

4. FIELD SAMPLING SUMMARY

The objective of the RI field sampling effort was to collect and develop sufficient information to characterize the nature and extent of chemicals in the Uplands Environment of the Site. The scope of the RI, as detailed in the Upland Management Plan, was developed based on an evaluation of existing Site information and knowledge of the former operations at the Site. The following sections provide a media-specific summary of the RI sampling efforts conducted in May and June 2003. Deviations from the methods detailed in the management plan are also described.

4.1 Soil Sampling

RI surface and subsurface soil sampling was conducted from May 12-20, 2003, with the objective to collect and analyze scientifically valid and legally defensible data to establish the nature and extent of chemicals in soils at the Site. The sampling design, sampling methods, and chemical analyses for surface and subsurface soil samples are described in the following sections.

4.1.1 Overall Design

The design of the RI soils investigation was prepared based on knowledge of the historical mill operations and the findings of previous Site investigations. The sample locations were selected to provide broad characterization of Site conditions, to characterize areas not sampled during previous investigations, and to further characterize areas where previous sampling indicated elevated chemical concentrations were present. The Uplands Management Plan (Integral 2004) identified 15 data gaps to be addressed during the RI soil sampling (Table 4-1).

The RI soil sampling involved the collection of 85 total samples from 43 different locations across the Site. The sample locations are shown on Figures 4-1 and 4-2, and coordinates are provided in Table 4-2. A total of 45 surface samples were collected—typically from a depth of 0 to 3 inches bgs.² Forty subsurface samples were collected from a depth range of 3 inches to groundwater. Groundwater was encountered at depths ranging from 3.5 to 16 ft bgs during the subsurface sample collection.

² This total includes samples of fine materials collected from the concrete rubble found at the surface at locations AP20, AP03, and PC20 (see Section 4.1.4). These samples were collected to represent the site surface conditions at these locations at the time of sampling. An additional two samples were collected from the initial soil layer immediately underlying the concrete rubble at these locations. These samples, which are comparable to the surface soil conditions at the time of the mill site closing and the ESI sampling, have also been classified as surface samples.

4.1.2 Soil Sampling Methods

The soil samples were collected according to the methods prescribed in Volume II of the Uplands Management Plan: Sampling and Analysis Plan (SAP) (Integral 2004). The following provides a summary of the methods used to collect the surface and subsurface soil samples.

4.1.2.1 Surface Soil Samples

The surface soil samples were collected from a depth interval of 0 to 3 inches bgs using a stainless-steel spoon and bowl. The general procedures that were followed during the collection of each of the surface soil samples included:

- The sample location was visually inspected to ensure the area was relatively free of debris and foreign objects.
- A stainless-steel spoon was used to dig a small hole at the location and expose a soil face. A steel rod was used to assist in breaking up the surface soils at some locations where the ground surface was extremely firm.
- A stainless-steel spoon was used to cut a clean soil face.
- The soil sample was then collected from the clean face using the stainless-steel spoon. Soils collected with the spoon were transferred to a stainless-steel bowl for homogenization, taking care to collect an even amount of material from the entire face.
- The soils in the stainless-steel bowl were inspected for non-soil material, which were removed from the sample.
- A stainless-steel spoon was used to homogenize the soil sample.
- The soils were then transferred directly to labeled sample jars.
- Samples were collected for duplicate analysis, if required.
- The sample container lids were secured, and the containers were placed on ice in a cooler.
- Pertinent sampling information (e.g., soil type, time, location, observations) were recorded in the field logbook and soil logs, and photographs were taken of the sample and/or sample location.
- The coordinates (longitude/latitude) of each sample location were measured using a handheld GPS unit and recorded in the field logbook.

At several of the locations where the subsurface sample was collected using a backhoe (Table 4-3), the surface sample was collected from the 0- to 3-inch depth interval of the exposed soil face in the trench.

Prior to collection of each sample, the stainless-steel spoon and bowl were decontaminated according to the procedures below:

- Gross contamination was removed from the equipment.

- The equipment was washed with tap water containing Alconox® detergent.
- The equipment was rinsed with tap water.
- Using a spray bottle, the equipment was rinsed with hexane (only if pesticide/PCB analyses were to be performed on the sample).
- Using a spray bottle, the equipment was rinsed with methanol.
- Using a spray bottle, the equipment was rinsed with deionized water.
- The equipment was covered with clean aluminum foil and allowed to dry.

