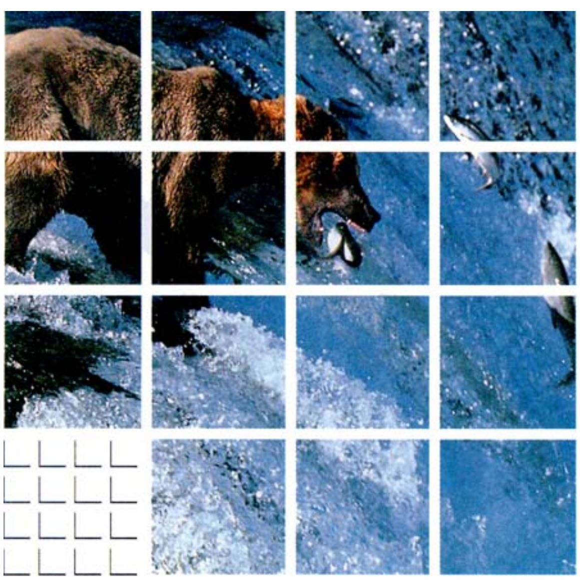
ENTRIX

DRAFT FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
FOR WORK AREA 1
BRIGGS NURSERY, INC.

Prepared for:

BRIGGS NURSERY
Olympia, WA



Prepared by:

ENTRIX, INC.
Seattle, WA

Project No. 3105102

February 15, 2006

E N T R I X

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FOR WORK AREA 1
BRIGGS NURSERY, INC.

Prepared for:

BRIGGS NURSERY, INC.
4407 Henderson Boulevard
Olympia, Washington 98501-6001

Prepared by:

ENTRIX, INC.
2701 First Avenue, Suite 300
Seattle, Washington 98121

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APPENDICES

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Briggs Nursery, Inc. (Briggs) presents this Remedial Investigation and Feasibility Study (RIFS) in partial fulfillment of its obligations under Agreed Order 1315 with the Department of Ecology (Ecology) and the *Final Remedial Investigation Feasibility Study Work Plan* (ENTRIX 2005). The RIFS addresses a 120-acre property (Site), located at 4407 Henderson Boulevard SE in Olympia, Washington (Figure 1-1). Briggs has operated at this location as a grower and wholesale landscape plant material vendor since 1912. As part of its nursery operations, Briggs historically applied pesticides and fertilizers to on-site plant inventory in accordance with manufacturer specifications. The Briggs Site was initially listed on Ecology's Confirmed and Suspected Contaminated Sites List (CSCSL) on July 15, 2002. After cleanup of the Briggs Site Debris Field under Agreed Order DE 02 TCPSR-4593, the Site was temporarily removed from the CSCSL. On May 11, 2004 Ecology informed Briggs that the Site was removed from the list in error, and that a site ranking for the remainder of the nursery property was underway. After the ranking was completed, Briggs entered into Agreed Order 1315 to address the Site contamination and cleanup.

Chemicals of Concern (COC)

Based on work completed prior to this RIFS and reviewed in the current study, the COCs at various locations across the Site are dieldrin, polychlorinated biphenyls (PCBs), herbicide, chromium, copper, and petroleum hydrocarbons in upland areas and polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDD/Fs) in Kettle bottoms.

RI Work Summary

The following major investigation activities occurred during the RIFS in conformance with a workplan reviewed and approved by Ecology.

- Upland Soils: Sampling on a 200-foot (ft) grid occurred in upland areas across the site, with the exception of the Main Operations Area where sampling occurred on a 100-foot grid. The 200-ft grid samples were analyzed for dieldrin and screened for PCBs, as were the 100-ft grid samples. The 100-ft grid samples were also analyzed for copper and chromium. During demolition, select samples approved by Ecology were analyzed for herbicides. Underground storage tanks and associated petroleum contaminated soils (PCS) were removed and disposed in accordance with applicable regulations. Confirmation samples were obtained to verify cleanup to regulatory standards. Geophysical surveys and trenching were conducted to identify any buried drums or sumps in an area where the presence of these types of features was suspected.

- Kettle Bottoms and Street Sediments: Kettle bottom water and soils were recovered and tested for PCDD/Fs, as were nearby street sediments. Samples were recovered from a variety of locations within the Kettle bottoms to fully assess the potential distribution of contaminants. The characteristic profiles of the PCDD/Fs were assessed to determine PCDD/Fs sources.

- Groundwater: Six monitoring wells, one upgradient and five downgradient, were installed across the Site. Groundwater samples were recovered and analyzed for pesticides, herbicides, PCBs, chromium, and copper.

RI Findings

The following bullets provide the principal findings of the RI.

- Dieldrin in excess of the unrestricted land use standard was identified in 12 of the grid nodes from the surficial soil sampling. In two test pits, dieldrin was concentrated in the upper six in. (in.) to one foot of the soil profile.

- PCBs in excess of the unrestricted land use standard were identified along with dieldrin in two of the 12 grid nodes referenced above. Additional PCB exceedances were found at a later date, as discussed in Section 8.1.3.

- No samples exhibited chromium, copper, or herbicides exceeding the unrestricted land use standard.

- Pesticides, herbicides, PCBs, chromium, and copper were not detected in groundwater samples from the first groundwater layer beneath the Site.

- Demolition and Underground Storage Tank (UST) and soil removal successfully lowered residual hydrocarbon levels to regulatory standards.

- Sampling for pesticides, herbicides, and metals in the septic tank drain fields, wash basins, and stormwater drainages provided no evidence of chemical dumping or disposal.

- No buried drums or sumps were identified in the suspect area through the geophysical survey and trenching activities.

- PCDD/Fs were detected in the Kettle bottom soils. The PCDD/Fs also were detected in upgradient locations in street sediments along runoff pathways to the Kettles. The PCDD/F profiles from the Kettles are similar to the profile in the upgradient street samples, and are typical of PCCD/F profiles for urban runoff available in the refereed literature. The source of PCDD/F in the Kettles is, therefore, consistent with urban stormwater runoff.

Interim Remedial Action (IRA)

Soils contaminated with dieldrin above the Model Toxic Control Act (MTCA) unrestricted land use standard and PCBs below the MTCA unrestricted land use standard were addressed through an IRA. These soils are classified as solid waste. With the approval of Ecology and the Grays Harbor Health Department, these soils were moved to Hidden Valley nursery property near Porter, Washington and used as a soil amendment. Extensive analysis showed that the dieldrin concentrations in these soils met the stringent standards under MTCA for human health, groundwater protection, and terrestrial ecological protection. The average area-weighted dieldrin concentration in the soils was 0.24 mg/kg prior to excavation. After excavation the average concentration was estimated to be approximately one-half this value. The soils were then tilled into the on-site soils, resulting in an estimated concentration near or below the unrestricted land use standard. As a further control on dieldrin concentration, phytoremediation through the growth and subsequent solid waste disposal of carving pumpkins is scheduled for a minimum of three years following the soil amendment.

Also as part of the IRA, soil that contain PCBs in excess of the 1 mg/kg unrestricted land use standard was disposed of at a lined landfill permitted for the disposal of soils with PCBs in the identified concentration range. All concentrations were well below the industrial standard of 10 mg/kg.

FS Findings

The following are the principal findings of the FS.

- As a result of the IRA, the upland areas of the Briggs Nursery Site no longer contain contaminants in excess of the unrestricted land use standards or the Ecological Indicator Soil Concentrations. Therefore, no further remediation of these soils was required.

- The Kettle bottoms contain low levels of PCDD/Fs. The composition and concentrations of the PCDD/Fs in the Kettle bottoms are indistinguishable from street runoff, which is both an off-Site source and a ubiquitous source of PCDD/Fs in urban western Washington. Therefore, PCDD/Fs in the Kettles pose no ecological risks in excess of regional background. In three of the four Kettles, concentrations of the PCDD/Fs in the sediments and waters may pose an unacceptable level of risk to human health. However, institutional controls (including fencing) on access to these Kettles reduces the frequency of human exposure such that the risks to human health are within an acceptable range.

- Groundwater underlying the Briggs Nursery site is unaffected by site contamination. No groundwater remediation is necessary at the Briggs Nursery site.

1.0
INTRODUCTION

This report provides a detailed account of a Remedial Investigation (RI) and Feasibility Study (FS) of the Briggs Nursery, Inc. (Briggs) 120-acre property (Site), located at 4407 Henderson Boulevard SE in Olympia, Washington (Figure 1-1). The property is being transformed in stages from a wholesale nursery facility into a residential housing community. The first stage involved the demolition of buildings, greenhouses and associated facilities from an approximately 104-acre portion, while Briggs continued to operate some of their facilities in the smaller 16-acre area. Remedial investigation and demolition activities were conducted under Agreed Order 1315 (Ecology 2004) with the Department of Ecology (Ecology) and the *Final Remedial Investigation Feasibility Study Work Plan* (ENTRIX 2005).

Consistent with the provisions of Agreed Order 1315, the Site was divided into Work Areas 1, 2, and 3 (Figure 1-2) for the purpose of both Site investigation and analysis, and to facilitate early release of areas that are found to have contamination levels below applicable cleanup standards. Chemicals of concern (COCs) were defined initially based on the results of previous work done on the Site and updated as appropriate during the RI. The RI objectives were defined based on an analysis of the Site history and the results of previous investigations addressing potential site contamination within the overall Site.

This document includes:

- A summary of historical practices and previous site investigations, which provided pertinent data and information to help focus the investigation;
- A summary of regional and site characteristics including descriptions of climate, physiography, geology, groundwater and specific COCs;
- RI methods and a sampling and analysis plan;
- RI results followed by a summary and discussion;
- A detailed narrative of the removal and cleanup of underground storage tanks (USTs), septic tanks and wash basins;
- A thorough description of the Interim Remedial Action (IRA) of surficial upland soils;
- A baseline human HHRA of the Kettles; and
- A FS presenting remedial alternatives for the Kettle bottoms and upland soils were remediated through an Interim Remedial Action, obviating the need for an FS on upland soil remediation. HHRAs conducted for each Kettle bottom remediation under feasibility alternatives.

Figure 1-1. Site Location Map

Figure 1-2. Site Map with Work Areas

1.1 SITE LOCATION AND SETTING

Briggs Nursery is located in the City of Olympia in Thurston County, Washington near the intersection of Yelm Highway and Henderson Boulevard SE, in Sections 35 and 36, Township 18 North, Range 2 West, latitude 47°00'19"N, longitude 122°53'06"W. The Site is bounded to the north and west by several single-family residences, to the south by the YMCA and Yelm Highway, and to the east by Ward Lake and several single-family residences. Henderson Boulevard cuts through the property, running north-south.

The Site was divided into three Work Areas based on previous and on-going site activities (Figure 1-2). Work Area 1 forms the northern and western part of the Site, is the largest work area at approximately 79-acres, and formerly contained greenhouses and general landscape plant storage. Work Area 2 forms the central part of the Site, is approximately 24-acres, and formerly contained the Main Operations Area of the Site, where concentrated fertilizer and pesticide storage and chemical mixing occurred. As part of the development process, in August 2004, all structures in Area 2, except for the business office to the west of Henderson Boulevard were demolished. Briggs is currently still operating some facilities in Work Area 3, which forms the eastern part of the Site, and consists of the plant tissue culture research laboratory, specialty growth greenhouses for plants produced in the laboratory, and standard greenhouses for additional plant inventory.

The Site is situated on a relatively flat to gently sloping upland terrace. No major or minor streams cut through or are adjacent to the property, but there are six bowl-shaped depressions or "Kettles" that are either wholly or partially situated on the Site (Figure 1-2). These Kettles are important drainage features on the Site and have been the focus of some of the investigations. These Kettles[1] are remnant geologic features from the region's last glacial episode. In previous reports, the Kettles have been named based on their location on the Site. The 8.9-acre Central Kettle is approximately 430-ft in diameter, approximately 45-ft deep, and occupies a large proportion of the central portion of Area 1. A large pond has historically occupied the bottom of the Central Kettle. To the north, also in or partly in Area 1, are the smaller and shallower Northwest and North Kettles. The 9.7-acre South Kettle lies in the southern portion of Area 1. The Northeast and Southeast Kettles form the northern and southern boundaries of Area 3. There are no Kettles in Area 2. Over many years, stormwater and irrigation runoff from the Site, adjoining roads, and residential properties have been diverted into various Kettles.

1.2 SITE BACKGROUND AND USES

Briggs has operated at this location as a grower and wholesale landscape plant material vendor since 1912. As part of its nursery operations, Briggs historically applied pesticides and fertilizers to on-site plant inventory in accordance with manufacturer specifications. Pesticide and fertilizer chemicals were stored and mixed on-site in structures used for these

[1] The Kettles were created when stranded blocks of glacial ice gradually melted during the last glacial recession of the Puget Sound lobe over 12,000 years ago.

purposes in the Main Operations Area (Work Area 2) on the west side of Henderson Boulevard. Flat to gently sloped areas surrounding the Main Operations Area (including parts of Work Areas 2 and 3) were used to store, grow, and retail plant inventory. The landscape plants were either set out in the open on plastic sheets for easy buyer access or retained in greenhouses.

1.3 PREVIOUS SITE INVESTIGATIONS AND CLEANUP ACTIVITIES

Since 1996, a number of reports, sampling programs, and chemical analyses have addressed various locations at the Site. Other similar off-site work has been conducted since 1995. These data and reports in aggregate documented low levels of pesticide contamination within the very near surface soils in the general nursery property. In a few instances, the concentration of the pesticide dieldrin in the near surface soil exceeded the 2001 Model Toxics Control Act (MTCA) Method B soil concentration for unrestricted land use, direct contact (ingestion only), and leaching pathway (carcinogen). In total, four samples (three on-site and one from the current YMCA property) exhibited dieldrin concentrations in excess of this Method B concentration limit.

Previous Site work also identified very low levels of PCDD/Fs in the water and sediments within several on-site Kettles. These Kettles have received runoff from both the Site and from nearby roads and highways over the years.

Key reports from this time period are summarized below, with updates to 2001 MTCA standards as appropriate:

1996 On January 16, 1996, S. Chamberlain & Associates Inc. issued a letter report to Thurston County Health Department concerning sampling and analyses at the new YMCA property near the corner of Yelm Highway and Henderson Boulevard. Chemical analysis of one sample (#5) at a four-inch depth indicated dieldrin at a concentration (0.362 mg/kg) in excess of 2001 MTCA Method B levels for unrestricted land use direct contact pathway (0.0625 mg/kg carcinogen) and the calculated (following the Washington State Department of Ecology workbook *MTCASGL* for calculating cleanup levels) Method B Modified soil concentration deemed protective of ground water (0.173 mg/kg). Discrete depth sample analytical results indicated that dieldrin concentrations decreased with depth, and were at non-detectable levels in samples collected at one-foot below ground surface (bgs).

1996 On October 10, 1996, Landau Associates, Inc. (Landau) issued a letter report to Mr. Alexander Mackie, Esq. of Owens Davies Mackie. The report documented sampling and analytical data from the South, Central, and Northwest Kettles, and four soil samples from two locations in the western portion of the Briggs Nursery property. The Kettle samples had very low concentrations of PCDD/Fs in shallow (less than 1.5-ft deep) Kettle sediments. Concentrations of pesticides, herbicides, PCBs, and priority pollutant metals in the two soil samples in the western portion of the Site did not exceed MTCA 2001 Method A, Standard Method B, or background levels for

Washington State, with the exception of thallium. Thallium was detected at 0.3[2] mg/kg, exceeding the level in soil considered protective of groundwater at that time, but below the level in soil considered protective of groundwater based on the calculated (*i.e.*, following the Ecology *MTCASGL* workbook) 2001 Method B Modified soil concentration (0.327 mg/kg).

1998 On March 26, 1998, Phillips Services Corporation (Phillips) issued a *Limited Phase I Site Assessment for the Briggs Nursery Olympia Facility* to Owens Davies Mackie. The report provided descriptions and locations, with an abbreviated Site history, of 14 nursery facilities, features, and operational areas with a potential for contamination. Five of the 14 facilities/features discussed were Kettles (Central, South, Southeast, Northeast, and Northwest). The use of the Kettles for Site drainage detention was noted. One of the 14 facilities/features identified and discussed was the Debris Pile on the eastern edge of the Central Kettle that has since been cleaned up and delisted and is not part of the Site under this Agreed Order. The remaining eight Site facilities/features identified and discussed include the following:

- Shop;
- Fertilizer Injector Shed area;
- Pesticide Chemical Shed;
- Dry Chemical Fertilizer Shed;
- Canning Barn;
- Old Barn and culvert
- Fumigation Shed used for dry herbicide and pesticide storage;
- A small stormwater detention area just south of the Northeast Kettle; and
- The Laboratory area to the east of Henderson Boulevard.

The report provided some information on surface drainage to the Central and Northeast Kettles and also provided estimates of the distribution of return flows from the pumped on-site well water and city irrigation water to the various on-site Kettles. The report identified two on-site underground storage tanks near the shop and provided volumetric tank tightness test results. The report also documented a 1992 spill of copper chromium arsenical (CCA) wood preservative in the area around the pesticide chemical shed, the dry chemical fertilizer shed, and the fumigation shed. A contractor cleanup report indicated that approximately two vertical ft of contaminated soil was removed from the spill area and post-excavation soil samples were tested for TPH. The report included a copy of the October 10, 1996 Landau report described above.

1998 On July 15, 1998, Phillips issued a *Phase II Executive Summary Report for the Briggs Nursery Olympia Facility*. Phillips collected twenty samples from various locations within the Site. Ten samples were concentrated in the Main Operations

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[2]These laboratory data results were reported to one significant digit.

Area west of Henderson Boulevard. Ten additional samples randomly located around the Site area were collected. Two samples (301 and 1001) had analytical results (0.19 mg/kg and 0.13 mg/kg, respectively) indicating dieldrin concentrations in excess of the 2001 MTCA Standard Method B level for unrestricted land use direct contact pathway. Sample 301 was located within the Main Operations Area. The exact location of sample 1001 is uncertain, although a later map produced by L.C. Lee and Associates (L.C. Lee) located the sample to the north of the Main Operations Area.

2000 On February 29, 2000, L.C. Lee issued a letter report entitled *Briggs Village Thallium and Water Quality Sampling* to Owens Davies Mackie. This report was a follow-up to the Landau 1996 report that reported thallium at a level in soil that was below the MTCA residential cleanup level based on direct contact but above the level for protection of groundwater. To address this issue, L.C. Lee collected discrete soil samples at one-foot intervals from the surface to 6-ft bgs at three sample locations. Thallium concentrations in all of these samples were below the *MTCASGL* workbook-calculated 2001 Method B Modified soil concentration (0.327 mg/kg) considered protective of groundwater. All sample concentrations were well below the 2001 MTCA Method B levels for unrestricted land use direct contact pathway. L.C. Lee also collected sediment samples from within and along the wetted perimeter of the Central, South, and Southeast Kettles. All sediment thallium concentrations were also below the 2001 MTCA Method B levels acceptable in soil.

2001 On January 18, 2001, L.C. Lee issued a letter report to Briggs entitled *Data Summary from the Additional Contaminant Sampling at the Briggs Nursery Site in Olympia, Washington*. L.C. Lee tested water from the on-site irrigation well for arsenic, beryllium, chromium, and thallium. None of these contaminants were detected in the well water sample. L.C. Lee conducted additional sampling and analysis in the following areas:

- The Fertilizer Injector Shed Area;
- A swale east of the Central Kettle and downgradient from the Fertilizer Injector Shed Area;
- A location east of the South Kettle;
- A location east of the Northwest Kettle;
- An area south of the Central Kettle previously sampled by Landau in 1996;
- The Northeast Kettle;
- The Central Kettle; and
- The Southeast Kettle.

The key results from the 2001 report were summarized and combined with data previously collected from these areas.

- Arsenic was reported at 8.0 mg/kg in a sample from the Central Kettle near the debris field and at 9.0 mg/kg in a sample from the Fertilizer Injector Shed

Area. These values are within the range of background values for soils in the Puget Sound area. The values were below the Method A cleanup level of 20.0 mg/kg.

- DDE and DDT, reported at concentrations of 0.08 mg/kg and 0.6 mg/kg, respectively, in sample 301 from the Fertilizer Injector Shed area by Phillips in 1998, exceeded the Method B level in soil considered protective of groundwater at that time. However, these levels did not exceed the current 2001 Standard Method B soil level for the direct contact pathway for unrestricted land use. The DDE concentration reported in sample 301 (0.79 mg/kg) did not exceed the *MTCASGL* workbook-calculated 2001 Modified Method B soil level protective of groundwater (0.787 mg/kg), and the DDT concentration did not exceed the Method A soil cleanup level of 3.0 mg/kg.

- DDE and DDT, reported at 0.07 mg/kg and 0.05 mg/kg, respectively, in sample 1001 in an uncertain location (as noted above, L.C. Lee later mapped the sample location to the north of the Main Operations Area) by Phillips in 1998, exceeded the Method B level in soil considered protective of groundwater at that time. However, these levels did not exceed the 2001 Standard Method B soil level for the direct contact pathway for unrestricted land use. The DDE concentration reported in sample 301 (0.79 mg/kg) did not exceed the *MTCASGL* workbook-calculated 2001 Modified Method B soil level protective of groundwater (0.787 mg/kg), and the DDT concentration did not exceed the Method A soil cleanup level of 3.0 mg/kg.

- Aroclor 1254 reported at 0.059 mg/kg in one surficial sediment sample from the Southeastern Kettle was below the Method A cleanup level for PCB.

2003 On February 5, 2003, ENTRIX issued the closure report for the Briggs Nursery Debris Field following remediation of the site under Agreed Order DE 02TCPSR-4593 (Ecology 2002). The extensive testing following debris excavation at the Debris Field Site on the east side of the Central Kettle showed that all COCs were below their detection limits. Subsequently, Ecology delisted the debris field in 2004, stating that the Debris Site was clean and required no further action or monitoring.

2003 On September 30, 2003, ENTRIX issued a letter report to Perkins Coie entitled *Supplemental Letter Report In Response to Hearing Examiner Decision No. 97-0187 Briggs Urban Village* (ENTRIX 2003). The report incorrectly reported dieldrin levels in sample 301 (Phillips 1998), 1001 (Phillips 1998), and FIS-4 (ENTRIX, 2003) as being below applicable 2001 MTCA soil standards. Dieldrin concentrations in each of these samples exceeded the 2001 Standard Method B soil level for the direct contact pathway for unrestricted land use due to carcinogenicity (0.062 mg/kg). Values of DDT, DDE, and dieldrin for sample 301 (collected at 3-ft bgs) should be corrected to 0.6 mg/kg, 0.08 mg/kg, and 0.19 mg/kg, respectively. The workbook calculated values for 2001 MTCA Method B soil levels protective of groundwater for thallium, DDE, and dieldrin attached to this report as Appendix A are correct as presented. The key finding of this report as amended herein was that dieldrin concentrations found in three on-site samples (301, 1001, and FIS-4) were the only exceedances of relevant MTCA standards found up to that time on the Site.

2004 On January 22, 2004, ENTRIX issued a report entitled *Dioxin and Furan Sampling and Analysis and Human Health Risk Assessment Report for the Central Kettle Briggs Urban Village*. The key finding of this report was that the measured concentrations of PCDD/F in sediment and water collected in 2000 and 2003 from the Central Kettle did not pose an unacceptable risk to on-site workers and "trespassing" children from dermal contact and ingestion. Overall incremental lifetime cancer risk for these populations resulting from dermal contact with and ingestion of Central Kettle sediments and water is below the MTCA cancer risk guidance value of 1 in 10^{-6}.

2005 On February 2, 2005, ENTRIX provided to Ecology a draft report entitled *Dioxin and Furan Profile Analyses Report for the Central and Southeast Kettles*. In this report, PCDD/Fs found in the Central and Southeast Kettles were shown to occur in homologue mixtures that resemble distributions reported in the literature as typical of urban street and highway runoff. Those profiles were also shown to closely resemble the profile of samples collected from Henderson Boulevard, adjacent to the Briggs Nursery. Concentrations of PCDD/Fs in the Kettles receiving substantial street runoff were similar to those of the Henderson Boulevard samples; Kettles receiving little runoff or only runoff from the Briggs Nursery had substantially lower concentrations of PCDD/Fs.

2.1 CLIMATE AND PHYSIOGRAPHY

The climate of the area is typical of mid-latitude, west coast marine environments that are characterized by cool, wet winters and warm, dry summers (USGS, 1994). More than 80 percent of the 51 to 54 in. of average annual rainfall occurs between October and April (State of Washington, 1966).

