface sediment sample from near the seawall in 2010 and copper concentrations in the 2010 sample were approximately 35,000 mg/kg.

The 2018 sample result for copper was 10,400 mg/kg. The location of the 2010 and 2018 surface sediment samples are shown on Figure 7 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a), along with photos of the surface sediment locations.

NuStar staff have documented red-brown staining on the roof of the northwestern corner of warehouse building 2655. The staining was located above a portion of the building gutter that looked to be heavily corroded and filled with 2 to 3 inches of sediment. The stained roof and corroded gutter are located directly beneath the KMBT conveyor system, where copper concentrate and bentonite material are transported from storage buildings to vessels at the Port Berth 7, located on the Columbia River. Cascadia field staff collected a sample of the gutter sediment from two locations as shown on Figure 7 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a). Samples were submitted to Apex Laboratories (Apex Labs) of Tigard, Oregon, for analysis of arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, selenium, silver, zinc, aluminum, and iron by U.S. Environmental Protection Agency (EPA) Method 6020A. Analytical results for the metals are provided in Table 4 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a), and copper results are presented on Figure 7 of *Summary of Additional Field Activities at the NuStar Facility – March through June 2018* (Cascadia, 2018a).

Copper concentrations in the two gutter samples were 174,000 mg/kg and 88,200 mg/kg, respectively. Photos of the gutter sediments and surrounding area are also provided in Attachment G.

2.5.6 Routine Groundwater Sampling and Analysis for Copper, Nitrates, and Ammonia

Groundwater monitoring has been conducted at the Investigation Area to monitor the progress of remediation of chlorinated solvents in groundwater. Selected wells have also been analyzed for copper, nitrates, and/or ammonia as described below.

Copper. Routine groundwater monitoring for copper was initiated by KMBT following the November 2017 groundwater sampling which indicated the presence of copper concentrations above typical background levels in groundwater in the Project Area (see Section 2.4.2).

Groundwater sampling for copper has been conducted in conjunction with NuStar's semi-annual groundwater monitoring program for VOCs. Since the initial sampling conducted in November 2017, an additional four groundwater sampling events have been completed from select monitoring wells with the most recent occurring in September 2019 (see Table 2).

Groundwater samples have been analyzed for the following constituents:

- General water quality parameters (alkalinity, bicarbonate, carbonate, calcium);
- Total dissolved solids;
- Total and dissolved copper;
- Chloride; and
- Sulfate.

Table 2 presents results of groundwater samples analyzed for total and dissolved copper. There has been a general reduction in copper concentrations in most wells since 2017. In September 2019, the highest concentration measured in groundwater was from monitoring well S-2 (211 µg/L) located west of the bulk terminal conveyor belt (see Figure 5). Groundwater from several monitoring wells located a significant distance from KMBT operations contained copper greater than detection limits. For example, in September 2019, groundwater from well MW-2, located approximately 1,000 feet east of the ore conveyor contained 75.1 µg/L copper (Figure 5).

Nitrates and Ammonia. Groundwater samples collected from select NuStar monitoring wells between 2007 and 2016 were analyzed for ammonia and nitrates to evaluate natural attenuation processes in Project Area groundwater and to aid in the design of enhanced bioremediation interim actions for remediation of VOCs in groundwater. These data were reported in the NuStar RI (Apex, 2013) and are summarized in Table 3 herein.

Additionally, quarterly groundwater monitoring for ammonia, nitrate, and nitrite was initiated in November 2017 and has continued through the present. The analytical results are reported in each semi-annual groundwater monitoring report (Apex, 2017 and Cascadia, 2018b, 2019a, 2019b) and have been summarized in Table 3 for reference. Figures 6 through 9 illustrate the map view and extent of ammonia, nitrate, and nitrite in groundwater based on June 2019 results. In general, the concentrations of both nitrate and ammonia have been variable during the monitoring history at each well, with no discernible trend.

As shown on Figures 6 through 10, elevated ammonia and nitrate concentrations are generally limited to shallow zone groundwater beneath the part of the NuStar Leasehold where fertilizer is handled. With the exception of ammonia in well MW-2, fertilizer constituents are not present in groundwater on the eastern side of the NuStar Leasehold in the small and large tank farm areas.

2.5.7 Soil Investigation at KMBT Operations Area

As part of the West Vancouver Freight Access Project (WVFA), three soil investigations were completed near the north end of KMBT Operations Area. The WVFA project included expansion and relocation of rail facilities and associated utilities at the Port. Parametrix prepared a memorandum summarizing the results of these investigations (Parametrix, 2019c). A brief summary of the three investigations is provided below.

In April 2010, the Port completed a soil investigation that included 16 direct-push borings (labelled PT1 to PT16) to collect soil samples and to assess soil conditions where the new railcar unload facility was sited (Parametrix, 2019c). The Project Area is located on the Port property along the northern boundary of the KMBT Operations Area, south of the mainline tracks and north of Harborside Drive. The borings were generally located to the north and west of buildings 2725 and 2745 in the area where bulk copper concentrate material is unloaded (Parametrix, 2019c). A total of 53 soil samples were submitted for petroleum hydrocarbons and metals (including copper) analysis. Except for soil from one boring (PT-10), detected constituent concentrations were below Ecology cleanup levels and the Port's fill acceptance criteria (Parametrix, 2019c). Copper was detected at a concentration of 3,800 mg/kg in a soil sample collected from 1 to 2 feet bgs in boring PT10 (see Table 1 in

Parametrix, 2019c). This boring was located directly north of building 2745. The Method B cleanup level for copper in 2010 was 3,000 mg/kg; the current cleanup level is 3,200 mg/kg. This area was further investigated in 2016 for soil profiling prior to removal, as detailed below.

In April 2016, a limited Phase II Environmental Site Assessment (ESA) was conducted as part of the Grain Track Unit Train Improvements & South Lead project. The intent of the investigation was to evaluate soil conditions around the KMBT Dumper Pit and to characterize the soil for disposal. A total of 17 borings (labelled B1 to B17) were completed to a depth of approximately 5 feet bgs (see Figure 1 of Attachment B in Parametrix, 2019c). The boring locations were close to borings completed during the 2010 investigation but extended to the west and east.

Soil collected from 0 to 5 feet bgs was homogenized and collected as composite samples at each boring location. Composite soil samples were submitted for petroleum hydrocarbons, priority pollutant metals, and follow-up Toxicity Characteristic Leaching Procedure (TCLP) analysis, if necessary. Copper was detected at concentrations ranging from 7.83 to 1,120 mg/kg. The Phase II report text, tables, and figures are included as Attachment B of the Parametrix 2019c memorandum.

In July 2017, the Port conducted a soil investigation along the former railroad tracks less than a quarter mile east and west of the former bulk mineral railcar unload building. The tracks were removed as part of the WVFA project. The intent of the investigation was to characterize the material beneath the former railroad line. A total of 12 test pits (labelled 001 to 012) were completed along the former tracks (see Exhibit A of Attachment C in Parametrix, 2019c).

Two samples were collected from each test pit, one from the near-surface ballast material and one from the underlying sand. The ballast samples were from the fine-grained material within the ballast. The samples were analyzed for petroleum hydrocarbons, priority pollutant metals, PCBs, and polynuclear aromatic hydrocarbons (PAHs). The analytical results are summarized in Table 1 of Attachment C in Parametrix, 2019c. The ballast samples contained elevated concentrations of petroleum-related compounds and metals. Copper was detected in the ballast samples at concentrations ranging from 1,200 to 12,000 mg/kg. The concentrations of copper detected in the sand underlying the ballast material ranged from 6.8 to 600 mg/kg (one to two orders of magnitude lower than ballast samples).

The data indicated petroleum hydrocarbons and elevated metals concentrations were limited to the shallow ballast material located directly below the copper-ore loading area and railroad line (Parametrix, 2019c). Based on the findings, the Port retained a contractor to excavate the ballast material from the track area to a depth of approximately 5 feet bgs after removal of the tracks. The ballast material was screened to separate the fine-grained material. The coarse-grained ballast was washed in a contained system and reused. The fine-grained material and wash water were properly disposed.

2.5.8 November 2015 Sediment Sampling and Chemical Analysis

The Port completed an investigation of sediment in November 2015 as part of maintenance dredging at Ports berths 2, 3, 4, 5, 7, 8, and 9 (Floyd Snider, 2016). Because the focus was on dredge material quality, sampling was conducted in the shipping berths; samples were not collected from the area between the shoreline and the berths.

Details of the field November 2015 activities and sediment characterization results are presented in a January 27, 2016 Memorandum by Floyd Snider (Floyd Snider, 2016).

The objectives of the sediment sampling and a summary of the results are provided in Section 2.4.2.1.

2.5.9 2018 Airborne Dust Assessment

In March 2018, the Port assessed the potential that dust generated during KMBT copper concentrate or NuStar fertilizer operations was migrating via air and depositing in the Project Area. Details can be found in the July 26, 2018 *Updated Roof Gutter Sampling Results* memorandum (Parametrix, 2018b). Prior to replacing gutters on specific buildings located on and near copper handling operations, gutter sediment was sampled in March 2018 and tested for seven metals and nitrates (see Figure 1 in Parametrix, 2018c). One additional sample was also collected from a gutter on a small bathroom building located directly beneath the conveyor system. Roof gutters on the NuStar Leasehold were not included in the gutter evaluation performed by the Port.

The gutter sediment analytical results are provided in Table 2 of the July 26, 2018 *Updated Roof Gutter Sampling Results* memorandum (Parametrix, 2018b). The results in Table 2 are compared to Clark County soil background levels (Ecology, 1994) as well as MTCA SLs. Elevated copper concentrations were detected in gutter sediment around copper handling operations, arsenic and cadmium concentrations also consistently exceeded Cleanup Levels and Risk Calculation (CLARC) levels. Results show the highest concentrations were from gutters located closest to the KMBT Operations Area and attenuating with distance (Parametrix, 2018c).

Of the 21 gutter samples analyzed for nitrates, 20 did not contain nitrate at concentrations above method reporting limits. One sample collected from the northeast side of Port building 2835 contained nitrate at a concentration of 12.3 mg/kg.

2.5.10 2018 Pavement Evaluation Project

The Port initiated a pavement rehabilitation project in May 2018 at Terminals 2 and 3, southeast of the KMBT facility. Part of the project consisted of assessing the asphalt and subsurface conditions to determine the thickness, condition, and remaining life of the pavements and sub-grade. Parametrix prepared a memorandum documenting the results of sampling conducted in support of the project (Parametrix, 2018c) A brief summary is provided herein.

As part of the investigation, six borings (B-1 through B-6; Figure 10) were advanced to a depth of approximately 4 feet. Soil samples were collected at two depths from each location for chemical analysis and to evaluate road base structural conditions. Borings were generally located over asphalt cracks. The shallow samples were collected at 1 to 2 feet below grade and the deeper samples were collected at 3 to 4 feet bgs. The samples were analyzed for nitrate-nitrogen, ammonia, total Kjeldahl nitrogen (TKN), aluminum, calcium, copper, iron, lead, selenium, and zinc. The sample collected from boring B-5 at 2 feet bgs, which had the highest copper concentration (133 mg/kg), was further analyzed for antimony, arsenic, beryllium, cadmium, chromium, nickel, silver, and thallium. Tables summarizing the analytical results are included in Parametrix, 2018c.

Samples from borings B-6, B-5, and B-4, located closest to the KMBT Operations Area, contained copper above the Clark County soil background level of 34 mg/kg (Parametrix, 2018c). However, the results were below the MTCA Method B Non-Cancer soil cleanup level for copper of 3,200 mg/kg and Vadose Zone Soil - Protective of Groundwater cleanup level of 284 mg/kg (Parametrix, 2018c).

Nitrate concentrations ranged from non-detect (i.e., <2.7 mg/kg) in five of the twelve soil samples to a maximum of 137 mg/kg at location B-5 at 3 feet bgs. Ammonia ranged from 0.224 mg/kg at boring B-1 at 4 feet bgs to 1,070 mg/kg at boring B-4 (1 foot bgs). TKN concentrations ranged from below reporting limits (i.e., <42 mg/kg) in two of the twelve samples up to 2,400 mg/kg in boring B-4 at 1 foot bgs. There are no MTCA regulatory standards available for screening nitrate or ammonia concentrations in soil.

The Port repaved the asphalt around buildings 2655 and 2625 in September/October 2019. Representatives for NuStar noted an ammonia odor emanating from the subsurface after the old pavement had been removed (and prior to laying the new asphalt). Surface soil samples (collected after the asphalt was removed) were collected from three areas with discernable ammonia odors, and the samples were analyzed for ammonia by Method SM 4500-NH3 and nitrate/nitrite by EPA Method 9056A. The sample locations and analytical results for ammonia and nitrate are shown on Figure 10. The ammonia concentration in the three samples ranged from 40 to 122 mg/kg and the nitrate concentrations ranged from non-detect (<2.59 mg/kg) to 37.8 mg/kg.

In general, the ammonia, nitrates, and metals results support the conclusion that the pavement is limiting migration of copper concentrate and fertilizer into the underlying soil. The presence of the higher copper, nitrates, and/or ammonia concentrations in soil in borings B-4 through B-6 can be explained by the more intensive operations in these areas; the area around sample locations B-6, B-5, and B-4 are subject to tracking by vehicles, and the area around B-6 is subject to washdown activities when mineral handling equipment is cleaned after transfer operations.

2.5.11 2019 Storm Pond Outfall

On July 30, 2019, the Port and Ecology each collected samples from the Terminal 4 storm pond outfall for analysis of total nitrate/nitrite as nitrogen by EPA Method 353.2. The Port sampled the outfall for total nitrate and nitrite again on October 3, 16, and 22, 2019, and Ecology sampled for total nitrate and nitrite on October 16, and 22, 2019. The October 3 and 16, 2019 outfall sampling events were conducted concurrently with a fertilizer offloading event at Berths 8 and 9 that lasted from September 11, 2019 through October 18, 2019. The October 22, 2019 sampling was conducted following completion of the unloading event. The results from the outfall sampling events are provided in Table 4. The concentration of total nitrate/nitrite ranged from 0.342 to 0.895 mg/L during the sampling events. Water from the storm pond is ultimately discharged to the Columbia River under a National Pollutant Discharge Elimination System (NPDES) permit held by the Port. The permit benchmark for nitrates is 0.68 mg/L.

On November 6, 2019, Jones Stevedoring Company and Two Rivers Terminal, LLC, received a Notice of Violation (NOV) from Ecology, identifying that bulk fertilizer was visible on the ship's rail and in scuppers, allowing fertilizer to enter the Columbia River via the Port's stormwater system. The NOV requires improved BMPs to be implemented by the longshoreman and stevedore companies to mitigate fertilizer from entering the river. In addition, Ecology transmitted a Water Compliance Inspection Report (Report) to the Port on December 30, 2019, which listed the results of the Ecology sampling of stormwater discharge in July and October 2019. The Report noted that the benchmark was exceeded during the offloading event but not before or after the offloading event. Ecology concluded in the Report that the sweeping and BMPs implemented by Jones Stevedoring are not sufficient to prevent nitrate concentrations above benchmark values from entering the river via stormwater discharge. The Report references the NOV issued to Jones Stevedoring and Two Rivers requiring they file a report describing how they will improve cargo handling to prevent nitrates from entering the Port's stormwater system during unloading activities. Ecology has decided to defer enforcement until after Jones Stevedoring implements their proposed improved BMPs.

On February 10, 2020, NuStar received an NOV from Ecology, identifying that nitrate and ammonia were detected in stormwater runoff on the NuStar leasehold at concentrations that exceed Stormwater General Permit Benchmarks. As discussed later in this document, the recent stormwater data are currently being evaluated along with Ecology and additional stormwater investigation will be conducted during the Phase II investigation.

2.6 COPPER-RELATED RELEASES AND REMEDIAL ACTION

Four separate remedial activities associated with releases of copper have been performed in the Project Area:

1. Copper concentrate release to sediments near the Port's bulk loading facility (Port Berth 7 in 1987),
2. Copper concentrate release to soil south of the former sand shed (West Coast Marine, 2006).
3. CCA wood treatment preservative concentrate release near storage tank 132 at ST Services Facility in 2006 (Valero, 2006a/b)

4. ACQ wood treatment preservative release within the ST Services Facility in 2007 (Ash Creek, 2007a/b/c).

The first two releases were associated with copper concentrate in the KMBT Operations Area, and the second two were associated with copper-containing wood preservative in the eastern portion of the NuStar Leasehold. A summary of each release and remedial efforts to address the release are provided below.

2.6.1 Copper Concentrate Release to Columbia River Sediments and Remedial Action

Below is a summary of a Parametrix memorandum (Parametrix, 2019d) that describes the copper concentrate release investigation and remedial response.

Discovery and Initial Investigation. In August 1987, Ecology discovered a release of copper concentrate to the Columbia River from the Port loading facility at Berth 7. Ecology issued the Port a Compliance Order (DE 87-S225) in November 1987 that required a site investigation to determine the nature and extent of copper-contaminated sediment. Ecology approved a Work Plan submitted by the Port in January 1988. The findings of the investigation were documented in a report submitted to Ecology in October 1988. Sediment samples were collected near Berth 7 to define the extent of copper contamination in sediment. Concentrations of copper detected in sediment are summarized on Figure 3 of the Parametrix memorandum (Parametrix, 2019d). The investigation found the highest concentrations of metals were in the immediate vicinity of the bulk loading facility. Over 70 sediment samples were analyzed, concentrations under and adjacent to the shiploader ranged from 1,000 to 5,000 mg/kg copper. For the most part, concentrations decreased downstream and away from the shiploader. Copper and arsenic concentrations were greater than background in the study area as established by collection of background sediment samples (Parametrix, 2019d). Zinc, chromium, lead, and mercury concentrations were within the range of background levels.

Additional Sampling and Required Remediation. Based on the findings of the initial investigation, a Phase II Columbia River Impact Investigation was completed, which included additional sediment sampling and acute static bioassay testing. The findings of the Phase II investigation indicated the highest concentrations of copper in sediment were located immediately adjacent to the bulk loading facility (see Figure 5 of Parametrix, 2019d). In addition, the bioassays indicated the sediments were not acutely toxic to fish and not classified as Extremely Dangerous Waste. However, sediment with higher concentrations of copper was determined to be a potentially Dangerous Waste. In December 1989, the Port submitted a Draft Dredging and Disposal Feasibility Evaluation, which included a recommended action of hydraulic dredging. In July 1990, Ecology issued an enforcement order (DE 90-S189) that required the cleanup of copper-impacted sediments from the Columbia River using hydraulic dredging. In addition, remedial activities included the design and construction of a water pollution control facility for the Bulk Facility Operation Area, including the construction of a concrete curb near the loading facility to eliminate surface stormwater flow to the river.

Remediation Activities. In July 1990, dredging of the copper-contaminated sediment was initiated. A cleanup level of 1,300 mg/kg was determined to be protective of freshwater organisms. The area of sediment containing copper at concentrations exceeding the cleanup level was limited to the area around the Berth 7 dock. The Port removed approximately 5,000 CY of sediment with copper concentrations exceeding 1,300 mg/kg. The dredge area was divided into 35 cells that were 40 by 40 feet in size. The dredged volume was approximately 34,700 cubic feet and the average depth of the dredge was 1.5 feet.

Cleanup Verification Sampling and Closure. Cleanup verification sampling of sediment in the grid cells was completed in June and August 1990, and April 1991. Based on the sampling, sediment with copper concentrations exceeding 1,300 mg/kg was identified in the area directly under the dock (grid cells 10 and 11) and the area of grid cells 25 and 26 (Century West, 1990). In August 1992, approximately 400 CY of additional sediment were removed from grid cells 25 and 26 using clamshell dredging in accordance with an Ecology-approved supplemental remedial alternatives plan. The dredged material was placed on a barge for dewatering prior to transport by truck to the Port's upland disposal site. Verification sampling in grid cells 25 and 26 indicated copper concentrations in sediment were below the 1,300 mg/kg cleanup level. The sediment with copper exceeding the cleanup level in grid cells 10 and 11 (beneath the dock) was left in place due to safety concerns for divers. As approved by Ecology, natural sedimentation was relied upon to reduce copper concentrations over time in the area beneath the dock.

In 1993, Ecology notified the Port that all required actions of the Enforcement Order had been fulfilled, and the site was removed from the Hazardous Sites List.

2.6.2 2006 Copper Concentrate Release to Soil at KMBT

Release. In early 2006, during the drying process to reduce moisture in copper concentrate, the drying system failed, resulting of a release of copper concentrate to the ground surface. The release was localized in the area immediately south of the former sand shed footprint.

Cleanup and Cleanup Verification Sampling. Cleanup began on January 29, 2006, and final cleanup verification samples were collected in April 2006. Information and analytical results are presented in a copper concentrate clean up report prepared by West Coast Marine (2006). West Coast Marine did not prepare a figure showing the final cleanup sampling locations and the actual soil sample locations are unknown. However, a sketch found in the Ecology Report Tracking System file (ERTS# 553779) shows the general area of the release.

The area is generally an arc wrapping around and within 120 feet of the east end of the former sand shed and the area between the sand shed and the A-frame building (building 2725). It is assumed that the verification soil samples were collected in this area. Cleanup began on January 29, 2006. Details of the remedial actions are unknown but as reported in Ecology ERTS# 553779, included excavating approximately 2-inch depth of paved area. Project details, the sketch, and the reference to the "no further action" needed are presented in the ERTS File 553779, 2006 KMBT Copper Cleanup.

Ten verification soil samples were analyzed for copper and lead concentrations. Results show copper concentrations ranged from 16,200 to 37 mg/kg and lead concentrations ranged from 138 to 3 mg/kg. One of the ten samples analyzed for copper was above the MTCA limit of 3,000 mg/kg at the time. All ten of the lead results were below the MTCA Method A limit of 250 mg/kg.

2.6.3 2006 Release of Chromated Copper Arsenate and Remedial Action at NuStar Leasehold

Based on a review of NuStar records, two historical releases of liquid wood preservatives products containing copper occurred on the NuStar Leasehold. This included a release of CCA in 2006 and a release of ACQ 2102 in 2007. A summary of the two releases and subsequent remediation activities is provided in the sections below and were also provided to Ecology in a memorandum entitled *Historical Handling of Historical Products Containing Copper and Historical Management of Copper Dust from Nearby Operations – NuStar Vancouver Facility* (Cascadia, 2020b).

Release and Initial Response. On March 10, 2006, 15 gallons of CCA were spilled on the ground at the NuStar Leasehold during a product transfer from a railcar to a storage tank due to a leaking valve. The National Response Center (NRC), Ecology, and the EPA were notified within an hour after the spill was identified.

Spill Clean Up and Stockpile Characterization Activities. The spill cleanup operations were initiated within an hour after the release was discovered and the leaking valve was addressed and contained. Cleanup activities included cleaning the side of the railcar (to minimize additional spill material) and excavation of stained soil. The impacted soil was easy to identify and remove because the CCA left a distinct greenish color where it had contacted the soil. The soil was excavated vertically until the stained soil was removed; the sidewalls of the excavation were then extended an additional 2 feet laterally from the stained/unstained interface. The lateral extent and depth(s) of the historical excavation are depicted on Figure 3 of Cascadia, 2020b.

The excavation activities were completed on March 15, 2006. Water from the railcar cleanup and soil from the excavation were containerized pending sampling and profiling for subsequent disposal. Composite samples of the excavated soil and cleanup water were submitted for laboratory analysis of total metals and TCLP metals, including arsenic, chromium, and copper. The TCLP soil and water results were below state dangerous waste criteria, so the waste was classified as unregulated waste.

Soil Confirmation Sampling. On March 16, 2006, a work plan memorandum was submitted to Ecology, proposing methods and procedures for collecting soil confirmation samples from the excavation area (Ash Creek, 2006a). Locations of the confirmation sampling are shown on Figure 3 of Cascadia, 2020b.

Soil samples CS-1 through CS-4 were collected on April 5, 2006, and were submitted to a laboratory for analysis of total arsenic, chromium, and copper. The analytical results from the soil samples are tabulated below.

Sample	**Total Concentration in Soil (mg/kg)**		
	Arsenic	**Copper**	**Chromium**
CS-1	35.7	29.8	54.4
CS-2	1.20	5.97	50.6
CS-3	3.31	15.9	41.2
CS-4	2.86	14.3	94.5

Sample	**Total Concentration in Soil (mg/kg)**		
	Arsenic	**Copper**	**Chromium**
CS-5	26.1	not analyzed as detailed below	not analyzed as detailed below
CS-6	5.85	not analyzed as detailed below	not analyzed as detailed below
MTCA Cleanup Level	20	3,000	2,000

Note: Cleanup Levels: MTCA Method A, Copper Method B; CLARC database.

With the exception of arsenic in sample CS-1, the soil confirmation samples were below MTCA cleanup levels. On April 12, 2006, an additional 6 inches of soil were removed from the area around sample CS-1, and a second confirmation sample (CS-5) was collected and analyzed for arsenic. The analytical result for arsenic in confirmation sample CS-5 was 26.1 mg/kg, which still exceeded the MTCA Method A cleanup level of 20 mg/kg.

On April 17, 2006, an additional 6 inches of soil were excavated in the vicinity of confirmation samples CS-1 and CS-5, in the deepest part of the excavation. The maximum size of the “deep” part of the excavation was approximately 36 inches across and 30 inches deep. After the excavation was completed, sample CS-6 was collected from the base of the excavation and was analyzed for arsenic. The resulting concentration was 5.85 mg/kg, which was below the MTCA Method A cleanup level of 20 mg/kg. NuStar submitted a letter to Ecology on April 24, 2006, documenting the completion of the CCA excavation and soil sampling activities.

2.6.4 2007 Release of Alkaline Copper Quaternary and Remedial Action at NuStar Leasehold

A description of the release, initial response, remedial activities, and confirmation sampling results is provided below.

Release and Initial Response. On May 26, 2007, a release of ACQ 2102 occurred at the NuStar Leasehold during off-loading of a rail tanker car. A loaded tanker car containing preservative was being prepared for off-loading following standard operating procedures (SOPs). Due to an incorrectly installed valve on the railcar, the valve was physically open when set in the position marked as being “closed.” When the cap was removed from beneath the valve prior to connecting the transfer hose, the open valve allowed a total of 5,000 gallons of wood preservative to be released. Product was released to both paved and unpaved areas.

The following activities were conducted immediately in response to the release:

- The release was reported to the City emergency services (fire department), Ecology, NRC, US Coast Guard, the Port, and the Washington State Department of Transportation (DOT). The notifications were made within two hours of the release.
- An emergency response contractor mobilized to the facility within 15 minutes and immediately initiated the following activities:
  - Soil containment berms were created to contain product;
  - Liquid product was collected and placed in a temporary storage tank;
  - Surface soil with visible product (blue staining) was excavated and placed in roll-off boxes;
  - Paved areas were pressure washed and the water was collected in the storage tank; and
  - Plastic was placed over the excavated area pending further action.

A total of 5,000 gallons of liquid were recovered (estimated as 4,200 gallons of ACQ 2102 and 800 gallons of water) and approximately 60 yards of soil with visible staining were excavated. The approximate location and lateral extent of the excavation is shown on Figure 4 of Cascadia, 2020b.

Soil Confirmation Sampling. On June 1, 2007, NuStar submitted an ACQ Cleanup Sampling Work Plan to Ecology with a proposed soil confirmation sampling plan for the excavated area (Ash Creek, 2007a). The samples were collected and analyzed for copper by EPA Method 6020. The sampling methodologies and analytical results were summarized in the July 6, 2007 ACQ Cleanup Sampling Results report (Ash Creek, 2007b). The excavated surface samples from the two areas with remaining visible staining had copper concentrations that exceeded the excavation cleanup goal of 3,000 mg/kg copper, at concentrations of 6,110 mg/kg in sample ACQSS-4 and 5,550 mg/kg in sample ACQSS-9, respectively.

Push probe samples were collected from two borings (ACQ-B-1 and ACQ-B-2) at depths up to 5 feet bgs in the areas of locations ACQSS-4 and ACQSS-9 to define the extent of additional excavation that was needed. A detailed description of the sampling and analytical results was provided in the July 6, 2007 ACQ Cleanup Sampling Report (Ash Creek, 2007b). The push-probe results demonstrated that the vertical extent of the soil to be excavated was limited to a depth of about 2 feet bgs near boring ACQ-B-1 and about 3 feet bgs near boring ACQ-B-2.

Additional Excavation. Additional excavation was completed on August 7, 2007, in the areas where the push probe data identified slightly deeper impacts. The extent of the excavation is shown on Figure 4 of Cascadia, 2020b. Approximately 0.8 CY of soil was removed from the northern excavation area (near location ACQSS-4 and boring ACQ-B-1) to a final depth of approximately 5.5 feet, and approximately 2 CY of soil were removed from the southern excavation area (near location ACQSS-9 and boring ACQ-B-2 and the rail piping manifold) to a total depth of about 3.5 feet. After the additional excavation, the exposed soil at both locations was free of visible staining. Because unstained soil was correlated with concentrations one to two orders of magnitude below the cleanup goal, the remedial effort was considered complete. After excavation activities were completed, the excavation was backfilled with crushed gravel.

2.7 POTENTIAL RECEPTORS

There is the potential for both human and ecological receptors in the Project Area.

Human Receptors. The Project Area is located adjacent to the Columbia River and includes industrial land which is owned by the Port and leased by various industrial operators. Human receptors will include occupational workers of the industrial operations as well as construction or excavation workers contracted for shorter term projects. Because the leased land is highly secured, there is little opportunity for human trespassers onto the upland portion of the Project Area.

The Project Area includes the Columbia River adjacent to the KMBT Operations Area and the NuStar Leasehold. The Columbia River has many uses, including as a navigational channel for commerce and recreational boaters and fisher persons. Therefore, human consumers of fish from the Columbia River are a potential receptor, as well as recreational users exposed to the water of the river via ingestion or direct contact.

Ecological Receptors. Ecological receptors are both terrestrial and aquatic. As discussed in Section 2.1, the NuStar and KMBT facilities and surrounding areas are predominantly covered with impermeable surfaces and provide no terrestrial habitat. Benthic and aquatic organisms, including anadromous and resident fish species, some of which are threatened or endangered, use parts of the river during various stages in their life cycles.

2.8 CHEMICALS OF POTENTIAL CONCERN

COPCs for the Supplemental RI for the bulk mineral and fertilizer operations at KMBT and NuStar, respectively, are developed in the following subsections.

2.8.1 Bulk Mineral Operations

Based on a review of the historical and current site use information, bulk materials including copper, silica, zinc, and manganese concentrates, bauxite, hydrated alumina, and ferrophosphorus have been imported, stored, and exported from the bulk minerals operations area. The bulk minerals operation area extends from the rail unload building in the north to the storage warehouses and along the conveyor to the shiploader at the Berth 7 dock. Figure 4 calls out the two bulk mineral operations areas, which are connected by the overhead conveyor. Previous investigations indicate the presence of some metals in media in the bulk mineral operations area at concentrations above regional background levels. Therefore, the COPCs associated with the bulk mineral operations are focused on metals.

Metal COPCs associated with bulk handing operations were identified using information from the following sources:

1. Analytical results of a copper concentrate sample collected by Ecology in 2015;
2. Information of metal compounds associated with the concentrate found in SDS supplied to KMBT by both Montana Resources and KGHM (Appendix A);
3. Gutter sediment analytical results collected in 2018 by the Port near the bulk mineral operations (Parametrix, 2018b; Parametrix, 2020) and in 2018 by NuStar from warehouses on the NuStar Leasehold (Cascadia, 2018a);
4. MTCA Method A Soil Cleanup Levels for Industrial Properties – Table 745-1 (Ecology, 2007);
5. Washington Background Concentrations for Clark County (Ecology 1994); and
6. Table VI – Freshwater Sediment Cleanup Objectives and Cleanup Screening Levels Chemical Criteria (WAC 173-204-563; adopted February 22, 2013).

On December 16, 2015, Ecology collected and analyzed a copper concentrate sample from Montana Resources as part of a railcar release response approximately 0.75 mile west of the KMBT railcar unload facility. The release was assigned ERTS number 661538. The copper concentrate sample was analyzed at the Ecology Manchester Environmental Laboratory in Port Orchard, Washington. The sample was tested for copper and Resource Recovery and Conservation Act (RCRA) eight heavy metals (RCRA-8 metals). The SDS listed expected metal compounds (other than copper) and their associated percentages in the copper concentrate. The analytical results were compared with soil background concentrations published by Ecology in 1994 (Ecology, 1994) and summarized in the table below along with the SDS metal compound percentages.

Metal	**Ecology Copper Concentrate Sample – 12/16/15 (mg/kg)**	**Copper Concentrate SDS (Presence of metal or metal compounds listed in product) (Yes/No)**	**Washington Background Concentration for Clark County (Ecology 1994) (mg/kg)**	**Washington Freshwater Sediment Cleanup Objective SCO (mg/kg)**	**Method A Cleanup Levels for Industrial Properties (mg/kg)**
Copper	226,000	Yes (25 – 80%)	34		None
Zinc	Not Analyzed	Yes (0.1 – 15%)	96		None
Nickel	Not Analyzed	No	21	26	None

Metal	**Ecology Copper Concentrate Sample – 12/16/15 (mg/kg)**	**Copper Concentrate SDS (Presence of metal or metal compounds listed in product) (Yes/No)**	**Washington Background Concentration for Clark County (Ecology 1994) (mg/kg)**	**Washington Freshwater Sediment Cleanup Objective SCO (mg/kg)**	**Method A Cleanup Levels for Industrial Properties (mg/kg)**
Manganese	Not Analyzed	No	1,511	None	None
	RCRA-8 Metals				
Arsenic	1,590	Yes (trace)	6	14	20
Cadmium	80.7	No	1	2.1	2
Chromium	4.26	No	27	72	19 (Cr^6/2,000 (Cr^3)*
Lead	4,950	Yes (<1%)	17	360	1,000
Mercury	0.82	No	0.04	0.66	2
Silver	147	No	Not Available	0.57	None
Barium	1.50	No	Not Available	None	None
Selenium	55.9	No	Not Available	11	None

Note: Cr^3 = Trivalent Chromium; Cr^6 = hexavalent chromium; Cr^3 cleanup level is for Total Chromium

The tabulated results show the copper concentrate sample contained copper and four other RCRA-8 metals (arsenic, cadmium, lead, and mercury) greater than available Clark County 90th percentile background values. Chromium, while detected in the copper concentrate sample, was less than the background. In addition, the SDS did not identify the presence of chromium compounds in the concentrate.

Results from the gutter sediment data collected in February and March 2018 by the Port are consistent with the copper concentrate data collected by Ecology. The gutter data show elevated (above background) concentrations of copper, arsenic, cadmium, lead, and mercury (Parametrix, 2018b) near the KMBT facility. Zinc was not analyzed by Ecology in the concentrate samples. However, gutter sediment results show zinc concentrations above background. Chromium concentrations detected in the gutter samples were near the regional background of 27 mg/kg. Approximately half of the chromium concentrations near the bulk terminal operations were less than background and all were below 50 mg/kg (Parametrix, 2018b). Concentrations of silver, barium, and selenium were also detected in the gutter data.

Barium and aluminum are not considered COPCs because they are not expected to be significantly present in the copper concentrate, and no MTCA Method A or sediment SCO are established. Aluminum is not present in concentrations above background where sampled. While chromium is not considered to be a likely COPC for copper ore based on: (1) SDS information showing chromium is not significantly present in the copper concentrate, and (2) the concentration of chromium detected in the copper concentrate sample collected by Ecology was below background, historical speciation data (trivalent vs. hexavalent chromium concentrations) is not available. Based on conversations with Ecology, it is proposed that the five highest concentration copper soil samples be further analyzed for hexavalent chromium concentrations. Based on the low detected concentrations and relatively high cleanup limits for these metals, they are not considered COPCs in this investigation.

In summary, based on the available lines of evidence discussed above, the metal COPCs associated with bulk operations for all media are as follows:

- Copper – Present above the background concentration in both the copper concentrate sample and gutter samples. Copper compounds are also a component of the concentrate as listed in the available SDS.
- Arsenic – Present above the background concentration in both the copper concentrate sample and gutter samples and present above the referenced Method A cleanup level. Arsenic compounds are also a component of the concentrate as listed in SDS.
- Cadmium – Present above the background concentration in both the copper concentrate sample and gutter samples. Also present above the referenced Method A cleanup level.
- Lead – Present above the background concentration in both the copper concentrate sample and gutter samples. Lead was present above the referenced Method A cleanup level. Lead is also a component of the concentrate as listed in SDS.
- Mercury – Present above the background concentration in both the copper concentrate sample and gutter samples.
- Zinc – Zinc was not tested by Ecology in the copper concentrate sample. However, zinc was detected above background in the gutter samples and, according to the available SDS, zinc compounds can be expected to be present in the concentrate.

For the five samples with the highest copper concentrations (for soil), the following additional metals will be analyzed as follows:

- Chromium – Present above the background concentration in gutter samples, and a lack of speciation data in soil to compare to applicable screening levels. The five highest copper containing samples will be further analyzed for hexavalent chromium.

- Silver, selenium, nickel, and manganese based on a lack of comprehensive historical data for comparison. Barium and aluminum are not considered COPCs because they are not expected to be significantly present in the copper concentrate or have not been detected in high concentrations in soil samples that were otherwise highly impacted.

For the five samples with the highest copper concentrations (for sediment), the following additional metals will be analyzed as follows:

- Chromium – Present above the background concentration in gutter samples. The five highest copper containing samples will be further analyzed for total chromium for comparison to sediment SCOs.
- Silver, selenium, nickel, and manganese based on concentrations (in one or more media) above sediment SCOs and/or a lack of comprehensive historical data for comparison. Barium and aluminum are not considered COPCs because they are not expected to be significantly present in the copper concentrate or have not been detected in high concentrations in soil samples that were otherwise highly impacted.

2.8.2 Fertilizer Operations

Fertilizers, consisting predominantly of phosphorous, nitrogen, potassium, and ammonium sulfate products, have been imported, handled, and exported from the NuStar Leasehold. Previous investigations indicate the presence of nitrate, nitrite, and ammonia in media at or near the NuStar Leasehold. In addition, the fertilizer products historically handled at the facility are partially comprised of potassium and phosphorous; therefore, the COPCs associated with the fertilizer operations are nitrate, nitrite, ammonia, potassium, phosphate, and sulfate.

3.0 PRELIMINARY SITE CONCEPTUAL MODEL

For exposure to chemicals and potential risks to occur, a complete exposure pathway from release to receptor must exist. That pathway requires a source, release mechanism, transport mechanism, environmental exposure point and receptors. Two CSMs have been constructed to assess the potential for complete exposure pathways to exist based on the historical site use information and previous investigation data described in Section 2. Section 3.1 presents the CSM for copper concentrate operations at the KMBT Operations Area, a potential source of metals. Section 3.2 presents the CSM for fertilizer operations at the NuStar Leasehold, a potential source of ammonia and nitrate/nitrites. In each section, the potential release mechanisms from the product operations are summarized, the transport mechanisms are then developed, and potentially complete pathways between the releases and possible receptors are identified.

3.1 COPPER/METALS

3.1.1 Summary of Bulk Mineral (e.g., Copper Concentrate) Operations

The copper/metals CSM depicting potential contaminant release mechanisms, transport, and exposure pathways is presented on Figure 11. As detailed in Section 2, historical operations at the KMBT facility consist of the import, handling, and export of bulk minerals and other bulk dry products. Bulk mineral concentrates are shipped to the facility primarily via rail. Railcars are unloaded by an excavator-type machine onto a covered conveyor system for transport into the bulk material warehouse. Heavy mobile equipment, including front-end loaders working inside the warehouse, transfer the ores onto a covered ship-loading conveyor. The conveyor connects directly to the shiploader and loads ore cargo into the ship’s storage compartment. The bulk minerals are a potential source of metals, the COPCs for the KMBT.

3.1.2 Potential Release Mechanisms and Pathways

3.1.2.1 Site Activities as Primary Release Mechanisms

Based on the historical and current site operations at the KMBT, primary release mechanisms include:

- Untarping and unloading of railcars and transport of ore to Storage Building;
- Loading of ore from Storage Building onto the conveyor belt;
- Transit on the conveyor; and
- Loading on to ships at Berth 7.

3.1.2.2 Secondary Sources and Transport Mechanisms

COPCs from the primary release mechanisms can impact media in the Project Area, which can then act as secondary sources and transport mechanisms, as described below.

Bulk Materials, Including Copper Concentrate, as Fugitive Dust. Dust has been documented during the loading, handling, and unloading operations at the KMBT Operations Area. Fugitive dust particles can be transported in outdoor air to potential receptors; they can also be transported and settle into stormwater and onto the surface water of the Columbia River.

Based on fugitive dust as a secondary source and the transport mechanisms described above, the following potentially affected media have been identified:

- Surface soil
- Air
- Stormwater
- Surface water
- Sediment

Bulk Materials, Including Copper Concentrate, on Paved Ground Surfaces. Bulk materials have the potential for falling onto paved surfaces both during transport and handling. From the paved surfaces, the ore concentrates have the potential for reaching potential receptors when rainfall creates stormwater that enters the stormwater conveyance or management system, or via overland flows to surface water and/or sediment, or to groundwater via monitoring wells.

Based on paved ground surfaces as a secondary source and overland flow as a transport mechanism, the following potentially affected media have been identified:

- Stormwater
- Groundwater
- Surface water
- Sediment

Bulk Materials, Including Copper Concentrate, on Unpaved Ground Surface. Approximately 26 percent of the KMBT Operations Area is currently unpaved, including the area along the rail corridors. Additionally, the area east of building 2745 was historically unpaved. Ore concentrates that are deposited on unpaved soil, either from airborne dust or from direct releases during bulk materials operations, are potentially accessible to receptors on the ground surface. Additionally, the ore can be secondarily transported in stormwater runoff and to groundwater via leaching through the soil to groundwater. Finally, impacted groundwater could discharge to surface water and act as a potential source of contaminants to surface water and/or sediment.

Based on unpaved ground surfaces as a secondary source and leaching through soil to groundwater as a transport mechanism, the following potentially affected media have been identified:

- Shallow soil
- Groundwater
- Sediment
- Surface water

Bulk Materials, Including Copper Concentrate, in Stormwater. Stormwater in the majority of the KMBT Operations Area is contained and pumped to the industrial water treatment plant and ultimately discharged to the City sanitary sewer. Stormwater in the area of the rail corridors infiltrates. Stormwater in the remainder of the Project Area flows to catch basins that discharge into the Port's underground stormwater conveyance system and ultimately to the Port's stormwater pond. Water from the stormwater pond ultimately is discharged to the Columbia River, thus there is a potential exposure pathway for metals COPCs to reach potential receptors in the river. Historically, outfalls near the KMBT Operations Area discharged directly to the river.

Based on stormwater as a secondary source and the flow pathway either directly to the river (via historical outfalls), to the Port stormwater pond as a transport mechanism to the Columbia River, or the infiltration flow pathway as a transport mechanism to groundwater, the following potentially affected media have been identified:

- Surface water (Columbia River)
- Groundwater
- Sediment

Bulk Materials, Including Copper Concentrate, Direct Release to Sediment. Copper ore could be inadvertently released to Columbia River sediments during loading of concentrate onto ships at Berth 7.

3.1.3 Potentially Complete and Incomplete Pathways to Receptors

In summary, the CSM identified the following media that could have been impacted by metals from bulk minerals operations:

- Groundwater
- Soil
- Sediment
- Surface water
- Stormwater
- Outdoor air

Possible receptors were then evaluated to assess whether receptors could potentially be exposed to one or more of the identified media and the potential exposure route. As detailed in Section 2.6, there is the potential for both human and ecological receptors in the Project Area. Ecological receptors are both terrestrial and aquatic. Human receptors could be occupational or construction/excavation workers in the Project Area or human consumers of fish in the Columbia River.

The copper concentrate CSM on Figure 11 illustrates the potentially complete exposure routes to ecological and human receptors. A list of the potentially complete exposure pathways to receptors are:

- Human receptors (occupational workers) via inhalation or direct contact with fugitive dust containing metals COPCs.
- Human receptors (construction/excavation workers) via direct contact with shallow groundwater containing metals COPCs.
- Human receptors (recreational users of Columbia River) via ingestion or direct contact with Columbia River (surface water) containing metals COPCs.
- Human receptors (occupational or construction/excavation workers) via ingestion and/or direct contact with unpaved soil containing metals COPCs.
- Human receptors (tribal fishers of Columbia River) via ingestion or direct contact with Columbia River (surface water) containing metals COPCs.
- Aquatic receptors via ingestion and/or direct contact with surface water and/or sediments that have been impacted by metals COPCs potentially transported to these media via stormwater, direct releases, or groundwater.
- Aquatic receptors via ingestion and/or direct contact with stormwater from the current Port Storm Pond Outfall.
- Aquatic receptors via ingestion and/or direct contact with stormwater from historic Port outfalls.
- Human consumption of fish exposed to metals COPCs.

Other potential pathways were evaluated and considered incomplete, as follows:

Human receptors (occupational and construction/excavation) via ingestion or direct contact of surface water, groundwater (occupational only), and sediments containing copper concentrate. Occupational and construction workers are not expected to be exposed to copper concentrate COPCs through these exposure routes during a typical workday.

Aquatic receptors via exposure (inhalation, contact, or ingestion) of outdoor air, on-site surface soil, or on-site groundwater containing copper concentrate COPCs.

Terrestrial receptors are considered insignificant because the Investigation Area is industrial and provides insufficient habitat for terrestrial receptors.

3.2 AMMONIA/NITRATE

3.2.1 Summary of Project History in Support of CSM

As discussed in Section 2.5.1, fertilizer has been received at the Port and handled on the NuStar Leasehold since the late 1960s. Historically, fertilizer products were received via vessel at Berth 3, and in recent years (2014 to mid-2020), fertilizer was received almost exclusively at Port Berths 8 and 9. As previously described, the stevedores were hired by the product distributer to offload the product, using a clam shell, into temporary storage facilities at the berths. The longshoremen (hired by the stevedores) loaded the fertilizer into trucks that then transported the fertilizer to the NuStar Leasehold. NuStar assumed possession of the fertilizer when it reached the Leasehold. As discussed in Section 2.5.1, the Port had many BMPs in place during vessel offloading activities to prevent the fertilizer from entering the river and stormwater. As also summarized in Section 2.5.1, NuStar had BMPs in place on their Leasehold to prevent the fertilizer from impacting stormwater, surface water, sediment, and groundwater. Once the fertilizer reached the NuStar Leasehold, the products were stored primarily in buildings 2645 and 2655 prior to 2008 and from 2014 to mid-2020, were stored in all five warehouses on the NuStar Leasehold (2645, 2585, 2655, 2625, and 2565). Loading docks were installed at each of the five warehouses on the NuStar Leasehold. Trucks were loaded with fertilizer at one of the five locations, covered, and then driven off the property for distribution to customers.

3.2.2 Potential Release Mechanisms and Pathways

A CSM describing the fertilizer handling practices that might have acted as primary release mechanisms, secondary sources, transport mechanisms, pathways, and exposure routes to potential receptors was prepared and is shown on Figure 12. A narrative of the CSM for fertilizer, from site product handling activities through potential receptors, is summarized below.

3.2.2.1 Site Activities as Primary Release Mechanisms

Based on our understanding of the historical handling of fertilizer products at the Port and on the NuStar Leasehold, the following site activities or mechanisms have been identified as having the potential for release of fertilizer to media:

- Unloading ships at Berth 3 (historically) and Berths 8 and 9 (historically and recently).
- Transportation of trucks containing fertilizer from the Berths to the NuStar Leasehold.
- Dumping fertilizer into dump pits on the NuStar Leasehold.
- Handling of fertilizer at the NuStar Leasehold
- Transport of fertilizer from the NuStar Leasehold by truck.

3.2.2.2 Secondary Sources and Transport Mechanisms

Fertilizer as Fugitive Dust. As discussed in Section 2.5.1, fertilizer was offloaded from ships using a clam shell and dropped into temporary storage containers. There was a potential for airborne dust to be generated during this process. In addition, fugitive dust may have been generated during transport of trucks to the NuStar Leasehold and while loading fertilizer onto trucks for distribution from the facility. Fugitive dust could have reached potential receptors through pathways such as particles in outdoor air settling directly onto ground surface, or into the Columbia River surface water and sediments.

Based on fugitive dust as a secondary source and the transport mechanisms described above, the following potentially affected media have been identified:

- Surface soil
- Surface water
- Sediment

Fertilizer on Paved Ground Surfaces. Fertilizer had the potential to fall onto paved surfaces both during transport and handling of fertilizer products. From the paved surfaces, fertilizer could reach potential receptors through pathways such as overland flow of precipitation directly to surface water and/or sediment, overland flow to groundwater via unsecured monitoring wells, or overland flow to stormwater.

Based on paved ground surfaces as a secondary source and overland flow as a transport mechanism, the following potentially affected media have been identified:

- Stormwater
- Groundwater
- Surface water
- Sediment

Fertilizer on Unpaved Ground Surface. There is currently no unpaved ground surface at Berths 3, 8, and 9. There is a limited portion of the NuStar Leasehold in the railroad corridor that is not paved, as shown on Figure 3. The paved versus unpaved portions of the NuStar Leasehold have generally remained unchanged since fertilizer was first handled in the late 1960s. Additionally, there are 11 SVE system well vaults which are not paved at the bottom and have a small access point for stormwater in the vault cover. Fertilizer that was deposited on unpaved soil, either from airborne dust or (more likely) falling off trucks or from truck tires, has the potential for leaching through the soil to groundwater.

Based on unpaved ground surfaces as a secondary source and leaching through soil to groundwater as a transport mechanism, the following potentially affected media have been identified:

- Shallow soil
- Groundwater

- Sediment
- Surface water

Fertilizer in Stormwater. Stormwater at the Port is captured into catch basins that discharge into the Port's underground stormwater conveyance system and ultimately to a stormwater pond located at Terminal 4 (see Figure 2). Water from the stormwater pond ultimately is discharged to the Columbia River. While NuStar was actively handling fertilizer, there was historically a potential exposure pathway for fertilizer constituents to reach potential receptors in the river via stormwater. However, with the suspension of fertilizer handling and storage at the terminal, this pathway is no longer complete. Should fertilizer handling be resumed in the future, this pathway could once again be complete.

Prior to the Port's construction of the existing stormwater conveyance system, water at the Port flowed into catch basins that discharged directly to the river. The approximate location of stormwater outfalls in the subject area are shown on Figure 20. There is the potential that fertilizer compounds could have historically discharged into the Columbia River via stormwater runoff through these outfalls.

Based on stormwater as a secondary source and the flow pathway to the Port stormwater pond as a transport mechanism to the Columbia River, should fertilizer handling resume in the future, the following could be potentially affected media:

- Surface water (Columbia River)
- Sediment

Surface water and sediments have also been identified as potentially affected media based on historical stormwater flows to outfalls at the NuStar Leasehold.

3.2.3 Potentially Complete Pathways to Receptors

In summary, the CSM identified the following media that could have been impacted by fertilizer operations:

- Groundwater
- Soil
- Sediment
- Surface water
- Stormwater
- Outdoor air

Possible receptors include ecological (terrestrial and aquatic) and human (occupational or construction/excavation workers, recreational users of the Columbia River, or human consumers of fish in the Columbia River). The fertilizer CSM on Figure 12 illustrates the potentially complete exposure routes to ecological and human receptors. A list of the potentially complete exposure pathways to receptors are:

- Human receptors (occupational or construction/excavation workers) – ingestion and/or direct contact with unpaved soil containing fertilizer COPCs.
- Aquatic receptors – ingestion and/or direct contact with surface water and/or sediments that have been impacted by fertilizer COPCs potentially transported to these media via stormwater, direct releases, or groundwater.
- Aquatic receptors – ingestion and/or direct contact with sediments near historical outfalls.

Should fertilizer handling and storage operations resume at the terminal, the following would be additional potentially complete pathways:

- Human receptors (occupational workers) – inhalation or direct contact with fugitive dust containing fertilizer COPCs.
- Human receptors (recreational users of Columbia River) – ingestion or direct contact with Columbia River (surface water) containing fertilizer COPCs.
- Human receptors (tribal fishers of Columbia River) via ingestion or direct contact with Columbia River (surface water) containing fertilizer COPCs.
- Aquatic receptors – ingestion and/or direct contact with stormwater from the current Port Storm Pond Outfall.

Other potential pathways were evaluated and considered incomplete, as follows:

- Human consumption of fish exposed to surface water or sediments containing fertilizer; the fertilizer constituents—ammonia, nitrates/nitrites—are not bioaccumulative in fish tissue; therefore, fish exposed to these constituents in surface water or sediment will not uptake the constituents into tissue, and this pathway is incomplete.
- Human receptors (occupational and construction/excavation) via ingestion or direct contact of surface water, groundwater (occupational only) and sediments containing fertilizers or copper concentrate. Occupational and construction workers are not expected to be exposed to copper concentrate or fertilizer COPCs through these exposure routes during a typical workday and fertilizer is no longer being handled.
- Aquatic receptors via exposure (inhalation, contact, or ingestion) of outdoor air, on-site surface soil, or on-site groundwater containing fertilizer constituents.
- Terrestrial receptors are considered insignificant because the Investigation Area is industrial and provides insufficient habitat for terrestrial receptors.

3.3 MEDIA PATHWAY EVALUATION

While the CSMs were prepared to identify potential pathways to receptors, there are infrastructure and BMPs in place in the Project Area which limit or prevent actual exposure to receptors. These are discussed further by media in this section.

For each media, a summary of relevant historical information is provided. This may include a description of facility upgrades or engineering or administrative controls that are in-place to reduce or eliminate impacts from COPCs, a summary of relevant data collected to-date, and a description of BMPs that have been implemented to reduce or eliminate risk from COPCs.

Taking into account the relevant historical data and background information, objectives have been established for investigating each media in the RI work plan. These are considered “Phase I” objectives as the Parties understand that the results of this initial investigation may solicit additional questions and/or the need for further investigation.

From the Phase I objectives, Phase I Investigative actions have been established, which in most cases, involve the physical collection of data. The detailed scope used to carry out those investigations is proposed in Section 4.0.

After implementation of the scope proposed in this SRIWP, the data will be evaluated and reported to Ecology. At that time, additional investigation will likely be proposed to answer additional questions/meet other objectives and to expand on existing datasets (i.e., further delineate, fill in data gaps, etc.). Those “Phase 2” objectives will be identified in a future work plan.

3.3.1 Groundwater

3.3.1.1 Summary of Relevant Historical Information

Selected wells in the Project Area have been monitored quarterly for nitrate, nitrite, and ammonia since November 2017 and monitored quarterly for copper since September 2018. Tables 2 and 3 summarize the analytical results from the quarterly groundwater monitoring.

Copper

Figure 5 summarizes copper analytical results for groundwater in selected wells in the Project Area. Monitoring wells were sampled before and after redevelopment in 2018, as identified in Section 2.4.3. A decrease in copper concentrations was observed following the redevelopment of selected monitoring wells and suggests that copper concentrate entrained in overland flow may have entered compromised well monuments/surface completions and accumulated as sediment in the wells.

Nitrate, Nitrite, and Ammonia

Fertilizer COPC data include historical groundwater data dating back to 2007 collected from select monitoring wells in support of enhanced bioremediation interim action and quarterly monitoring data from up to 43 monitoring wells collected from November 2017 through September 2019. As can be seen in Table 3, the results of the nitrates and ammonia are variable but appear to be generally decreasing since 2017. Figures 6 through 10 illustrate the current extent and distribution of nitrates and ammonia in Project Area wells.

3.3.1.2 Phase I Objectives

Based on the analytical data available to-date as well as the information gathered from the inspection of the SVE system, the wellhead assessment, and well redevelopment and subsequent resampling, two objectives were identified for evaluation in the first phase of the Supplemental RI.

1. Collect additional data to better assess whether groundwater is impacted via sediment in monitoring (or other) wells.
2. Collect additional data to assess whether groundwater is impacted via leaching of COPCs at the ground surface.

These two objectives apply to evaluation under both the fertilizer and copper CSM. It should be noted that the source of impacts to groundwater, which are being evaluated in this investigation, may be different for the various COPCs.

3.3.1.3 Phase I Investigative Actions

The following lists the proposed actions to be conducted to address the Phase I objectives for groundwater.

Objective 1 (Groundwater Impacted via Sediments Entering Wells) – Select monitoring wells will be sampled, redeveloped, and then resampled to evaluate whether the removal of potential sediment accumulation in the well or well filter screen has an effect on COPC concentrations in groundwater.

In addition, a grab groundwater investigation will be conducted to collect groundwater samples adjacent to monitoring wells located in copper concentrate and/or fertilizer operations areas. Three grab groundwater samples will be collected adjacent to each selected well in a line of increasing distance from the well. The results from well sampling and grab groundwater sample analyses will be evaluated to assess whether the concentrations in the well are consistent with the grab groundwater results or whether the concentrations decrease with distance from the well. If the concentrations of COPCs are higher in the well samples and decrease after the redevelopment/ resampling and/or decrease with distance from the well, the data would suggest that sediment accumulation in the well might be impacting groundwater quality local to the well but not distal. If COPC concentrations post redevelopment are generally consistent with grab groundwater samples radiating from the well location, then the primary source to groundwater may not be from sediment accumulation in the wells. These data will help to identify the presence and extent of metals, nitrate, and/or ammonia in groundwater in the Project Area, and to develop objectives for a Phase II investigation of groundwater.

Objective 2 (Leaching through Soil to Groundwater) – Grab groundwater sampling identified under Objective 1 will be conducted in both paved and unpaved areas to assess whether and to what extent COPCs that may be present in surface soil are leaching to groundwater. If the distribution and extent of COPCs in groundwater in paved areas differ from those in unpaved areas (e.g., concentrations decrease with distance from wells in paved areas but not in unpaved areas), these results might suggest leaching from surface soil may be occurring. Grab groundwater samples will be collected from borings in the unpaved rail corridor east of the ore conveyor between the NuStar warehouses and selected borings in unpaved locations near the railcar unload facility.

3.3.1.4 Phase I Evaluation and Potential Phase II Work

The first phase of groundwater investigation is intended to identify the potential pathway or pathways for copper, ammonia, and nitrate at the ground surface to reach Project Area groundwater. The results of the investigation will be tabulated and figures will be prepared depicting the concentration of each COPC in both shallow and intermediate zone groundwater. The Phase I Data Evaluation will consider the following three questions (in italics):

1. *Are data sufficient to identify source/mechanisms?* If the source/mechanisms for metals, nitrates, and/or ammonia reaching groundwater are not clearly identified from the Phase I and other existing data, additional exploration may be needed and/or other sources or mechanisms may be evaluated in a Phase II investigation. If the source and mechanisms are sufficiently understood following the Phase I data evaluation, no additional investigation will be needed to address this question.

2. *Is the extent of COPCs in groundwater defined?* If the data collected during the Phase I investigation identify that the extent of one or more COPC is not defined, additional data collection may be needed under a Phase II investigation. If the extent of copper, nitrates, and ammonia is sufficiently defined, no further investigation will be needed to address this question.

3. *Is there the potential for groundwater containing COPCs at concentrations of potential concern to discharge to the Columbia River?* If the Phase I and existing data support that metals, nitrates, and ammonia are not present in groundwater at concentrations of potential concern to the river at the southern NuStar Leasehold boundary, surface water assessment for these constituents will not be needed. If, however, the southern extent has not been sufficiently defined and/or metals, ammonia, and/or nitrate concentrations are above applicable surface water criteria in sampling locations located at the top of bank adjacent to the Columbia River, further groundwater and/or surface water assessment may be needed during a Phase II investigation. Further discussion of sediment and surface water data evaluation is included in Section 3.3.3.

3.3.2 Soil

3.3.2.1 Summary of Relevant Historical Information

As discussed in Sections 2.4 and 2.5 above, existing metals and/or nitrate/ammonia soil data are available from three general areas:

1. Soil data consisting of metals and petroleum hydrocarbon analyses collected along the northern portion of KMBT Operations Area along the railroad tracks. The data associated with the WVFA project soil investigations indicated that metals were limited to the shallow soil in this area (e.g., railroad ballast material) and decreased with depth. Based on these findings, the Port excavated the ballast material to a depth of approximately 5 feet.
2. Soil data (metals, nitrates, and ammonia) collected in the central and southern part of the Project Area as a part of the Port's Pavement Rehabilitation Project, Asphalt Assessment Soil Investigation. These data support that pavement is limiting downward migration of metals and fertilizer COPCs into underlying soil.
3. Copper data from soil sampling following the cleanup of a copper concentrate release to the ground south of the former sand shed.

In addition, two cleanups of copper-containing wood preservatives were completed in 2006 and 2007, as detailed in Section 2.5. Soil containing the spilled wood preservatives was immediately removed, and confirmation sampling demonstrated copper (and other applicable wood preservative compounds) were below applicable regulatory criteria following the removal actions. Therefore, no further soil sampling and analysis for copper near these former release areas is necessary.

3.3.2.2 Phase I Objectives

The objective of the Phase I soil investigation is to assess for the presence of metals and fertilizer COPCs in shallow soil in areas not previously sampled. Areas to be evaluated include areas that are currently unpaved or, in the past, were unpaved during the periods of ore concentrate or fertilizer handling.

3.3.2.3 Phase I Investigative Actions

To meet the Phase I objective, soil samples will be collected from shallow soil in currently or historically unpaved areas. Proposed Phase I soil sampling locations are presented on Figure 19. Locations 25 through 38 and locations 41 and 42 are currently unpaved areas. Locations 39, 40, and 15 are in operations areas that were unpaved in the past. Location 43 was added at the request of Ecology to assess soil beneath the SVE vault from which blue water was noted.