4.1.2.2 Subsurface Soil Samples

Subsurface samples were co-located with the surface soil sample locations, except for locations DB02, MR20, and PF02, where no subsurface soil samples were collected (Figures 4-1 and 4-2). The subsurface soil sample was collected following the collection of the surface soil sample, using either a hollow stem auger drill rig (27 locations), a backhoe (12 locations), or a hand auger (1 location). The following provides a summary of the procedures used to collect the subsurface samples.

4.1.2.2.1 Hollow Stem Auger Sampling

After the surface soil sample had been collected, the drill rig was positioned such that the subsurface sample would be collected from the same location. The augers were then put in place and drilled to the desired sampling depth. A decontaminated, split spoon sampler was then driven according to ASTM Method D-1586 to the desired depth and the sampler then retrieved. The sampler was opened, and a clean face was cut along the core using a stainless-steel spoon. The materials were then described on the field logs in accordance with ASTM Method C2488-69. A representative sample of the soils was then collected from the clean soil face and placed in a stainless-steel bowl. The sampler was then decontaminated and the entire process repeated until groundwater was encountered, as indicated by wetness on the sampler and saturation of the soils within the sampler. The soils collected from each of the core samples were then homogenized in the bowl using the stainless-steel spoon prior to placement of the samples in labeled sample bottles.

4.1.2.2.2 Backhoe Sampling

A backhoe was used to collect the subsurface sample at locations that either could not be accessed by the drill rig or where excessive amounts of rock/concrete debris were present and sampling with the drill rig was not possible. During sampling with the backhoe, a trench was dug extending from the soil surface to the groundwater table. The soils were logged based on visual inspection of the exposed soils in the trench and of the soils in the backhoe bucket and spoils pile. Once logging was complete, the backhoe was used to scrape into the bucket an even amount of soil from along the excavation face extending from the top of the groundwater table to 3 inches bgs. The sample was homogenized, and a representative sample was collected from the bucket using a stainless-steel spoon and bowl. The sample was homogenized prior to placement in the individual sample jars. The backhoe bucket was decontaminated using a heated pressure washer prior to trenching at each sample location.

4.1.2.2.3 Hand Auger Sampling

A hand auger was used to collect the subsurface sample from location MR03. This sample location was below an elevated concrete slab and could not be safely accessed using the drill rig or backhoe. The hand auger sampling followed the same general procedure described for the hollow stem auger sampling in Section 4.1.2.2.1 above, only a decontaminated hand auger was used to retrieve the materials from the desired depth interval.

4.1.3 Chemical Analyses

Table 4-3 presents a summary of the samples collected and chemical analyses performed on the soil samples collected during the May 2003 RI sampling. The table includes a reference to the specific area of concern from which the sample was collected (e.g., bone yard, wood mill, etc.). Detailed methods used for sample preparation and analysis are described in the Uplands Management Plan (Integral 2004).

4.1.4 Deviations from the Uplands Management Plan

Although the soil sampling for the Uplands RI was largely conducted according to the procedures identified in the Uplands Management Plan (Integral 2004), there were some minor deviations from the plan during the execution of the field program. The following summarizes the deviations from the plan during the soil sampling.

- The Uplands Management Plan called for use of a Geoprobe® drill rig as the initial approach to be taken to collect the subsurface soil samples. If the Geoprobe® rig was incapable of pushing through the soils, a hollow stem auger rig was the preferred method. However, based on visual inspection of the proposed sample locations and knowledge of the probable subsurface soil conditions at these locations, it was concluded that the Geoprobe® would have very limited success in

collecting the subsurface samples. The presence of large concrete rubble and other Site debris would limit the capability of a Geoprobe® to drive a sampler to the required sample depths. Further, it was determined that at many locations the amount of concrete rubble and other debris was so extensive that sampling with a hollow stem auger would be infeasible. As a result, a backhoe was used at these locations to collect the subsurface sample. Finally, location MR03 could not be accessed by a drill rig or backhoe, and therefore the subsurface sample was collected using a hand auger.