Thurston County is drained by three prominent rivers: the Nisqually and Deschutes Rivers which drain to the north, and the Black River which drains southwest and is a tributary to the Chehalis River (USGS 1994). Of these drainages, the Deschutes River is closest to the Site and is located approximately one mile to the west. The Site is located on a north-trending late Pleistocene glacial upland terrace adjacent to the Deschutes River Valley. As is typical of much of the area between the Deschutes and Nisqually Rivers, the Site is on a gently-sloped sandy outwash terrace that is broken by the six Kettles (as described in Section 1.1) of varying depth, which have historically received both natural and engineered runoff from the Site, surrounding roadways, and residential properties. Ward Lake, also a very large Kettle, is the most prominent water body in the area and borders the Site to the east.

2.2 SOILS

Soils within the site area are agriculturally mapped as Yelm fine sandy loam. The Yelm series consists of deep, moderately well drained soils on terraces formed in volcanic ash and glacial outwash. The slopes for the Yelm Series are classified in three different ranges; 0 to 3 percent, 3 to 15 percent, and 15 to 30 percent (USDA, 1990).

2.3 GEOLOGIC SETTING

Based on regional data and information (Ecology, 1995; Thurston County, 1992), the major geologic units in the area consist of the Quaternary Kitsap Formation (Qk), sea level glacial deposits (Qc) and older undifferentiated Quaternary/Tertiary sediments (Tqu). Above these units lies the Quaternary Vashon recessional outwash (Qvr). The Qvr, when deposited by the receding glacier and meltwater streams, formed the primary landscape features that still dominate the area east of Tumwater and the Deschutes River valley, including Ward Lake and Hewitt Lake (another large Kettle-lake to the southeast) and the Site Kettles. In places, the landforms of the recessional outwash have been somewhat denuded and are mantled by more recent alluvium, palustrine or lacustrine deposits, or have been deeply incised and filled with a moderate thickness of alluvium (*i.e.*, the Deschutes River Valley).

Qvr is comprised predominantly of sands and gravels, with lenses of silty sand and, in places, clay lenses. To the east of Ward Lake, the thickness of Qvr ranges from 10 to 50-ft, but in the immediate area of the Site Qvr is much thicker, ranging from 100 to over 200-ft thick. The Qk consists predominantly of clay and silt with minor sand, gravel, peat, and wood. The Qk was deposited in shallow lakes and wetlands during an interglacial period. The thickness of the Qk unit typically ranges from 10 to 100-ft (Thurston County, 1992).

Below the Qk lies the sea level glacial deposit (Qc). This unit consists of coarse sand and gravel, and was deposited by glacial meltwater during a pre-Vashon glacial period. Well logs and interpretations of regional data (Ecology, 1995) indicate that Vashon Till (Qvt) and Vashon Advance (Qva) deposits likely are not present below the Site. In other areas, the Qvt and Qva are typically found throughout the region forming an aquitard and aquifer, respectively.

Well-log data from two deep wells (*i.e.*, 35K03 at the old Olympia Brewery (Brewery Well), and 36D01 at the Site (Briggs Well)) drilled in the vicinity of the Site indicate that there are two main hydrostratigraphic units in the local area. The two wells penetrated to undifferentiated formations that include the Quaternary Kitsap Formation (Qk), sea-level glacial deposits (Qc) and older undifferentiated Quaternary/Tertiary sediments (Tqu) at between 50 and 100-ft below mean sea level (msl). Above these units lies about 200 to 280-ft of Quaternary Vashon recessional outwash (Qvr).

2.4 GROUNDWATER OCCURRENCE

The depth to groundwater in the vicinity of the study area varies due to the topographic irregularities of the recessional outwash and glacial deposits, and through flowing drainages. The general elevation of the water table can be inferred from the water levels in the nearby large Kettles filled by Ward and Hewitt Lakes (*i.e.*, water levels in Ward Lake have fluctuated over several decades from 119-ft to over 126-ft msl, based on local and USGS topographic data), the Central Kettle and the off-site Kettles located just off the Briggs property (117 ft to 125-ft msl) and the Deschutes River (which is around 100-ft msl).

Although there are other main aquifers found throughout northern Thurston County (Ecology, 1995; Thurston County, 1992), based on the well logs and head data from the Brewery and Briggs wells and regional hydrostratigraphic information, it is apparent that there are only three water-bearing units of concern beneath the Site and surrounding areas.

The upper unit is the unconfined aquifer that occurs within the Qvr deposits and is in hydraulic connection with the major surface water bodies in the area (Ward and Hewitt Lakes). A second unit is suggested by the well log data from the Briggs well, which was screened across the contact of the Qvr and underlying Qk/Qc deposits. In the Briggs well a clay seam was present at an approximate depth of 129-ft bgs (or 58-ft msl) and the well produces from a zone between 43 to 132-ft msl. The clay lenses and silty sand portions that occur with the Qvr suggest that the Briggs well is producing from a much deeper zone within the Qvr that is in a leaky-confined condition, and to a degree, isolated from the upper portions of the aquifer in contact with the large Kettle lakes.

A third unit is indicated by head data in the Brewery well, which has penetrated to a lower aquifer, most likely within the Qc deposits and/or coarser portions of the Qk deposits. Locally, fine-grained portions of the Qk unit (*i.e.*, the silty clay layer) retard the movement of groundwater. At these locations the laterally continuous silty clay serves as a confining layer between aquifers that lie stratigraphically above and below it, causing substantial vertical head gradients to form. This vertical gradient is indicated by the relatively high head data (*i.e.*, artesian conditions) in the Brewery Well (*i.e.*, approximately 140-ft msl), and depicted by the upward groundwater flow directions shown in Figure 2-1.

Based on the available well log data, regional and local hydrostratigraphy, and local physiography, it can be inferred that regional groundwater gradients between Ward Lake and the Deschutes River valley, and the Kettles and the river valley range from 0.006 to 0.010-ft/ft. This gradient may fluctuate slightly with the rising and falling water table associated with changes in recharge due to short (seasonal to annual) and long-term (decadal to longer) climate changes.

2.5 CHEMICALS OF CONCERN

Based on past investigations and the findings of the Supplemental Letter Report (ENTRIX 2003), the primary COCs were dieldrin in the fields and work areas and PCDD/Fs in the Kettles. Summaries of the information regarding the presence of those COCs and additional chemicals that are potential COCs are provided below.

2.5.1 PESTICIDES

Dieldrin was the only contaminant identified in site fields and work areas that has exceeded any relevant 2001 MTCA standard (soil level for unrestricted land use based on dermal contact inhalation pathway). Because of detections of other pesticides in previous cleanup activities in other areas, all samples collected in the initial investigation phase were analyzed for a full pesticide screen, including DDT (Dichlorodiphenyltrichloroethane), DDD (Dichlorodiphenyldichloroethane), and DDE (Dichlorodiphenylchloroethane). Also, sediment samples from the Kettles were analyzed for a full pesticide screening, including DDD/E/T.

2.5.2 POLYCHLORINATED BIPHENYLS (PCBS)

In a previous study (L.C. Lee, 2001), PCBs were detected in a single sample from the Southeast Kettle. In light of this single detection, particular care was taken during quality assurance of laboratory analyses to review interferences that could indicate PCBs at elevated levels in upland soils.

Briggs Nursery soil samples were analyzed by U.S. EPA Method 8081A, which is used to analyze for chlorinated pesticides using an electron capture detector (ECD). The output of the ECD is a series of peaks on a chromatogram. Each of these peaks is associated with an individual pesticide, except for pesticides that occur as mixtures of compounds, such as chlordane and mirex. The ECD is also sensitive to other chlorinated compounds such as PCBs, which are simultaneously detected when analyzing for chlorinated pesticides. PCBs occur as multi-component mixtures of compounds that produce patterns on the chromatogram potentially interfering with, or at least complicating, the detection of pesticides. Therefore, the potential co-occurrence of PCBs and pesticides needs to be taken into account whether analyzing solely for pesticides, solely for PCBs, or analyzing for both compound classes.

Figure 2-1. Conceptual Hydrogeologic Cross-section, Briggs Site, Tumwater and the Surrounding Area.

Pesticide results were carefully reviewed for interferences that could indicate PCBs at elevated concentrations.

2.5.3 Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (PCDD/Fs)

Previous investigations, conducted in 2000 and 2003, indicate that PCDD/Fs are present in sediments of the Southeast and Central Kettles at concentrations above the MTCA unrestricted land use standards. PCDD/Fs have also been linked to stormwater runoff from the roads. Sampling for PCDD/Fs was conducted in the surface water and sediments within the Kettles during the 2004 Dioxin and Furan Sampling and Analysis (ENTRIX, 2004).

2.5.4 Herbicides

The 2001 L.C. Lee report reported one detection of the herbicide 2,4-D in the Southeast Kettle (L.C. Lee 2001). Although the result (17 µg/kg) was well below the identified MTCA standard of 160 µg/kg, selected discretionary samples were analyzed for herbicides upon Ecology request during this RI.

2.5.5 Petroleum Hydrocarbons

Two USTs located in Work Area 2 stored unleaded gasoline and diesel fuel. Four other USTs in the operations area stored fuel oil No. 2. Therefore, in the UST area additional COCs included gasoline, diesel, oil, and their individual components. The USTs were decommissioned and removed during the demolition process in accordance with the Washington State UST removal guidelines. The UST Closure Report is attached as Appendix B.

2.5.6 Metals

The metals tested historically were not of concern but based on preliminary testing of three soil samples collected in July 2004 from the Fertilizer Injector Shed under the former tank crib liner, copper became a COC at some locations in Work Area 2. Additionally, given the reported CCA release in Area 2, chromium was also a COC in some locations in Area 2. As described below in Section 3.0, selected samples were analyzed for copper and chromium to ensure accurate characterization of metals contamination. The selected samples focused on the areas of the highest potential for metals contamination, such as the fertilizer shed, the area of the 1992 spill and the chemical storage and mixing sheds.

In compliance with Ecology's Agreed Order 1315 (Ecology, 2004a), the RI of the Briggs Nursery Site included the following four objectives:

1) To fully characterize and assess options to remediate chemically-contaminated soils associated with the excavation and removal of various USTs, septic tanks and drainfields, wash basin drainage areas, catch basins and stormwater drainage outfalls;

2) To characterize and assess options to remediate any chemical contamination of surficial soils left behind by nursery practices. Later an Interim Remedial Action Plan (IRAP) was developed to address specific COCs identified in soils;

3) To characterize groundwater and assess whether nursery practices could have affected any water-bearing zones beneath the Site; and

4) To characterize the sediment and water quality of site Kettles and evaluate potential risks to human health.

Agreed Order 1315 and this RI exclude the debris field area that was previously listed by Ecology in 2002, cleaned up by Briggs in accordance with Agreed Order DE 02TCPSR-4593 (Ecology, 2002), and subsequently delisted by Ecology in 2004 (Ecology, 2004b). Further, although the scope of this remedial investigation did not include the demolition of the various structures in the Main Operations Area, any field activities associated with the characterization and remedial action had to follow the demolition and removal of these features.

3.1 UST, SEPTIC TANK, WASH BASIN AND SUMP INVESTIGATIONS AND REMOVAL

The scope of work that was followed to characterize and assess remediation options for chemically contaminated soils associated with the demolition and excavation of various facilities included:

- Developing a work plan in conjunction with demolition activities to include the characterization of soils surrounding various excavations;
- Collecting characterization and confirmatory samples; and
- Directing additional excavation and removal of chemically affected soils.

3.2 SURFICIAL SOILS

The scope of work that was followed to characterize and remove chemical contamination of surficial soils left behind by nursery practices consisted of:

- Developing a sampling and analysis plan for soils;
- Establishing and surveying in a primary sampling grid;
- Collecting and analyzing a first round of surficial soil samples;
- Based on laboratory analytical results, identifying zones of impact and then refining the sampling grid in specific problem areas;
- Collecting additional rounds of soil samples to assess the extent of contamination; and
- Based on these results, developing an IRAP to excavate and dispose of soils with chemical concentrations exceeding applicable regulatory standards.

3.3 GROUNDWATER

The characterization of groundwater consisted of:

- A review of pertinent literature and documents and the development of a monitoring well installation plan;
- Drilling of boreholes and the installation of groundwater monitoring wells;
- The measurement of groundwater elevations and the collection of groundwater samples;
- An interpretation of groundwater data with other local and regional data to describe hydrogeologic conditions at the Site and assess groundwater flow directions and gradients; and
- Assessing possible effects to groundwater from Site practices based on the hydrogeologic, hydraulic, and laboratory analytical data.

3.4 KETTLES

Remedial investigation activities associated with the sediment and water quality of site Kettles included the following:

- Developing a sampling and analysis plan;
- Collecting sediment and water quality samples; and
- Evaluating potential risks to human health.

3.5 SUBDIVISION OF SITE INTO THREE WORK AREAS

As described previously, the Site was divided into three Work Areas (Figure 1-2) for the purpose of both Site investigation and analysis, and to facilitate early release of areas that are found to have contamination levels below applicable cleanup standards.

3.5.1 WORK AREA 1

Work Area 1 encompasses the northern and western portion of the Site. It includes the North, Northwest, Central, and South Kettles. It excluded the Debris Field Site that has been cleaned up and delisted (Ecology 2004b). The Site history indicates that Work Area 1 was only used for greenhouses and general landscape plant storage over the operational life of Briggs Nursery. The Kettles were and are currently used for on-site stormwater and irrigation return flow detention. The Kettles also received street and highway runoff from Yelm Highway, Henderson Boulevard, and from residential areas to the northwest of the Site.

In Work Area 1, the primary RI objective was to fully characterize any chemical contamination left behind by nursery practices. Previous work performed by others identified one sample of uncertain location (1001) within Work Area 1 that exceeded the MTCA Method B standard (soil level for unrestricted land use based on dermal contact inhalation pathway) for dieldrin. For the most part, the area contained greenhouses and outside potted plants. To achieve the stated remedial objective, soils in this area were sampled in a grid pattern. The surficial soil grid sampling method is described in Section 4.2. The soil grid sampling identified areas that required Interim Remedial Actions that are further described in Section 8.0.

An additional RI objective for Work Area 1 was to determine in a methodical way the concentrations of PCDD/Fs in the water and sediments of the North, Northwest, Central, and South Kettles, to support supplemental Human Health Risk Assessments (HHRAs) that takes into account the future uses and institutional controls of the Kettles.

3.5.2 WORK AREA 2

Work Area 2 encompasses the Main Operations Area of the Site west of Henderson Boulevard and the southeastern corner of the Site east of Henderson Boulevard, south of the Southeast Kettle, and north of Yelm Highway. The portion of Work Area 2 to the west of Henderson Boulevard is the area where concentrated fertilizer and pesticide storage and chemical mixing occurred. It also includes the shop area where two fuel storage USTs were located and where vehicle maintenance activities were conducted. Work Area 2 also contained four #2 fuel oil USTs and four septic tanks.

In Work Area 2, the primary RI objective was to assess the extent of contamination associated with concentrated nursery activities that exceeds relevant MTCA cleanup standards. Work Area 2 includes the chemical storage and mixing areas where fertilizers and pesticides were prepared for use on landscape plants around the facility. In work conducted previous to this RI, two samples in the area of the Fertilizer Injector Shed (301 and FIS-4) indicated dieldrin levels that exceeded the MTCA Method B Standard for unrestricted land use based on dermal contact inhalation pathway.

In addition, Work Area 2 included three septic tanks, four wash basins that drained directly to the ground or into makeshift septic systems, and six petroleum USTs. An additional RI objective was to determine whether the operation of the UST or drainage systems contributed to surface or subsurface contamination in the area.

3.5.3 WORK AREA 3

Work Area 3 comprises the portion of the Site east of Henderson Boulevard, north of the southern boundary of the Southeast Kettle, and west of Ward Lake. It includes the Southeast Kettle and the Northeast Kettle. This area includes the actively operating portion of the Site, including the laboratory and specialty growth greenhouses for plants produced in the laboratory. It is presumed that any chemical contamination in this area would be associated with either laboratory activities or associated with plant care in the greenhouse area.

Because this portion of the Site is still actively operating, the only RI activities conducted in Work Area 3 involved sediment and water samples in the Kettles, limited sampling in the area of a proposed overlook, sampling within the outfall channel to Ward Lake, and the drilling, installation and sampling of one groundwater monitoring well. The upland portion of Work Area 3 will not be investigated until nursery operations have ceased.

This section describes the field procedures used to characterize soils, sediment, surface water and groundwater for the four principal RI activities that included:

- The characterization of soils associated with the decommissioning of Site facilities;
- The upland surface soil investigation;
- The groundwater investigation; and
- The investigation of the Site Kettles.

4.1 DECOMMISSIONING OF SITE FACILITIES

In July and August 2004, Briggs decommissioned and demolished facilities in the Operations Area located in Work Area 2. The Main Operations Area included the shop area and two fuel storage USTs where vehicle maintenance occurred, and other maintenance buildings and facilities with four #2 fuel oil USTs, four septic tanks and four wash basins. The wash basins drained directly to the ground or into makeshift septic systems. The locations of the structures, septic tanks and drainfields, USTs, and wash basins are provided on Figure 4-1. Samples collected from these locations and the locations of additional samples requested by Ecology are also provided. Prior to any demolition activities, a site reconnaissance of site facilities was conducted to identify probable locations and depths of tanks, basins and other features. During demolition of the structures in the Main Operations Area, an experienced environmental scientist visually inspected the condition of the building foundations for any signs of compromised concrete or evidence of releases that may have reached the soils underneath. Discretionary samples were collected if potential contamination was observed or upon the request of the Ecology representative.

One historical (1992) product spill of unknown quantity near the chemical storage area was documented in the Phillips Services Corporation Phase I Site Assessment (Phillips 1998). According to available documentation, soil affected by the spill was excavated to a depth of 2-ft and the underlying soil designated as “clean” after testing for total petroleum hydrocarbons (TPH). Additional sampling was conducted during decommissioning to determine any residual impacts from the spill.

Figure 4-1. Map showing all structures, USTs, Septic Tanks, wash basins and Discretionary sample locations.

4.1.1 USTs and Septic Tanks

In 1998, the 500-gallon steel diesel tank and the 1,000-gallon regular unleaded gasoline tank and associated delivery lines were tested using a volumetric tank test procedure. Results indicated that these two USTs and associated delivery lines were "tight", within the limitations of the tank testing procedure. Size and material specifications for the petroleum USTs are provided in the Closure Report provided as Appendix B.

AEG and Advanced Environmental contracted with Briggs Nursery, Inc. to remove and dispose of the six petroleum USTs. A certified tank removal contractor conducted the excavation. ENTRIX was on-site during the tank decommissioning and disposal tasks to address any potential contamination issues.

A Site inspection was conducted prior to tank excavation. Recent Site plans showing tank components and piping systems were reviewed and verified prior to tank decommissioning activities. Prior to tank removal, the Site was inspected for signs of leaks or spills and to confirm the tank components and piping system. In order to minimize risk of a spill during the tank excavation, the demolition contractor confirmed that the tanks were completely empty.

Visual examination of soil was performed during excavation to identify potential petroleum contamination. A Photo-Ionization Detector (PID) was used to detect petroleum hydrocarbons in the soil.

4.1.2 Septic Tanks and Wash Basins

Ecology requested sampling of the septic tanks, drainfields, and washbasins to determine if contamination occurred through the disposal of chemicals into the septic systems and the wash basins. The septic tanks were excavated and samples collected directly beneath the tank and within the drainfield. The wash basin drain outfalls were located and sampled.

4.1.3 Abandoned Sump Investigation

According to former site workers at the Briggs Nursery, a number of years ago a collection of perhaps five to ten plastic 55-gallon drums were placed in an excavation that was used as an infiltration gallery for site runoff. The drums were possibly used as energy dissipators or to help stabilize the excavation and were reportedly buried in soil comprised mainly of sands to a depth of 6 to 10-ft bgs. However, due to subsequent changes to surface conditions at the Nursery (*e.g.*, buildings, greenhouses and access paths, *etc.*) former and current site workers were unable to place the exact location of this former gallery and could not recollect if the drums had been removed during the site renovations.

In an effort to confirm the presence or absence of the drum collection, several test pits were excavated at likely locations of the infiltration gallery (as reported by the site workers) during the August 2004 demolition activities on the nursery property. No drums were discovered during this effort.

As a further check on the potential for buried drums in the site area, ENTRIX arranged for Northwest Geophysical Associates, Inc. (NGA) of Corvallis, Oregon, to conduct a ground penetrating radar (GPR) survey at the Briggs Nursery on October 21, 2004. The objective of the survey was to conduct a broad and then detailed sweep of the entire area where the gallery would have been located. The survey extended over a 130-ft by 170-ft rectangular grid, with 5-ft spacing between survey lines. Anomalous areas were re-surveyed along perpendicular lines to increase the resolution of the investigation in these areas.

The methods of NGA's survey are described in their November 8, 2004 report, provided as Appendix C. The results of the survey are summarized in Section 6.1.4 of this report and also described in more detail in the GPR Report provided as Appendix C.

4.2 UPLAND SURFACE SOIL INVESTIGATION

In August and September 2004, ENTRIX conducted an upland surface soil investigation to characterize any chemical contamination of surficial soils left behind by nursery practices. The results of this characterization were then used to develop and implement an IRAP to address soil in the upland portions of Areas 1 and 2 certain locations on Site that were identified to contain COCs.

In Work Area 1 and portions of Work Area 2, surficial soil samples were collected on a regular 200-ft square grid. This included most of the Site with the exception of the Kettles and Kettle slopes and the areas identified as excluded from the Remedial Investigation. In the Main Operations Area, samples were collected in a higher density 100-ft square grid to more accurately assess any soil contamination in that area (Figure 4-2).

A licensed surveyor staked the 200-ft square grid throughout Work Area 1 prior to sample collection. Each grid node (sampling location) was located with a flag and identified by a unique alphanumeric code. The 100-ft square grid in the Main Operations Area was developed by simple measurement from the 200-ft grid nodes during the sampling event.

Each surficial soil sample was a composite of five individual samples. At a given sampling location, a center grab sample was collected. Four more grab samples were collected on the four cardinal points of the compass (N, S, E, and W) approximately two feet from the center sample. The grab samples were collected from zero to six in. in depth using a pre-cleaned shovel and were composited by homogenization in a stainless steel mixing bowl. Rocks, vegetation, and debris were removed from the homogenized samples.

Figure 4-2a. Grid Sampling Points.

Figure 4-2b. Grid Sampling Points.

4.3 GROUNDWATER INVESTIGATION

Beginning in August 2004, ENTRIX conducted a groundwater investigation, including the drilling and installation of monitoring wells, the recovery and analyses of groundwater samples, and the measurement of groundwater levels. The objective of this work was to determine whether the shallow unconfined aquifer in the Qvr deposits was impacted by Site activities. Additionally, it was important to determine if any perched water-bearing zone existed and, if so, if it was impacted. The monitoring wells would also provide data to assess groundwater flow directions, gradients, and possible migration pathways in the shallow Qvr aquifer and within any perched water-bearing zones.

4.3.1 DRILLING AND INSTALLING MONITORING WELLS

Based on the assumed westward-flowing regional groundwater flow direction and the locations of activities of concern, six wells were installed in the following locations (Figure 4-3):

- An upgradient well location in Work Area 3 between the Southeast and Northeast Kettles;

- Two wells situated along the western arcuate boundary of Work Area 2 and immediately downgradient of the Main Operations Area; and

- Three wells in Work Area 1 situated along the western and northern Briggs property boundary.

The borings were advanced using a hollow-stem auger rig to at least six but not more than 12-ft below the first presence of saturated soils (*i.e.*, the groundwater table). Drill cuttings were described and logged following standard United Soil Classification System (USCS). Borehole logs were recorded following standard practices.

The moisture content of the soils as an indicator of unsaturated or saturated conditions was monitored during drilling. No significant water-bearing zone was encountered in strata measurably above the projected groundwater surface elevation for any of the six well locations. Had such a perched water zone been encountered in any of the boreholes, the workplan outlined procedures to install additional shallow wells that could have monitored the perched conditions. All the wells were set with two-inch diameter schedule 40 PVC, using at least 10-ft of ten-slot screen. All wells were constructed with sand filters that extended above the screen, and were sealed with bentonite. All six wells were completed as stick-up wells 2 to 3-ft above ground surface, with steel monument casings set in a concrete foundation. All wells have locking caps, and were developed within 48 hours after well completion following standard well development techniques. Boring logs, with well completion information for each of the six wells, are provided in Appendix D.

Figure 4-3. Groundwater Monitoring Well Locations.