Two soil samples will be collected at each location to assess for the presence of the COPCs in surface soil and whether the concentrations decrease with depth. The surficial sample will be collected at

0 to 1 foot bgs and a deeper sample will be collected at 2 to 3 feet bgs. Chemical analyses for the samples are detailed in Section 4.

3.3.2.4 Phase I Evaluation and Potential Phase II Work

Phase I baseline soil data will be validated and summarized in tables. The tables will also provide a comparison of the results to appropriate MTCA screening criteria to address the following:

> Assess whether COPCs are above regional background levels (where available) and, if so, whether the concentrations are above MTCA screening criteria for occupational and construction/excavation worker receptors.
>
> Assess whether COPCs are above regional background levels (where available) and, if so, whether the concentrations are above MTCA SLs for the potential leaching to groundwater pathway.

If COPCs are detected above background and applicable risk screening criteria, additional Phase II investigation may include:

> Additional delineation of the lateral extent of COPCs in soil.
>
> Additional delineation of the vertical extent of COPCs in soil.

3.3.3 Sediment/Surface Water

3.3.3.1 Summary of Relevant Historical Information

As discussed in Section 2.4.2, samples collected as part of Port berth sediment management projects include metals and/or ammonia data for sediments in the Project Area. The most recent comprehensive sediment sampling was completed in 2015. Details of the November 2015 field activities and sediment characterization results are presented in a January 27, 2016 Memorandum by Floyd Snider (Floyd Snider, 2016).

The Port data include copper and ammonia data in sediment from the Port berth areas. The sediments were not analyzed for nitrate (or nitrite) as those analytes are not included in the analytical suite for dredged material characterization under Sediment Evaluation Framework (SEF) and there are no Sediment Management Standards freshwater criteria. Figures depicting the sediment sampling locations from the Port's post-dredge sampling events are provided in Floyd Snider, 2016. The results of the dredge material and post-dredge sampling indicated that copper and ammonia concentrations were low and consistently below the sediment management standards (freshwater SCO of 400 mg/kg and 230 mg/kg, respectively).

In addition, as discussed in Section 2.6.1.1, sediment samples were collected in 1988 as part of the copper concentrate release investigation and remedial response at Berth 7.

The Port sediment characterization projects primarily focused on the navigation channel and there are two general areas located between the navigation channel and the shoreline; one to the west and one to the east of the Berth 7 dock that have not historically been sampled for copper or fertilizer constituents. These two areas are shown on Figure 20. In 2011, 2012 and 2016, sediment samples in these areas were collected as part of the VOC investigation at the NuStar facility. Historical VOC sample locations are shown on Figure 20.

3.3.3.2 Phase I Objectives

Based on the sediment data collected during the Port dredge work, there are two sediment areas adjacent to Berth 7 that have not been investigated for metals, nitrate, or ammonia. In addition, limited data are available at the transloading areas at Berths 8 and 9. Based on the identified data gaps, the Phase I objective for sediment/surface water investigation is to assess whether COPCs are present in these sediments in the Port Berths 7, 8, and 9 areas at potential concentrations of concern.

3.3.3.3 Phase I Investigative Actions

To meet the Phase I objective, a sediment investigation will be conducted in the areas shown on Figure 20. The Phase I sediment sampling locations have been selected to collect data from the areas with the highest potential for COPC impacts. These include:

- Immediately adjacent to the KMBT copper concentrate handling areas.
- Immediately adjacent to potential dust to river depositional areas from fertilizer handling activities and historical outfalls associated with the former Port stormwater system.

3.3.3.4 Phase I Evaluation and Potential Phase II Work

The results of the sediment investigation will be evaluated including the tabulation of data and preparation of figures depicting the magnitude and extent of COPCs in sediment in the Project Area. COPCs will be compared to applicable regulatory or background levels and the aerial extent of sediments exceeding applicable regulatory levels will be identified, if applicable. In certain instances, background levels may need to be established. If the results of the Phase I investigation indicate that one or more of the COPCs are present at concentrations of potential concern and the extent has not been defined by the Phase I results, additional sediment investigation will be conducted during a Phase II investigation. Additionally, if the Phase I data suggest that COPC concentrations in sediments might present a potential concern to surface water quality, a surface water assessment will be conducted during the Phase II investigation. The PLPs will work with Ecology to identify the appropriate sediment SLs to use to assess the Phase I data.

If COPCs are not identified in sediments at concentrations of concern, then further sediment investigation is not anticipated. Results from both the sediment investigation and groundwater investigation immediately adjacent to the river will be evaluated to determine if surface water investigation is warranted.

3.3.4 Outdoor Air

As discussed in Section 2.4, the Port conducted sampling of sediment accumulated in roof gutters to assess the potential for ore concentrate migration via airborne dust. The results showed metals concentrations in roof gutter sediment exceeded regional background levels in soil in most of the samples, with the highest concentrations located near the bulk terminal and attenuating with distance.

While it is recognized that additional assessment is needed to better understand the extent and distribution of metals COPCs in outdoor air via fugitive dust, these assessments will be conducted as a part of the Phase II investigation. The results of the Phase I soil investigation will be used to inform the requirements and the methodology for the Phase II outdoor air evaluation.

3.3.5 Stormwater

As detailed in the discussion of the CSM (Section 3.0), stormwater is a transport mechanism for metals and fertilizer contaminants to reach potential receptors to the river. As discussed in Section 2.4, a recent investigation was completed to assess the potential of the stormwater system as a complete pathway to groundwater. The results did not identify evidence that the conveyance system, including sumps and associated pipeline, is a source of contaminants to the subsurface and potentially to groundwater.

Stormwater sampling in areas potentially impacted by KMBT operations will be addressed during Phase I of the RI sampling and are detailed below. Due to the current suspension of fertilizer handling at the NuStar facility, stormwater sampling for fertilizer constituents will not be completed in the first phase of RI sampling. Stormwater sampling for fertilizer constituents will be conducted in later phases if fertilizer handling at NuStar resumes.

3.3.5.1 Summary of Relevant Historical Information

While stormwater permit sampling data has been produced for NuStar, KMBT, and the Port, stormwater sampling has been limited to a small number of metals and is not representative of the all of the sub-basins around the KMBT Operations Area. The goal of the Phase I stormwater sampling is to determine if and where the COPCs associated with bulk minerals handling are entering stormwater conveyances in the Investigation Area. This sampling effort will create a baseline which can be used to complete the pathway analysis and focus future sampling plans. Stormwater sampling will be conducted in the locations shown on Figure 21.

3.3.5.2 Phase I Investigative Actions

Stormwater samples will be collected from catch basins and stormwater conveyances in the vicinity of the KMBT Operations Area. This phase of investigation does not include sampling from area-wide stormwater mains carrying stormwater from other parts of the Port to the stormwater pond. The stormwater samples will be collected from catch basins or stormwater manholes using methods described in Section 4.6. The sample locations have been selected to be representative of stormwater originating in the KMBT Operations Area. The locations will be field-confirmed to originate in or near the KMBT Operations Area and not receive significant run-on stormwater from distant areas. Samples from catch basins will be collected prior to any filtration or treatment inserts. If catch basin configuration prevents sampling in one of the proposed locations, a similar alternate catch basin or surface sheet flow may be sampled.

Two rounds of sampling are proposed, each will be completed during the first rain event resulting in discharge which follows ship loading activities. Sampling will be in general accordance with that laid out in the Ecology Stormwater Sampling Manual – A Guide for the Industrial Stormwater General Permit (December 2015).

3.3.5.3 Phase I Evaluation and Potential Phase II Work

Stormwater analytical data will be compared to SLs for the COPCs identified in section 2.8.1. Total and dissolved detections will be compared to determine what phase(es) of the COPCs are mobile in stormwater. Analytical results will be reviewed for variability based on time and location of sample collection to determine patterns that could identify potential release or transport mechanisms related to bulk minerals handling in the KMBT Operations Area.

If concentrations of COPCs are detected above SLs, additional sample locations will be considered for Phase II sampling.

4.0 SCOPE OF WORK FOR SUPPLEMENTAL REMEDIAL INVESTIGATION

The subsections below summarize the proposed phased approach to the supplemental RI as well as the approach, rationale, and procedures for Phase I investigation of groundwater, soil, sediment, and surface water. As mentioned in Section 1.1, Ecology has recommended additional VOC delineation in the vicinity of NuStar monitoring well MW-26 (located off the NuStar Leasehold to the west). The last portion of this section describes the work scope and procedures for additional VOC investigation requested by Ecology.

4.1 SUMMARY OF PHASED APPROACH TO INVESTIGATION

The table below summarizes the investigative actions proposed as "Phase I" of the supplemental RI investigation. The Parties acknowledge that additional activities will likely be required after the data from the first phase of the investigation are evaluated. However, the following Phase I investigation is proposed as a reasonable first step in evaluating the sources, transport mechanisms, and extent of COPCs in the Project Area.

Phase I Investigation	**Phase II Investigation**
Investigate surface soil in unpaved areas of copper concentrate and fertilizer operations.	Conduct further surface soil investigation if not adequately defined in Phase I.
Investigate shallow soil in historically unpaved copper ore operation areas.	Conduct further shallow soil investigation if not adequately defined in Phase I.
Assess riverbank for potentially erodible areas.	If erodible areas present, conduct surface soil sampling in these riverbank areas.
Redevelop and re-sample selected wells.	
Conduct grab groundwater (e.g., push probe) investigation.	Conduct further groundwater assessment if extent not defined by Phase I groundwater investigation. Conduct surface water sampling if groundwater data suggest a potential for groundwater containing COPCs at concentrations of potential concern to migrate to Columbia River.
Conduct sediment investigation.	Conduct sediment investigation at other areas, if extent not adequately defined. Conduct surface water investigation if COPCs are present at concentrations of potential concern in sediment.

Phase I Investigation	Phase II Investigation
	Conduct an outdoor air assessment to define the extent of outdoor airborne particle deposition.
Conduct stormwater assessment of KMBT Operations Area.	Conduct stormwater assessment of NuStar Leasehold if fertilizer handling activities resume and/or additional source tracing based on initial KMBT stormwater investigation results.

4.2 APPROACH, RATIONALE, AND SCOPE FOR PHASE I GROUNDWATER INVESTIGATION

This section describes the general sampling approach for evaluating COPCs in groundwater, a rationale for the proposed sample locations, and a discussion of the proposed sampling methodology and procedures.

4.2.1 Approach/Rationale

The following table summarizes how each portion of the Project Area will be investigated to evaluate the source/transport mechanism of COPCs to groundwater. The table includes the area to be investigated, the objective for each investigation area, and the proposed sampling locations to meet these objectives. Boring and well locations are shown on Figure 18. A detailed description of the proposed approach and rationale for each boring follows the table.

Investigation Area	Objective	Boring or Well Location to Address
Project Area-Wide	Further assess whether groundwater affected by sediment entering well	Redevelop and Resample Wells: MW-1, MW-14, MW-17, S-1, S-2, MW-9, MW-10, MW-12, MW-13, MW-22i, MW-E Install and sample borings: 15, 16, 17, 18, 22, 23, 24, 40
Unpaved Areas including KMBT Rail Unloading Area (De-tarping area)	Assess potential impact of COPCs in shallow soil leaching to groundwater	Borings 25, 26, 27, 34, 41,42, and 44.

Project Area-Wide – Eleven wells (MW-1, MW-14, MW-17, S-1, S-2, MW-9, MW-10, MW-12, MW-13, MW-22i, and MW-E) have been selected to be redeveloped and sampled to better assess whether soil containing COPCs is entering the wells and affecting groundwater quality. These wells were selected because copper, nitrates, and/or ammonia have been identified in these wells in the recent past and they are proximal to copper concentrate and/or fertilizer handling areas. The wells will be sampled prior to redevelopment (as part of a quarterly monitoring event), and then again after redevelopment.

Additionally, following redevelopment of the monitoring wells and at the time of the resampling of the wells, groundwater samples will be collected at 11 boring locations (15, 16, 17, 18, 22, 23, 24, 25, 26, 27, and 40) using push probe technology; boring locations are shown on Figure18. As described in Section 3.3.1.3, groundwater data collected from these borings and from the redevelopment/sampling of the identified monitoring wells will be used to assess the potential transport mechanisms for COPCs at ground surface to enter groundwater in the Project Area. More detail on the rationale for the selected sampling locations is provided below.

Paved Areas – Seven boring locations (15 through 18, and 22 through 24) are proposed in paved areas to better assess the possible effect on groundwater of soil containing COPCs entering monitoring wells. One to three borings are each located in the vicinity of three monitoring wells at spaced intervals to assess whether COPC concentrations decrease with distance from the well. A pattern of higher concentrations in well samples diminishing quickly with distance from the well could suggest a source to groundwater of soil containing COPCs entering the wells. If the concentrations are relatively consistent between the wells and nearby borings, the distribution could suggest that leaching to groundwater from COPCs at the ground surface may be a source to groundwater. The wells and borings selected in the paved areas to facilitate this assessment are:

> **Well MW-10 and Borings 22, 23, and 24.** This area is located in both the NuStar fertilizer handling area and under the KMBT conveyor system. Well MW-10 will be sampled, redeveloped, and then sampled again. Groundwater samples will be collected from borings 22, 23, and 24 located in a line approximately 100, 50, and 25 feet, respectively, from MW-10.
>
> **Well MW-13 and Boring 15.** This area is located near fertilizer handling and copper ship-loading portions of the Project Area. Well MW-13 will be sampled, redeveloped, and then sampled again. Groundwater samples will be collected from location 15, located between well MW-13 and the Columbia River. Well MW-13 and boring 15 are located at the top of the riverbank and data from these locations will also help inform whether further COPC data are needed to better assess the groundwater to river pathway.
>
> **Wells S-1 and S-2 and Borings 16, 17, and 18.** This area is located near the copper loading area at Berth 7. Well S-2 is screened from 45 to 50 feet bgs but does not screen first encountered groundwater; well S-1 is screened in intermediate zone groundwater with a screened interval of 69 to 74 feet bgs. Both wells S-1 and S-2 will be sampled, redeveloped, and then sampled again. Groundwater samples will be collected from borings 16, 17, and 18, which are located in a line perpendicular to the riverbank and between wells S-1 and S-2 and the Columbia River and spaced approximately 25, 50, and 100 feet from the S-1/S-2 well pair, respectively. Groundwater samples will be collected from three depth intervals from each boring: first encountered groundwater (estimated to be at approximately 25 to 30 feet below

grade depending upon the season and river stage); 45 to 50 feet – equivalent to the screened interval for well S-2, and from 69 to 74 feet – equivalent to the screened interval for well S-1. These depth intervals will provide data to access whether first encountered groundwater has been impacted by fertilizer and/or copper concentrate, and whether or not the COPC concentrations observed in wells S-1 and S-2 are consistent with a larger groundwater plume or are indicative of an isolated area of "higher concentration". Results from borings 16 through 18 will also be used to evaluate if groundwater in close proximity to the river contains COPCs at concentrations of concern for aquatic receptors.

Unpaved Areas – Seven boring borings (25, 26, 27, 34, 40, 41, and 42) have been proposed in unpaved areas of the Project Area to evaluate the soil leaching to groundwater pathway. Details regarding the approach and rationale for each location are provided below:

> **Well MW-9 and Borings 25, 26, and 27.** This area is in an unpaved rail corridor and is located between two warehouses in which fertilizer is handled and in close proximity to the KMBT copper conveyor system. Well MW-9 will be sampled, redeveloped, and then sampled again. Groundwater samples will be collected from borings 25, 26, and 27 located in a line from MW-9. Borings 25 and 26 are located approximately 150 feet and 50 feet, respectively, to the west of MW-9; boring 27 is located approximately 50 to the east of MW-9.
>
> **Borings 34, 42, and 44.** Proposed borings 34, 42, and 44 are located in an unpaved rail corridor. Boring 34 is west of the former railcar unload building, boring 42 is to the west of the KMBT railcar unload building 2877, and boring 44 is north of the a-frame storage building and south of the former railcar unload facility in an area that was formerly paved.
>
> **Boring 40.** Proposed boring 40 is located south of the sand shed, near the center east-to-west.
>
> **Boring 41.** Proposed boring 41 is located in an unpaved area approximately 100 feet north of the former sand shed and approximately 50 feet east of building 2745 (the Coverall Building).

4.2.2 Procedures

Methods to complete the groundwater investigation will include preparatory activities, advancing borings at the locations shown on Figure 18, field screening and/or (potentially) sampling of vadose zone soil, depth discreet sampling of groundwater, monitoring well redevelopment, and monitoring well sampling. The procedures for each of these methods are described below.

4.2.2.1 Preparatory Activities

Prior to the investigation, the public utility notification center will be contacted, and a private utility locator will be contracted to check for the presence of buried utilities or infrastructure in the work area. It should be noted that the presence of buried utilities or infrastructure, or other access issues, may result in the relocation of the proposed borehole locations from those presented on Figure 18. In addition to the utility locator, each boring will be advanced using a hand auger or air knife down to 8 feet to further assess for the potential presence of utilities or other buried materials in the near surface.

4.2.2.2 Boring Installation

Borings will be advanced using a direct push rig at the locations shown on Figure 18. A licensed drilling subcontractor will be retained to advance the borings, and a field engineer or geologist will oversee the installation under the supervision of a registered professional. The investigation will be conducted in accordance with the SOPs for direct-push explorations, which are included in Appendix E.

4.2.2.3 Field Screening

Continuous soil samples will be collected during push-probe activities for the purpose of documenting the lithology encountered and for field screening for VOCs[2] with a photoionization detector (PID). These procedures are detailed in the field screening SOPs in Appendix E.

4.2.2.4 Temporary Pre-Pack Well Screen Installations for COPC Analyses

Temporary wells will be installed in the borings where groundwater samples are to be collected for COPC analysis (i.e., borings 15 through 18, 22 through 27, 34, 40, 41, 42, and 44) to facilitate the collection of groundwater samples representative of the formation. The borings will be advanced to the bottom depth of the screened interval of the nearest monitoring well using a push-probe rig, and temporary pre-packed well screens will be installed in the borehole to screen the approximate equivalent screened interval of the adjacent well. For borings 40, 41, 42, and 44, where there is not an immediately adjacent well, the boring will be advanced to the first significant saturated zone; shallow and thin (perched) saturated zones may be ignored. If available, nearby wells can be gauged to determine appropriate sampling depths.

Prepacked well screens are typically built around a slotted PVC casing that can be threaded onto standard flush-threaded PVC well casing. The casing is wrapped with fine stainless steel mesh and the annular space between the casing and the screen is filled with appropriately sized silica sand. The casing slots and the sand size should be selected to match the expected soil types; generally, finer mesh sand is used in finer soil types to prevent the formation soil from passing through the well assembly and into the well. The drive casings for pre-packed temporary wells will be driven to their target sample depths through undisturbed formation using a sealed expendable drive-point to prevent contaminant drag down.

Where the sample interval is in the intermediate aquifer, precautions will be taken to prevent cross-contamination between the upper and intermediate aquifers. Typically, this involves driving

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[2] Although VOCs are not a Supplemental RI COPC, there is ongoing monitoring and remedial action to address VOCs in soil and groundwater in the Project Area; therefore, soil samples will be screened for VOCs to supplement the VOC data for the Site.

a larger diameter casing to the upper portion of the lower permeability zone separating the shallow and intermediate groundwater zones. The soil is then removed from that casing to prevent contaminant drag down as drill tooling is advanced down the casing into the underlying aquifer. The borehole is then advanced within this secondary casing to the targeted screened interval in the intermediate zone, and the temporary well is then constructed as described above.

Groundwater samples will be collected from each of the pre-packed temporary wells using low-flow sampling equipment using the technology described below in Section 4.2.2.7.

When the samples have been collected, the temporary wells will be abandoned in compliance with Washington State regulations.

4.2.2.5 Monitoring Well Redevelopment

Prior to well development, the depth to water and total depth of the well will be measured and the casing volume will be calculated. The total depth will be noted before and after the redevelopment effort to determine if any sediment or fines have been cleaned from the well casing and sump.

The wells will be developed using a submersible pump and by conducting vigorous over-extraction of the groundwater until the removed water is visually clear to the extent practicable; this is generally referred to as the “downhole pump method” for well development. The intake of the pump will be placed in the center of the screened interval of the monitoring well. A minimum of three well volumes of water will be pumped from the well while raising and lowering the pump line through the screened interval to remove silt laden water. The well will continue to be pumped until the water removed is free of visible suspended material and at least 10 casing volumes are removed. The downhole pump method may be combined with manually surging the well with a surge block (referred to as “the surge block method”) if the sustainable extraction rate from the submersible pump is not sufficient to efficiently complete the well redevelopment.

The surge block method involves using a plunger or “block” to force the water within the well through the well screen and out into the formation; the surge block is pulled up, pulling the water back through the screen into the well along with fine soil particles that may have accumulated in the well pack material. First, an initial surging involving short plunger strokes of approximately 3 feet, will allow material that is blocking the screen to separate and become suspended. After 5 to 10 plunger strokes, the surge block will be removed and the well will be purged using a pump. The process is repeated slowly increasing depths until the bottom of the well screen is reached. The cycle of surging and purging is continued until the water yielded by the well is free of visible suspended material.

For either removal method, field parameters (temperature, pH, and conductivity) will be measured for each volume removed. After the removal of eight casing volumes, field parameters will be monitored for stability. Field parameters will be considered stable if temperature, pH, and conductivity are within 10 percent for three consecutive casing volumes. The well will be considered developed after field parameters have stabilized (minimum of 10 casing volumes), and sediment is no longer visible in the purged water. Purge water will be placed in DOT approved drums or high-capacity tank and will be managed and disposed of as investigation-derived waste (IDW).

4.2.2.6 Monitoring Well Sampling

The monitoring wells proposed for well redevelopment (MW-1, MW-14, MW-17, S-1, S-2, MW-9, MW-10, MW-12, MW-13, MW-22i, and MW-E) will be sampled prior to and at least 48 hours after monitoring well redevelopment.

Groundwater samples will be collected from each of the referenced wells using SOPs for low-flow groundwater sampling provided in Appendix E. Prior to initiating the groundwater sampling, water levels in the wells will be measured and recorded for the purpose of determining groundwater elevations and gradient. The wells will be opened, and the water level allowed to equilibrate before the measurements are taken. Measurements of the depth to water will be made to the nearest 0.01 foot using an electronic water level indicator. Well depth will be measured by a weighted measuring line and the presence of sediment in the well bottom will be documented.

Groundwater will then be purged using low-flow sampling equipment (e.g., peristaltic or bladder pump) at a rate no greater than the recharge rate of the groundwater to prevent water table drawdown. Per the SOPs, the flow rate should range between 0.1 to 0.5 liter per minute (L/min), with 0.2 to 0.3 L/min typically appropriate for the conditions at this site. The sample tubing/pump will be lowered to the middle of the screened interval. Groundwater field parameters (pH, electrical conductivity, and temperature) will be measured using a water quality meter and flow cell connected to the discharge tubing of the sample pump to assess the effectiveness of purging. Purging will be considered complete when the water quality parameters (i.e., pH, temperature, and specific conductance) stabilize within 10 percent for three consecutive 3-minute intervals. Purge water will be placed in DOT-approved drums.

The samples will be uniquely labeled, stored in insulated coolers with ice, and transported under chain-of-custody protocol to the analytical laboratory for chemical analysis. Because of varying hold-times for the analyses in the analytical program (see Section 4.2.2.7), samples may be submitted to the laboratory under more than one chain-of-custody for the same sampling event.

4.2.2.7 Groundwater Analytical Program

Monitoring well and grab groundwater samples will be submitted to a Washington accredited laboratory for analysis of the following COPCs (see Section 2.7):

Nitrate as nitrogen and nitrite as nitrogen by EPA Method 300.0;

Ammonia as nitrogen by SM-4500-NH3 G;

Potassium by EPA 6020A;

Total Phosphorous by SM-4500-P E

Sulfate by EPA 300.0

Total and dissolved metals:(copper, arsenic, lead, cadmium, mercury [total only] and zinc) by EPA Method 6020A; and

Total suspended solids.

Groundwater samples to be submitted for dissolved copper analysis will be field-filtered using an 0.45 micron (µm) membrane filter, prior to transport for analysis.

The laboratory hold time for nitrate and nitrite is 48 hours, thus these samples will be submitted to the laboratory the same day as collection for immediate sample preparation and analysis. The remaining samples may be submitted to a laboratory with less urgency under a separate chain-of-custody.

4.3 SOIL INVESTIGATION SCOPE

The following sections describe the general sampling approach for evaluating COPCs in soil, a rationale for the proposed sampling locations, and details regarding sampling methodology and procedures.

4.3.1 Approach/Rationale

The approach of the proposed soil investigation was prepared to meet the Phase I objectives described in Section 3.3.2.2 above; namely, to establish a baseline understanding of the presence of COPCs in shallow soils and, if present, the potential of the COPCs to adversely impact shallow groundwater, migrate via stormwater at concentrations of potential concern, or present an unacceptable risk to human receptors via direct contact or inhalation pathways.

The following table summarizes how each portion of the Project Area will be evaluated for the presence of metals, ammonia, and nitrate/nitrites. The table includes the investigation area, the objective for each investigation area, and the proposed sampling locations to meet these objectives. Soil sampling locations are shown on Figure 19.

Investigation Area	**Objective**	**Location to Address**
Unpaved Ground Surface	Assess COPC concentrations in surface soil.	Borings 25 through 38, 41, 42
SVE Vault	Assess COPCs in soil beneath the vault and the potential to adversely impact groundwater.	Boring 43

Investigation Area	Objective	Location to Address
Historically Unpaved Ground Surface	Assess whether COPCs are present at concentrations of potential concern.	Borings 39, 15
High Use Areas	Assess whether COPCs are present at concentrations of potential concern.	Borings 40, 44
Riverbank	Identify whether erodible soil is present on the riverbanks in the investigation area.	Qualitative field observation

Two samples will be collected at each location: a surface sample and an additional sample at 2 to 3 feet bgs. The surface samples will be collected from 0 to 1 foot beneath the subgrade of the pavement in paved areas and the same depth in unpaved areas. The rationale for the boring locations is identified by operations area below.

NuStar Leasehold – Ten boring locations have been proposed on the NuStar Leasehold for collection of soil samples using direct push technology. These borings include:

- **Boring 15.** Boring 15 is located in a paved area between monitoring well MW-13 and the Columbia River. Historical aerial photos show that a small area near that location was historically not paved. This boring will be used to evaluate whether shallow soil is impacted with COPCs from historical operations.
- **Borings 25 through 32.** These sample locations are located in the unpaved portion of the NuStar Leasehold, along the railway corridor that runs east to west through the NuStar Leasehold.
- **Boring 43.** Boring 43 is located within the vault of one of the SVE wells on the NuStar Leasehold (VE-1-2). The SVE well vaults, including VE-1-2, were installed in 2008 in native soil and do not have a concrete bottom. Ecology has requested that a sample be taken from beneath the SVE vault to evaluate for the presence of COPCs.

KMBT Operations Area – Nine shallow soil sample locations have been proposed on the KMBT Operations Area. A discussion of the approach for investigation and rationale for selection of the sample location is detailed below:

- **Borings 33 through 38.** These sample locations are located in the unpaved portions of the KMBT Operations Area. They are located along the facility northern portion near the railroad tracks, railroad unloading area (building 2877) and Coverall Building 2745 – see Figure 2.

- **Boring 39.** This boring is located in a historically unpaved portion of the bulk material operations area. Boring 39 is located between buildings 2745 and 2685.
- **Borings 40 and 44.** These two borings are located in paved high-use areas. Boring 40 is located immediately south of the former Sand Shed building footprint (west of building 2695) which is currently used to store tire chips. Boring 44 is located between the rail unloading area (building 2877) and the material storage building (buildings 2725 and 2745).

Riverbank Erosion. The riverbank will be visually inspected for the presence of apparent erodible soils that could provide a potential pathway for COPCs to enter the river. If erodible areas are observed, riverbank sampling will be proposed as a part of the Phase II investigation.

4.3.2 Procedures

Methods to complete the soil investigation will include preparatory activities and collecting shallow soil samples at the locations shown on Figure 19. Procedures for each of these methods are described below.

4.3.2.1 Preparatory Activities

Prior to the investigation, the public utility notification center will be contacted, and a private utility locator will be contracted to check for the presence of buried utilities or infrastructure in the work area. It should be noted that the presence of buried utilities or infrastructure, or other access issues, may result in the relocation of the proposed borehole locations from those presented on Figure 19.

4.3.2.2 Soil Sampling

At each utility-cleared location, a borehole will be advanced using a hand auger or air knifing technologies. A licensed subcontractor will be retained to core through and repair the asphalt or concrete and provide as needed air-knife services to advance each boring. A representative from Cascadia and Antea will oversee the work. Soil samples will be collected at each location at 0 to 1 foot bgs (below any pavement and associated subgrade aggregate) and 2 to 3 feet bgs using a decontaminated stainless-steel hand auger. The investigation will be conducted in accordance with Cascadia and KMBT SOPs for soil grab sampling and management which are included in Appendix E.

4.3.2.3 Soil Analytical Program and Testing Protocol

Soil samples will be submitted to a Washington accredited laboratory for analysis. Analytical testing will be completed using the following protocol and EPA test methods.

Nitrate, nitrite and sulfate by EPA Method 9056A

Ammonia by Plumb/SM 4500-NH3 G;

Potassium by EPA 6020A;

Total Phosphorous by EPA 365.3M; and

Metals (copper, arsenic, lead, cadmium, mercury, and zinc), and the five highest copper containing samples will be run for selenium, nickel, manganese, silver, and chromium speciation by EPA Method 6020A.

4.4 SEDIMENT INVESTIGATION SCOPE

The following sections describe the general sampling approach for evaluating COPCs in sediment, a rationale for the proposed sample locations, and detail regarding sampling methodology and procedures. The objective of the Phase I sediment sampling, as detailed in Section 3.3.3.2, is to assess whether metals or fertilizer COPCs are present in sediment in the Port Berths 7, 8, and 9 areas at concentrations of potential concern. Sediment samples will also be analyzed for VOCs to assess whether reductions in concentrations in groundwater at the NuStar Leasehold have led to reduced VOC concentrations in sediment. To assist with the latter objective, sediment sampling locations will be co-located to the extent feasible with sediment sampling locations advanced during previous sediment investigations conducted in support of the NuStar VOC RI, as described further below.

Sediment sampling will be conducted in accordance with the SMS (Chapter 173-204 WAC) and guidance in the Sediment Cleanup User's Manual II (Ecology, 2019).

4.4.1 Approach/Rationale

Proposed sediment target locations are shown on Figure 20. In the Berth 7 area, these locations are located immediately adjacent to the KMBT Operations Area and NuStar Leasehold, are located in a portion of the river outside of the navigation channel that is not subject to maintenance dredging, and are co-located with previous VOC sediment sampling efforts where appropriate. In general, a surface sample and 7-foot core will be collected from within each proposed target location. Each sample will be analyzed for both VOCs as well as fertilizer and metals COPCs identified for this investigation (and summarized in Section 4.4.2.5). In addition to sampling locations that are co-located with the previous VOC sediment sampling, two surface grab samples will be collected at the end of the Berth 7 dock (Locations 55 and 56) and one surface grab sample will be collected near the navigation channel dredge boundary (Location 47).

In the Berth 8/9 area, eight surface sediment locations are proposed in the vicinity of the fertilizer ship offloading areas (Locations 46 and 48 through 54).

A discussion of the approach for investigation and rationale for selection of the sample locations and the proposed analysis is detailed below.

1. **Sediment Locations 1 through 13.** These sediment locations are co-located with or adjacent to historical sediment sample locations from a 2016 sediment sampling event for VOCs. Several of the sediment samples from 2016 were co-located with sediment samples from 2011 or 2012 sediment investigations for VOCs. There was a noted reduction in VOC concentration between 2011/2012 and 2016 (Apex, 2017). The VOC analyses from this

proposed sampling event will be used to evaluate if the concentration of VOCs has decreased in response to the upland bioremediation injection interim action in 2016. As these locations are also located adjacent to the KMBT vessel loading dock (for metals) and the NuStar fertilizer handling areas, these sample locations will also be analyzed for nitrates, nitrates, sulfates, ammonia, potassium, phosphorous (the fertilizer COPCs) and copper, arsenic, cadmium, lead, mercury, and zinc (copper concentrate COPCs) to see if there are COPCs in sediment associated with Project Area activities. Both surface sample and subsurface core collection are proposed at these locations.

2. **Locations 45 and 46.** These two locations are placed adjacent to former stormwater outfall locations to assess for the presence of fertilizer, and/or copper concentrate COPCs that might be associated with historical discharges from these former outfalls. Both surface samples and subsurface core collection are proposed at location 45 and a surface sample is proposed at location 46.
3. **Location 14.** This location is upstream of the KMBT vessel loading area and the fertilizer handling areas and may provide a delineation point should copper or fertilizer constituents be detected in sediment. Furthermore, this location is outside the historical extent of VOCs in river sediment, as shown on Figure 20, and will be used to confirm the delineation of VOCs in the Project Area. Therefore, the sample from this location will be analyzed for VOCs, fertilizer and copper concentrate COPCs. A surface sample and subsurface core are proposed at this location.
4. **Locations 55 and 56.** These locations are adjacent to and to either side of the KMBT conveyor system terminus and are proposed at shallower riverbed depths as documented in the March 2020 multi-beam survey conducted by the Port (see Appendix B). Surface samples are proposed at these locations. Samples will be analyzed for copper concentrate COPCs.
5. **Location 47.** This sample is proposed riverward of sample Location 13, in the non-dredged area identified in the Port's March 2020 multi-beam survey. A surface sample is proposed at this location and will be analyzed for copper concentrate COPCs.
6. **Location 51.** This location is proposed in an area of sediment accumulation at Berth 9 that is near the Terminal 4 storm pond outfall (see Figure 20). A surface sample is proposed at this location and will be analyzed for fertilizer and copper concentrate COPCs.
7. **Location 53 and 54.** Surface samples are proposed at these two locations, in the non-dredged sediment accumulation area west of Berths 8 and 9. Samples will be analyzed for fertilizer and copper COPCs.
8. **Locations 48, 49, 50 and 52.** Surface samples are proposed at four locations at the face of Berths 8 and 9 to evaluate the extent of the fertilizer vessel offloading operations. Samples will be analyzed for fertilizer and copper COPCs.

Note, samples will also be collected for archive in all project samples. For the five sediment samples with the highest copper concentrations, the following additional metals will be analyzed from the archive sample: Selenium, nickel, manganese, silver, and chromium speciation by EPA Methods 6020A/3060A.

4.4.2 Procedures – Sediment Investigation

The following sections describe the methods and procedures for the proposed sediment investigation.

4.4.2.1 Understanding of Shoreline and River Bathymetry

A seawall borders much of the Property Area along the boundary with the Columbia River. The United States Army Corp of Engineers navigation channel within the Columbia River and the Port operational berths are maintained at the authorized dredge depth of -43 ft CRD[3] plus a 2-foot allowable overdredge. The area between the docking berths and the seawall is not dredged as no vessels navigate the landward side of the docking berths. The seawall and approximate extent of river dredging are shown on Figure 20. Figures from the March 2020 multi-beam survey conducted by the Port and a cross section of the shoreline adjacent to the NuStar Leasehold, excerpted from a historical report, is included in Appendix B.

4.4.2.2 Sampling Locations and Depths

Sediment samples will be collected from proposed locations 1 through 14, and 45 through 56 as shown on Figure 20. Actual sample locations will be determined in the field using proposed coordinates, mud-line elevation, and presence/absence of rip-rap or debris. If refusal at the desired sampling location occurs due to debris or obstructions, attempts will be made to offset slightly parallel to the shoreline in order to maintain as constant a depth as possible. If rip-rap continues to be encountered, the sampling location may be offset in the direction perpendicular to the shoreline. Samples will be collected within ±10 feet of the proposed locations.

Up to four sediment samples will be collected at each location. Sampling depths will include the top 10 centimeters (cm), and for the core samples, subsurface intervals at approximately 1 to 3 feet, 3 to 5 feet, and 5 to 7 feet below the mudline. These sample depths are consistent with the previous sediment sampling locations at this location (note: with the exception of the first sampling event in which the surface sample was collected from within the first foot [12 inches] of sediment). Based on previous investigations, refusal is typically encountered between 5 and 7 feet below the mudline.

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[3] Which is approximately -36.5 to-43.5 feet msl referenced to the North American Vertical Datum of 1988 (NAVD88).

4.4.2.3 Sampling Procedures

The following subsections summarize sediment sampling procedures. Additional information on sampling procedures is provided in the Sediment SAP provided in Appendix F. The Sediment SAP describes procedures for sample location control, documentation, sediment sampling, sample processing, sample containers and handling, equipment decontamination, IDW management, and data quality assurance.

Sampling Procedures. Sediment samples will be collected using two methodologies. Surface grab samples will be collected using a stainless-steel pneumatically-operated grab sample deployed from a vessel (a.k.a. "power grab"). The power grab sampler will be used to collect surface sediment from 0 to 10 cm below the mudline over approximately a 2-square-foot area. The top of the sampler will have a rubber cover that prevents sediment from washing out when the sampler is retrieved. If the power grab sample meets acceptable criteria as described in the SAP, the grab sample will be lithologically described and samples will be collected from the sampler for processing as described later in this section and detailed in the SAP.

After collection of the surface samples, sediment cores will be collected at the same location. The cores will be collected using a vessel equipped with a Vibracore sediment coring instrument, or similar, in accordance with Section 2.2 of the SAP. One continuous core will be collected at each location with a target depth of 7 feet below mudline. After cores are collected, the cores will be sealed and stored upright on the vessel, until the vessel returns to shore for processing. Processing will be conducted in accordance with Section 2.2 of the SAP.

The sediment core samples will be logged for lithology and screened for VOCs using a PID. Field screening measurements are intended to comply with SOPs and are not intended to replace laboratory analytical data.

Sample Processing. VOCs and ammonia are considered volatile constituents, and samples will be collected for those analyses prior to compositing for the remainder of the analyses. For the other analytes (copper, nitrate, etc.), the sediment from the identified sampling interval (e.g., 1 to 3 feet, 3 to 5 feet, etc.) will be composited and homogenized prior to placing in laboratory supplied containers for analysis. Details on sample collection and compositing are provided in the SAP. The samples will be submitted to a Washington accredited laboratory for analysis within the appropriate method specific hold-time.

4.4.2.4 Control of Station and Sample Locations

A positioning procedure will be utilized to ensure that the proposed sampling stations are achieved and to accurately determine the horizontal and vertical positions of the sampling stations. For sample locations co-located with historical VOC sampling locations, historical coordinates will be used as target locations during this investigation. This determination will be achieved by referencing each sampling location to state plane coordinates through the use of known survey control points, onshore landmarks, and a differential global positioning system (GPS). The following parameters will be documented at each sampling location:

- Time and date;
- Horizontal location in local grid coordinates, referenced to North American Datum of 1983 (NAD83); and
- River level and mudline elevations referenced to NAVD88.

These parameters will be measured from the sampling vessel using a combination of differential GPS, pre-surveyed visual horizontal triangulation to known control points (e.g., surveyed on-site monitoring wells, benchmarks, etc.) and/or permanent structures onshore, single beam echo sounder data, and weighted tape measures. Additional information on vertical and horizontal sample control is provided in Section 1.0 of the SAP (Appendix F).

4.4.2.5 Sediment Analytical Program

As described in Section 4.4.1, the analytical program varies at the proposed sample locations based on the objective/rationale for sampling at that location. Sediment samples will be submitted to a Washington accredited laboratory for analysis as described in Section 4.4.1 using the EPA-approved methodologies listed below.

- Chlorinated (halogenated) VOCs by EPA Method 8260B;
- Nitrate, nitrite, and sulfate by EPA Method 9056A;
- Potassium by EPA 6020A;
- Total Phosphorous by EPA 365.3M;
- Ammonia (Plumb 1981) by Plumb/SM4500-NH3 G;
- Total organic carbon (TOC) by EPA Method 9060Amod;
- Metals (copper, arsenic, lead, cadmium, mercury and zinc) on all sediment stations, and the five highest copper containing samples will be run for selenium, nickel, manganese, silver, and total chromium by EPA Method 6020A.

4.5 ADDITIONAL VOC INVESTIGATION SCOPE

As discussed in Section 1.1, Ecology has requested additional VOC delineation to the west of NuStar monitoring well MW-26. To that end, borings 19 through 21 are proposed to delineate VOCs in shallow zone groundwater west of well MW-26. The proposed locations of the borings are shown on Figure 18.

4.5.1 Groundwater Sampling Procedures for VOC Locations

To be consistent with previous groundwater investigations, borings to be sampled for chlorinated VOCs (locations 19 through 21) will be advanced using push probes and the groundwater sampled using depth discrete sampling techniques. Samples will be collected from 5-foot screened intervals starting with first encountered groundwater and proceeding to the bottom of the shallow zone, which is identified by the silt layer at the NuStar Leasehold. The bottom of the shallow zone—the top of the silt layer—is anticipated to be encountered at a depth of approximately 43 feet bgs based on the lithologic logs for well MW-26 (Apex, 2013) and boring AGP-55 (Ash Creek, 2006b). Consistent with the previous groundwater investigations in this area, groundwater samples will be collected every 10 vertical feet; therefore, in practice, there will be 5 feet between each 5-foot screened interval. Based on an anticipated depth to groundwater of approximately 28 feet and the identified depth to the silt layer of 43 feet bgs in this area, it is anticipated that two depth discrete groundwater samples will be collected at each boring: the shallowest from approximately 28 to 33 feet bgs and the second from approximately 38 to 43 feet bgs, directly above the silt layer. If the depth to groundwater is several feet shallower than anticipated, it may be possible to collect three samples per boring. To the extent possible, the sampling intervals will be consistent with the sampled intervals of the previous grab groundwater investigation conducted in this area.

Borings will be advanced to the bottom depth of the uppermost targeted groundwater sampling interval (i.e., 5 feet below first encountered groundwater). A temporary well with a 5-foot-long well screen will be installed through the push probe rod, and the rod will be pulled up 5 feet to allow the temporary well screen to be placed across the targeted sampling interval. A groundwater sample will be collected from the temporary well using low flow methodology in accordance with the Low Flow Groundwater Sampling Method SOPs contained in Appendix E. Following collection of the uppermost groundwater sample, the borehole will be advanced to the bottom depth of the next targeted interval, and a new temporary well will be installed as described above across the second targeted interval. This process will continue until the final targeted interval is the sampling interval directly above the silt layer.

4.5.1.1 VOC Analytical Program

Soil and groundwater samples will be submitted to a Washington accredited laboratory for analysis of chlorinated VOCs by EPA Method 8260D. Soil samples will be collected using 5035A preservation methods.

4.6 STORMWATER INVESTIGATION

This section describes the general sampling approach for evaluating COPCs in stormwater, a rationale for the proposed sample locations, and a discussion of the proposed sampling methodology and procedures. Stormwater sampling locations are shown on Figure 21.

4.6.1 Approach/Rationale

The five proposed stormwater sampling locations were chosen near or within the KMBT Operations Area. These sample points were selected to ensure that stormwater sampled is representative of KMBT areas. Where possible, sample points that contain stormwater from multiple catch basins were selected. This approach provides characterization of a wider area than sampling only individual catch basins. For the Phase I sampling, larger stormwater trunk-lines carrying stormwater from other facilities and distant portions of the Port have been excluded. Two rounds of stormwater sampling will be conducted. These two sample events will be performed during the first rain event after a ship has been loaded with copper ore for export. Given the limited number of copper ships in a year, sampling may be completed during the ship-loading operations if the project team determines that the conditions are suitably similar to site conditions after completion of ship loading.

4.6.2 Procedures – Stormwater Sampling Methods and Analytical Plan

Stormwater samples will be collected from the proposed sampling locations by accessing them from a storm drain or manhole. Where feasible, samples will be collected by attaching the sample bottles to a pole that can be lowered into the flow of stormwater; this process can be repeated until the bottle is nearly full. Bottles with preservative will not be completely filled to avoid loss or dilution of the preservative in the bottle. Overfilled bottles will be disposed of, and another bottle will be attached and the stormwater flow will be resampled. Where sample bottles cannot be placed directly into the stormwater to be sampled, alternate means such as dippers and peristaltic pumps using disposable tubing may be employed. Samples for dissolved metals analyses will be filtered in the field using a peristaltic pump and pushed through the filter capsule and into to the sample container. Samples will be collected and handled in general accordance with the procedures stated in the Ecology Stormwater Sampling Manual – A Guide for the Industrial Stormwater General Permit (December 2015).

Immediately after sampling, samples will be packed on ice and prepared for transport or shipping to the selected laboratory in accordance with standard chain-of-custody procedures.

Samples will be analyzed for copper, arsenic, lead, cadmium, mercury, zinc, selenium, nickel, manganese, silver, and chromium speciation by EPA Method 6020A. Stormwater samples will be tested for total and dissolved phases of the listed metals.

5.0 SUPPLEMENTAL PHASE I INVESTIGATION SUMMARY REPORT

After completion of the investigative activities summarized in this SRIWP, project data will be uploaded to Ecology's Environmental Information Management (EIM) database, along with any other pertinent site information. The PLPs will submit to Ecology a Supplemental Phase I Investigation Summary Report. The report will include, at a minimum, the following information:

- A summary of the Phase I investigative activities conducted;
- Documentation from any deviations from the scope identified in this SRIWP, if applicable;
- A discussion of the results of the investigation, which will include a discussion of whether or not the objectives outlined for the various media were met; and
- Recommendations for Phase II Investigative activities, if applicable, and a schedule for completion of the Supplemental RI.

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TABLES

Table 1
Summary of Historical Stormwater Data - NuStar Leasehold
NuStar Vancouver Main Terminal
Vancouver, Washington

Discharge Monitoring Report Period	Date	Sample Location	Turbidity (NTU)		pH		Zinc (µg/L)		Copper (µg/L)		Lead (µg/L)		Nitrate (mg/L)	
			Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Quarter 2 2003	4/17/2003	#9	19	--	7.75	--	**612**	--	33	--	ND	--	0.6	--
	4/17/2003	#10	55	--	6.75	--	269	--	76	--	ND	--	**1.7**	--
	4/17/2003	#11	87	--	5.8	--	**382**	--	151	--	ND	--	**163**	--
	4/17/2003	#12	13	--	6.57	--	138	--	44	--	ND	--	**5**	--
	4/17/2003	#14	87	--	6.3	--	**3,070**	--	**1,870**	--	**294**	--	**30**	--
Quarter 4 2003	12/10/2003	#9	49	--	6.63	--	166	--	NA	--	NA	--	**1.5**	--
	12/10/2003	#10	21	--	6.97	--	54	--	NA	--	NA	--	0.5	--
	12/10/2003	#11	58	--	6.3	--	206	--	NA	--	NA	--	**19**	--
	12/10/2003	#12	50	--	6.76	--	150	--	NA	--	NA	--	**7.1**	--
	12/10/2003	#14	70	--	6.54	--	**542**	--	NA	--	NA	--	**10.6**	--
Quarter 1 2004	2/17/2004	#9	32.1	32.1	6.55	6.55	105	105	17	17	9.5	9.5	ND	ND
	2/17/2004	#10	41.4	41.4	6.94	6.94	70	70	17	17	6.4	6.4	ND	ND
	2/17/2004	#11	8.9	8.9	5.96	5.96	69	69	ND	ND	7.2	7.2	**1.5**	**1.5**
	2/17/2004	#12	164	164	6.62	6.62	252	252	118	118	34.5	34.5	**5.8**	**5.8**
	2/17/2004	#14	36.3	36.3	5.9	5.9	142	142	89	89	9.2	9.2	**62**	**62**
Quarter 1 2006	3/29/2006	Main - CB at NW end of #2585	8.8	8.8	6.08	6.08	**2,210**	**2,210**	**2,800**	**2,800**	20.3	20.3	**23.9**	**23.9**
	3/29/2006	SW End of #2655	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Quarter 2 2006	5/22/2006	Main #1 - CB at NW end of #2585	23	23	6.46	6.46	238	238	**368**	**368**	17.5	17.5	**10.1**	**10.1**
	5/22/2006	#2 -SW End of #2655	89	89	6.91	6.91	**902**	**902**	**9,680**	**9,680**	106	106	**10.7**	**10.7**
Quarter 3 2006	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
Quarter 4 2006	11/21/2006	Main #1 - CB at NW end of #2585	22	22	6.05	6.05	141	141	**397**	**397**	13.1	13.1	**2.4**	**2.4**
	11/21/2006	#2 -SW End of #2655	22	22	6.1	6.1	134	134	**480**	**480**	13.2	13.2	**5**	**5**
Quarter 1 2007	2/15/2007	Main #1 - CB at NW end of #2585	19	19	6.41	6.41	243	243	**329**	**329**	19.6	19.6	**9.4**	**9.4**
	2/15/2007	#2 -SW End of #2655	28	28	6.6	6.6	**431**	**431**	**3,290**	**3,290**	80.5	80.5	0.4	0.4
Quarter 2 2007	5/21/2007	Main #1 - CB at NW end of #2585	18	18	6.2	6.2	**637**	**637**	**368**	**368**	16.8	16.8	**2.2**	**2.2**
	5/21/2007	#2 -SW End of #2655	53	53	6.57	6.57	**499**	**499**	**893**	**893**	32.9	32.9	**20.3**	**20.3**
Quarter 3 2007	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
Quarter 4 2007	10/16/07 & 12/03/07	Main #1 - CB at NW end of #2585	57	82	6.77	6.43	**775**	**1,150**	**1,831**	**2,740**	91	128	**17**	**33.3**
	10/16/07 & 12/03/07	#2 -SW End of #2655	43	62	6.04	6.06	**397**	**632**	**778**	**1,070**	25	31	**20.3**	**137**

Please refer to notes on last page of table.

Table 1
Summary of Historical Stormwater Data - NuStar Leasehold
NuStar Vancouver Main Terminal
Vancouver, Washington

Discharge Monitoring Report Period	Date	Sample Location	Turbidity (NTU)		pH		Zinc (µg/L)		Copper (µg/L)		Lead (µg/L)		Nitrate (mg/L)	
Quarter 1 2008	3/13/08 & 3/28/08	Main #1 - CB at NW end of #2585	39	47	6.15	6.19	329	**380**	**370**	**499**	20	29	**5.8**	**6.2**
	3/13/08 & 3/28/08	#2 -SW End of #2655	18	18	6.24	6.26	**408**	**575**	**705**	**1,060**	**201**	**394**	**120**	**192**
Quarter 2 2008	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
Quarter 3 2008	8/20/2008	Main #1 - CB at NW end of #2585	19.2	19.2	6.17	6.17	239	239	**286**	**286**	13.4	13.4	**1.9**	**1.9**
	NA	#2 -SW End of #2655	32	32	6.3	6.3	259	259	**957**	**957**	30.8	30.8	**35.4**	**35.4**
Quarter 4 2008	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
	NA	No qualifying event	--	--	--	--	--	--	--	--	--	--	--	--
Quarter 1 2009	2/10/2009	65-SW at SW End of #2565	14	14	6.27	6.27	57	57	109	109	4.6	4.6	ND	ND
Quarter 2 2009	4/1/2009	65-SW at SW End of #2565	12.9	12.9	6.21	6.21	74	74	**197**	**197**	4	4	0.4	0.4
Quarter 3 2009	9/30/2009	65-SW at SW End of #2565	11.6	11.6	6.08	6.08	**1,300**	**1,300**	**5,250**	**5,250**	28	28	**1.5**	**1.5**
Quarter 4 2009	10/29/2009	65-SW at SW End of #2565	5.1	--	6.14	--	81	--	**187**	--	2.2	--	ND	--
	12/15/2009	65-SW at SW End of #2565	5	--	6.09	--	55	--	138	--	3	--	--	--
Quarter 1 2010	1/12/2010	65-SW at SW End of #2565	5.5	--	6.03	--	38	--	99	--	--	--	--	--
Quarter 2 2010	5/28/2010	65-SW at SW End of #2565	4.5	--	5.65	--	83.5	--	**197**	--	--	--	--	--
Quarter 3 2010	7/2/2010	65-SW at SW End of #2565	5.3	--	5.51	--	30.9	--	81.8	--	--	--	--	--
Quarter 4 2010	10/25/2010	65-SW at SW End of #2565	2.9	--	5.68	--	86	--	138	--	--	--	--	--
	11/30/2010	65-SW at SW End of #2565	6.2	--	5.82	--	33	--	51	--	--	--	--	--
Quarter 1 2011	2/14/2011	65-SW at SW End of #2565	10.1	--	5.82	--	68.3	--	121	--	--	--	--	--
Quarter 2 2011	4/28/2011	65-SW at SW End of #2565	8.7	--	6.27	--	177	--	**370**	--	--	--	--	--
	5/31/2011	65-SW at SW End of #2565	6.7	--	6.15	--	147	--	**383**	--	--	--	--	--
Quarter 4 2011	10/10/2011	65-SW at SW End of #2565	10	--	6.32	--	85	--	149	--	--	--	--	--
Quarter 1 2012	1/19/2012	65-SW at SW End of #2565	2.3	--	5.32	--	44.6	--	86.1	--	--	--	--	--
Quarter 2 2012	4/5/2012	65-SW at SW End of #2565	1.24	--	6.31	--	47.2	--	128	--	--	--	--	--
Quarter 1 2013	2/10/2013	Main header	--	--	--	--	--	--	--	**1,270**	--	--	--	--
Permit Limit Action Level			NA		NA		372		149		159		1.36	

Notes:

NTU = Nephelometric Turbidity Unit

µg/L = micrograms per liter

mg/L = milligrams per liter

ND = Not Detected (laboratory reporting limits not consistently available).

NS = Not Sampled

-- = data not available.

BOLD = exceeds Permit Benchmark

Shaded = Data summarized from operations group spreadsheet, and could not be verified with analytical reports. It should be noted that where analytical reports were available, the data were consistent with data in the operations group spreadsheet.

"Average" results indicate the average concentration taken from a single sample location from multiple events during the quarterly reporting period. The average was typically the average of two samples; however, in some instances only one sample was collected per quarter (at a given location). The "maximum" was the highest of the concentrations among multiple samples collected during a reporting period.

Table 2

Copper Groundwater Analytical Results

NuStar Vancouver Main Terminal

Vancouver, Washington

Well ID	Sample Date	Total Copper (µg/L)	Dissolved Copper (µg/L)
MW-1	11/9/2017	535	--
	9/25/2018	<5.00	<5.00
	3/21/2019	19.3	16.5
	6/5/2019	33.4	9.94
	9/27/2019	47.8	11.0
MW-2	11/9/2017	31.8	--
	9/25/2018	38	<5.00
	3/21/2019	38	2.42
	6/5/2019	2.86^{J}	1.11^{J}
	9/27/2019	75.1	47.8
MW-3	11/8/2017	14.8	--
	9/26/2018	13.3	10.1
	3/20/2019	18.5	9.1
	6/7/2019	9.82^{B}	7.89
	9/27/2019	14.6^{B}	3.72^{J}
MW-5	11/7/2017	<10.0	--
MW-6	11/7/2017	25.7	--
	9/25/2018	<5.00	<5.00
	3/20/2019	4.48^{J}	<5.00
	6/5/2019	1.44^{J}	1.05^{J}
	9/27/2019	9.24^{B}	1.16^{J}
MW-7	11/7/2017	241	--
	9/27/2018	147	7.89
	3/20/2019	43.5	16.6
	6/5/2019	38.6	24.6
	9/1/2019	28.7	18.6
MW-8	11/6/2017	<10.0	--
MW-9	11/7/2017	13.7	--
	9/27/2018	5.76	<5.00
	3/20/2019	10.8	11.2
	6/7/2019	12.7^{B}	10.9
	9/26/2019	4.72^{B,J}	5.49^{B}
MW-10	11/6/2017	327	--
	9/25/2018	49.4	32.6
	3/21/2019	114	35.4
	6/6/2019	45.1	34.6
	9/25/2019	10.2^{B}	9.56
Ecology General Industrial Stormwater Permit Benchmark (µg/L)		*14*	
MTCA Method B (non-carcinogen) Cleanup Level (mg/L)		*640*	

Please refer to notes at end of table.

Table 2
Copper Groundwater Analytical Results
NuStar Vancouver Main Terminal
Vancouver, Washington

Well ID	Sample Date	Total Copper (µg/L)	Dissolved Copper (µg/L)
MW-12	11/9/2017	1050	--
	9/25/2018	27.5	<5.00
	3/20/2019	37.8	2.99^{J}
	6/5/2019	77.4	15.4
	9/26/2019	10.8^{B}	$1.23^{B,J}$
MW-13	11/7/2017	4,530	--
	4/10/2018	13,400	--
	9/25/2018	19.4	<5.00
	3/19/2019	191	15.6
	6/6/2019	36.1	1.92^{J}
	9/26/2019	33.6	12.8
MW-14	1/22/2018	1510	--
	9/26/2018	343	67.2
	3/19/2019	636	45
	6/6/2019	213	81.1
	9/25/2019	181	81.9
MW-15	11/6/2017	<10.0	--
MW-16	11/6/2017	<10.0	--
MW-17	11/8/2017	267	--
	9/26/2018	146	106
	3/19/2019	107	89.8
	6/6/2019	95.4	26.8
	9/27/2019	77.3	59.1
MW-19	11/9/2017	89	--
	9/25/2018	19.2	8.6
	3/20/2019	25.6	5.84
	6/7/2019	14	4.35^{J}
	9/26/2019	7.88^{B}	$4.11^{B,J}$
MW-18i	11/7/2017	<10.0	--
MW-19i	11/8/2017	15.6	--
MW-20i	11/7/2017	<10.0	--
MW-21i-40	11/8/2017	<10.0	--
MW-21i-105	11/8/2017	16.8	--
	9/26/2018	14.6	<5.00
	3/21/2019	18.7	12.5
	6/6/2019	118	96
	9/25/2019	46.4	47.5
MW-22i	11/7/2017	27.2	--
	9/26/2018	166	<5.00
	3/21/2019	27.7	23.6
	6/6/2019	67.7	3.31^{J}
	9/25/2019	57.1	6.62^{B}
Ecology General Industrial Stormwater Permit Benchmark (µg/L)		*14*	
MTCA Method B (non-carcinogen) Cleanup Level (mg/L)		*640*	

Please refer to notes at end of table.

Table 2
Copper Groundwater Analytical Results
NuStar Vancouver Main Terminal
Vancouver, Washington

Well ID	Sample Date	Total Copper (µg/L)	Dissolved Copper (µg/L)
MW-23i	11/8/2017	<10.0	--
MW-24i	11/9/2017	<10.0	--
MW-25i	11/8/2017	<10.0	--
MW-26	1/22/2018	<10.0	--
MW-32i	11/10/2017	<10.0	--
MW-32s	11/10/2017	14.8	--
MGMS1-43	11/7/2017	<10.0	--
MGMS1-60	11/7/2017	<10.0	--
MGMS2-40	11/9/2017	<10.0	--
MGMS2-60	11/9/2017	<10.0	--
MGMS3-40	11/10/2017	<10.0	--
MGMS3-60	11/10/2017	<10.0	--
S-1	11/8/2017	20,900	--
	3/20/2018	370	--
	4/2/2018	829	--
	9/26/2018	19.1	7.2
	3/19/2019	130	22.9
	6/5/2019	56.4	13.8
	9/25/2019	43.7	14.9
S-2	11/8/2017	1,620	--
	3/20/2018	2,480	--
	4/2/2018	1,050	--
	9/26/2018	201	11.5
	3/19/2019	686	163
	6/5/2019	24.8	8.12
	9/25/2019	211	28.3
MP-1	11/9/2017	13.7	--
	9/26/2018	<5.00	<5.00
	3/20/2019	3.46 ^{J}	1.71 ^{J}
	6/7/2019	3.28 $^{B\ J}$	2.43 ^{J}
	9/26/2019	1.86 ^{B,J}	2.57 ^{B,J}
EW-1	11/9/2017	12	--
Ecology General Industrial Stormwater Permit Benchmark (µg/L)		*14*	
MTCA Method B (non-carcinogen) Cleanup Level (mg/L)		*640*	

Notes:

µg/L = Micrograms per liter.

J = The identification of the analyte is acceptable; the reported value is an estimate.

B = The same analyte is found in the associated blank.

Copper results per Method 6020B.

Dissolved copper samples were filtered in the field using a 0.45 micron single use filter.