- Portions of the main process area were covered with as much as 3 ft of concrete rubble resulting from Site dismantling activities completed in 1999. The Uplands Management Plan called for the collection of a surface sample from 0 to 3 inches for sampling locations within the main process area. The general objectives of these surface samples were to establish surface soil conditions and confirm the results of previous ESI sampling of surface soils (which had been performed prior to placement of the concrete rubble). After discussion with the Project Manager, it was decided that, if possible, 0- to 3-inch samples of fine-grained materials would be collected from both the current Site ground surface (i.e., the concrete rubble) and the soils that were at the surface prior to placement of the concrete rubble (i.e., the first 3 inches of soil below the base of the concrete rubble). This approach would allow for characterization of the current surface conditions as well as provide data on chemical concentrations in surface soils at the time of mill closure and the ESI sampling. Consequently, the sampling program was expanded to include collection of a surface sample of the fine-grained material from the concrete rubble at locations AP20 and PC20. Although rubble was also present at AP03, there was insufficient fine-grained material within the rubble to collect a sample.

A surface sample of the soil/fill materials underlying the concrete rubble was collected at all three of the locations where concrete rubble was present (i.e., AP20, PC20, and AP03). These materials were below the layer of concrete rubble (which was typically approximately 2 ft thick), and thus were collected using the split spoon sampler per the methods described for collection of the subsurface samples. As a result, the amount of material collected from the 3-inch depth interval was minimal at each of these locations—particularly at location AP20 where material recovery was poor. Therefore, the sample from AP20 was collected over the 0- to 9-inch interval of soil/fill (rather than the first 3 inches), and a sample was not collected for conventional analyses.³

- A subsurface sample could not be collected using a hollow stem auger at locations DB02 and MR20. At location DB02, wood was encountered from a depth of 0.5 to 2.5 ft bgs, and the material collected from 2.5 to 4 ft bgs was saturated. At location MR20, there was no recovery from 3 inches to 2.5 ft bgs, and the material collected from 2.5 to 3 ft bgs was saturated. The saturated conditions observed at these two locations were thought to be representative of groundwater. However, during later backhoe excavation sampling at nearby locations SR03 and SR23, groundwater was encountered at depths of 11 and 13 feet bgs, respectively, and several shallow perched zones of water were observed in the trenches. The observations at SR03 and SR23 suggest that the shallow water encountered in DB02 and MR20 most

³ Includes pH, CEC, phosphorous, DTPA micro-nutrients (Zn, Mn, Cu, Fe), Mehlich-3 (K, Ca, Mg, Na, Al), combustion analyses (OC, Total N, % organic), Inorganic-N (NO₃-N, NH₄-N).

likely reflected perched groundwater conditions—conditions that are difficult to discern when sampling with a hollow stem auger drill rig. As a result, the water encountered at these locations may not have been representative of the shallow aquifer.

According to the Management Plan, the suite of analyses specified for the surface sample and subsurface sample at location MR20 were different. Since the subsurface sample could not be collected at MR20, the suite of analyses for the surface sample was modified to be inclusive of the same suite of chemicals as the subsurface samples.

- At the request of the Project Manager, the suite of analyses for location AP03 was modified to include PCDD/Fs.
- A few locations were moved due to field conditions:
 - Location LY20 was originally marked by a telephone pole on the west end of the Site. During the utility clearance, Doyle McGinley of the Port Angeles Public Works requested that the location be moved toward the property fence line to avoid a 27-inch concrete pressurized sewer line. A 48-inch water line is also located just south of the fence line. Mr. McGinley also requested that the location be sampled by backhoe excavation rather than by a drill rig.
 - Location RS20 was moved approximately 8 ft to the north to allow the mini-backhoe safer access to the location.
 - Location RB22 was moved 6 ft to the east due to the presence of a subsurface utility trench encountered at a depth of 3 ft bgs at the originally specified sample location.
 - As directed by the Project Manager, location RB21 was moved approximately 10 ft northwest from the originally specified location to a better achieve the objective of the sample—to identify upgradient conditions from the recovery boiler.
 - Location SR20 was moved 5 ft north due to the presence of a 12-inch pipeline encountered at a depth of 5 ft bgs at the original location.
 - Due to the presence of wood chips from 0 to 1 ft bgs, the surface sample at location CS20 was collected when soil was first encountered at a depth of 1 ft bgs. As a result, this surface sample was collected using a hollow stem auger drill rig and a split spoon sampler device. The sample was collected from a 1-ft interval (i.e., from 1 to 2 ft bgs) due to limited sample material recovery.
- Samples for conventional analyses (pH, CEC, phosphorous, DTPA micro-nutrients [Zn, Mn, Cu, Fe], Mehlich-3 [K, Ca, Mg, Na, Al], combustion analyses [OC, Total N, % organic], Inorganic-N [NO₃-N, NH₄-N]) could not be collected in the subsurface (3 inches to groundwater) sample at location SR21 due to limited sample material recovery.
- Sample location SR23 was originally completed (May 14, 2003) with a drill rig to a depth of 4 ft bgs, where water was encountered at a depth of 3 ft bgs. As discussed above, groundwater was encountered at a depth of 11 ft bgs during trenching at