4.3.2 WELL SURVEY AND GROUNDWATER LEVEL MONITORING

Absolute elevations of the top-of-casing for each monitoring well were surveyed by a licensed surveyor and recorded to the nearest hundredth of a foot using standard surveying techniques with reference to the appropriate local datum control (*i.e.*, NAD 83). At least 48 hours after well development, groundwater levels were measured below the top of the casing in each well with a decontaminated electric water level indicator. The depth to groundwater in each monitoring well was determined in accordance with American Society of Testing Materials Standard (ASTM) D4750-87 *Standard Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)* (ASTM, 1993).

4.3.3 GROUNDWATER SAMPLING

Following well development and just prior to well sampling, the groundwater level below the top of casing in each well was measured with a decontaminated electric water level indicator and the volume of water in the borehole was calculated. Groundwater samples from all monitoring wells were collected in accordance with ASTM D4448-85a *Standard Guide for Sampling Groundwater Monitoring Wells* (ASTM 1992) to obtain valid, representative samples. At least three well volumes were purged from each well prior to sampling. Well purging and sampling was accomplished using a disposable polyethylene bailer. All sampling equipment utilized was disposable.

Groundwater samples were collected into various appropriate laboratory-provided containers and immediately cooled in an iced cooler for transportation to an approved laboratory. Chain of custody documentation was maintained throughout the process.

4.4 KETTLE INVESTIGATION

In August and December 2004, an investigation of the six on-site Kettles was conducted to characterize their sediment and water quality and provide data to help evaluate potential risks to human health. Sediment samples were collected from each of the six Kettles and water samples from those four Kettles containing water (the Southeast, Northwest, Central and Northeast Kettles). Sampling locations are shown on Figures 4-4a and 4-4b.

4.4.1 SEDIMENT SAMPLES

Sediment samples were distributed within each Kettle to capture variability in sediment conditions. To the extent practical, samples representative of Kettle features (water depth, inflows, *etc.*) were collected in a uniform pattern, such that each sample represented an approximately equivalent amount of the Kettle's area. For example, a small channel runs into the Southeast Kettle. Sediment samples were collected from locations distributed evenly along the channel, and the remaining samples were uniformly distributed throughout the remainder of the Kettle. Discretionary samples were also collected at the direction of Ecology personnel. Sample points were located using a combination of a hand-held GPS unit, lensatic compass, and sketches.

Figure 4-4a. Kettle Sampling Locations

Figure 4-4b. Kettle Sampling Locations

In the dry Kettles, a spade was used to collect sediments, following the same protocols as the upland soil sample collection. For the Kettles containing water, sediment samples were collected from a small push corer that was deployed from a small boat. Care was taken to ensure that the surface sediments were not disturbed in the vicinity before samples were collected.

Upon collection, the core was extruded from the corer onto clean aluminum foil, described in field notes, and photographed. After removing leaves, sticks, and other debris from the top of the core, the surface six in. of the core was collected into an eight-oz. jar. The samples were subsequently treated in the same fashion as described in Section 4.2 for soil samples.

4.4.2 SURFACE WATER SAMPLES

Water samples were collected from each of the four Kettles containing surface water. Water samples were collected in two ways. In the Northwest and Southeast Kettles, the water was shallow, and in these Kettles, the samples were collected directly into amber one Liter glass bottles. Care was taken to collect water beneath the surface, but above the Kettle sediments, in order to prevent inclusion of sediment or surface debris. In the Northeast and Central Kettles, samples were collected from a boat using a horizontal Van Doren-type sampler. The sampler was closed mid-column in the Kettle water, similar to the technique described above, to collect water without surface debris or sediments. Because the South and North Kettles were dry at the time of this investigation, no water samples were collected.

5.1 SAMPLING METHODOLOGY, HANDLING, PRESERVATION, ANALYSIS, AND DERIVED WASTE

Sampling methods and handling procedures were described in detail in the *Revised Draft Remedial Investigation Feasibility Study Work Plan* (ENTRIX, 2005). The following is a brief description of analytical methods.

5.1.1 CHLORINATED PESTICIDES AND HERBICIDES

Chlorinated pesticides were analyzed according to requirements of EPA Method 8091a. Reporting limits in soil are 3.5 μg/Kg (parts per billion) for dieldrin, DDD, DDT, and DDE. Reporting limits in water are approximately 0.025 μg/L (parts per billion).

5.1.2 POLYCHLORINATED BIPHENLS (PCBS)

As noted in Section 2.5.2, certain interferences observed in pesticide analyses of soil samples were caused by and used as indicators of the presence of elevated PCB concentrations. When these interferences were present, the samples were re-analyzed using Method 8082 to determine the composition and concentration of total PCBs as the sum of detected Aroclor® mixtures. The primary methodology for extraction used in the analysis was sonication (EPA Method SW 3550B). At the request of Ecology, some samples were extracted using Soxhlet (EPA Method SW 3540C). After June 17, 2005 all PCB samples were extracted using the Soxhlet Method. Routine reporting limits for these analyses are 130 μg/Kg for each kind of Aroclor® (*e.g.*, Aroclor® 1254). Actual reporting limits varied from approximately 40 μg/Kg to 250 μg/Kg, and occasionally higher for an individual Aroclor®, depending on sample conditions. In addition, four groundwater samples were analyzed for PCBs using Method 8082 with detection limits of approximately 0.01 to 0.05 μg/L, depending on the particular Aroclor®.

5.1.3 COPPER AND CHROMIUM

Copper and chromium were analyzed according to the requirements of EPA method 6020 for sediment, soil, surface water, and groundwater matrices. The laboratory equipment was calibrated so that additional metals can be reported in the future if deemed necessary. The reporting limit for copper is approximately 10 mg/kg in soil. The reporting limit for copper in water is approximately 0.01 mg/kg.

5.1.4 PETROLEUM HYDROCARBONS

Petroleum hydrocarbons were analyzed according to the requirements of NWTPH-Gx (toluene through C_{12}) and NWTPH-Dx including diesel range (C_{12}-C_{24}), and heavy oil (C_{24}-C_{40}). Diesel reporting limits are 25 mg/Kg in soil and 0.25 mg/L in water. Heavy oil reporting limits are 100 mg/Kg in soil and 0.50 mg/L in water.

5.1.5 Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans (PCDD/Fs)

PCDD/Fs were analyzed using the isotope dilution, multimedia EPA method 1613B for the seventeen 2,3,7,8-substituted tetra- through octa- PCDDs) and dibenzofurans (PCDFs) and for total tetra- through hepta- PCDD and PCDF homologues in surface water and sediment matrices.

Detection limits using this procedure were generally highest for the octa-chlorinated compounds and decreased with decreasing chlorination. In sediments, detection limits ranged from 3.5 to 15 picogram/g (pg/g) for 1,2,3,4,6,7,8,9-octachlorodibenzodioxin (OCDD) and 2.0 to 6.7 pg/g for 1,2,3,4,6,7,8,9-octachlorodibenzofuran (OCDF), decreasing to 0.37 to 1.0 pg/g for different tetrachlorodibenzodioxin (TCDD) congeners and 0.28 to 1.3 pg/g for different tetrachlorodibenzofuran (TCDF) congeners. In water, detection limits decreased from 5.5 to 19 pg/L for OCDD and 2.9 to 15 pg/L for OCDF to 0.92 to 2.1 pg/L for TCDD congeners and 0.84 to 1.7 pg/L for TCDF congeners.

5.1.6 Herbicides

Chlorinated herbicides analysis was conducted according to the requirements of EPA method 8151 for sediment, soil, surface water, and groundwater matrices. Reporting limits vary, for example, ranging from 8.7 µg/kg for 2,4,5-TP (Silvex), to 18 µg/kg (Dinoseb, Dicamba) to 35 µg/kg (2,4-D and Dichloroprop) to 18,000 µg/kg (MCPA) in soil. Reporting limits for the same herbicides in water range from approximately 0.1 to 10 µg/kg.

5.2 Data Management and Quality Assurance Review

The overall quality assurance (QA) objective was to develop and implement procedures for field sampling, chain-of-custody, laboratory analyses, and reporting that provided legally defensible results and were of sufficient quality to support a risk assessment.

5.2.1 Field Methods

Field duplicate, laboratory duplicate, laboratory control sample, quality control (QC) check samples, and matrix spike samples were analyzed to assess the quality or heterogeneity of the data resulting from the field sampling and laboratory analytical programs.

Method blank samples were generated within the laboratory and were used to assess contamination resulting from laboratory procedures. Field duplicate samples were analyzed to check for sampling and analytical reproducibility. Matrix spikes provided information about the effect of the sample matrix on the preparation and measurement methodology. Matrix spikes were performed in duplicate.

The planned level of the QC effort included one field duplicate for every ten or fewer investigative samples; this goal was reasonably met for dieldrin and other pesticides (9% and 11%, respectively), copper and chromium (13%), PCDD/PDCF (20%), and total petroleum hydrocarbon analyses (11%). Other analyses were conducted infrequently and field duplicate samples were not collected or submitted for analysis.

One matrix spike/matrix duplicate (MS/MSD) was analyzed for every batch of samples analyzed for organic compounds. One MS sample was analyzed for every batch of samples analyzed for metals, which was standard laboratory procedure.

Field logbooks provided the means of recording data collecting activities performed. Logbooks were assigned to field personnel and stored with the project files. Associated with each surficial soil (grid) sample and Kettle sediment sample was a sample record sheet, which identified the sample and its collection date and location. Relevant field notes were also included. The sample was photographed, along with the sample record sheet. The sheets and photographs were also retained in the project files.

5.2.2 LABORATORY METHODS

Each laboratory logged samples according to standard operating procedures for tracking samples. Final data reports provide a copy of the completed chain-of-custody forms as well as forms showing the correlation between laboratory identification numbers and chain-of-custody identification numbers for each sample.

The laboratory has a QC program used to ensure the reliability and validity of the analysis performed at the laboratory. The internal quality control checks may vary slightly for each individual procedure.

All data were properly recorded. The data package provided to ENTRIX included a summary of QC data and most included backup data (depending on the particular analysis). Any samples analyzed in nonconformance with QC criteria were re-analyzed by the laboratory, if sufficient volume was available.

5.2.3 DATA QUALITY ASSURANCE REVIEW

ENTRIX has conducted an independent data QA review of all data reported by laboratories. The level-of-effort for these reviews corresponded to the level of detail that can be provided by the laboratory.

For organic compounds and metals (*i.e.*, pesticides, PCDD/Fs, copper, and chromium) full data packages were requested, including instrument calibration. The findings were summarized in a brief QA review report (Appendix H) to document appropriate qualification of the data values after resolution of any discrepancies with the laboratory and any re-analyses that might have been completed.

For TPH analyses, a more limited review was conducted because those data packages are typically limited to a laboratory-provided summary of their own QC data without the ability to verify that summary from the original data. This QA review was also summarized in a brief report that documents any appropriate qualification of the data values.

This section summarizes results from characterization sampling and analyses in preparation for developing work plans for any of the subsequent assessments or interim remedial action.

6.1 DECOMMISSIONING OF SITE FACILITIES

In the case of the decommissioned facilities, samples were not collected for characterization prior to demolition. Characterization and confirmatory soil samples were collected during the decommissioning activities. The Site Facilities described below are located as shown in Figure 4-1. A table of results is presented following each facility discussion.

6.1.1 FERTILIZER INJECTION SHED TANK CRIB AND PETROLEUM USTS

In late June 2004 the Fertilizer Injection Shed Tank Crib was decommissioned. Soils beneath the tank crib liner were discolored with a green tint. ENTRIX removed samples of the discolored soils and analyzed them for chromium, copper, thallium, herbicides, and pesticides. Copper concentrations exceeded the most restrictive MTCA standard. The soils were excavated for appropriate disposal. Prior to disposal at the Thurston County landfill in Lacey, Washington, the samples were subjected to TCLP analysis for priority metals at the request of the landfill. The TCLP results were acceptable for disposal at the landfill.

From August 3 through 11, 2004, the decommissioning of six abandoned USTs located in the main operations area occurred. After appropriate shoring was completed, the USTs were inspected and extracted for disposal as scrap metal. Approximately 515 tons of petroleum contaminated soils (PCS) were removed from the six UST locations. All PCS were profiled for disposal prior to transport to TPS, Inc. in Lakewood, WA. The excavations were filled with clean fill material from TPS, Inc.

No wet or moist soils due to groundwater occurrence were encountered throughout the excavation activities.

Soil samples were collected from the UST excavations, sidewalls, and bases. The samples were collected directly from the center of the excavator bucket. Soil samples containing petroleum hydrocarbons above the MTCA Method-A Cleanup Levels were flagged and the corresponding areas of the excavation pit were overexcavated 1 to 2-ft. After overexcavation, appropriate confirmation samples were collected and analyzed for total petroleum hydrocarbons. Refer to the diagrams presented in the UST report attached as Appendix B for the locations and depths of the samples.

All soil samples collected on August 3 and 4, 2004 were analyzed onsite by Libby Environmental mobile lab services. The remaining soil samples were delivered to Libby Environmental for laboratory analysis. The soil samples were analyzed for TPHs in the gasoline range, Gasoline & BTEX (NWTPH-Gx/BTEX), Diesel and Oil (NWTPH-Dx/Dx

Extended) and Lead (EPA Method 7010). Each confirmation soil sample was non-detect or below MTCA Method-A Cleanup Levels.

6.1.1.1 Shop Heating Oil UST

One abandoned, Diesel #2 UST was removed from the southeast corner of the former shop. The UST was single-wall steel with an approximate 500-gallon storage capacity with no corrosion protection and was in poor condition with signs of corrosion and failure. The subsurface materials in the initial 6-ft deep excavation appeared to be petroleum stained and had a strong odor of degraded diesel fuel.

Soil samples were collected from the excavation base to identify the levels of diesel range petroleum hydrocarbons (DRPH). Samples were collected from the stockpiled soils collected from the base and sidewalls of the excavation. All samples contained elevated levels of DRPH above MTCA Method-A Cleanup Levels.

The excavation was continued until sidewall and base confirmation soil samples results were below MTCA Method-A Cleanup Levels for DRPH (See Table 6-1). The final excavation extended 22-ft running north and south and 33-ft running east and west. The final depth of the excavation ranged from 10 to 17-ft bgs. The soils consisted of brown sandy loam with gravel to 5-ft bgs. Soils below 5-ft to the base of the excavation consisted of gray sand with compacted sandy clay layers at 6 and 10-ft bgs.

6.1.1.2 Boiler USTs (P1 UST)

One Diesel #2 UST and two Bunker C USTs were removed from the boiler area at P1. The tanks were used to supply fuel to the boiler and were located south of the former boiler.

After appropriate shoring of the 5 to 13-ft deep excavation was completed, the USTs were inspected and extracted for disposal as scrap metal. The approximately 800-gallon single-wall steel diesel #2 tank was in fair condition with no signs of corrosion and/or failure. The two approximately 1,200-gallons Bunker C tanks were double-wall steel with an interstitial space. No evidence of corrosion was observed. However, PCS were observed beneath the diesel #2 tank at approximately 5-ft bgs.

Soil samples were collected from the excavation base to identify the levels of DRPH. Samples were collected from the stockpiled soils collected from the base and sidewalls of the excavation. All samples contained elevated levels of DRPH above MTCA Method-A Cleanup Levels. The excavation was continued on various dates until final confirmation soil sample results (from the walls and base of the excavation) for DRPH were below MTCA Method-A Cleanup Levels (Table 6-1).

Table 6-1. Heating Oil Tank Removal

Sample ID #	Sample Date	TPH-Gx (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	EthylBenzene (mg/kg)	Xylenes (mg/kg)	TPH-Dx (mg/kg)
standard[a]		100[b]	0.03	7.0	6.0	9.0	2000
Shop Fuel Oil Tank							
Shop-01	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-02	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-03	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-04	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-05	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-06	8/10/2004	NA	NA	NA	NA	NA	250
Shop-07	8/10/2004	NA	NA	NA	NA	NA	nd
Shop-08	8/11/2004	NA	NA	NA	NA	NA	630
Shop-09	8/11/2004	NA	NA	NA	NA	NA	nd
Shop-10	8/11/2004	NA	NA	NA	NA	NA	790
Shop-11	8/11/2004	NA	NA	NA	NA	NA	515
P1 Heating Oil Tanks							
P1-1	8/6/2004	u	u	u	u	u	u
P1-2	8/6/2004	u	u	u	u	u	u
P1-3	8/6/2004	u	u	u	u	u	u
P1-4	8/6/2004	u	u	u	u	u	u
P1-5	8/6/2004	u	u	u	u	u	u
P1-6	8/6/2004	u	u	u	u	u	u
P1-7	8/6/2004	u	u	u	u	u	u
P1-8	8/6/2004	u	u	u	u	u	u
P1-9	8/6/2004	u	u	u	u	u	u
P1-10	8/6/2004	u	u	u	u	u	u

a - MTCA Method A Soil Cleanup Values (Ecology 2001)
b - w/o benzene
u - not detected
NA - not analyzed

The final excavation extended 56-ft running north and south and 19-ft running east and west; the final depth of the excavation varied between 5 and 13-ft bgs. The soils consisted of brown sandy loam with gravel to 6-ft bgs. The soils below 6-ft bgs consisted of grayish brown sand with poorly graded gravels.

6.1.1.3 Diesel and Gasoline USTs

One 1,000-gallon diesel UST and one 1,100-gallon gasoline UST, along with the associated pump island were removed from the site. Both USTs were single-wall steel. No evidence of corrosion protection was observed.

The tanks were removed from the approximately 8-ft deep excavation for disposal as scrap metal. The gasoline tank was in good condition and did not show signs of extensive corrosion or failure. The diesel tank showed minor signs of corrosion and seam failure. The subsurface materials in the excavation appeared to be petroleum stained and had a strong odor of gasoline and diesel fuel starting at approximately 2.5-ft bgs.

Based on observation, the PCS appeared to have originated from historical overfills. Slight odors of diesel and gasoline fuel were observed immediately beneath the two product dispensers. The areas were excavated and the removed soil was stockpiled for appropriate disposal. The excavation was continued until sidewall and base confirmation sample results were below MTCA Method A cleanup levels for GRPH, DRPH, and BTEX (Table 6-2). During the excavation, hydraulic oil was encountered in a soil sample extracted beneath the pump island above MTCA Method-A Cleanup Levels. All soil contaminated with hydraulic oil were removed based on follow-up confirmation sampling.

Continued excavation of each sidewall and one to 2-ft at the base prior to collecting confirmation soil samples. The final excavation extended 13-ft running north and south and 33-ft running east and west. The final depth of the excavation varied 5-ft to 9-ft bgs. The soils consisted of brown sandy loam with gravel to 6-ft bgs. The soils below 6-ft bgs consisted of grayish brown sand with poorly graded gravels.

6.1.2 Septic Tanks

Four septic tanks were located in the Main Operations Area. Three of these tanks were excavated and removed, while the septic tank for the Business Office remains on-site. Care was taken to leave as much of this system undisturbed as possible. Once the septic tanks were removed, three discrete soil samples were collected from the bottom of the pit, just under each tank. Two samples were collected from the soils just under the drain gravel at the pipe outlets. Table 6-3 provides results of sampling conducted during demolition and septic tank removal activities. These samples were collected to determine if herbicides, metals, or pesticides had affected soils associated with the septic tanks.

6.1.3 Wash Basins and Other Discretionary Sampling

Several wash basins were located outside the Canning Barn and outside the Chemical Mixing Shed. These basins drained directly to the ground. Another wash basin was located inside the Shop. This basin drained directly to the concrete floor and flowed out to the ground between the Shop foundation and the fuel pump island. Wash basins located inside the personnel office and the lunchroom were piped to makeshift septic tanks and drainage areas buried in the Block House and outside the Shop, respectively.

During the demolition activity, an Ecology representative requested sampling of the drainage areas from the wash basins. The drainage area for the wash basin at the Chemical Mixing Shed was very well defined. A discrete soil sample was collected at that drainage point. The Basin at the Canning Barn drained to an asphalt surface. Water was poured from the area of the drain to determine the actual flow from that point. Once the drainage area was established to Ecology's satisfaction, a composite soil sample was collected from the primary drainage area. The drainage area for the wash basin located inside the Shop had been disturbed because of the UST excavation already underway. The top three feet of soil had been set aside in a separate stockpile. The stockpile was sampled as a composite sample. All results indicate concentrations were either not detected or below MTCA Method B standards for Unrestricted Land Use (Table 6-4 and 6-5).

Table 6-2. Gasoline and Diesel Underground Storage Tank Removal -- Confirmation Sampling

Sample ID #	Sample Date	TPH-Gx (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	EthylBenzene (mg/kg)	Xylenes (mg/kg)	TPH-Dx (mg/kg)	Hydraulic Oil (mg/kg)	TPH-Oil (mg/kg)	Lead (mg/kg)
standard[a]		**100[b]**	**0.03**	**7.0**	**6.0**	**9.0**	**2000**		**2,000**	**250**
Gas and Diesel Fuel Tank and Island										
GD Tank B1	8/3/2004	u	u	u	u	u	NA	NA	NA	6.47
GD Tank B2	8/3/2004	u	u	u	u	u	NA	NA	NA	16.2
GD Tank B3	8/3/2004	u	u	u	u	u	390	NA	NA	12.1
GD Tank B4	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank B5	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank NW1	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank NW2	8/4/2004	u	u	u	u	u	u	NA	NA	89.3
GD Tank NW3	8/4/2004	u	u	u	u	u	u	NA	NA	30.4
GD Tank NW4	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank EW1	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank WW1	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank SW1	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank SW2	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank SW3	8/4/2004	u	u	u	u	u	u	NA	NA	NA
GD Tank SW4	8/4/2004	u	u	u	u	u	u	NA	NA	NA
Stock Gas	8/4/2004	u	u	u	u	u	u	NA	u	NA
Isl-1	8/4/2004	u	u	u	u	u	u	NA	u	13.9
Isl-2	8/4/2004	u	u	u	u	u	u	12000	u	6.36
Isl-3	8/4/2004	NA	NA	NA	NA	NA	u	u	u	5.03

a - MTCA Method A Soil Cleanup Values (Ecology 2001)

b - w/o benzene

u - not detected

NA - not analyzed

Table 6-3. Septic Tanks and Drainfield Samples

Sample ID #	Location Description	Sample Date	Herbicides	Metals		Pesticides
				Cr mg/kg	Cu mg/kg	DDT (ppm)
standard[a]				**240,000**	**2,960**	**2.94**
background[b]				**48.2**	**36.4**	
P1-Drain - 01	Sample at Drainfiled for Septic Tank at P-1	8/6/2004	U	42.0	37.9	U
Canning Drain - 01	Sample at Drainfiled for Septic Tank at the Canning Barn	8/6/2004	U	32.7	47.1	U
674177	N. Excavation wall	8/9/2004	U	33.3	27.8	U
673749	Beneath decomm drain field	8/9/2004	U	29.2	27.4	U
673750	Beneath drum WNW drywell	8/9/2004	U	41.0	35.2	0.011

a - MTCA Method B Unresticted Land Use for Soils (Ecology 2001)

b - background for soils in the Puget Sound region (Ecology 1994)

c - analyzed herbicides -- 2,4,5-TP, 2,4,5-T, Dinoseb, Dicamba, 2,4-D, 2,4-DB, Dalapon, MCPA, Dichloroprop

d - analyzed Pesticides: Dieldrin, DDE, DDD, DDT, gamma-Chlordane, Aldrin, Endosulfan I, Endosulfan II, Endosulfate, Endrin, Endrin Ketone, Heptachlor Epoxide. Only the analytes with detections are shown.

NA - Not Analyzed

U - not detected

Table 6-4. Wash Basin Sampling Results

Sample ID #	Sample Date	Herbicides	Metals		Pesticides				
			Cr (mg/kg)	Cu (mg/kg)	DDT (ppm)	gamma-Chlordane (ppm)	Endosulfan I (ppm)	Endosulfan II (ppm)	Endosulfate (ppm)
standard[a]			**2,000**	**2,960**	**2.94**	**2.86**	**480**	**480**	**480**
background[b]			**48.2**	**36.4**					
Canning barn sink	8/6/2004	U	27.5	179	U	U	U	U	U
Chemical mixing sink (dil)	8/6/2004	U	33.6	88.9	0.15	0.056	0.0092	0.12	0.11
Gas Stockpile (from Shop Sink drainage area)	8/5/2005	U	31.3	30.0	U	U	U	U	U

a - MTCA Method B Unresticted Land Use for Soils (Ecology 2001)

b - background for soils in the Puget Sound region (Ecology 1994)

c - analyzed herbicides -- 2,4,5-TP, 2,4,5-T, Dinoseb, Dicamba, 2,4-D, 2,4-DB, Dalapon, MCPA, Dichloroprop

d - analyzed Pesticides: Dieldrin, DDE, DDD, DDT, gamma-Chlordane, Aldrin, Endosulfan I, Endosulfan II, Endosulfate, Endrin, Endrin Ketone, Heptachlor Epoxide. Only the analytes with detections are shown.