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
EX	2/6/2007	**26.7**	**108**	**0.49**
	3/23/2009	**14**	**43**	**0.54**
	3/16/2010	**3.4**	**89**	**0.71**
	6/7/2011	--	**150**	<0.10
	12/9/2011	--	<0.50	<0.10
	3/21/2018	**302**	**1.22**	**0.47**
	6/28/2018	**119**	<0.10	<0.050
	9/24/2018	**132**	**0.461**	<0.250
	12/4/2018	**117**	**24.1**	<0.250
MW-1	11/9/2017	**3.96**	**46.4**	<1.0
	3/20/2018	**6.2**	**1.84**	<0.10
	7/1/2018	**1.47**	<0.10	<0.10
	9/25/2018	**5.79**	<0.250	<0.250
	12/4/2018	**3.38**	**79.4**	<0.250
	3/21/2019	**22.0**	**2.8**	<0.250
	6/5/2019	**176**	**32.8**	**0.802**
	9/27/2019	**56.9**	**44**	<0.25
MW-2	11/6/2017	**6.34**	**0.26**	<0.10
	7/2/2018	**9.85**	<0.10	<0.10
	3/21/2019	**11.0**	<0.250	<0.250
	6/5/2019	**9.86**	<0.25	<0.25
	9/27/2019	**9.82**	<0.25	<0.25
MW-3	11/8/2017	**1.68**	**2.7**	<1.0
	3/20/2018	<0.40	**19.7**	<0.10
	7/2/2018	**0.569**	**15.4**	**1.49**
	9/26/2018	**1.56**	**5.64**	<0.250
	12/7/2018	**1.18**	**10.2**	<0.250
	3/20/2019	<0.0200	**17.1**	<0.250
	6/7/2019	<0.0200	**15.1**	<0.25
	9/27/2019	**2.04**	**3.9**	<0.25
MW-5	11/7/2017	**2.86**	<0.10	<0.10
	3/21/2018	<0.05	**2.63**	<0.10
	6/29/2018	**0.819**	<0.10	<0.10
	9/27/2018	**9.55**	<0.250	<0.250
	12/7/2018	**1.22**	<0.250	<0.250
	3/26/2019	**2.40**	**0.866**	<0.250
	6/7/2019	**2.94**	<0.25	<0.25
MW-6	11/7/2017	**0.608**	**0.35**	<0.10
	7/1/2018	**4.17**	<0.10	<0.10
	9/25/2018	**4.30**	<0.250	<0.250
	3/20/2019	**5.17**	**0.738**	<0.250
	6/5/2019	**0.964**	**0.883**	<0.25
	9/27/2019	**6.36**	<0.25	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MW-7	2/6/2007	**3.00**	**60.7**	< 0.100
	6/10/2008	**4.89**	**67.5**	**0.1**
	3/23/2009	**11**	**56**	<0.10
	3/16/2010	**2.4**	**99**	<0.50
	6/7/2011	--	**140**	<0.10
	12/9/2011	--	<0.50	<0.10
	11/7/2017	**9.09**	<0.10	<0.10
	3/21/2018	**13.4**	<0.10	<0.10
	3/21/2018 DUP	**16.9**	<0.10	<0.10
	6/29/2018	**7.9**	**10.8**	0.10
	9/27/2018	**16.7**	<0.250	<0.250
	12/7/2018	**22.4**	**13.3**	<0.250
	12/7/2018 DUP	**22.1**	**13.5**	<0.250
	3/20/2019	**34.5**	**13.1**	<0.250
	3/20/2019 DUP	**33.7**	**13.4**	<0.250
	6/5/2019	**16.6**	**30.4**	<0.25
	6/5/2019 DUP	**17.0**	**30.3**	<0.25
	9/26/2019	**19.8**	**11.5**	<0.25
	9/26/2019 DUP	**20.3**	**11.5**	<0.25
MW-8	6/10/2008	<0.0500	**167**	<0.1
	11/6/2017	<0.050	**207**	<0.10
	3/19/2018	<0.40	**284**	<0.10
	6/29/2018	<0.050	**333**	<0.10
	9/25/2018	<0.0200	**235**	<0.250
	12/7/2018	**0.0230**	**260**	<0.250
	3/22/2019	**0.0350**	**544**	<0.250
	6/3/2019	<0.0200	**176**	<0.25
MW-9	9/21/2010	**1.4**	**89**	<0.10
	11/9/2017	**17.4**	**559**	<0.10
	3/21/2018	<0.050	**230**	<0.10
	6/29/2018	**14.2**	**382**	**0.61**
	9/27/2018	**17.0**	**468**	<0.250
	12/7/2018	**5.60**	**311**	<0.250
	3/20/2019	**0.198**	**173**	<0.250
	6/7/2019	**0.022**	**125**	<0.25
	9/26/2019	**0.68**	**138**	<0.25
MW-10	11/6/2017	**35.6**	**333**	**0.270**
	6/29/2018	**29.0**	**486**	<0.10
	9/25/2018	**37.2**	**413**	<0.250
	9/25/2018 DUP	**38.0**	**412**	<0.250
	3/21/2019	**45.0**	**412**	<0.250
	6/6/2019	**36.5**	**363**	**0.463**
	9/25/2019	**37.3**	**429**	<0.5

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MW-12	10/19/2010	--	**59**	--
	6/7/2011	--	**1.1**	<0.10
	12/7/2011	--	**67**	<0.10
	9/22/2015	**110**	**47**	--
	11/9/2017	**55.4**	**0.57**	<0.25
	3/20/2018	**39.4**	<0.10	<0.10
	3/20/2018 DUP	**39.9**	<0.10	<0.10
	7/1/2018	**33.0**	<0.10	<0.10
	9/25/2018	**126**	<0.250	<0.250
	9/25/2018 DUP	**129**	<0.250	<0.250
	12/4/2018	**37.2**	**82.2**	**0.487**
	12/4/2018 DUP	**37.1**	**80.0**	**0.526**
	3/20/2019	**53.2**	<0.250	<0.250
	3/20/2019 DUP	**48.2**	<0.250	<0.250
	6/5/2019	**19.8**	**2.34**	<0.250
	6/5/2019 DUP	**22.4**	**2.32**	<0.250
	9/26/2019	**107**	**0.371**	<0.25
	9/26/2019 DUP	**122**	**0.383**	<0.25
MW-13	9/22/2015	**48**	**135**	--
	11/7/2017	**35.0**	**0.52**	<0.10
	3/20/2018	**191**	<0.10	<0.10
	7/1/2018	**23.5**	<0.10	<0.10
	9/25/2018	**37.7**	<0.250	<0.250
	12/5/2018	**49.8**	<0.250	<0.250
	3/19/2019	**110**	<0.250	<0.250
	6/6/2019	**78.5**	<0.25	<0.25
	9/26/2019	**76.2**	<0.25	<0.25
MW-14	11/8/2017	**34.7**	**50.3**	<1.0
	3/20/2018	**50.7**	**17.1**	<0.10
	6/28/2018	**31.6**	**104**	<2.5
	9/26/2018	**41.0**	**150**	<0.250
	12/5/2018	**53.7**	**75.5**	<0.250
	3/19/2019	**190**	**51.3**	<0.250
	6/6/2019	**33.9**	**28.6**	**0.958**
	9/25/2019	**29.6**	**145**	<0.25
MW-15	11/6/2017	<0.050	**9.78**	<0.10
	7/2/2018	<0.050	**6.06**	<0.10
	6/6/2019	<0.0200	**2.42**	<0.25
MW-16	11/6/2017	<0.050	**9.95**	<0.10
	3/19/2018	<0.40	**15.7**	<0.10
	7/2/2018	<0.050	**19.4**	<0.10
	9/25/2018	<0.0200	**6.10**	<0.250
	12/6/2018	<0.0200	**10.2**	<0.250
	3/22/2019	**5.31**	**7.90**	<0.250
	6/4/2019	<0.0200	**8.58**	<0.25
	9/25/2019	<0.02	**7.15**	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MW-17	11/8/2017	**0.634**	**43.4**	<1.0
	6/28/2018	<0.050	**7.84**	<0.10
	9/26/2018	**2.13**	**0.760**	<0.250
	3/19/2019	**5.77**	**25.3**	<0.250
	6/6/2019	**0.119**	**24.7**	<0.25
	9/26/2019	**2.12**	**1.1**	<0.25
MW-18i	6/10/2008	<0.0500	**0.35**	<0.1
	11/7/2017	<0.050	**1.07**	<0.10
	3/21/2018	<0.050	**0.75**	<0.10
	7/2/2018	<0.050	**1.13**	<0.10
	9/27/2018	<0.0200	**1.00**	<0.250
	12/6/2018	<0.0200	**0.715**	<0.250
	3/21/2019	<0.0200	**0.509**	<0.250
	6/3/2019	<0.0200	**0.755**	<0.25
	9/25/2019	<0.02	**0.831**	<0.25
MW-19	10/19/2010	--	**19**	--
	9/22/2015	46	**135**	--
	11/9/2017	**80**	**41**	<1.0
	3/21/2018	**150**	**47.8**	<0.10
	3/21/2018 DUP	**152**	**46.5**	<0.10
	6/28/2018	**194**	<0.10	<0.10
	9/25/2018	**122**	**120**	<0.250
	9/25/2018 DUP	**125**	**121**	<0.250
	12/5/2018	**188**	**118**	<0.250
	12/5/2018 DUP	**188**	**119**	<0.250
	3/20/2019	**242**	**195**	<0.250
	3/20/2019 DUP	**192**	**191**	<0.250
	6/7/2019	**145**	**34.8**	**1.06**
	9/26/2019	**113**	**232**	<0.25
	9/26/2019 DUP	**119**	**233**	<0.25
MW-19i	11/8/2017	**0.236**	<0.10	<0.10
	3/20/2018	<0.40	<0.10	<0.10
	7/2/2018	**0.158**	<0.10	<0.10
	9/27/2018	**0.213**	<0.250	<0.250
	12/6/2018	**0.240**	<0.250	<0.250
	3/25/2019	**0.212**	<0.250	<0.250
	6/3/2019	**0.178**	<0.25	<0.25
MW-20i	11/7/2017	**0.125**	**0.28**	<0.10
	3/21/2018	**1.01**	**1.06**	<0.10
	7/2/2018	**0.115**	**0.37**	<0.10
	9/25/2018	**0.244**	**1.11**	<0.250
	12/6/2018	<0.0200	<0.250	<0.250
	3/22/2019	**0.0270**	**0.261**	<0.250
	6/3/2019	**0.353**	**1.77**	<0.25
	9/25/2019	<0.02	**0.617**	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MW-21i-40	6/10/2008	**0.0594**	<0.100	<0.100
	11/8/2017	<0.050	**1.90**	<1.0
	3/22/2018	**0.071**	**1.70**	<0.10
	6/29/2018	<0.050	**5.12**	<1.0
	9/27/2018	<0.0200	**3.61**	<0.250
	12/6/2018	<0.0200	**3.16**	<0.250
	3/21/2019	**0.0360**	**3.41**	<0.250
	6/3/2019	<0.0200	**1.49**	<0.25
	9/25/2019	<0.02	**3.49**	<0.25
MW-21i-105	6/10/2008	**0.0645**	<0.100	<0.100
	11/8/2017	<0.050	**1.6**	<1.0
	3/22/2018	**13.0**	**15.8**	**0.10**
	6/29/2018	**12.3**	**13.1**	<0.10
	9/26/2018	**0.409**	**0.759**	<0.250
	12/6/2018	**3.05**	**5.29**	<0.250
	3/21/2019	**49.6**	**0.755**	<0.250
	6/6/2019	**45.7**	**7.57**	**1.25**
	9/25/2019	**28.3**	**4.46**	**1.81**
MW-22i	11/7/2017	**0.354**	<1.0	<1.0
	3/22/2018	**1.25**	**0.63**	<0.10
	6/29/2018	**0.469**	<1.0	<1.0
	9/26/2018	**0.369**	<0.250	<0.250
	12/5/2018	**0.378**	<0.250	<0.250
	3/21/2019	**0.448**	<0.250	<0.250
	6/6/2019	**0.329**	<0.25	<0.25
	9/25/2019	**0.339**	<0.25	<0.25
MW-23i	6/10/2008	<0.0500	**0.440**	<0.100
	11/8/2017	<0.050	**0.78**	<0.10
	3/21/2018	<0.050	**0.72**	<0.10
	6/28/2018	<0.050	**0.53**	<0.10
	9/27/2018	<0.0200	**1.04**	<0.250
	12/6/2018	<0.0200	**0.520**	<0.250
	3/22/2019	<0.0200	**0.592**	<0.250
	6/3/2019	<0.0200	**0.604**	<0.25
MW-24i	6/7/2011	--	**0.50**	<0.10
	12/7/2011	--	**1.6**	<0.10
	11/9/2017	<0.050	**3.09**	<0.10
	3/21/2018	**0.687**	**7.36**	<0.10
	6/28/2018	<0.050	**2.37**	<0.050
	9/27/2018	<0.0200	**7.56**	<0.250
	12/4/2018	**0.0670**	**2.97**	<0.250
	3/25/2019	**0.0200**	**4.07**	<0.250
	6/7/2019	<0.0200	**2.19**	<0.25
	9/27/2019	**0.116**	<0.25	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MW-24d	11/6/2017	**0.153**	<0.10	<0.10
	3/20/2018	<0.40	<0.10	<0.10
	6/27/2018	**0.160**	<0.10	<0.050
	9/28/2018	**0.145**	<0.250	<0.250
	12/10/2018	**0.993**	<0.250	<0.250
	3/25/2019	**0.147**	<0.250	<0.250
	6/4/2019	**0.131**	<0.25	<0.25
	9/27/2019	**0.05**	**3.76**	<0.25
MW-25i	11/8/2017	**0.138**	**0.53**	<0.25
	3/21/2018	<0.050	**0.40**	<0.10
	6/29/2018	<0.050	**0.27**	<0.10
	9/27/2018	<0.0200	**0.775**	<0.250
	12/6/2018	<0.0200	**0.541**	<0.250
	3/22/2019	**0.0250**	**0.0389**	<0.250
	6/3/2019	<0.0200	**0.383**	<0.25
	9/25/2019	<0.02	**0.71**	<0.25
MW-26	11/8/2017	**34.1**	**101**	<2.5
	3/20/2018	**30.0**	**271**	<0.25
	6/29/2018	**22.4**	**213**	<0.10
	9/24/2018	**30.2**	**212**	<0.250
	12/5/2018	**35.3**	**152**	<0.250
	3/22/2019	**60.6**	**544**	<0.250
	6/3/2019	**41.3**	**476**	<0.25
	9/26/2019	**32.4**	**383**	<0.5
MW-32i	11/10/2017	<0.050	**1.33**	<0.10
MW-32s	11/10/2017	**0.235**	**0.58**	<0.10
	3/22/2018	<0.050	**0.16**	<0.10
	10/1/2018	<0.0200	<0.250	<0.250
	12/10/2018	**0.0690**	**1.81**	<0.250
	3/25/2019	<0.0200	<0.250	<0.250
	9/26/2019	**0.063**	<0.25	<0.25
EW-1	11/9/2017	<0.050	**0.50**	<0.10
	7/1/2018	<0.050	**2.91**	<0.10
	9/27/2018	<0.0200	**0.686**	<0.250
	3/25/2019	<0.0200	**3.69**	<0.250
	6/4/2019	<0.0200	**3.42**	<0.25
S-1	11/8/2017	**7.13**	**4.14**	<0.10
	3/20/2018	**35.5**	**11.4**	**0.24**
	6/28/2018	<1.3	**3.02**	<0.10
	9/26/2018	**0.259**	**3.03**	<0.250
	12/5/2018	<0.0200	**2.16**	<0.250
	3/19/2019	**0.846**	**3.35**	<0.250
	6/5/2019	**0.141**	**1.95**	<0.250
	9/25/2019	**<0.02**	**3.72**	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
S-2	11/8/2017	**5.64**	**1.05**	<0.10
	3/20/2018	**6.1**	**1.25**	<0.10
	6/28/2018	**8.05**	**3.28**	**0.054**
	9/26/2018	**7.55**	**5.93**	<0.250
	12/5/2018	**7.76**	<0.250	<0.250
	3/19/2019	**25.6**	**3.23**	**0.259**
	6/5/2019	**6.06**	<0.250	<0.250
	9/25/2019	**0.691**	**1.77**	<0.25
MGMS1-3(43)	10/19/2010	--	**390**	--
	11/7/2017	**217**	**120**	<1.0
	3/22/2018	**214**	<0.10	<0.10
	7/1/2018	**198**	<0.10	<0.10
	9/28/2018	**240**	**75.8**	<0.250
	12/4/2018	**246**	**30.6**	<0.250
	3/26/2019	**238**	**13.5**	<0.250
	6/7/2019	**209**	<0.25	<0.25
	9/27/2019	**233**	**84.1**	<0.25
MGMS1-2(60)	11/7/2017	<0.050	**1.91**	<0.10
	3/22/2018	**0.054**	**3.18**	<0.10
	7/1/2018	<0.050	**1.83**	<0.10
	10/1/2018	<0.0200	**3.65**	<0.250
	12/4/2018	**0.104**	**0.697**	<0.250
	3/26/2019	<0.0200	**1.39**	<0.250
	6/7/2019	<0.02	**1.08**	<0.25
	9/27/2019	<0.02	2.58	<0.25
MGMS1-1(110)	11/7/2017	**0.822**	**0.73**	<0.10
	7/1/2018	**0.134**	**0.11**	<0.10
	10/1/2018	**0.595**	**0.898**	<0.250
	6/7/2019	**0.179**	**0.533**	<0.250
MGMS2-4(40)	9/21/2010	**130**	**560**	<0.10
	6/7/2011	--	**200**	<0.10
	12/7/2011	--	**8.0**	<0.10
	11/9/2017	**87.1**	<0.10	<0.10
	3/22/2018	**84.2**	<0.10	<0.10
	7/1/2018	**83.6**	**0.76**	<0.10
	9/28/2018	**85.2**	**9.38**	<0.250
	12/10/2018	**80.7**	<0.250	<0.250
	3/25/2019	**85.2**	<0.250	<0.250
	6/4/2019	**78.7**	<0.25	<0.25
	9/27/2019	**78.9**	**1.34**	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MGMS2-3(60)	11/9/2017	**1.03**	**0.12**	<0.10
	3/22/2018	**0.153**	**0.68**	<0.10
	7/1/2018	<0.050	**0.77**	<0.10
	12/10/2018	**1.39**	<0.250	<0.250
	3/25/2019	**0.407**	<0.250	<0.250
	6/4/2019	<0.0200	**0.852**	<0.25
	9/27/2019	**0.719**	<0.25	<0.25
MGMS2-2(110)	11/9/2017	<0.050	**0.37**	<0.10
	7/1/2018	**0.050**	**0.28**	<0.10
	9/28/2018	<0.0200	**0.412**	<0.250
	6/4/2019	<0.0200	**0.402**	<0.25
MGMS2-1(132)	11/9/2017	<0.050	<0.10	<0.10
	7/1/2018	<0.050	<0.10	<0.10
	9/28/2018	**0.0500**	<0.250	<0.250
	6/4/2019	<0.0200	<0.25	<0.25
MGMS3-4(40)	9/22/2015	**1.1**	**<.10**	--
	11/10/2017	**1.71**	<0.10	<0.10
	3/22/2018	**1.55**	<0.10	<0.10
	7/1/2018	**0.971**	<0.10	<0.10
	9/28/2018	**1.71**	<0.250	<0.250
	9/28/2018 DUP	**1.68**	<0.250	<0.250
	12/10/2018	**1.04**	<0.250	<0.250
	3/26/2019	**2.67**	<0.250	<0.250
	6/3/2019	**1.31**	<0.25	<0.25
	6/3/2019 DUP	**1.32**	<0.25	<0.25
	6/3/2019 DUP	**1.32**	<0.25	<0.25
	9/27/2019	**1.14**	<0.25	<0.25
	9/27/2019 DUP	**1.26**	<0.25	<0.25
MGMS3-3(60)	11/10/2017	<0.050	<0.10	<0.10
	3/22/2018	**0.272**	**0.39**	<0.10
	7/1/2018	**0.100**	**0.29**	<0.10
	9/28/2018	<0.0200	**0.393**	<0.250
	12/10/2018	<0.0200	<0.250	<0.250
	3/26/2019	<0.0200	**0.495**	<0.250
	6/3/2019	<0.0200	**0.371**	<0.25
	9/27/2019	<0.02	<0.25	<0.25
MGMS3-2(110)	11/10/2017	<0.050	**0.48**	<0.10
	7/1/2018	<0.050	**0.43**	<0.10
	9/28/2018	<0.0200	**0.506**	<0.250
	6/3/2019	<0.0200	**0.467**	<0.25

Please refer to notes at end of table

Table 3
Groundwater Analytical Results - Ammonia, Nitrate, and Nitrite
NuStar Vancouver Facility
Vancouver, Washington

Well Number	Sample Date	Ammonia (as Nitrogen)	Nitrate-Nitrogen	Nitrite-Nitrogen
		Concentrations in mg/L (ppm)		
MGMS3-1(132)	11/10/2017	<0.050	**0.52**	<0.10
	7/1/2018	<0.050	**0.46**	<0.10
	9/28/2018	<0.0200	**0.468**	<0.250
	6/5/2019	<0.0200	**0.560**	<0.250
MP-1	2/6/2007	**42.4**	**247**	**0.18**
	3/23/2009	**35**	**210**	**1.2**
	3/16/2010	**37**	**990**	**0.76**
	6/7/2011	--	**160**	<0.10
	12/9/2011	--	**120**	**0.91**
	11/9/2017	**12.2**	**23.0**	<0.50
	3/21/2018	**7.13**	**37.8**	<0.10
	6/28/2018	**8.71**	**38.2**	<0.10
	9/26/2018	**10.9**	**113**	<0.250
	12/4/2018	**6.01**	**80.8**	<0.250
	3/20/2019	**7.05**	**77.6**	<0.250
	6/7/2019	**8.24**	**61.6**	**0.366**
	9/26/2019	**2.15**	**97.7**	**0.384**
MP-3	6/28/2018	**18.8**	**138**	**0.42**

Notes:

1. Milligrams per liter (mg/L) = parts per million (ppm).
2. **Bold** value represents detected concentration of listed analyte.
3. -- = Not sampled or not analyzed.
4. < = Not detected at or above the specified laboratory method reporting limit (MRL).
5. Ammonia as nitrogen by Method 350.1
6. Nitrate as nitrogen and nitrite as nitrogen by Method 300.0

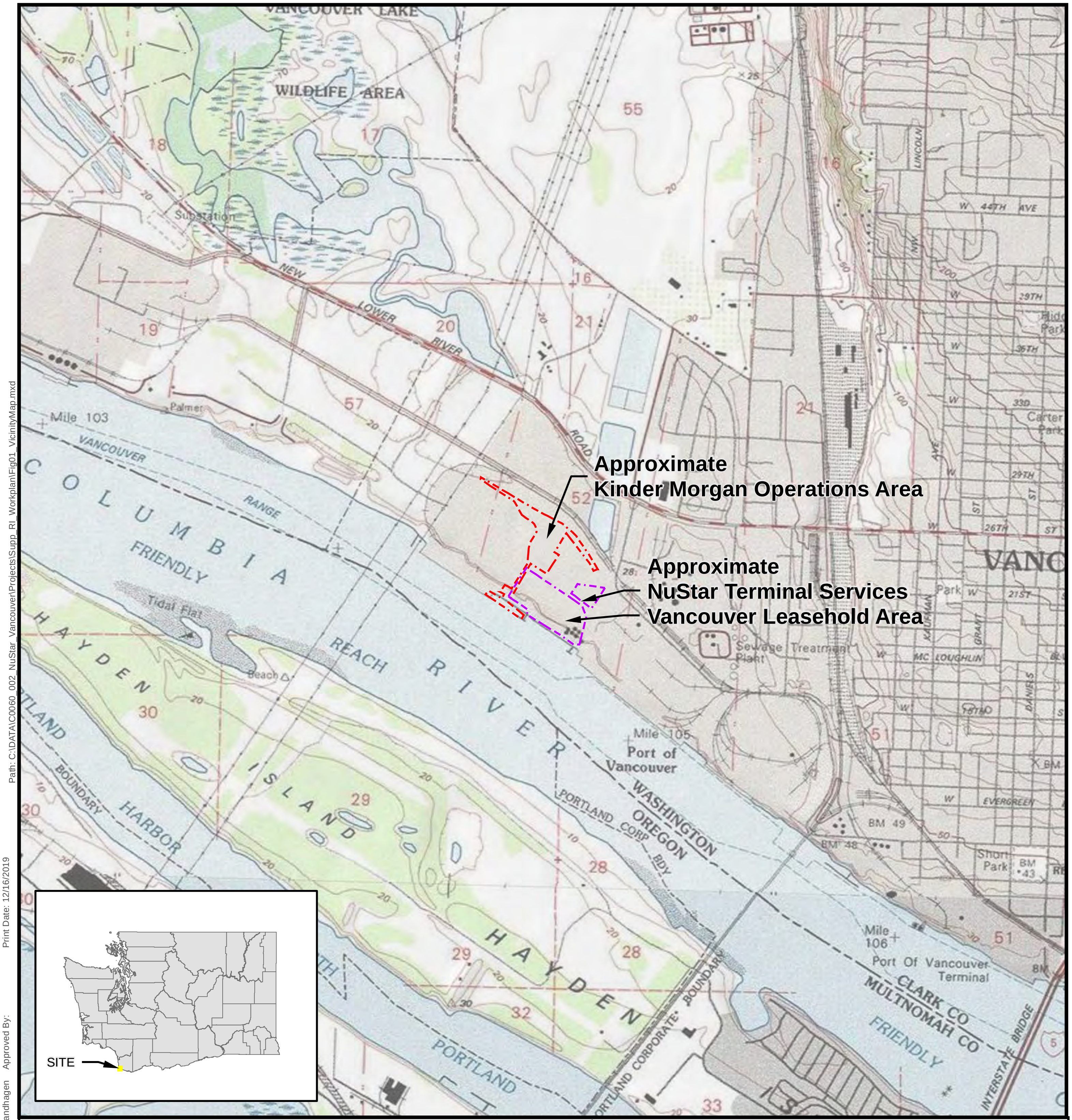
Table 4
Terminal 4 Outfall Analytical Results
Nu Star Vancouver/Port of Vancouver
Vancouver, Washington

Date	Collected By	NO3/NO2 as Nitrogen (mg/L)
7/30/2019	POV	0.396
7/30/2019	DOE	0.393
10/3/2019	POV	0.342
10/16/2019	POV	0.895
10/16/2019	DOE	0.837
10/22/2019	POV	0.777
10/22/2019	DOE	0.669

Notes:

1. POV = Port of Vancouver
2. DOE = Washington State Department of Ecology
3. mg/L - milligrams per liter

FIGURES



Source: USGS Map obtained from Esri ArcGIS Online

0 1,000 2,000
Feet

Project Area Location Map

Supplemental Remedial Investigation Work Plan
Vancouver, Washington

anteagroup
Cascadia Associates, LLC
Parametrix

Figure
1

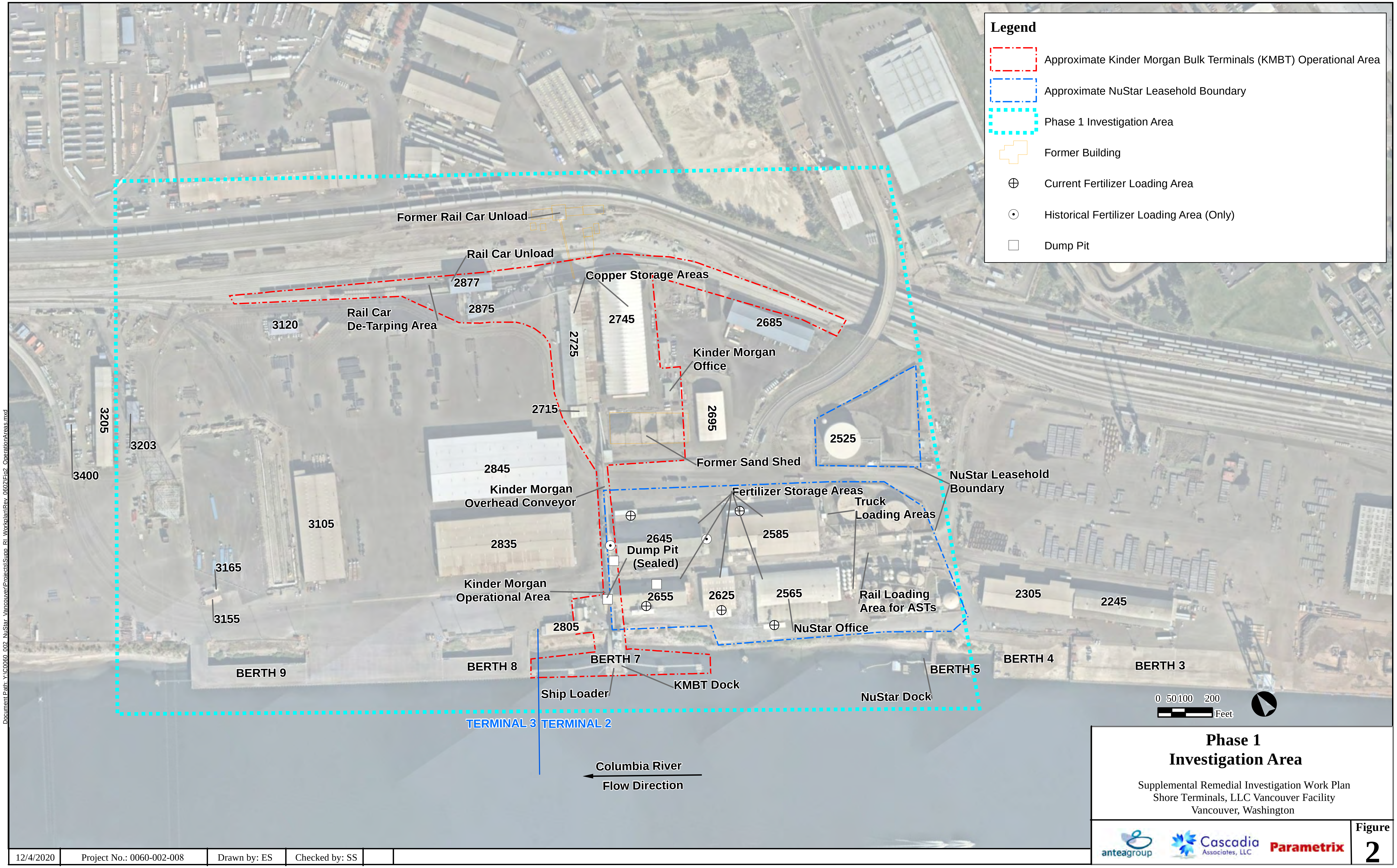
Path: C:\DATA\C0060_002_NuStar_Vancouver\Projects\Supp_RI_Workplan\Fig01_VicinityMap.mxd

Print Date: 12/16/2019

Approved By:

Produced By: ErikStrandhagen

Project: 0060-002-008



Phase 1
Investigation Area

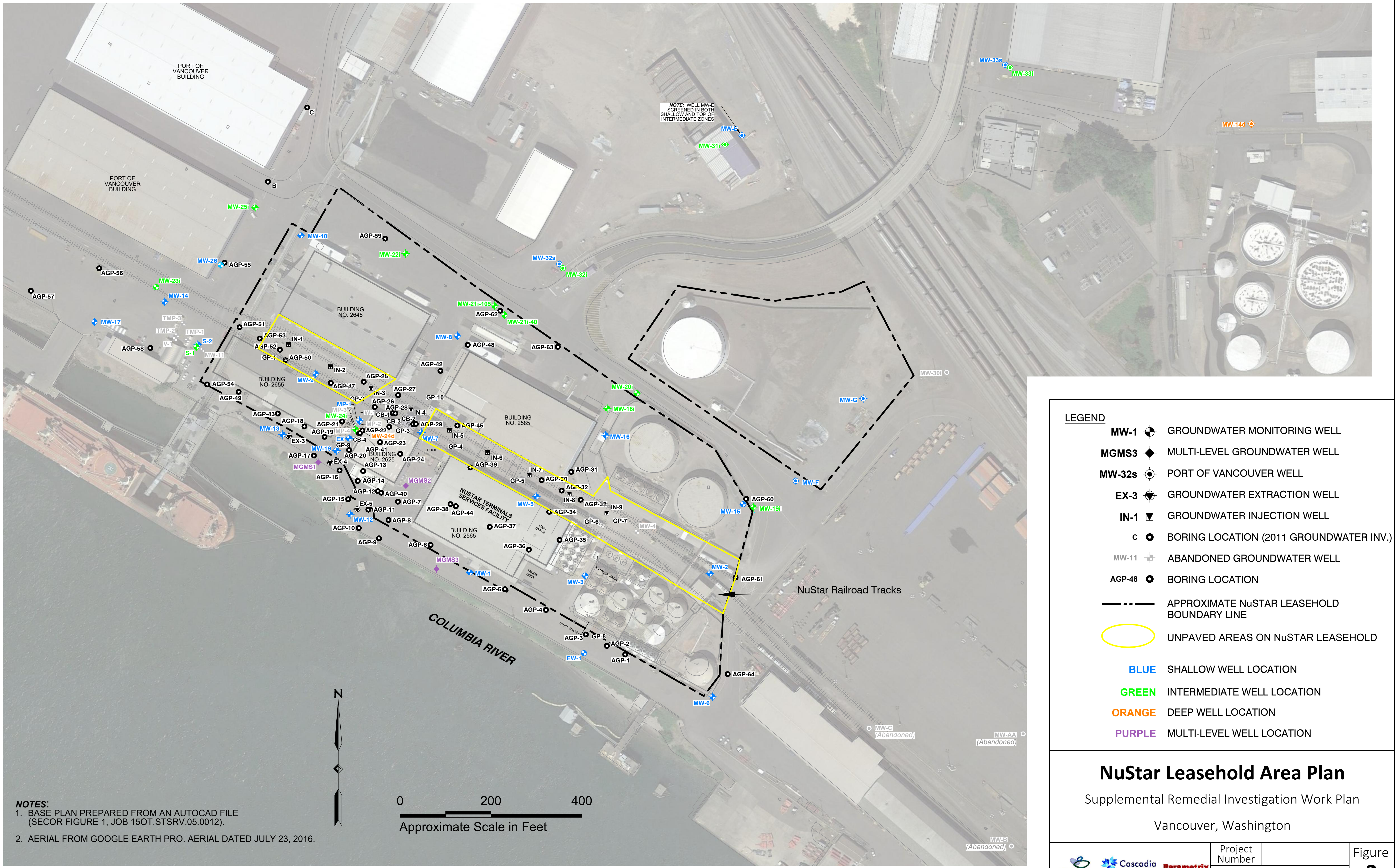
Supplemental Remedial Investigation Work Plan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Figure
2

12/4/2020	Project No.: 0060-002-008	Drawn by: ES	Checked by: SS

Document Path: Y:\C0060 002 NuStar Vancouver\Projects\Supp RI Workplan\Rev 0602\Fig2 OperationAreas.mxd



NOTES:
1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. AERIAL FROM GOOGLE EARTH PRO. AERIAL DATED JULY 23, 2016.

LEGEND

MW-1 ⊕	GROUNDWATER MONITORING WELL
MGMS3 ◆	MULTI-LEVEL GROUNDWATER WELL
MW-32s ⊙	PORT OF VANCOUVER WELL
EX-3 ⊕	GROUNDWATER EXTRACTION WELL
IN-1 ▼	GROUNDWATER INJECTION WELL
C ●	BORING LOCATION (2011 GROUNDWATER INV.)
MW-11 ⊕	ABANDONED GROUNDWATER WELL
AGP-48 ●	BORING LOCATION
— - · —	APPROXIMATE NuSTAR LEASEHOLD BOUNDARY LINE
◯	UNPAVED AREAS ON NuSTAR LEASEHOLD
BLUE	SHALLOW WELL LOCATION
GREEN	INTERMEDIATE WELL LOCATION
ORANGE	DEEP WELL LOCATION
PURPLE	MULTI-LEVEL WELL LOCATION

NuStar Leasehold Area Plan

Supplemental Remedial Investigation Work Plan

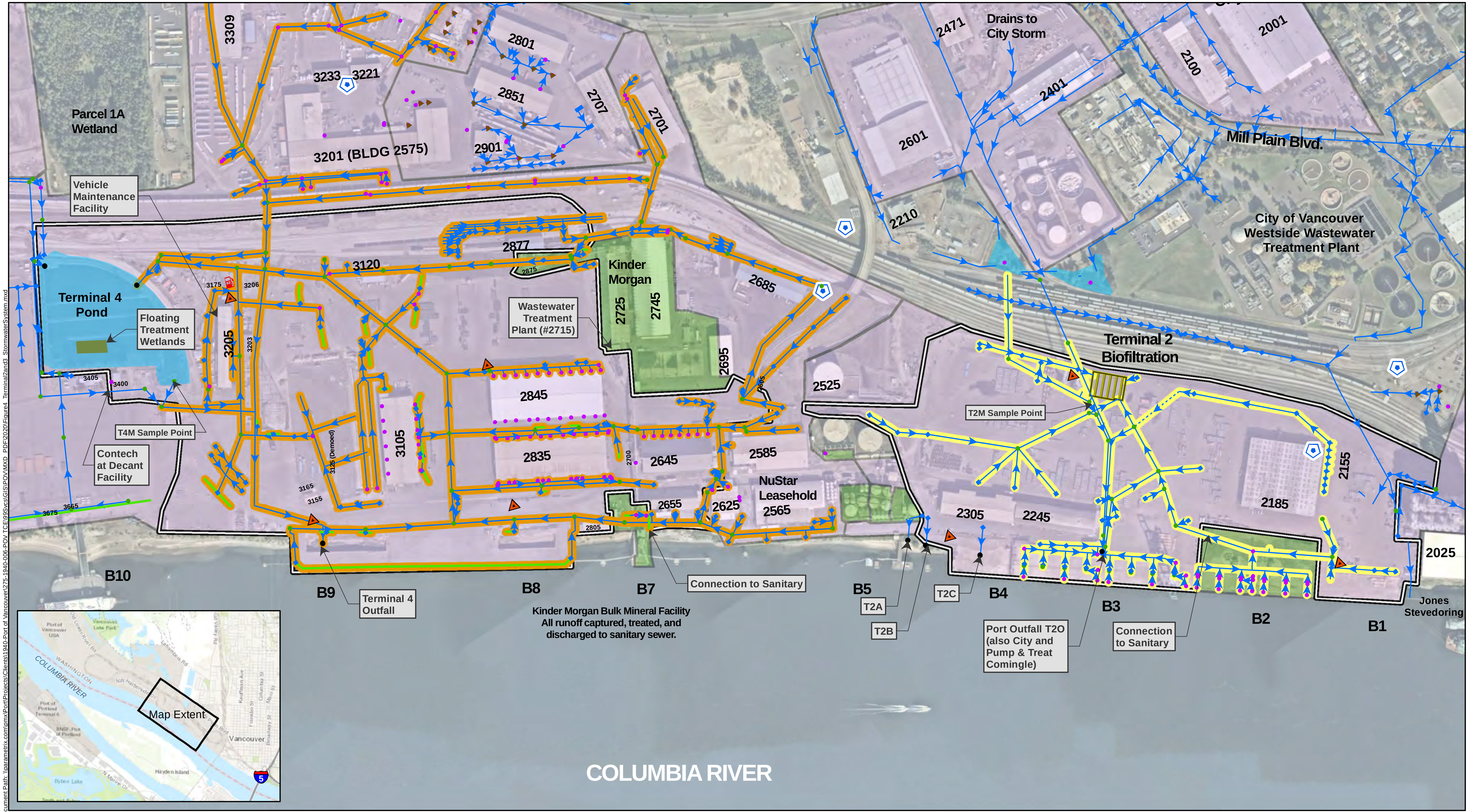
Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Project Number

Figure
3

Document Path: \\parametrix.com\pmx\Port\Projects\Clients\1940-Port of Vancouver\275-1940-006-POV TCE\99Svcs\GIS\POV\MXD_PDF\2020\Figure4_Terminal2and3_StormwaterSystem.mxd



Parametrix

Source: © Mapbox, © OpenStreetMap, Port of Vancouver
All data shown on this map is approximate and should not be relied upon for planning or design at the Port of Vancouver.
This map covers the core of the port's active operating area.
Terminal 1 and other parcels are not mapped.

0 200 400 800 Feet

Fueling Station
Spill Kit
Spill Containment Shed

Stormwater Structures
- ● Other Stormwater Feature
- ■ Stormwater Catch Basin
- ● Stormwater Manhole
- ● Stormwater Outfall
- ▲ UIC

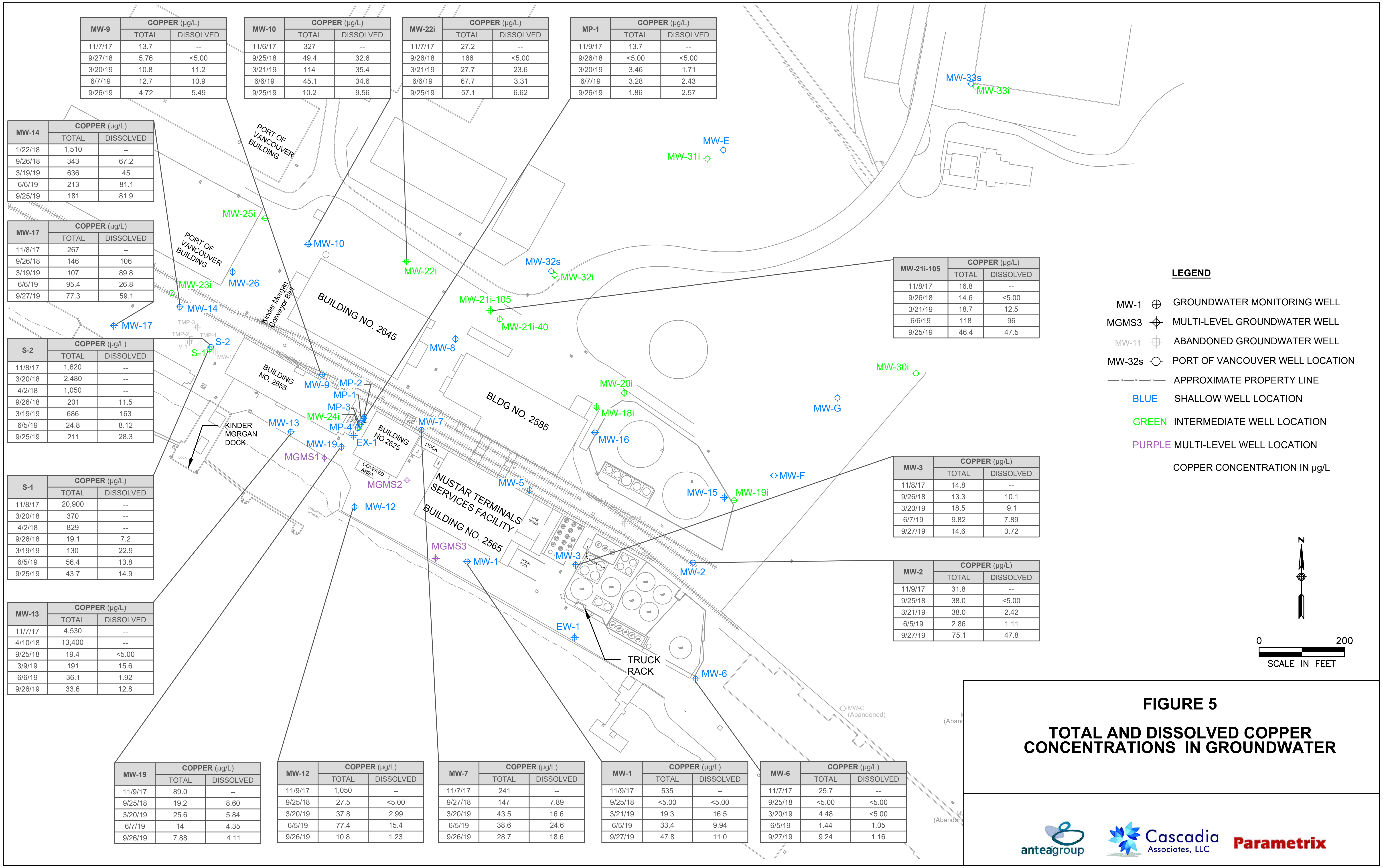
→ Stormwater Pipe, Flow Direction
Trench Drain

Stormwater System
- 🟨 East
- 🟧 West

- ▭ Stormwater Drainage Basin
- 🟩 Sanitary Sewer Drainage Basin
- ▭ PORT ISG, 134 acres
- ▨ Infiltration Area
- 🟦 Ponds

Figure 4.
Terminal 2 and 3 Stormwater System
Supplemental Remedial Investigation Work Plan

Port of Vancouver, WA



MW-9	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/7/17	13.7	--
9/27/18	5.76	<5.00
3/20/19	10.8	11.2
6/7/19	12.7	10.9
9/26/19	4.72	5.49

MW-10	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/6/17	327	--
9/25/18	49.4	32.6
3/21/19	114	35.4
6/6/19	45.1	34.6
9/25/19	10.2	9.56

MW-22i	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/7/17	27.2	--
9/26/18	166	<5.00
3/21/19	27.7	23.6
6/6/19	67.7	3.31
9/25/19	57.1	6.62

MP-1	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/9/17	13.7	--
9/26/18	<5.00	<5.00
3/20/19	3.46	1.71
6/7/19	3.28	2.43
9/26/19	1.86	2.57

MW-14	COPPER (µg/L)	
	TOTAL	DISSOLVED
1/22/18	1,510	--
9/26/18	343	67.2
3/19/19	636	45
6/6/19	213	81.1
9/25/19	181	81.9

MW-17	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/8/17	267	--
9/26/18	146	106
3/19/19	107	89.8
6/6/19	95.4	26.8
9/27/19	77.3	59.1

S-2	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/8/17	1,620	--
3/20/18	2,480	--
4/2/18	1,050	--
9/26/18	201	11.5
3/19/19	686	163
6/5/19	24.8	8.12
9/25/19	211	28.3

S-1	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/8/17	20,900	--
3/20/18	370	--
4/2/18	829	--
9/26/18	19.1	7.2
3/19/19	130	22.9
6/5/19	56.4	13.8
9/25/19	43.7	14.9

MW-13	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/7/17	4,530	--
4/10/18	13,400	--
9/25/18	19.4	<5.00
3/9/19	191	15.6
6/6/19	36.1	1.92
9/26/19	33.6	12.8

MW-21i-105	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/8/17	16.8	--
9/26/18	14.6	<5.00
3/21/19	18.7	12.5
6/6/19	118	96
9/25/19	46.4	47.5

MW-3	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/8/17	14.8	--
9/26/18	13.3	10.1
3/20/19	18.5	9.1
6/7/19	9.82	7.89
9/27/19	14.6	3.72

MW-2	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/9/17	31.8	--
9/25/18	38.0	<5.00
3/21/19	38.0	2.42
6/5/19	2.86	1.11
9/27/19	75.1	47.8

MW-19	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/9/17	89.0	--
9/25/18	19.2	8.60
3/20/19	25.6	5.84
6/7/19	14	4.35
9/26/19	7.88	4.11

MW-12	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/9/17	1,050	--
9/25/18	27.5	<5.00
3/20/19	37.8	2.99
6/5/19	77.4	15.4
9/26/19	10.8	1.23

MW-7	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/7/17	241	--
9/27/18	147	7.89
3/20/19	43.5	16.6
6/5/19	38.6	24.6
9/26/19	28.7	18.6

MW-1	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/9/17	535	--
9/25/18	<5.00	<5.00
3/21/19	19.3	16.5
6/5/19	33.4	9.94
9/27/19	47.8	11.0

MW-6	COPPER (µg/L)	
	TOTAL	DISSOLVED
11/7/17	25.7	--
9/25/18	<5.00	<5.00
3/20/19	4.48	<5.00
6/5/19	1.44	1.05
9/27/19	9.24	1.16

FIGURE 5

TOTAL AND DISSOLVED COPPER CONCENTRATIONS IN GROUNDWATER

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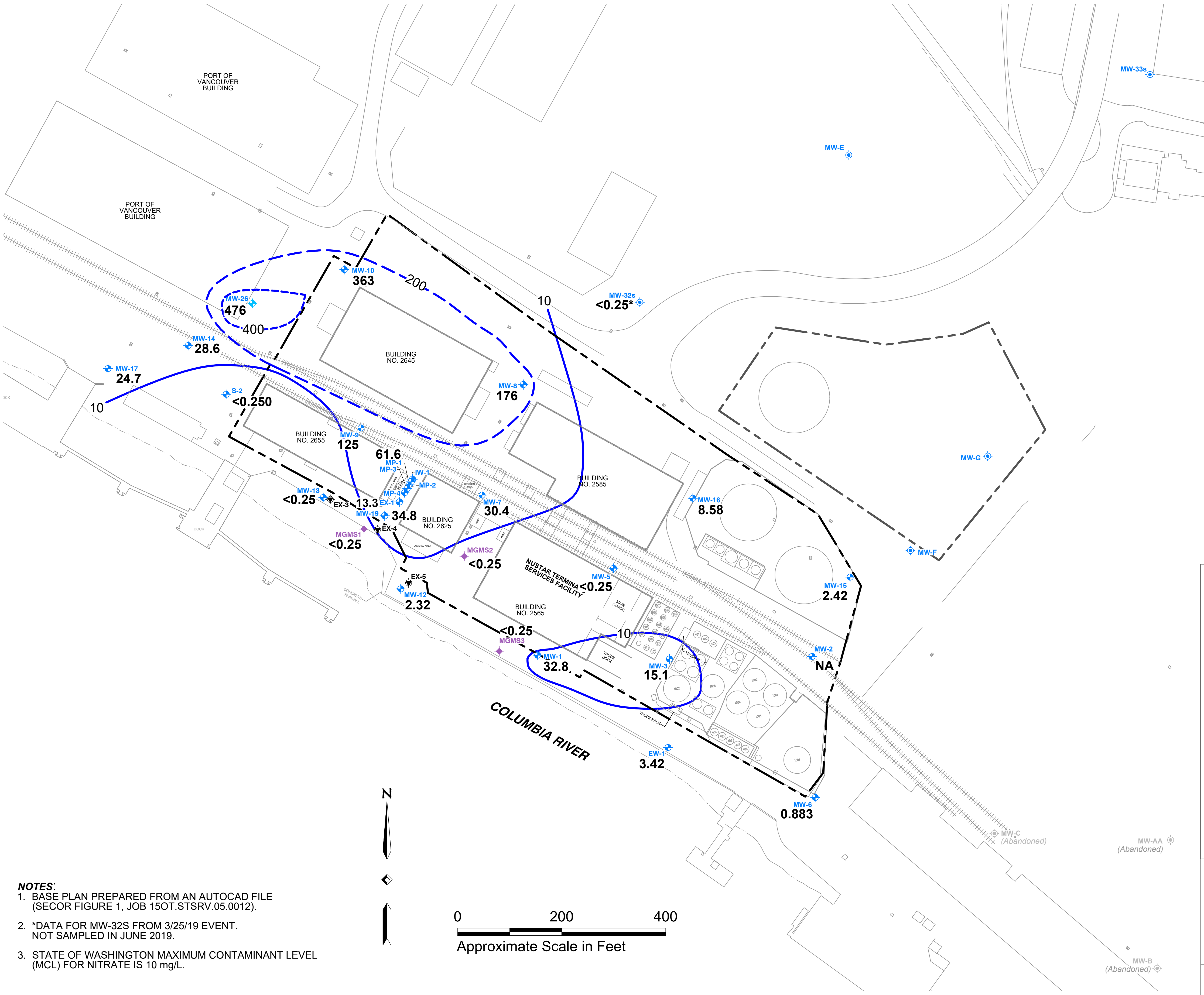
Parametrix



NOTES:
1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. *DATA FOR MW-32S FROM 3/25/19 EVENT. NOT SAMPLED IN JUNE 2019.
3. STATE OF WASHINGTON MAXIMUM CONTAMINANT LEVEL (MCL) FOR NITRATE IS 10 mg/L.

LEGEND

2.42	NITRATE AS NITROGEN CONCENTRATION IN mg/L
10 ——	NITRATE AS NITROGEN CONCENTRATION CONTOUR IN mg/L (DASHED WHERE INFERRED)
NA	NOT AVAILABLE
MW-1 ⊕	GROUNDWATER MONITORING WELL
MGMS3 ✦	MULTI-LEVEL GROUNDWATER WELL
MW-32s ⊙	PORT OF VANCOUVER WELL LOCATION
EX-3 ▼	GROUNDWATER EXTRACTION WELL
—·—·—	APPROXIMATE LEASEHOLD BOUNDARY LINE
BLUE	SHALLOW WELL LOCATION
PURPLE	MULTI-LEVEL WELL LOCATION

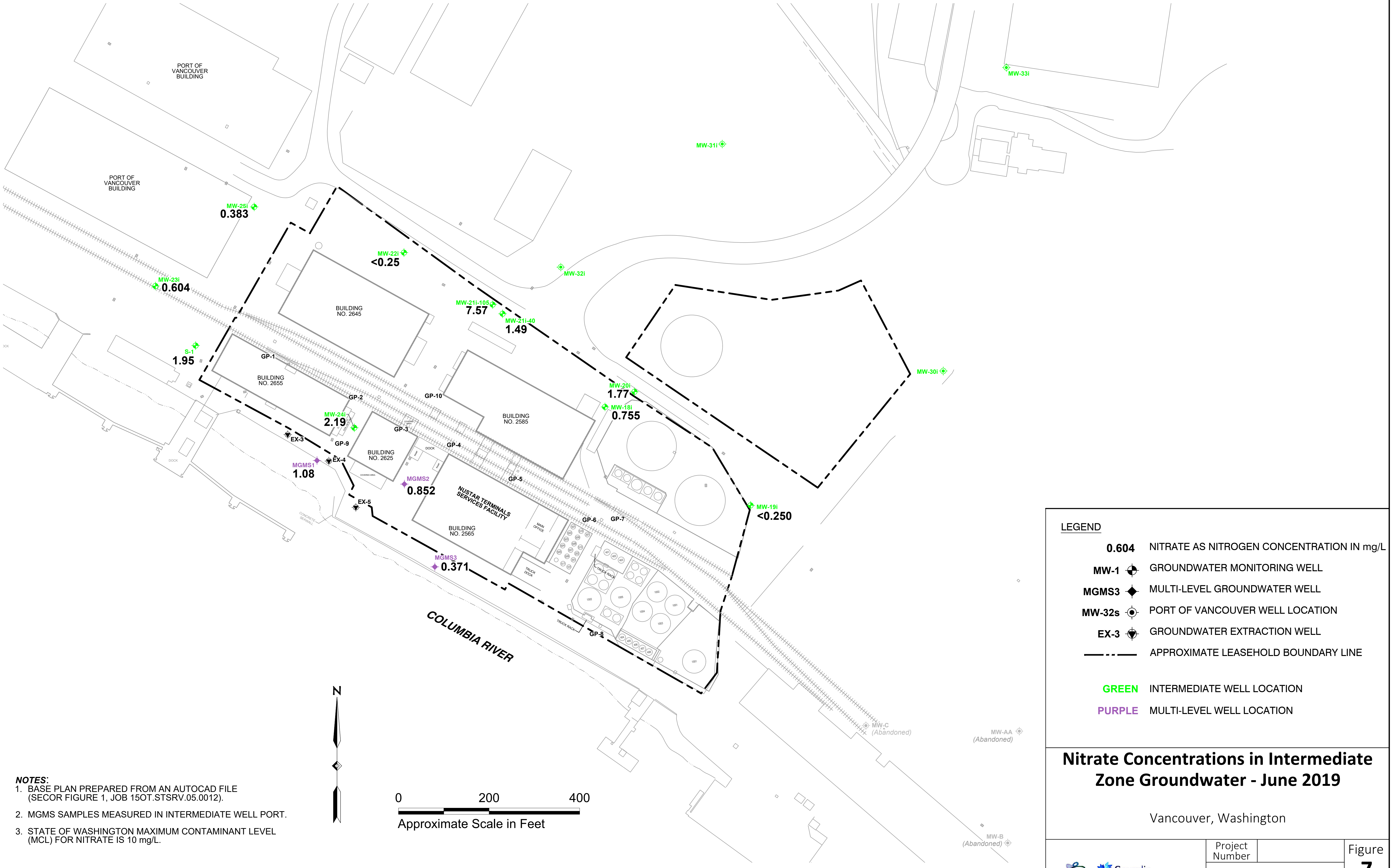
Nitrate Concentrations in Shallow Zone Groundwater - June 2019

Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Project Number

Figure 6



NOTES:
1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. MGMS SAMPLES MEASURED IN INTERMEDIATE WELL PORT.
3. STATE OF WASHINGTON MAXIMUM CONTAMINANT LEVEL (MCL) FOR NITRATE IS 10 mg/L.

LEGEND

0.604	NITRATE AS NITROGEN CONCENTRATION IN mg/L
MW-1 ⌖	GROUNDWATER MONITORING WELL
MGMS3 ◆	MULTI-LEVEL GROUNDWATER WELL
MW-32s ⊙	PORT OF VANCOUVER WELL LOCATION
EX-3 ▼	GROUNDWATER EXTRACTION WELL
—·—·—	APPROXIMATE LEASEHOLD BOUNDARY LINE
GREEN	INTERMEDIATE WELL LOCATION
PURPLE	MULTI-LEVEL WELL LOCATION

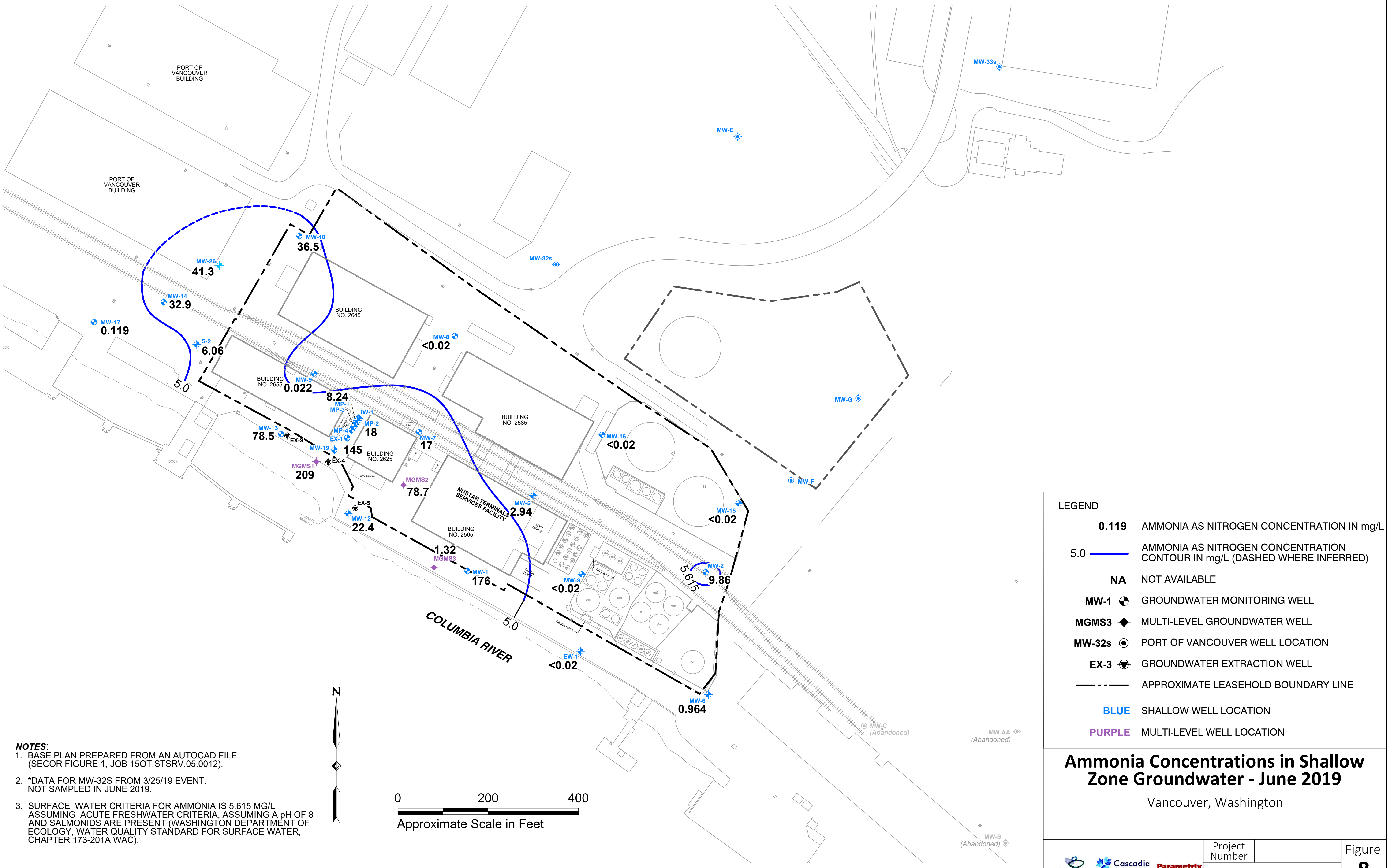
Nitrate Concentrations in Intermediate Zone Groundwater - June 2019

Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Project Number

Figure
7



LEGEND

0.119	AMMONIA AS NITROGEN CONCENTRATION IN mg/L
5.0 ━━	AMMONIA AS NITROGEN CONCENTRATION CONTOUR IN mg/L (DASHED WHERE INFERRED)
NA	NOT AVAILABLE
MW-1 ⊕	GROUNDWATER MONITORING WELL
MGMS3 ◆	MULTI-LEVEL GROUNDWATER WELL
MW-32s ⊙	PORT OF VANCOUVER WELL LOCATION
EX-3 ▼	GROUNDWATER EXTRACTION WELL
—·—·—	APPROXIMATE LEASEHOLD BOUNDARY LINE
BLUE	SHALLOW WELL LOCATION
PURPLE	MULTI-LEVEL WELL LOCATION

NOTES:

1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. *DATA FOR MW-32S FROM 3/25/19 EVENT. NOT SAMPLED IN JUNE 2019.
3. SURFACE WATER CRITERIA FOR AMMONIA IS 5.615 MG/L ASSUMING ACUTE FRESHWATER CRITERIA, ASSUMING A pH OF 8 AND SALMONIDS ARE PRESENT (WASHINGTON DEPARTMENT OF ECOLOGY, WATER QUALITY STANDARD FOR SURFACE WATER, CHAPTER 173-201A WAC).