nearby location SR03 (May 19, 2003), and saturated gravelly channels and lenses were encountered in sand and silt at depths from 5 to 11 feet bgs within the SR03 trench. Based on these observations, it was assumed that the shallow water encountered in SR23 during drilling on May 14 was actually perched water and not the aquifer. Therefore, the location was re-sampled by backhoe excavation on May 20, and groundwater was encountered at 13 ft. Perched groundwater was also seen in discontinuous gravelly layers from 5 to 9 ft bgs. Consequently, the original subsurface sample (sample number RY03-72) collected on May 14 using the drill rig is not representative of the entire unsaturated section. The subsurface sample (sample number RY03-102) collected on May 20 by backhoe excavation is a composite sample from 3 inches to groundwater (13 ft) and represents the entire unsaturated section.

During excavation sampling at location SR23, a 12-inch green pipe was encountered at a depth of 5 ft. The pipe was not completely broken but the top was peeled off. The liquid inside appeared to be black spent sulfite liquor. None of the liquid appeared to drain into the trench; however, the pipe was covered and the trench was shifted south 3 ft for sampling.

The pipe, liquid, and surrounding soils were not sampled because:

- The pipe encountered in the initial sample location prohibited the collection of the subsurface soil sample.
- Although the contents of the green pipe encountered at sample location SR23 are not known for certain, the location of the pipe and knowledge of site history and processes indicate the pipe most likely contained either 1) cooking liquor (ammonium bisulfite) being transported from the acid plant to the digesters, 2) washed pulp being transported from the red stock washers to the bleach plant, or 3) spent sulfite liquor (SSL) being transported from the red stock washers. Neither the cooking liquor nor the washed pulp is expected to contain chemicals of potential concern as these chemicals were not introduced into these processes (Anderson 2005, pers. comm.).
- SSL would not result in significant concentrations of chemicals of potential concern. The SSL lagoon was sampled in 1997 (see Uplands RI Sampling and Analysis Plan, Section 2.3.6). Samples were collected from the clay liner, the berm, and residual material that had been in direct contact with the SSL for more than 25 years. Although metals, dioxins/furans, and other organic chemicals were detected in some of these samples, detected concentrations were either below MTCA Method B levels for unrestricted land use or below natural soil background concentrations.

4.2 Groundwater Sampling

The objective of the groundwater investigation at the Site was to collect and analyze scientifically valid and legally defensible data to assess current groundwater conditions in the shallow-water bearing zone (fill aquifer) beneath the Site. Data collected in the groundwater field sampling program are used to augment existing information derived from previous groundwater studies and to complete the RI process by closing existing data

gaps and allowing a more comprehensive evaluation of physical characteristics of the fill aquifer, possible sources of chemicals, and the nature and extent of chemical concentrations in groundwater.

4.2.1 Overall Design

Previous investigations at the Site have generated a significant volume of data relating to groundwater quality. As a result, the existing data set was, to a large extent, sufficient to evaluate chemical pathways and assess potential risks to human health and the environment. However, the collection of some additional information was necessary to close existing data gaps and complete the RI. The existing data gaps relating to groundwater at the Site and the RI activities needed to obtain the information required to close each data gap are outlined in the following sections and summarized in Table 4-4.

Twenty existing monitoring wells were sampled as part of the RI/FS: PZ-3, PZ-4, PZ-5, PZ-6, PZ-7, PZ-9, PZ-10, PZ-11, PZ-12, MW23, MW29, MW-51, MW-52, MW-53, MW-54, MW-55, MW-56, MW-57, MW-58, and MW-59. The location of these wells is shown previously in Figure 3-6, with location coordinates provided in Table 3-2. These 20 groundwater monitoring wells were selected based on their suitability to provide scientifically valid data and the physical location of each well. These wells form a monitoring network that has been used to assess groundwater conditions throughout the mill property.