NA - Not Analyzed

U - not detected

In addition to these discretionary samples, samples were collected in other areas where the potential existed for an accumulation of COCs. The results of these samples are provided in Table 6-5.

Table 6-5. Other Discretionary Samples Collected During Demolition

Location Description	Sample Date	Herbicides[c]	Metals		Pesticides					
			Cr mg/kg	Cu mg/kg	Dieldrin (mg/kg)	DDE (mg/kg)	DDD (mg/kg)	DDT (ppm)	gamma-Chlordane (ppm)	Endo-sulfate (ppm)
			2,000	**2,960**	**0.0625**	**2.94**	**4.17**	**2.94**	**2.86**	**480**
			48.2	**36.4**						
Sediment in Catch Basin South of Old Barn	8/11/2004	U	29	98.7	0.007	U	U	0.010	U	U
Sediment at Outfall from Barn Catch Basin in ditch along Henderson Blvd	8/11/2004	U	33.4	444	U	U	U	U	U	U
Actually taken at Chemical Mixing Shed Error in field resulted in mis-name	8/11/2004	U	31.0	917	U	U	0.064	0.320	U	0.066
Irrigation Valve Box at the Fertilizer Injector Shed	8/12/2004	NA	38.0	1,020	U	U	U	U	U	U
Irrigation Valve Box at the Fertilizer Injector Shed	8/12/2004	U	51.0	2,050	U	U	U	U	U	U
Soil Sample from beneath the Concrete Pad at the Fertilizer Injector Shed	8/11/2004	U	43.0	167	U	U	U	0.013	U	U
Soil Sample Under Fertilizer Injector Bin	7/1/2004	U	46.0	1310	U	U	U	0.012	U	U
Soil Sample Under Fertilizer Injector Bin	7/1/2004	U	43.0	843	U	U	U	0.018	U	U
Soil Sample Under Fertilizer Injector Bin	7/1/2004	U	35.0	466	U	U	U	0.026	U	U
Sample Collected from Blockhouse Floor	8/6/2004	NA	30.4	34.5	0.13	0.0037	0.02	0.26	0.026	U

d Land Use for Soils (Ecology 2001)

uget Sound region (Ecology 1994)

TP, 2,4,5-T, Dinoseb, Dicamba, 2,4-D, 2,4-DB, Dalapon, MCPA, Dichloroprop

n, DDE, DDD, DDT, gamma-Chlordane, Aldrin, Endosulfan I, Endosulfan II, Endosulfate, Endrin, Endrin Ketone, Heptachlor Epoxide.

tions are shown.

6.1.4 ABANDONED SUMP INVESTIGATION

As previously discussed, due to historical changes in the locations of buildings, greenhouses and access paths at the nursery, former and current site workers were unable to place the exact location of a former sump gallery and could not recollect if the drums had been removed during the site renovations. Further, exploratory excavations within the identified sump area did not uncover the abandoned sump described by the former employee. NGA then conducted a ground penetrating radar survey at the Briggs Nursery on October 21, 2004. The objective of the survey was to conduct a broad and then detailed sweep of an approximate 130 by 170-ft rectangular area.

The findings of the GPR survey by NGA are described in their November 8, 2004 report, provided as Appendix C. The report identified four anomalous areas (referenced as Areas A, B, C, and D in the report) of disturbed soils. None of the anomalies in these areas bear a resemblance to a collection of plastic or metal drums. These anomalies were described as follows:

- Briggs' site personnel identified Area A as the most likely area for buried drums, and during site demolition activities excavations occurred in this area in search of the drums. NGA reported that the anomalous features discovered in Area A were consistent with extensive soil disturbance (*i.e.*, the previous excavations) down to a depth of 4 to 6-ft bgs, but that the excavations did not appear to reach the "sand" horizon at 7 to 9-ft bgs. No strong reflections at any depth, however, such as would be expected from plastic or metal drums were observed in this Area. Based on the near-surface site stratigraphy, the limited excavations, and the GPR survey, it is evident that if the drums were installed and/or buried in Area A, then they were subsequently removed.

- Anomalous Area B is also characteristic of a former excavation. Based on the GPR signatures, several horizons at depths of 5 to 8-ft bgs have been truncated (*e.g.*, possibly by trenching), and GPR signatures at depths shallower than 5-ft bgs possibly represent trenching or buried material piles from an excavation. A poorly resolved single reflective feature, is evident on the north side of this Area at a depth of 7 to 8-ft bgs. None of these features, however, bears a resemblance to a collection of plastic or metal drums.

- Anomalous Area C was also typical of an excavation to a depth of approximately 8-ft bgs. A broad irregular feature was evident on the north side of the excavation, but it did not have the signature of a collection of plastic or metal drums.

- In Area D, disturbed soils were evident to a depth of 10 to 12-ft bgs, but no drum-like features were present.

6.2 SURFICIAL SOILS

Surficial soil samples were initially collected on a 200-ft grid for most of the uplands within Areas 1 and 2 and a 100-ft grid near the central working portion of in Area 2. All soil samples were analyzed for pesticides using EPA Method 8081A. Select soil samples collected in the Fertilizer Injection Shed area were also analyzed for metals using EPA Method 200.8. Results of the grid sample analyses indicated that soil collected from 12 grid nodes in Work Area 1 had concentrations of dieldrin that exceeded the MTCA Method B cleanup standard for unrestricted land use. Concentrations of metals and other pesticides were either not detected or were below the MTCA Method B cleanup levels in the remaining soil samples. Additionally, PCBs were detected as interference in two surficial soil samples, and their concentrations were determined to be above the MTCA standard. All sample results are provided in Appendix E. These samples-and further delineations of the horizontal and vertical extent of chemicals-whose concentrations were in exceedance of MTCA criteria, were subsequently conducted during an interim remedial action. Those activities are described in Section 8.0 below.

6.3 GROUNDWATER

6.3.1 GROUNDWATER LEVELS

From August 11 to 16, 2004, six boreholes were drilled and completed as monitoring wells on the Briggs property. These are noted as AKB991 to AKB996 in Table 6-6 and on Figure 4-3. Aside from the near surface soils (0 to 5-ft to 10-ft bgs) the lithologies to total depths in all the boreholes were predominantly fine to medium sands with occasional finer (silty) or coarser (coarse sands) zones, consistent with descriptions of Qvr. Although the property is fairly large, the well locations are distributed evenly across the site so that the depth to groundwater can be readily estimated for most of the site.

Except in the Kettles, the surface elevation of the Site ranges from 170-ft to 202-ft msl. The Kettle bottoms range from 117-ft msl in the off-site Kettle to 149-ft msl in the Northeast Kettle. Thus, except in the Kettles, the depth to groundwater based on regional data (as discussed above in Section 2.4) was estimated to range from approximately 45-ft to 80-ft below the ground surface (or at elevations ranging from 117-ft to 125-ft msl).

Table 6-6. Groundwater Elevations in Monitoring Wells

Well No.	Aug 24, 2004		Jan 31, 2005		Apr 6, 2004		July 11, 2005	
	Depth to GW	GW Elev	Depth to GW	GW Elev	Depth to GW	GW Elev	Depth to GW	GW Elev
	ft bgs	*ft msl*	*ft bgs*	*ft msl*	*ft bgs*	*ft msl*	*ft bgs*	*ft msl*
AKB991	87.6	109.5	90.5	106.6	90.0	107.1	90.1	107.0
AKB992	89.2	110.4	89.7	109.9	89.7	109.9	89.6	110.0
AKB993	33.8	106.8	34.6	106.0	34.5	106.1	34.2	106.4
AKB994	82.6	109.5	83.5	108.6	83.5	108.6	83.3	108.8
AKB995	68.4	112.2	69.0	111.6	68.9	111.7	68.8	111.8
AKB996	86.1	106.0	86.4	105.7	86.4	105.7	86.4	105.7

The depth to water in all the monitoring wells was initially measured on August 24, 2004 and then again in January, April, and July 2005 (Table 6-6). The water levels of Ward Lake and the Central Kettle pond were surveyed on August 25, 2004 (Table 6-7). The drilling and water level data indicated five principle findings:

- Groundwater occurred in relatively high transmissive soils (fine to medium well-sorted sands of Qvr).
- The groundwater table was encountered at elevations ranging from 106 to 112-ft bgs. These measured water levels in the wells were 5 to 10-ft lower than that suggested from the regional data.
- Measured groundwater elevations have varied only slightly during the four monitoring events. All but AKB991 have fluctuated from 0.3 to 0.9-ft, whereas AKB991 has fluctuated up to 2.9-ft. Of the four monitoring events, groundwater elevations were highest in August 2005 just after they were completed. Similarly in all cases, the minimum groundwater elevations occurred during the January 2005 monitoring event.
- In August 2005, the groundwater table sloped regularly and gently to the west at approximately 0.2 to 0.3%. Since then, for the next three monitoring events, the groundwater table has sloped at about the same gradient but towards the northwest and west, responding to the larger relative drop in the AKB991 groundwater elevation.
- The August 2005 Central Kettle pond water level was about 7 to 11-ft above the surrounding groundwater table.
- The August 2005 Ward Lake water level of 119.3-ft msl was about 7-ft higher than the water level elevations measured in the well AKB995 nearest to the lake (at 11.6 to 112.2-ft msl).

Table 6-7. August 25, 2004 Water Levels of Surface Water Bodies

Water Body	Estimated Depth (ft)	Water Level Elevation (ft msl)
Ward Lake[1]	30 to 50	119.3
Central Kettle[2]	7 to 8	117.1

1 - Along southwest shoreline approx. 200-ft southeast of AKB995.

2 - Near center of pond

6.3.2 GROUNDWATER SAMPLING

On August 24, 2004, groundwater samples were collected from each of the six monitoring wells and were then analyzed for herbicides, metals, and pesticides. An additional sampling round occurred on July 11, 2005. The results indicated that PCBs, herbicides, pesticides and metals (chromium and copper) were all non-detected (Table 6-8).

Table 6-8. Groundwater Well Sampling Results.

Well ID	Location	Pesticides[a]	Metals[a]		PCBs[b]
			Cu	Cr	
AKB991	In Area 1 between the Northwest and North Kettles approximately 700 ft west of Henderson Blvd and 225 ft south of the northern property boundary.	U	U	U	U
AKB992	At the west edge of Area 2, approximately 400 ft southeast of Central Kettle, and 400 ft northeast of South Kettle.	U	U	U	U
AKB993	In Area 1 approximately 100 ft west of Central Kettle and 250 ft east of western property boundary.	U	U	U	U
AKB994	At the west edge of Area 2 and approximately 400 ft east of Central Kettle.	U	U	U	U
AKB995	In Area 3 approximately 200 ft west of Ward Lake and 300 ft south of the Northeast Kettle.	U	U	U	U
AKB996	In Area 1 approximately 800 ft north of Yelm Hwy along the western property boundary.	U	U	U	U

a - samples collected in August 26, 2004 were analyzed for pesticides and metals

b - samples collected in July 11, 2005 were analyzed for PCBs

U - not detected

d - analyzed pesticides: Dieldrin, DDE, DDD, DDT, gamma-Chlordane, Aldrin, Endosulfan I, Endosulfan II, Endosulfate, Endrin, Endrin Ketone, Heptachlor Epoxide. Only the analytes with detections are shown.

6.4 KETTLES

Sediment and water samples collected from the Southeast and Central Kettles in October 2003 were analyzed for PCDD/Fs. Sediment and water samples were collected from all six Kettles in August 2004 during RI activities, and these samples were analyzed for PCDD/Fs, grain size, and total organic carbon (TOC). ENTRIX also collected soil and surface water samples from Henderson Boulevard adjacent to the Southeast Kettle in March 2004 (ENTRIX 2004).

Additional sediment and water samples were collected from the Kettles in December 2004 and analyzed for chlorinated pesticides. TOC samples were collected in December 2004 from the same locations on Henderson Boulevard as where PCDD/Fs samples were collected. These data are provided in Appendix E and are summarized below in Section 7.4.

7.1 SITE FACILITIES

Between August 3 through 11, 2004, six abandoned USTs, four septic tanks and several wash basins were excavated, decommissioned, and removed from the main operations area. During these activities, approximately 515 tons of petroleum-hydrocarbon affected soils were excavated and delivered to a disposal facility. All excavations were well above the groundwater table (based on the drilling results described in Section 6.3, the deepest excavation was at least 65-ft above the water table) and no perched zones were evident in any of the excavations. Confirmatory samples were also collected from each excavation's sidewalls and bases to demonstrate that each pit was cleaned up to MTCA soil standards. No further action is recommended.

With regard to the purported abandoned sump, the results of the GPR survey, the near-surface site stratigraphy, the excavations conducted during site demolition activities, and discussions with site personnel, it is evident that if a collection of drums was installed and/or buried in the area of investigation at the Briggs Nursery, then the collection has since been removed. No further action is recommended.

7.2 SURFICIAL SOILS

Surficial soil samples were collected on a 200-ft grid (most of the upland areas) or a 100-ft grid (near the central working portion of Work Area 2) across most of the Site. Samples containing dieldrin and/or PCBs at concentrations above MTCA unrestricted land use standards were identified at 12 of over 100 grid nodes in Work Area 1. Based on these results an interim remedial action was undertaken, which is described in detail in Section 8.0.

7.3 GROUNDWATER

7.3.1 GROUNDWATER LEVELS

Based on regional groundwater data and hydrogeological information regarding the unconfined nature of the aquifer in the Qvr deposits, the water table likely fluctuates a minor amount over the short-term (seasonal to annual) and perhaps a significant amount (up to 5-ft) over the long-term (decadal). Although, there are no long-term water level data for the site, the water table may be expected to be lowest following long drought periods and highest following a period of successively rainy years. Based on data collected in August 2004 and January, April, and July 2005, water levels varied from 0.3 to 0.9-ft in five of the wells and 2.9-ft in well AKB991. These fluctuations did not have any obvious seasonal connection with precipitation, as the highest elevations were observed in the drier summer (August) and the lowest were observed in the wetter winter (January).

The amount of potential water table variation at the Site is not known with specificity. Based on USGS topographic data for Ward Lake, the lake water elevation was historically over 5-ft higher than the elevation surveyed in August 2004. It is therefore reasonable to assume that a long period of wet years could increase the water table elevation by at least 5-ft. This suggests then that a slightly higher water table could also potentially intersect the bottom of the South Kettle (*i.e.*, a water table elevation of > 115-ft msl is plausible), but it is also very clear that an increase of 20-ft or more is improbable so that none of the other Kettles (Northwest, North, Northeast, and Southeast) would ever be in direct hydraulic connection with the groundwater table.

7.3.2 Groundwater Flow and Potential Interaction with the Kettles

Based on field observations and discussions with local residents, the depth of Ward Lake is estimated to range from 30 to 50-ft (or from about 67 to 87-ft msl), which indicates that the lake would intersect the regional water table. Furthermore, the 7+ ft of head that Ward Lake has above the water table (along the lake's west margin and including monitoring well AKB995) suggests that while Ward Lake is recharging (or losing to) the regional aquifer, the hydraulic connection between the lake water body and the regional water table is likely retarded somewhat by a layer of fine-grained sediments (*i.e.*, silts and clays) that have settled on the lake bottom (*i.e.*, a skin effect). Further, due to the westerly-sloping groundwater table, it is possible that Ward Lake's apparent 7-ft higher level may also be due to the effect of the intersection of a flat surface water body with a sloping water table, in which the lake water surface will be lower at the upgradient end and higher at the downgradient end. There are no upgradient well data, however, to confirm this.

In contrast, except for the Central Kettle, the bottoms of all the Kettles on the Briggs site are well above the measured groundwater table. Table 7-1 summarizes the August 2004 conditions and indicates that the bottom elevations of the South, Northwest, North, Northeast and Southeast Kettles were at least 5, 20, 47, 22 and 31-ft above the site groundwater table, respectively. Since the highest levels were observed in August 2004, this condition has persisted since monitoring began.

The bottom elevation of the Central Kettle (109 to 110-ft msl) is approximately the same as or a little higher than the groundwater table (106.5 to 109.5-ft msl). Thus, as is with Ward Lake, the slightly higher pond water level (117.2-ft msl) suggests that while the Central Kettle may be recharging the regional aquifer, fine-grained sediments may retard the hydraulic connection between the pond water body and the water table.

Table 7-1. Groundwater and Kettles, August 2004.

Kettle	Condition	Kettle Bottom Contour or Pond Level Elevation (ft msl)	Assumed Kettle Bottom Elevation (ft msl)	Estimated Groundwater Levels August 2004 (ft msl)	Height Difference Between Kettle Bottom and Water Table (ft)
North	Dry	165	> 160	110 to 113	47 to 50
Southeast	Mostly Dry	150	> 145	111 to 114	31 to 34
Northeast	Marsh and Pond	150[c]	> 135[d]	110 to 113	22 to 25
Northwest	Dry	135	> 130	107 to 109.5	20 to 23
South	Dry	120	> 115	106.5 to 110	5 to 8
Central	Pond	117[a]	109 to 110[b]	106.5 to 109.5	-7 to –10[e]

a) Water surface elevation
b) Depth of water estimated to be 7 to 8-ft during August 2004 sediment sampling program
c) Water surface elevation estimated to be at the bottom contour during August 2004 sediment sampling program
d) Depth of water estimated to be about 10 to 12-ft during August 2004 sediment sampling program
e) Height difference between pond water level elevation and groundwater table elevation

7.3.3 GROUNDWATER SAMPLING

Groundwater samples collected from each of the six monitoring wells distributed across the Site were analyzed for PCBs, herbicides, metals, and pesticides. No PCBs, herbicides, pesticides, or metals (chromium and copper) were detected in any of these samples. Given these results, in combination with the knowledge that the water table is over 80-ft below most of the upland areas (that is, a vadose zone over 80-ft thick), there is no indication of any historical or potential effect to groundwater from the Site activities. No further investigation is warranted.

7.4 KETTLES

In August and December 2004, sediment and water quality conditions from the six on-site Kettles were characterized to help evaluate potential risks to human health. Sediment samples from six kettles and water samples from four Kettles (the Southeast, Northwest, Central, and Northeast Kettles) were analyzed for PCDD/Fs, grain size, and TOC. The significance of the findings summarized and tabulated in Section 6.4 for PCDD/Fs and chlorinated pesticides are discussed below.

7.4.1 PCDD/Fs in Kettles

PCDD/Fs are discussed in the following order:

- An introduction to PCDD/Fs;
- A summary of PCDD/Fs profiles from the Briggs Nursery Kettles, nearby streets and highways, and relevant PCDD/Fs sources as reported in the referenced literature;
- An analysis of the concentrations of PCDD/Fs within the Kettles and from sampling locations in a nearby street, normalized by the concentrations of TOC (OC-normalized concentrations) found at the various sampling locations;
- A comparison of the concentrations of PCDD/Fs found in the Briggs Nursery Kettles to typical urban background PCDD/Fs concentrations in Washington State as reported by Ecology; and
- A comparison of the contributions to each Kettle from street and highway runoff and runoff from the Briggs Nursery, indicating that the North Kettle bottom soils provide a representation of PCDD/Fs originating solely from the Briggs Nursery upland operation areas.

7.4.1.1 Introduction to PCDD/Fs

PCDD/Fs are ubiquitous in the environment and are formed in many chemical processes, including the combustion of gasoline and diesel fuels in engines, emissions from oil and wood burning, and incineration of household and other wastes. They may be detected in soil samples from remote, pristine areas of Alaska (Peek, *et al.* 2002). Their presence is, therefore, not a direct indication that Site activities produced substantial quantities of PCDD/Fs.

PCDD/Fs concentrations are typically reported by congener. Each congener is a unique arrangement of four or more chlorine atoms on the two benzene rings of the dioxin or furan compound. Of 209 possible PCDD/Fs congeners, 17 are known to be preferentially retained by organisms and bioaccumulated, and typically, no more than these 17 are analyzed for in samples. These 17 congeners are those used for the calculation of Toxic Equivalency Quotient (TEQ), based on their Toxic Equivalence Factors (TEFs) (WHO 1998). However, for the purposes of recognizing the profile of the PCDD/Fs in a given set of samples, these 17 congeners are only sufficient if:

- Essentially all PCDD/Fs concentrations are found in those 17 congeners across all samples; or
- The proportions of the remaining 209 – 17 = 192 congeners remain essentially unchanged between samples.

With such a limited representation of all possible congeners, the composition of the total PCDD/Fs concentration is typically not well characterized by the 17 TEF congeners.

Another taxonomy of the PCDD/Fs is that the number of chlorine atoms attached to the dioxin or furan rings may be 4, 5, 6, 7, or 8 chlorines on a dioxin or furan compound. Each of these 10 groups is a homologue. While a homologue group can contain several or many congeners[1], in total they are a comprehensive account of all dioxins and furans, unlike the 17 TEF congeners. As importantly, homologue analytical measurements are usually available.

Thus, the profile, or fingerprint, of a particular source of PCDD/Fs may be represented by the composition of its homologues. In the RI, the homologue concentrations for a given sample were normalized by dividing each by the total PCDD/Fs concentration, resulting in the proportion each homologue contributes to the total PCDD/Fs concentration for a given sample. This was done to eliminate the effect of total concentrations differing between samples. Homologues reported as not detected were represented by a concentration equal to one-half of their detection limit. Homologue concentration data were also gleaned from the literature for several potential sources for PCDD/Fs in the Kettles, and these were also normalized, with non-detects reported at one-half of their detection limit.

TOC data allow another comparison of the concentrations of PCDD/Fs in the Kettles, on an organic carbon (OC)-normalized basis. As noted in an Ecology Technical Information Memorandum (Michelsen 1992):

> "Nonpolar contaminants in sediments or water preferentially partition into the organic material in sediments because of the similar chemical nature of the organic material to the nonpolar organic contaminants. Contaminants that form ions, such as acids, bases, phenols, and metals, do not partition as strongly into the organic fraction in sediments."

The memorandum continues that:

> "In addition, because nonpolar organic contaminants are primarily associated with the organic matter in sediments, these contaminants move in the environment along with the organic fraction in sediments and may also move along with suspended organic matter in water. Therefore, gradients of chemical concentration associated with a source may be more easily observed when the data are OC-normalized than when they are presented in dry weight."

The samples collected in March 2004 from Henderson Boulevard could not be analyzed for TOC, as these samples had already been discarded by the laboratory[2]. However, the same field crew who collected those samples returned to the same locations, and using notes and

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[1] With the exception that octa-dioxins and octa-furans are both homologue groups and individual congeners. That is, given that only eight sites are available for attachment of chlorine atoms, there is only one possible way that all eight sites may be occupied.

[2] The samples were discarded because analyses were complete and holding times for dioxin analyses were exceeded. This is a routine procedure.

recollection, collected new samples for TOC analyses[3]. These samples thus allow OC-normalization of PCDD/Fs concentrations on Henderson Boulevard. Sediment samples collected from the Central Kettle and Southeast Kettle in October 2003 were also discarded[4]. Their treatment in the OC-normalized data set is described separately below.

OC-normalized PCDD/Fs concentrations were calculated in a manner consistent with the Ecology 1992 memorandum (Michelsen, 1992) previously quoted. Dry weight PCDD/Fs concentrations were divided by the proportion of TOC measured in the sample. For the Henderson Boulevard samples, the TOC concentrations from the recent samples were used.

7.4.1.2 PCDD/Fs profiles

PCDD/Fs profile graphs for sediment samples from the Site Kettles and soil samples from nearby Henderson Boulevard are shown in Figures 7-1 through 7-7. PCDD/Fs in the samples collected from the Kettles were dominated by octa-dioxins and hepta-dioxins. In soil samples collected from Henderson Boulevard, the proportional contributions of octa-dioxins and hepta-dioxins were very similar to those of the Site Kettles.

The homologue profiles of sediment samples from all of the Kettles closely resembled the profiles of the Henderson Boulevard samples and literature data for urban stormwater.

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[3] The TOC samples were composited over an area of approximately 2 square ft. This was done to make those samples (and their TOC concentrations) representative of the previously collected dioxin samples, which were composited in a similar fashion.

[4] The samples were discarded for the reasons described in footnote 2.