Ammonia Concentrations in Shallow Zone Groundwater - June 2019

Vancouver, Washington

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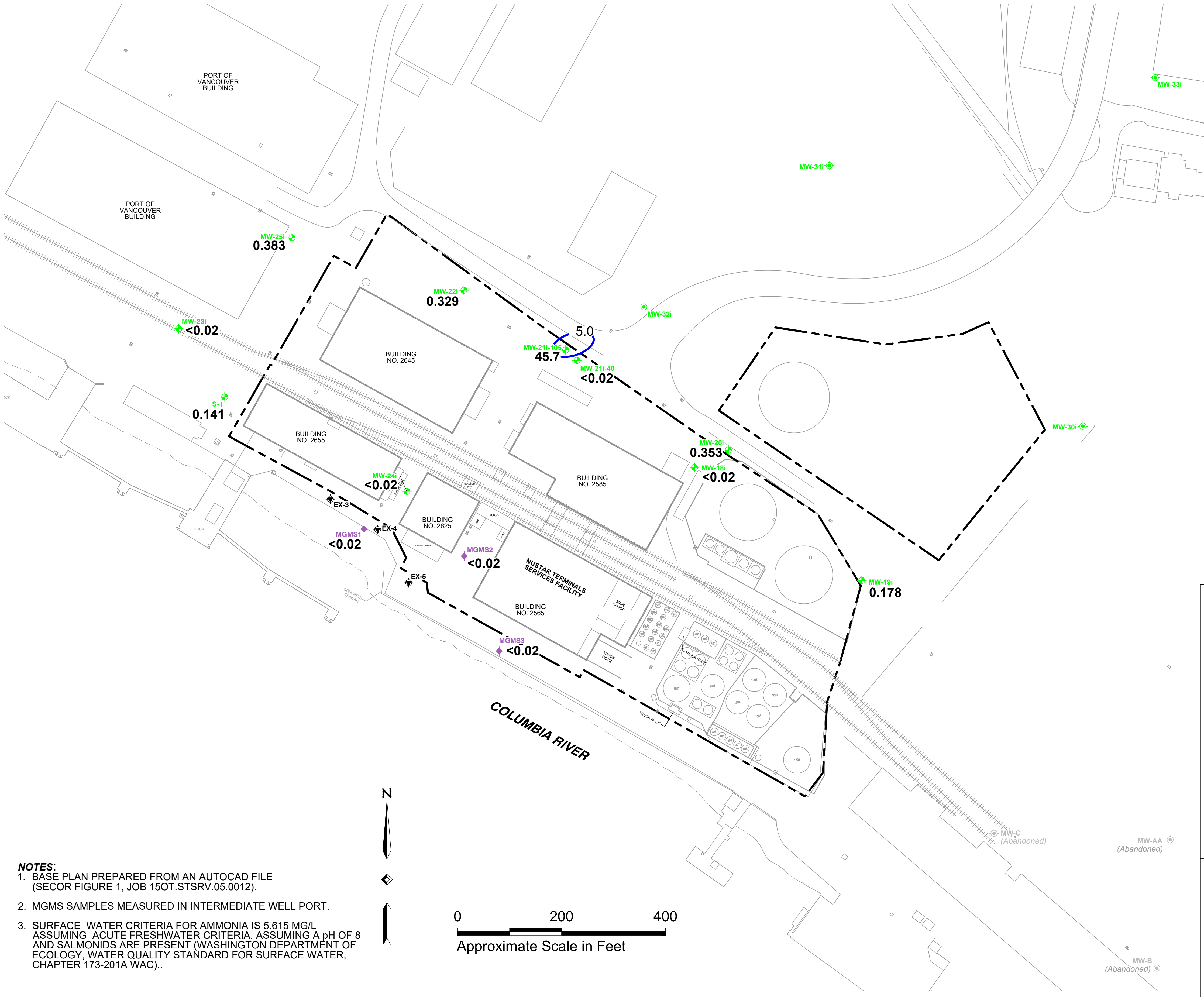
Project Number

Figure
8



NOTES:

1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. MGMS SAMPLES MEASURED IN INTERMEDIATE WELL PORT.
3. SURFACE WATER CRITERIA FOR AMMONIA IS 5.615 MG/L ASSUMING ACUTE FRESHWATER CRITERIA, ASSUMING A pH OF 8 AND SALMONIDS ARE PRESENT (WASHINGTON DEPARTMENT OF ECOLOGY, WATER QUALITY STANDARD FOR SURFACE WATER, CHAPTER 173-201A WAC)..

LEGEND

0.141	AMMONIA AS NITROGEN CONCENTRATION IN mg/L
5.0 ——	AMMONIA AS NITROGEN CONCENTRATION CONTOUR IN mg/L
MW-1 ⊕	GROUNDWATER MONITORING WELL
MGMS3 ◆	MULTI-LEVEL GROUNDWATER WELL
MW-32s ⊙	PORT OF VANCOUVER WELL LOCATION
EX-3 ⊕	GROUNDWATER EXTRACTION WELL
—·—·—	APPROXIMATE LEASEHOLD BOUNDARY LINE
GREEN	INTERMEDIATE WELL LOCATION
PURPLE	MULTI-LEVEL WELL LOCATION

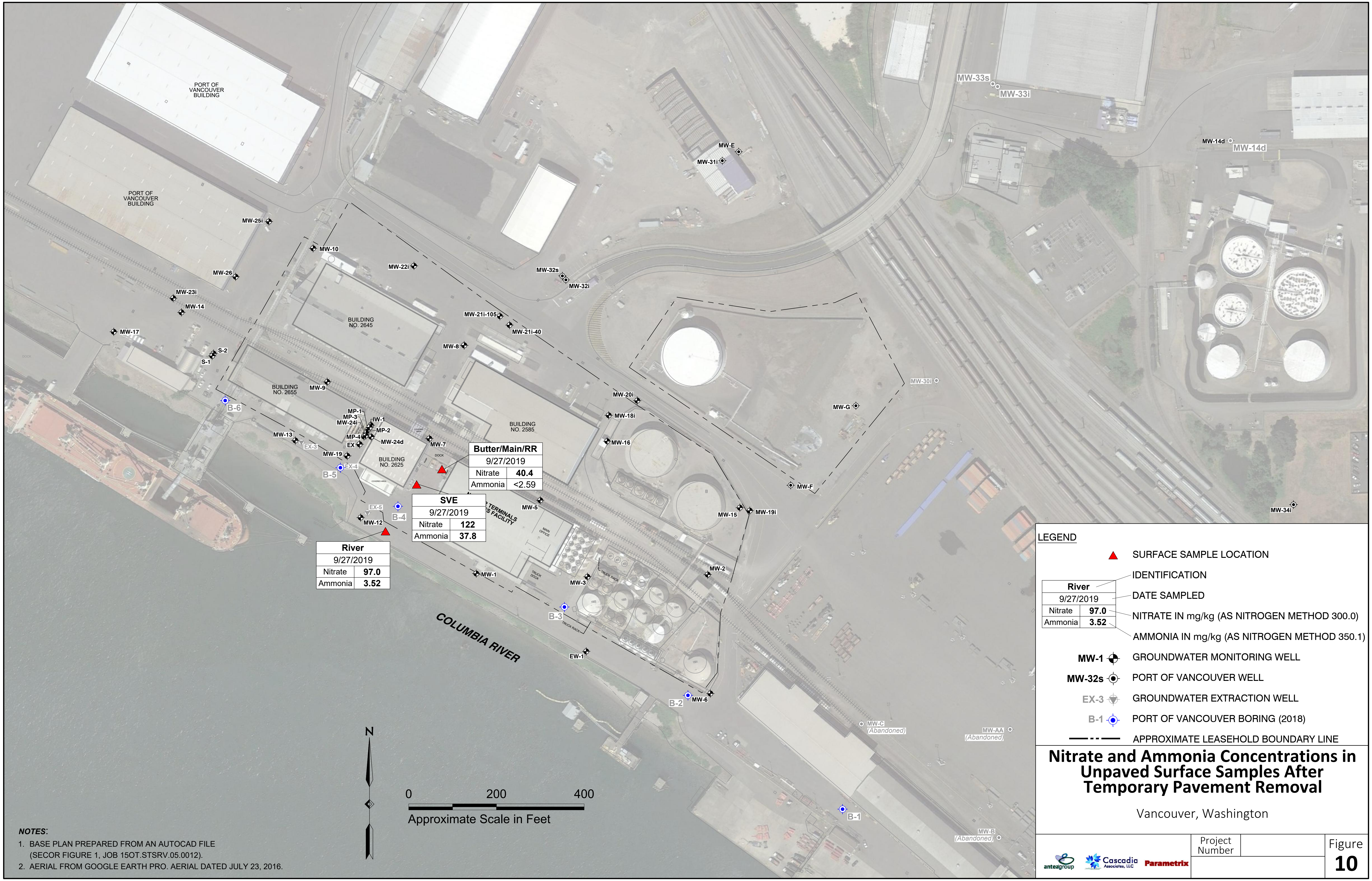
Ammonia Concentrations in Intermediate Zone Groundwater - June 2019

Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Project Number

Figure
9



Butter/Main/RR	
9/27/2019	
Nitrate	**40.4**
Ammonia	<2.59

SVE	
9/27/2019	
Nitrate	**122**
Ammonia	**37.8**

River	
9/27/2019	
Nitrate	**97.0**
Ammonia	**3.52**

LEGEND

🔺 SURFACE SAMPLE LOCATION

River	
9/27/2019	
Nitrate	**97.0**
Ammonia	**3.52**

IDENTIFICATION
DATE SAMPLED
NITRATE IN mg/kg (AS NITROGEN METHOD 300.0)
AMMONIA IN mg/kg (AS NITROGEN METHOD 350.1)

MW-1 GROUNDWATER MONITORING WELL
MW-32s PORT OF VANCOUVER WELL
EX-3 GROUNDWATER EXTRACTION WELL
B-1 PORT OF VANCOUVER BORING (2018)
APPROXIMATE LEASEHOLD BOUNDARY LINE

Nitrate and Ammonia Concentrations in Unpaved Surface Samples After Temporary Pavement Removal

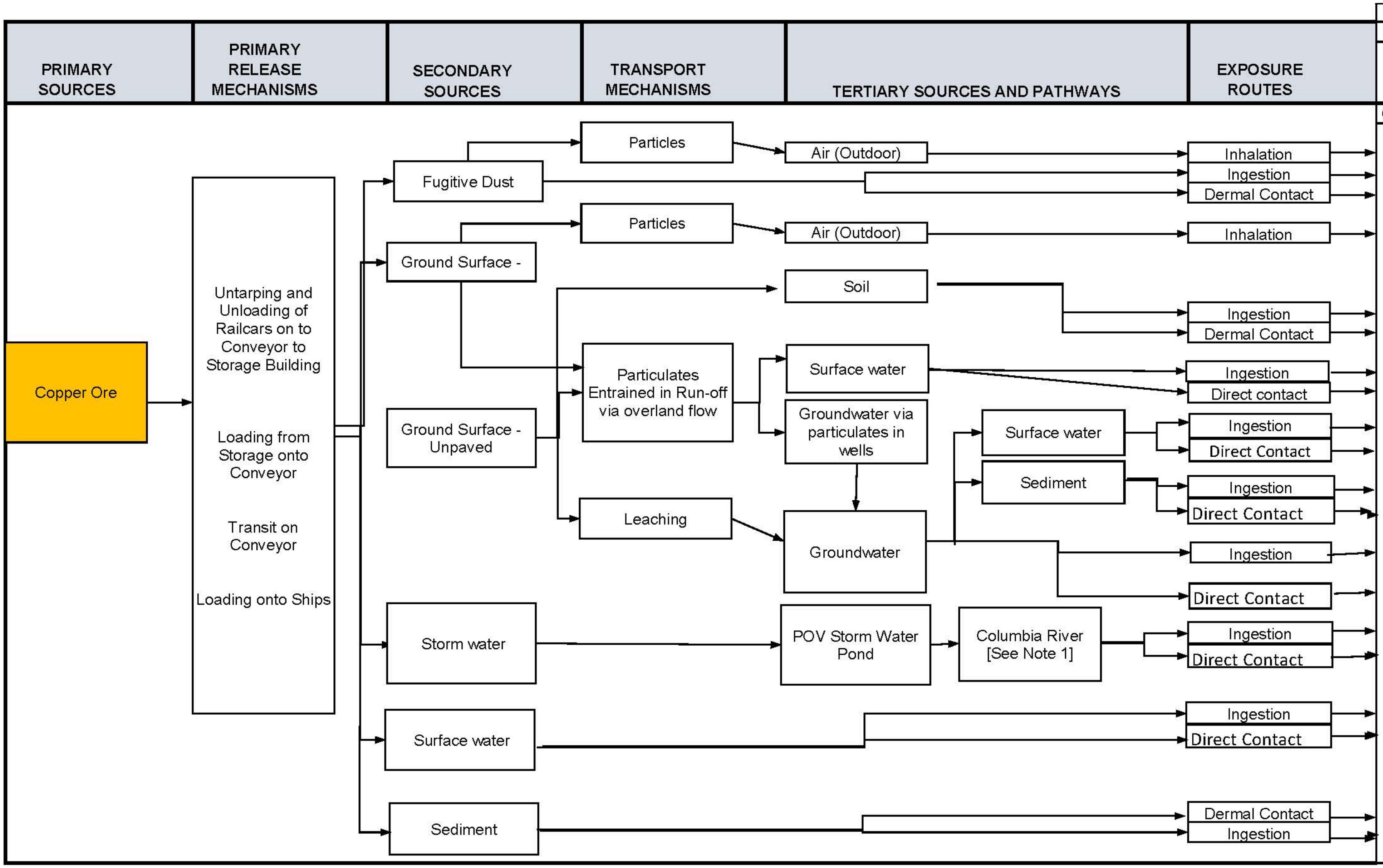
Vancouver, Washington

anteagroup Cascadia Associates, LLC Parametrix

Project Number

Figure
10

NOTES:
1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. AERIAL FROM GOOGLE EARTH PRO. AERIAL DATED JULY 23, 2016.



EXPOSURE ROUTES	POTENTIAL RECEPTORS											
	Ecological				Human							
	Terrestrial		Aquatic		Occupational		Construction & Excavation		Recreational		Tribal Net Fisher (also see Note (2))	
	Current	Future	Current	Future	Current	Future	Current	Future	Current	Future	Current	Future
Inhalation	?	?	--	--	x	x	x	x	I	I	I	I
Ingestion	?	?	x	x	x	x	x	x	I	I	I	I
Dermal Contact	?	?	x	x	x	x	x	x	I	I	I	I
Inhalation	?	?	--	--	x	x	x	x	I	I	I	I
Ingestion	?	?	--	--	x	x	x	x	--	--	--	--
Dermal Contact	?	?	--	--	x	x	x	x	--	--	--	--
Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
Direct contact	--	--	x	x	--	--	--	--	--	--	--	--
Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Ingestion	--	--	--	--	--	--	--	--	--	--	--	--
Direct Contact	--	--	--	--	--	--	x	x	--	--	--	--
Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Ingestion	--	--	x	x	--	--	--	--	I	I	I	I
Direct Contact	--	--	x	x	--	--	--	--	I	I	I	I
Dermal Contact	--	--	x	x	--	--	--	--	I	I	I	I
Ingestion	--	--	x	x	--	--	--	--	I	I	I	I

Note: (1) Port of Vancouver (POV) storm water pond discharges to the Columbia River under an industrial discharge permit.
(2) Metals are not bioaccumulative in fish tissue so fish consumption is not a complete pathway.
-- = Incomplete pathway
X = Potentially complete pathway
? = The Site is an industrial property with no habitat for terrestrial receptors; however, opportunist terrestrial species such as rodents may be present.
I = Potentially complete but insignificant.

Copper Ore CSM

Supplemental Remedial Investigation Workplan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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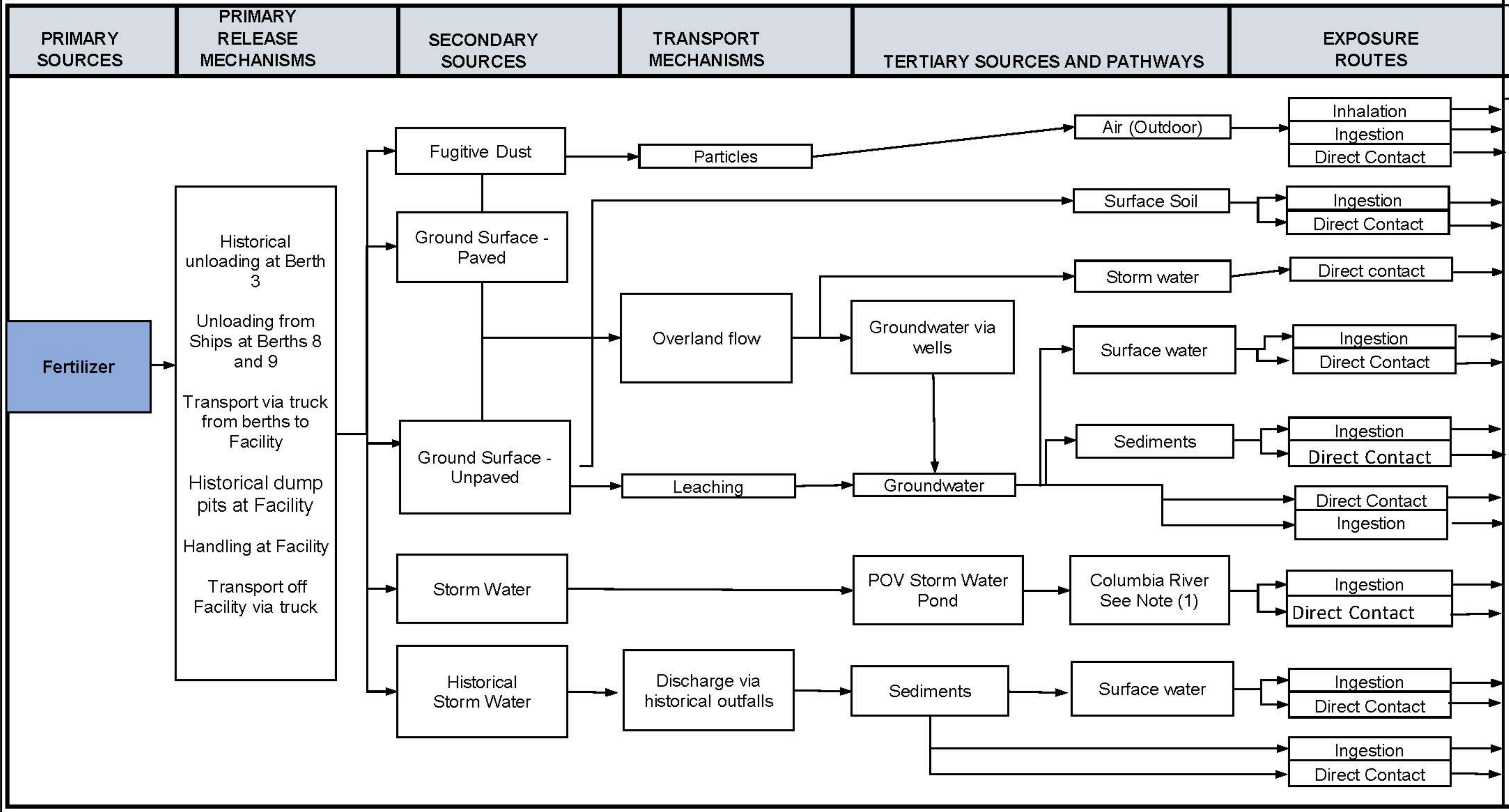
Parametrix

Figure
11

06/05/2020



Tertiary Sources and Pathways	Exposure Routes	POTENTIAL RECEPTORS: Ecological: Terrestrial: Current	Terrestrial: Future	Aquatic: Current	Aquatic: Future	Human: Occupational: Current	Occupational: Future	Construction & Excavation: Current	Construction & Excavation: Future	Recreational: Current	Recreational: Future	Tribal Net Fisher (also see Note (2)): Current	Tribal Net Fisher: Future
Air (Outdoor)	Inhalation	?	?	--	--	x	x	x	x	I	I	I	I
	Ingestion	?	?	x	x	x	x	x	x	I	I	I	I
	Direct Contact	?	?	x	x	x	x	x	x	I	I	I	I
Surface Soil	Ingestion	?	?	--	--	x	x	x	x	--	--	--	--
	Direct Contact	?	?	--	--	x	x	x	x	--	--	--	--
Storm water	Direct contact	--	--	--	--	--	--	--	--	--	--	--	--
Surface water	Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
	Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Sediments	Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
	Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Groundwater	Direct Contact	--	--	--	--	--	--	x	x	--	--	--	--
	Ingestion	--	--	--	--	--	--	--	--	--	--	--	--
Columbia River See Note (1)	Ingestion	--	--	x	x	--	--	--	--	--	--	--	--
	Direct Contact	--	--	x	x	--	--	--	--	--	--	--	--
Surface water	Ingestion	--	--	x	x	--	--	--	--	I	I	I	I
	Direct Contact	--	--	x	x	--	--	--	--	I	I	I	I
Sediments	Ingestion	--	?	x	x	--	--	--	--	I	I	I	I
	Direct Contact	--	--	x	x	--	--	--	--	I	I	I	I

Note: (1) Port of Vancouver (POV) storm water pond discharges to the Columbia River under an industrial discharge permit.
(2) Fertilizer constituents are not bioaccumulative in fish tissue so fish consumption is not a complete pathway.

-- = Incomplete pathway
X = Potentially complete pathway
? = The Site is an industrial property with no habitat for terrestrial receptors; however, opportunist terrestrial species such as rodents may be present.
I = Potentially complete but insignificant.

Fertilizer CSM

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Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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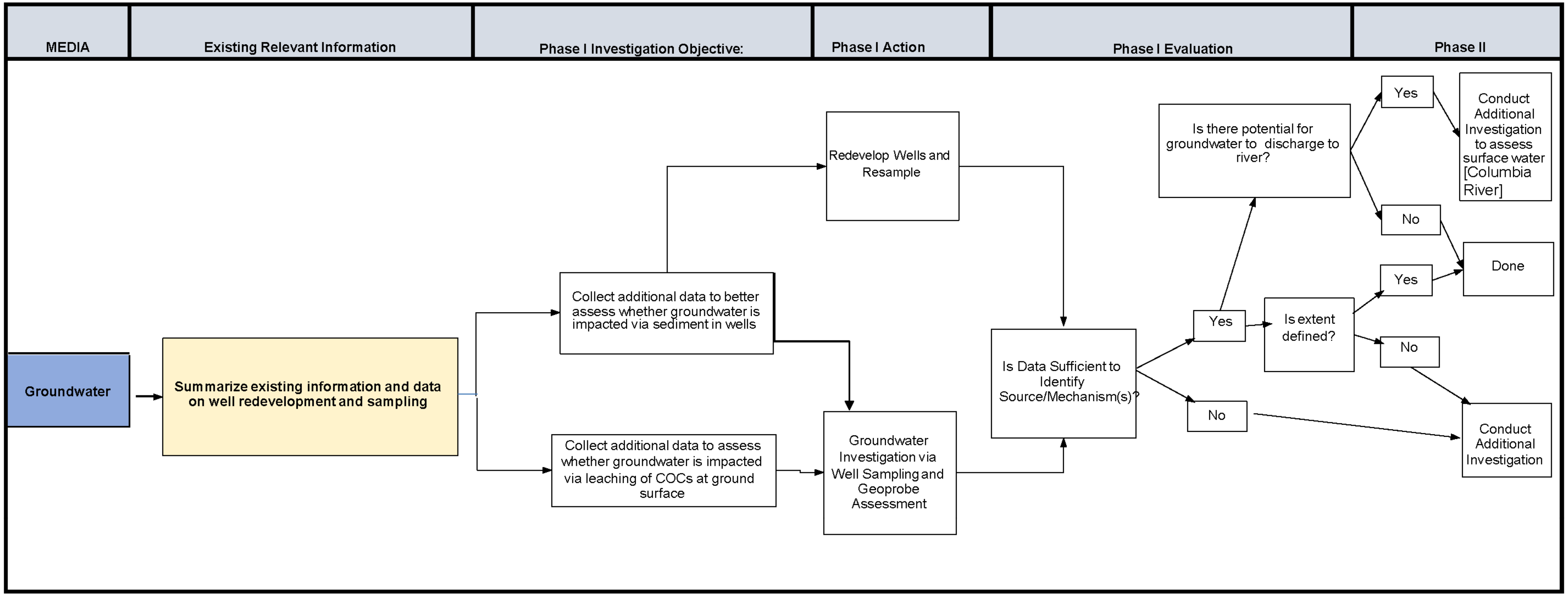
Figure 12

06/05/2020



Note:
COCs = Copper Ore and/or Fertilizer Constituents of Concern

Groundwater Flowchart

Supplemental Remedial Investigation Workplan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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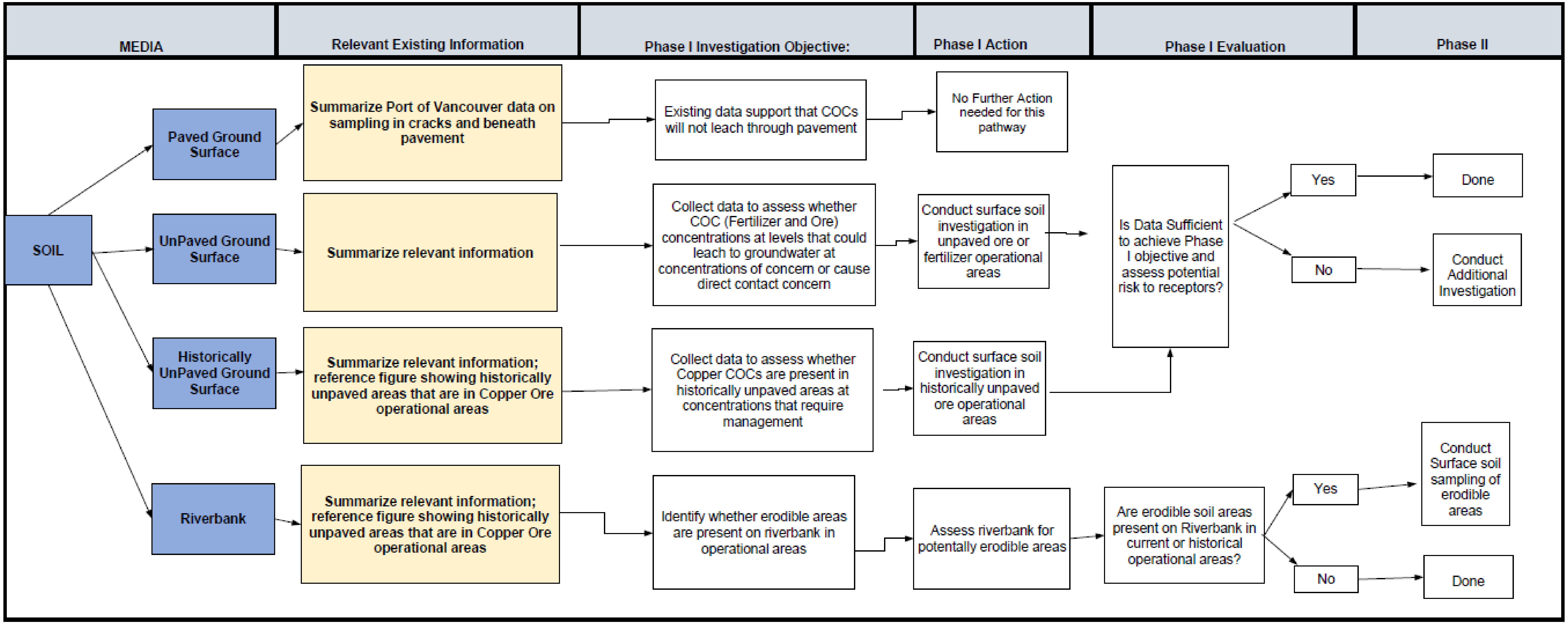
Figure
13

12/10/2019 | Project No.: 0060-002-008



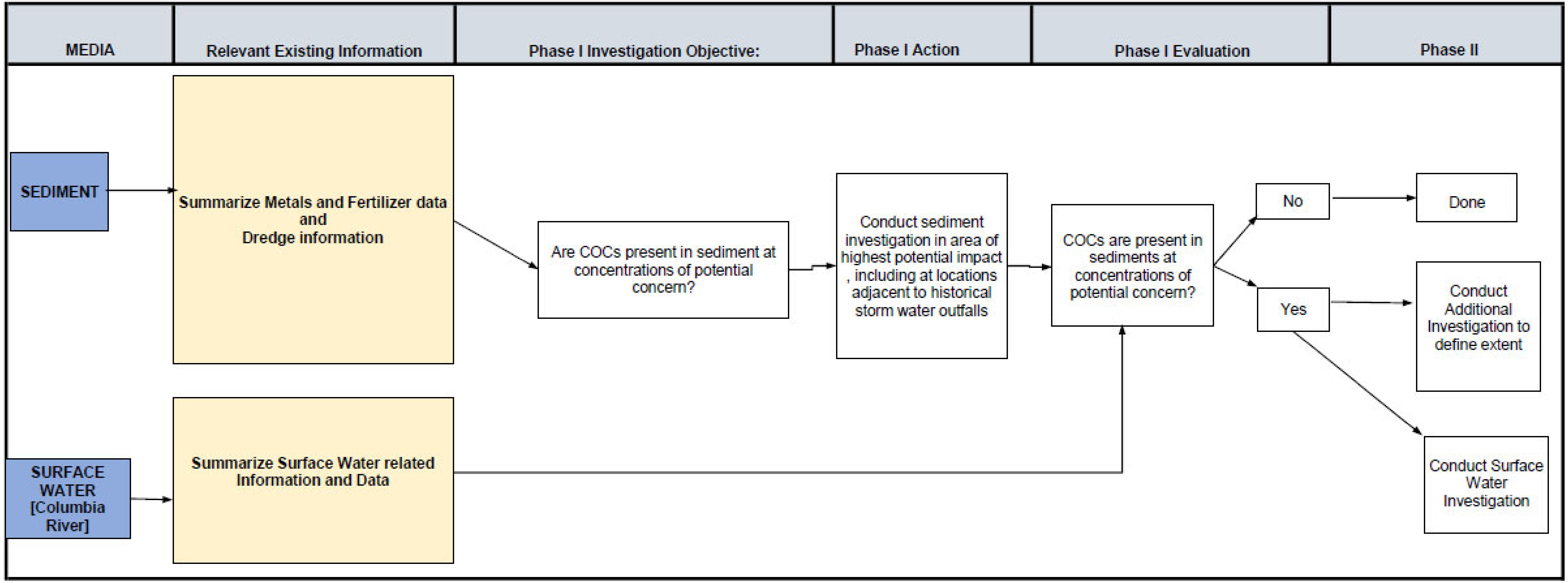
Note:
COCs = Copper Ore and/or Fertilizer Constituents of Concern

Soil Flowchart

Supplemental Remedial Investigation Workplan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

Figure
14

12/10/2019 | Project No.: 0060-002-008



Note:
COCs = Copper Ore and/or Fertilizer Constituents of Concern
Sediment Samples collected during Phase 1 of the investigation will also be analyzed for VOCs as a part of the ongoing VOC monitoring efforts for the NuStar Leasehold.

Sediment and Surface Water Flowchart

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Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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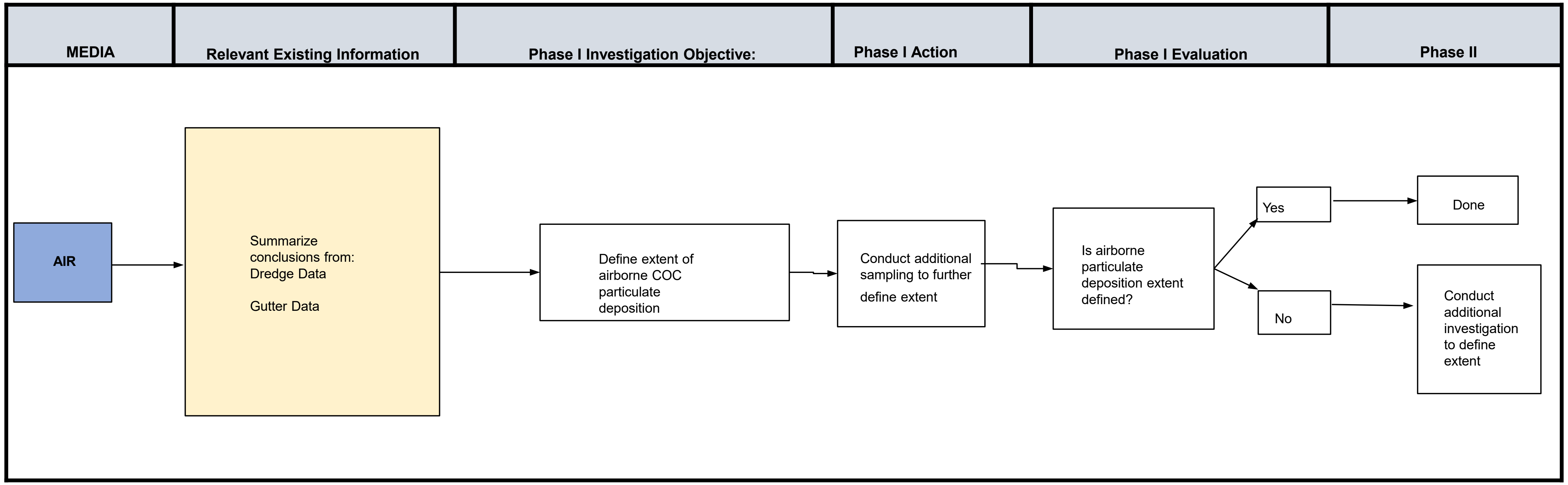
Figure
15

12/10/2019 | Project No.: 0060-002-008



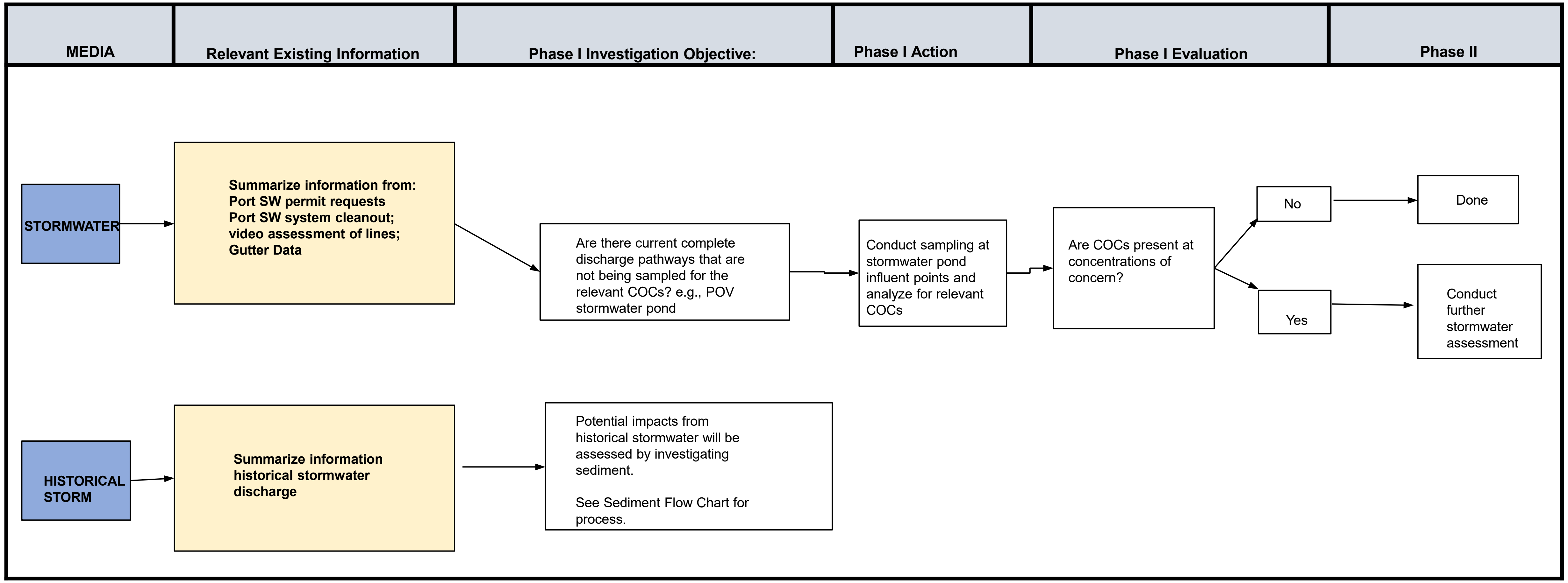
Note:
COCs = Copper Ore and/or Fertilizer Constituents of Concern

Air Flow Chart

Supplemental Remedial Investigation Workplan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

Figure
16

12/10/2019 | Project No.: 0060-002-008



Note:
COCs = Copper Ore and/or Fertilizer Constituents of Concern

Stormwater Flow Chart

Supplemental Remedial Investigation Workplan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

Figure
17

12/10/2019 | Project No.: 0060-002-008

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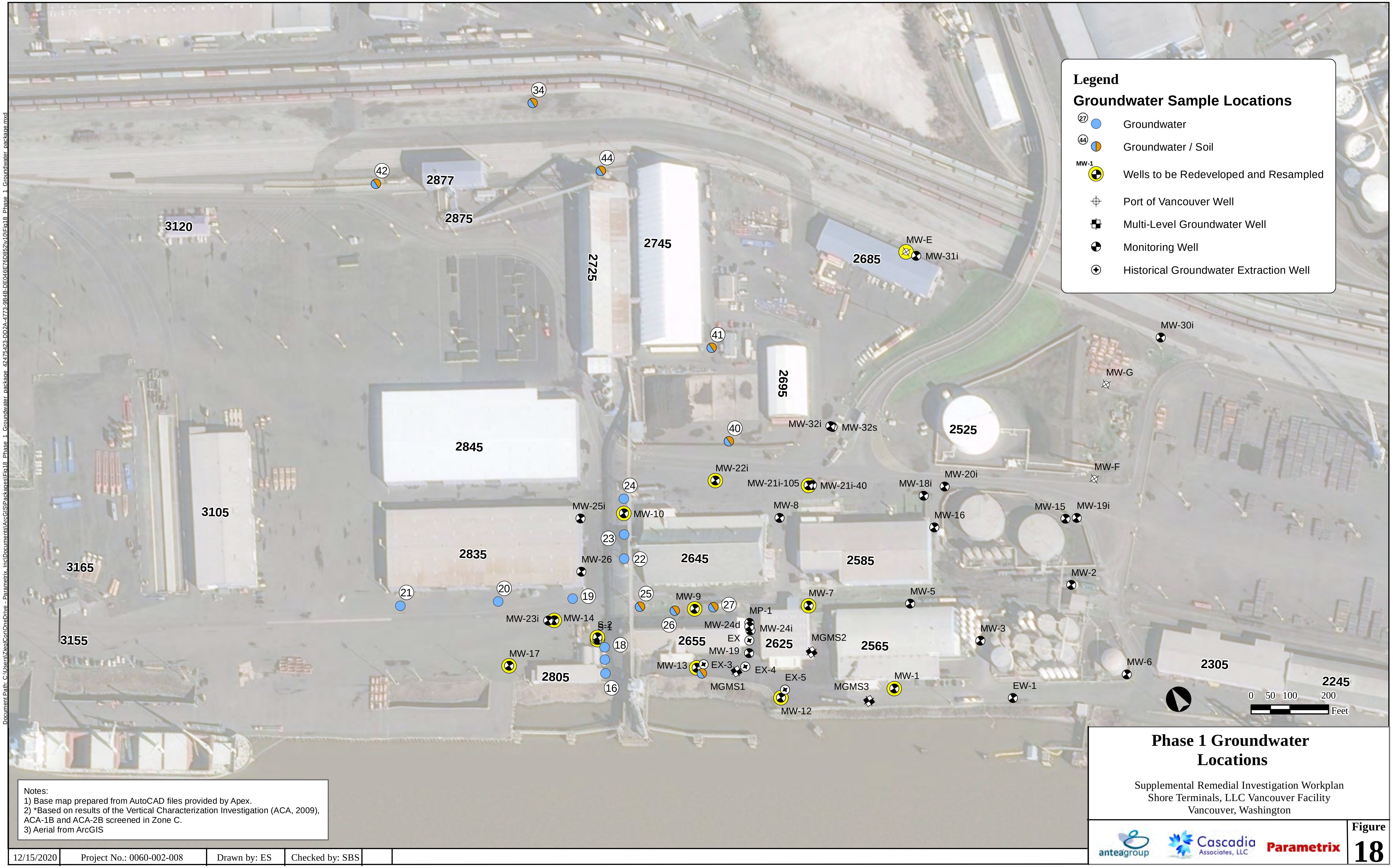

Legend

Groundwater Sample Locations

27 ●	Groundwater
44 ◐	Groundwater / Soil
MW-1 ◉	Wells to be Redeveloped and Resampled
⌖	Port of Vancouver Well
▚	Multi-Level Groundwater Well
◕	Monitoring Well
⊕	Historical Groundwater Extraction Well

Notes:
1) Base map prepared from AutoCAD files provided by Apex.
2) *Based on results of the Vertical Characterization Investigation (ACA, 2009), ACA-1B and ACA-2B screened in Zone C.
3) Aerial from ArcGIS

Phase 1 Groundwater Locations

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Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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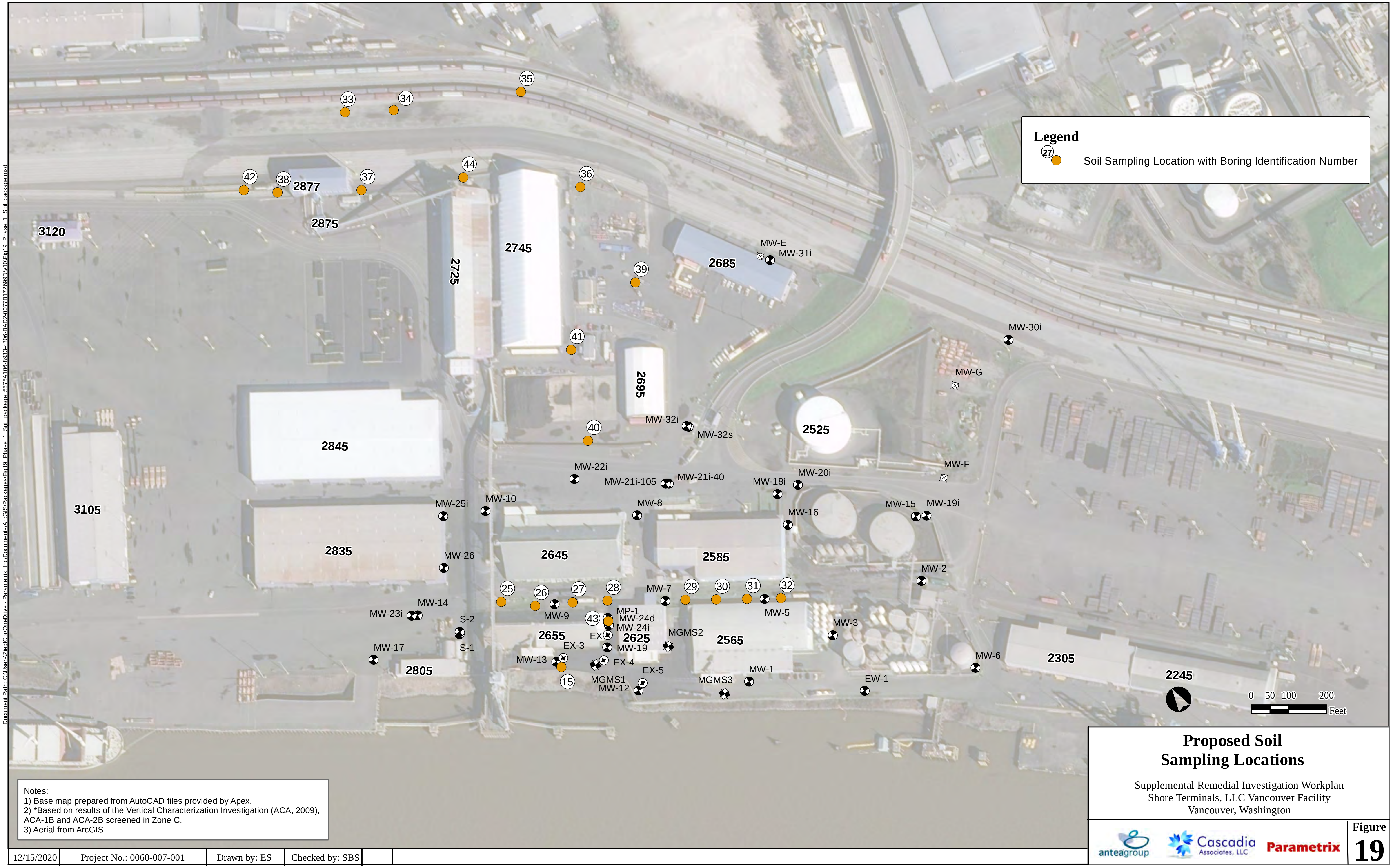
Figure
18

12/15/2020	Project No.: 0060-002-008	Drawn by: ES	Checked by: SBS



Legend

(27) ● Soil Sampling Location with Boring Identification Number

Notes:
1) Base map prepared from AutoCAD files provided by Apex.
2) *Based on results of the Vertical Characterization Investigation (ACA, 2009), ACA-1B and ACA-2B screened in Zone C.
3) Aerial from ArcGIS

Proposed Soil Sampling Locations

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Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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Figure
19

12/15/2020 | Project No.: 0060-007-001 | Drawn by: ES | Checked by: SBS

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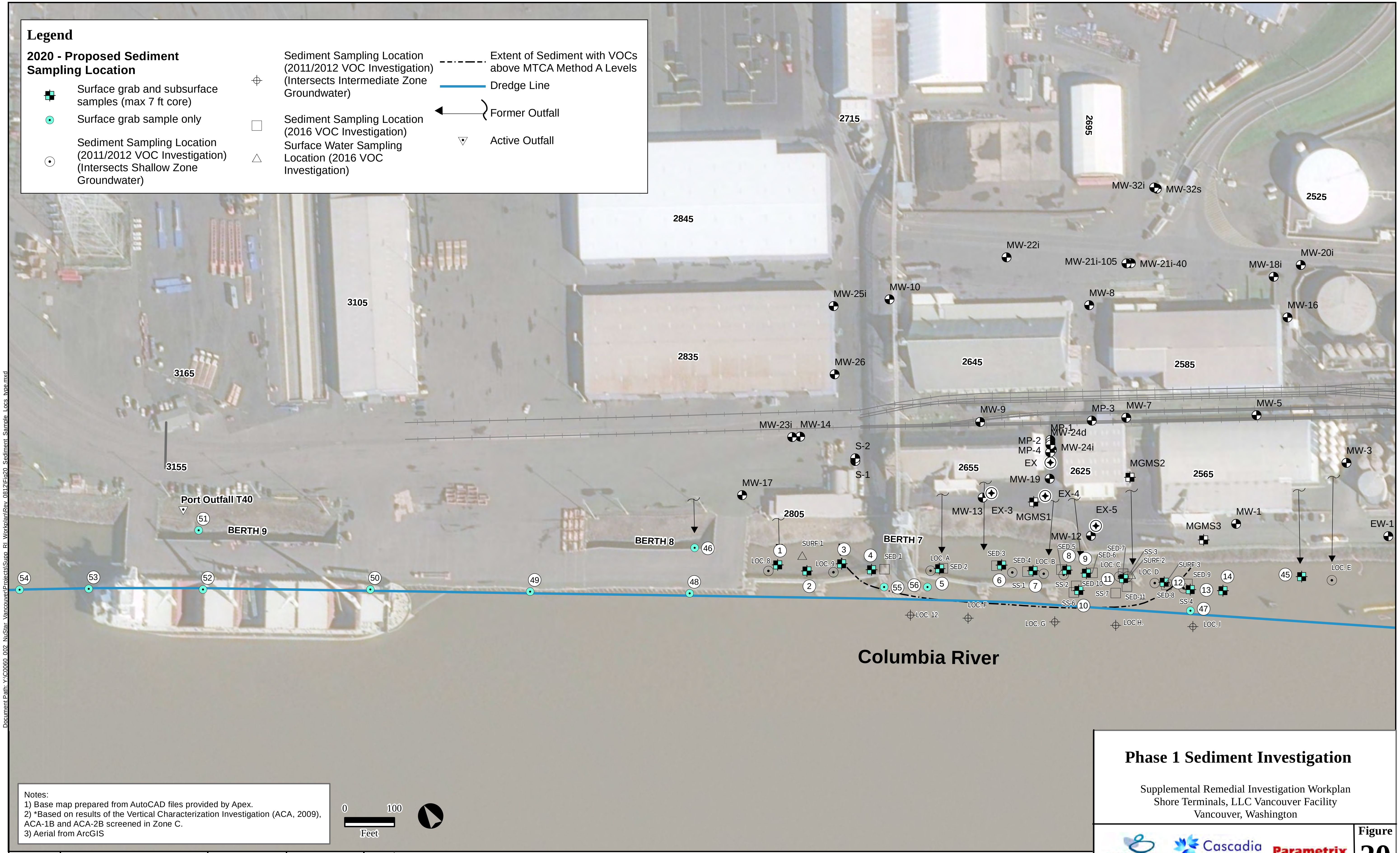

Legend

2020 - Proposed Sediment Sampling Location

■	Surface grab and subsurface samples (max 7 ft core)
⊙	Surface grab sample only
⊙	Sediment Sampling Location (2011/2012 VOC Investigation) (Intersects Shallow Zone Groundwater)
⌖	Sediment Sampling Location (2011/2012 VOC Investigation) (Intersects Intermediate Zone Groundwater)
□	Sediment Sampling Location (2016 VOC Investigation)
△	Surface Water Sampling Location (2016 VOC Investigation)
-·-·-	Extent of Sediment with VOCs above MTCA Method A Levels
—	Dredge Line
◄—	Former Outfall
▽	Active Outfall

Notes:
1) Base map prepared from AutoCAD files provided by Apex.
2) *Based on results of the Vertical Characterization Investigation (ACA, 2009), ACA-1B and ACA-2B screened in Zone C.
3) Aerial from ArcGIS

Phase 1 Sediment Investigation

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Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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Figure
20

12/4/2020	Project No.: 0060-002-008	Drawn by: ES	Checked by: SS

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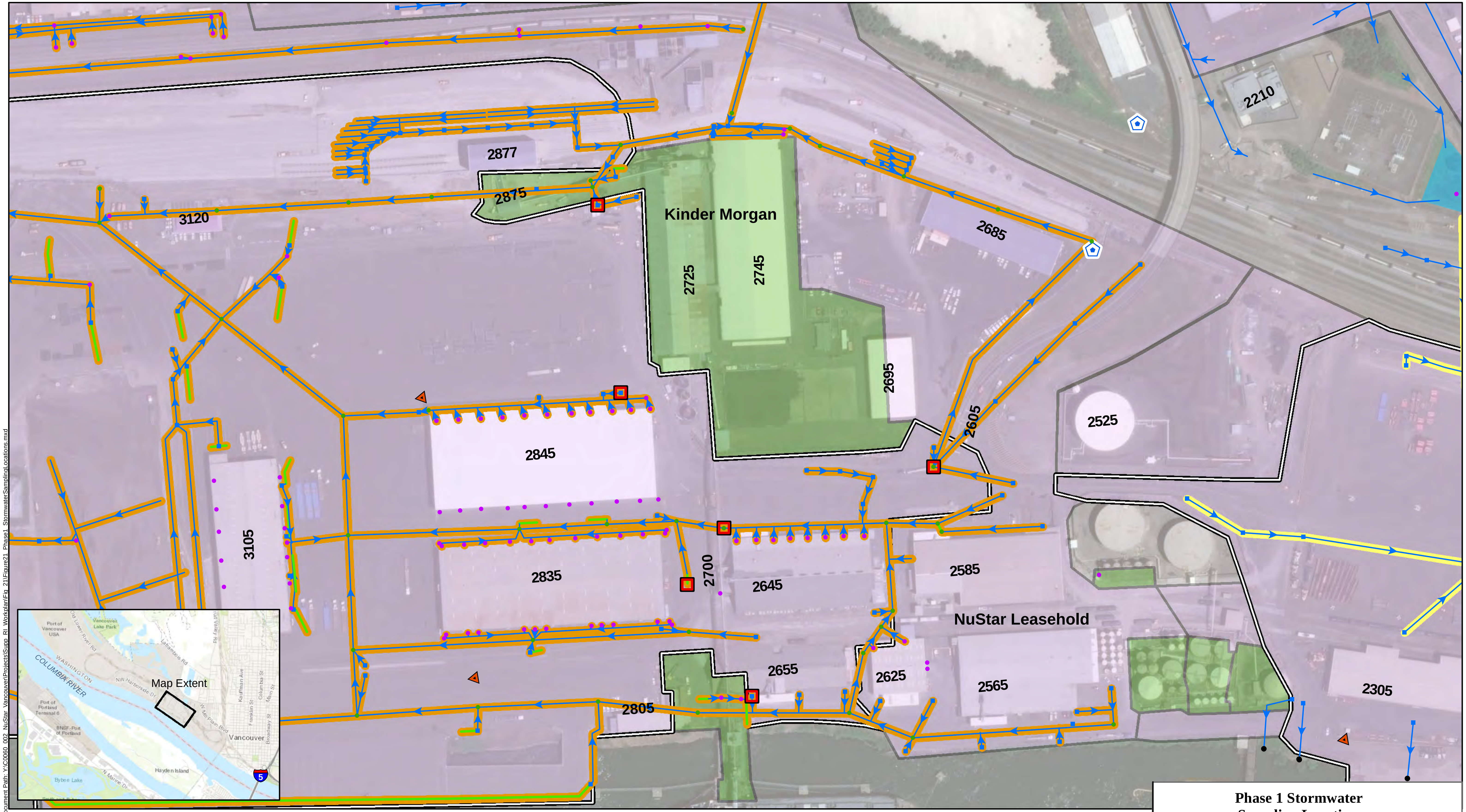

Document Path: Y:\C0060 002 NuStar Vancouver\Projects\Supp RI Workplan\Fig 21\Figure21 Phase1 StormwaterSamplingLocations.mxd

Source: Port of Vancouver, ESRI (Aerial Imagery)
All data shown on this map is approximate and should not be relied upon for planning or design at the Port of Vancouver.

🟥 Sampling Location
▲ Spill Kit
⬠ Spill Containment Shed

Stormwater Structures
● Other Stormwater Feature
■ Stormwater Catch Basin
● Stormwater Manhole
● Stormwater Outfall

→ Stormwater Pipe, Flow Direction
— Trench Drain

Stormwater System
🟨 East
🟧 West

▭ Stormwater Drainage Basin
🟩 Sanitary Sewer Drainage Basin
▭ PORT ISG, 134 acres
▨ Infiltration Area
▭ Ponds

0 100 200 400
Feet

Phase 1 Stormwater Sampling Locations

Supplemental Remedial Investigation Work Plan
Shore Terminals, LLC Vancouver Facility
Vancouver, Washington

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Figure
21

APPENDIX A

SAFETY DATA SHEETS FOR COPPER CONCENTRATE

Montana Resources

SAFETY DATA SHEET

This SDS complies with REACH 1907/2006 and 2001/58/EC, GHS, OSHA 29CFR 1910.1200

Section 1: Chemical Product and Company Identification

MANUFACTURER'S NAME
Montana Resources, LLP
600 Shields Avenue
Butte, MT 59701

EMERGENCY TELEPHONE	
Chemtrec U.S.-Canada:	800-424-9300
Chemtrec International:	703-527-3887
Information:	406-496-3207
Fax:	406-723-9542

Safety Data Sheet Competent Person: Mike McGivern
mmcgivern@montanaresources.com

DATE PREPARED: July 26, 2014

REVISION DATE: July 30, 2014

PRODUCT NAME:	**COPPER CONCENTRATE**
FORMULA:	Naturally occurring substance
PRODUCT USE:	Copper concentrate that is a source of copper after smelting.

Section 2: Hazards Identification

GHS Hazard Class Category 1 Inhalation

Signal word:		Danger
Hazard Statement:		May Cause cancer
Precautionary Statements:	Prevention	Obtain special instructions before use Do not handle until all safety precautions have been read and understood Wear protective gloves/protective clothing/eye protection/face protection
	Response	If exposed or concerned: Get medical advice/attention
	Storage	Store locked up
	Disposal	Dispose of material in accordance with local/national/international regulations

Hazard(s) Not Otherwise Classified (HNOC): Not classified

HAZARD CLASSIFICATION:	Not classified as hazardous based on IATA, IMDG, and DOT.
FIRE AND EXPLOSION:	Not considered flammable or combustible.
POTENTIAL HEALTH EFFECTS:	<0 % of mixture consists of ingredients of unknown acute toxicity
CHRONIC EFFECTS OF OVEREXPOSURE:	None
APPEARANCE:	Solid, brown powder.
OTHER:	None
Skin Contact:	May cause dry skin, abrasions, discomfort, and irritation.
Eye Contact:	Eye contact to airborne dust may cause immediate or delayed irritation or inflammation from mechanical irritation. Eye exposures require immediate first aid and medical attention to prevent significant damage to the eye.
Inhalation (acute):	Breathing dust may cause nose, throat or lung irritation, including choking, depending on the degree of exposure.
Inhalation (chronic):	
Silicosis:	This product contains crystalline silica. Prolonged or repeated inhalation of respirable crystalline silica from this product can cause silicosis, a seriously disabling and fatal lung disease. <u>See Note to Physicians in Section 4 for further information.</u>
Carcinogenicity:	Crystalline silica is classified by IARC and NTP as a known human carcinogen.

Autoimmune Disease: Some studies show that exposure to respirable crystalline silica (without silicosis) or that the disease silicosis may be associated with the increased incidence of several autoimmune disorders such as scleroderma (thickening of the skin), systemic lupus erythematosus, rheumatoid arthritis and diseases affecting the kidneys.

Tuberculosis: Silicosis increases the risk of tuberculosis.

Renal Disease: Some studies show an increased incidence of chronic kidney disease and end-stage renal disease in workers exposed to respirable crystalline silica.

Ingestion: No significant adverse effects are expected upon ingestion of the product.

Medical Conditions Aggravated by Exposure: Individuals with lung disease (e.g. bronchitis, emphysema, COPD, pulmonary disease) can be aggravated by exposure.

NFPA Rating:

Component	Health (Blue)	Flammability (Red)	Reactivity (Yellow)	Special (White)
Copper Concentrate	2	0	0	NONE

Section 3: Composition, Information on Ingredients

PRODUCT COMPOSITION	APPRX %	ACGIH TLV	OSHA PEL	NIOSH REL	CAS NO.	EINECS/ ELINCS	DANGER SYMBOL	RISK PHRASE	DSL CANADA	TSCA
Copper	25-30	0.1 mg/m^3 As copper dust/mist/fume	-----	-----	7440-50-8	231-159-6	-----	-----	Y	Y
Iron	25-30	-----	-----	-----	7439-89-6	231-096-4	-----	-----	Y	Y
Quartz (SiO2)	8-10	0.025 mg/m^3 (Respirable quartz)	30 mg/m^3 / $(\%Si0_2+2)$ (Total Dust) 10 mg/m^3 /$(\%Si0_2+2)$ (Respirable Dust)	0.05 mg/m^3 (Respirable quartz) 10 Hr TWA	14808-60-7	238-878-4	-----	-----	Y	Y
Lead	<1	0.05 mg/m^3	0.05 mg/m^3	0.05 mg/m^3	7439-92-1	231-100-4	-----	-----	Y	Y
Arsenic Compounds	Trace	0.01 mg/m^3	0.01 mg/m^3 Inorganic cmpds	0.002 mg/m^3 15 min STEL	-----	213-148-6	T, N	R23/25; 50/53; S2, 20/21; 28; 45; 60; 61	Y	Y

Trade Secret (TS) Some items on this SDS may be designated as trade secrets. Bonafide requests for disclosure of trade secret information to medical personnel must be made in accordance with the provisions contained in 29 CFR 1910.1200 I 1-13. The full text for all R-Phrases is shown in Section 16.

Occupational exposure limits

ACGIH

Components	Type	Value	Form
Arsenic Compounds (-)	TWA	0.01 mg/m3	
Copper (7440-50-8)	TWA	1 mg/m3	Dust and mist.
		0.2 mg/m3	Fume.
Iron oxide (1309-37-1)	TWA	5 mg/m3	Respirable fraction.
Lead (7439-92-1)	TWA	0.05 mg/m3	

Components	Type	Value	Form
Quartz (SiO2) (14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.

U.S. - OSHA

Components	Type	Value	Form
Arsenic Compounds (-)	TWA	0.01 mg/m3	
Copper (7440-50-8)	PEL	1 mg/m3	Dust and mist.
		0.1 mg/m3	Fume.
Iron oxide (1309-37-1)	PEL	10 mg/m3	Fume.
Lead (7439-92-1)	TWA	0.05 mg/m3	
Quartz (SiO2) (14808-60-7)	TWA	0.1 mg/m3	Respirable.
		0.3 mg/m3	Total dust.
		2.4 mppcf	Respirable.

Canada - Alberta

Components	Type	Value	Form
Arsenic Compounds (-)	TWA	0.01 mg/m3	
Copper (7440-50-8)	TWA	1 mg/m3	Dust and mist.
		0.2 mg/m3	Fume.
Iron oxide (1309-37-1)	TWA	5 mg/m3	Respirable.
Lead (7439-92-1)	TWA	0.05 mg/m3	
Quartz (SiO2) (14808-60-7)	TWA	0.025 mg/m3	Respirable particles.

Canada - British Columbia

Components	Type	Value	Form
Arsenic Compounds (-)	TWA	0.01 mg/m3	
Copper (7440-50-8)	TWA	1 mg/m3	Dust and mist.
		0.2 mg/m3	Fume.
Iron oxide (1309-37-1)	STEL	10 mg/m3	Fume.
	TWA	5 mg/m3	Dust.
		5 mg/m3	Fume.
		10 mg/m3	Total dust.
		3 mg/m3	Respirable fraction.
Lead (7439-92-1)	TWA	0.05 mg/m3	
Quartz (SiO2) (14808-60-7)	TWA	0.025 mg/m3	Respirable fraction.