4.2.2 Physical Characteristics of Fill Aquifer

Knowledge of the hydraulic gradient, aquifer conductivity, degree of tidal influence, groundwater flow direction, and other physical characteristics of the fill aquifer is necessary to complete the overall groundwater evaluation. Much of these data were obtained during previous Site investigations. RI activities regarding physical characteristics of the aquifer included verifying groundwater gradient and flow patterns with additional measurements, reviewing existing data and calculations of hydraulic conductivity, and measuring the effects of tidal influence on groundwater elevation over a 14-day period.

4.2.3 Groundwater Sampling Methods

Groundwater sampling for the RI was performed from June 16-20 2003. The shoreline wells were sampled during periods of low tide to minimize seawater intrusion. The shoreline wells included MW-53, MW-54, MW-51, MW-56, and MW-59.

The groundwater sampling included the following general tasks: field preparation and well inspection, light non-aqueous phase liquid (LNAPL) thickness/water level measurement, well purging, and groundwater sample collection. Each of these tasks is described below. Detailed sampling methods are provided in Volume II of the Uplands Management Plan (Integral 2004).

4.2.4 Field Preparation and Well Inspection

Before the start of sampling activities, plastic sheeting was placed on the ground surrounding the well to provide a clean working area around the wellhead and to minimize the potential for soil contaminants contacting sampling equipment. This step was not taken if the well was surrounded by a clean, paved surface. Water in the protective casing or in the vaults around the well casing, if present, was removed prior to venting and purging.

Prior to sampling, the wells were inspected for signs of tampering or other damage. There were no signs of tampering or damage at any of the wells. Wellhead maintenance (replacement of all locks and some compression caps) was performed during the sampling event.

4.2.5 LNAPL Thickness/Water Level Measurements

Water levels were collected on June 17, 2003, within a 2-hour period during the low tide. A decontaminated interface probe was inserted into each well to determine if a nonconductive LNAPL layer was present in the well. No LNAPL layers were detected in the wells. Using the interface probe, the groundwater level was measured to the nearest 0.01 ft. Water levels were measured from the survey reference notch located at the top of each well casing.

The water level depth was subtracted from the total depth of the well (as shown on well logs) to determine the height of the water column present in the well casing. This information was used to calculate minimum purge volumes.

4.2.6 Well Purging

Purging of monitoring wells was performed to evacuate water that had been stagnant in the well and may not be representative of the aquifer. Purging was accomplished using a surface-mounted peristaltic pump and micropurge techniques. Micropurge is a low-flow-rate monitoring well purging and sampling method that induces laminar (nonturbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device. Pumping rates were regulated at 2 to 3 L/min. The low-flow rates minimized disturbance in the screened aquifer, resulting in minimal production of artificial turbidity and oxidation, minimal mixing of chemically distinct zones, minimal loss of VOCs, and collection of representative samples while minimizing purge volume. Each well was purged until the selected field parameters had been stabilized, as defined in Section 4.2.3.4.

Tubing used for purging consisted of permanent tubing that has been in place in the wells. The tubing consisted of 5/8-inch diameter HDPE tubing fitted with a foot valve and a coupling. New discharge tubing was used for this sampling event. The tubing was prepared prior to field activities by assembling the tubing and connections and by rinsing

with a 10 percent solution of hydrochloric acid solution and deionized water and hang drying. The dried tubing was placed in new, re-sealable plastic bags.

4.2.7 Groundwater Sample Collection

Groundwater samples at each well were collected using the micropurge techniques described in Section 4.2.3.3. Groundwater samples were collected after the temperature, pH, specific conductance, dissolved oxygen, redox potential (Eh), and turbidity had stabilized during well purging, in accordance with Standard Operating Procedure (SOP) 5 of the SAP (Integral 2004). Stabilization parameters are defined in Table 4-5.

Field parameter monitoring equipment was calibrated daily in accordance with the manufacturer's specifications and the procedures presented in SOP 4 of the SAP.

Groundwater samples were collected directly from the discharge bib on the peristaltic pump system. Samples for dissolved metals were field-filtered by attaching a 0.45-micron filter directly in-line with the discharge tubing.