Figure 7-1. Southeast Kettle Sediment PCDD/F Profile

Figure 7-2. Central Kettle Sediment PCDD/F Profile

Figure 7-3. Northeast Kettle Sediment PCDD/F Profile

Figure 7-4. North Kettle Sediment PCDD/F Profile

Figure 7-5. Northwest Kettle Sediment PCDD/F Profile

Figure 7-6. South Kettle Sediment PCDD/F Profile

Figure 7-7. Henderson Boulevard Sediment PCDD/F Profile

Other possible sources of PCDD/Fs in the Kettles were also examined. PCDD/Fs profiles for these sources were based on literature values found in:

- PVC pyrolysis (Thiesen *et al.* 1989),
- Fertilizer (Harrad *et al.* 1991 and Rogowski *et al.* 1999),
- 2,4,5 T herbicides (Wenning *et al.* 1992),
- Pentachlorophenols ("penta") preservative residues (Hagenmaier and Berchtold 1986, Harrad, *et al.* 1991, and NATO 1988),
- Open trash burning (Lemieux 2000), and
- Urban stormwater runoff (Moore *et al.* 1999).

The PCDD/Fs profiles reported in the literature are shown in Figures 7-8 through 13.

Burning pentachlorophenol-treated wood can produce PCDD/Fs homologue profiles similar to those of urban runoff. There is, however, no record of the burning of pentachlorophenol-treated wood at the Site. According to nursery personnel, treated wood was not burned on Site. ENTRIX provided environmental oversight during the excavation of the debris field near the Central Kettle. ENTRIX scientists supervised the classification of excavated debris and sediment for appropriate disposal. They did not report evidence of treated wood, either burned or unburned, during these excavations. Their recollection is that the wood in the debris pile was comprised of mostly tree stumps, with some lumber mixed in. Without any evidence of routine burning of pentachlorophenol-treated wood, street runoff is the most probable source of PCDD/Fs in the Kettle sediments. This conclusion is supported by the differences in PCDD/Fs concentrations between Kettles relative to the different amounts of street runoff they receive, which is discussed below. Further, PCDD/Fs profiles from other sources do not closely match the profiles shown in the Site Kettle data.

Figure 7-8. PVC Burn PCDD/F Profile

Figure 7-9. Fertilizer PCDD/F Profile

Figure 7-10. 2,4,5T Herbicide PCDD/F Profile

Figure 7-11. Pentachlorophenol PCDD/F Profile

Figure 7-12. Trash Burning PCDD/F Profile

Figure 7-13. Stormwater Outfall PCDD/F Profile

7.4.1.3 OC-normalized PCDD/Fs concentrations

In order to include the PCDD/Fs data collected from the Central Kettle and Southeast Kettle in 2003 in this analysis, these data were OC-normalized using the mean TOC concentration reported for each respective Kettle. Summary statistics for the Central Kettle and Southeast Kettle are provided with (Table 7-2) and without (Table 7-3) those OC-normalized 2003 data, along with the data for the remainder of the Kettles and Henderson Boulevard samples.

Table 7-2. Dioxin Summary Statistics 2003 2004

Location	Statistic	Total Dioxins (pg/g)	Total Organic Carbon (%)	Total dioxins - OC (pg/g OC)	TEQs (pptr=pg/g)
Street	N of cases	4	4	4	4
Street	Minimum	3.2E+03	1.3	1.5E+05	9.2
Street	Maximum	9.6E+03	6.0	2.5E+05	33.1
Street	Mean	6.2E+03	3.7	1.8E+05	18.8
SEK	N of cases	11	11	11	11
SEK	Minimum	1.1E+02	2.0	1.9E+03	0.8
SEK	Maximum	5.1E+03	9.6	1.1E+05	16.5
SEK	Mean	1.9E+03	5.8	3.8E+04	6.4
SK	N of cases	6	6	6	6
SK	Minimum	8.9E+01	0.8	1.2E+04	0.7
SK	Maximum	4.9E+03	7.0	1.3E+05	13.1
SK	Mean	2.1E+03	3.3	5.4E+04	6.1
NWK	N of cases	5	5	5	5
NWK	Minimum	1.3E+02	2.5	3.8E+02	0.9
NWK	Maximum	8.1E+02	34.8	3.2E+04	3.4
NWK	Mean	4.2E+02	10.0	1.2E+04	2.0
CK	N of cases	12	12	12	12
CK	Minimum	9.4E+00	21.0	2.7E+01	1.7
CK	Maximum	2.4E+03	46.8	6.9E+03	19.1
CK	Mean	4.0E+02	35.1	1.3E+03	7.5
NK	N of cases	4	4	4	4
NK	Minimum	1.7E+02	2.3	7.3E+03	1.1
NK	Maximum	6.1E+02	5.4	1.1E+04	3.8
NK	Mean	3.4E+02	3.6	8.8E+03	2.1
NEK	N of cases	6	6	6	6
NEK	Minimum	1.4E+03	1.6	8.4E+04	4.5
NEK	Maximum	7.4E+03	5.8	1.8E+05	22.0
NEK	Mean	5.5E+03	3.8	1.4E+05	18.2

Table 7-3. Dioxin Summary Statistics Sediment Samples 2004

Location	Statistic	Total Dioxins (pg/g)	Total Organic Carbon (%)	Total dioxins - OC (pg/g OC)
Street	N of cases	4	4	4
Street	Minimum	3.2E+03	1.3	1.5E+05
Street	Maximum	9.6E+03	6.0	2.5E+05
Street	Mean	6.2E+03	3.7	1.8E+05
SEK	N of cases	4	4	4
SEK	Minimum	1.7E+03	2.0	2.9E+04
SEK	Maximum	5.1E+03	9.6	1.1E+05
SEK	Mean	3.3E+03	5.8	6.9E+04
SK	N of cases	6	6	6
SK	Minimum	8.9E+01	0.8	1.2E+04
SK	Maximum	4.9E+03	7.0	1.3E+05
SK	Mean	2.1E+03	3.3	5.4E+04
NWK	N of cases	5	5	5
NWK	Minimum	1.3E+02	2.5	3.8E+02
NWK	Maximum	8.1E+02	34.8	3.2E+04
NWK	Mean	4.2E+02	10.0	1.2E+04
CK	N of cases	5	5	5
CK	Minimum	2.1E+01	21.0	4.4E+01
CK	Maximum	2.4E+03	46.8	6.9E+03
CK	Mean	8.8E+02	35.1	2.9E+03
NK	N of cases	4	4	4
NK	Minimum	1.7E+02	2.3	7.3E+03
NK	Maximum	6.1E+02	5.4	1.1E+04
NK	Mean	3.4E+02	3.6	8.8E+03
NEK	N of cases	6	6	6
NEK	Minimum	1.4E+03	1.6	8.4E+04
NEK	Maximum	7.4E+03	5.8	1.8E+05
NEK	Mean	5.5E+03	3.8	1.4E+05

The three Kettles with substantial runoff originating from major arterial streets (Northeast Kettle, South Kettle, and Southeast Kettle) had the highest mean concentrations of total PCDD/Fs, calculated on a dry weight basis. These mean concentrations were lower than that for the Henderson Boulevard samples. The remaining three Kettles (Northwest Kettle, Central Kettle, and North Kettle) had lower mean total PCDD/Fs. This distribution of PCDD/Fs concentrations is consistent with our knowledge of the history of runoff contribution to the various Kettles.

The OC-normalized total PCDD/Fs concentrations further support this conclusion based on the total, dry-weight concentrations. The mean OC-normalized PCDD/Fs concentration in Henderson Boulevard samples, 1.8 E+05 pg/g OC, was higher than those means in the Northeast Kettle, South Kettle, and Southeast Kettle, which were 1.4 E+05, 5.4 E+04, and 6.9 E+04 pg/g OC, respectively. The Northwest Kettle, Central Kettle, and North Kettle had mean concentrations of 1.2 E+04, 2.9 E+03, and 8.8 E+03 pg/g OC, respectively. These

OC-normalized means, like the dry-weight basis means, are also lower relative to the Kettles receiving substantial street runoff.

When the mean OC-normalized PCDD/Fs concentrations for the Central Kettle and Southeast Kettle were calculated by applying the mean TOC concentration for each Kettle to its respective PCDD/Fs data, including October 2003 data, the results were similar. With the additional data, the OC-normalized PCDD/Fs means for the Southeast Kettle and Central Kettle are 3.8 E+04 pg/g OC and 1.3 E+03 pg/g OC, respectively. With the 2003 data, the mean for the Southeast Kettle became the lowest of the Kettles receiving substantial street runoff, but otherwise, the relative concentration relationships described above did not change.

The Kettles that receive substantial street runoff (Northeast Kettle, South Kettle, and Southeast Kettle) had TOC sample means (3.8, 3.3, and 5.8%, respectively) that were comparable to those of the Henderson Boulevard samples (3.7%). This fact, in combination with the lower PCDD/F means in the Kettles, is further evidence that no Site-related sources of organic carbon containing PCDD/Fs are entering into the Kettles, and that their PCDD/Fs reflect street runoff.

7.4.1.4 Typical urban PCDD/Fs concentrations in Washington State

Another way to represent PCDD/Fs concentrations is by their TEQ, which is calculated by multiplying the concentrations of the 17 dioxin and furan congeners discussed above in Section 7.4.4.1 by their toxicity equivalent factors (TEFs) that express their toxicity relative to 2,3,7,8 TCDD. The Ecology 1999 publications on metals and dioxins data in Washington provide PCDD/Fs concentrations in TEQs (Rogowski *et al.* 1999a, Rogowski *et al.* 1999b). TEQs for all of the Kettles and Henderson Boulevard provide the data to allow comparison to the Ecology statewide data set.

In the Rogowski *et al.* reports, samples were collected from throughout the state from locations in urban, open, forest, and agricultural land use. The urban sample data are the most appropriate for comparison to the Kettle data, because the Site is near arterial streets and a city. Also, the Kettles' sediments have not been substantially disturbed.[5] As Rogowski *et al.* (1999b) noted in the Addendum, agricultural soils may have lower PCDD/Fs concentrations because of their distance from urban areas (where many sources of PCDD/Fs originate) and because the soils are tilled (which reduces concentrations by dilution of the PCDD/Fs deposited on the surface soils).

In Rogowski *et al.* (1999b), the mean TEQ for n=14 urban soils samples was 5.7 parts per trillion (pptr = pg/g), with a range of 0.64 – 22 pptr[6]. The mean TEQs of the Kettle samples were either comparable or lower (means ranged from 2.0 to 7.5 pptr TEQ), with the exception of the Northeast Kettle, where the mean TEQ concentration was 18.2 pptr[7].

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[5] There is anecdotal evidence that the South Kettle may have received sewage sludge for a brief period in the past.

[6] Using ½ the detection limit for congeners reported as non-detect.

[7] TEQ calculations are in Section 9.0, "Human Health and Ecological Risk Assessments."

However, this mean TEQ is comparable to the mean of the Henderson Boulevard samples (18.8 pptr) and the maximum observation from the Kettle (22.0 pptr TEQ) was equal to the maximum in the Rogowski *et al.* (1999b) data set.

The Rogowski *et al.* (1999a, 1999b) data provides further evidence that PCDD/Fs concentrations in the Site Kettles are typical for urban areas in Washington.

7.4.1.5 PCDD/Fs Representative of Site Activities

Samples from the North Kettle provide the best available representation of possible sporadic Site activities that could have been dioxin sources. Due to the surrounding topography, the North Kettle has not received any substantial stormwater runoff from streets or housing developments in the area. One of the upland areas associated with the Interim Remedial Actions discussed in the following Section (8.0) and identified for remediation due to exceedances of dieldrin and PCBs (Excavation Area 7), was located southwest of the North Kettle (Figures 1-2 and 8-1b). The presence of dieldrin in these soils demonstrates that this was an area of nursery operations, uphill from the North Kettle, allowing runoff into the Kettle from approximately five acres of the Site, including portions of Excavation Area 7. The North Kettle, like the other Site Kettles, has no surface outflow, making it a very effective collection basin for chemicals like PCDD/Fs, which are associated with organic material. Sediment samples from the North Kettle, therefore, represent potential PCDD/Fs runoff to the Kettles that arose exclusively from Briggs Nursery operations. Any PCDD/Fs that might have originated from Nursery operations are as likely to have occurred in this area as any other area at the Site. Also, because PCDD/Fs are persistent, and based on the above considerations, PCDD/Fs concentrations measured in samples from the North Kettle are a reasonable and cumulative representation of operations at the Briggs Nursery over a long period of time.

However, the North Kettle had the lowest mean total PCDD/Fs concentration on the Site, and the second lowest mean concentrations of OC-normalized PCDD/Fs and TEQs. These low concentrations, in comparison to nearby street runoff and urban background in Washington State, provide corroboration that no substantial sources of PCDD/Fs are currently or have ever been present on the Site.

7.4.1.6 Conclusions

The results described above indicate that the predominant source of PCDD/Fs in the Kettles at the Site is urban runoff from nearby streets and highways runoff, and that no upland sources of dioxin/furan exist at this Site. Thus, further PCDD/Fs testing in the upland areas of the Site is not necessary. Also, the samples collected and analyzed to date sufficiently characterize the sources and concentrations of PCDD/Fs at the Site and provide sufficient data to allow assessment of the risk to human health and the environment that they might represent.

7.4.2 CHLORINATED PESTICIDES

Pesticides in Kettle samples were predominately reported as undetected. Dieldrin was detected in one sample (0.06 mg/kg); DDTs were detected in about one-half of the samples.

The maximum concentrations for DDD, DDE, and DDT from all Kettles samples (0.048, 0.019, and 0.008 mg/kg, respectively) were two orders of magnitude lower than relevant MTCA criteria (4.17, 2.94, and 2.94 mg/kg, respectively). No further investigation or remediation for chlorinated pesticides is warranted.

The site-wide surficial soil sampling and analysis program described in Section 4.2 determined that dieldrin and PCB concentrations exceeded their MTCA Method B criteria in 12 grid node samples. Therefore, as the RI proceeded, these contaminated areas were considered candidates for Interim Remedial Actions (IRA), which involved additional work to quickly assess and remediate the areas of contamination that exceeded MTCA criteria without the need for a formal Feasibility Study. These IRA activities are described below. Soil containing dieldrin or PCBs at concentrations above the MTCA standards applicable to the future uses of the Site was moved off-site in a manner consistent with MTCA Cleanup Standards and State and County solid waste guidelines. Post-excavation sampling was conducted to ensure that residual contaminants were below relevant soil action levels. All work was conducted in a manner consistent with applicable State, local, and Federal regulations.

The delineation sampling efforts are described in Section 8.1; the remediation actions are described in Section 8.2; disposal activities are described in Section 8.3; and confirmation sampling activities are described in Section 8.4.

8.1 EXCEEDANCE DELINEATION

Based on the results of the soil sampling from the site-wide 200-ft and 100-ft wide grid network, further soil sampling was required to refine the horizontal and vertical delineation of soil concentrations that exceeded MTCA criteria. Thus, additional samples were collected and analyzed in the vicinity of samples whose concentrations exceeded MTCA criteria. The approaches are described below.

8.1.1 HORIZONTAL DIELDRIN DELINEATION

In the vicinity of the 12 soil sample locations whose dieldrin concentrations exceeded the criterion, additional samples were collected. These delineation samples were collected at 25, 50, 75, 100, and 150-ft stations in the four cardinal directions (based on the grid orientation) from the grid nodes where soil sample concentrations exceeded MTCA standards. At some of those grid nodes, soil samples were also collected at approximately 142-ft and 213-ft in the appropriate diagonal directions (NE, SE, SW, and NW) equal to ½ and ¾ of the distance to the next grid node, respectively, in order to provide additional data about horizontal extent of dieldrin. These sampling protocols were modified, as necessary, to account for property boundaries and impenetrable vegetation.

Samples were collected and handled, and sampling equipment was decontaminated according to the protocols described in Sections 3.1, 3.5, 3.6, and 3.8 of the *Revised Draft Remedial Investigation Feasibility Study Work Plan* (ENTRIX 2005). Each sample was labeled with a unique sample number.

Not all samples were analyzed. Those samples lying 25-ft from a grid node in question were analyzed first. Typically, where a 25-ft sample exceeded dieldrin MTCA cleanup standards, the sample collected at 50-ft from the grid node along the same transect, was then analyzed. Further, if the 50-ft sample also exceeded MTCA cleanup standards, then the 100-ft sample along the same transect was analyzed. Finally, where the 100-ft sample exceeded dieldrin standards, the 150-ft sample was analyzed.

Similarly, the 142-ft diagonal samples were analyzed for dieldrin when the 100-ft samples were analyzed. Where a 142-ft sample exceeded MTCA cleanup standards, the 213-ft sample along the same diagonal transect (NE, SE, SW, or NW) was analyzed.

The grid sample and subsequent delineation sample results are summarized in Figures 8-1a and 8-1b with categories designating the levels of dieldrin exceedance.

Figure 8-1a. Excavation Map – show grid sample points and levels of dieldrin concentrations

Figure 8-1b. Excavation Map

8.1.2 Vertical Dieldrin Delineation

To assess the depth of soil that exceeded MTCA cleanup levels, subsurface samples were collected at two grid nodes with dieldrin concentrations above MTCA standards for soil. These grid nodes -J-11 and H-7- were selected to provide a screen of the potential distribution of dieldrin throughout the property. Near each node, a pit 24 in. in diameter and 30 in. deep was dug, and samples were collected from within each pit at five distinct 6-inch intervals: 0-6, 6-12, 12-18, 18-24, and 24-30 in. bgs. At each depth, equal amounts of soil were scraped from the four sides and homogenized together in a stainless-steel bowl. Each composite sample was collected, handled, and decontaminated following methods consistent with those described in the *Remedial Investigation Work Plan* (ENTRIX 2005).

Results from these pit samples indicated that dieldrin at concentrations in exceedance of MTCA Method B unrestricted land use standards was restricted to the upper 12 in. of the soil column (Table 8-1). This finding is consistent with known fate and transport properties of dieldrin. Dieldrin is essentially insoluble in water, and tends to bind with organic materials in the soil. Applied to plants at the nursery, overspray and runoff would be captured by organic materials in the silty sand that is present at ground surface across the site (and observed to over 40-ft bgs during the installation of the monitoring wells). With the dieldrin thus “locked up” at ground surface, its potential for vertical transport is minimal. As noted in the chemical database developed by the International Programme on Chemical Safety (IPCS 2004):

> “As would be expected from their very low water solubility, hydrophobic character, and strong adsorption by soil, aldrin and dieldrin are very resistant to downward leaching through the soil profile.”

Excavation to a depth of 12 in. bgs was therefore considered to be generally conservative. However, confirmation samples were also collected in the excavation areas to detect dieldrin at concentrations above the MTCA Method B unrestricted land use standard.

Table 8-1. Vertical Delineation Results

Sample ID	Sample Depth (bgs)	Dieldrin Conc. (mg/kg)	Qualifier
Pit at Grid Point H7			
S-092104-H7-pit-0-6	0 to 6"	0.33	
S-092104-H7-pit-6-12	6" to 12"	0.016	Y
S-092104-H7-pit-12-18	12" to 18"	0.0125	J
S-092104-H7-pit-18-24	18" to 24"	0.014	U
S-092104-H7-pit-24-30	24" to 30"	0.014	U
Pit at Grid Point J11			

S-092204-J11-PIT-0-6"	0 to 6"	0.15	
S-092204-J11-PIT-6-12"	6" to 12"	0.22	
S-092204-J11-PIT-12-18"	12" to 18"	0.024	
S-092204-J11-PIT-18-24"	18" to 24"	0.013	U
S-092204-J11-PIT-24-30"	24" to 30"	0.013	U

Qualifiers:

J - Estimated concentration when the value is less than established reporting limits

U - Indicates that the target analyte was not detected at the reported concentration

Y - The analyte reporting limit is raised due to a positive chromatographic interference. The compound is not detected at or above the raised limit but may be present below the limit

8.1.3 Delineation of PCBs

The effects of the PCB interference in the dieldrin analyses were described above in Section 2.5.2. This interference was observed in two samples, collected from locations H7+142SE and J11+50E. To reiterate, if PCBs were present in any other samples, they were found at concentrations well below the 1 mg/kg requirement under MTCA Method B unrestricted use standards. The delineation method for excavation of the PCB-contaminated soils was therefore partially based on the results from samples for the delineation of the dieldrin-contaminated soils.

Any PCB contamination is probably associated with the legal use of PCBs (prior to approximately 1970) as an “extender” during pesticide applications according to label instructions, and not the result of a PCB spill at the Briggs Nursery, based on known site history. In particular, there are no known historical electrical transformer installations on the Site west of Henderson Boulevard. Therefore, soils associated with PCBs above 1 mg/kg were initially excavated to the same depth (1-ft) as were soils containing dieldrin.

In the areas of the samples whose PCBs concentrations exceeded the MTCA criterion, additional samples were collected to further delineate horizontal and vertical extent of exceedance. Confirmation samples in the PCB excavation areas determined that the areal extent of PCB contamination was greater than anticipated. The excavation areas were extended until additional confirmation sampling determined these additional areas were excavated and removed.

8.2 Excavation of Contaminated Soils

Areas identified for excavation were determined based on analytical results from the initial sampling activities described in the *Final Remedial Investigation Feasibility Study Work Plan* (ENTRIX 2005) and results from the subsequent sampling effort described in Section 8.1 above. The methods for excavation and removal of the contaminated soils are presented in this section.

8.2.1 Determination of Excavated Area

The excavation areas were based on the delineation of dieldrin and PCB contamination as described previously in Section 8.1. Excavation area boundaries were measured from the surveyed sample points and marked with survey stakes and distinctive spray paint markings. The areas identified on Figures 8-1a and 8-1b were initially excavated to approximately one foot in depth, in accordance with the findings in the vertical delineation described in Section 8.1.2 above.

8.2.2 Excavation Procedure

A bulldozer and trackhoe were used for the excavation. Care was taken to minimize the equipment traffic through the excavation area. Excavated soils were transported off-site to the appropriate facility.

Soils associated with samples whose PCB concentrations were in exceedance of the MTCA Method B unrestricted land use standard (1 mg/kg) were segregated, stockpiled, further characterized, and as necessary, delivered to a lined landfill for disposal. During excavation, standard practices to prevent dispersion of excavated soil were employed. These included the following:

- Trucks accessed the excavation by large rock roads;
- Excavation and loading dust was controlled using water spray;
- Truckloads were tarped; and
- Erosion control measures were employed where surface water runoff could erode excavations.

8.2.3 Disposal Requirements

This section discusses the applicable regulatory requirements for determining the disposal location of the excavated soils.

The excavated soil was disposed of at one of two facilities. The dieldrin-contaminated soil that did not contain PCBs in excess of 1 mg/kg (the unrestricted land use or residential standard) was excavated and transported to the Briggs Farm Property (Farm Site) in Porter, Washington, where it was re-used as a soil amendment. The 95 percent upper confidence limit (UCL) on the mean PCB concentration of soil transported to Porter is less than 0.65 ppm, the ecological screening value, and no individual sample concentration exceeds 1 ppm, the MTCA unrestricted land use standard for PCBs. The Farm Site is a working farm with clay-rich soils and poor drainage. The sandy soils excavated from the Nursery Site were tilled into the Farm Site soil to improve drainage and increase agricultural productivity. The soil amendment covered an area of about 15 acres and the area was re-graded to avoid stormwater runoff. As an additional protection, the tilled soil will be phytoremediated as discussed further in Section 8.2.4. The PCB-contaminated soils (whose sample concentrations exceeded 1 mg/kg) were segregated from the dieldrin-contaminated soils, tarped, and transported to a lined landfill with regulatory approval to receive PCB soils in excess of the residential soil standard. During the Site excavation activities, approximately 100 cubic yards (cy) of soil containing PCB slightly in excess of the 1 mg/kg standard was inadvertently sent to stockpile at the Farm Site. Additional sampling was performed to identify the location and extent of soil in excess of 1 mg/kg PCB in the Farm Site stockpile. It was removed from the stockpile and sent to the same lined landfill with regulatory approval to receive PCB soils in excess of the residential soil standard.

8.2.3.1 Washington Dangerous Waste Regulations

The State of Washington Dangerous Waste Regulations do not identify a criterion specific to dieldrin under WAC 173-303-090. However, dieldrin is a halogenated organic compound (HOC) that must meet the "Dangerous Waste Criteria Level" under WAC 173-303-100. This criterion requires that the sum of all HOC concentrations is less than 1% (or 10,000 mg/kg). The sum of HOC constituents in soil from the Site is substantially below 1% and therefore below the Dangerous Waste standards.

In addition, WAC 173-303-100 also provides a formula to ensure that the Equivalent Concentration does not exceed the level for "Toxic Dangerous Waste." The formula indicates that the sum of the pesticide concentrations (on a % basis) is divided by 10. That value is then summed with other chemical classes to see if the total is less than 0.001% (or 10 mg/kg). Again, Site HOC concentrations are well below this criterion. The soil is therefore below the standards for Toxic Dangerous Waste. The dieldrin-contaminated soils are designated as non-hazardous waste under the Washington Dangerous Waste regulations.