Canada - Ontario

Components	Type	Value	Form
Copper (7440-50-8)	TWA	0.2 mg/m3	Fume.
		1 mg/m3	Dust and mist.
Iron (7439-89-6)	TWA	5 mg/m3	Welding fume.
Iron oxide (1309-37-1)	TWA	5 mg/m3	Respirable.
Lead (7439-92-1)	TWA	0.05 mg/m3	
Quartz (SiO2) (14808-60-7)	TWA	0.1 mg/m3	Respirable fraction.

Canada - Quebec

Components	Type	Value	Form
Copper (7440-50-8)	TWA	1 mg/m3	Dust and mist.
		0.2 mg/m3	Fume.
Iron oxide (1309-37-1)	TWA	10 mg/m3	Total dust.
		5 mg/m3	Dust and fume.
Lead (7439-92-1)	TWA	0.05 mg/m3	
Quartz (SiO2) (14808-60-7)	TWA	0.1 mg/m3	Respirable dust.

Mexico

Components	Type	Value	Form
Copper (7440-50-8)	STEL	2 mg/m3	Fume.
		2 mg/m3	Dust and mist.
	TWA	1 mg/m3	Dust and mist.
		0.2 mg/m3	Fume.
Iron oxide (1309-37-1)	STEL	10 mg/m3	

	TWA	5 mg/m3	
Lead (7439-92-1)	TWA	0.15 mg/m3	Dust and fume.

Section 4: First Aid Measures

INHALATION:	Remove to fresh air. Seek immediate medical attention for persistent coughing or other symptoms.
SKIN CONTACT:	Remove contaminated clothing. Wash with soap and water. Get medical attention if irritation develops or persists. Cuts or abrasions should be treated promptly with thorough cleansing of the affected area.
EYE CONTACT:	Do not rub eyes. Remove any contact lenses. Immediately flush eyes with plenty of water for at least 15 minutes. Get immediate medical attention for abrasions or irritation.
INGESTION:	If swallowed do not induce vomiting. Have person drink large quantities of water. Never give anything to an unconscious person. Get immediate medical attention.

Note to Physician:

The three types of silicosis include:

- Simple chronic silicosis – which results from long-term exposure (more than 20 years) to low amounts of respirable crystalline silica. Nodules of chronic inflammation and scarring provoked by the respirable crystalline silica form in the lungs and chest lymph nodes. This disease may feature breathlessness and may resemble chronic obstructive pulmonary disease (COPD).
- Accelerated silicosis – occurs after exposure to larger amounts of respirable crystalline silica over a shorter period of time (5-15 years). Inflammation, scarring, and symptoms progress faster in accelerated silicosis than in simple silicosis.
- Acute silicosis – results from short-term exposure to very large amounts of respirable crystalline silica. The lungs become very inflamed and may fill with fluid, causing severe shortness of breath and low blood oxygen levels.

Progressive massive fibrosis may occur in simple or accelerated silicosis, but is more common in the accelerated form. Progressive massive fibrosis results from severe scarring and leads to the destruction of normal lung structures.

Section 5: Fire-fighting Measures

FLASH POINT:	Not applicable
FLAMMABLE LIMITS IN AIR (% by vol):	Not applicable
EXTINGUISHING MEDIA:	None
SPECIAL FIREFIGHTING PROCEDURES:	Fire or high temperatures create: Sulphur Oxides (SOx).
UNUSUAL FIRE AND EXPLOSION HAZARDS:	Material does not burn. Use extinguishing agent suitable for the type of surrounding fire.

Section 6: Accidental Release Measures

ACTION TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

Wear proper protective equipment as specified in Section 8: Exposure Controls/Personal Protection
Warn other workers of spill. Contain spills. Place in a chemical waste container.
Sweep up or gather material and place in appropriate container for disposal. Do not vacuum clean unless vacuum cleaners are equipped with HEPA filter.

DISPOSAL METHOD: disposal should be made in accordance with federal, state and local regulations.

Section 7: Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE:

Provide adequate ventilation.
Some sulphide concentrates may slowly oxidize in storage and generate sulphur dioxide as well as deplete the oxygen content of a confined space. The atmosphere within confined spaces containing concentrate must be tested before entry and the area thoroughly ventilated or self-contained breathing apparatus used, if conditions warrant.

Keep container tightly closed. Keep dry. Keep away from incompatible material.
Wear proper protective equipment and avoid contact with skin, eyes, or clothing.
Wash hands after handling this material.
Use work methods which minimize dust production.
Avoid breathing dust. Avoid contact with eyes, skin, and clothing.
Use with adequate ventilation. Wash thoroughly after handling.
Handle in accordance with good industrial hygiene and safety practice.
Follow all applicable local regulations for handling and storage.

INFORMATION ON EMPTIED CONTAINER: Not applicable

SPECIFIC USES:

This product is a copper concentrate that is a source of copper after smelting.

Section 8: Exposure Controls/Personal Protection

VENTILATION:	Always provide good general, mechanical room ventilation where this chemical/material is used.
SPECIAL VENTILATION CONTROLS:	Use this material inside totally enclosed equipment, or use it with local exhaust ventilation at points where vapors can be released into the workspace air.
RESPIRATORY PROTECTION:	Follow the OSHA respirator regulations found in 29 CFR 1910.134. Recommend the use of a NIOSH certified dust mask or particulate mask respirator.
PROTECTIVE GLOVES:	Wear chemical impervious gloves at all times while working with this product.
EYE PROTECTION:	Recommend eye protection using safety glasses or goggles.
PROTECTIVE CLOTHING:	Wear suitable protective clothing to prevent skin contact.
SKIN PROTECTION:	Suitable protective clothing to prevent skin contact
WORK/HYGIENE PRACTICES:	Avoid breathing dust. Avoid contact with eyes. Wash hands after handling.
EXPOSURE LIMITS	Reference Section 2
OTHER EQUIPMENT:	Make safety shower, eyewash stations, and hand washing equipment available in the work area.

Section 9: Physical and Chemical Properties

APPEARANCE - COLOR:	Brown
PHYSICAL STATE:	Solid powder
ODOR:	Odorless

PRODUCT CRITERIA

	PRODUCT CRITERIA
ODOR THRESHOLD	Not applicable for product
PH	Not applicable for product
FLASH POINT:	Not applicable for product
LOWER EXPLOSIVE LIMIT; UPPER EXPLOSIVE LIMIT	Not applicable for product
FLAMMABILITY (Solid, gas)	Not applicable for product
EXPLOSIVE PROPERTIES	Not applicable for product
OXIDIZING PROPERTIES	Not applicable for product
SPECIFIC GRAVITY (@25 ºC):	8.9
EVAPORATION RATE:	Not applicable for product
% VOLATILE by VOLUME	Not applicable for product
PARTITION COEFFICIENT	Not applicable for product
AUTO IGNITION TEMPERATURE	Not applicable for product
DECOMPOSITION TEMPERATURE	Not applicable for product
BOILING POINT:	Not applicable for product
MELTING POINT:	1800 ºF (982.2 ºC)
VAPOR PRESSURE	Not applicable for product
VAPOR DENSITY (AIR = 1)	Not applicable for product
SOLUBILITY IN WATER:	Insoluble
WATER SOLUBILITY IN THE SOLVENT	Not applicable for product
FREEZING POINT:	Not applicable for product
VISCOSITY	Not applicable for product

VOC CONTENT	Not applicable for product

Section 10: Stability and Reactivity

STABILITY:	Stable under normal temperature conditions. However, some sulphide concentrates may slowly oxidize in storage and generate sulphur dioxide.
CONDITIONS TO AVOID:	Contact with incompatible materials. Contact with strong acids will release highly flammable and highly toxic hydrogen sulphide gas.
INCOMPATIBILITY (MATERIALS TO AVOID):	Mineral acid. Strong oxidizing agents. Acetylene. Phosphorus. Bromates. Sodium azide.
HAZARDOUS DECOMPOSITION PRODUCTS:	Fire or high temperatures create: Sulphur oxides.
HAZARDOUS POLYMERIZATION:	Will not occur

Section 11: Toxicological Information

There is no toxicological information available for the product mixture.

GHS Required Criteria	Toxicity Criteria	Toxicity Information	Comments	Chemical Constituent
Acute Toxicity	LD50 (Oral/Rat):	470mg/kg		Copper oxide
Skin Corrosion/Irritation		Data not available		
Serious Eye Damage / Eye Irritation		Data not available		
Respiratory or Skin Sensitization		Data not available		
Germ Cell Mutagenicity		Data not available		
Carcinogenicity		Known To Be Human Carcinogen	NTP	Crystalline Silica Respirable Size
		Human Sufficient Evidence IMEMDT 68,41,1997 Group 1	IARC	Crystalline Silica Respirable Size
		Listed in Section 3	OSHA	Arsenic, Lead
		Known To Be Human Carcinogen	NTP	Crystalline Silica Respirable Size
		Group 1	IARC	Arsenic
		Group 2B	IARC	Lead
		Not listed	IARC	
		Not listed	OSHA	
Reproductive Toxicity		Data not available		
STOST -- Single Exposure		Data not available		
STOST – Repeated Exposure		Data not available		
Aspiration Hazard		Data not available		

STOST = Specific Target Organ Systemic Toxicity

OTHER INFORMATION:
Only selected Registry of Toxic Effects of Chemical Substances (RTECS) data is presented here. See actual entry in RTECS for complete information.

Section 12: Ecological Information

		Chemical
BIODEGRADATION:	The product is not biodegradable	
BIOACCUMULATION:	The product contains potentially bioaccumulating substances.	
	LC50 Rainbow trout, donaldson trout (Oncorhynhus mykiss):1.17 mg/l 96 Hours	Lead
ECO TOXICITY:	LC50 Channel catfish (Ictalurus punctatus): > 500 mg/l 96 hours	Iron
MOBILITY:	The product is insoluble in water and will sediment in water systems.	

Note: No environmental hazards were identified based on a review of available data for the ingredients in this product.

Section 13: Disposal Considerations

WASTE FROM RESIDUES / UNUSED PRODUCTS:
Follow the waste disposal requirements of your country, state, or local authorities.

Section 14: Transport Information

DOT TRANSPORT:	This product is not shipped by truck.
ADR = International Carriage of Dangerous Goods by Road	This product is not shipped by truck.
RAIL TRANSPORT:	
PROPER SHIPPING NAME	Environmentally hazardous Substances, Solid, N.O.S., (Contains Copper and Lead sulfide), RQ Lead Sulfide
UN NUMBER SEA	UN 3077
CLASS:	9
PACKING GROUP:	III
SEA TRANSPORT: IMDG	
PROPER SHIPPING NAME	Environmentally hazardous Substances, Solid, N.O.S., (Contains Copper and Lead sulfide), RQ Lead Sulfide
UN NUMBER SEA	UN 3077
CLASS:	9
PACKING GROUP:	III
MARINE POLLUTANT:	No
AIR TRANSPORT: IATA/ICAO	This product is not shipped by truck.

Section 15: Regulatory Information

Directive 1999/45/EC

LABEL FOR SUPPLY:

TOXIC

RISK PHRASES:

R23/24/25	Toxic by inhalation
R39/23/24/25	Toxic: danger of very serious irreversible effects from inhalation
S7	Keep container tightly closed.
S36/37	Wear suitable protective clothing and gloves.

TOXIC SUBSTANCES CONTROL ACT (TSCA) STATUS:

This product is in compliance with rules, regulations, and orders of TSCA. All components are listed on the TSCA Inventory.

SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (SARA) TITLE III SECTION 313 SUPPLIER NOTIFICATION:

This regulation requires submission of annual reports of toxic chemical(s) that appear in section 313 of the Emergency Planning and Community Right To Know Act of 1986 and 40 CFR 372. This information must be included in all SDS's that are copied and distributed for the material.

The Section 313 toxic chemicals contained in this product are: Arsenic, Lead, Copper

CALIFORNIA PROPOSITION 65:

This regulation requires a warning for California Proposition 65 chemical(s) under the statute.

The California proposition 65 chemical(s) contained in this product are: Arsenic, Crystalline silica (airborne particulates of respirable size).

WARNING: This product contains a chemical (lead) known by the State of California to cause cancer, birth defects or other reproductive harm.

Lead is a naturally occurring impurity in Zinc Oxide.
Lead: No Significant Risk Level (NSRL) for carcinogens = 15 µg/day (Oral)
Lead: Maximum Allowable Dose Level (MADL) for reproductive toxicants = 0.55 µg/day

STATE RIGHT-TO-KNOW TOXIC SUBSTANCE OR HAZARDOUS SUBSTANCE LIST:

Chemical Name	Massachusetts	New Jersey	Pennsylvania
Copper 7440-50-8	X	X	X
Lead 7439-50-8	X	X	X
Quartz 14808-60-7	X	X	X
Arsenic compounds		X	X

CANADA:
This SDS will be non-compliant 3 years after the issue date. This SDS contains all of the information required by the Controlled Products Regulations (CPR).

WHMIS-INFORMATION:
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR), SOR/88-66, Current to February 20, 2012. The classes of controlled products listed in the CPR, Section 32, Part IV, have been reviewed and based on Professional Judgment this product has been determined to be WHMIS controlled.
Crystalline Silica: D2A - Chronic toxicity - very toxic – other, D2A - Carcinogenicity - very toxic - other

EUROPEAN UNION:
This product has been reviewed for compliance with the following European Community Directives: REACH 1907/2006; Directive 1999/45/EC, Regulation (EC) No 1272/2008 on classification, labeling, and packaging (CLP) of substances and mixtures. None of the chemicals used in this product are on the EU's REACH SVHC (Substances of Very High Concern) chemicals list (last updated June 16, 2014).

Section 16: Other Information

European Community Hazards Identification:

R:	None
S:	None
Danger Symbol(s):	None

Revision Comments:	Initial version July 26, 2014
Revision Number:	0
Information Sources:	RTECS, REACH, OSHA 29CFR 1910.1200

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SDS AUTHORED BY:
aegis
ENVIRONMENTAL STRATEGIES
WWW.AEGIS-EHS.COM

Copper Concentrate

Safety Data Sheet

According To Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules And Regulations And According To The Hazardous Products Regulation (February 11, 2015).

Revision Date: 12/18/2017 Date of Issue: 01/01/2004 Version: 2.0

SECTION 1: IDENTIFICATION

1.1. Product Identifier

Product Form: Mixture

Product Name: Copper Concentrate

1.2. Intended Use of the Product

Used in refining copper. For professional use only.

1.3. Name, Address, and Telephone of the Responsible Party

Company

Robinson Nevada Mining Company
PO Box 382
4232 West White Pine County Rd 44
Ruth, Nevada 89319
Phone #: 775-289-7305
www.kghm.com

1.4. Emergency Telephone Number

Emergency Number : 775-289-7305 Robinson Nevada Mining Co

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the Substance or Mixture

GHS-US/CA Classification

Carc. 1A	H350
STOT RE 1	H372
Aquatic Acute 2	H401

Full text of hazard classes and H-statements : see section 16

2.2. Label Elements

GHS-US/CA Labeling

Hazard Pictograms (GHS-US/CA) :

GHS08

Signal Word (GHS-US/CA) : Danger

Hazard Statements (GHS-US/CA) : H350 - May cause cancer (Inhalation).
H372 - Causes damage to organs (lung/respiratory system) through prolonged or repeated exposure (Inhalation).
H401 - Toxic to aquatic life.

Precautionary Statements (GHS-US/CA) : P201 - Obtain special instructions before use.
P202 - Do not handle until all safety precautions have been read and understood.
P260 - Do not breathe dust.
P264 - Wash hands, forearms, and other exposed areas thoroughly after handling.
P270 - Do not eat, drink or smoke when using this product.
P273 - Avoid release to the environment.
P280 - Wear protective gloves, protective clothing, and eye protection.
P308+P313 - If exposed or concerned: Get medical advice/attention.
P314 - Get medical advice/attention if you feel unwell.
P405 - Store locked up.
P501 - Dispose of contents/container in accordance with local, regional, national, territorial, provincial, and international regulations.

2.3. Other Hazards

Incompatible with acids. When combined with acid, may release toxic gas or represent an explosive risk. Exposure may aggravate pre-existing eye, skin, or respiratory conditions.

2.4. Unknown Acute Toxicity (GHS-US/CA)

No data available

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substance

Not applicable

3.2. Mixture

Name	Product Identifier	% *	GHS Ingredient Classification
Chalcopyrite (CuFeS2)	(CAS No) 1308-56-1	50 - 80	Not classified
Pyrite (FeS2)	(CAS No) 1309-36-0	5 - 40	Not classified
Zinc sulfide	(CAS No) 1314-98-3	0.1 - 15	Not classified
Calcite	(CAS No) 13397-26-7	1 - 15	Not classified
Copper(I) sulfide	(CAS No) 22205-45-4	1 - 15	Not classified
Clays	(CAS No) 1302-87-0	2 - 15	Not classified
Quartz	(CAS No) 14808-60-7	1 - 10	Carc. 1A, H350 STOT SE 3, H335 STOT RE 1, H372
Molybdenum sulfide	(CAS No) 1317-33-5	0.01 - 1.5	Not classified
Hematite	(CAS No) 1317-60-8	< 1	Not classified

Full text of H-phrases: see section 16

*Percentages are listed in weight by weight percentage (w/w%) for liquid and solid ingredients. Gas ingredients are listed in volume by volume percentage (v/v%).

SECTION 4: FIRST AID MEASURES

4.1. Description of First-aid Measures

General: Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show this SDS where possible).

Inhalation: When symptoms occur: go into open air and ventilate suspected area. Obtain medical attention if breathing difficulty persists.

Skin Contact: Wash affected area with soap and water to remove product. Do not allow product to stay on skin for prolonged periods. If clothing becomes heavily saturated, remove and launder.

Eye Contact: Rinse cautiously with water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Obtain medical attention.

Ingestion: Rinse mouth. DO NOT induce vomiting. Obtain medical attention.

4.2. Most Important Symptoms and Effects Both Acute and Delayed

General: May cause cancer. Causes damage to organs through prolonged or repeated exposure.

Inhalation: Prolonged exposure may cause irritation.

Skin Contact: Prolonged exposure may cause skin irritation.

Eye Contact: May cause slight irritation to eyes.

Ingestion: Ingestion may cause adverse effects.

Chronic Symptoms: Long term exposure to respirable crystalline silica results in a significant risk of developing silicosis and other non-malignant respiratory disease, lung cancer, kidney effects, and immune system effects.

4.3. Indication of Any Immediate Medical Attention and Special Treatment Needed

If exposed or concerned, get medical advice and attention. If medical advice is needed, have product SDS at hand.

SECTION 5: FIRE-FIGHTING MEASURES

5.1. Extinguishing Media

Suitable Extinguishing Media: Water spray, dry chemical, foam, carbon dioxide.

Unsuitable Extinguishing Media: Do not use a heavy water stream. Use of heavy stream of water may spread fire.

5.2. Special Hazards Arising From the Substance or Mixture

Fire Hazard: Not considered flammable but may burn at high temperatures.

Explosion Hazard: Product is not explosive.

Reactivity: Incompatible with acids. When combined with acid, may release a toxic gas or represent an explosive risk. Quartz (silica) will dissolve in hydrofluoric acid producing a corrosive gas, silicon tetrafluoride.

5.3. Advice for Firefighters

Precautionary Measures Fire: Exercise caution when fighting any chemical fire.

Firefighting Instructions: Use water spray or fog for cooling exposed containers.

Protection During Firefighting: Do not enter fire area without proper protective equipment, including respiratory protection.

Hazardous Combustion Products: Metal oxides. Sulfur oxides. Hydrogen sulfide.

Other Information: Do not allow run-off from fire fighting to enter drains or water courses.

Reference to Other Sections

Refer to Section 9 for flammability properties.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal Precautions, Protective Equipment and Emergency Procedures

General Measures: Do not breathe dust. Do not get in eyes, on skin, or on clothing. Do not handle until all safety precautions have been read and understood.

6.1.1. For Non-Emergency Personnel

Protective Equipment: Use appropriate personal protective equipment (PPE).

Emergency Procedures: Evacuate unnecessary personnel.

6.1.2. For Emergency Personnel

Protective Equipment: Equip cleanup crew with proper protection.

Emergency Procedures: Upon arrival at the scene, a first responder is expected to recognize the presence of dangerous goods, protect oneself and the public, secure the area, and call for the assistance of trained personnel as soon as conditions permit. Ventilate area.

6.2. Environmental Precautions

Prevent entry to sewers and public waters. Avoid release to the environment.

6.3. Methods and Materials for Containment and Cleaning Up

For Containment: Contain solid spills with appropriate barriers and prevent migration and entry into sewers or streams.

Methods for Cleaning Up: Clean up spills immediately and dispose of waste safely. Recover the product by vacuuming, shoveling or sweeping. Transfer spilled material to a suitable container for disposal. Contact competent authorities after a spill.

6.4. Reference to Other Sections

See Section 8 for exposure controls and personal protection and Section 13 for disposal considerations.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for Safe Handling

Additional Hazards When Processed: Contact with acids can result in a release of hydrogen sulfide gas. Hydrogen sulfide is a highly toxic gas and may be fatal if inhaled. It is also flammable under certain conditions. Gas can accumulate in the headspace of closed containers, use caution when opening sealed containers. Heating the product or containers can cause thermal decomposition of the product and release hydrogen sulfide.

Precautions for Safe Handling: Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Do not breathe dust. Avoid contact with eyes, skin and clothing.

Hygiene Measures: Handle in accordance with good industrial hygiene and safety procedures.

7.2. Conditions for Safe Storage, Including Any Incompatibilities

Technical Measures: Comply with applicable regulations.

Storage Conditions: Store in a dry, cool place. Avoid exposure to extremely high temperatures and incompatible materials.

Incompatible Materials: Strong acids. Strong oxidizers. Halogenated compounds. Acetylene.

7.3. Specific End Use(s)

Used in refining copper. For professional use only.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control Parameters

For substances listed in section 3 that are not listed here, there are no established Exposure limits from the manufacturer, supplier, importer, or the appropriate advisory agency including: ACGIH (TLV), AIHA (WEEL), NIOSH (REL), OSHA (PEL), Canadian provincial governments, or the Mexican government.

Quartz (14808-60-7)

Mexico	OEL TWA (mg/m^3)	0.1 mg/m^3 (respirable fraction)
USA ACGIH	ACGIH TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate matter)
USA ACGIH	ACGIH chemical category	A2 - Suspected Human Carcinogen
USA OSHA	OSHA PEL (TWA) (mg/m^3)	50 µg/m^3
USA NIOSH	NIOSH REL (TWA) (mg/m^3)	0.05 mg/m^3 (respirable dust)
USA IDLH	US IDLH (mg/m^3)	50 mg/m^3 (respirable dust)
Alberta	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate)
British Columbia	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable)
Manitoba	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate matter)
New Brunswick	OEL TWA (mg/m^3)	0.1 mg/m^3 (respirable fraction)
Newfoundland & Labrador	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate matter)
Nova Scotia	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate matter)
Nunavut	OEL TWA (mg/m^3)	0.05 mg/m^3 (respirable fraction)
Northwest Territories	OEL TWA (mg/m^3)	0.05 mg/m^3 (respirable fraction)
Ontario	OEL TWA (mg/m^3)	0.1 mg/m^3 (designated substances regulation-respirable)
Prince Edward Island	OEL TWA (mg/m^3)	0.025 mg/m^3 (respirable particulate matter)
Québec	VEMP (mg/m^3)	0.1 mg/m^3 (respirable dust)
Saskatchewan	OEL TWA (mg/m^3)	0.05 mg/m^3 (respirable fraction)
Yukon	OEL TWA (mg/m^3)	300 particle/mL

Molybdenum sulfide (1317-33-5)		
USA ACGIH	ACGIH TWA (mg/m^3)	10 mg/m^3 (inhalable fraction); 3mg/m3 TWA (respirable fraction)(listed under Molybdenum)
USA OSHA	OSHA PEL (TWA) (mg/m^3)	15 mg/m^3 (total dust)(listed under Molybdenum insoluble compounds)
USA NIOSH	NIOSH REL (TWA) (mg/m^3)	5000 mg/m^3 (Listed under Molybdenum)

Calcite (13397-26-7)		
Alberta	OEL TWA (mg/m^3)	10 mg/m^3

Particulates not otherwise classified (PNOC)		
USA ACGIH	ACGIH TWA (mg/m^3)	3 mg/m^3 Respirable fraction 10 mg/m^3 Total Dust
USA OSHA	OSHA PEL (TWA) (mg/m^3)	5 mg/m^3 Respirable fraction 15 mg/m^3 Total Dust
Alberta	OEL TWA (mg/m^3)	10 mg/m^3 (total) 3 mg/m^3 (respirable)
British Columbia	OEL TWA (mg/m^3)	10 mg/m^3 (nuisance dust-total dust) 3 mg/m^3 (nuisance dust-respirable fraction)
Manitoba	OEL TWA (mg/m^3)	10 mg/m^3 (inhalable particles, recommended) 3 mg/m^3 (respirable particles, recommended)
New Brunswick	OEL TWA (mg/m^3)	3 mg/m^3 (particulate matter containing no Asbestos and <1% Crystalline silica, respirable fraction) 10 mg/m^3 (particulate matter containing no Asbestos and <1% Crystalline silica, inhalable fraction)
Newfoundland & Labrador	OEL TWA (mg/m^3)	10 mg/m^3 (inhalable particles, recommended) 3 mg/m^3 (respirable particles, recommended)
Nova Scotia	OEL TWA (mg/m^3)	10 mg/m^3 (inhalable particles, recommended) 3 mg/m^3 (respirable particles, recommended)
Nunavut	OEL STEL (mg/m^3)	20 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 6 mg/m^3 (insoluble or poorly soluble-respirable fraction)
Nunavut	OEL TWA (mg/m^3)	10 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 3 mg/m^3 (insoluble or poorly soluble-respirable fraction)
Northwest Territories	OEL STEL (mg/m^3)	20 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 6 mg/m^3 (insoluble or poorly soluble-respirable fraction)

Northwest Territories	OEL TWA (mg/m^3)	10 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 3 mg/m^3 (insoluble or poorly soluble-respirable fraction)
Ontario	OEL TWA (mg/m^3)	10 mg/m^3 (inhalable) 3 mg/m^3 (respirable)
Prince Edward Island	OEL TWA (mg/m^3)	10 mg/m^3 (inhalable particles, recommended) 3 mg/m^3 (respirable particles, recommended)
Québec	VEMP (mg/m^3)	10 mg/m^3 (including dust, inert or nuisance particulates-total dust)
Saskatchewan	OEL STEL (mg/m^3)	20 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 6 mg/m^3 (insoluble or poorly soluble-respirable fraction)
Saskatchewan	OEL TWA (mg/m^3)	10 mg/m^3 (insoluble or poorly soluble-inhalable fraction) 3 mg/m^3 (insoluble or poorly soluble-respirable fraction)

8.2. Exposure Controls

Appropriate Engineering Controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Ensure adequate ventilation, especially in confined areas. Ensure all national/local regulations are observed.

Personal Protective Equipment: Gloves. Protective clothing. Protective goggles. Insufficient ventilation: wear respiratory protection.

Materials for Protective Clothing: Chemically resistant materials and fabrics.

Hand Protection: Wear protective gloves.

Eye and Face Protection: Chemical safety goggles.

Skin and Body Protection: Wear suitable protective clothing.

Respiratory Protection: If exposure limits are exceeded or irritation is experienced, approved respiratory protection should be worn. In case of inadequate ventilation, oxygen deficient atmosphere, or where exposure levels are not known wear approved respiratory protection.

Other Information: When using, do not eat, drink or smoke.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on Basic Physical and Chemical Properties

Physical State	:	Solid
Appearance	:	Dark green/greenish or black, fine powder
Odor	:	None
Odor Threshold	:	Not available
pH	:	4.07 - 7.15 s.u.
Evaporation Rate	:	Not available
Melting Point	:	900 - 1170 °C (1652 - 2138 °F)
Freezing Point	:	Not available
Boiling Point	:	2595 °C (4703 °F)
Flash Point	:	Not applicable
Auto-ignition Temperature	:	> 400 °C (752 °F)
Decomposition Temperature	:	> 900 °C (1652 °F)
Flammability (solid, gas)	:	Not flammable
Lower Flammable Limit	:	Not available
Upper Flammable Limit	:	Not available
Vapor Pressure	:	Not available
Relative Vapor Density at 20°C	:	Not available
Relative Density	:	1.1 - 1.3 g/cm^3 @ 20 °C (68 °F)
Specific Gravity	:	4.1 - 4.5

Solubility	:	Low solubility
Partition Coefficient: N-Octanol/Water	:	Not available
Viscosity	:	Not available

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity: Incompatible with acids. When combined with acid, may release a toxic gas or represent an explosive risk. Quartz (silica) will dissolve in hydrofluoric acid producing a corrosive gas, silicon tetrafluoride.

10.2. Chemical Stability: Stable under recommended handling and storage conditions (see section 7).

10.3. Possibility of Hazardous Reactions: Hazardous polymerization will not occur.

10.4. Conditions to Avoid: Extremely high temperatures and incompatible materials.

10.5. Incompatible Materials: Strong acids. Strong oxidizers. Halogenated compounds. Acetylene.

10.6. Hazardous Decomposition Products: Will give off sulfur dioxide gas under extreme heat or exposed to fire.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on Toxicological Effects - Product

Acute Toxicity (Oral): Not classified
Acute Toxicity (Dermal): Not classified
Acute Toxicity (Inhalation): Not classified
LD50 and LC50 Data: Not available

Skin Corrosion/Irritation: Not classified
pH: 4.07 - 7.15 s.u.

Eye Damage/Irritation: Not classified
pH: 4.07 - 7.15 s.u.

Respiratory or Skin Sensitization: Not classified

Germ Cell Mutagenicity: Not classified

Carcinogenicity: May cause cancer (Inhalation).

Specific Target Organ Toxicity (Repeated Exposure): Causes damage to organs (lung/respiratory system) through prolonged or repeated exposure (Inhalation).

Reproductive Toxicity: Not classified

Specific Target Organ Toxicity (Single Exposure): Not classified

Aspiration Hazard: Not classified
Symptoms/Injuries After Inhalation: Prolonged exposure may cause irritation.
Symptoms/Injuries After Skin Contact: Prolonged exposure may cause skin irritation.
Symptoms/Injuries After Eye Contact: May cause slight irritation to eyes.
Symptoms/Injuries After Ingestion: Ingestion may cause adverse effects.
Chronic Symptoms: Long term exposure to respirable crystalline silica results in a significant risk of developing silicosis and other non-malignant respiratory disease, lung cancer, kidney effects, and immune system effects.

11.2. Information on Toxicological Effects - Ingredient(s)

LD50 and LC50 Data:

Quartz (14808-60-7)	
LD50 Oral Rat	> 5000 mg/kg
LD50 Dermal Rat	> 5000 mg/kg

Zinc sulfide (1314-98-3)	
LD50 Oral Rat	> 2 g/kg
LC50 Inhalation Rat	> 5040 mg/m³ (Exposure time: 4 h)

Molybdenum sulfide (1317-33-5)	
LC50 Inhalation Rat	> 2820 mg/m³ (Exposure time: 4 h)

Quartz (14808-60-7)	
IARC Group	1
National Toxicology Program (NTP) Status	Known Human Carcinogens.
OSHA Hazard Communication Carcinogen List	In OSHA Hazard Communication Carcinogen list.

Hematite (1317-60-8)

IARC Group	3

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Ecology - General: Toxic to aquatic life.

Copper Concentrate	
Ecology - Water	The physical form (solid) and the physico-chemical properties (constituents are poorly soluble in water) limit the solubility of constituents in aquatic environment and subsequently their potential uptake. The toxicity is therefore primarily related to the degree to which the metal mineral phases react with aquatic environment and release soluble, potentially bio available ionic species. For the environmental classification short term transformation/dissolution tests (7 days, pH 6, loading of 1 and 100 mg/L in the standard aqueous medium) in accordance to a standard protocol (OECD 29) were carried out on 10 selected copper concentrates and 8 minerals (Rodriguez et al, 2010-2012). Relative metal release rates, measured at 1 and 100 mg/L, are usually a bit higher at 1 mg/L than at 100 mg/L. Consistent with the mineralogical profile of copper minerals and copper concentrates, metal release rates (Cu, Zn, Pb, As, Cd, Ni…) after acute transformation/dissolution demonstrate lower bioavailability of the metals from the minerals and concentrates compared to the soluble metal compounds with known hazard profile. The mineral-specific Cu release rates (0.8% Cu for Chalcopyrite, 0.8% for Diginite, 0.9% for covellite, 1.3% Cu for Enargite, 3.4% for Tennantite, 4.4 % Bornite and 9.9% for Chalcocite) and worst case release rates for the other metals (12% As, 9 % Zn, 42% Pb, 7% Ni, 9.7% Cd, 11.7% Co), assessed at mass loadings of 1 mg/L, are applied to the composition (see section 3.1) to calculate the potential concentrations of the metal ions transformed/dissolved in the standard aqueous medium (OECD 29) at 1,10 and 100mg/l. In accordance to the GHS hazard classification system, the evaluation of the short term aquatic toxicity is accomplished by comparison of (a) the calculate concentrations of the metal ions transformed/dissolved in the standard aqueous medium (OECD 29) at 1, 10 and 100mg/L and (b) the appropriate standard ecotoxicity data as determined from tests carried out with the soluble metal species (acute L(E)C50 values). To derive the aquatic hazard classification, a Toxic Unit (TU) approach was applied assuming additive metal toxicity (in accordance to the GHS guidance for mixtures). The assessment demonstrated that no acute environmental toxicity is observed at a loading of 1 mg/L (TU<1). Environmental toxicity is observed at loadings >= 10 mg/L (TU>1). In accordance to GHS 2011, this leads to acute 2 classification entry. The comparison was done using the ECI December 2012 excel version of the Meclas l tool (http://www.meclas.eu) Chronic aquatic toxicity: Based on the information available, the classification criteria are not met. Assessment summary - chronic : Long term transformation/dissolution tests (28 days, pH 6, loading of 1 mg/L in the standard aqueous medium), in accordance to a standard protocol (OECD 29), were carried out on 10 selected copper concentrates and 8 minerals (Rodriguez et al, 2010-2012). Consistent with the mineralogical profile of copper minerals and copper concentrates, metal release rates (Cu, Zn, Pb, As, Cd, Ni, Co, Ag) after long term transformation/dissolution demonstrate lower bioavailability of the metals from the concentrates compared to the soluble metal compounds with known hazard profile. The mineral-specific Cu release rates (0.9% for Chalcopyrite, 2.2% for Enargite 2.2% for covellite, 2.7% for Diginite, 5.8% for Tennantite, 7 % Bornite and 20.9% for Chalcocite) and

	the worst case release rates for the other metals (27% As, 20% Zn, 53% Pb, 29% Ni, 9.7% Cd, 30% Co) are applied to the composition (see section 3.1) to calculate the potential concentrations of the metal ions transformed/dissolved in the standard aqueous medium (OECD 29) at 1, 0.1, and 0.01 mg/l. In accordance to the GHS hazard classification system, the evaluation of the long term aquatic toxicity is accomplished by comparison of (a) the calculated concentrations of the metal ions transformed/dissolved in the standard aqueous medium (OECD 29) at 1, 0.1, 0.01 mg/l (loading depending if the metal is rapidly removed) and (b) the appropriate standard eco toxicity data as determined from tests carried out with the soluble metal species (chronic NOEC/EC10 values). To derive the aquatic hazard classification, a Toxic Unit (TU) approach was applied assuming additive metal toxicity (in accordance to the GHS guidance for mixtures). The comparison was done using the MECLAS excel tool (http://www.meclas.eu) and demonstrated that the chronic environmental classification criteria are not met. Environment hazards, Transport in Bulk According to Annex II of MARPOL 73/78 and the IBC Code, MARPOL Annex V: The TDP test on Robinson concentrate and has shown that the concentrate is not harmful to the marine environment.

12.2. Persistence and Degradability

Copper Concentrate	
Persistence and Degradability	It has been recognized (GHS guidance) that “rapid degradability” as defined for organic substances does not apply to metals. In accordance to GHS 2011, information on changes in metal speciation, absorption, deposition and remobilization in the water-column and sediment have been assessed for copper (Rader et al, 2010), lead, zinc and other single metals (Rader et al, 2012a) and copper concentrates (Rader et al, 2012b). The model simulations are based on “The Tableau Input Coupled Kinetics Equilibrium Transport Unit World Model for Metals in Lakes” (http://blog.unitworldmodel.net), which was developed to address the complexities of metal speciation and its influence on the fate and effects of metals in the environment. The model output was validated with information from laboratory mesocosm and field tests. The assessed showed that at least for “copper, zinc and lead” the information on “removal rates from the water-column, deposition and absence of remobilization” can be considered as equivalent to “rapid degradation” of organic substances.

12.3. Bioaccumulative Potential

Copper Concentrate	
Bioaccumulative Potential	The copper Risk Assessment Report (2008) and REACH Chemical Safety Report (2010) have provided detailed information on (1) the essentiality of copper; (2) the homeostatic control of copper; (3) the mechanisms of action of copper-ions; (4) the comparison between copper toxicity from dietary versus waterborne exposures. From the information it has been concluded that the bio-accumulation criterion does not apply to the essential element copper. Similarly, in the zinc risk assessment and chemical safety report (2010), it has been concluded that the bio-accumulation criterion does not apply to the essential element zinc. No data available for other metals.

12.4. Mobility in Soil

Not available

12.5. Other Adverse Effects

Other Information: Avoid release to the environment.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste Disposal Recommendations: Dispose of contents/container in accordance with local, regional, national, territorial, provincial, and international regulations.

Ecology - Waste Materials: Avoid release to the environment. This material is hazardous to the aquatic environment. Keep out of sewers and waterways.

SECTION 14: TRANSPORT INFORMATION

The shipping description(s) stated herein were prepared in accordance with certain assumptions at the time the SDS was authored, and can vary based on a number of variables that may or may not have been known at the time the SDS was issued. Though this product does not meet the definition of a marine pollutant, Appendix B to the 49 CFR 172.101 states this product may be transported as a marine pollutant in accordance with the applicable requirements.

14.1. In Accordance with DOT

Proper Shipping Name : ENVIRONMENTALLY HAZARDOUS SUBSTANCES, SOLID, N.O.S. (Contains copper, zinc)
Hazard Class : 9
Identification Number : UN3077
Label Codes : 9

Packing Group : III
ERG Number : 171

14.2. In Accordance with IMDG

Proper Shipping Name : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (Contains copper, zinc)
Hazard Class : 9
Identification Number : UN3077
Label Codes : 9

Packing Group : III
EmS-No. (Fire) : F-A
EmS-No. (Spillage) : S-F

14.3. In Accordance with IATA

Proper Shipping Name : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (Contains copper, zinc)
Identification Number : 9
Hazard Class : UN3077
Label Codes : 9

Packing Group : III
ERG Code (IATA) : 9L

14.4. In Accordance with TDG

Proper Shipping Name : ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (Contains copper, zinc)
Hazard Class : 9
Identification Number : UN3077
Label Codes : 9

Packing Group : III

SECTION 15: REGULATORY INFORMATION

15.1. US Federal Regulations

Copper Concentrate	
SARA Section 311/312 Hazard Classes	Delayed (chronic) health hazard

15.2. US State Regulations

Quartz (14808-60-7)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Molybdenum sulfide (1317-33-5)
U.S. - Massachusetts - Right To Know List

15.3. Canadian Regulations

Pyrite (FeS2) (1309-36-0)
Listed on the Canadian NDSL (Non-Domestic Substances List)

Quartz (14808-60-7)
Listed on the Canadian DSL (Domestic Substances List)

Zinc sulfide (1314-98-3)
Listed on the Canadian DSL (Domestic Substances List)

Molybdenum sulfide (1317-33-5)
Listed on the Canadian DSL (Domestic Substances List)

Copper(I) sulfide (22205-45-4)
Listed on the Canadian DSL (Domestic Substances List)

Clays (1302-87-0)
Listed on the Canadian DSL (Domestic Substances List)

Hematite (1317-60-8)
Listed on the Canadian NDSL (Non-Domestic Substances List)

SECTION 16: OTHER INFORMATION, INCLUDING DATE OF PREPARATION OR LAST REVISION

Date of Preparation or Latest Revision : 12/18/2017

Other Information : This document has been prepared in accordance with the SDS requirements of the OSHA Hazard Communication Standard 29 CFR 1910.1200 and Canada’s Hazardous Products Regulations (HPR) SOR/2015-17.

GHS Full Text Phrases:

Aquatic Acute 2	Hazardous to the aquatic environment - Acute Hazard Category 2
Carc. 1A	Carcinogenicity Category 1A
STOT RE 1	Specific target organ toxicity (repeated exposure) Category 1
STOT SE 3	Specific target organ toxicity (single exposure) Category 3
H335	May cause respiratory irritation
H350	May cause cancer
H372	Causes damage to organs through prolonged or repeated exposure
H401	Toxic to aquatic life

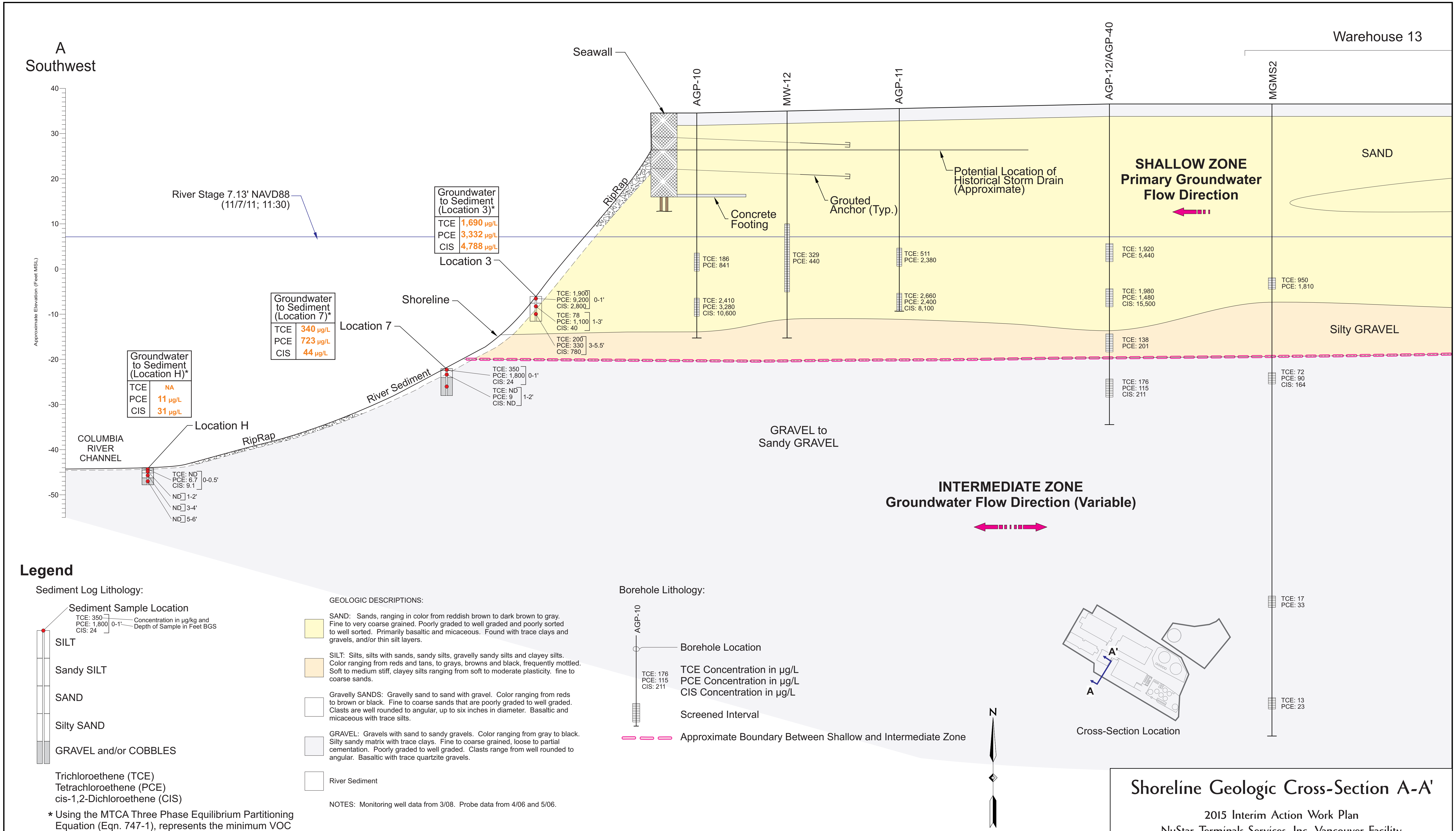
NA GHS SDS 2015 (Can, US, Mex)

APPENDIX B

GEOLOGIC CROSS-SECTIONS

AND

SHORELINE BATHYMETRY



Legend

Sediment Log Lithology:

- SILT
- Sandy SILT
- SAND
- Silty SAND
- GRAVEL and/or COBBLES

Trichloroethene (TCE)
Tetrachloroethene (PCE)
cis-1,2-Dichloroethene (CIS)

* Using the MTCA Three Phase Equilibrium Partitioning Equation (Eqn. 747-1), represents the minimum VOC concentration in groundwater needed to partition to sediments at the concentration present in the surface-most sediment sample. Concentration data for the surface-most sediment sample are depicted on the sediment core diagram.

GEOLOGIC DESCRIPTIONS:

SAND: Sands, ranging in color from reddish brown to dark brown to gray. Fine to very coarse grained. Poorly graded to well graded and poorly sorted to well sorted. Primarily basaltic and micaceous. Found with trace clays and gravels, and/or thin silt layers.

SILT: Silts, silts with sands, sandy silts, gravelly sandy silts and clayey silts. Color ranging from reds and tans, to grays, browns and black, frequently mottled. Soft to medium stiff, clayey silts ranging from soft to moderate plasticity. fine to coarse sands.

Gravelly SANDS: Gravelly sand to sand with gravel. Color ranging from reds to brown or black. Fine to coarse sands that are poorly graded to well graded. Clasts are well rounded to angular, up to six inches in diameter. Basaltic and micaceous with trace silts.

GRAVEL: Gravels with sand to sandy gravels. Color ranging from gray to black. Silty sandy matrix with trace clays. Fine to coarse grained, loose to partial cementation. Poorly graded to well graded. Clasts range from well rounded to angular. Basaltic with trace quartzite gravels.

River Sediment

NOTES: Monitoring well data from 3/08. Probe data from 4/06 and 5/06.

Borehole Lithology:

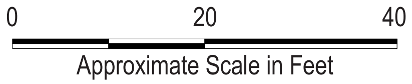
Borehole Location

TCE Concentration in µg/L
PCE Concentration in µg/L
CIS Concentration in µg/L

Screened Interval

Approximate Boundary Between Shallow and Intermediate Zone

Cross-Section Location



Approximate Scale in Feet

NOTE: Mean Sea Level (MSL) referenced to NAVD88 Datum.

Shoreline Geologic Cross-Section A-A'

2015 Interim Action Work Plan
NuStar Terminals Services, Inc. Vancouver Facility
Vancouver, Washington

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number	1126-17	Figure
September 2015		12

Parametrix Date: 9/8/2014 Path: P:\GIS\POV\MXD_PDF\Figures_01082014\Figure2-2_CrossSectionOrientation_V2.mxd

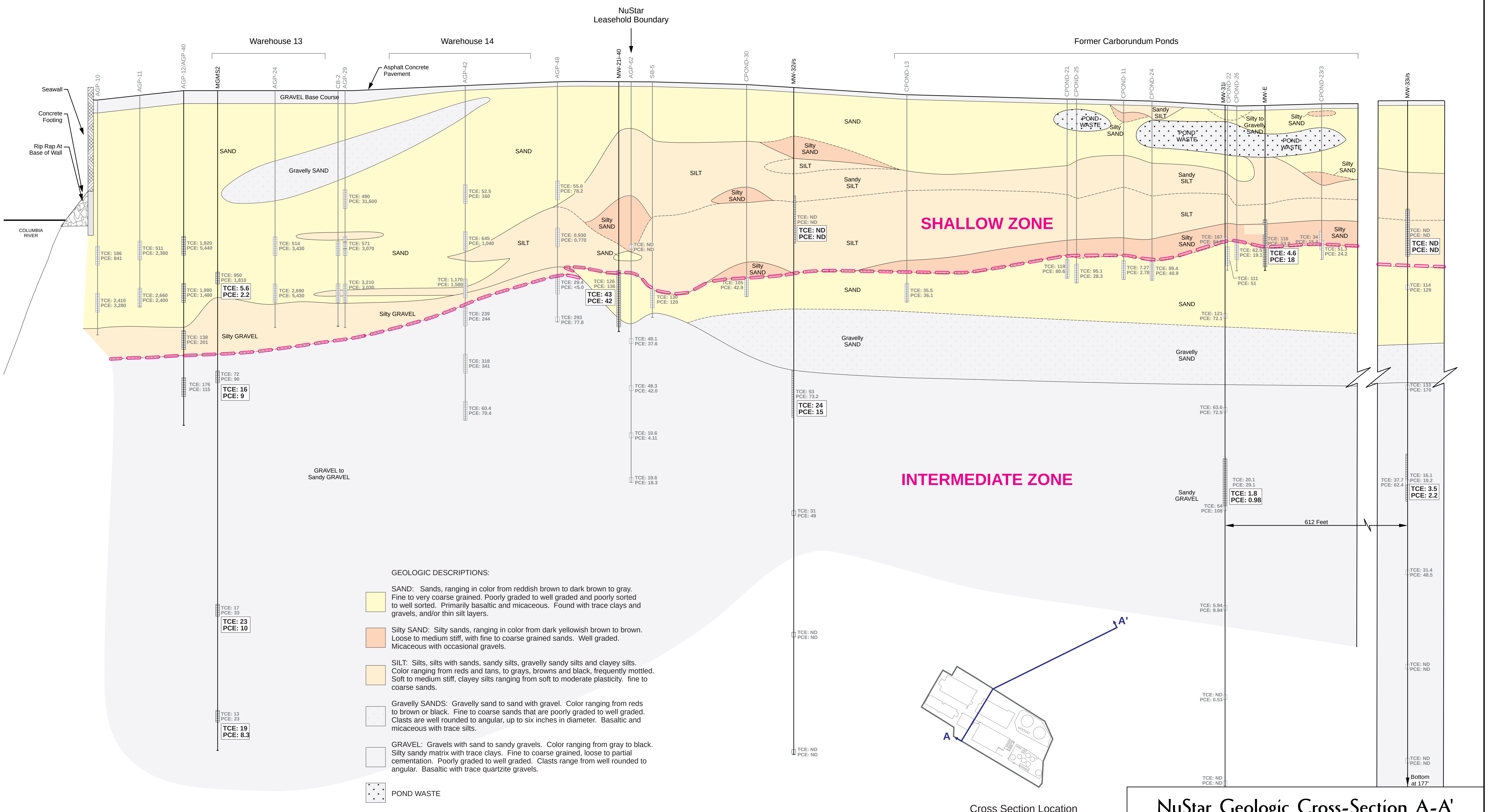
N

0 250 500
Scale in Feet

⬠ SMC Site Well
⬠ Cadet Manufacturing Well
⬠ NuStar Well
■ Recirculating Well
⬠ Carborundum Well
— Cross Section Location

Figure 2-2
Cross Section Orientations

Feasibility Study
NuStar, SMC, and Cadet
Vancouver, WA



GEOLOGIC DESCRIPTIONS:

SAND: Sands, ranging in color from reddish brown to dark brown to gray. Fine to very coarse grained. Poorly graded to well graded and poorly sorted to well sorted. Primarily basaltic and micaceous. Found with trace clays and gravels, and/or thin silt layers.

Silty SAND: Silty sands, ranging in color from dark yellowish brown to brown. Loose to medium stiff, with fine to coarse grained sands. Well graded. Micaceous with occasional gravels.

SILT: Silts, silts with sands, sandy silts, gravelly sandy silts and clayey silts. Color ranging from reds and tans, to grays, browns and black, frequently mottled. Soft to medium stiff, clayey silts ranging from soft to moderate plasticity. fine to coarse sands.

Gravelly SANDS: Gravelly sand to sand with gravel. Color ranging from reds to brown or black. Fine to coarse sands that are poorly graded to well graded. Clasts are well rounded to angular, up to six inches in diameter. Basaltic and micaceous with trace silts.

GRAVEL: Gravels with sand to sandy gravels. Color ranging from gray to black. Silty sandy matrix with trace clays. Fine to coarse grained, loose to partial cementation. Poorly graded to well graded. Clasts range from well rounded to angular. Basaltic with trace quartzite gravels.

POND WASTE

Cross Section Location

Legend:

Borehole

TCE: 176 PCE: 115 — Recent Trichloroethene (TCE) Concentration in µg/L
Recent Tetrachloroethene (PCE) Concentration in µg/L

TCE: 176 PCE: 115 — Historical TCE Concentration in µg/L
Historical PCE Concentration in µg/L

Screened Interval

Depth Discrete Sample Location

Sampling Notes:

1. Historical Data (in grey):
   a. NuStar (AGP) data from 2006; “SB” boring data from March 2005.
   b. Off-facility well data from March 2006; “C-Pond” data collected by Parametrix in March 2005.
   c. Historical monitoring well data from March/June 2008.
   d. Boring CB-2 data from September 2010.
   e. Depth discreet data from POV wells MW-31i and MW33i/s are from January 2003 and July/August 2004, respectively.
2. Recent Data (in black; boxed):
   a. Monitoring well data from March 2013.
3. ND = Not detected (reporting limit of 0.5 µg/L unless otherwise specified).

Approximate Horizontal Scale in Feet
0 100 200
0 20 40
Approximate Vertical Scale in Feet
Vertical Exaggeration x 5

NuStar Geologic Cross-Section A-A'

Feasibility Study
NuStar Terminals Services, Inc. Vancouver Facility
Vancouver, Washington

Apex Companies, LLC
3015 SW First Avenue
Portland, Oregon 97201

Project Number	1126-14	Figure
March 2014		2-6

SHEET INDEX:

C1 : PROJECT INFORMATION
~~S1 : TERMINAL 1~~
~~S2 : GENERAL BATHYMETRY~~
S3 : GENERAL BATHYMETRY
S4 : GRAIN TERMINAL & BERTH 1
S5 : BERTHS 2 - 4
S6 : BERTH 5
S7 : BERTHS 8 - 9
S8 : BERTH 10
S9 : BERTHS 13 - 14
S10: BERTHS 14
~~S11: GENERAL BATHYMETRY~~
~~S12: GENERAL BATHYMETRY~~
~~S13: GENERAL BATHYMETRY~~
~~S14: GENERAL BATHYMETRY~~
~~S15 : FLUSHING CHANNEL GENERAL~~
~~S16 : FLUSHING DETAIL~~

THIS HYDROGRAPHIC SURVEY WAS COMPLETED UNDER THE OVERSIGHT OF AN ACSM/THSOA CERTIFIED HYDROGRAPHER

David R. Neff C.H.(275)

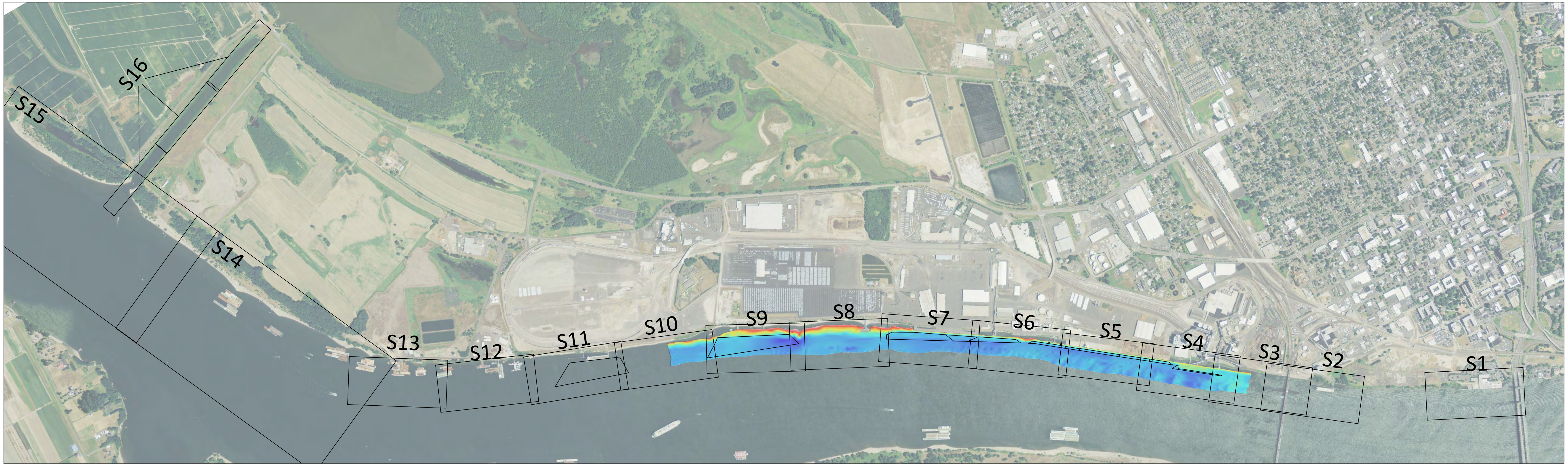
PORT OF VANCOUVER, WASHINGTON

Multibeam Conditional Survey

GENERAL NOTES:

1. SURVEY DATA COLLECTED BY ETRAC INC, ON MARCH 23-24, & MARCH 26, 2020.
2. HORIZONTAL DATUM/PROJECTION: NAD83/SPCS WA SOUTH - US SURVEY FEET.
3. VERTICAL DATUM: COLUMBIA RIVER DATUM (FEET)
4. HORIZONTAL/VERTICAL CONTROL: WASHINGTON STATE REFERENCE NETWORK STATION: PDXA
5. POSITION AND MOTION DATA WERE COLLECTED USING TRIMBLE MPS 500 IMU.
6. SOUNDINGS WERE COLLECTED USING AN R2SONIC 2020 MULTIBEAM SONAR.
7. BATHYMETRIC INFORMATION IS ONLY VALID FOR THE TIME IN WHICH THE SURVEY WAS CONDUCTED.
8. SOUNDINGS ARE NEGATIVE UNLESS OTHERWISE INDICATED.
9. THE SOUNDINGS IN THIS DOCUMENT ARE DISPLAYED IN A 10x10 GRID.