Groundwater samples were packaged in accordance with SOP 11 of the SAP. Samples were shipped daily by courier to Columbia Analytical Services (CAS) in Kelso, Washington. One sample cooler, containing tannin and lignin samples, did not meet temperature requirements upon receipt at the laboratory. These wells were resampled for tannins and lignins on June 20, 2003.

Protocols and procedures for groundwater sample collection are presented in SOP 5 of the SAP (Integral 2004).

4.2.8 Tidal Influence Assessment

Tidal influence on groundwater elevations was measured in selected wells based on previous investigations at the Site (HLA 1993). The wells used for the tidal assessment included PZ-02, PZ-04, PZ-05, PZ-09, MW-23, MW-51, MW-52, MW-55, MW-56, MW-57, MW-58, and MW-59 (Figure 3-6). A stilling well and transducer were installed at the Rayonier dock to measure sea level changes concurrently with the 14-day tidal influence assessment. The transducers were placed in the wells and monitored using electronic data loggers for 14 days to achieve a more detailed analysis of tidal influences on the unconfined fill aquifer. Tidal influence monitoring was conducted between July 14 and 21, 2003. This period coincided with the maximum range in tidal extremes for July, August, and September 2003. Water elevations of all Site wells were measured at the beginning and end of the tidal influence monitoring.

4.2.9 Chemical Analyses

Table 4-6 summarizes the chemical analyses performed on groundwater samples collected from each of the monitoring wells, with the exception of well PZ-7. Sample analyses from

well PZ-7 were limited to ammonia, tannins and lignins, total metals, dissolved metals, and TPH-Dx due to limited sample volume.

4.2.10 Deviations from the Uplands Management Plan

The groundwater sampling for the Uplands RI was largely conducted in accordance with the procedures identified in the Uplands Management Plan (Integral 2004). Deviations from the management plan are discussed below:

- The SAP (Table 3-1; Integral 2004) had specified that several of the wells be sampled for a reduced list of chemical analytes (relative to that specified for other wells). The analyte list for these wells was expanded to include analysis of the complete analyte list, as defined by Table 4-6.
- The SAP (Section 5.5.2; Integral 2004) specified purging and sampling with a submersible pump using micropurge techniques. Historical sampling had been conducted with a surface-mounted peristaltic pump using micropurge techniques. This method was adopted to be consistent with historic sampling events.
- Clean sampling techniques were adopted to correspond with clean techniques used by the laboratory. These techniques include the following:
 - Plastic sheeting was placed around wellhead prior to sampling. The sheeting was approximately 20 X 20 feet with a hole approximating the size of the well monument cut in the center. The sheeting was weighted down at the center and edges.
 - The sampler changed gloves before purging and before sampling at each well. One individual was designated as the sampler for each well. A second individual was responsible for preparing each well for sampling.
 - The existing in-well purge and sampling tubing was used and connected to the pump. New tubing was used for the peristaltic pump head and the pump discharge line at each well. This tubing was prepared at the office and individually bagged as described in Section 4.2.3.3.
- The containers for each well were consistently filled in the following order:

1. Total Mercury	7. TPH-Dx
2. Total Metals	8. Ammonia
3. VOCs	9. Conventional I ⁴
4. SVOCs	10. Conventional II ⁵
5. PAHs	11. Filtered Mercury
6. PCBs/Pesticides	12. Filtered Metals

⁴ Includes tannins/lignins, chloride, fluoride, nitrate, nitrite, sulfate, and cations/anions.

⁵ Includes ammonia, TOC, TDS, TSS, and alkalinity.