The MTCA Method B unrestricted land use standard for total PCBs is 1 mg/kg. The soils associated with the PCB-contaminated areas in excess of 1 mg/kg did not meet the requirements to be listed as a dangerous waste under Chapter 173-303 WAC. These soils were not associated with any of the waste types covered under the listing for W001 (including, *e.g.*, transformers, capacitors, bushings, and associated wastes). The excavated soils from the PCB-contaminated areas that exceed the 1 mg/kg unrestricted land use standard were segregated and disposed of at a lined landfill with regulatory approval to receive PCB soils in excess of the residential soil standard.

8.2.3.2 MTCA

Unrestricted land use criteria under MTCA Method B have driven the need to remove soils from the Site. Applicable standards for dieldrin and PCBs are discussed in separate sections below.

8.2.3.2.1 Dieldrin under MTCA

The most stringent unrestricted land use cleanup standard for dieldrin is 0.0625 mg/kg based on dermal contact and inhalation exposure pathway. The highest level of contamination in site soils that were excavated based on the sampling and analysis program described in Section 8.1 was 0.930 mg/kg. This level is almost an order of magnitude lower than the MTCA Method B standard for industrial land use based on dermal contact and inhalation exposure pathway of 8.2 mg/kg dieldrin.

The dieldrin-contaminated soils did not pose a threat to groundwater due to the facts determined during the RI as summarized below.

- Six groundwater monitoring wells were installed at the Briggs site during this investigation (discussed above in Sections 4.3, 6.3, and 7.3). No contaminants, including dieldrin, were detected in any of these monitoring wells.
- Sampling from two test pits during this investigation indicates that dieldrin contamination in soils above the most stringent unrestricted land use criterion (0.0625 mg/kg) occurred only within the upper 12 in. of the soil profile.
- Dieldrin use for everything except termite control was banned by EPA in 1974. It is therefore reasonable to assume that dieldrin use at the Briggs Nursery site did not occur after 1974. The preponderance of the dieldrin is confined to the upper foot of soil even after a residence period of at least 30 years. Therefore, dieldrin clearly did not migrate and was tightly bound to the site excavated soils.
- As reported in the database developed by the International Program on Chemical Safety, dieldrin is very resistant to downward leaching through the soil profile.
- The soils excavated comprise an organic-rich sandy loam that strongly and preferentially adsorbed the dieldrin.

The data collected at the Site empirically demonstrate that chemicals in the excavated soils represent no threat to groundwater. Additionally, the data collected empirically demonstrated that these soils do not pose a threat to the groundwater underlying the Farm Site (the receiving site for the excavated soils).

8.2.3.2.2 PCBs under MTCA

The most stringent MTCA Method B unrestricted land use soil cleanup standard for PCBs is 1 mg/kg based on dermal contact and inhalation exposure pathway. Two samples collected during the RI were determined to contain PCBs at concentrations in exceedance of the MTCA Method B unrestricted land use standard (1 mg/kg). Additional samples collected during the IRA exceeded the 1-mg/kg criterion. These samples were near the initial exceedances, within the same excavation areas (Excavation Areas 2 and 7). None of the samples had PCBs concentrations higher than 4.4 mg/kg (initially detected in one of the RI samples).

MTCA's 3-phase model (NTCASGL10) was used to calculate a PCBs concentration protective of groundwater. This calculation is particularly sensitive to the organic carbon partioning coefficient (K_{oc}) and the fraction organic content (f_{oc}) assumed for the soils.

A K_{oc} value was derived from the literature. The f_{oc} representative of the soils at the Olympia Site and Porter Farm Site were based on analytical results for samples from those locations.

Using the literature-derived K_{oc} value and the most conservative foc (lowest observed f_{oc}, which results in the lowest concentration protective of groundwater), Ecology personnel determined the site-specific PCBs soil concentration protective of groundwater to be 6.6 mg/kg (Personal Correspondence with Ecology, Appendix G). Therefore, the 1-mg/kg standard is more conservative.

Ecology's Terrestrial Ecological Evaluation (TEE)[1] was also used to screen PCBs concentration present in the soils to be received at the Farm Site, to determine if further study was required. A table of screening criteria is provided in Table 749-3 associated with the TEE. The table notes that they "are provided for use in eliminating hazardous substances from further consideration under WAC 173-340-7493 (2)(a)(i)." The criteria for total PCBs in Table 749-3 is 0.65 mg/kg, which is to be compared to the UCL of the mean concentration. Using all PCBs values from samples collected in stockpiles at both the Olympia Site and the Farm Site, the data were treated as follows:

- Duplicates were averaged;
- Non-detects were represented by 1/2 their detection limit for Aroclor 1254 and Aroclor 1260; other Aroclors were never detected in any sample, and these were not included in the total PCBs;
- Samples exceeding 1 mg/kg PCBs were excluded from the calculations, as they are representative of soils that will be removed and hauled to a landfill; and
- Using MTCASTAT's UCL calculator, the 95% UCL was calculated to be 0.4 mg/kg PCBs, which is less than the 0.65 mg/kg ecological screening value (Appendix A).

8.2.3.2.3 MTCA Disposal Characterization

Exceedances of the MTCA Method B unrestricted residential standard for dieldrin were found in 12 of the initial 105 grid samples collected. Additional samples were collected in the vicinities of these exceedances to further delineate their extent, for a total of 194 dieldrin observations. The maximum observed dieldrin concentration was 0.930 mg/kg. The area-weighted average concentration within the areas designated for excavation is estimated at 0.25 mg/kg. Given that the concentration estimated to represent excavated soils was based on a large number of observations (n=82), the stockpiles did not require additional sampling for their characterization prior to their delivery to the Farm Site.

The area-weighted average concentration of dieldrin in the top six in. (where the soil samples were collected) within the areas designated for excavation is estimated to be 0.25 mg/kg. However, concentrations should be substantially lower in the deeper portions (6 to 12 in. deep) of the excavations. Also, the excavation extended beyond all known locations of exceedance of the MTCA standard. Taken together, these factors indicate that the average dieldrin concentration in the excavated soils was substantially less than 0.25 mg/kg.

As a result of the mixing that occurred as the amending soil was tilled into the ground at the Farm Site, any localized maximum and area-wide average dieldrin concentrations have decreased even further. It is likely that the average concentration after tilling is near the residential standard, or about one-tenth of the industrial standard. As an additional protection, the tilled soil will be phytoremediated through the planting of carving pumpkins for a minimum of three years. Pumpkins have been shown to be an effective agent for

[1] http://www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm, viewed on August 4, 2005.

extracting dieldrin and other chlorinated hydrocarbons (including PCBs) from contaminated soils (American Chemical Society 2004).

8.3 DISPOSAL OF EXCAVATED SOIL

A total of approximately 15,000 cubic yards of material was removed from the Site. The initial grid samples, additional delineation samples, and post-excavation confirmation samples all demonstrated that the soils containing dieldrin above the MTCA criterion (0.0625 mg/kg) were below the Dangerous Waste standards and could be reused in accordance with state solid waste regulations as a soil amendment. To accomplish this goal, a grade and fill permit application was provided to the County of Grays Harbor along with a SEPA checklist. After review by a respected third-party environmental consultant, Environment International (EI) of Seattle, the County approved the Grade and Fill permit with conditions. After receipt of the conditioned permit, the soil was transported to the Farm Site for use as a soil amendment and all permit conditions have been met.

The soil containing PCBs at concentrations above the MTCA criterion (1 mg/kg) was transported to a lined landfill with regulatory approval to receive PCB soils in excess of the residential soil standard.

8.4 CONFIRMATION SAMPLING

As soil excavation proceeded, samples were collected for analysis within the excavated area to confirm that soil with dieldrin and PCBs at concentrations above MTCA cleanup standards had been removed. As necessary, additional soil was excavated to remove soils whose chemical concentrations exceeded MTCA criteria. The methods for confirmatory sampling and analysis and the decision process are described in the following sections.

8.4.1 SAMPLE COLLECTION, HANDLING, AND ANALYSIS

Locations for confirmation samples were established in each of the eight excavation areas identified on Figures 8-2a and 8-2b. The Ecology Site Manager approved the number and placement of these samples. Discrete soil samples were collected from 0-6 inch depth in the floor of the excavation, and in the sidewall of the excavation, at the mid-point of excavation depth. Confirmation soil samples were otherwise collected and handled according to the protocols described in the IRAP. As noted in Section 2.5.2 above, the laboratory analysis for dieldrin also serves as an indicator for the presence of PCBs (PCBs in those samples were also quantified), and therefore the dieldrin confirmation samples were also used to guide the collection of samples for PCBs analysis. The PCBs confirmation samples were conducted in the same manner and to the same depth as the pesticide confirmation samples.

8.4.2 DECISION PROCESS

Soil containing dieldrin above appropriate MTCA levels was excavated and transported to the Farm Site, consistent with the disposal procedures outlined above. Each excavation area remained open until all confirmation samples were analyzed and it was determined that the dieldrin concentrations in soils remaining within the excavation area did not exceed applicable MTCA cleanup standards. Soils associated with samples whose total PCBs concentration exceeded 1 mg/kg were excavated, and taken to a licensed transfer facility in Bremerton, Washington for disposal in a lined landfill in Arlington, Oregon.

When confirmation results indicated that contaminant concentrations were below appropriate MTCA levels, the excavated areas were closed in place with Ecology's approval.

8.4.3 SUMMARY OF EXCAVATION AND CONFIRMATION SAMPLING

Over 60 confirmation samples were analyzed for dieldrin within the excavation areas. Figures 8-2a and 8-2b display the total extent of excavations and the confirmation samples used to close each area. Confirmation samples for dieldrin excavations, and PCB analyses for confirmation and stockpiled samples, are not shown here but are provided in Appendix E.

Figure 8-2a. Extent of Excavation with Confirmation Samples

Figure 8-2b. Extent of Excavation with Confirmation Samples

The human health risks associated with Site chemicals in the upland areas of Work Area 1 and 2 were addressed by the soil removals conducted as part of the IRA (Section 8.0). The remaining human health risks in the Site Kettles and ecological risks in both the upland areas and the Site Kettles are assessed below in separate studies.

9.1 BASELINE HUMAN HEALTH RISK ASSESSMENTS OF SITE KETTLES

A baseline HHRA was conducted for each of the Site Kettles. They address the potential risks associated with PCDD/Fs, which were identified by Ecology as the COCs therein. These risk assessments assume that the Site Kettles remain in their current state and that a residential exposure scenario is appropriate. The assessments are provided as Appendix I to this RI/FS, and conclude that:

- The sediments and waters of the North Kettle pose no unacceptable risks to human health;
- The sediments and waters of the Northwest Kettle may pose an unacceptable risk to human health;
- The sediments and waters of the Central Kettle may pose an unacceptable risk to human health; and
- The sediments and waters of the South Kettle may pose an unacceptable risk to human health.

Remedial alternatives assessed to reduce human health risk to acceptable levels in the Northwest, Central and South Kettles are addressed in Section 10.4, "Feasibility Study: Kettles."

9.2 ECOLOGICAL RISK ASSESSMENT OF THE SITE

Ecological screening evaluations were conducted for the Site. The TEE process was used to evaluate the potential for ecological risk. The TEE process provides Ecological Indicator Soil Concentrations that are "expected to be protective at any MTCA site and are provided for use in eliminating hazardous substances from further consideration under WAC 173-340-7493 (2((a)(i)" (Table 749-3). These values are effectively screening concentrations, below which no reasonable amount of ecological risk exists.

The ecological evaluations were separated by habitat. These were:

- The bottoms of the four Kettles in Work Area 1,

- The sideslopes and benches immediately adjacent to the four Kettles in Work Area 1, and
- The remaining upland areas of Work Areas 1 and 2.

9.2.1 Kettle Bottoms

Samples collected from the Kettle sediments in previous studies (Section 1.3, "Previous Site Investigations and Cleanup Activities") and during the RI were analyzed for pesticides, PCBs, selected metals, and PCDD/Fs. Based on this sampling, PCDD/Fs were the only compounds identified as Contaminants of Potential Ecological Concern (COPECs) in the Kettle bottoms (see RI/FS Section 2.5 "Chemicals of Concern").

The potential for ecological risks in the Kettles was assessed using the TEE process under WAC 173-340-7493 (2)(a)(i). The PCDD/Fs concentrations in the Kettles exceed the Ecological Indicator Soil Concentrations in Table 749-3. However, footnote *a* of the Table recognizes that:

"Natural background concentrations may be substituted for ecological indicator concentrations provided in this table."

Ecology has recognized that the composition and concentrations of PCDD/Fs present in the Kettles are consistent with street runoff:

"Ecology is satisfied that the PCDD/F concentrations found in site Kettles are a result of street runoff, as Briggs contends, and our own research demonstrates[1,2]."

While street runoff is not a "natural" background, it is an ubiquitous off-Site source of PCDD/Fs that constitutes a reference background in western Washington. PCDD/Fs are therefore eliminated from further consideration in the ecological evaluation process.

9.2.2 Kettle Slopes and Benches

The sideslopes lead from the nearby upland portions of the Site down to the Kettles. They are typically steep, and no Site activities are known to be associated with them. The benches represent relatively level areas that lie above the Kettle bottoms, and below the elevation of nearby upland portions of the Site. These benches occur on the east side of the South Kettle, the southwest side of the Central Kettle, and the east and south sides of the Northwest Kettle (Figures 4-2a and 4-2b).

These areas lie above the Kettle bottoms, and do not retain stormwater runoff that could contain PCDD/Fs. For the upland portions of Work Areas 1, dieldrin was the only COC

[1] March 11, 2005 letter from Lisa Pearson / Ecology to Gary Briggs / Briggs Nursery.
[2] See Section 7.4, "Kettles," for further discussion of PCDD/Fs and other COCs in Kettle bottoms.

over widespread areas of the Site, and therefore, the only likely COPEC for the sideslopes and benches. The Ecological Indicator Soil Concentration for dieldrin in soil is 0.07 mg/kg (protective of wildlife) (Table 749-3, WAC 173-340-7493 (2((a)(i)). The MTCA clean-up criterion for dieldrin based on human health considerations applied at the Site was 0.0625 mg/kg. During the IRA if any sample exceeded this criterion of 0.0625 mg/kg, soils in the portion of the Site associated with that sample were excavated and removed and confirmation samples collected. This process of excavation, removal, and confirmation continued in all directions away from the initial exceedance sample until dieldrin concentrations were confirmed to be below the criterion of 0.0625 mg/kg. As a result, over 180 samples were collected throughout the Site, including in areas directly adjacent to the Kettles' sideslopes and on the benches of the Kettles (Figures 8-2a and 8-2b, showing locations of all dieldrin samples, including confirmation samples).

Since all soil associated with samples whose dieldrin concentration exceeded 0.0625 mg/kg was removed, remaining soil adjacent to the Kettles exceeding 0.07 mg/kg. As the TEE process guide notes in Exclusions:

"Compare chemical concentrations in the soil to the values in Table 749-3. If soil values do not exceed the table values, the evaluation is complete for those chemicals."

For the Kettle sideslopes and benches, dieldrin is thus eliminated from further consideration in the ecological evaluation process.

PCBs were also found in two localized upland portions of Work Area 1. As discussed in Section 8.2.3.2.2 above, total PCBs concentrations remaining at the site after remediation were below the TEE screening value. PCBs are therefore eliminated from further consideration in the ecological evaluation process.

9.2.3 Upland Portions of Work Area 1

As noted in Section 9.2.2. above, dieldrin was the only COC over widespread areas of the uplands of Work Area 1 and 2, and therefore, the only likely COPEC. Any sample in the upland areas whose dieldrin concentration exceeded 0.0625 mg/kg – which is less than the Ecological Indicator Soil Concentration for dieldrin in soil (0.07 mg/kg) – resulted in excavation and removal of associated soils.

Therefore, for the upland areas of Work Area 1, dieldrin is eliminated from further consideration in the ecological evaluation process.

9.3 Summary

Based on the above evaluations, ecological risks in Work Area 1 are within acceptable limits under MTCA, and no further ecological assessment is necessary.

Based on the RI data and the completion of the IRA, a formal FS is not required for remediation of the upland areas of Work Area 1. The baseline HHRA concludes that no additional action to protect human health is necessary for the North Kettle.

The baseline HHRA further concludes that additional action is required to protect human health for the Kettle bottoms of the Northwest, Central, and South Kettles.

10.1 DECOMMISSIONING OF SITE FACILITIES AND USTS

The petroleum contaminated soils encountered during the excavation of the petroleum USTs were excavated and removed during the UST decommissioning activities. Confirmation samples were collected and analyzed to ensure the full extent of contamination was remediated. No further remedial activities are required.

The wash basin samples and septic tank samples were below the MTCA Method B Unrestricted Land Use Standards. No further remediation is required.

Based on the results of the GPR survey, the near-surface site stratigraphy, the excavations conducted during site demolition activities, and discussions with site personnel, there is no evidence for the purported abandoned sump at the Briggs Nursery. No further action is required.

10.2 SURFICIAL SOILS

Surficial soil samples were collected across the Site. Samples containing dieldrin and PCBs at concentrations above MTCA unrestricted land use standards were identified and delineated into excavation areas. As described in Section 8.0, the soils in these areas have been remediated as part of the IRA. The unrestricted land use standard for dieldrin (the widespread COC at the Site) is also less than the Ecological Indicator Soil Concentration and no reasonable amount of ecological risk exists. Therefore, no further action is required.

10.3 GROUNDWATER

Groundwater samples collected from each of the six monitoring wells distributed across the Site were analyzed for herbicides, metals and pesticides. The results indicated that herbicides, pesticides and metals (chromium and copper) were not detected. These results, in combination with the knowledge that the water table is over 80-ft below most of the upland areas (that is, a vadose zone over 80-ft thick) indicate that there is no historical or potential effect to groundwater from previous Site activities. No further investigation is warranted.

10.4 KETTLES

The baseline HHRAs of the Kettles determined that the sediments and waters of the Northwest, Central, and South Kettles may pose an unacceptable risk to human health due to the presence of PCDD/Fs. Here, the HHRAs for these Kettles are revisited to determine the levels of risk to human health associated with sediment and water in the presence of alternative remedies that might be imposed on these Kettles.

The feasibility study addresses Kettles west of Henderson Boulevard, which are all in Work Area 1. In Phase 3, Kettles in Work Area 3, east of Henderson Boulevard, will be addressed.

10.4.1 REMEDIAL ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Alternative A – Excavation and Disposal of Kettle Bottoms

The excavation of the Kettle bottoms would temporarily remove contaminated sediments from the Kettle bottoms. It would also completely destroy the habitat values of these geologically unique wetlands. The contaminants in the Kettle bottoms result from urban stormwater runoff. Since the Kettles are to be used into the future for stormwater detention, it is likely that sediments with low levels of PCDD/Fs consistent with urban stormwater runoff would again reach the Kettle bottoms. The destruction of these sensitive wetlands would therefore achieve nothing over the long term relative to human health or ecological protection. This alternative was therefore eliminated from further analysis.

Alternative B – Capping of Kettle Bottoms

The importation and deposition of clean fill material would temporarily isolate the contaminated Kettle sediments from the environment. Sensitive ecological habitat within the Kettle bottoms would be destroyed. The contaminants in the Kettle bottoms result from urban stormwater runoff. Since the Kettles are to be used into the future for stormwater detention, it is likely that low levels of PCDD/Fs consistent with urban stormwater runoff would again reach the Kettle bottoms. The destruction of these sensitive wetlands would therefore achieve nothing over the long term relative to human health or ecological protection. This alternative was therefore eliminated from further analysis.

Alternative C – Boardwalks around the Kettle Bottom Areas

The Kettle bottoms will be deeded to a foundation, which will preserve them in perpetuity. Given the unique ecological character of the Kettles, any destruction of the Kettle bottoms would degrade their ecological value. Boardwalks could be constructed to encourage people to view the Kettles and to avoid entry into the Kettle bottom areas. Unfortunately, boardwalks in these areas would encourage human entry into the contaminated areas and are not sufficiently restrictive to prohibit unauthorized entry into the Kettle bottoms. This alternative does not adequately protect human health and was therefore eliminated from further analysis.

10.4.2 ACTION ALTERNATIVES

Two action alternatives were considered which address the human health hazards the Kettles may present and that preserve, to the degree practicable, the ecological charcter of the Kettles. They are described below.

Alternative A – Restrictive Covenants and Warning Signs

Alternative A uses a suite of institutional controls to limit human access to the Kettle bottoms. A proposed restrictive covenant would provide institutional controls on the future use and maintenance of the Kettle bottoms (Appendix J). Under this restrictive covenant, the following conditions would be applied to the Kettles:

- The Kettle bottoms will be deeded to a foundation that will maintain them as ecological reserves and natural features.
- The Kettle bottoms will be accessed in the course of maintenance, but no soil or sediment may be removed from the Kettle bottoms, without the prior consent of Ecology.
- Public access to the Kettle bottoms will be expressly prohibited.
- Unauthorized access will be considered criminal trespass, and the violators will be subject to prosecution; this prohibition will extend to homeowners, family members, clients, and guests.
- No-trespassing signs will be posted around the perimeters of the Kettle bottoms at intervals of approximately 100 feet. The signs will be permanently maintained.

No guidance is readily available on the efficacy that institutional controls provide in the reduction of access afforded by such institional controls on access (in the absence of physical barriers). Available survey literature is inconclusive. The HHRA relied on qualitative studies and professional judgment to evaluate their likely effectiveness (Appendix K).

Alternative B – Restrictive Covenants, Warning Signs, and Fences

The Kettle bottoms will be subject to the same restrictive covenants and signage described under Alternative A. In addition, physical control – in the form of fencing – will be installed around the Kettle bottoms. The fence will be six feet in height, constructed of chain-link mesh, with a knuckled upper selvage (finished edge) without barbed wire. The fencing will be installed at an elevation about 3 feet above the estimated mean high water lines for the respective Kettles. This positioning will serve to prevent human access to water and sediment, as well as to facilitate the fence installation.

The use of this type of fence to restrict human access to certain hazardous areas is consistent with guidance and regulations from Washington State and its municipalites, counties, and industries. These areas include:

- Swimming pools,
- Solid waste, hazardous waste, and composting facilities,
- Electrical substations, and
- Nuclear waste facilities.

Appendix K of this RI/FS includes an evaluation of the requirements for fences in these circumstances. In summary, that evaluation determined that a chain-link fence six feet in height is consistent with the level of risks – both physical and chemical – that the Kettle bottoms present to humans.

10.4.3 Human Health Risk Assessments For Alternatives A and B

HHRAs were conducted for the Northwest, Central, and South Kettles under the proposed action alternatives (Appendix K). In summary, these HHRAs determined that:

- Alternative A – Institutional controls without fencing failed to adequately reduce risks to human health in all three Kettles.
- Alternative B – Institutional controls and fencing reduced exposure to the sediments and waters of these Kettles to a sufficient degree so that they pose no unacceptable risks to human health under a residential scenario.

Therefore, Alternative B is the preferred remedy to address human health risks that the Northwest, Central, and South Kettles may present.