Overview



not to scale

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3103 N.W. LOWER RIVER ROAD
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TEL: 360-693-3611
FAX: 360-735-1565

eTrac

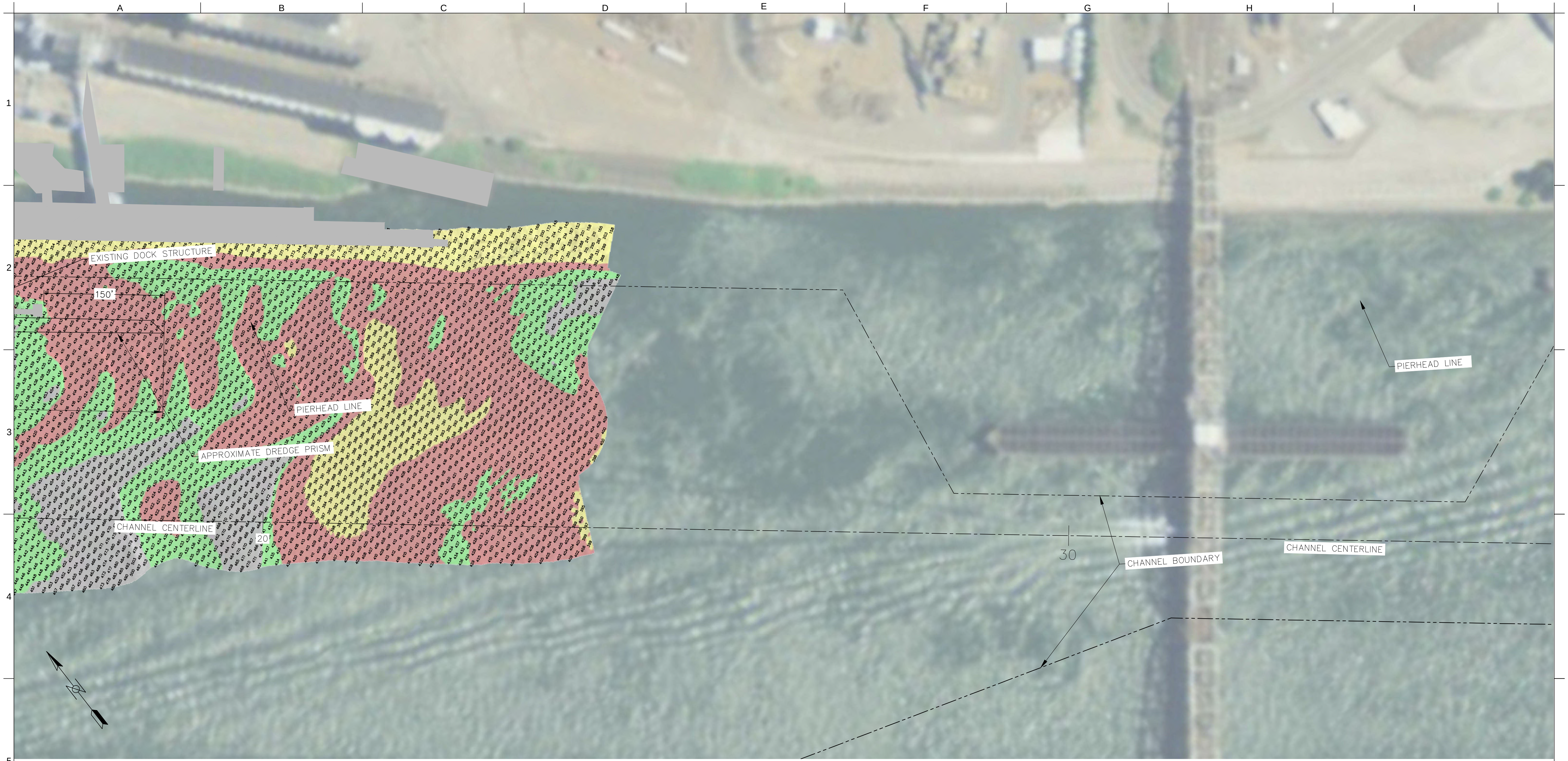
207 E RESERVE ST
SUITE 103
VANCOUVER, WA 98661
415.462.0421
eTracInc.com

DATE: MARCH 30, 2020
DESIGNED BY: RG | CHECKED BY: BC
CONTRACT #:
PERMIT #: EPISODE #:
PROJECT NAME:
PVAN_2020_PORT OF VANCOUVER

PORT OF VANCOUVER, U.S.A.
MULTIBEAM SURVEY
CONDITIONAL

Project Information

Reference Number:
C1



—·—·—·— CHANNEL CENTERLINE
—··—··— CHANNEL BOUNDARY
—•—•—•— FACE OF FENDER PILE
- - - - - - APPROXIMATE DREDGE PRISM
▨ EXISTING DOCK STRUCTURE

Color Bar – Depth
🟨 SOUNDING < 40.0
🟥 40.0 < SOUNDING < 43.0
🟩 43.0 < SOUNDING < 45.0
⬛ SOUNDING > 45.0

6

0 60 120
SCALE IN FEET

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SAN RAFAEL, CA 94901
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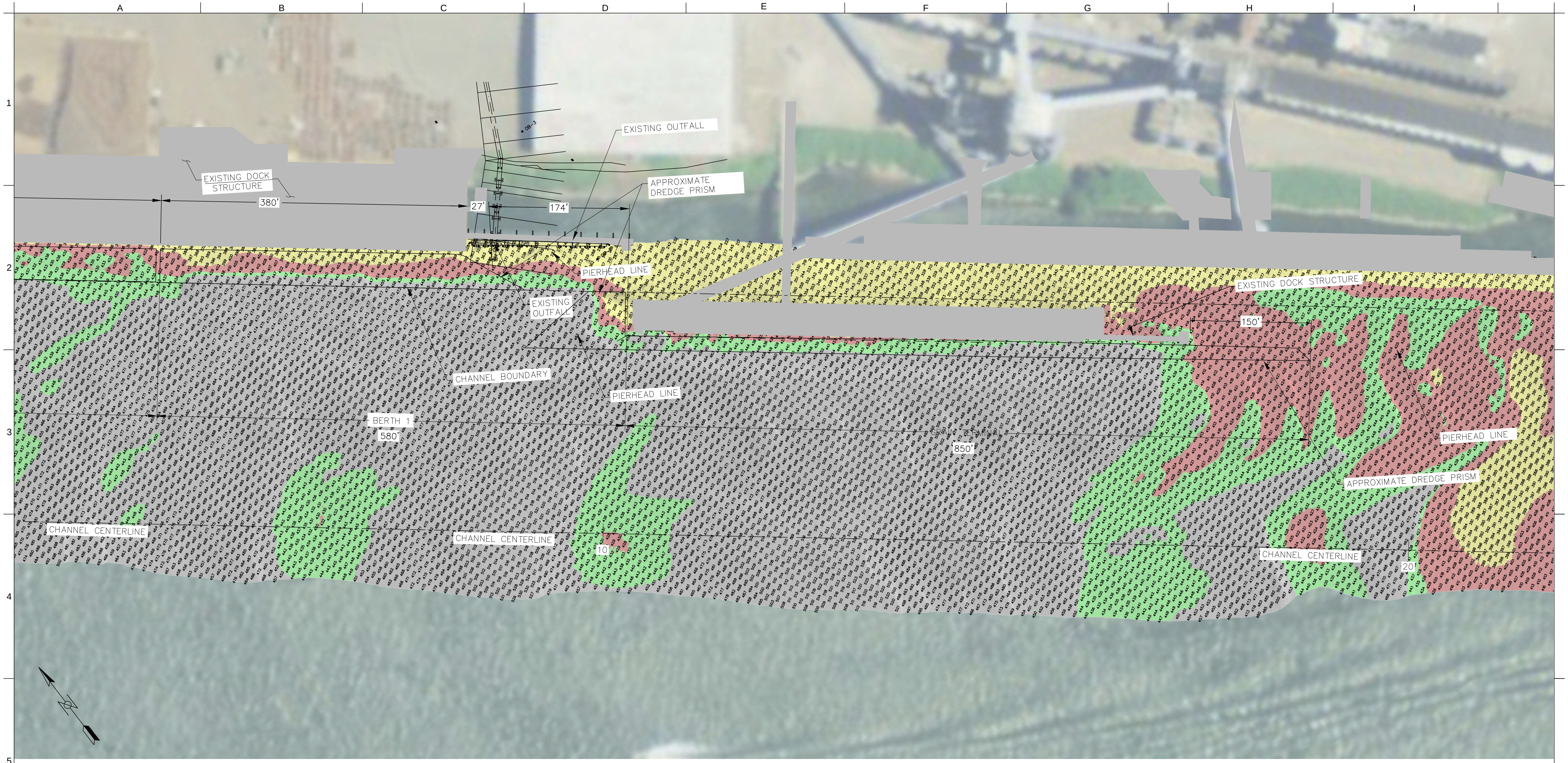

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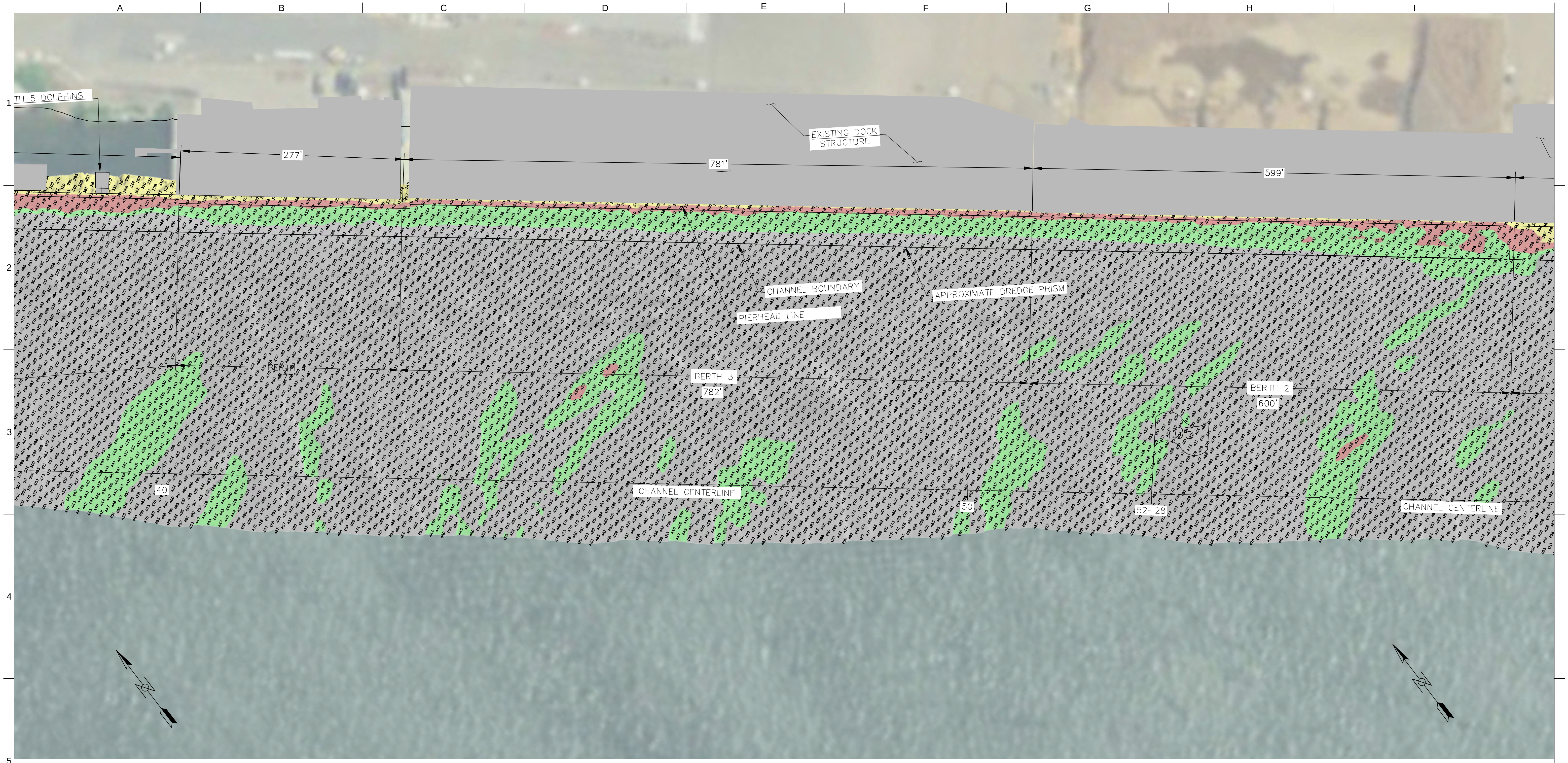

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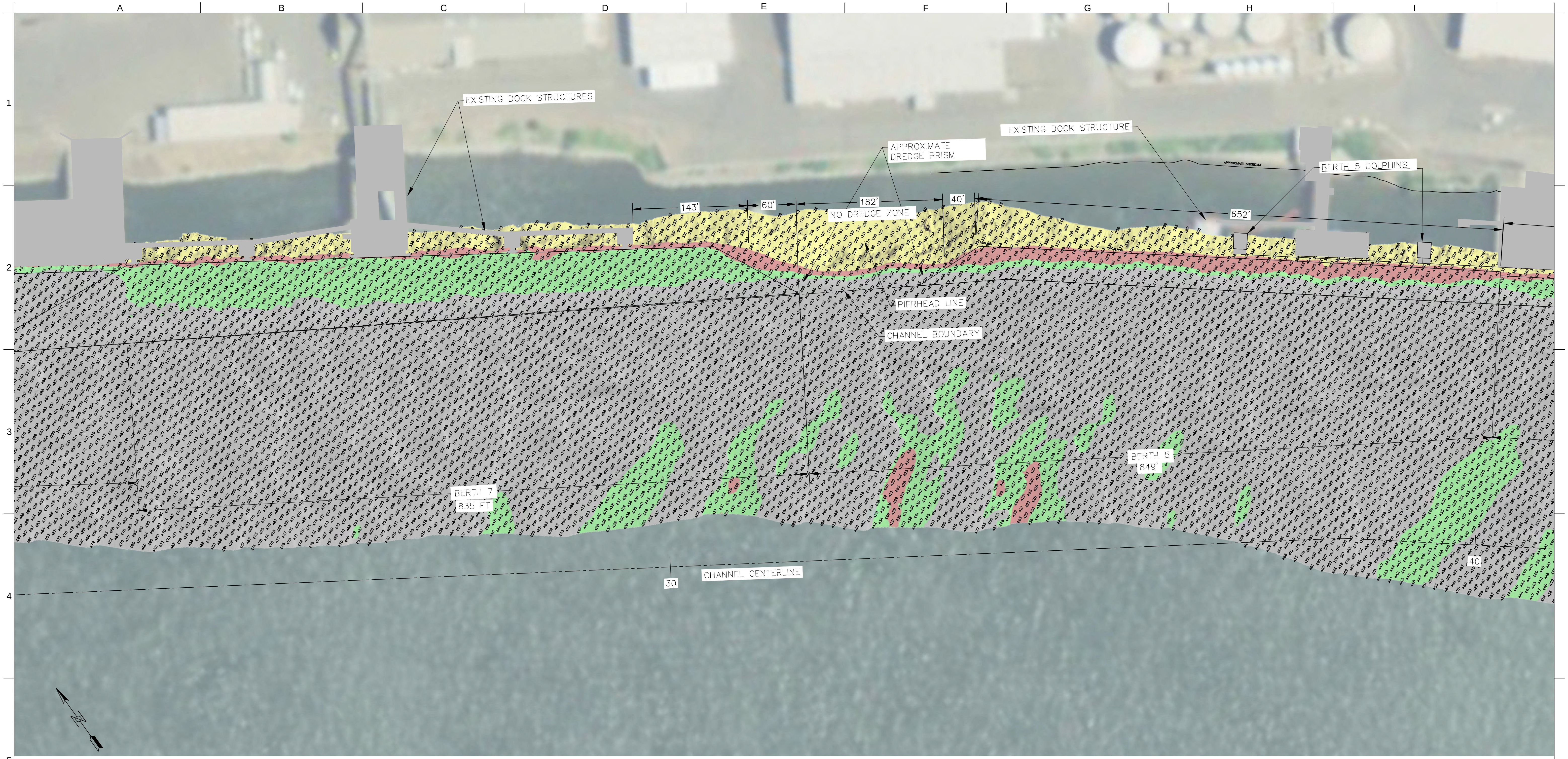

— - — - — CHANNEL CENTERLINE

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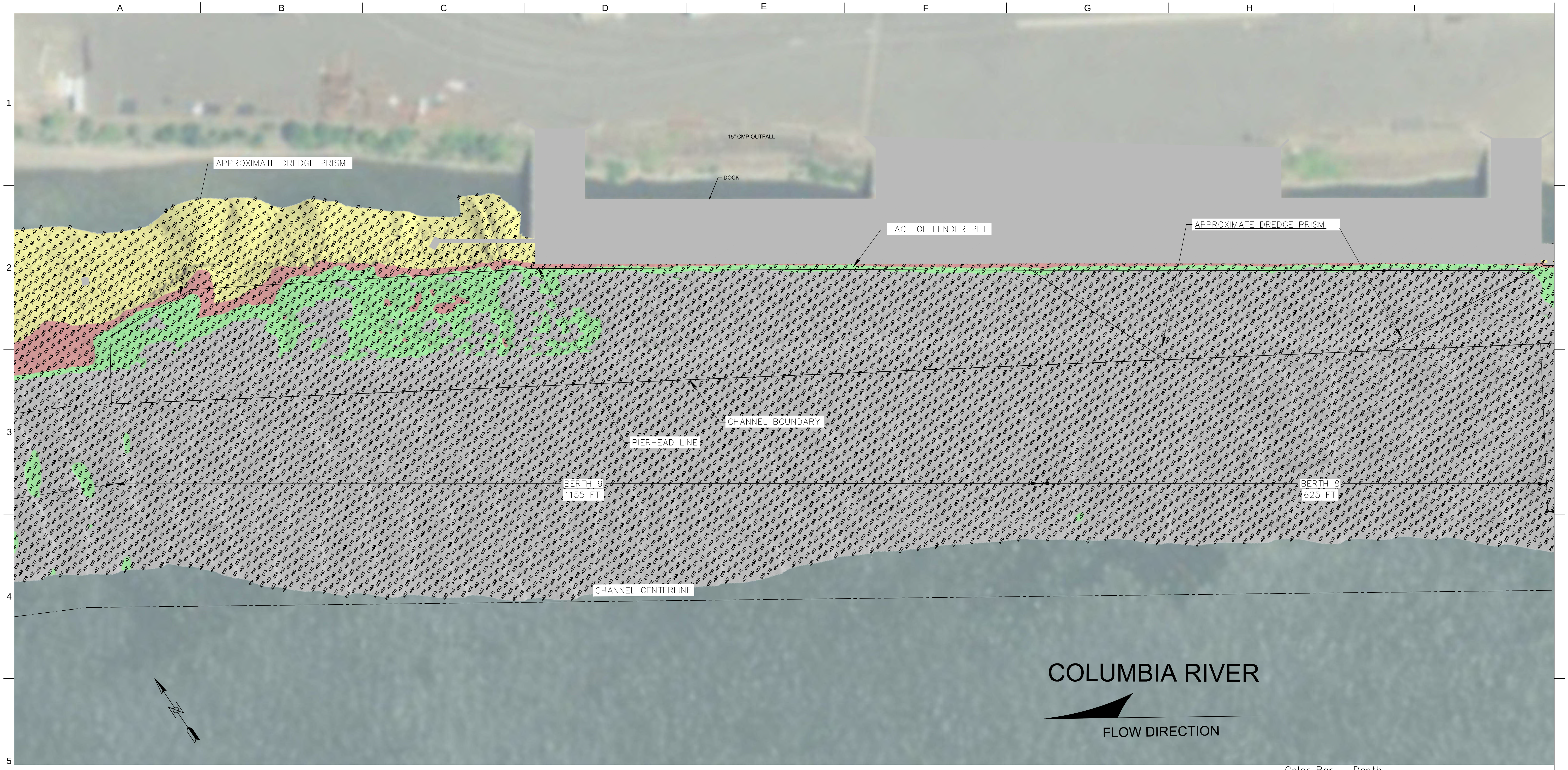

CHANNEL CENTERLINE
CHANNEL BOUNDARY
FACE OF FENDER PILE
APPROXIMATE DREDGE PRISM
EXISTING DOCK STRUCTURE

Color Bar – Depth

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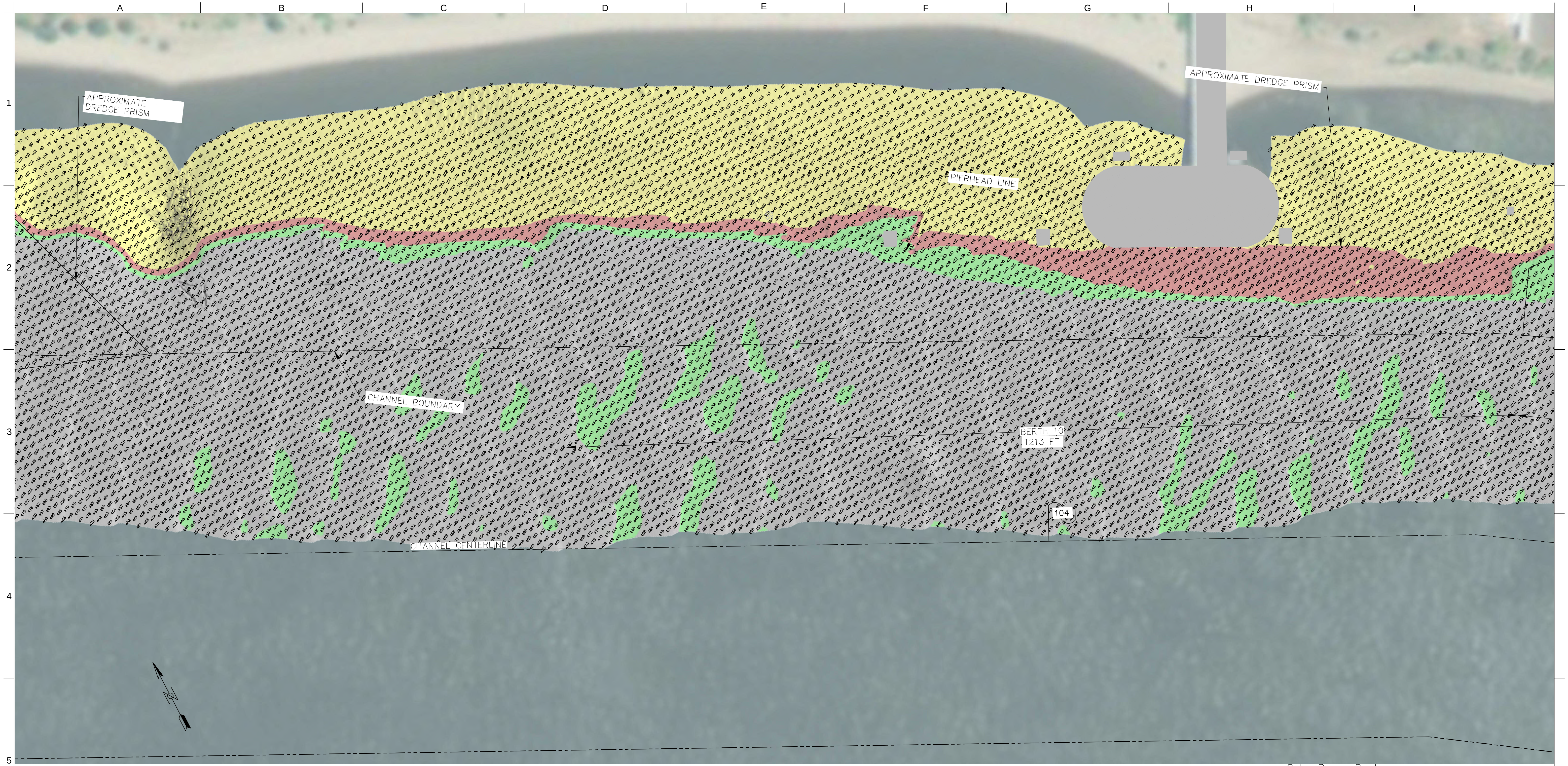

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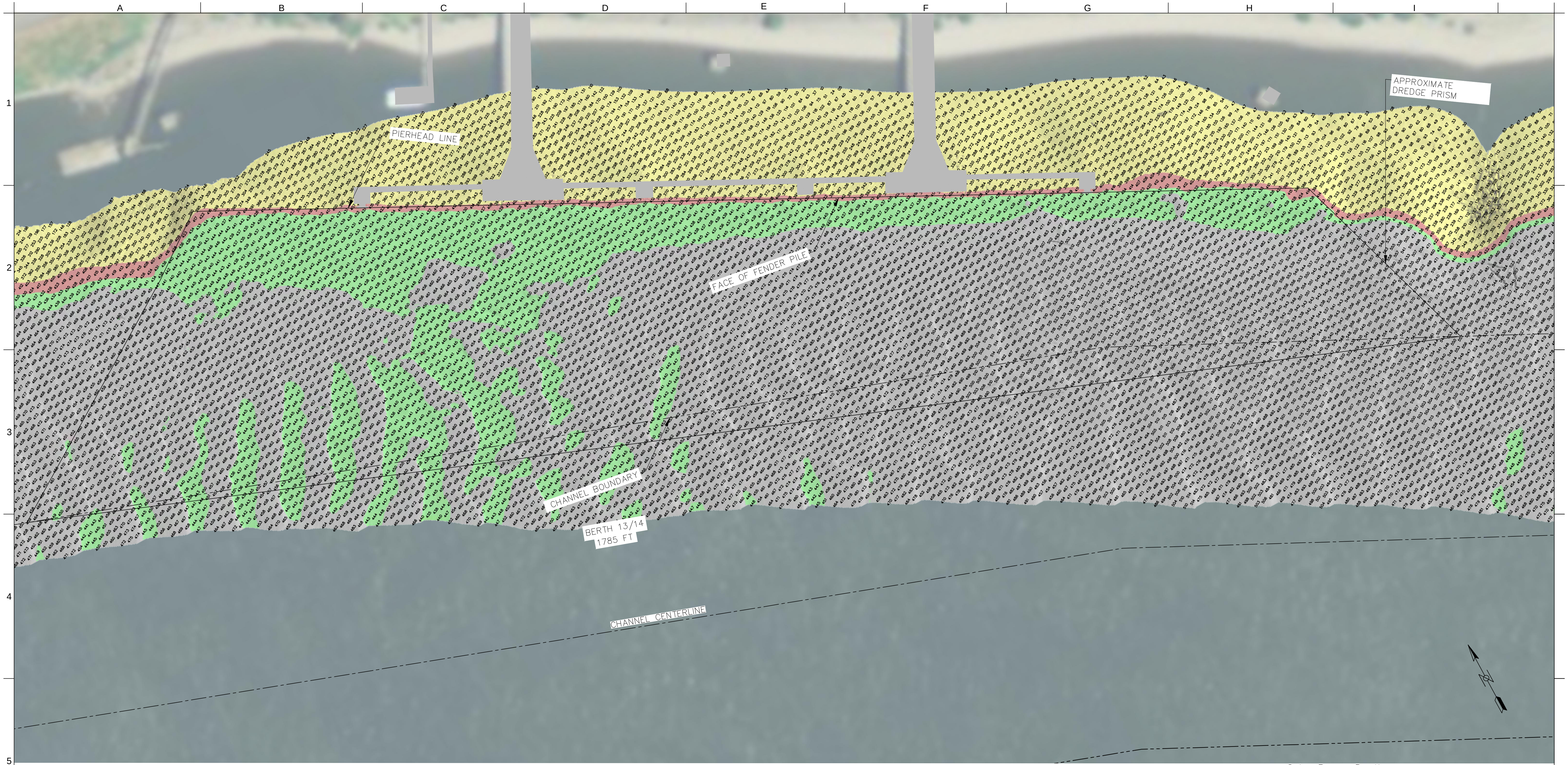
DESIGNED BY: RG | CHECKED BY: BDC
CONTRACT #:
PERMIT #: EPISODE #:
PROJECT NAME:
PVAN_2020_PORT OF VANCOUVER

PORT OF VANCOUVER, U.S.A.
MULTIBEAM SURVEY
CONDITIONAL

DEM and Soundings

Reference Number:
S8



— · — · — CHANNEL CENTERLINE
—··—··— CHANNEL BOUNDARY
—·—·—·— FACE OF FENDER PILE
- - - - - - APPROXIMATE DREDGE PRISM
▨ EXISTING DOCK STRUCTURE

Color Bar – Depth
🟨 SOUNDING < 40.0
🟥 40.0 < SOUNDING < 43.0
🟩 43.0 < SOUNDING < 45.0
⬛ SOUNDING > 45.0

0 60 120
SCALE IN FEET

PORT OF VANCOUVER U.S.A.
3103 N.W. LOWER RIVER ROAD
VANCOUVER, WA 98660-1027
TEL: 360-693-3611
FAX: 360-735-1565

eTrac

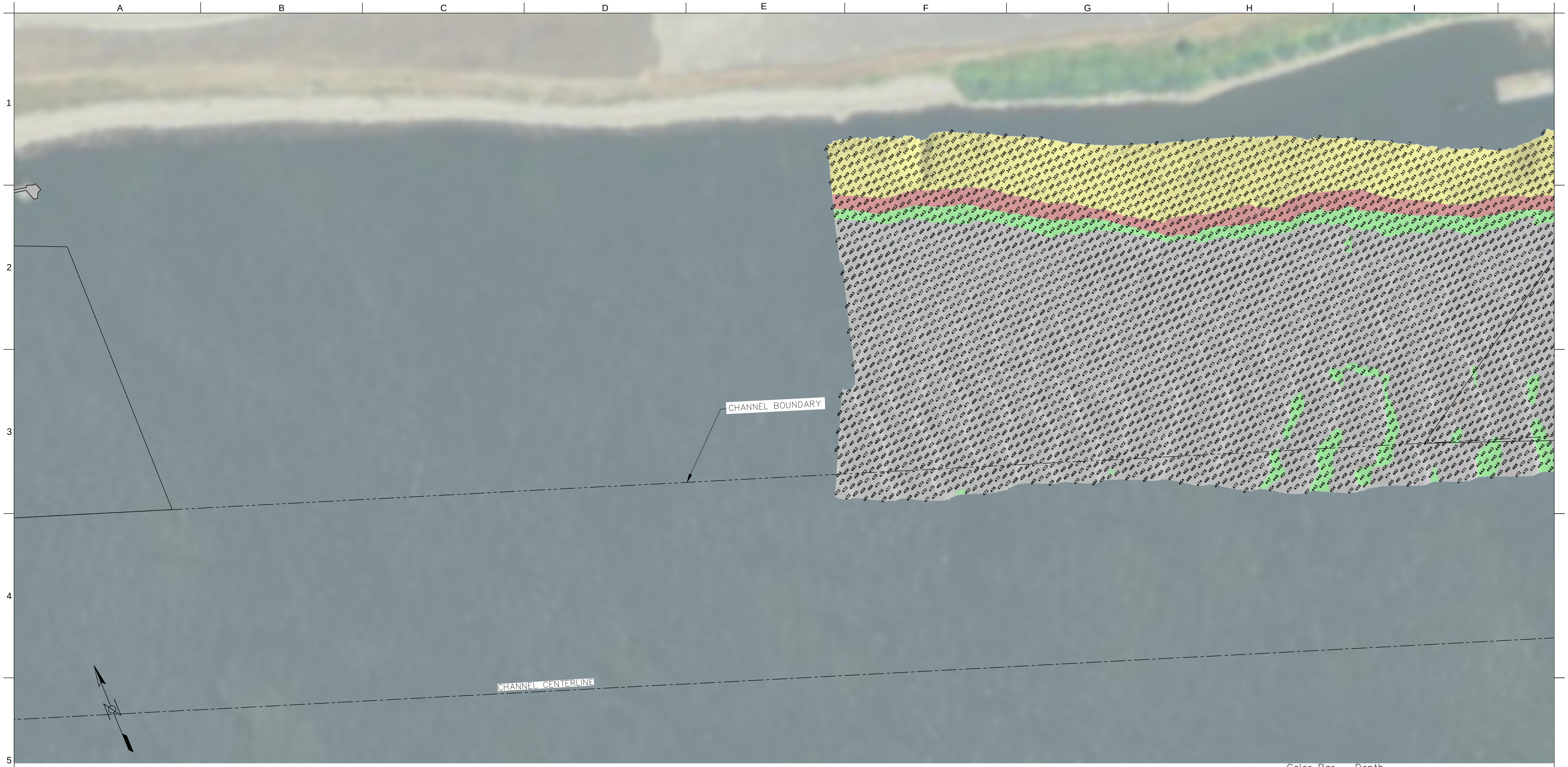
637 LINDARO STREET
SUITE 100
SAN RAFAEL, CA 94901
415.462.0421
eTracInc.com

DATE: MARCH 30, 2020	
DESIGNED BY: RG	CHECKED BY: BDC
CONTRACT #:	
PERMIT #: EPISODE #:	
PROJECT NAME: PVAN_2020_PORT OF VANCOUVER	

PORT OF VANCOUVER, U.S.A.
MULTIBEAM SURVEY
CONDITIONAL

DEM and Soundings

Reference Number:
S9



— - —— - — CHANNEL CENTERLINE

—·-·—·-·— CHANNEL BOUNDARY

—•—•—•— FACE OF FENDER PILE

– – – – – – APPROXIMATE DREDGE PRISM

▒ EXISTING DOCK STRUCTURE

Color Bar – Depth

🟨 SOUNDING < 40.0

🟥 40.0 < SOUNDING < 43.0

🟩 43.0 < SOUNDING < 45.0

⬛ SOUNDING > 45.0

0 60 120
SCALE IN FEET

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MULTIBEAM SURVEY
CONDITIONAL

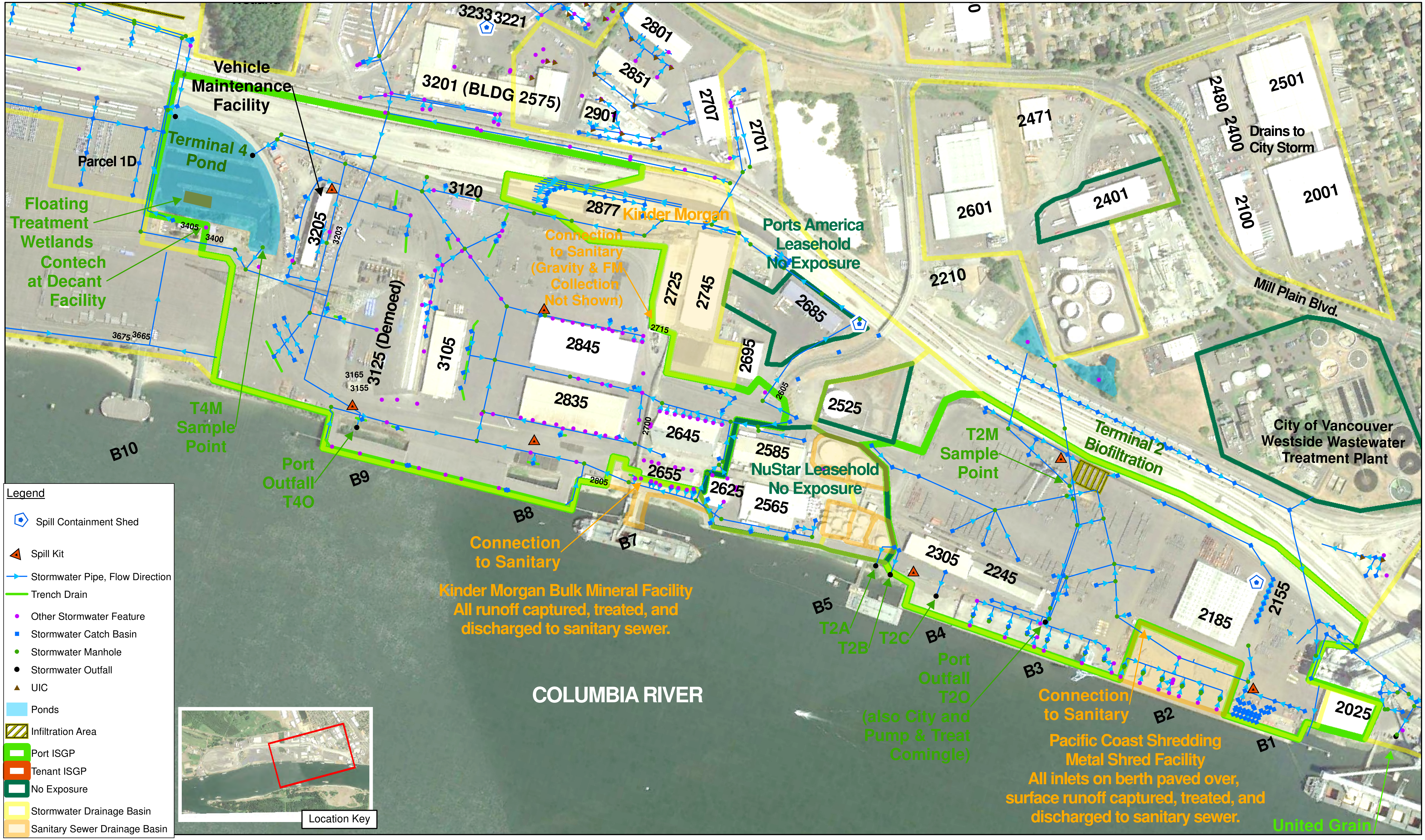
DEM and Soundings

Reference Number:

S10

APPENDIX C

PORT OF VANCOUVER STORMWATER SYSTEM MAP



All data shown on this map is approximate and should not be relied upon for planning or design at the Port of Vancouver. This map covers the core of the port's active operating area. Terminal 1 and other parcels are not mapped.

Background imagery Google Earth, 16 July 2018

Port of Vancouver
Industrial Stormwater General Permit WAR000424
January 2019

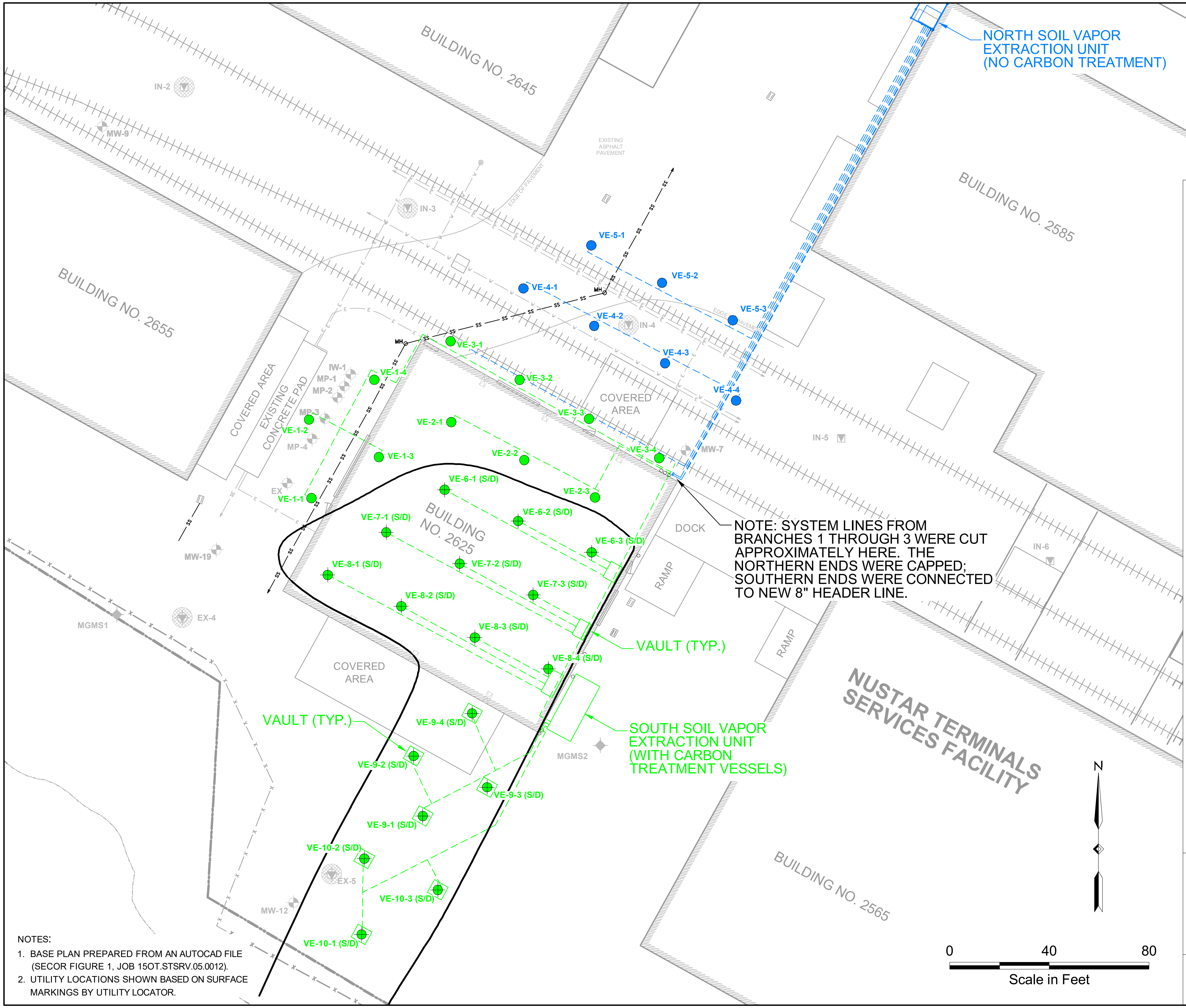
0 250 500 1,000 1,500 Feet (NTS)

N

Port of Vancouver USA

APPENDIX D

NUSTAR SVE SYSTEM MAP



NOTES:
1. BASE PLAN PREPARED FROM AN AUTOCAD FILE (SECOR FIGURE 1, JOB 15OT.STSRV.05.0012).
2. UTILITY LOCATIONS SHOWN BASED ON SURFACE MARKINGS BY UTILITY LOCATOR.

LEGEND:

VE-6-2 (S/D) ⊕	2011 WELL PAIR LOCATION (SHALLOW SCREENED FROM 5-15 FEET BGS) (DEEP SCREENED 15-25 FEET BGS)
VE-1-2 ●	2008 INTERIM ACTION VAPOR EXTRACTION WELL LOCATION
◎	VAPOR EXTRACTION WELL (2000-2005)
EX-3 ⊕	EARLY 2000s INTERIM ACTION GROUNDWATER EXTRACTION WELL
IN-1 ▽	EARLY 2000s INTERIM ACTION GROUNDWATER INJECTION WELL AND VAPOR EXTRACTION WELL
MW-1 ◐	GROUNDWATER MONITORING WELL
MGMS3 ✦	MULTI-LEVEL GROUNDWATER WELL
▭	CATCH BASIN
▭	BUILDING
— x — x —	FENCE
— E — E —	ELECTRICAL
— SE — SE —	SYSTEM ELECTRICAL
— SS — SS —	STORM SEWER
— W — W —	WATER
MH ○	MANHOLE
┼┼┼┼┼┼	RAILROAD TRACKS
— — — — — —	UNDERGROUND SOIL VAPOR EXTRACTION (SVE) PIPING
BLUE	NORTH VAPOR EXTRACTION UNIT
GREEN	SOUTH VAPOR EXTRACTION UNIT

2011 SVE Layout

Second Semi-Annual Groundwater Monitoring Report 2018
NuStar Terminals Services, Inc. Vancouver Facility
Vancouver, Washington

Cascadia Associates, LLC

Project Number	0060-001-003	Figure
	February 2019	13

APPENDIX E

STANDARD OPERATING PROCEDURES

SOIL AND GROUNDWATER INVESTIGATION

PROCEDURE

Soil Sampling Using a Hand Auger SOP

Author: John Gobins

Antea Group USA

Approved by: (Signatures on File)

John Gobins Process Owner	March 20, 2012 Date
Rosanna Ouellette QMS Document Control Representative	March 20, 2012 Date
John Gobins QMS Management Representative	March 20, 2012 Date

This is a controlled document with the original located at:

https://anteaintra.anteausainc.com/qms/qms_index.htm

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Document Change Tracking Form

Version	**Revision date**	**Revisions**
0	3/20/2012	Final Document Based upon Previous Team Meetings and Management Approvals in March 2012.

Soil Sampling Using a Hand Auger SOP

1.0 Scope/Applicability:

This standard operating procedure (SOP) provides guidance for sampling soil using a hand auger.

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on visual evidence of contamination, discoloration or staining, organic vapor meter readings, odors, predetermined depth, and any other appropriate field screening method.

This procedure is applicable to the collection of soil samples from the near ground surface by hand augering. This sampling depth achievable by this method is a function of several factors, including soil type, groundwater depth, and experience of the field geologist.

2.0 Summary:

This procedure entails advancing a borehole with a hand auger to the desire depth, retrieving the auger bucket, removing the soil sample from the auger bucket, homogenizing the sample, and placing the sample in the appropriate sample container(s) for shipment to an analytical laboratory.

3.0 Definitions:

A list of definitions is provided in Attachment 1 (SOP Definitions).

4.0 Health and Safety:

The Health and Safety considerations for conducting this procedure are described in the following documents:

- Site Health and Safety Plan – H&S Plan Templates (https://anteaintra.anteausainc.com/h&s/plans.htm)
- Job Safety Analysis – Soil Sampling (https://anteaintra.anteausainc.com/h&s/files/jsa/Soil_sampling_JSA.doc)

Specific health and safety considerations for this procedure include:

- Health and safety considerations associated with this procedure are addressed during the Job Safety Analysis.

5.0 Cautions and Interferences:

Cautions associated with conducting this procedure include:

- Hand augering (auger advancement into, and retrieval from, the borehole) can be strenuous and therefore caution should be exercised to avoid back injury.

Interferences having the potential to impact the quality of the final product include:

- Rock or impenetrable soil, fill material over natural surface, utilities, dense vegetation, or location access - a different drilling method may be required or it may be necessary to move to another location in order to achieve soil sampling objectives.
- Recently applied backfill - it will not show accurate results for that area. In such cases, digging through the fill down to the native soil or moving to another location may be necessary.

6.0 Personnel Qualifications/Responsibilities:

Personnel performing this procedure are required to have the following qualifications:

- HSSE Training in accordance with Health, Safety, Security, and Environment Practice (https://anteaintra.anteausainc.com/h&s/practices/hsse/HSSE_Practice_Training.pdf).
- Health and Safety training in accordance with Client Required Training (if applicable) (https://anteaintra.anteausainc.com/h&s/training_client_req.htm).
- All field team members engaged in this procedure must have on file a completed Demonstration of Capability for this SOP.

The minimum roles involved and their responsibilities in this procedure include:

- **Project Manager** – Responsible for determining, communicating, and upholding the regulatory, client, and other requirements associated with performing this procedure as part of a project-specific scope of work.
- **Project Professional** – Responsible for creating project-specific scopes of work requiring this procedure in accordance with the identified requirements of this procedure.
- **Staff Professional** – Responsible for implementing project-specific scopes of work requiring this procedure in accordance with this procedure.

7.0 Equipment/Supplies:

The following is the typical list of equipment required for completing this procedure:

- Field Safety Equipment Bag - https://anteaintra.anteausainc.com/h&s/faq_field_bag.htm
- Traffic control devices, as defined in Site Control and Work Zones training - https://anteagroup.adobeconnect.com/sitecontrolworkzones/
- Field logbook and appropriate field form(s)
- Waterproof permanent pens and markers
- Mobile phone - with clock and camera feature
- Spare locks - for buildings, compounds, and well covers (if appropriate)
- Keys - to access existing on-site locks (if appropriate)
- Decontamination supplies/equipment (if appropriate)

Procedure-specific equipment/supplies include:

- Tape measure (in 0.1 foot increments)
- Stainless steel hand auger buckets

- Extension shafts
- Cross handle
- Duct tape
- Plastic sheeting
- Paper towels
- Sample jars with labels
- Cooler with ice
- Ziploc bags
- Drum for drill cuttings, if necessary
- Photo Ionization Detector
- Table for examining drilled cores

8.0 Procedure:

Hand augering is used to collect soil samples from depths as great as 10 ft below ground surface (bgs), although the technique can sometimes be used to a depth as great as 30 ft bgs. This method is not appropriate for collecting samples for volatile organic analysis because volatile compounds may be lost. Samples for VOC analysis shall be collected in accordance with **VOC Sample Collection SOP**. Each hand auger is equipped with 3-inch diameter cylindrical stainless steel with cutting teeth. Hand auger sampling shall be collected in accordance with the following procedure:

1. Select the proper sample containers for collecting the sample.
2. Complete the sample labels with the appropriate information.
3. Depending on the type of soil material present, attach either a regular auger bucket or a mud auger bucket to an extension shaft. Attach a cross handle to the other end of the extension shaft.
4. Decontaminate the auger bucket prior to the initial use in accordance with **Equipment Decontamination SOP**.
5. Turning the handle clockwise, auger down until the bucket is full of soil.
6. Lift the auger out of the borehole and deposit the excavated soil on an impermeable plastic liner to prevent any leaching of possible contaminates.
7. Attach additional extension shafts as needed.
8. Place the auger back in the borehole and advance it to the required sampling depth.
9. Remove the auger from the borehole and decontaminate the auger bucket in preparation for sample collection.
10. Place the auger back in the borehole and advance it through the required sampling depth interval.
11. Place the material from the auger into a stainless steel bowl.
12. Fill the appropriate sample jars using the material from the bowl.
13. Describe the sample lithology(ies) in accordance with **Geological Observations SOP**.
14. Homogenize soil samples from different sample intervals in accordance with **Soil Sample Homogenation SOP**.
15. Collect QC samples in accordance with **QA/QC Sample Collection SOP**.
16. Tighten the caps securely on the sample jars.

17. Place collected samples in a cooler with ice in accordance with **Sample Packaging and Shipping SOP**. Complete a Chain-of-Custody record in accordance with **Completing Chain of Custody SOP**.
18. Record the appropriate information in the Boring Log (Attachment 2) and in the field logbook in accordance with **Fieldwork Documentation SOP**.

If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

The sampling equipment shall be decontaminated between each sample, and new gloves shall be worn each time, in accordance with **Equipment Decontamination SOP**.

9.0 Data and Records Management:

Before finalizing fieldwork documentation:

- Recheck all data inputs to prevent errors.
- If data were generated from multiple/different sample locations (borings, wells, etc.) at the same site, use appropriate file naming conventions to distinguish one file from another.
- Ensure that any repair work needed, issues to be resolved, and/or any uncompleted fieldwork are noted in the fieldwork documentation.

Upon completion of fieldwork, field personnel shall file fieldwork documentation, any electronic field files, the Site Health and Safety Plan, and any associated health and safety forms to the correct project folder, in accordance with **Control of Records SOP**.

10.0 Quality Control:

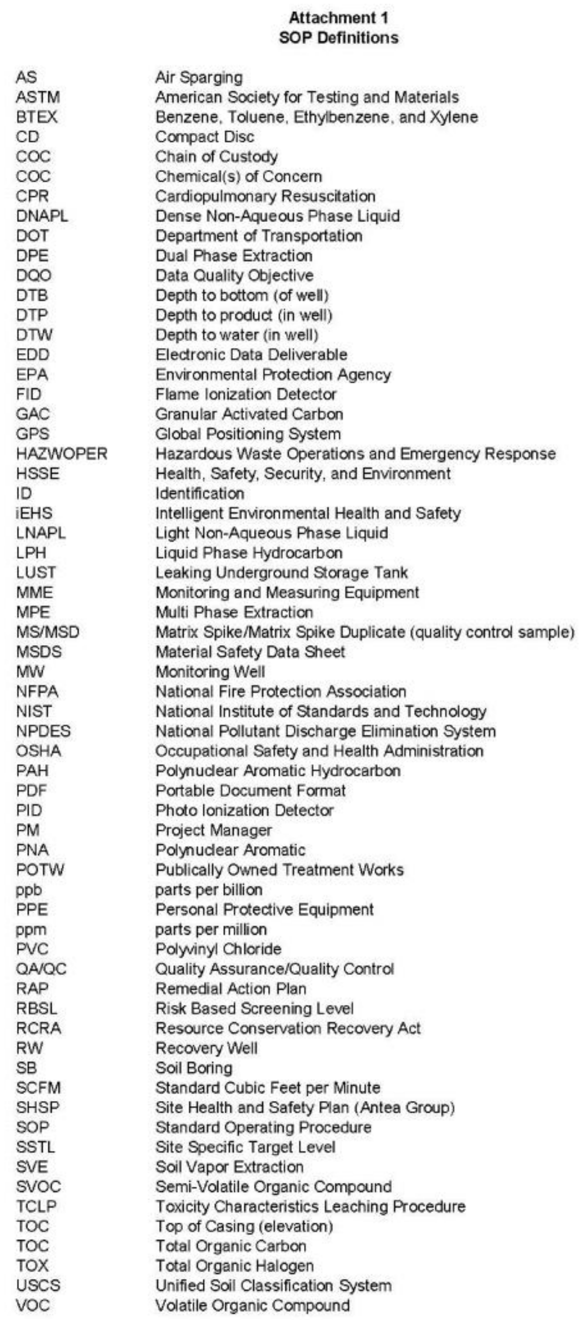
- All data, observations, calculations must be documented in the field logbook, field forms, and/or any electronic data recording devices (field computers, digital cameras, etc.).
- Adequate traceability must be ensured between any field notes and complementary field forms.
- Any electronic data recording devices must be operated in accordance with manufacturer’s operating instructions, unless documented otherwise.
- Monitoring and Measuring Equipment must be calibrated prior to the event and calibration results documented in accordance with **Equipment Calibration and Maintenance SOP**.

11.0 References:

- Superfund Program Standard Operating Procedures
- SOP Definitions (Attachment 1)
- VOC Sample Collection SOP
- Equipment Decontamination SOP
- Geological Observations SOP
- Soil Sample Homogenation SOP
- QA/QC Sample Collection SOP

- Sample Packaging and Shipping SOP
- Completing Chain of Custody SOP
- Boring Log (Attachment 2)
- Fieldwork Documentation SOP
- Control of Records SOP
- Equipment Calibration and Maintenance SOP

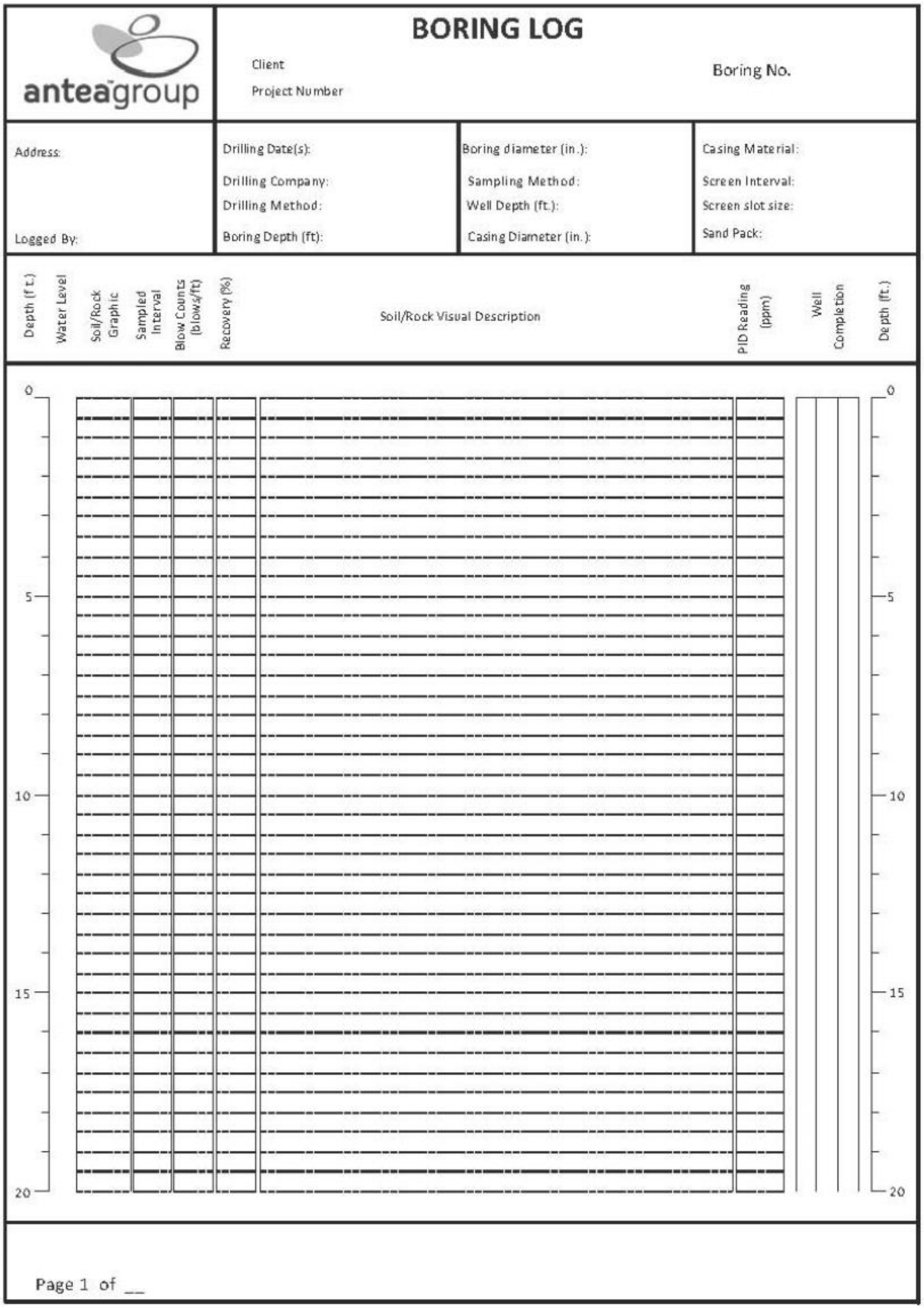
Attachment 1
SOP Definitions



Attachment 1
SOP Definitions

AS	Air Sparging
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CD	Compact Disc
COC	Chain of Custody
COC	Chemical(s) of Concern
CPR	Cardiopulmonary Resuscitation
DNAPL	Dense Non-Aqueous Phase Liquid
DOT	Department of Transportation
DPE	Dual Phase Extraction
DQO	Data Quality Objective
DTB	Depth to bottom (of well)
DTP	Depth to product (in well)
DTW	Depth to water (in well)
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
GAC	Granular Activated Carbon
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSSE	Health, Safety, Security, and Environment
ID	Identification
iEHS	Intelligent Environmental Health and Safety
LNAPL	Light Non-Aqueous Phase Liquid
LPH	Liquid Phase Hydrocarbon
LUST	Leaking Underground Storage Tank
MME	Monitoring and Measuring Equipment
MPE	Multi Phase Extraction
MS/MSD	Matrix Spike/Matrix Spike Duplicate (quality control sample)
MSDS	Material Safety Data Sheet
MW	Monitoring Well
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PDF	Portable Document Format
PID	Photo Ionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic
POTW	Publically Owned Treatment Works
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RBSL	Risk Based Screening Level
RCRA	Resource Conservation Recovery Act
RW	Recovery Well
SB	Soil Boring
SCFM	Standard Cubic Feet per Minute
SHSP	Site Health and Safety Plan (Antea Group)
SOP	Standard Operating Procedure
SSTL	Site Specific Target Level
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristics Leaching Procedure
TOC	Top of Casing (elevation)
TOC	Total Organic Carbon
TOX	Total Organic Halogen
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

Attachment 2
Boring Log (page 1)



anteagroup

BORING LOG

Client
Project Number
Boring No.

Address:
Logged By:

Drilling Date(s):
Drilling Company:
Drilling Method:
Boring Depth (ft):

Boring diameter (in.):
Sampling Method:
Well Depth (ft.):
Casing Diameter (in.):

Casing Material:
Screen Interval:
Screen slot size:
Sand Pack:

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
0									0
5									5
10									10
15									15
20									20

Page 1 of __

PROCEDURE

Soil Sampling Using a Split Barrel Sampler SOP

Author: John Gobins

Antea Group USA

Approved by: (Signatures on File)

John Gobins Process Owner	March 20, 2012 Date
Rosanna Ouellette QMS Document Control Representative	March 20, 2012 Date
John Gobins QMS Management Representative	March 20, 2012 Date

This is a controlled document with the original located at:

https://anteaintra.anteausainc.com/qms/qms_index.htm

WHEN PRINTED, **COPY IS UNCONTROLLED**

Document Change Tracking Form

Version	Revision date	Revisions
0	3/20/2012	Final Document Based upon Previous Team Meetings and Management Approvals in March 2012.

Soil Sampling Using a Split Barrel Sampler SOP

1.0 Scope/Applicability:

This standard operating procedure (SOP) provides guidance for sampling soil using a split barrel sampler. Soil sampling using a split barrel sampler is typically used in conjunction with hollow stem auger drilling (see **Hollow Stem Auger Drilling SOP**).

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on visual evidence of contamination, discoloration or staining, organic vapor meter readings, odors, predetermined depth, and any other appropriate field screening method.

This procedure is applicable to the collection of soil samples using a split barrel sampler in conjunction with hollow stem auger drilling.

2.0 Summary:

This procedure entails collecting soil samples using a stainless steel, continuous drive, California modified split-barrel sampler, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 2 inches to accommodate four 2-inch diameter brass/stainless steel rings, each of which is 6 inches in length. The sampler is driven 24 inches into the soil with a 140 pound hammer, as per the Standard Penetration Test. The sampler is then retrieved, both ends of the sampler are unscrewed, and the sample barrel split lengthwise to reveal the sample-containing rings.

3.0 Definitions:

A list of definitions is provided in Attachment 1 (SOP Definitions).

4.0 Health and Safety:

The Health and Safety considerations for conducting this procedure are described in the following documents:

- Site Health and Safety Plan – H&S Plan Templates (https://anteaintra.anteausainc.com/h&s/plans.htm)
- Job Safety Analysis – (drilling subcontractor shall provide this)

Specific health and safety considerations for this procedure include:

- US Department of Labor, Safety and Health Information Bulletin “Hazards of Auger Drilling” - http://www.osha.gov/dts/shib/shib041608a.html

5.0 Cautions and Interferences:

Cautions associated with conducting this procedure include:

- Care should be exercised when handling and assembling split barrel samplers as gloves/skin can become pinched in the longitudinal groove along each side of the barrel.

Interferences having the potential to impact the quality of the final product include:

- Rock or impenetrable soil, or location access - a different drilling method may be required or it may be necessary to move to another location in order to achieve soil sampling objectives.
- Recently applied backfill - it will not show accurate results for that area. In such cases, digging through the fill down to the native soil or moving to another location may be necessary.

6.0 Personnel Qualifications/Responsibilities:

Personnel performing this procedure are required to have the following qualifications:

- HSSE Training in accordance with Health, Safety, Security, and Environment Practice (https://anteaintra.anteausainc.com/h&s/practices/hsse/HSSE_Practice_Training.pdf).
- Health and Safety training in accordance with Client Required Training (if applicable) (https://anteaintra.anteausainc.com/h&s/training_client_req.htm).
- All field team members engaged in this procedure must have on file a completed Demonstration of Capability for this SOP.

The minimum roles involved and their responsibilities in this procedure include:

- **Project Manager** – Responsible for determining, communicating, and upholding the regulatory, client, and other requirements associated with performing this procedure as part of a project-specific scope of work.
- **Project Professional** – Responsible for creating project-specific scopes of work requiring this procedure in accordance with the identified requirements of this procedure.
- **Staff Professional** – Responsible for implementing project-specific scopes of work requiring this procedure in accordance with this procedure.

7.0 Equipment/Supplies:

The following is the typical list of equipment required for completing this procedure:

- Field Safety Equipment Bag - https://anteaintra.anteausainc.com/h&s/faq_field_bag.htm
- Traffic control devices, as defined in Site Control and Work Zones training - https://anteagroup.adobeconnect.com/sitecontrolworkzones/
- Field logbook and appropriate field form(s)
- Waterproof permanent pens and markers
- Mobile phone - with clock and camera feature
- Spare locks - for buildings, compounds, and well covers (if appropriate)
- Keys - to access existing on-site locks (if appropriate)
- Decontamination supplies/equipment (if appropriate)

Procedure-specific equipment/supplies include:

- Tape measure (in 0.1 foot increments)
- Split-barrel samplers

- Knife
- Duct tape
- Paper towels
- Sample jars with labels
- Cooler with ice
- Ziploc bags
- Drum for drill cuttings, if necessary
- Photo Ionization Detector
- Table for examining drilled cores

8.0 Procedure:

When soil samples are to be submitted for laboratory analysis, they shall be collected using stainless steel, continuous drive, California modified split-barrel sampler, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 2 inches to accommodate four 2-inch diameter brass/stainless steel rings, each of which is 6 inches in length. The brass/stainless steel rings are optional and are used only when collecting geotechnical samples. Each time a split-barrel sample is taken, a standard penetration test shall be performed in accordance with ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. Split barrel sampling shall be conducted in accordance with the following procedure:

1. Decontaminate the split barrel sampler to be used for soil sampling in accordance with **Equipment Decontamination SOP**.
2. Soil sampling using a split barrel soil sampler is performed in accordance with **Hollow Stem Auger Drilling SOP**.
3. Attach the split barrel sampler to the center rods and lower the sampler to the bottom of the bore hole.
4. Attach the drill rig drive hammer to the center rods.
5. Drive the sampler a depth of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches.
6. Drive 6 inches to seat it in undisturbed soil; then perform test.
7. For each 6 inches of penetration, record the number of hammer blows for seating the spoon and making the test (i.e., 5/7/8).
8. Obtain the standard penetration test result (N) by adding the last two figures (i.e., 7+8=15 blows per foot).
9. Drive the sampler an additional 6 inches to fill the remainder of the split-spoon prior to retrieval, if necessary.
10. Detach the hammer and attach the center rods to the hanger assembly.
11. Pull the split-barrel sampler out of the borehole and detach the sampler from the center rods.
12. Disassemble the sampler.
13. As soon as the split-spoon is opened, monitor the open ends of the brass/stainless steel rings for organic vapors using the PID or FID.
14. Describe the sample lithology in accordance with **Geological Observations SOP**.
15. Collect samples for VOC analysis in accordance with **VOC Sample Collection SOP**.
16. Collect QC samples in accordance with **QA/QC Sample Collection SOP**.