- Monitoring Well PZ-7 had very low yield during the sampling event. Approximately seven hours of recharge was required to collect a 500- to 700-mL sample. Filling containers for a complete set of analytes was not possible. A discussion with the Project Manager was held to prioritize the analytes and minimum volumes collected from the well. Samples for ammonia, tannins and lignins, total metals, dissolved metals, and TPH-Dx were successfully collected.
- The SAP (Section 5.5.4; Integral 2004) did not specify a time interval for water level measurements other than within a 24-hour period. During recent groundwater investigations at the Site, water levels were collected within a 2-hour period during low tide, and this convention was adopted for the RI.
- The SAP (Section 5.5.5; Integral 2004) included a task for slug testing to determine the hydraulic conductivity of the unconfined fill aquifer. Slug testing results and hydraulic conductivity calculations conducted during a recent study at the Site (Landau 2001c) were reviewed and determined to be adequate to meet the Uplands Management Plan objectives (A memorandum describing this approach and rationale was circulated and accepted by the Site Management Team (SMT); attached in Appendix B).
- The SAP (Section 5.5.6; Integral 2004) included a 24-hour tidal monitoring task to determine the wells to be used for the 14-day test. A 24-hour tidal monitoring study at the Site (HLA 1993) was reviewed and used to determine the wells for use in the 14-day test (A memorandum describing this approach and rationale was circulated and accepted by the SMT; attached in Appendix C).

4.3 Ennis Creek Sediment Sampling

The sediment sample was collected from a depth interval of 0 – 10 cm and 10 – 30 cm in Ennis Creek (Figure 4-2). This location is upstream of the area addressed by the Ennis Creek-Finishing Room Interim Action, which was completed in 2002 (see Section 3.1.1). The sediment samples were analyzed for total metals (EPA Method 6020), PAHs (EPA Method 8270C), and PCDD/Fs (EPA Method 1613B).

Due to the substantial number of large cobbles in the creek bed, the sediment samples could not be collected by a handheld coring device, as recommended in the Uplands Management Plan (Integral 2004). Instead, the samples were collected using a decontaminated, stainless-steel spoon and bowl. Each sample was homogenized prior to transfer to the individual sample jars.

4.4 Ecological Sampling

Ecological sampling was conducted on June 5, 6, 7, 15, and 16, 2003. The objective of the ecological sampling effort was to collect and analyze scientifically valid and legally defensible data to allow for assessment of risks posed to terrestrial ecological receptors by chemicals present in the uplands environment of the Site.

4.4.1 Overall Design

Table 4-1 summarizes the data gaps identified in the Uplands Management Plan (Integral 2004) for the ecological sampling effort. The riparian corridor along Ennis Creek, the forested areas along the east and west coastal bluffs, and forested areas along the entrance to the mill property contain habitat suitable for the species of the region. These areas were the focus of the ecological sampling. Three areas within the developed portion of the Site were determined to currently contain habitat that could potentially support a variety of plant and animal species, and these areas were also included in the ecological sampling [see Appendix A of the Work Plan (Volume I); Integral 200]. The remainder of the developed portion of the Site currently contains little or no habitat, and no ecological samples were collected from these areas.

Ecological samples were collected from 15 locations on the Site (Figure 4-3). Soil samples were collected from each of the 15 locations, and biota samples were collected from 8 of the 15 locations. Biota sampling was not required at all locations because site-specific soil-to-biota accumulation factors were developed to estimate chemical concentrations in biota based upon soil concentration data. The site-specific bioaccumulation factors were derived from the chemical data generated from the eight co-located soil and biota samples.

4.4.2 Sampling Methods

The ecological samples (soils, plant, and earthworm) were collected according to the methods described in Volume II (SAP) of the Uplands Management Plan (Integral 2004). Table 4-7 presents a summary of sampling requirements for the ecological evaluation. The following provides a summary of the methods.

4.4.3 Ecological Soil Sampling

The biologically active soil horizon was identified at each sample location by digging test pits with a shovel. The average depth to which most earthworms and grass roots extended was determined to be the biologically active horizon. Soil samples were collected from the biologically active soil horizon from each location.

Representative samples of soil were obtained from each sample location using a composite sample design. The composite sample consisted of subsamples from five locations distributed across the sample area. A 4-pointed, star-shaped, subsampling design with approximately 15 meters between subsample points was preferred. However, the soil subsample design was often dictated by the presence of co-located biota samples or by the physical configuration of the sample area.

A pit was dug with a shovel to a depth encompassing the biologically active zone, and a clean soil face was exposed along one wall of the pit using a decontaminated, stainless-steel knife. Following removal of the undecomposed plant matter layer, a uniform slice of soil extending from the surface to the maximum depth of the biologically active zone was excised with the aid of the stainless-steel knife and placed into a decontaminated stainless-

steel bowl (Figure 4-4). The soil characteristics were described for each pit (Figure 4-5). The sampling was repeated at the five subsample locations, and the cuttings mixed thoroughly with a decontaminated, stainless-steel spoon prior to filling the sample containers. Large roots and stones were excluded from the sample containers. Decontamination of the stainless-steel knife, mixing bowl, and spoon was performed between sample locations. Soil was removed from shovels between sample locations using a brush and soapy water and water rinses.