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Figure 1-1. Site Location Map

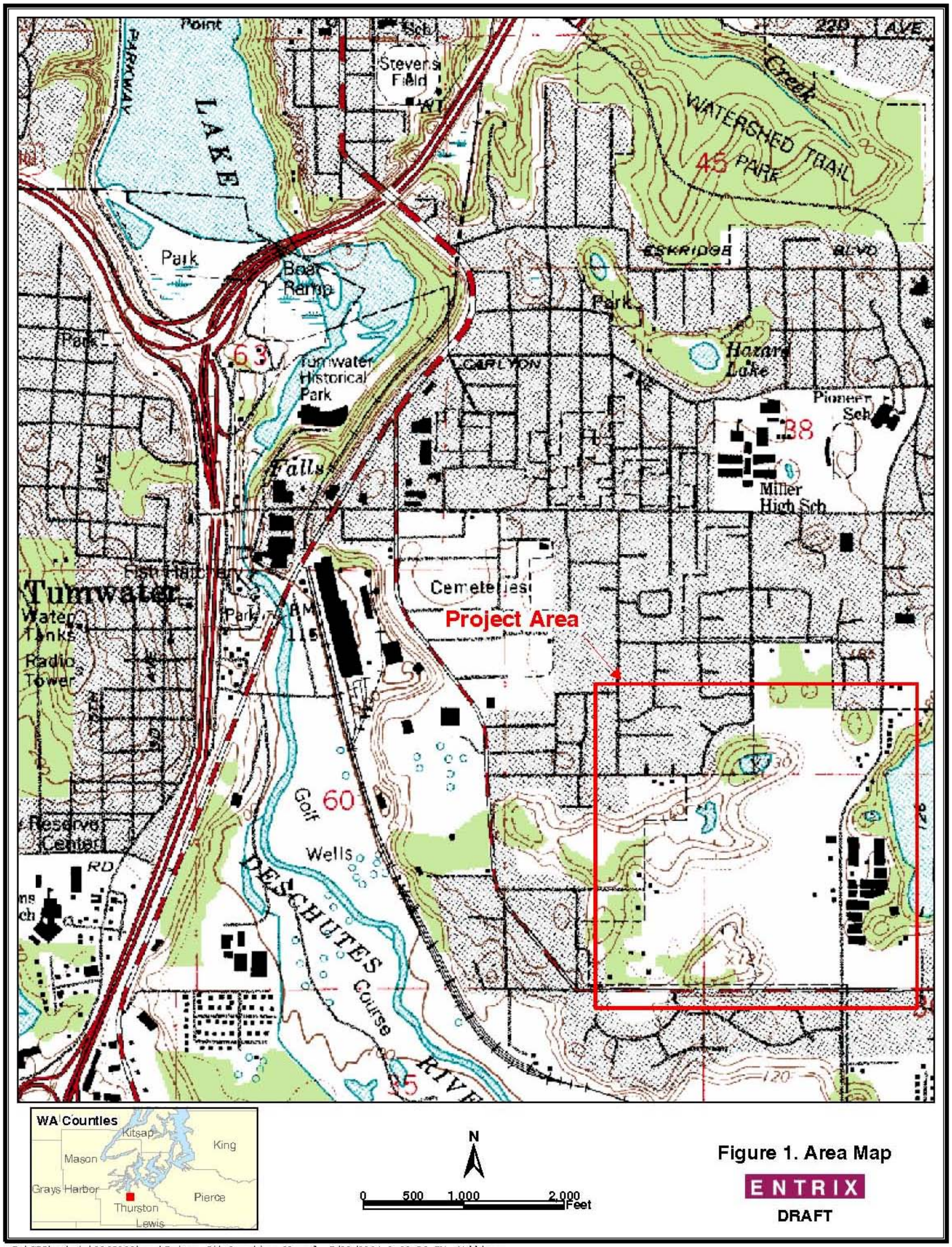

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Figure 1-2. Site Map with Work Areas

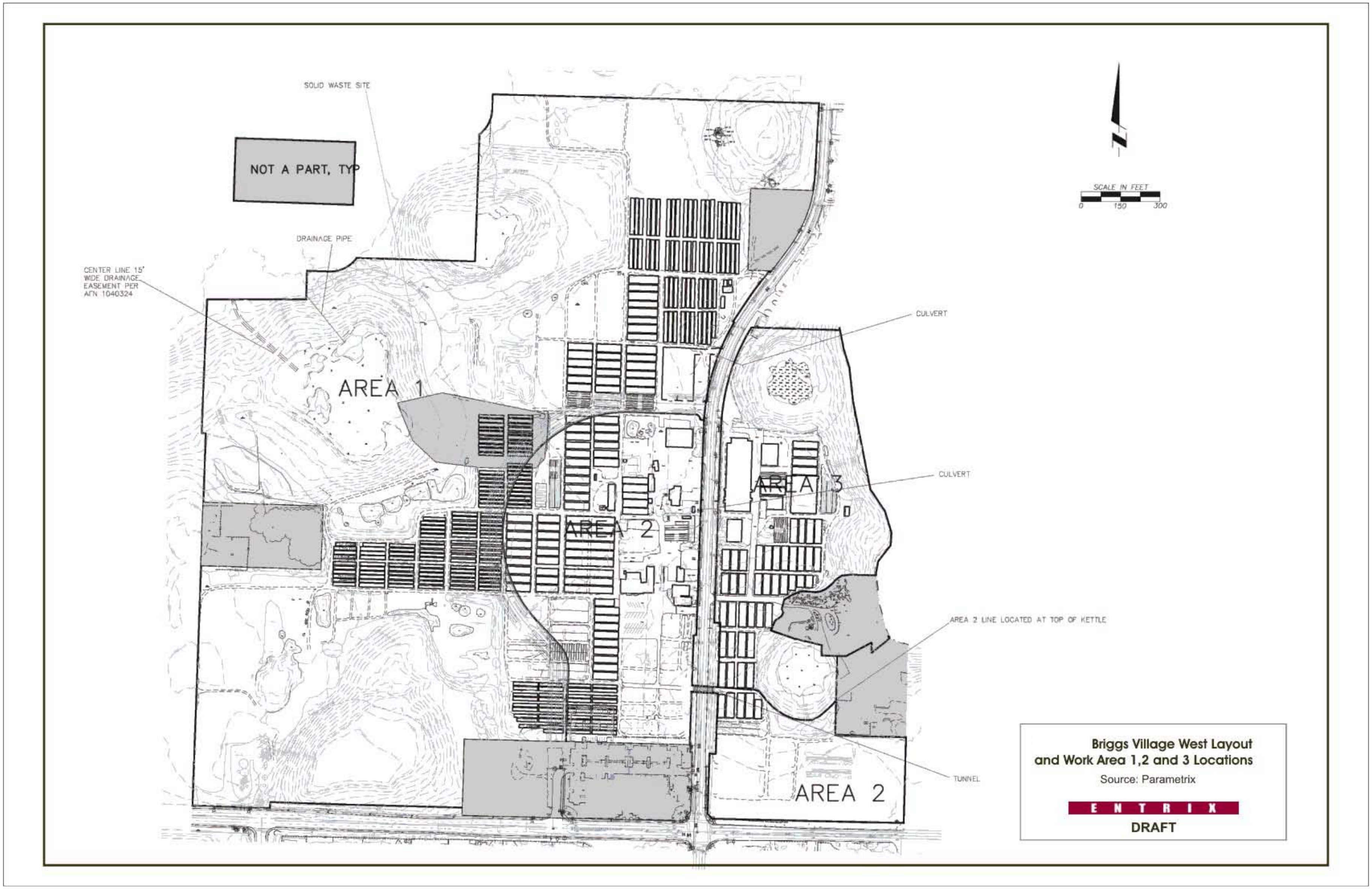

Figure 2-1. Conceptual Hydrogeologic Cross-Section, Briggs Nursery, Olympia and the Surrounding Area

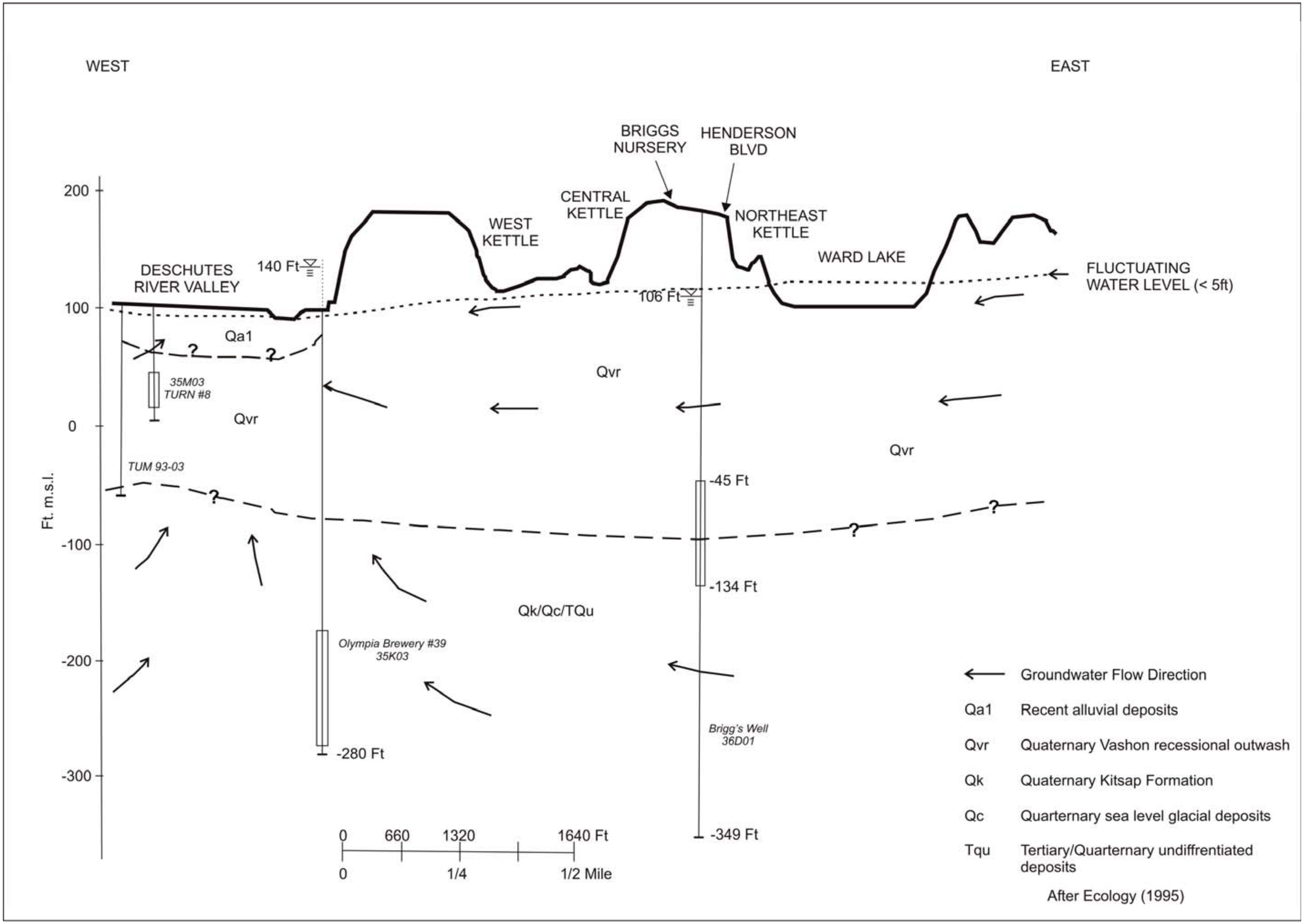

Figure 2-1. Conceptual Hydrogeologic Cross-Section for Briggs, Tumwater and Surrounding Areas

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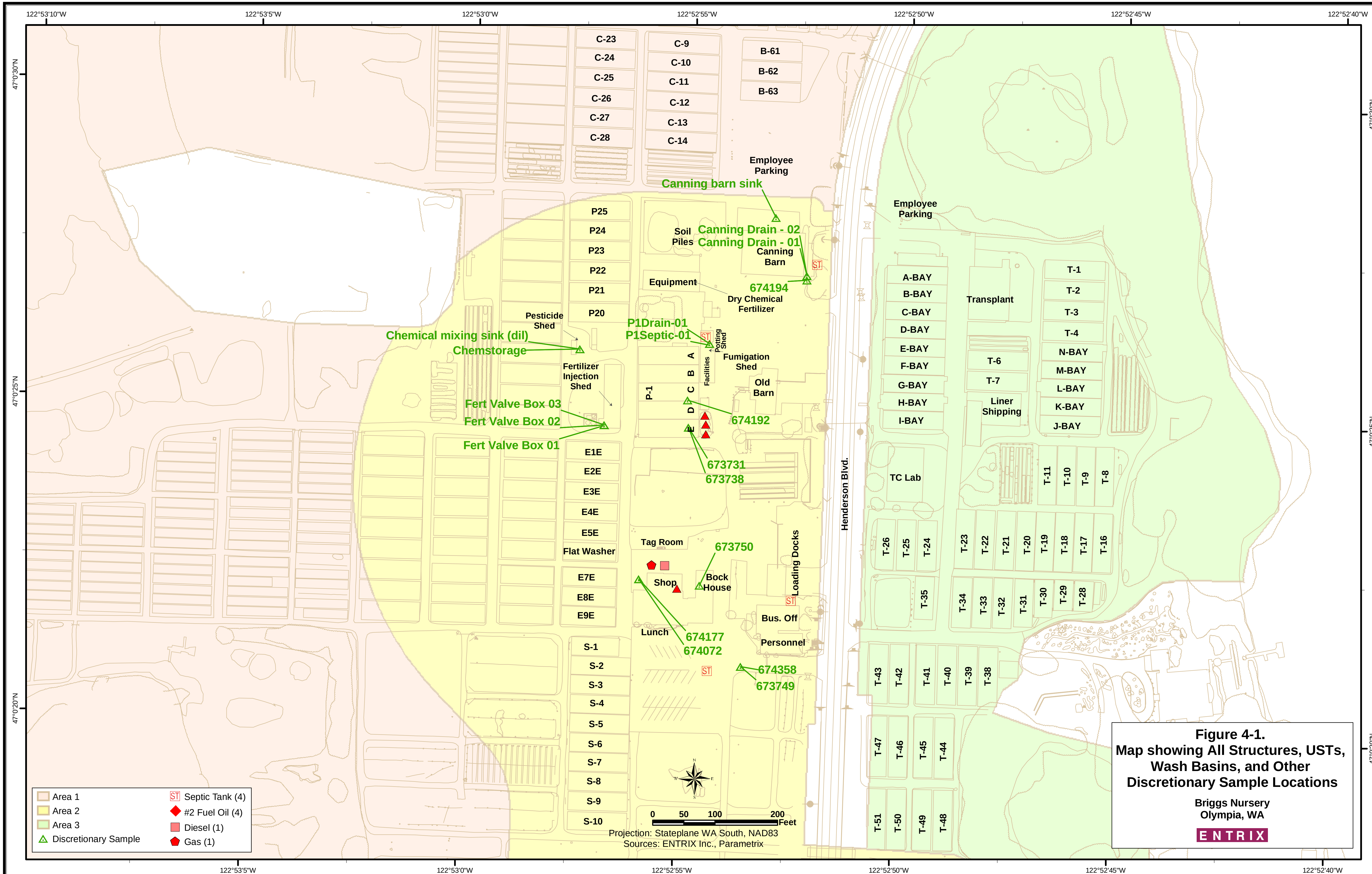

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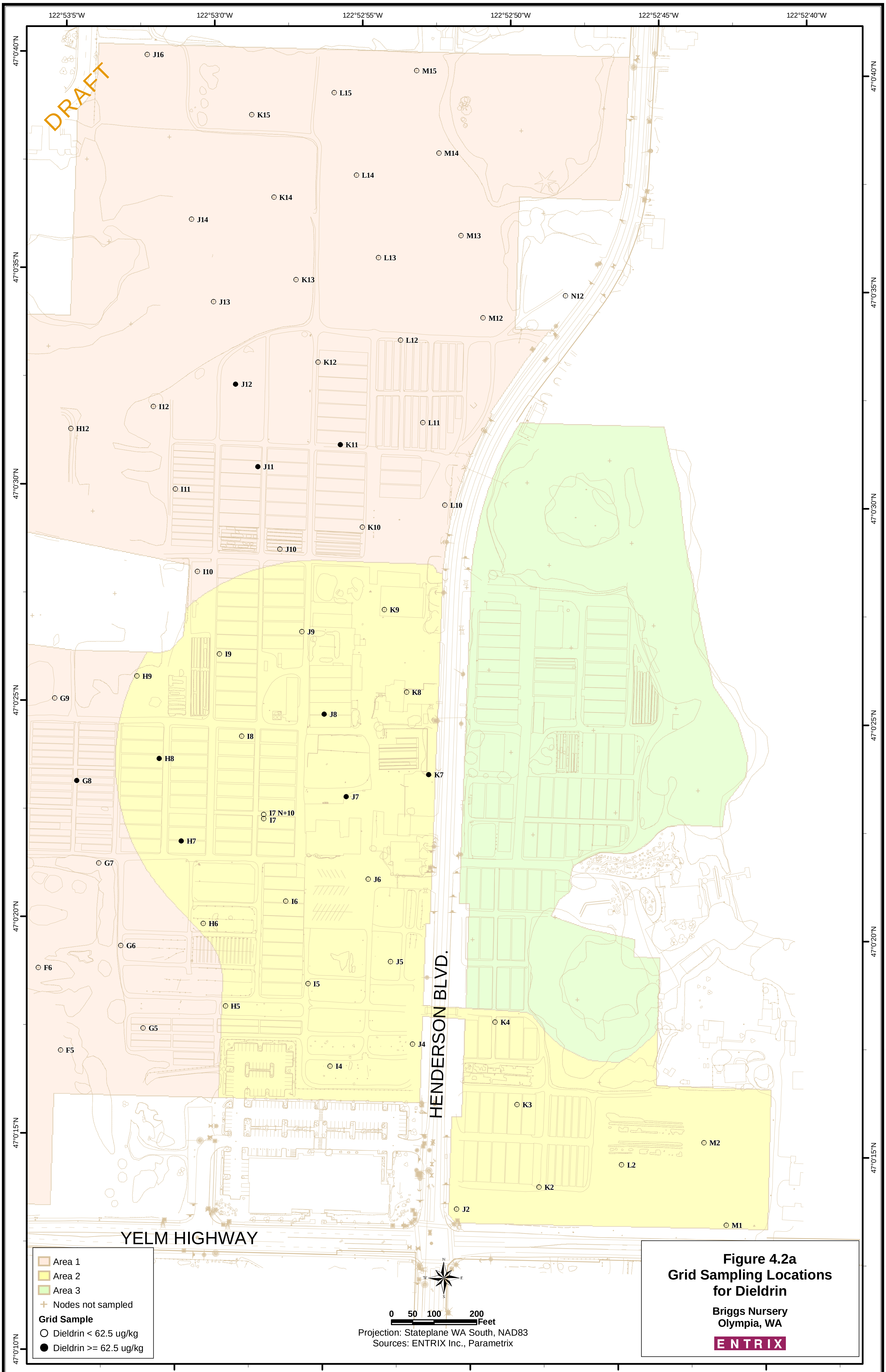

Figure 4.2a
Grid Sampling Locations for Dieldrin

Briggs Nursery
Olympia, WA

ENTRIX

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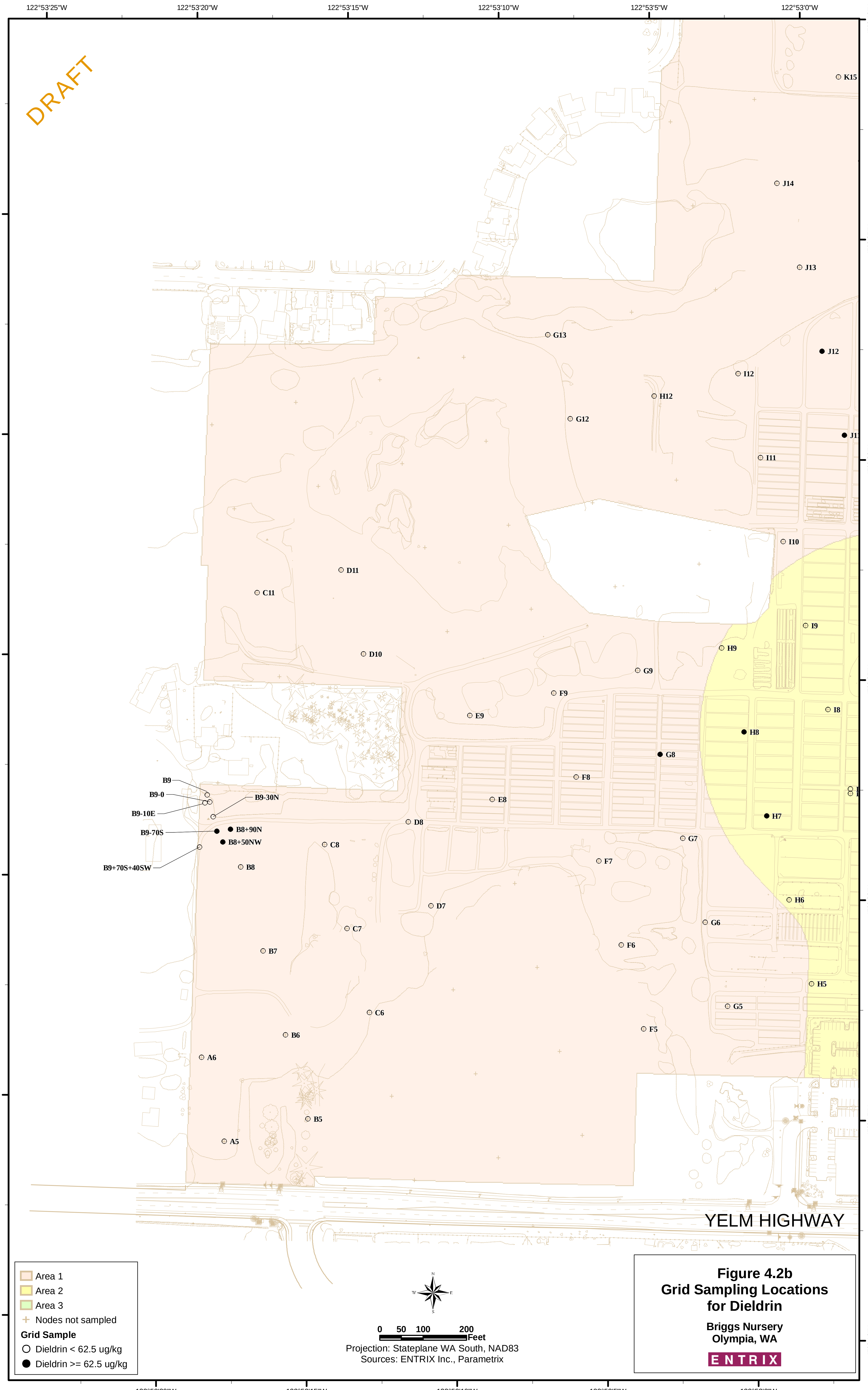

Figure 4.2b
Grid Sampling Locations for Dieldrin

Briggs Nursery
Olympia, WA

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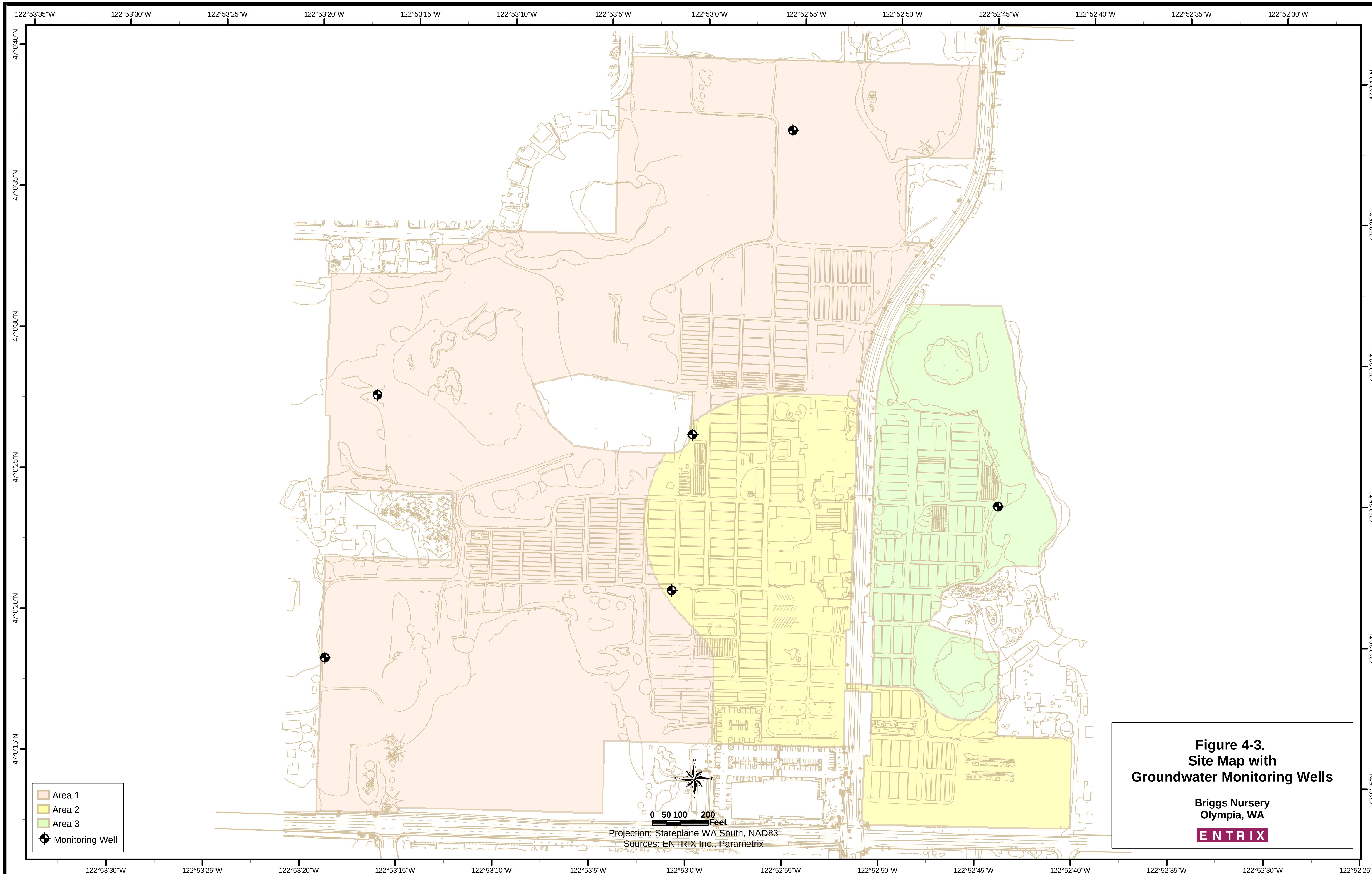