17. Place collected samples in a cooler with ice in accordance with **Sample Packaging and Shipping SOP**. Complete a Chain-of-Custody record in accordance with **Completing Chain of Custody SOP**.
18. Record the appropriate information on the Boring Log (Attachment 2) and in the field logbook in accordance with **Fieldwork Documentation SOP**.

If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

The sampling equipment shall be decontaminated between each sample, and new gloves shall be worn each time, in accordance with **Equipment Decontamination SOP**.

9.0 Data and Records Management:

Before finalizing fieldwork documentation:

- Recheck all data inputs to prevent errors.
- If data were generated from multiple/different sample locations (borings, wells, etc.) at the same site, use appropriate file naming conventions to distinguish one file from another.
- Ensure that any repair work needed, issues to be resolved, and/or any uncompleted fieldwork are noted in the fieldwork documentation.

Upon completion of fieldwork, field personnel shall file fieldwork documentation, any electronic field files, the Site Health and Safety Plan, and any associated health and safety forms to the correct project folder, in accordance with **Control of Records SOP**.

10.0 Quality Control:

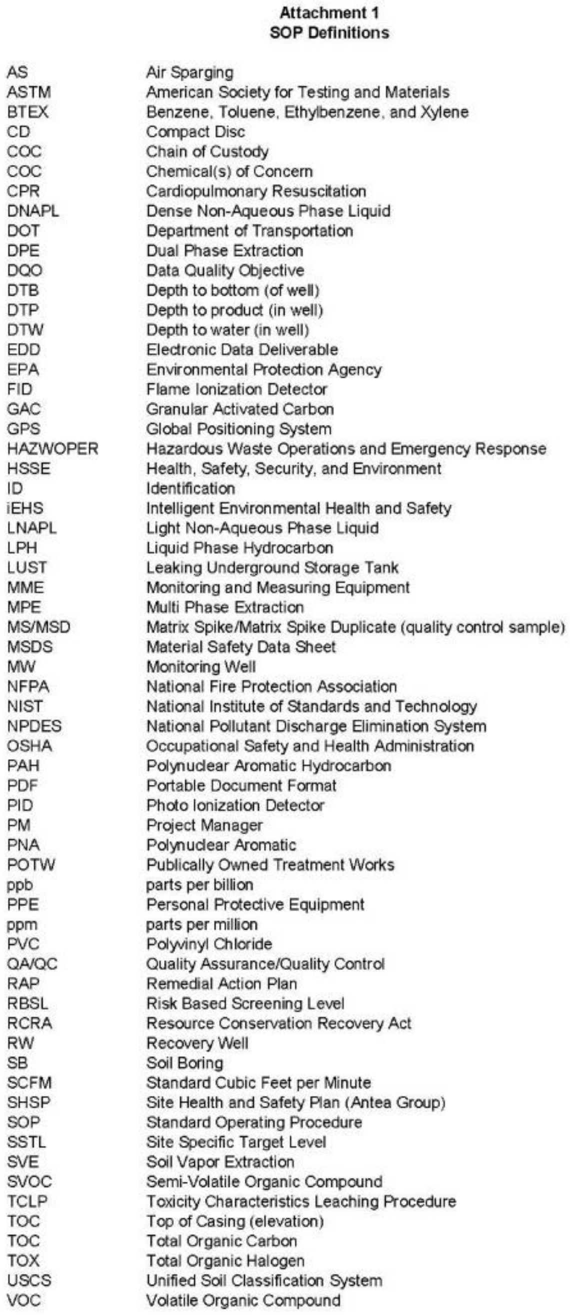
- All data, observations, calculations must be documented in the field logbook, field forms, and/or any electronic data recording devices (field computers, digital cameras, etc.).
- Adequate traceability must be ensured between any field notes and complementary field forms.
- Any electronic data recording devices must be operated in accordance with manufacturer’s operating instructions, unless documented otherwise.
- Monitoring and Measuring Equipment must be calibrated prior to the event and calibration results documented in accordance with **Equipment Calibration and Maintenance SOP**.

11.0 References:

- Superfund Program Standard Operating Procedures
- Hollow Stem Auger Drilling SOP
- SOP Definitions (Attachment 1)
- ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT)
- Equipment Decontamination SOP
- Geological Observations SOP
- VOC Sample Collection SOP

- QA/QC Sample Collection SOP
- Sample Packaging and Shipping SOP
- Completing Chain of Custody SOP
- Boring Log (Attachment 2)
- Fieldwork Documentation SOP
- Control of Records SOP
- Equipment Calibration and Maintenance SOP

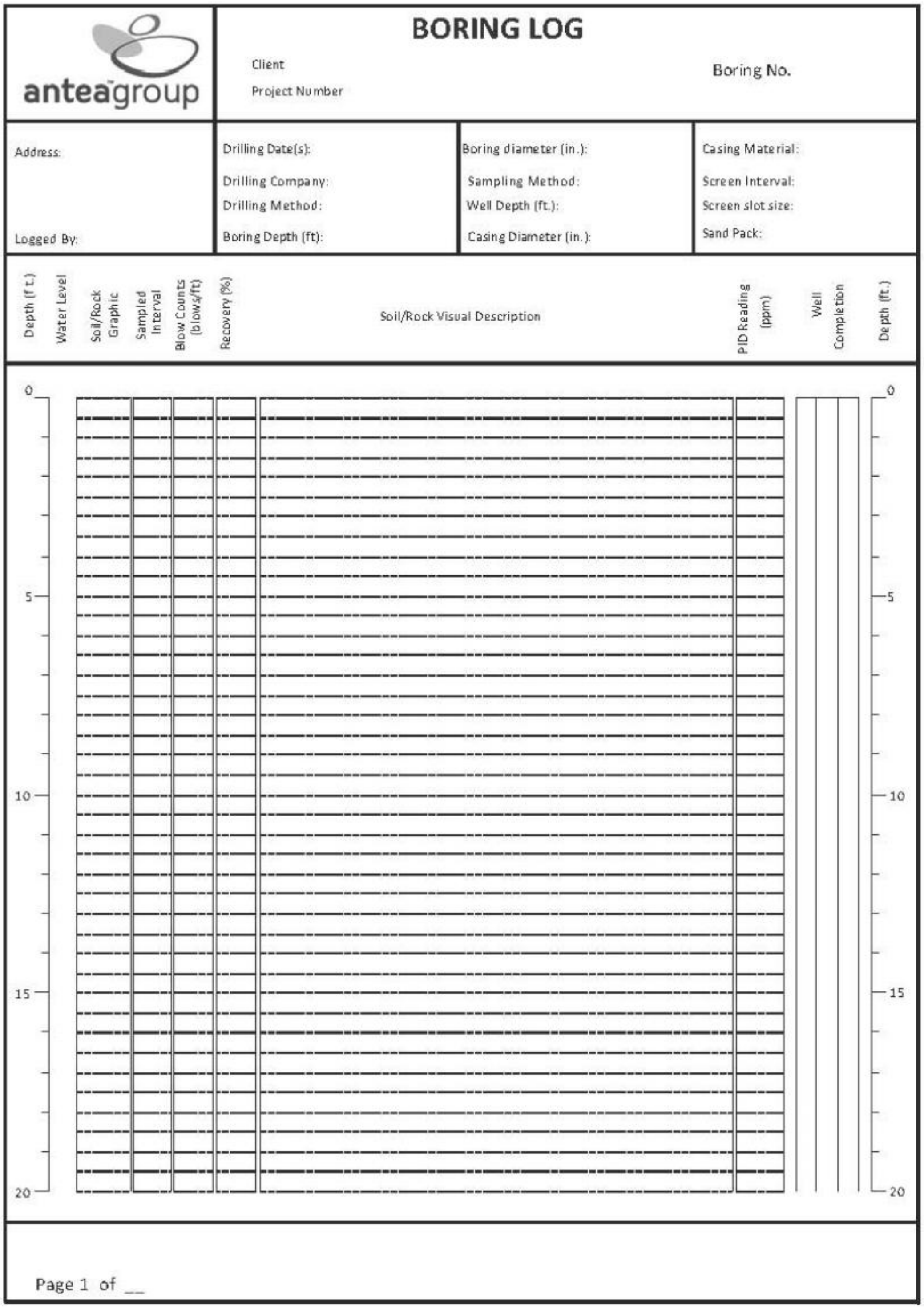
Attachment 1
SOP Definitions



Attachment 1
SOP Definitions

AS	Air Sparging
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CD	Compact Disc
COC	Chain of Custody
COC	Chemical(s) of Concern
CPR	Cardiopulmonary Resuscitation
DNAPL	Dense Non-Aqueous Phase Liquid
DOT	Department of Transportation
DPE	Dual Phase Extraction
DQO	Data Quality Objective
DTB	Depth to bottom (of well)
DTP	Depth to product (in well)
DTW	Depth to water (in well)
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
GAC	Granular Activated Carbon
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSSE	Health, Safety, Security, and Environment
ID	Identification
iEHS	Intelligent Environmental Health and Safety
LNAPL	Light Non-Aqueous Phase Liquid
LPH	Liquid Phase Hydrocarbon
LUST	Leaking Underground Storage Tank
MME	Monitoring and Measuring Equipment
MPE	Multi Phase Extraction
MS/MSD	Matrix Spike/Matrix Spike Duplicate (quality control sample)
MSDS	Material Safety Data Sheet
MW	Monitoring Well
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PDF	Portable Document Format
PID	Photo Ionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic
POTW	Publically Owned Treatment Works
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RBSL	Risk Based Screening Level
RCRA	Resource Conservation Recovery Act
RW	Recovery Well
SB	Soil Boring
SCFM	Standard Cubic Feet per Minute
SHSP	Site Health and Safety Plan (Antea Group)
SOP	Standard Operating Procedure
SSTL	Site Specific Target Level
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristics Leaching Procedure
TOC	Top of Casing (elevation)
TOC	Total Organic Carbon
TOX	Total Organic Halogen
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

Attachment 2
Boring Log (page 1)



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BORING LOG

Client
Project Number
Boring No.

Address:
Logged By:

Drilling Date(s):
Drilling Company:
Drilling Method:
Boring Depth (ft):

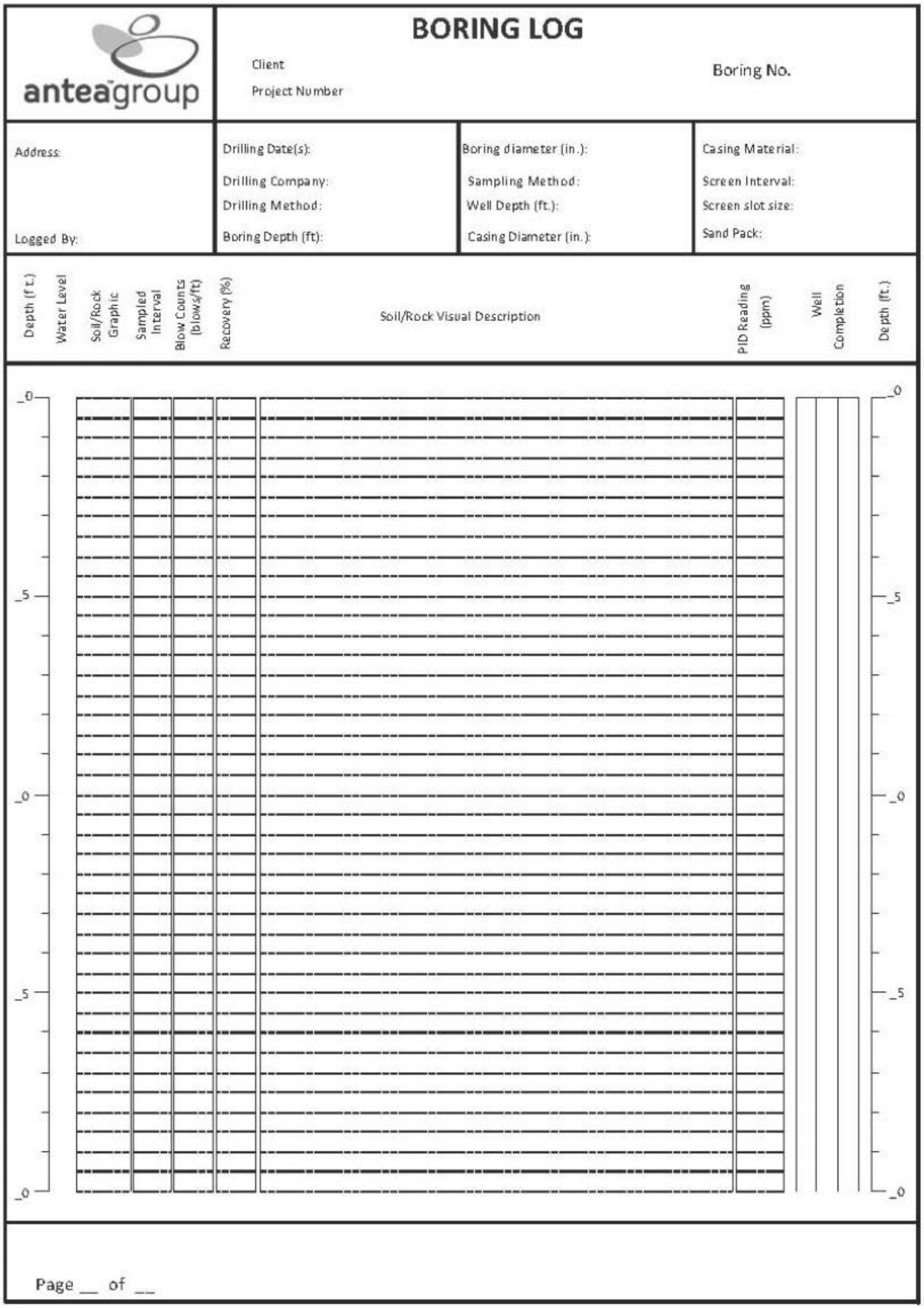
Boring diameter (in.):
Sampling Method:
Well Depth (ft.):
Casing Diameter (in.):

Casing Material:
Screen Interval:
Screen slot size:
Sand Pack:

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
0									0
5									5
10									10
15									15
20									20

Page 1 of __

Attachment 2 (cont.)
Boring Log (page 2)



BORING LOG

Client
Project Number
Boring No.

Address:
Logged By:

Drilling Date(s):
Drilling Company:
Drilling Method:
Boring Depth (ft):

Boring diameter (in.):
Sampling Method:
Well Depth (ft.):
Casing Diameter (in.):

Casing Material:
Screen Interval:
Screen slot size:
Sand Pack:

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
_0									_0
_5									_5
_0									_0
_5									_5
_0									_0

Page __ of __

PROCEDURE

Soil Sampling Using a Trowel SOP

Author: John Gobins

Antea Group USA

Approved by: (Signatures on File)

John Gobins Process Owner	March 20, 2012 Date
Rosanna Ouellette QMS Document Control Representative	March 20, 2012 Date
John Gobins QMS Management Representative	March 20, 2012 Date

This is a controlled document with the original located at:

https://anteaintra.anteausainc.com/qms/qms_index.htm

WHEN PRINTED, **COPY IS UNCONTROLLED**

Document Change Tracking Form

Version	**Revision date**	**Revisions**
0	3/20/2012	Final Document Based upon Previous Team Meetings and Management Approvals in March 2012.

Soil Sampling Using a Trowel SOP

1.0 Scope/Applicability:

This standard operating procedure (SOP) provides guidance for sampling soil using a trowel.

Surface soil sampling involves the removal of a representative portion of the topsoil (0-6 inches) to be analyzed in a lab. This sampling method attempts to ascertain the extent of contamination in the uppermost layer of soil. Aboveground plant debris is excluded from the sample.

This procedure is applicable to the collection of soil samples from the shallow ground surface, by hand using a trowel. This procedure can also be applied, with prior approval, for sampling the walls of test pits and shallow excavations.

2.0 Summary:

This procedure entails collecting a soil sample from the land surface, homogenizing it, and placing it in the appropriate sample container(s) for shipment to an analytical laboratory.

3.0 Definitions:

A list of definitions is provided in Attachment 1 (SOP Definitions).

4.0 Health and Safety:

The Health and Safety considerations for conducting this procedure are described in the following documents:

- Site Health and Safety Plan – H&S Plan Templates (https://anteaintra.anteausainc.com/h&s/plans.htm)
- Job Safety Analysis – Soil Sampling (https://anteaintra.anteausainc.com/h&s/files/jsa/Soil_sampling_JSA.doc)

Specific health and safety considerations for this procedure include:

- Health and safety considerations associated with this procedure are addressed during the Job Safety Analysis.

5.0 Cautions and Interferences:

Cautions associated with conducting this procedure include:

- Samples for VOC analysis should not be homogenized as the homogenization will cause a release of VOC constituents.

Interferences having the potential to impact the quality of the final product include:

- Rocky or extremely hard surface soil, fill material over natural surface, and dense vegetation - the soil could be impenetrable, rendering sampling impossible at that particular location.
- Recently applied backfill - it will not show accurate results for that area. In such cases, digging through the fill down to the native soil or moving to another location may be necessary.

6.0 Personnel Qualifications/Responsibilities:

Personnel performing this procedure are required to have the following qualifications:

- HSSE Training in accordance with Health, Safety, Security, and Environment Practice (https://anteaintra.anteausainc.com/h&s/practices/hsse/HSSE_Practice_Training.pdf).
- Health and Safety training in accordance with Client Required Training (if applicable) (https://anteaintra.anteausainc.com/h&s/training_client_req.htm).
- All field team members engaged in this procedure must have on file a completed Demonstration of Capability for this SOP.

The minimum roles involved and their responsibilities in this procedure include:

- **Project Manager** – Responsible for determining, communicating, and upholding the regulatory, client, and other requirements associated with performing this procedure as part of a project-specific scope of work.
- **Project Professional** – Responsible for creating project-specific scopes of work requiring this procedure in accordance with the identified requirements of this procedure.
- **Staff Professional** – Responsible for implementing project-specific scopes of work requiring this procedure in accordance with this procedure.

7.0 Equipment/Supplies:

The following is the typical list of equipment required for completing this procedure:

- Field Safety Equipment Bag - https://anteaintra.anteausainc.com/h&s/faq_field_bag.htm
- Traffic control devices, as defined in Site Control and Work Zones training - https://anteagroup.adobeconnect.com/sitecontrolworkzones/
- Field logbook and appropriate field form(s)
- Waterproof permanent pens and markers
- Mobile phone - with clock and camera feature
- Spare locks - for buildings, compounds, and well covers (if appropriate)
- Keys - to access existing on-site locks (if appropriate)
- Decontamination supplies/equipment (if appropriate)

Procedure-specific equipment/supplies include:

- Stainless steel trowel, bowl, and spoon
- Duct tape
- Paper towels
- Sample jars with labels (volume based on analysis)
- Cooler with ice
- Ziploc bags

- Photo Ionization Detector

8.0 Procedure:

Surface soil samples shall be collected from the land surface not to exceed six (6) inches below ground surface (bgs). The sample shall be homogenized and quartered in accordance with the following procedure:

1. Select the proper sample containers for collecting the sample.
2. Complete the sample labels with the appropriate information.
3. Place the sample material into a stainless steel bowl and homogenize the sample with a stainless steel spoon in accordance with **Soil Sample Homogenation SOP**. Do not homogenize samples for VOC analysis as the homogenization will cause a release of VOC constituents.
4. Collect VOC samples in accordance with **VOC Sample Collection SOP**.
5. Fill the appropriate sample jars using the material from the bowl, placing equal portions of sample into the sample jar.
6. Describe the sample lithology in accordance with **Geological Observations SOP**.
7. Collection of QC samples will be performed in accordance with **QA/QC Sample Collection SOP**.
8. Tighten the caps securely on the sample jars.
9. Place samples in a cooler with ice in accordance with **Sample Packaging and Shipping SOP** and fill out the Chain-of-Custody in accordance with **Completing Chain of Custody SOP**.
10. Document sample location, time, and sample type on the Soil Sampling Form (Attachment 2) in accordance with **Fieldwork Documentation SOP**.

Grab samples shall be collected by obtaining a representative volume of soil from the area to be sampled and placing it directly into the appropriate sample jar.

The sampling equipment shall be decontaminated between each sample, and new gloves shall be worn each time, in accordance with **Equipment Decontamination SOP**.

9.0 Data and Records Management:

Before finalizing fieldwork documentation:

- Recheck all data inputs to prevent errors.
- If data were generated from multiple/different sample locations (borings, wells, etc.) at the same site, use appropriate file naming conventions to distinguish one file from another.
- Ensure that any repair work needed, issues to be resolved, and/or any uncompleted fieldwork are noted in the fieldwork documentation.

Upon completion of fieldwork, field personnel shall file fieldwork documentation, any electronic field files, the Site Health and Safety Plan, and any associated health and safety forms to the correct project folder, in accordance with **Control of Records SOP**.

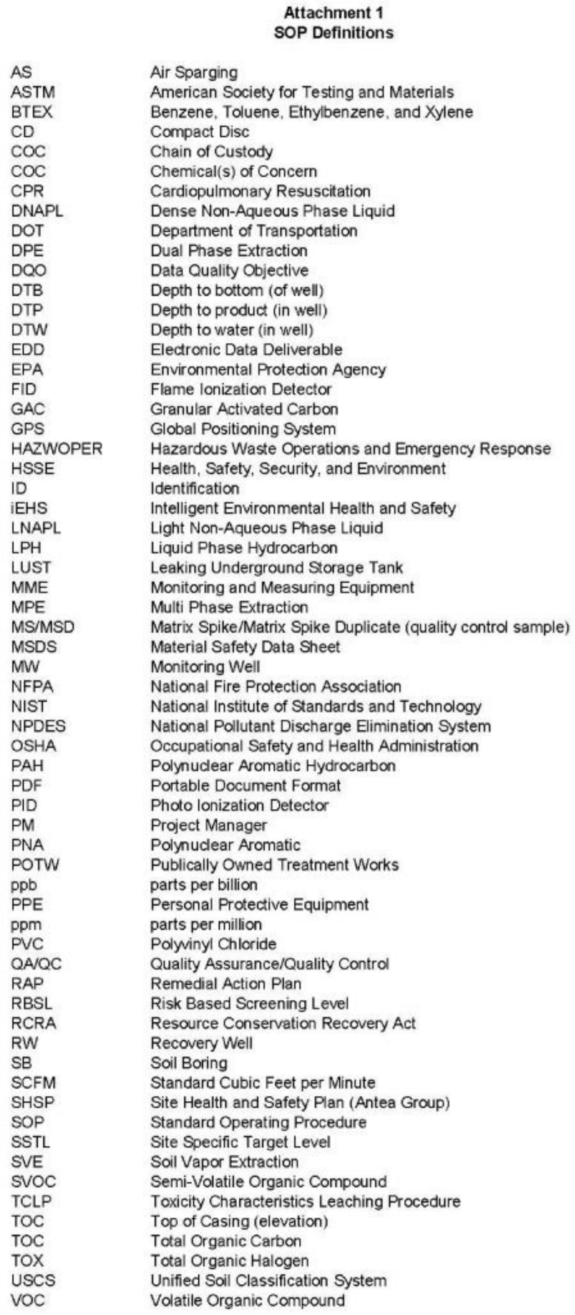
10.0 Quality Control:

- All data, observations, calculations must be documented in the field logbook, field forms, and/or any electronic data recording devices (field computers, digital cameras, etc.).
- Adequate traceability must be ensured between any field notes and complementary field forms.
- Any electronic data recording devices must be operated in accordance with manufacturer’s operating instructions, unless documented otherwise.
- Monitoring and Measuring Equipment must be calibrated prior to the event and calibration results documented in accordance with **Equipment Calibration and Maintenance SOP**.

11.0 References:

- Superfund Program Standard Operating Procedures
- SOP Definitions (Attachment 1)
- Soil Sample Homogenation SOP
- VOC Sample Collection SOP
- Geological Observations SOP
- QA/QC Sample Collection SOP
- Sample Packaging and Shipping SOP
- Completing Chain of Custody SOP
- Soil Sampling Form (Attachment 2)
- Fieldwork Documentation SOP
- Equipment Decontamination SOP
- Control of Records SOP
- Equipment Calibration and Maintenance SOP

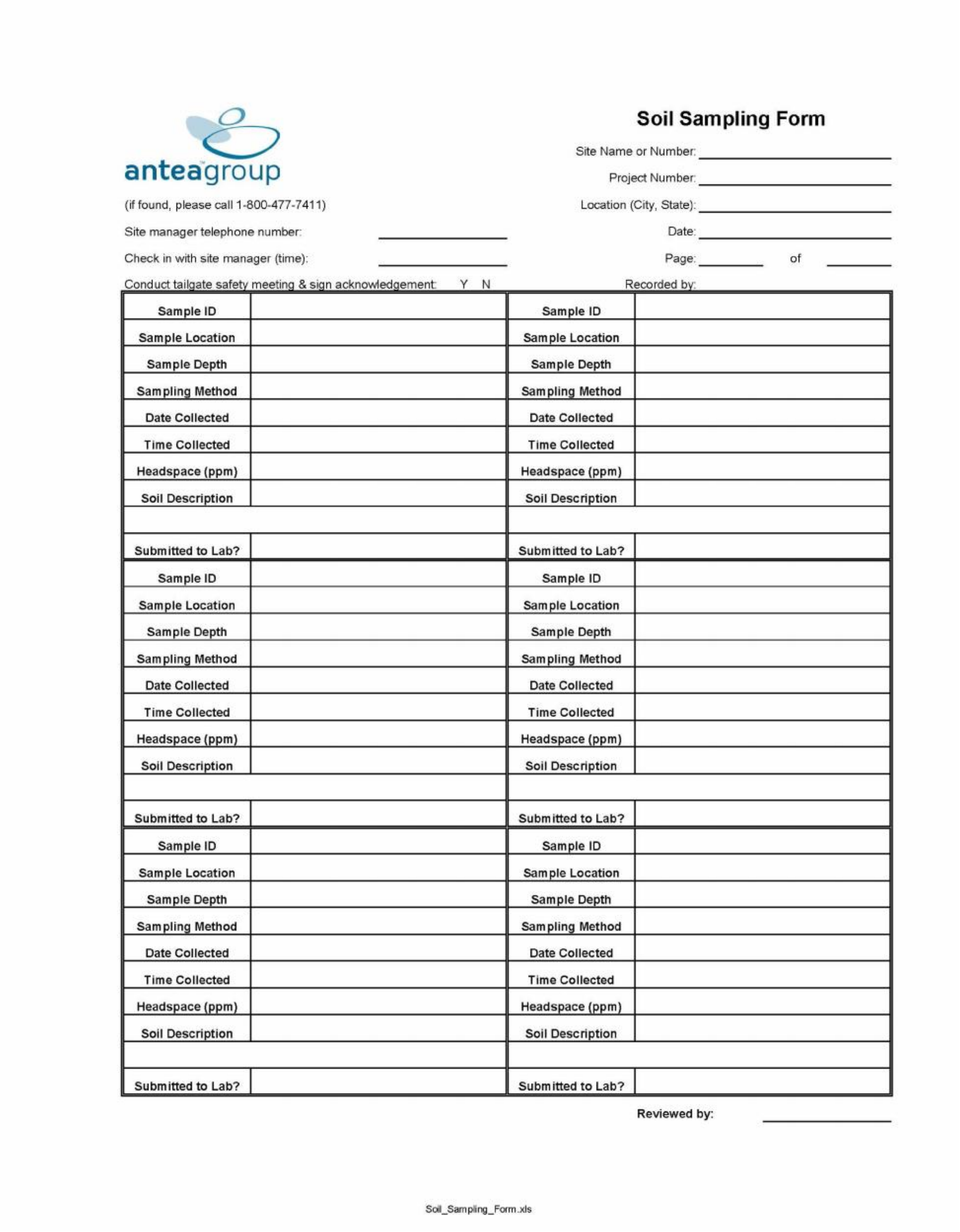
Attachment 1
SOP Definitions



Attachment 1
SOP Definitions

AS	Air Sparging
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CD	Compact Disc
COC	Chain of Custody
COC	Chemical(s) of Concern
CPR	Cardiopulmonary Resuscitation
DNAPL	Dense Non-Aqueous Phase Liquid
DOT	Department of Transportation
DPE	Dual Phase Extraction
DQO	Data Quality Objective
DTB	Depth to bottom (of well)
DTP	Depth to product (in well)
DTW	Depth to water (in well)
EDD	Electronic Data Deliverable
EPA	Environmental Protection Agency
FID	Flame Ionization Detector
GAC	Granular Activated Carbon
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSSE	Health, Safety, Security, and Environment
ID	Identification
iEHS	Intelligent Environmental Health and Safety
LNAPL	Light Non-Aqueous Phase Liquid
LPH	Liquid Phase Hydrocarbon
LUST	Leaking Underground Storage Tank
MME	Monitoring and Measuring Equipment
MPE	Multi Phase Extraction
MS/MSD	Matrix Spike/Matrix Spike Duplicate (quality control sample)
MSDS	Material Safety Data Sheet
MW	Monitoring Well
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PDF	Portable Document Format
PID	Photo Ionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic
POTW	Publically Owned Treatment Works
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAP	Remedial Action Plan
RBSL	Risk Based Screening Level
RCRA	Resource Conservation Recovery Act
RW	Recovery Well
SB	Soil Boring
SCFM	Standard Cubic Feet per Minute
SHSP	Site Health and Safety Plan (Antea Group)
SOP	Standard Operating Procedure
SSTL	Site Specific Target Level
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristics Leaching Procedure
TOC	Top of Casing (elevation)
TOC	Total Organic Carbon
TOX	Total Organic Halogen
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

Attachment 2
Soil Sampling Form



anteagroup

(if found, please call 1-800-477-7411)

Site manager telephone number: ____________

Check in with site manager (time): ____________

Conduct tailgate safety meeting & sign acknowledgement: Y N

Soil Sampling Form

Site Name or Number: ____________

Project Number: ____________

Location (City, State): ____________

Date: ____________

Page: ______ of ______

Recorded by:

Sample ID		**Sample ID**	
Sample Location		**Sample Location**	
Sample Depth		**Sample Depth**	
Sampling Method		**Sampling Method**	
Date Collected		**Date Collected**	
Time Collected		**Time Collected**	
Headspace (ppm)		**Headspace (ppm)**	
Soil Description		**Soil Description**	
Submitted to Lab?		**Submitted to Lab?**	
Sample ID		**Sample ID**	
Sample Location		**Sample Location**	
Sample Depth		**Sample Depth**	
Sampling Method		**Sampling Method**	
Date Collected		**Date Collected**	
Time Collected		**Time Collected**	
Headspace (ppm)		**Headspace (ppm)**	
Soil Description		**Soil Description**	
Submitted to Lab?		**Submitted to Lab?**	
Sample ID		**Sample ID**	
Sample Location		**Sample Location**	
Sample Depth		**Sample Depth**	
Sampling Method		**Sampling Method**	
Date Collected		**Date Collected**	
Time Collected		**Time Collected**	
Headspace (ppm)		**Headspace (ppm)**	
Soil Description		**Soil Description**	
Submitted to Lab?		**Submitted to Lab?**	

Reviewed by: ____________

Soil_Sampling_Form.xls

PROCEDURE

Soil Sampling Using Direct Push SOP

Author: Wayne Hutchinson

Antea Group USA

Approved by: (Signatures on File)

Wayne Hutchinson Process Owner	March 20, 2012 Date
Rosanna Ouellette QMS Document Control Representative	March 20, 2012 Date
John Gobins QMS Management Representative	March 20, 2012 Date

This is a controlled document with the original located at:

https://anteaintra.anteausainc.com/qms/qms_index.htm

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Document Change Tracking Form

Version	**Revision date**	**Revisions**
0	3/20/2012	Final Document Based upon Previous Team Meetings and Management Approvals in March 2012.

Soil Sampling Using Direct Push SOP

1.0 Scope/Applicability:

This standard operating procedure (SOP) provides guidance for sampling soil using a direct push sampler. Soil sampling using a split barrel sampler is typically used in conjunction with direct push drilling (see **Direct Push Drilling SOP**).

Subsurface sampling attempts to remove soil below the ground surface in a relatively undisturbed state in order to quantify the extent of contamination at specific depths. Soil samples shall be collected based on visual evidence of contamination, discoloration or staining, organic vapor meter readings, odors, predetermined depth, and any other appropriate field screening method.

This procedure is applicable to soil samples collected as part of direct push drilling.

2.0 Summary:

This procedure entails collecting soil samples with a specially-designed sample tube, such as a split-spoon sampler, macrocore, or dual-tube sampler. The sample tube is pushed and/or vibrated to the top of the specified sampling depth. The sample tube is then driven the length of the sampling tube. The probe sections and sample tube are then withdrawn and the sample is extruded from the tube into sample jars.

3.0 Definitions:

A list of definitions is provided in Attachment 1 (SOP Definitions).

4.0 Health and Safety:

The Health and Safety considerations for conducting this procedure are described in the following documents:

- Site Health and Safety Plan – H&S Plan Templates (https://anteaintra.anteausainc.com/h&s/plans.htm)
- Job Safety Analysis – (drilling subcontractor shall provide this)

Specific health and safety considerations for this procedure include:

- none

5.0 Cautions and Interferences:

Cautions associated with conducting this procedure include:

- Obtaining sufficient volume of soil for multiple analyses from one sample location may present a problem. The Geoprobe soil sampling system recovers a limited volume of soil and it is not possible to reenter the same hole and collect additional soil. When multiple

analyses are to be performed on soil samples collected with the Geoprobe, it is important that the relative importance of the analyses be identified. Identifying the order of importance will ensure that the limited sample volume will be used for the most crucial analyses.
- Decontamination of sampling tubes, probe rods, adaptors, non-expendable points and other equipment that contacts the soil is necessary to prevent cross-contamination of samples.

Interferences having the potential to impact the quality of the final product include:
- Rock or impenetrable soil - a different drilling method may be required or it may be necessary to move to another location in order to achieve soil sampling objectives.
- During sampling, the bottom portion and outside of the sampling tube can be contaminated with soil from other depth intervals. Excess soil should be carefully wiped from the outside surface of the sampling tube and the top 3 inches of the sample should be discarded before extruding the sample into a sample jar if it appears the soil fell into the borehole from the sidewall above.
- Note that sample recovery less than 100% means that some of the sample has fallen out of the sample tube and the depth interval of the sample should be adjusted based on the assumption that the top of the sampler was advanced to the top of the intended sample interval and no deeper. This, of course, assumes that the soil near the top of the sampler is from the intact sample interval and not material that had fallen into the borehole from above (see discussion item above).

6.0 Personnel Qualifications/Responsibilities:

Personnel performing this procedure are required to have the following qualifications:
- HSSE Training in accordance with Health, Safety, Security, and Environment Practice (https://anteaintra.anteausainc.com/h&s/practices/hsse/HSSE_Practice_Training.pdf).
- Health and Safety training in accordance with Client Required Training (if applicable) (https://anteaintra.anteausainc.com/h&s/training_client_req.htm).
- All field team members engaged in this procedure must have on file a completed Demonstration of Capability for this SOP.

The minimum roles involved and their responsibilities in this procedure include:
- **Project Manager** – Responsible for determining, communicating, and upholding the regulatory, client, and other requirements associated with performing this procedure as part of a project-specific scope of work.
- **Project Professional** – Responsible for creating project-specific scopes of work requiring this procedure in accordance with the identified requirements of this procedure.
- **Staff Professional** – Responsible for implementing project-specific scopes of work requiring this procedure in accordance with this procedure.

7.0 Equipment/Supplies:

The following is the typical list of equipment required for completing this procedure:
- Field Safety Equipment Bag - https://anteaintra.anteausainc.com/h&s/faq_field_bag.htm

- Traffic control devices, as defined in Site Control and Work Zones training - https://anteagroup.adobeconnect.com/sitecontrolworkzones/
- Field logbook and appropriate field form(s)
- Waterproof permanent pens and markers
- Mobile phone - with clock and camera feature
- Spare locks - for buildings, compounds, and well covers (if appropriate)
- Keys - to access existing on-site locks (if appropriate)
- Decontamination supplies/equipment (if appropriate)

Procedure-specific equipment/supplies include:

- Tape measure (in 0.1 foot increments)
- Utility knife
- Duct tape
- Paper towels
- Sample jars with labels
- Cooler with ice
- Ziploc bags
- Photo Ionization Detector
- Table for examining drilled cores

8.0 Procedure:

Direct push sampling involves advancing a sampling probe by applying direct hydraulic pressure by using a slide or rotary hammer. Samples may be collected continuously or at specific depths. Typically, a subcontractor is used to perform the actual probing operation. To collect samples using push methods:

Direct push sampling shall be conducted in accordance with the following procedure:

1. Decontaminate the direct push sampler to be used for soil sampling in accordance with **Equipment Decontamination SOP**.
2. Soil sampling using a direct push sampler is performed in accordance with **Direct Push Drilling SOP**.
3. Once the sampler is removed from the hole, unscrew the cutting shoe and pull the liner out from the sample tube.
4. Carefully cut the liner open, using a utility knife with a hooked blade (linoleum blade). By cutting the sample liner along two sides, the sample can be exposed.
5. Fill the appropriate sample jars using the material from the open sample liner.
6. Describe the sample lithology(ies) in accordance with **Geological Observations SOP**.
7. Collect samples for VOC analysis in accordance with **VOC Sample Collection SOP**.
8. Collect QC samples in accordance with **QA/QC Sample Collection SOP**.
9. Tighten the caps securely on the sample jars.
10. Place collected samples in a cooler with ice in accordance with **Sample Packaging and Shipping SOP**. Complete a Chain-of-Custody record in accordance with **Completing Chain of Custody SOP**.
11. Record the appropriate information in the Boring Log (Attachment 2) and in the field logbook in accordance with **Fieldwork Documentation SOP**.

If initial screening results indicate the presence of organic vapors, a headspace analysis shall be conducted on remaining portions of the sample.

The sampling equipment shall be decontaminated between each sample, and new gloves shall be worn each time, in accordance with **Equipment Decontamination SOP**.

9.0 Data and Records Management:

Before finalizing fieldwork documentation:
- Recheck all data inputs to prevent errors.
- If data were generated from multiple/different sample locations (borings, wells, etc.) at the same site, use appropriate file naming conventions to distinguish one file from another.
- Ensure that any repair work needed, issues to be resolved, and/or any uncompleted fieldwork are noted in the fieldwork documentation.

Upon completion of fieldwork, field personnel shall file fieldwork documentation, any electronic field files, the Site Health and Safety Plan, and any associated health and safety forms to the correct project folder, in accordance with **Control of Records SOP**.

10.0 Quality Control:

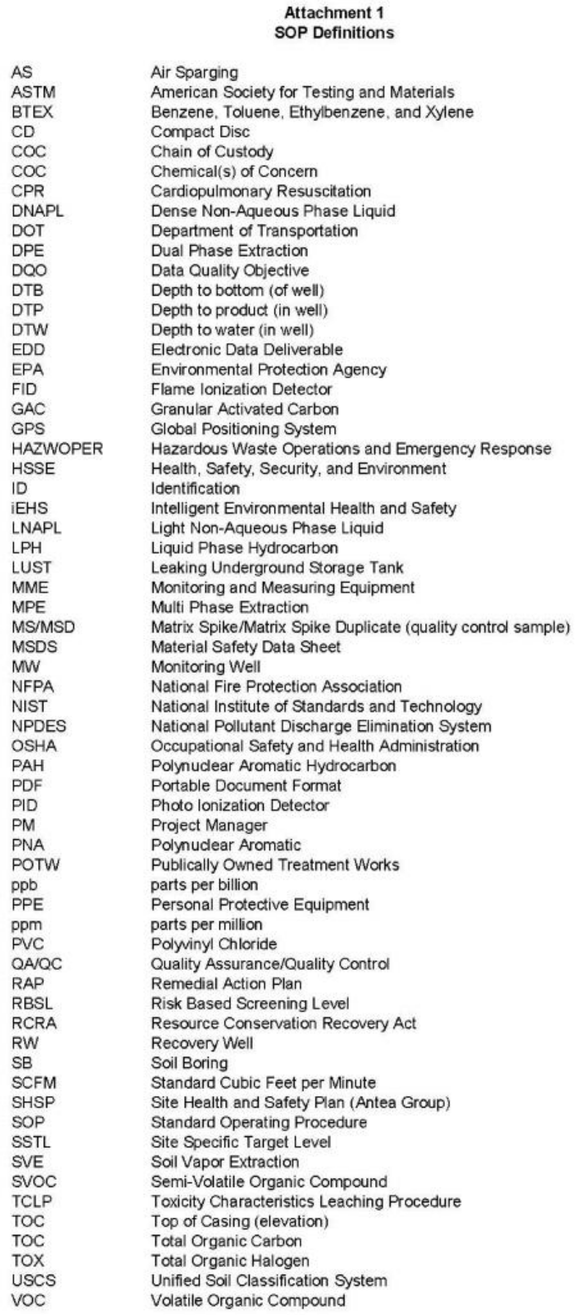
- All data, observations, calculations must be documented in the field logbook, field forms, and/or any electronic data recording devices (field computers, digital cameras, etc.).
- Adequate traceability must be ensured between any field notes and complementary field forms.
- Any electronic data recording devices must be operated in accordance with manufacturer’s operating instructions, unless documented otherwise.
- Monitoring and Measuring Equipment must be calibrated prior to the event and calibration results documented in accordance with **Equipment Calibration and Maintenance SOP**.

11.0 References:

- Superfund Program Standard Operating Procedures
- Direct Push Drilling SOP
- SOP Definitions (Attachment 1)
- ASTM D1586-11 Standard Test Method for Standard Penetration Test (SPT)
- Equipment Decontamination SOP
- Geological Observations SOP
- VOC Sample Collection SOP
- QA/QC Sample Collection SOP
- Sample Packaging and Shipping SOP
- Completing Chain of Custody SOP
- Boring Log (Attachment 2)
- Fieldwork Documentation SOP

- Control of Records SOP
- Equipment Calibration and Maintenance SOP

Attachment 1
SOP Definitions



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iEHS	Intelligent Environmental Health and Safety
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LUST	Leaking Underground Storage Tank
MME	Monitoring and Measuring Equipment
MPE	Multi Phase Extraction
MS/MSD	Matrix Spike/Matrix Spike Duplicate (quality control sample)
MSDS	Material Safety Data Sheet
MW	Monitoring Well
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
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PID	Photo Ionization Detector
PM	Project Manager
PNA	Polynuclear Aromatic
POTW	Publically Owned Treatment Works
ppb	parts per billion
PPE	Personal Protective Equipment
ppm	parts per million
PVC	Polyvinyl Chloride
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RBSL	Risk Based Screening Level
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RW	Recovery Well
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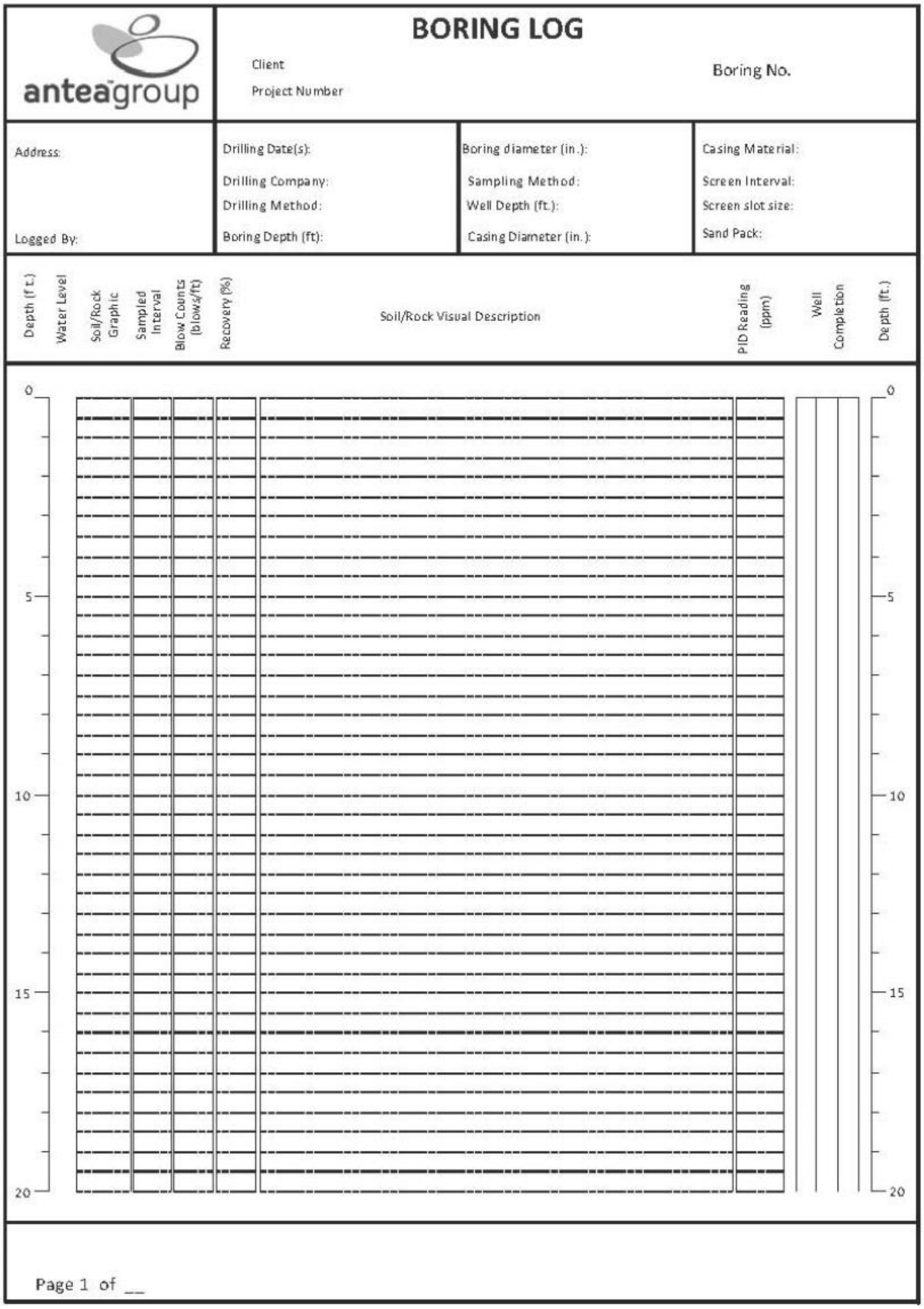
SCFM	Standard Cubic Feet per Minute
SHSP	Site Health and Safety Plan (Antea Group)
SOP	Standard Operating Procedure
SSTL	Site Specific Target Level
SVE	Soil Vapor Extraction
SVOC	Semi-Volatile Organic Compound
TCLP	Toxicity Characteristics Leaching Procedure
TOC	Top of Casing (elevation)
TOC	Total Organic Carbon
TOX	Total Organic Halogen
USCS	Unified Soil Classification System
VOC	Volatile Organic Compound

Attachment 2
Boring Log (page 1)



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BORING LOG

Client
Project Number
Boring No.

Address:	Drilling Date(s):	Boring diameter (in.):	Casing Material:
	Drilling Company:	Sampling Method:	Screen Interval:
	Drilling Method:	Well Depth (ft.):	Screen slot size:
Logged By:	Boring Depth (ft):	Casing Diameter (in.):	Sand Pack:

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
0									0
5									5
10									10
15									15
20									20

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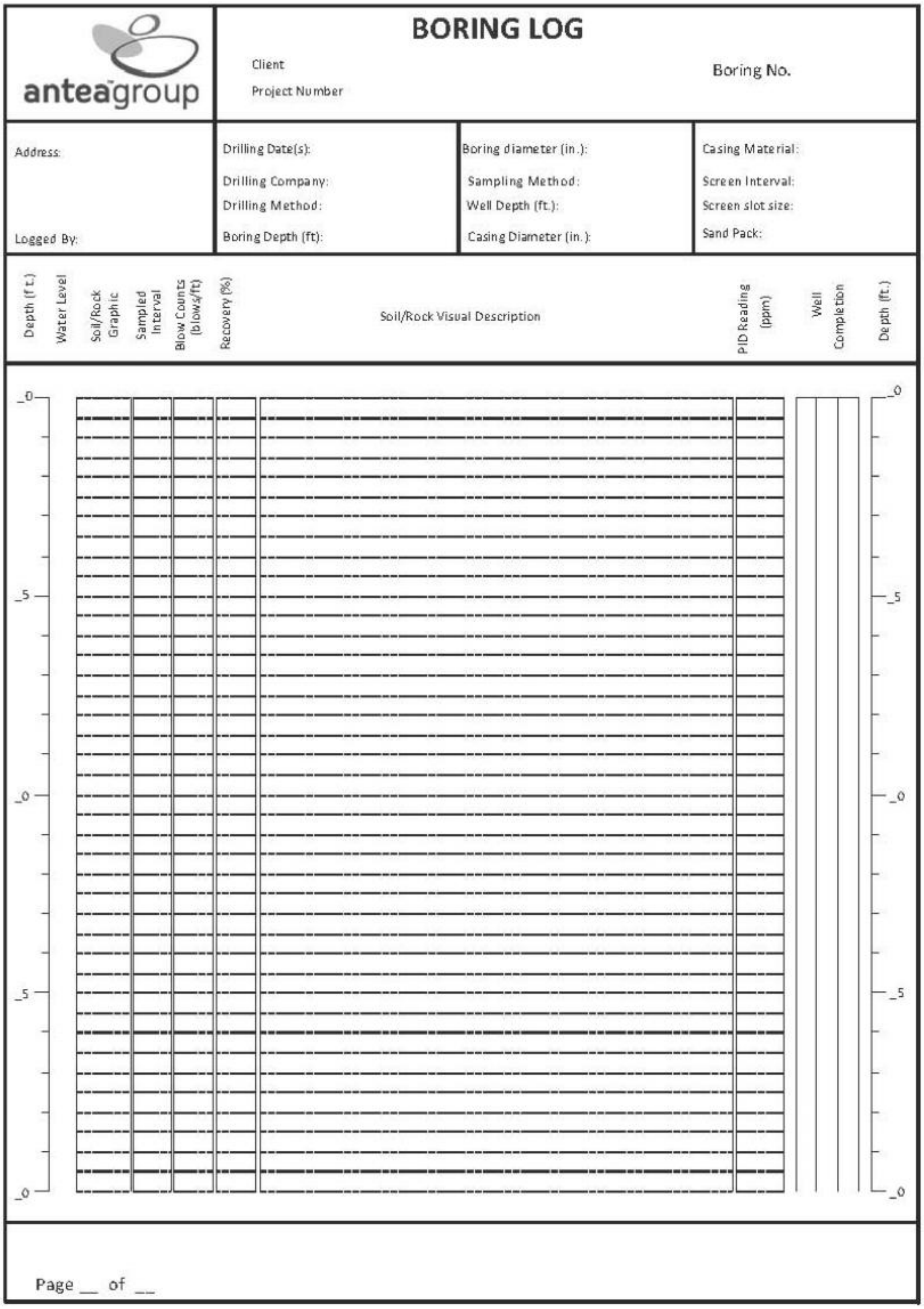
Attachment 2 (cont.)
Boring Log (page 2)



antea group

BORING LOG

Client

Project Number

Boring No.

Address:

Logged By:

Drilling Date(s):

Drilling Company:

Drilling Method:

Boring Depth (ft):

Boring diameter (in.):

Sampling Method:

Well Depth (ft.):

Casing Diameter (in.):

Casing Material:

Screen Interval:

Screen slot size:

Sand Pack:

Depth (ft.)	Water Level	Soil/Rock Graphic	Sampled Interval	Blow Counts (blows/ft)	Recovery (%)	Soil/Rock Visual Description	PID Reading (ppm)	Well Completion	Depth (ft.)
_0									_0
_5									_5
_0									_0
_5									_5
_0									_0

Page __ of __

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for observing and sampling from push-probes (i.e., GeoProbe™, AMS PowerProbe™, or similar). Subsurface soil cores may be obtained using this system for purposes of determining subsurface soil conditions and for obtaining soil samples for physical and/or chemical evaluation. Grab groundwater samples may be collected using temporary well screens. Soil vapor samples may be obtained using temporary well points. Shallow (less than 50 feet), small-diameter (2-inch max) pre-packed wells may also be installed using push-probe equipment. This procedure is applicable during Cascadia Associates, LLC (Cascadia) push-probe activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, and buckets/drums
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes)
- Sampling equipment (water level probe, pumps, tubing) and laboratory-supplied sample containers
- Field documentation materials
- Decontamination materials
- Personal protective equipment (as required by project Health and Safety Plan)

3. METHODOLOGY

Coring Procedure (Conducted by Drilling Subcontractor):

The sampling procedure includes driving a 2-inch outside-diameter, 5-foot-long, push-probe soil sampler to the desired depth using a combination of hydraulic pressure and mechanical hammer blows. When the sampling depth is reached, the pin attaching the sampler's tip is released (if a tip is used), which allows the tip to slide inside the sampler (Macro-Core Sampler with removable plastic liner). The sampler is driven the length of the sampler to collect a soil core, which is then withdrawn from the exploration. When the sampler is retrieved from the borehole the drive head/cutting shoe is detached and the liner is removed and the liner is cut open to expose the recovered soil core. Soil cores are collected continuously to the full depth of the exploration unless otherwise specified in a project-specific sampling and analysis plan (SAP). Verify that the subcontractor decontaminates the sampling device prior to its initial use and following collection of each soil sample.

Logging and Soil Sample Collection:

Remove the soil core from the sampler for field screening, description, and placement into sample jars. Soil samples will be collected for field screening and possible chemical analysis on two foot intervals unless otherwise specified in a project-specific SAP. The sampling interval will be determined in the field based on recovery, soil variability, and evidence of contamination, or as specified in the SAP. Complete field screening as specified in the applicable SOP or SAP. Soil samples should be collected using different procedures for volatile or non-volatile analyses, as follows.

- Volatile Analyses. Sampling for volatile organics analysis (VOA) is different than other routine physical or chemical testing because of the potential loss of volatiles during sampling. To limit volatile loss, the soil sample must be obtained as quickly and as directly as possible. If a VOA sample is collected as part of a multiple analyte sample, the VOA sample portion will be obtained first. The VOA sample should be obtained from a discrete portion of the entire collected sample and should not be composited or homogenized. Sample bottles should be filled to capacity, with no headspace.
- Other Analyses. Soil samples for non-volatile analyses will be thoroughly homogenized in a stainless-steel bowl prior to placing the sample material in the sample container. Sample homogenizing is accomplished by manually mixing the soil sample material from the desired sampling interval and location in the stainless-steel bowl with a clean sampling tool until a uniform mixture is achieved. The sample jar or container should then be filled completely with mixed soil material.

Grab Groundwater Sample Collection:

Collect grab groundwater samples using a sampling attachment with a 4 to 5-foot-long temporary screen (specify to drillers whether to use decontaminated stainless steel or disposable PVC. Also, specify whether a filter pack is necessary based on field observations). Obtain samples using a peristaltic pump unless otherwise specified in the SAP with new tubing for each boring. Record field parameters (e.g., temperature, conductivity, and pH) prior to sampling.

Backfilling the Excavation (Conducted by Drilling Subcontractor):

After sampling activities are completed, abandon each exploration in accordance with Oregon Water Resources Department (OWRD) regulations and procedures (or other regulatory authority if work is completed outside of the State of Oregon). The abandonment procedure typically consists of filling the exploration with granular bentonite and hydrating the bentonite with water. Match the surface completion to the surrounding materials.

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides instructions for standard field screening. Field screening results are used to aid in the selection of soil samples for chemical analysis. This procedure is applicable during all Cascadia Associates, LLC (Cascadia) soil sampling operations.

Standard field screening techniques include the use of a photoionization detector (PID) to assess for volatile organic compounds (VOCs) and for the presence of separate-phase petroleum hydrocarbons using a sheen test. These methods will not detect all potential contaminants, so selection of screening techniques shall be based on an understanding of the site history. The PID is not compound or concentration-specific, but it can provide a qualitative indication of the presence of VOCs. PID measurements are affected by other field parameters such as temperature and soil moisture. Other field screening methods, such as screening for dense non-aqueous phase liquid (DNAPL) using dye or UV light, are not considered “standard” and will be detailed in the site-specific sampling and analysis plan (SAP).

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- PID with calibration gas (record daily calibration/calibration check in field notes);
- Plastic resealable bags (for PID measurement); and
- Glass jars or stainless steel bowls (for sheen testing).

3. METHODOLOGY

Each soil sample will be field screened for VOCs using a PID and for the presence of separate-phase petroleum hydrocarbons using a sheen test.

PID lamps come in multiple sizes, typically 9.8, 10.6, and 11.7 electron volts (eV). The eV rating for the lamp must be greater than the ionization potential (in eV) of a compound for the PID to detect the compound. For petroleum hydrocarbons, a lamp of at least 9.8 eV should be used. For typical chlorinated alkenes (dichloroethene, trichloroethene, tetrachloroethene, or vinyl chloride), a lamp of at least 10.6 eV should be used. The compatibility of the lamp size with the site constituents should be verified prior to the field event and will be detailed in the site-specific SAP.

PID Calibration Procedure: The PID used on-site should be calibrated daily or more frequently if needed. Calibration of the PID should be documented in field notes. Calibrations procedures should be conducted per the manufacturer’s instructions.

PID Screening Procedure:

- Place a representative portion (approximately one ounce) of freshly exposed, uncompacted soil into a clean resealable plastic bag.
- Seal the bag and break up the soil to expose vapors from the soil matrix.
- Allow the bag to sit to reach ambient temperature. Note: Ambient temperature and

weather conditions/humidity should be recorded in field notes. Changes in ambient temperature and weather during the field work should also be recorded, as temperature and humidity can affect PID readings.

- Carefully insert the intake port of the PID into the plastic bag.
- Record the PID measurement in the field notes or boring logs.

Sheen Test Procedure:

- Following the PID screen, place approximately one ounce of freshly exposed, uncompacted soil into a clean glass jar or stainless steel bowl.
- Add enough water to cover the sample.
- Observe the water surface for signs of discoloration/sheen and characterize based on the descriptions below.

No Sheen (NS)	No visible sheen on the water surface
Biogenic Film (BF)	Dull, platy/blocky or foamy film.
Slight Sheen (SS)	Light sheen with irregular spread, not rapid. May have small spots of color/iridescence. Majority of water surface not covered by sheen.
Moderate Sheen (MS)	Medium to heavy coverage, some color/iridescence, spread is irregular to flowing. Sheen covering a large portion of water surface.
Heavy Sheen (HS)	Heavy sheen coverage with color/iridescence, spread is rapid, entire water surface covered with sheen. Separate-phase hydrocarbons may be evident during sheen test.

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for documenting environmental field activities. The purpose of establishing SOPs for field notes and documentation is to establish a consistent method and format for the use and control of documentation generated during daily field activities. Field notes and records are intended to provide sufficient information that can be used to recreate the field activities, as well as, the collection of environmental data. Information placed in these documents and/or records shall be factual, detailed and objective.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Bound field books;
- Black waterproof and/or indelible ink pens; and
- Field forms.

3. METHODOLOGY

This SOP primarily includes the documentation procedures for the field logbooks. However, procedures discussed in this SOP are applicable to all other types of field documentation collected, and should be universal in application. Details of other field records and forms (e.g. boring logs, sample labels, chain of custody records, and waste containment labels are discussed in the specific SOP associated with that field activity (e.g. borehole drilling, sample handling, investigative derived waste), and not covered in detail in this SOP.

Field Logbooks:

Field personnel will keep accurate written records of their daily activities in a bound logbook that will be sufficient to recreate the project field activities without reliance on memory. This information will be recorded in chronological order. All entries will be legible, written in black waterproof or indelible ink, and contain accurate and inclusive documentation of field activities, including field data observations, deviations from project plans, problems encountered, and actions taken to solve the problem. Each page of the field logbook will be consecutively numbered, signed and dated by the field author(s). Pages should not be removed for any reason.

There should be no blank lines on a page. A single blank line or a partial blank line (such as at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it.