4.4.4 Plant and Invertebrate Sampling

Earthworms were collected by digging with a shovel and hand sorting (Figure 4-6). Earthworms from the five subsamples at a sample location were pooled to yield a sample of at least 30 grams. Earthworm samples were placed in 16-ounce sample jars. Sampling equipment (e.g., stainless-steel forceps) was decontaminated between sample locations.

Soil was removed from the gut of the earthworms prior to sending samples to the analytical laboratory to ensure that representative estimates of the amount of chemical contained in the earthworm tissue were obtained. In an onsite laboratory, earthworms were held for approximately 48 hours to purge soil retained in their gut. Upon delivery of the samples to the onsite laboratory, the contents of each sample jar were emptied into a decontaminated, stainless-steel bowl containing approximately 250 mL of deionized water. Earthworms were removed from the bowl with decontaminated tweezers and replaced in the original sample jar that had been rinsed with deionized water and placed in the cooler containing blue ice. After approximately 24 hours, the contents of the sample jar were emptied into a decontaminated, stainless-steel bowl containing approximately 250 mL of deionized water. Earthworms were removed from the bowl with decontaminated tweezers and replaced in the original sample jar which had been rinsed with deionized water and placed in the cooler. Following another 24-hour period, the contents of the sample jar were emptied into a decontaminated, stainless-steel bowl containing approximately 250 mL of deionized water. Earthworms were removed from the bowl with decontaminated tweezers and placed on a piece of muslin cloth to remove excess water. The earthworms were then placed into a new 8-ounce sample jar for shipment to the analytical laboratory.

Plant tissue samples were collected using decontaminated, stainless-steel scissors, forceps, and bowls. Leaves of the dominant grass species in the area were collected from five subsamples and pooled to yield at least 30 grams of tissue. The entire leaf was excised from a minimum of five plants within each subsample area and placed on a decontaminated piece of aluminum foil for transportation to the onsite laboratory. Sampling equipment (e.g., scissors, forceps) was decontaminated between sample locations.

Soil and dust adhering to the surfaces of the plant samples were removed prior to shipping samples to the analytical laboratory. Leaf samples were rinsed for approximately one minute in each of three solutions and allowed to air-dry before being placed on decontaminated aluminum foil and then into a plastic bag for shipment to the analytical laboratory (Figure 4-7). The first rinse solution was EDTA (3×10^{-2} moles, pH 5) in

distilled/deionized water, the second rinse solution was EDTA (3×10^{-2} moles, pH 5) in distilled/deionized water, and the third rinse solution was distilled/deionized water.

4.4.5 Chemical Analyses

Table 4-3 summarizes the chemical analyses that were performed on the soil, earthworm, and plant samples collected during the ecological sampling effort.

4.4.6 Deviations from the Management Plan

The ecological sampling for the Uplands RI was conducted following the procedures described in the Uplands Management Plan (Integral 2004). However, some modifications to the Management Plan were made and are discussed below:

- Observations showed that considerable soil remained in the gut of earthworm samples after the 48-hour purging period. It was decided to add acid insoluble ash analysis (Stafford and McGrath 1986) to the ecological soil and earthworm sample analytical suite to allow for post-analysis correction of earthworm tissue chemical concentrations.
- Insufficient earthworms were collected to complete all chemical analyses from sample location ECO34 during the initial sampling effort conducted on May 7, 2003. A second attempt was made to collect earthworms from location ECO34 on May 14, 2003, and some additional earthworms (6 grams) were collected. Earthworms from both sampling episodes from location ECO34 were combined at the analytical laboratory and processed for subsequent chemical analyses.
- It was proposed that the same species of biota be collected from each of the eight ecological sample locations. However, this was not possible because the same species were not found at all locations. Thus, the dominant species present in each location were collected and identified. In the case of earthworms, several species were present at some sample locations. Considerable effort was required to collect sufficient mass of earthworms from each location to meet analytical requirements. Therefore, all earthworms collected from a location were combined to form a sample. Specimens of earthworms comprising each sample were retained for identification.

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