In addition to documenting field activities, field logbooks will include the following:

- Date and time of activities,
- Site location,
- Purpose of site visit,
- Site and weather conditions,

- Personnel present, including sampling crew, facility/site personnel and representatives (including site arrival and departure times),
- Subcontractors present,
- Regulatory agencies and their representatives (including phone numbers, site arrival and departure times),
- Level of health and safety protection,
- Sampling methodology and information,
- Sample locations (sketches are helpful),
- Source of sample(s), sample identifications, sample container types and preservatives used, and lot numbers for bottles and preservatives (if applicable and if not recorded on other forms or in a sample control logbook),
- A chronological description of the field observations and events,
- Specific considerations associated with sample acquisition (e.g., field parameter measurements, field screening data, HASP monitoring data, etc.) (if not recorded on another form),
- Wastes generated, containment units (including volumes, matrix, etc), and storage location (if not recorded on another form),
- Field quality assurance/quality control samples collection, preparation, and origin (if not recorded on other forms or in a sample control logbook),
- The manufacturer, model and serial number of field instruments (e.g., PID, water quality, etc.) shall be recorded, if not using a calibration form. Also, source lot # and expiration date of standard shall be recorded if calibrated in the field.
- Well construction materials, water source(s), and other materials used on-site (if not recorded on another form).
- Sample conditions that could potentially affect the sample results,
- If deviating from plan, clearly state the reason(s) for deviation,
- Persons contacted and topics discussed,
- Documentation of exclusion zone set-up and location,
- Documentation of decontamination procedures, and
- Daily Summary.

Field situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the field activity without relying on the collector's memory. Language used shall be objective, factual, and free of personal opinions. Hypothesis for observed phenomena may be recorded, however, they must be clearly indicated as such and only relate to the subject observation.

Logbooks will be assigned to a specific sampling team. If it is necessary to transfer the log book to alternative team member during field work, the person relinquishing the log book will sign and date the log book at the time of transfer.

Field logbooks should consist of a bound book, in which the insertion or removal of pages will be visibly noticeable after the logbook has been assembled. Logbooks can be prepared by gluing or laminating pages together either at the left side or top of the page. If inclement weather is expected, logbooks may have plastic laminated front and back covers to protect the interior pages, and should not be broken apart for coping. Loose-leaf binding, such as comb binding is not considered hard binding. To maintain the integrity of the logbook, pages should be consecutively numbered prior to use. Logbook pages can be of any format, and may include blank pages for recording or field forms that are used for specific tasks. As an alternative, commercially bound and consecutive page numbered field logbooks may also be used.

Additional Field Forms/Records:

Additional field records may be required for each specific field event. The use of these records and examples are described in other SOPs specific for the activity (e.g. Borehole Logging SOP, Groundwater Sampling and Purging SOP, etc.). These other records may include:

- Borehole Logs during drilling,
- Well Construction and Development records,
- Groundwater Purge and Sample Collection Records,
- Water Level Monitoring,
- Investigation Derived Waste (IDW) Tracking Records,
- Instrument Calibration Records, and
- Health and Safety Monitoring Records and sign-off sheets.

Prior to field activities, the field sampling personnel will coordinate with the Project Manager, or designee, to determine which additional records will be required for the specific field task. These additional records will be maintained in a field file or a three-ring notebook throughout the duration of the field activities, or included in a specially prepared site-specific notebook. If the field notebook is being created, the forms may be part of the laminated book.

Corrections:

If an error is made in the field, logbook corrections will be made by drawing a single line through the error, entering the correct information, and initialing and dating the change. Materials that obliterate the original information, such as correction fluids and/or mark-out tapes, are prohibited. All corrections will be initialed and dated. Some projects require that a brief reason for the change must also be added where the correction was made. Ask the Project Manager, if this requirement is necessary.

Documentation Reviews:

Periodically, the Project Manager, or designee, will review the field logbooks pertaining to the activities under their supervision. The elements of this review will include technical content, consistency, and compliance with the project plans and SOPs. Discrepancies and errors identified during the review should be resolved between reviewer and author of the field documentation. Corrections and/or additions of information shall be initialed and dated by the field author or reviewer.

CASCADIA ASSOCIATES
STANDARD OPERATING PROCEDURE

Low Flow Groundwater Sampling

SOP Number: 17.5
Date: July 25, 2017
Revision Number: 0

1. PURPOSE AND SCOPE

The objective of this standard operating procedure (SOP) is to define the methods and requirements for collection of groundwater samples from monitoring wells applying low flow protocols. Low flow sampling is a technique for collecting samples that does not require the removal of large volumes of water and therefore does not overly agitate the water, suspend particles, or potentially aspirate VOCs. Typical flow rates for low flow sampling should range from 0.1 L/min to 0.5 L/min depending on site characteristics. The groundwater monitoring activities will consist of measuring water levels, purging and sampling groundwater, and measuring groundwater field parameters. This procedure is applicable during all Cascadia Associates, LLC low flow groundwater sampling activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, and buckets/drums;
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes);
- Sampling equipment (water level indicator, pump, tubing);
- Laboratory-supplied sample containers (Consult the project-specific sampling and analysis plan (SAP) for sampling requirements);
- Field documentation materials;
- Decontamination materials; and
- Personal protective equipment (consult the site-specific Health and Safety Plan).

3. METHODOLOGY

Water Levels:

Water levels in the wells will be measured and recorded for the purpose of determining groundwater elevations and gradient. The wells will be opened and the water level allowed to equilibrate before the measurements are taken. Measurements of the depth to water will be made to the nearest 0.01 foot using an electronic water level indicator.

Purging:

Purge using low-flow sampling equipment (e.g., peristaltic or bladder pump) at a rate no greater than the recharge rate of the groundwater to prevent water table drawdown. Unless specified otherwise in the project-specific SAP the sample tubing/pump will be lowered to the middle of the screened interval. Groundwater field parameters (pH, electrical conductivity, and temperature) will be measured using a water quality meter and flow cell connected to the discharge tubing of the sample pump to assess the effectiveness of purging. Purging will be considered complete when the water quality parameters (i.e., pH, temperature, and specific conductance) stabilize within 10 percent for three consecutive 3-minute intervals. Consult the project-specific SAP for additional parameters and stabilization criteria. Purge water will be placed in Department of Transportation (DOT) approved drums.

Sample Collection:

After the purging of each well is complete, collect groundwater samples for chemical analyses using the same pump used for the well purging.

Low Yield Sampling Procedure:

If a well pumps dry during purging discontinue measurement of water quality parameters. Collect groundwater samples once the water level recovers to 90 percent of the pre-purge water column. Contact project manager in the event of slow recharge conditions. Always collect samples for VOC analysis as soon after recharge as possible.

CASCADIA ASSOCIATES
STANDARD OPERATING PROCEDURE

MONITORING WELL DEVELOPMENT PROCEDURES

SOP Number: 17-6
Date: July 15, 2019
Revision Number: 1

1. PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) describes the methods for developing monitoring wells following construction. Monitoring wells will be allowed to sit for a minimum of 12 hours after final completion before initiating the well development process. Wells will not be sampled for at least 24 hours following well development. This procedure is also applicable for the redevelopment of existing monitoring wells. This procedure is applicable during all Cascadia Associates, LLC (Cascadia) well development activities.

2. EQUIPMENT AND MATERIALS

The following materials are necessary for this procedure:

- Traffic cones, tools, keys, buckets, and drums or a high-capacity tank for storage of purged groundwater (such as a 250-gallon tote or small poly tank).
- Water quality meter with calibration solutions (record daily calibration/calibration check in field notes) to monitor temperature, pH, and conductivity.
- Well development equipment, including:
  - Water level probe;
  - Down-hole centrifugal pump (capable of at least 5 gpm) and tubing;
  - Weighted bailer and rope (if a down-hole pump will not be used to purge water); and
  - Surge block.
- Field documentation materials.
- Decontamination materials.
- Personal protective equipment (as required by Site Specific Health and Safety Plan)

3. METHODOLOGY

Well Purging

Initial Setup. The depth to water and total depth of the well will be measured prior to development and the casing volume will be calculated.

Casing Volume (gallons) = (Water Height) x (Well Diameter Multiplier)

Well Diameter	Multiplier (gallons per foot)
1-inch	0.041
2-inch	0.162
4-inch	0.653

Setup the well development equipment in a manner such that the volume of water generated can be easily determined and field parameters can be collected. The development activities will be completed to maximize the removal of sediment from the well casing.

Surge Block Procedure. A surge block is an effective method to develop most monitoring wells. The surge block forces water within the well through the well screen and out into the formation, and then pulls water back through the screen into the well along with fine soil particles. A slow initial surging, using plunger strokes of approximately 3 feet, will allow material that is blocking the screen to separate and become suspended. After 5 to 10 plunger strokes, remove the surge block and purge the well using a pump or bailer. Repeat the process and slowly increase the depth of surging to the bottom of the well screen. Continue this cycle of surging and purging until the water yielded by the well is free of visible suspended material.

Bailer Method. Bailers are not the preferred method of development but may be used in combination with a surge block to remove silt-laden water from the well. Lower the bailer into the screened interval of the monitoring well. Silt, if present, will generally accumulate within the lower portions of the well screen. The bailer may be raised and lowered repeatedly in the screened interval to further simulate the action of a surge block and pull silt through the well screen. Continue surging/bailing the well until the water removed is free of visible suspended material. If moderate to heavy siltation is still present, the surge block procedure should be repeated followed by additional bailing.

Down-Hole Pump Method. Well development using only a pump is most effective in monitoring wells that will yield water continuously. Effective development cannot be accomplished if the pump has to be shut off to allow the well to recharge. Set the intake of the pump in the center of the screened interval of the monitoring well. Pump a minimum of three well volumes of water from the well and raise and lower the pump line through the screened interval to remove silt laden water. Continue pumping water from the well until the water removed is free of visible suspended material. This method may be combined with the manual surge block method if well yield is not rapid enough to extract silt from the surrounding formations.

Investigation Derived Waste (IDW)

Any extra soil generated during the drilling activities or water generated during groundwater sampling or equipment decontamination will be placed in Department of Transportation (DOT)-approved drums or other project specific storage vessels, based on discussion with the Project Manager. Soil and water samples should be collected, consistent with the methods discussed above to profile the IDW for disposal.

APPENDIX F

SEDIMENT SAMPLING AND ANALYSIS PLAN

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CONTENTS

TABLES

FIGURE

1.0 KEY PERSONNEL

The sediment investigation is a joint effort being conducted on behalf of the Port of Vancouver (Port), NuStar Terminals Services, Inc. (NuStar), and Kinder Morgan Bulk Terminals, LLC (KMBT). The following key personnel have been identified to represent each party for the sediment investigation.

1.1 PROJECT MANAGERS

The project management for the sediment investigation will be a joint effort from the three parties, with representatives as follows:

Richard Roche – Parametrix, Inc. on behalf of Port of Vancouver

Stephanie Salisbury – Cascadia Associates, on behalf of NuStar

Kevin McCarthy – Antea Group, on behalf of KMBT

1.2 FIELD MANAGERS

Field managers will report directly to the Project Managers and will coordinate closely with project staff members and sampling subcontractors, as required. The field managers will oversee all aspects of the field investigations to ensure that the appropriate procedures and methods are used in accordance with this Sampling and Analysis Plan (SAP). Two field managers will be utilized for this investigation:

Cascadia Field Manager (to be determined [TBD]) – on behalf of NuStar

Nate Hemphill – Antea – on behalf of KMBT

In addition, field oversight will be provided by Rick Malin of Parametrix, on behalf of the Port.

1.3 SAMPLING AND ANALYSIS COORDINATOR

The sampling and analysis coordinator's (SAC's) primary role will be to coordinate with the analytical laboratories to obtain appropriate sampling containers, facilitate sample deliveries and chain of custody, and ensure the analytical work is conducted consistent with the requirements set forth in the SAP. NuStar will appoint a SAC (TBD) to coordinate the analytical program for the volatile organic compound (VOC) and fertilizer constituent analyses. KMBT will appoint a SAC (TBD) to coordinate the analytical program for the metals analyses.

1.4 SUBCONTRACTORS AND LABORATORY

Marine Contractor. To be determined based on capability and availability.

Laboratory. Apex Laboratories LLC. (Apex Labs) of Tigard, Oregon, will be used for sediment sample analyses of fertilizer chemicals of potential concern (COPCs) and VOCs.

ALS Laboratories of Kelso, Washington, will be used for copper COPC analyses.

2.0 SEDIMENT SAMPLING

Sediment sampling will be conducted in accordance with the Sediment Management Standards (SMS; Chapter 173-204 WAC) and guidance in the Sediment Cleanup User's Manual II (Washington State Department of Ecology [Ecology], 2019). Twenty-six surface sediment samples and 15 sediment cores will be collected in the undredged portion of the Columbia River, adjacent to the NuStar and KBMT operational areas. The locations of the proposed surface/subsurface sediment target locations are shown on Figure 20 (SRIWP, main document).

Sediment samples will be collected using several potential methodologies, depending upon the conditions encountered, as detailed in Sections 2.4 and 2.6.

As detailed in Section 7.5 and Table F-5, surface and core sediment samples collected at locations 1 through 14, and 45 will be analyzed for VOCs, metals, and fertilizer constituents; surface samples collected at locations 46 through 56 will be analyzed for metals and fertilizer constituents.

2.1 SAMPLE LOCATION CONTROL

The horizontal and vertical positions of the sediment sampling locations will be determined by referencing each sampling location to state plane coordinates using survey control points, onshore landmarks, and differential global positioning systems (DGPS). The target location for each sediment grab sample/core is provided in Table F-1. The following information will be documented for both the surface grab samples and sediment cores at each sampling station:

- Time and date;
- Horizontal location in local grid coordinates, referenced to the North American Datum of 1983 (NAD83); and
- River level and mudline elevations referenced to the North American Vertical Datum of 1988 (NAVD88).

Positioning while sampling will be performed using a DGPS. Horizontal locations of samples will be collected within +/- 10 feet of the proposed location. Vertical locations of sediment samples will be located to an accuracy of +/- 0.1 foot. Care will be taken to achieve horizontal and vertical accuracy to the maximum extent possible, so that samples can be taken from the same location during future sampling events.

Columbia River stage levels will be evaluated prior to the investigation. River mudline elevations, and thus the vertical control on sediment sample locations, will be determined by subtracting depth to mudline (from the sampling vessel) from the river surface elevation. The depth of surface water samples will be determined by subtracting the depth to the sample intake point from the river surface elevation. River surface elevation will be estimated using tide/river stage prediction data provided by the National Oceanic and Atmospheric Administration (NOAA) for Vancouver Tide station #9440083 located approximately 0.5 mile to the east of the project area. During periods of extreme precipitation, dam openings, snow melt, etc., actual river levels may significantly exceed river stage levels predicted on the tidal charts. Predicted river stage levels must approximate actual verified levels to ensure vertical accuracy during investigation activities. Therefore, the close monitoring of the factors that affect river stage will be essential in timing the investigation. Both the actual position of surface grab samples and sediment cores will be recorded in the field notes.

2.2 EQUIPMENT LIST

The following general equipment will be required during collection procedures:

Personal protective equipment as required by the project health and safety plan (HASP);
Navigation and site maps;
Sampling vessel;
Power grab sampler;
Vibracore;
Aluminum core barrel;
Stainless-steel mixing bowls and spoons;
Decontamination materials;
Weighted tape measure calibrated in 0.1-foot increments;
Duct tape;
Camera;
Field notebook;
Stainless steel bowls and spoons
Sample jars and labels;
Sample analysis plan; and
Chain-of-custody forms.

2.3 SAMPLE NOMENCLATURE

All project samples will be assigned a unique identification number. The unique identifier will consist of up to five components, separated by dashes (“-”), which will indicate the sampling event, station number, sample type, and field quality control (QC) sample type (if applicable):

- The first component is “PNK,” identifying the data as belonging to the Port-NuStar-KMBT sampling event.
- The second component begins with a “G,” representing a grab surface sediment sample type, or a “C,” representing a subsurface sediment core sample type. The letter will be followed by the unique station identification number starting with “001.”
- For subsurface sediment cores the sampling interval will be noted from the top to bottom depth of the sampling interval, in feet.

Examples of the unique sample identifiers are as follows:

- PNK-G001: Grab sediment sample from Location 1
- PNK-C005-1-3: Subsurface sediment core sample from Location 5 from the 1- to 3-foot sampling interval.

The final component, if applicable, identifies the QC sample type. For duplicate samples, a number of 1000 will be integrated with the station number of the original sample. For equipment rinsate blanks, a number of 9000 will be integrated with the station number.

Examples of the unique sample identifiers for QC samples are as follows:

- PNK-G1010: Duplicate grab sediment sample from Location 10
- PNK-G9010: Equipment rinsate blank sample during collection of grab sample from Location 10.

2.4 SURFACE SEDIMENT COLLECTION

Surface sediment samples will be obtained by the marine drilling contractor using power-grab sampling methodology, with a target penetration depth of 20 cm (centimeter) (or a minimum of 15 cm).

The power grab sampler will be attached to a winch and will be lowered slowly through the water column. The slow deployment will ensure that the sampler does not flip over while being lowered and will limit disturbance of the sediment during retrieval. After the power grab sampler is retrieved onto the vessel, it will be placed on a small table. Doors located in the cover at the top of the sampler will be opened for visual characterization of the sediment to assess sample acceptability. Before characterization, the overlying water in the sampler will be siphoned off and returned to the river. A photograph of each of the undisturbed grab samples will be taken prior to processing.

Sediments recovered by the power-grab sampler (at each grab location) will be inspected for acceptance by field staff. Sample acceptance criteria include the following:

1. No (or minimal) loss of sediments due to obstructions preventing sampler jaws from fully closing.
2. No (or minimal) excess water leaking from sampler jaws.
3. No (or minimal) turbidity in overlying water in sampler based on visual observations.
4. No over-penetration of sampler.
5. Sediment surface appears to be intact with minimal disturbance. Intact sediment surface features often include ripple marks, undulations, etc.

6. Target penetration depth of 20 cm (or 15 cm minimum) is achieved.

As part of the marine contractor selection process, alternative sampling methods for difficult to access locations, will be considered. Surface grab samples located in areas that cannot be accessed by a boat may alternatively be accessed from land or pier using a powergrab deployed from a boom truck or crane. If debris or rip-rap is present, but not covering the entire river bottom, a diver may be deployed to collect a surface grab using a cooker cutter core. To conduct diver-assisted surface sediment sampling, a cookie cutter will be inserted into the upper 30 cm of the sediment column and brought to the surface for sample processing.

2.5 SUBSURFACE SEDIMENT COLLECTION

At the 15 proposed sample core locations depicted on Figure 20, a vibracore sampler will be used to collect sediment cores unless in an area that is not accessible by boat. Sediment core samples located in areas that cannot be accessed by a boat may be collected with a diver-assisted piston core. To conduct diver-assisted piston coring, the core liner will be driven into the sediment using a driving head powered manually by a slide hammer.

Based on historical coring activities in the investigation area, a target coring depth of 7 feet below mudline is proposed. This is typically the maximum penetration depth achievable that allows acceptable recovery.

The coring device is comprised of an outer aluminum jacket with a polycarbonate liner. The vibracore system utilizes a high frequency vibrating head to break down the frictional resistance of the sediment, which allows the core tube to penetrate into the sediment with minimal disruption. Sediment coring will be conducted using the following procedures:

Maneuver the sampling vessel to the target sample location. Secure the vessel in place using spuds, anchors, or tie lines in a two- or three-point anchoring system.

Drop a weighted object (i.e., measuring tape) to the anticipated mudline to evaluate whether the river sediments are accessible or covered with rock. If rocky, the field personnel should be able to feel the weighted object impact the rock. If rocks are present at the river bottom, and core penetration is a low probability, the vessel will be relocated approximately 5-10 feet away and another attempt will be made to assess the subsurface. In general, offsets will be made parallel to the shoreline, but may be offset perpendicular to the shoreline if the area is particularly rocky.

Observations/tape measurements of rocky river bottom will be documented in the field notebook.

Once the targeted area is deemed suitable for core collection, select an appropriate 3- or 4-inch (outside diameter) core tube type and length based on the bathymetry data and target elevation. Mount a clean coring tube into the vibracore device. A core catcher will be inserted into the base of the coring tube-which will allow sediment into the core but will prevent it from falling out when the core is lifted.

Lower the coring apparatus with the core tube attached vertically through the water column, tube end first, until the mudline is reached.

Vibrate the core into the sediment to the targeted depth or point of refusal, whichever is shallower. Measure and record the depth of core tube penetration into the sediments in the field notebook.

Pull the apparatus upward (using a winch) to the surface while maintaining the core in a vertical position. Cap the bottom of the core tube with the core catcher remaining in place.

Allow water overlying the core tube in the coring apparatus to drain prior to removing the core tube.

Estimate the recovered length of the sediment core and record it in the field notebook.

- The length of the cores recovered in the tubing will be determined indirectly by tapping the outer aluminum core with a metal rod from top to bottom. The spot where the pitch of the sound changes corresponds to the approximate top of the recovered core.
- The distance between the top of the sediment in the core tube and the bottom of the coring tube corresponds to the estimated length of the recovered core.

Compare the length of the recovered core with the core penetration depth.

- If the recovered length of the sediment core is more than 70 percent of the penetration depth, keep the core.
- If there is less than 70 percent recovery, the core will be retained until a core with greater recovery is obtained at this location. If a core with greater recovery is not obtained, the core with the best recovery will be retained. If a core with greater recovery is obtained, the core(s) with an insufficient amount of material will be discarded over the side of the sampling vessel. Care will be taken to discard the material away from the sampling area to avoid cross contamination.
- Any additional attempts will be made at an approximate distance of 5 feet from the previously attempted location.
- A maximum of four attempts to advance a core will be made for a given location.
- Rinse the core tubes with river water between consecutive attempts.
- If all four attempts to collect a core are unsuccessful based on recovery alone (i.e., less than 70 percent recovery), retain the core with the greatest recovery and/or best penetration depth for analysis and indicate that the targeted recovery was not achieved.

Remove the core tube from the vibracore device and place a second cap on top of the core tube. Secure the cap in place with duct tape. Rinse the outside of the core tube with a small amount of river water.

Label each core with the station identification, core length, and an arrow indicating the top of the core. Label the core by scratching into the surface of the core barrel and with an indelible marker.

Store the core vertically while on the vessel and transport to the processing area.

2.6 SEDIMENT SAMPLE COLLECTION PROCEDURES

The following subsections describe the methods for collecting sediment samples from the power grab and vibracore sampling devices.

For evaluating the vertical extent of contamination, the following subsampling scheme will be used. The top 10 cm of the power grab sample will be collected as the surface sample. Subsurface samples via coring will be collected at 2-foot intervals beginning approximately 1 foot below the sediment surface. Therefore, the first subsample will be the approximately 1- to 3-foot section below mudline, and the subsamples will continue in 2-foot segments down to 7 feet below the mudline (i.e., 3 to 5 feet; 5 to 7 feet, etc.).

2.6.1 Surface Sediment Processing Methods

Approximately 1 liter (L) of sediment will be collected from the top 0 to 10 cm portion of the sampler and transferred to a stainless steel bowl. Sediments that are in contact with the sides of the sampler will be avoided. Large rocks, organisms, and pieces of debris will be removed and noted in the sample description form.

Prior to homogenization, the following physical characteristics of the grab samples will be described and recorded on a sample description form, using the ASTM International (ASTM) D2488 visual soil classification procedure (ASTM, 2017). This procedure includes describing sediment texture; sediment color; presence, type, and strength of odors or petroleum sheens; grab penetration depth (to the nearest cm); and any obvious features or characteristics, such as wood, shell fragments, or biological activity. The maximum depth of evidence of biological activity will be noted at each sample location. Also prior to visual observations and homogenization, the sample aliquots for ammonia and VOC analysis will be collected into laboratory supplied sample jars. The remaining sample material will then be thoroughly homogenized to a uniform color and consistency. After the sample is thoroughly mixed, the required amounts will be transferred to the appropriate sampling containers for the remaining analytes. An additional jar will be collected for archiving by freezing. With the exception of the archive sample, sample jars will be completely filled and immediately capped. The archive sample will be filled approximately 2/3 full to prevent from expansion and cracking due to freezing. After sealing the sample containers, the container threads will be thoroughly wiped down before storing on ice in a sampler cooler. This will prevent leakage and potential cross-contamination of samples. The transfer container and mixing bowl will be decontaminated between grab-sample locations.

Table F-2 lists the sample preservation appropriate to the analytical method, the analytical extraction and holding time, and the type and volume of containers required per sample/analysis.

2.6.2 Sediment Core Processing Methods

Once sediment coring is complete, the cores will be transported in an upright position, on ice, to a location onshore for processing. Processing will occur using an electric saw to cut along the length of the core in two places, forming two D-shaped core halves. Only the barrel-not the sediments-will be cut by the saw. When sediment is collected from the core, care will be taken not to collect sediment in contact with the core barrel. For VOC and ammonia collection, samples will not be composited because of the potential for loss of volatiles during the mixing process that could result in low-biased analytical results.

Core sections will not be opened until the sampler is ready to collect samples. Upon opening the core, a small volume (approximately 3 ounces) from each sample interval will be placed in a plastic bag for screening for VOCs using a photoionization detector (PID). Immediately upon completion of PID screening, the VOC sample will be collected from the approximate center of the core sample intervals. Sediment samples for VOC analysis will be placed into glass jars, with no headspace, for laboratory analysis. This methodology is consistent with historical VOC sediment investigations in the investigation area and Ecology's SCUM II guidance (Ecology, 2017). Samples collected for ammonia will also be placed into glass jars with no headspace. Both the VOC and ammonia samples will be cooled immediately after collection. Following collection of the VOC sample, the lithology of each sample interval will be logged in the field notebook.

Once the VOC and ammonia samples are collected, the remaining material from each sampling interval (i.e. 1- to 3-foot, 3- to 5-foot, etc.) will be placed in a stainless steel bowl and homogenized. The composited, homogenized sediment will be placed into laboratory provided sample jars for analysis of metals (including potassium), nitrate, nitrite, phosphorous, and sulfate. An additional sample jar will be collected for freeze archive purposes. It is estimated that 16 ounces of sample total will be needed for the chemical analyses. The stainless steel bowls and spoons will be cleaned in a Liquinox® solution, rinsed with tap water, followed by a rinse with deionized water prior to each use.

In addition, two 4-ounce or greater laboratory provided sample jars will be collected at each surface sample location in the Berth 7 area (i.e., at locations 1 – 14, 45, and 46) for total organic carbon (TOC) and percent solids analyses. Surface samples from locations 6, 45, 55, 49, 51 and 54 will also be analyzed for grain size analysis. It is estimated that 16 oz of sample will be required for grain size analysis. If additional volume is needed to meet (non-volatile) sample volume requirements, then multiple cores may be collected from the same approximate location and composited.

Sample jars will be labeled and placed in a cooler on ice. To the extent possible, samples will be submitted to the laboratory within 24 hours of sample collection. Sample containers, analytical methods, preservation methods, and maximum laboratory hold time for each chemical of potential concern are provided in Table F-2.

3.0 DOCUMENTATION

Field activities and samples must be properly documented during the sampling process. Documentation of field activities provides an accurate and comprehensive record of the work performed sufficiently for a technical peer to reconstruct the day's activities and provide certification that all necessary requirements were met. General requirements include:

Use of bound field notebooks as the primary source for information collection and recording. Field notebooks should be dedicated to the project and appropriately labeled.

Surface Sediment Collection and Subsurface Sediment Collection forms will be used to formally document activities and events as a supplement to bound field notebooks. The Sediment Collection forms can be a standard or project-specific form. Preprinted standard forms are available for many activities and should be used whenever possible. These forms will provide prompts and request additional information that may be useful and/or needed. Project-specific field forms may be generated or existing forms may be modified to meet specific project needs. As required, client-supplied forms may be substituted.

Appropriate header information documented on each page, including project title, project number, date, weather conditions, changes in weather conditions, other persons (if any) in the field party, and author. The specific information requested depends on the nature of the work being performed and on the form being used. Information fields that are not applicable should be noted "N/A" or with other appropriate notations.

Field documentation entries using indelible ink.

Legible data entries. A single line should be drawn through incorrect entries and the corrected entry should be written next to the original strikeout. Strikeouts should be initialed and dated by the originator.

Applicable units of measurement with entry values.

Field records maintained in project files.

3.1 DOCUMENTATION ENTRIES

A chronology of field events will be recorded. General entry requirements include:

Visitors to the site, including owner and regulatory representatives;

Summary of pertinent project communications with the client, regulators, or other site visitors;

Other contractors working on site;

A description of the day's field activities, in chronological sequence using military time notation (e.g., 9:00 am: 0900, and 5:00 pm: 1700);

If applicable, calibration of measuring and test equipment and identification of the calibration standard(s) and use of a Calibration Log, if available, with cross-reference entered into the field notebook;

Field equipment identification, including type, manufacturer, model number, or other specific information;

General weather conditions, including temperature, wind speed, and direction readings, including time of measurement and units;

Safety and/or monitoring equipment readings, including time of measurements and units;

Presence of vessels/ship at the dock or in nearby vicinity, including time of arrival and departure;

If applicable, reference in the field notebook to specific forms used for collection of data;

Subcontractor progress and/or problems encountered;

Changes in the scope of work; and

Other unusual events.

3.2 SPECIFIC REQUIREMENTS

Sample Collection. Field event information will be documented in a field notebook. Sample collection data and information will be documented on sample collection and processing forms. Where both are being used, information contained in one is cross-referenced to the other. Entries will include at a minimum:

Sample identification number, location taken, depth interval, sample media, sample preservative, collection time, and date;

Sample collection method and protocol;

Physical description of the sample;

Quality-control-related samples collected (e.g., duplicates, blinds, trip blanks, field blanks);

Container description and sample volume;

Pertinent technical data such as headspace reading;

Pertinent technical comments; and

Identification of personnel collecting the sample.

Sample Labeling. Sample labels must be prepared and attached to sample containers. Labels will either be provided by the laboratory performing the analyses or will be generated internally. The information to be provided includes:

- Sample identification number;
- Sample date and collection time;
- Physical description of the sample (e.g., water, sediment, etc.);
- Analytical parameters;
- Preservatives, if present;
- Sample location; and
- Client.

Core Logs. Surface and subsurface sediment samples should be recorded in bound field notebooks. Sediment logging information will be recorded on a core log sheet (Figure F-1). Personnel completing the log should supply the following information:

- Names(s) of personnel logging sampling;
- Administrative and technical information included in the header, including horizontal datum, tide elevation, water depth, mudline elevation, drive penetration, recovery length, percent of recovery and drive notes;
- Types of equipment used;
- Subcontractor/driller used;
- Descriptions of subsurface materials encountered and the number and type of samples collected, if any;
- Subsurface exploration depth and units of measure;
- Length of recovery;
- Sample type and sample number for geotechnical or analytical samples collected (these data should also be entered on the sample collection log, if used, and the sample label);
- Classification standard protocol used, if any;
- Narrative description of the sediment (using standard classification system) and other pertinent information;
- Description of consistency of cohesive sediments;
- Observations of sheen or odor if present; and
- PID measurements.

Equipment Calibration Documentation. The PID will be calibrated at the beginning of each day of intended use, or as directed per manufacturer instructions. Subsequent calibration during the day will be performed if needed (e.g., if an instrument malfunctions).

Records must be maintained for each piece of calibrated measuring and test equipment and each piece of reference equipment. The records must indicate that established calibration procedures have been followed.

Records for periodically calibrated equipment must include the following minimum information:

Type and identification number of equipment;

Calibration frequency and acceptance tolerances;

Calibration dates;

The individual and organization performing the calibration;

Reference equipment and/or standards used for calibration;

Calibration data;

Certificates or statements of calibration provided by manufacturers and external organizations; and

Documentation of calibration acceptance or failure and of repair of failed equipment.

An individual file folder should be established to maintain records for each piece of measuring and testing equipment. Equipment calibration files should contain an equipment calibration and maintenance record, calibration data forms and/or certification of calibration provided by manufacturers or external organizations, and notice of equipment calibration failure.

Measuring and testing equipment used for field investigations will typically be calibrated as part of operational use. For this equipment, records of the calibrations or checks will be documented as part of the test data (e.g., in the field notebook). Equipment-specific forms may also be developed. These records should include information similar to that required for periodically calibrated equipment. Documentation related to malfunctioning equipment or equipment that fails calibration should also be included in the individual equipment file.

Calibration files for equipment requiring periodic calibration should be sent with equipment that is transferred to allow a continuously updated record to be maintained. Recalibration of sensitive equipment should be performed following the transfer. When measuring and testing equipment is rented or leased, procurement documents must specify that a current certificate of calibration must accompany the equipment. This certificate must be maintained with the project documentation calibration records.

4.0 SAMPLE CONTAINERS AND HANDLING

4.1 CONTAINER REQUIREMENTS

Requirements for sample containers are given in Table F-2. Containers will be supplied by the analytical laboratory. The laboratory will certify that all sample containers were prepared according to standard U.S. Environmental Protection Agency (EPA) protocol.

4.2 LABELING REQUIREMENTS

A sample label will be affixed to each sample container before sample collection. The information to be included on the sample label is as follows:

Project identification number;

Sample number;

Initials of person collecting the sample;

Date and time of sample collection; and

Type of preservative (if any).

4.3 PACKAGING AND SHIPPING REQUIREMENTS

Samples will be sampled and preserved in accordance with Table F-2 and will be submitted to the laboratory within the acceptable hold time, taking into account shipping time, laboratory business hours, etc. To the extent possible, samples will be shipped to the laboratory within 24 hours of sample collection. Samples will be packed with ice (or blue ice) to maintain a shipment cooler temperature of 4 degrees Celsius (ºC) or below and will be shipped overnight for next day delivery to the laboratory. One copy of the chain-of-custody form will be placed in a sealed plastic bag taped to the inside of the cooler lid.

5.0 DECONTAMINATION PROCEDURES

Consistent decontamination procedures will be used for sampling. The objectives of decontamination are to prevent the introduction of contamination into samples from sampling equipment or other samples, to prevent contamination from leaving the site via sampling equipment or personnel, and to prevent exposure of field personnel to contaminated materials.

5.1 PERSONNEL DECONTAMINATION

Personnel decontamination procedures depend on the level of protection specified for a given activity. The site health and safety plan identifies the appropriate level of protection for each type of field work involved in this project. Regardless of the level of protection required, field personnel should thoroughly wash their hands and faces before taking any work breaks and at the end of the day.

5.2 SAMPLING EQUIPMENT

Decontamination procedures are designed to remove trace level contaminants from sampling equipment to prevent the cross contamination of exploration locations and samples. The sediment coring device shall be decontaminated using high-pressure washing, steam cleaning, or cleaning with detergent (see below) before use and between locations.

To prevent cross contamination between sampling events, clean dedicated sampling equipment will be used for each sampling event and discarded or decontaminated after use. Decontamination of non-disposable items will consist of washing in a detergent (e.g., Liquinox®) solution, rinsing with tap water, followed with a deionized water rinse. The decontamination water will be collected and managed as investigation-derived waste as described in the section below.

6.0 INVESTIGATION-DERIVED WASTE HANDLING

As discussed in Sections 2.2 and 2.3, sediment cores or grab samples not meeting acceptance criteria may be emptied overboard the vessel. After collecting samples from the power grab sampler, the remaining sediment will be emptied into the river, and the sampler will be rinsed with river water. Sediment cores that have been brought to shore for processing, as well as equipment decontamination water, will be considered investigation-derived waste (IDW). IDW will be placed in Department of Transportation (DOT)-approved drums. Each drum will be labeled with the project name, general contents, and date. The drummed IDW will be stored at the terminal drum storage area. The selected disposal option will be determined based on analytical results from the samples from the explorations.

Disposable items, such as gloves, protective overalls (e.g., Tyvek®), paper towels, etc., will be placed in plastic bags after use and deposited in trash receptacles for disposal.

7.0 QUALITY ASSURANCE PLAN

The purpose of the Quality Assurance Plan (QAP) is to specify procedures and methods for office and field documentation, sample handling and custody, recordkeeping, equipment handling, and laboratory analyses that will be used during sampling and analysis.

7.1 QUALITY ASSURANCE OBJECTIVES FOR DATA MANAGEMENT

The general quality assurance (QA) objectives for this project are to develop and implement procedures for obtaining and evaluating data of a specified quality that can be used to evaluate sediment conditions. To collect such information, analytical data must have an appropriate degree of accuracy and reproducibility, samples collected must be representative of actual field conditions, and samples must be collected and analyzed using unbroken chain-of-custody procedures.

Apex Laboratories of Portland, Oregon, was consulted regarding laboratory reporting limits for the constituents proposed in this SAP. The sediment limits, listed in Table F-3, are the expected reporting limits, based upon laboratory calculations and experience. If site conditions are such that reporting limits exceed screening levels, additional work may be required to evaluate an acceptable alternative, including reanalysis or resampling.

Specific QA objectives are as follows:

1. Establish sampling techniques that will produce analytical data representative of the media being measured.
2. Collect and analyze duplicate samples (at least one per every 20 sediment samples) to establish sampling precision. Splits collected for VOC and ammonia analysis will be collected before homogenizing; splits collected for other analyses will be collected after homogenization. Laboratory duplicates of the same sample will provide a measure of precision within the sample (sample homogeneity).
3. Analyze a sufficient number of blank, standard, duplicate, spiked, and check samples within the laboratory to evaluate results against numerical QA goals established for precision and accuracy.

Precision, accuracy, representatives, completeness, and comparability parameters used to indicate data quality are defined below. Table F-4 lists the QA samples that will be collected as part of the sediment investigation.

7.1.1 Precision

Precision is a measure of the reproducibility of data under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared to their average value. For duplicate measurements, precision can be expressed as the relative percent difference (RPD). Analysis of field duplicate samples (one per 20 samples) will serve to measure the precision of sampling. In addition, a minimum of one laboratory duplicate will be analyzed per batch of samples.

7.1.2 Accuracy

Accuracy is the measure of error between the reported test results and the true sample concentration. True sample concentration is never known due to analytical limitations and error. Consequently, accuracy is inferred from the recovery data from spiked samples.

Because of difficulties with spiking samples in the field, the laboratory will spike samples. The laboratory shall perform sufficient spike samples of a similar matrix (sediment) to allow the computation of the accuracy. One matrix spike sample (MS) sample and one matrix spike duplicate (MSD) sample will be analyzed per sample batch.

Perfect accuracy is 100 percent recovery.

7.1.3 Representativeness

Representativeness is a measure of how closely the results reflect the actual concentration of the chemical parameters in the medium sampled.

Sampling procedures, as well as sample-handling protocols for storage, preservation, and transportation, are designed to preserve the representativeness of the samples collected. Proper documentation will confirm that protocols are followed. This helps to ensure the sample identification and integrity.

Laboratory method blanks will be run in accordance with established laboratory protocols.

7.1.4 Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid measurements. The completeness goal is essentially that a sufficient amount of valid data be generated to allow for the evaluation of site cleanup.

7.1.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. The objective of this QAP is to ensure that all data developed during the sampling are comparable. Comparability of the data will be ensured by using EPA-defined procedures that specify sample collection, handling, and analytical methods.

7.1.6 Documentation

Essentially, EPA Level II documentation will be generated during sampling/analysis. This level of documentation is generally considered legally defensible and consists of the following:

Analytical Report;

Chain of Custody Form;

Method Blank (MB) Results;

Matrix Spike and Matrix Spike Duplicate (MS/MSD) Summary;

Reporting Limits (RL);

Laboratory Control Samples (LCS);

Surrogate Recoveries;

Case Narrative, upon request or if applicable; and

Corrective Action Reports, if applicable.

7.2 SAMPLING PROTOCOLS

7.2.1 Methods

Sampling methods are presented in Sections 2 and 4. These procedures are designed to ensure that:

- Samples collected are consistent with project objectives; and
- Samples are identified, handled, and transported in a manner that does not alter the representativeness of the data from the actual site conditions.

Quality assurance objectives for sample collection will be accomplished by a combination of the following items:

- Following and documenting standardized procedures.
- **Laboratory QA.** At least one laboratory duplicate measurement will be collected per batch of samples. Analytical procedures will be evaluated using the protocols of the analytical laboratory. These protocols can be submitted upon request.
- **Chain of Custody.** Described in Section 7.3.

7.2.2 Sample Containers, Preservation, and Holding Times

Sample containers, preservation, and holding times to be used for the project are listed in Table F-2.

7.3 SAMPLE AND DOCUMENT CUSTODY PROCEDURES

The various methods used to document field sample collection and laboratory operation are presented below.

7.3.1 Field Chain-of-Custody Procedures

Sample chain of custody refers to the process of tracking the possession of a sample from the time it is collected in the field through the laboratory analysis. A sample is considered to be under a person's custody if it is:

- In a person's physical possession;
- In view of the person after possession has been taken; or
- Secured by that person so that no one can tamper with the sample or secured by that person in an area that is restricted to authorized personnel.

A chain-of-custody form is used to record possession of a sample and to document analyses requested. Each time the sample bottles or samples are transferred between individuals, both the sender and receiver sign and date the chain-of-custody form. When a sample shipment is transported to the laboratory, a copy of the chain-of-custody form is included in the transport container (i.e., ice chest).

The chain-of-custody forms are used to record the following information:

- Sample identification number;
- Sample collector's signature;
- Date and time of collection;
- Description of sample;
- Analyses requested;
- Shipper's name and address;
- Receiver's name and address; and
- Signatures of persons involved in chain of custody.

7.3.2 Laboratory Operations

The analytical laboratory has a system in place for documenting the following laboratory information:

- Calibration procedures;
- Analytical procedures;
- Computational procedures;
- Quality control procedures;

- Bench data;
- Operating procedures or any changes to these procedures; and
- Laboratory notebook policy.

Laboratory chain-of-custody procedures provide the following:

- Identification of the responsible party (sample custodian) authorized to sign for incoming field samples and a log consisting of sequential lab-tracking numbers; and
- Specification of laboratory sample custody procedures for sample handling, storage, and internal distribution for analysis.

7.3.3 Corrections to Documentation

Original data are recorded in field notebooks and on chain-of-custody forms using indelible ink. Documents will be retained even if they are illegible or contain inaccuracies that require correction.

If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and initialing and dating the correction.

7.4 EQUIPMENT CALIBRATION PROCEDURES AND FREQUENCY

Instruments and equipment used during this project will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations. Operation, calibration, and maintenance will be performed by laboratory personnel fully trained in these procedures.

The PID used on-site will be calibrated on a daily basis according to the manufacturer’s specifications. The PID generally utilizes a 10.2 eV probe and is calibrated using a manufacturer-supplied standard gas (100 parts per million [ppm] isobutylene).

7.5 ANALYTICAL PROCEDURES

Table F-5 includes a list of sample locations along with the monitoring program for each location. Sediment samples will be analyzed using the following methods:

- Arsenic, cadmium, lead, copper, zinc, and potassium by EPA Method 6020A ([ICPMS]; reported as dry weight)
- Mercury by EPA Method 7471B (reported as dry weight)
- Ammonia by Plumb (extraction)/SM 4500 NH3-G (reported as dry weight)
- Nitrate, nitrite and sulfate by EPA 9056A (anions by ion chromatography; reported as dry weight)
- Phosphorous by EPA 365.3M (reported as dry weight)

The In addition, sediment samples from locations 1 through 14, and 45 will be analyzed for VOCs using EPA Method 8260D (reported as dry weight); surface sediment samples from these locations will also be analyzed for TOC by Method 9060A mod to assist in evaluating the adsorption capacity of the sediment. TOC analyses of subsurface samples from this area were previously conducted and this data can be used in this study to assess the subsurface adsorption.

Surface samples from locations 6, 45, 55, 49, 51 and 54 will also be analyzed for grain size by ASTM C136/C117 Methods.

In consultation with Ecology, the five highest copper containing samples will additionally be run for selenium, nickel, manganese, silver, and total chromium by EPA Method 6020A.

Data Reduction, Validation, and Reporting

Reports generated in the field and laboratory will be included with project reports. The Project Managers will ensure validation of the analytical data (Cascadia Project Manager for fertilizer constituents and VOCs, Antea Project Manager for metals). The laboratory generating analytical data for this project will be required to submit results that are supported by sufficient backup and QA/QC data to enable the reviewer to determine the quality of the data. Validity of the laboratory data will be determined based on the objectives outlined in Section 7.1 and 7.8. Upon completion of the review, the Project Manager will be responsible for ensuring development of a QA/QC report on the analytical data. Data will be stored and maintained according to the standard procedures of the laboratory. The method of data reduction will be described in the final report. Electronic data deliverables will be compatible with Ecology’s Environmental Information Management (EIM) database.

7.6 PERFORMANCE AUDITS

Performance audits are an integral part of an analytical laboratory's standard operating procedures and are available upon request.

7.7 DATA MEASUREMENT ASSESSMENT PROCEDURES

The quality of the data will be assessed based on precision, accuracy, and completeness. Procedures to compute each are discussed below.

7.7.1 Precision

The RPD is used to assess the precision of the analytical method and is calculated using the following equation:

$$RPD = \frac{X_s - X_d}{\left(X_s + X_d\right)\big/2} \times 100\%$$

(1)

where:

X_s = analytical result of the sample

X_d = analytical result of the duplicate sample

7.7.2 Accuracy

The accuracy of the data set is determined from the analysis of spiked samples. The accuracy is calculated using the following equation:

$$A = \frac{\left(X_{ss} - X_s\right)}{T} \times 100\%$$

(2)

where:

A = accuracy

X_{ss} = analytical result obtained from the spiked sample

X_s = analytical result obtained from the sample

T = true value of the added spike

The overall accuracy is the arithmetic mean of all the spiked samples.

7.7.3 Completeness

Completeness (percent complete, or PC) of the data is determined by the following equation:

$$PC = \frac{\text{Number of samples with acceptable data}}{\text{Number of samples collected}} \times 100\%$$

(3)

7.8 CORRECTIVE ACTIONS

The quality assurance sample results will be evaluated along with the project sample analytical results to determine if the complete data package is acceptable for the intended use. The results of an individual quality assurance sample/parameter may be out of acceptable control limits, yet the dataset is still considered of good quality if QA parameters indicate that the accuracy and precision of the overall analysis is acceptable. If the quality control audit detects unacceptable analysis accuracy and/or precision, the Project Manager will be responsible for developing and initiating corrective action. Corrective action may include the following:

- Reanalyzing the samples, if holding time criteria permit;

- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data and acknowledging level of uncertainty or inaccuracy by flagging the data.

7.9 QUALITY ASSURANCE REPORTS

A QA review will be conducted that presents a QA/QC evaluation of the data collected during the sampling activities for inclusion in the final report. In addition to an opinion regarding the validity of the data, the QA/QC evaluation will address the following:

- Any adverse conditions or deviations from the SAP;
- Assessment of analytical data for precision, accuracy, and completeness;
- Significant QA problems and recommended solutions; and
- Corrective actions taken for any problems previously identified.

TABLES

F-1
Proposed Sediment Target Location Coordinates
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

Proposed Sample Location	Northing	Easting
1	1075820.153	118656.233
2	1075862.864	118613.689
3	1075929.638	118587.799
4	1075973.617	118544.868
5	1076090.393	118472.017
6	1076199.013	118409.810
7	1076245.920	118365.599
8	1076303.566	118329.691
9	1076333.807	118303.068
10	1076301.652	118282.050
11	1076390.642	118252.641
12	1076455.241	118202.167
13	1076491.418	118160.864
14	1076545.211	118123.117
45	1076693.978	118060.441
46	1075698.341	118776.419
47	1076468.234	118125.103
48	1075639.700	118705.045
49	1075371.644	118883.518
50	1075103.589	119062.684
51	1074877.866	119351.557
52	1074820.342	119246.495
53	1074627.634	119373.231
54	1074509.578	119447.884
55	1075975.982	118501.703
56	1076049.316	118453.952

Datum: NAD 1983
Projection: State Plane
Zone: Washington South
Units: US Feet

Table F-2
Sediments – Analytical Methods – Sample Handling and Container Requirements
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

Analysis	Method	Container	Preservative	Storage Temperature	Holding Time
VOC	EPA Method 8260D	4 oz.	N/A	4°C.	14 days
Metals	EPA Method 6020A (arsenic, copper, cadmium, lead, zinc, potassium, chromium, silver, selenium, nickel, manganese); EPA Method 7471B (mercury)	8 oz glass jar	none	4°C	180 days
Ammonia	Plumb/SM4500-NH3 G	8 oz glass jar	none	4°C	7 days
Nitrate, Nitrite, and sulfate	EPA 9056A	8 oz glass jar	none	4°C	28 days
Phosphorous	EPA 365.3M	4 oz glass jar	none	4°C	28 days
TOC	EPA 9060Amod	6 or 8 oz glass jar	N/A	4°C	28 days
Grain Size Analysis	ASTM D422mod	8 oz glass jar	none	4°C	180 days

Notes:

1. Grain-size analysis may be performed or frozen and archived for potential future analysis.
2. VOC = Volatile organic compound; TOC = Total organic carbon.
3. oz = ounce
4. °C = degrees Celsius
5. N/A= Not Applicable
6. TOC = Total organic carbon
7. Note one 8 oz jar is sufficient volume for metals and anions (nitrate, nitriate and sulfate). One 4 oz jar is sufficient for VOCs and ammonia.

Table F-3
Analytical Methods Details — Sediment Reporting Limit Goals and Quality Control Parameters
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

						Surrogate		Matrix Spike		Blank Spike	
Method	**Analyte**	**CAS #**	**MDL**	**MRL**	**Units**	**% Recovery**	**RPD (maximum relative percent difference)**	**% Recovery**	**RPD (maximum relative percent difference)**	**% Recovery**	**RPD (maximum relative percent difference)**
Halogenated Volatile Organic Compounds by EPA 8260D											
	Bromobenzene	108-86-1	12.5	25.0	µg/kg dry wt	-	30	78-121	30	80-120	30
	Bromochloromethane	74-97-5	25.0	50.0	µg/kg dry wt	-	30	78-125	30	80-120	30
	Bromodichloromethane	75-27-4	25.0	50.0	µg/kg dry wt	-	30	75-127	30	80-120	30
	Bromoform	75-25-2	50.0	100	µg/kg dry wt	-	30	67-132	30	80-120	30
	Bromomethane	74-83-9	500	500	µg/kg dry wt	-	30	53-143	30	80-120	30
	Carbon tetrachloride	56-23-5	25.0	50.0	µg/kg dry wt	-	30	70-135	30	80-120	30
	Chlorobenzene	108-90-7	12.5	25.0	µg/kg dry wt	-	30	79-120	30	80-120	30
	Chloroethane	75-00-3	250	500	µg/kg dry wt	-	30	59-139	30	80-120	30
	Chloroform	67-66-3	25.0	50.0	µg/kg dry wt	-	30	78-123	30	80-120	30
	Chloromethane	74-87-3	125	250	µg/kg dry wt	-	30	50-136	30	80-120	30
	2-Chlorotoluene	95-49-8	25.0	50.0	µg/kg dry wt	-	30	75-122	30	80-120	30
	4-Chlorotoluene	106-43-4	25.0	50.0	µg/kg dry wt	-	30	72-124	30	80-120	30
	Dibromochloromethane	124-48-1	50.0	100	µg/kg dry wt	-	30	74-126	30	80-120	30
	1,2-Dibromo-3-chloropropane	96-12-8	125	250	µg/kg dry wt	-	30	61-132	30	80-120	30
	1,2-Dibromoethane (EDB)	106-93-4	25.0	50.0	µg/kg dry wt	-	30	78-122	30	80-120	30
	Dibromomethane	74-95-3	25.0	50.0	µg/kg dry wt	-	30	78-125	30	80-120	30
	1,2-Dichlorobenzene	95-50-1	12.5	25.0	µg/kg dry wt	-	30	78-121	30	80-120	30
	1,3-Dichlorobenzene	541-73-1	12.5	25.0	µg/kg dry wt	-	30	77-121	30	80-120	30
	1,4-Dichlorobenzene	106-46-7	12.5	25.0	µg/kg dry wt	-	30	75-120	30	80-120	30
	Dichlorodifluoromethane	75-71-8	50.0	100	µg/kg dry wt	-	30	29-149	30	80-120	30
	1,1-Dichloroethane	75-34-3	12.5	25.0	µg/kg dry wt	-	30	76-125	30	80-120	30
	1,2-Dichloroethane (EDC)	107-06-2	12.5	25.0	µg/kg dry wt	-	30	73-128	30	80-120	30
	1,1-Dichloroethene	75-35-4	12.5	25.0	µg/kg dry wt	-	30	70-131	30	80-120	30
	cis-1,2-Dichloroethene	156-59-2	12.5	25.0	µg/kg dry wt	-	30	77-123	30	80-120	30
	trans-1,2-Dichloroethene	156-60-5	12.5	25.0	µg/kg dry wt	-	30	74-125	30	80-120	30
	1,2-Dichloropropane	78-87-5	12.5	25.0	µg/kg dry wt	-	30	76-123	30	80-120	30
	1,3-Dichloropropane	142-28-9	25.0	50.0	µg/kg dry wt	-	30	77-121	30	80-120	30
	2,2-Dichloropropane	594-20-7	25.0	50.0	µg/kg dry wt	-	30	67-133	30	80-120	30
	1,1-Dichloropropene	563-58-6	25.0	50.0	µg/kg dry wt	-	30	76-125	30	80-120	30
	cis-1,3-Dichloropropene	10061-01-5	25.0	50.0	µg/kg dry wt	-	30	74-126	30	80-120	30
	trans-1,3-Dichloropropene	10061-02-6	25.0	50.0	µg/kg dry wt	-	30	71-130	30	80-120	30
	Hexachlorobutadiene	87-68-3	50.0	100	µg/kg dry wt	-	30	61-135	30	80-120	30
	Methylene chloride	75-09-2	250	500	µg/kg dry wt	-	30	70-128	30	80-120	30
	1,1,1,2-Tetrachloroethane	630-20-6	12.5	25.0	µg/kg dry wt	-	30	78-125	30	80-120	30
	1,1,2,2-Tetrachloroethane	79-34-5	25.0	50.0	µg/kg dry wt	-	30	70-124	30	80-120	30
	Tetrachloroethene (PCE)	127-18-4	12.5	25.0	µg/kg dry wt	-	30	73-128	30	80-120	30
	1,2,3-Trichlorobenzene	87-61-6	125	250	µg/kg dry wt	-	30	66-130	30	80-120	30
	1,2,4-Trichlorobenzene	120-82-1	125	250	µg/kg dry wt	-	30	67-129	30	80-120	30

Please refer to notes on last page of table.

Table F-3
Analytical Methods Details — Sediment Reporting Limit Goals and Quality Control Parameters
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

						Surrogate		Matrix Spike		Blank Spike	
Method	**Analyte**	**CAS #**	**MDL**	**MRL**	**Units**	**% Recovery**	**RPD (maximum relative percent difference)**	**% Recovery**	**RPD (maximum relative percent difference)**	**% Recovery**	**RPD (maximum relative percent difference)**
Halogenated Volatile Organic Compounds by EPA 8260D (continued)											
	1,1,1-Trichloroethane	71-55-6	12.5	25.0	µg/kg dry wt	-	30	73-130	30	80-120	30
	1,1,2-Trichloroethane	79-00-5	12.5	25.0	µg/kg dry wt	-	30	78-121	30	80-120	30
	Trichloroethene (TCE)	79-01-6	12.5	25.0	µg/kg dry wt	-	30	77-123	30	80-120	30
	Trichlorofluoromethane	75-69-4	50.0	100	µg/kg dry wt	-	30	62-140	30	80-120	30
	1,2,3-Trichloropropane	96-18-4	25.0	50.0	µg/kg dry wt	-	30	73-125	30	80-120	30
	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	50.0	100	µg/kg dry wt	-	30	66-136	30	80-120	30
	Vinyl chloride	75-01-4	12.5	25.0	µg/kg dry wt	-	30	56-135	30	80-120	30
	1,4-Difluorobenzene (Surr)	540-36-3			Surrogate	80-120	-	-	-	-	-
	Toluene-d8 (Surr)	2037-26-5			Surrogate	80-120	-	-	-	-	-
	4-Bromofluorobenzene (Surr)	460-00-4			Surrogate	79-120	-	-	-	-	-
Total Metals by EPA 6020A (ICPMS)											
EPA 6020A	Arsenic	NA	0.250	0.500	mg/kg dry wt	40	75-125	40	80-120	20	7440-38-2
EPA 6020A	Cadmium	NA	0.0500	0.100	mg/kg dry wt	40	75-125	40	80-120	20	7440-43-9
EPA 6020A	Lead	NA	0.0500	0.100	mg/kg dry wt	40	75-125	40	80-120	20	7439-92-1
EPA 6020A	Copper	NA	0.500	1.00	mg/kg dry wt	40	75-125	40	80-120	20	7440-50-8
EPA 6020A	Zinc	NA	1.00	2.00	mg/kg dry wt	40	75-125	40	80-120	20	7440-66-6
EPA 6020A	Mercury	NA	0.0200	0.0400	mg/kg dry wt	40	75-125	40	80-120	20	7439-97-6
EPA 6020A	Potassium	NA	25.0	50.0	mg/kg dry wt	40	75-125	40	80-120	20	7440-09-7
Ammonia by Plumb Extraction, Gas Diffusion and Colorimetric Detection											
Plumb/SM 4500-NH3 G	Ammonia as N	NH4	0.100	0.100	mg/kg dry wt	-	20	75-125	20	80-120	20
Anions by Ion Chromatography											
EPA 9056A	Nitrate-Nitrogen	7727-37-9	2.50	2.50	mg/kg dry wt	-	15	80-120	15	90-110	15
EPA 9056A	Nitrite-Nitrogen	14797-65-0	2.50	2.50	mg/kg dry wt	-	15	80-120	15	90-110	15
EPA 9056A	Sulfate	14808-79-8	10.0	10.0	mg/kg dry wt	-	15	80-120	15	90-110	15
Demand Parameters											
EPA 9060Amod	Total Organic Carbon	TOC	200	200	mg/kg	-	20	-	-	90-110	-
Total Phosphorus--EPA 365.3M Soil and Sediment Subcontract to ALS-Kelso											
EPA 365.3M	Total Phosphorus	NA	NA	1	mg/kg wet	NA	NA	NA	NA	NA	NA

Notes:

NA = not available.	mg/Kg - milligram per kilogram
-- = not applicable.	dry wt = dry weight
µg/Kg = microgram per kilogram	surr = surrogate

Table F-4
Sediments – Laboratory Quality Control Sample Analysis Summary
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

Analysis Type	Initial Calibration	Ongoing Calibration	Field Duplicate	MS/MSD	LCS/LCSD	Surrogate Spikes	Method Blank
Grain Size	Bi-annual	N/A	1 per 20 samples	N/A	N/A	N/A	N/A
VOCs*, ammonia, nitrate, sulfate, phosphorous	Each Batch	Every 12 hours	1 per 20 samples*	1 per 20 samples*	1 per batch	Every sample, standard and method blank.	1 per batch
Metals	Daily	Every 10 samples or every 2 hours, whichever is more frequent. Also after the last sample.	1 per 20 samples	With every sample batch or every 20 samples, whichever is more frequent.	With every sample batch or every 20 samples, whichever is more frequent.		With every sample batch or every 20 samples, whichever is more frequent.
TOC	Each Batch	Every 15 samples	1 per 20 samples	1 per batch	1 per 10 samples	N/A	1 per batch

Notes:

1. Calibration of drying ovens and scales are conducted bi-annually.
2. N/A = Not applicable
3. Initial calibrations are considered valid until the ongoing continuing calibration no longer meets method specifications. At this point, a new initial calibration is performed.
4. MS = Matrix Spike; MSD = Matrix Spike Duplicate
5. LCS = Laboratory Control Spike; LCSD = Laboratory Control Spike Duplicate
6. "Batch" indicates each group of samples received, or each group of 20 samples on a chain-of-custody.
7. VOC = Volatile organic compound; TOC = Total organic carbon.

Table F-5
Sediment Sampling Program
NuStar Vancouver Terminal - Phase I Remedial Investigation
Vancouver, Washington

Sediment Location Number	Surface Grab (Y/N)	Core (Y/N)	VOCs	Total Organic Carbon (**surface samples only)	Fertilizer COPCs	Copper Concentrate COPCs	Grain Size Analysis (Surface Samples Only)
1	Y	Y	x	x	x	x	
2	Y	Y	x	x	x	x	
3	Y	Y	x	x	x	x	
4	Y	Y	x	x	x	x	
5	Y	Y	x	x	x	x	
6	Y	Y	x	x	x	x	x
7	Y	Y	x	x	x	x	
8	Y	Y	x	x	x	x	
9	Y	Y	x	x	x	x	
10	Y	Y	x	x	x	x	
11	Y	Y	x	x	x	x	
12	Y	Y	x	x	x	x	
13	Y	Y	x	x	x	x	
14	Y	Y	x	x	x	x	
45	Y	Y	x	x	x	x	x
46	Y	N			x	x	
47	Y	N				x	
48	Y	N			x	x	
49	Y	N			x	x	x
50	Y	N			x	x	
51	Y	N			x	x	x
52	Y	N			x	x	
53	Y	N			x	x	
54	Y	N			x	x	x
55	Y	N				x	x
56	Y	N				x	

Notes:
COPCs = chemicals of potential concern.
Fertilizer COPCs = nitrate, nitrite, ammonia, potassium, phosphate and sulfate.
Metals COPCs = copper, arsenic, cadmium, lead, mercury, and zinc. Metals samples will also be archived for potential additional analyses.

Note: For the five sediment samples with these highest concentrations of copper, the additional metals will be analyzed for: selenium, nickel, manganese, silver, and total chromium.

FIGURE

Visual Classification of Subsurface Core

Job	Date
Job No.	Core Pushed By
Exploration No.	Core Logged By
Core No.	Type of Core ☐ Shelby ☐ Piston Core ☐ Other
Water Depth/Elevation of Core	Diameter of Core (inches)
Cored Length (feet; from log)	Core Quality ☐ Good ☐ Fair ☐ Poor ☐ Disturbed
Core Recovery (feet)	Average % Compaction =

Theoretical Depth in ( ) Actual Core Sections	Sample Interval	Sample Analytes	Classification and Remarks (Color, Consistency, Moisture, Grain Size, Sheen, Odor)

Figure F-1

Subsurface Core Log Form

Cascadia
Associates, LLC