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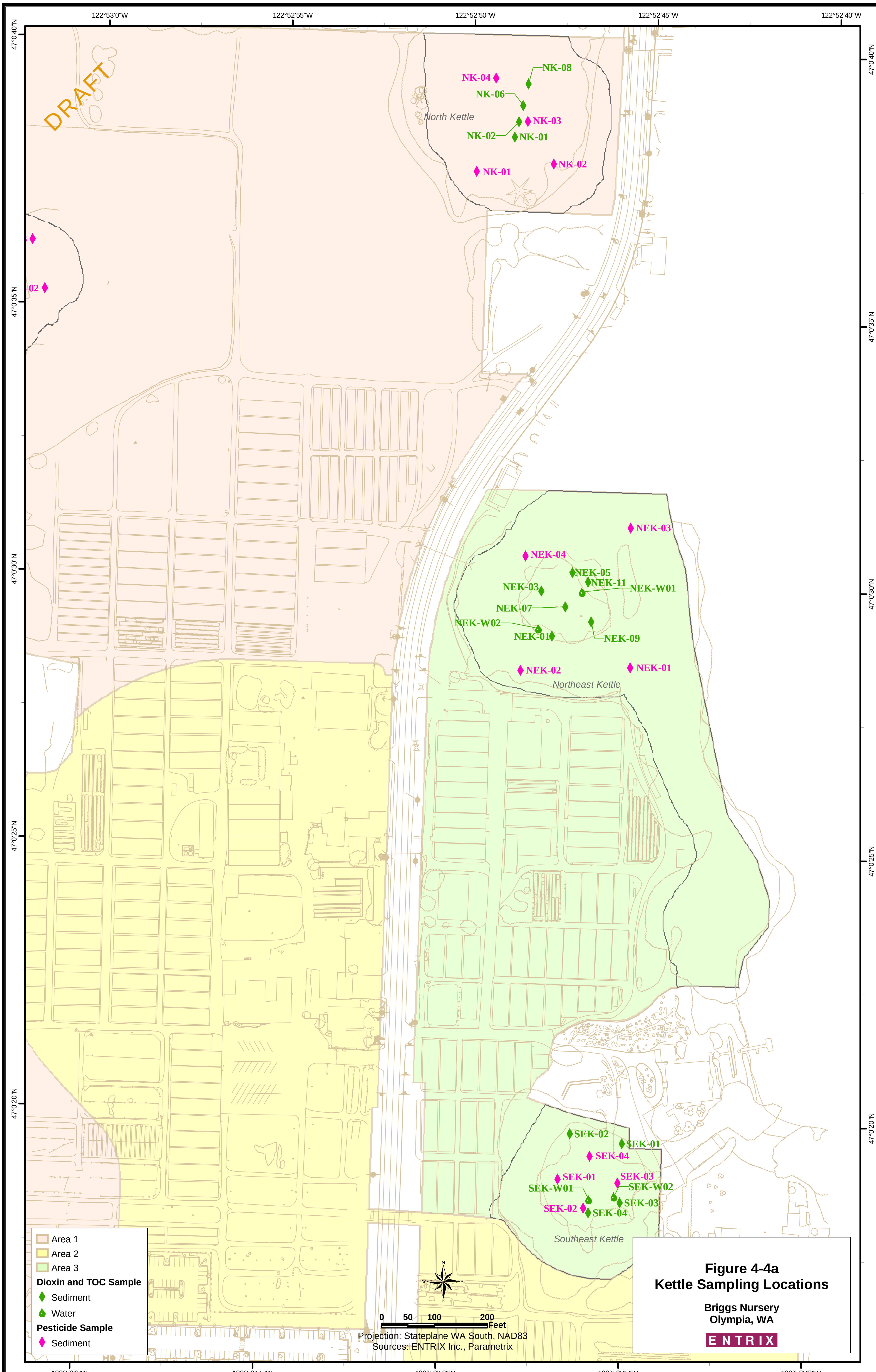

Figure 4-4a
Kettle Sampling Locations

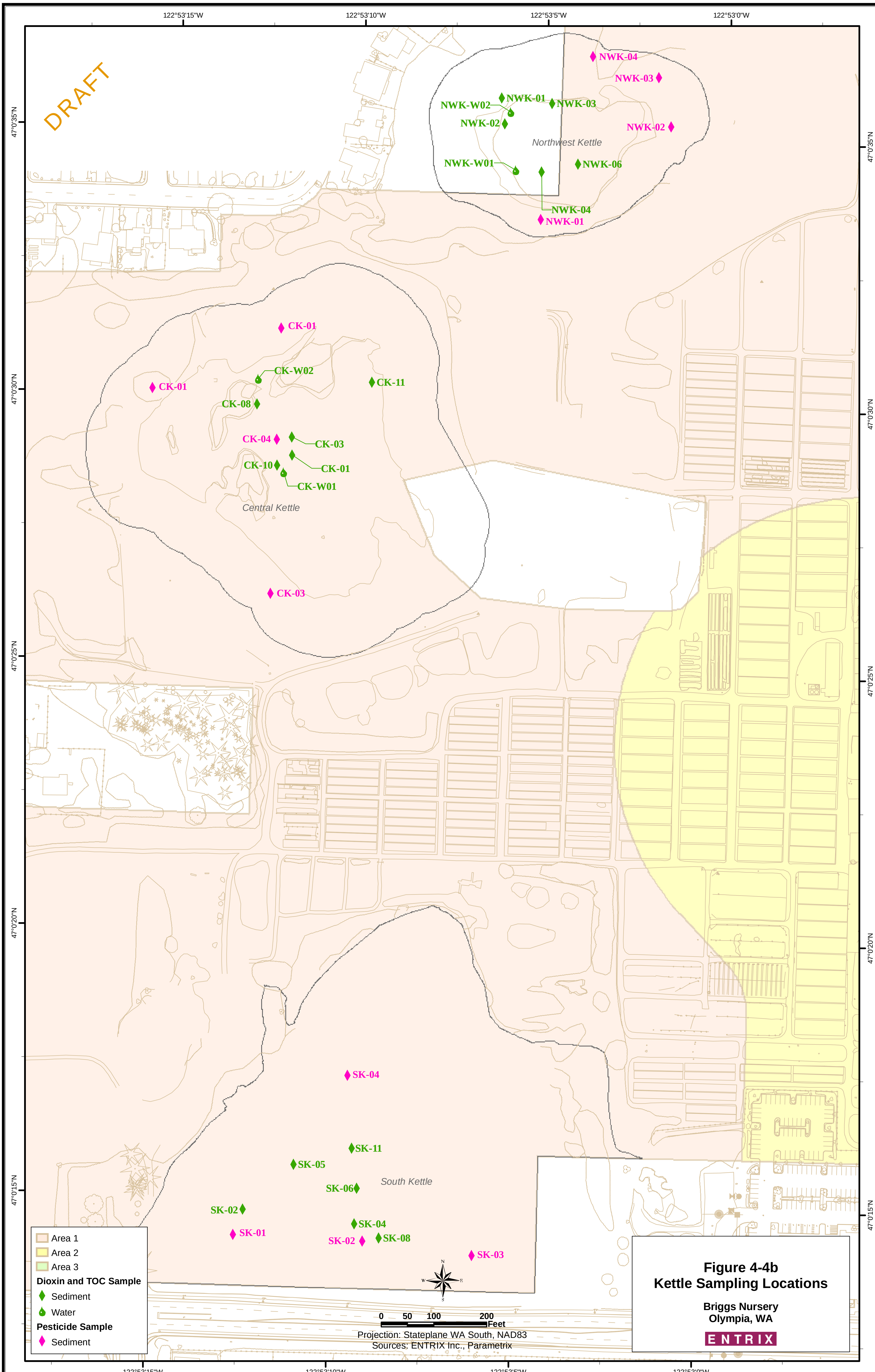

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Figure 7-1. Southeast Kettle Sediment PCDD/F Profile

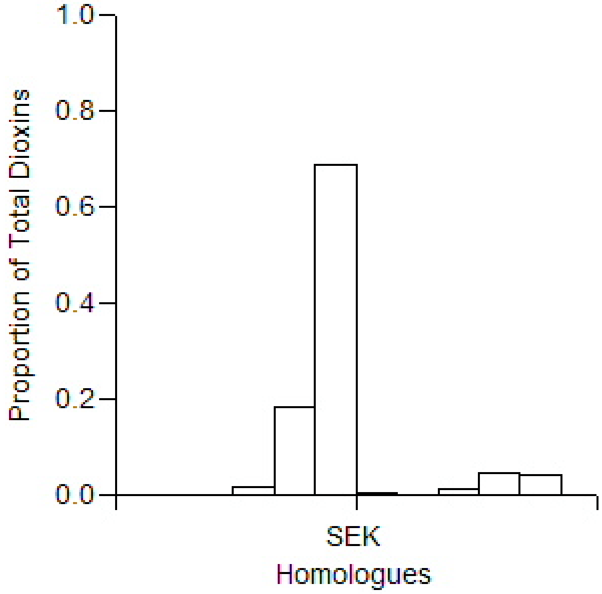


Figure 7-2. Central Kettle Sediment PCDD/F Profile

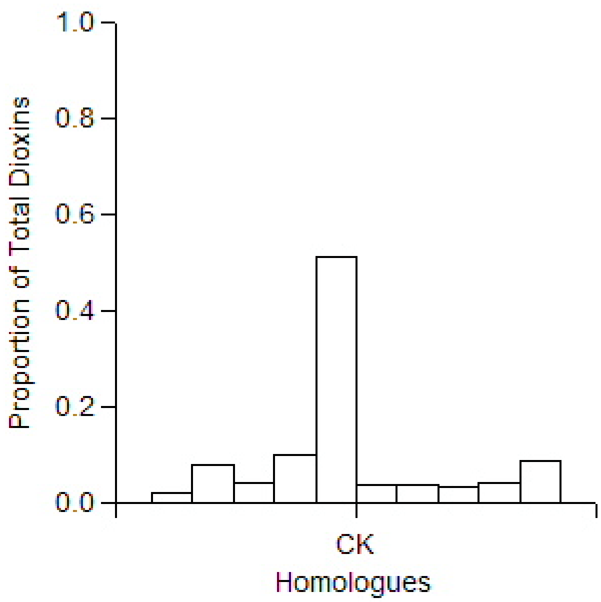


Figure 7-3. Northeast Kettle Sediment PCDD/F Profile

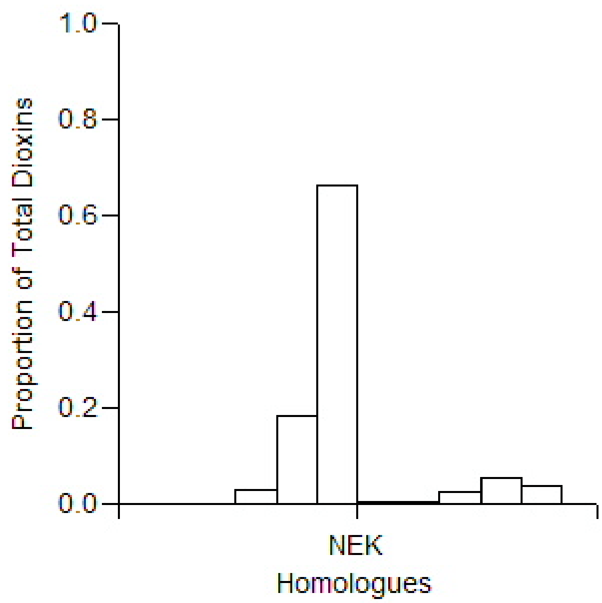


Figure 7-4. North Kettle Sediment PCDD/F Profile

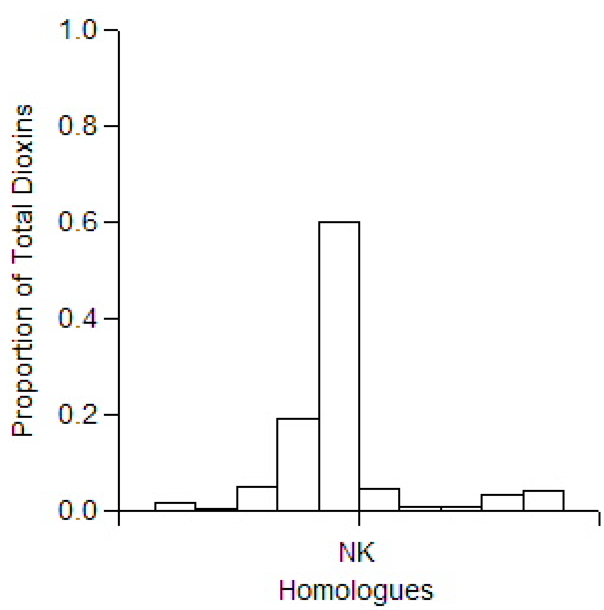


Figure 7-5. Northwest Kettle Sediment PCDD/PCDF Profile

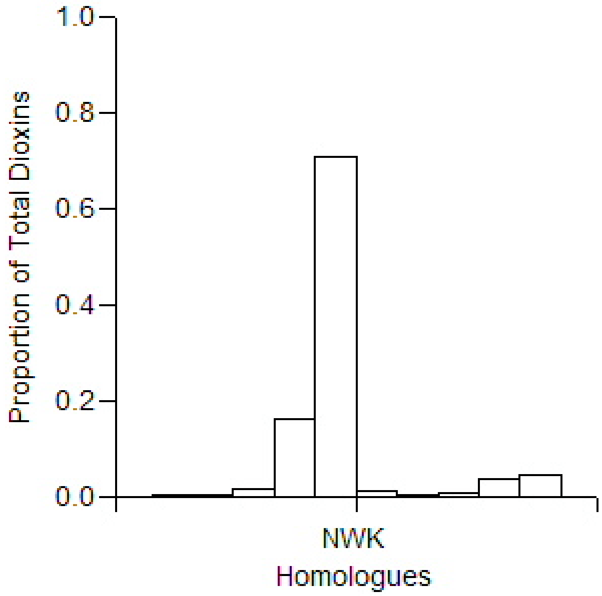


Figure 7-6. South Kettle Sediment PCDD/F profile

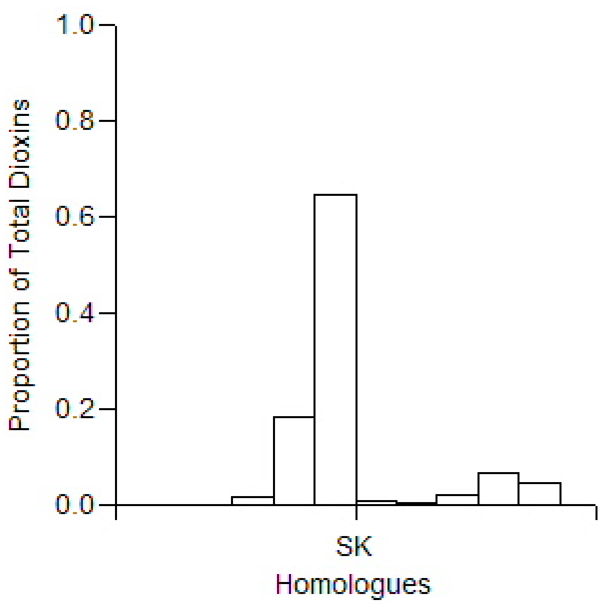


Figure 7-7. Henderson Boulevard Sediment PCDD/F Profile

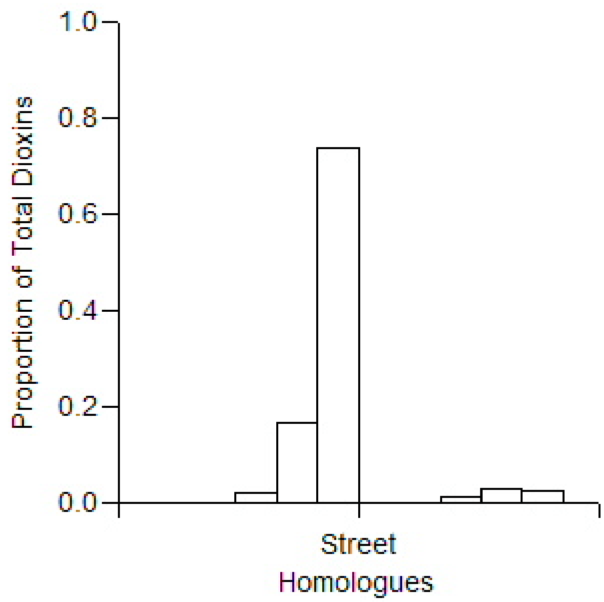


Figure 7-8. PVC Burn PCDD/F Profile

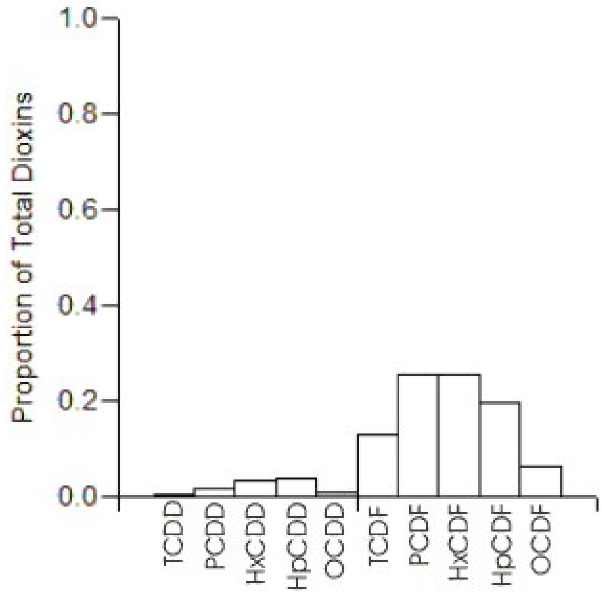


Figure 7-9. Fertilizer PCDD/F Profile

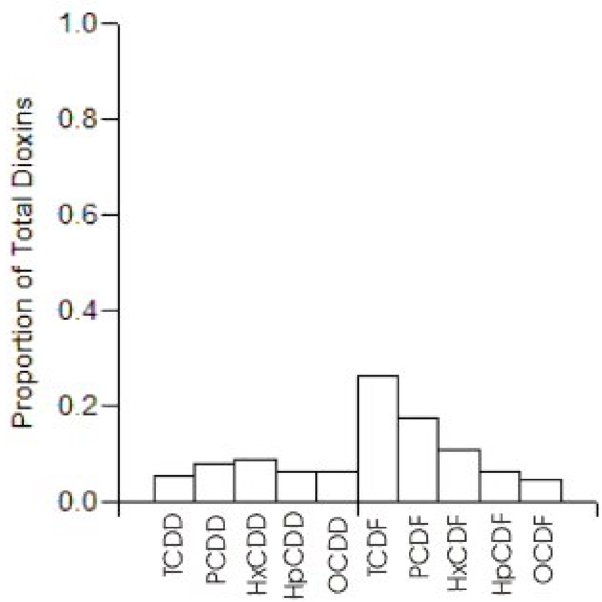


Figure 7-10. 2,4,5T Herbicide PCDD/F Profile

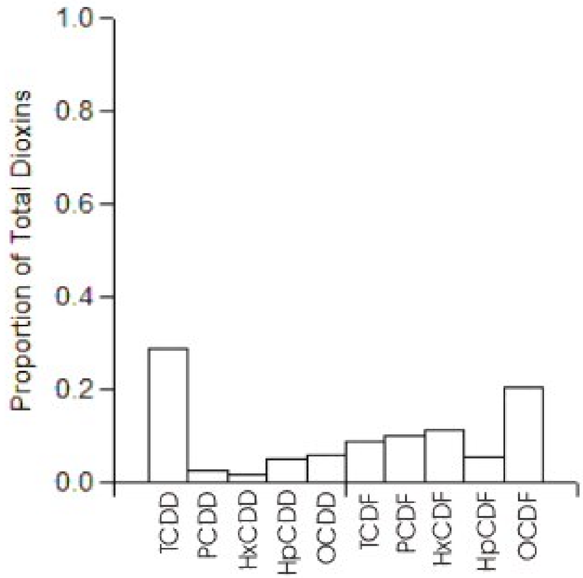


Figure 7-11. Pentachlorophenol PCDD/F Profile

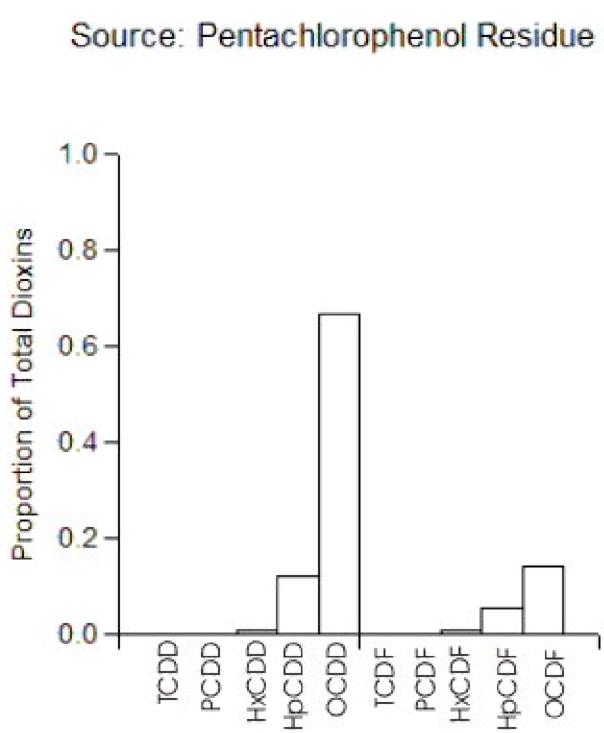


Figure 7-12. Trash burning PCDD/PCDF profile

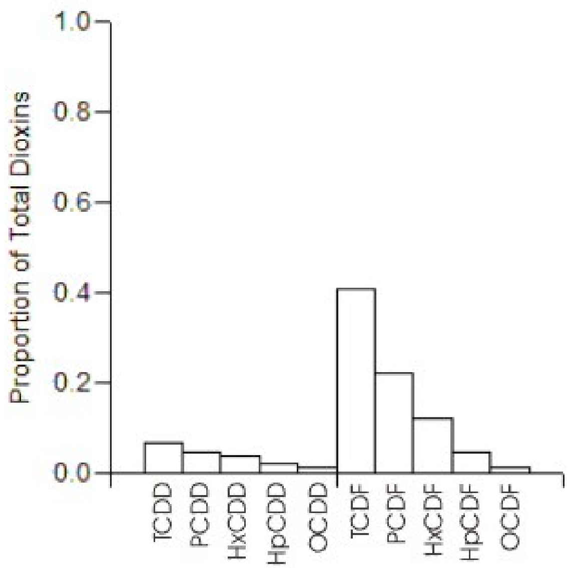
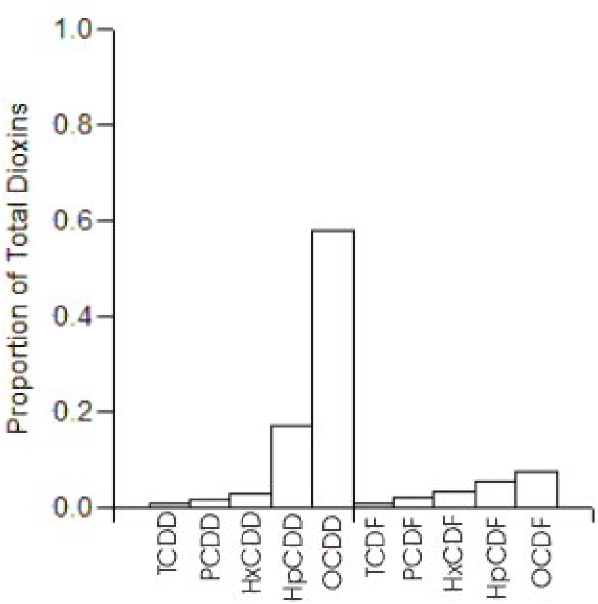
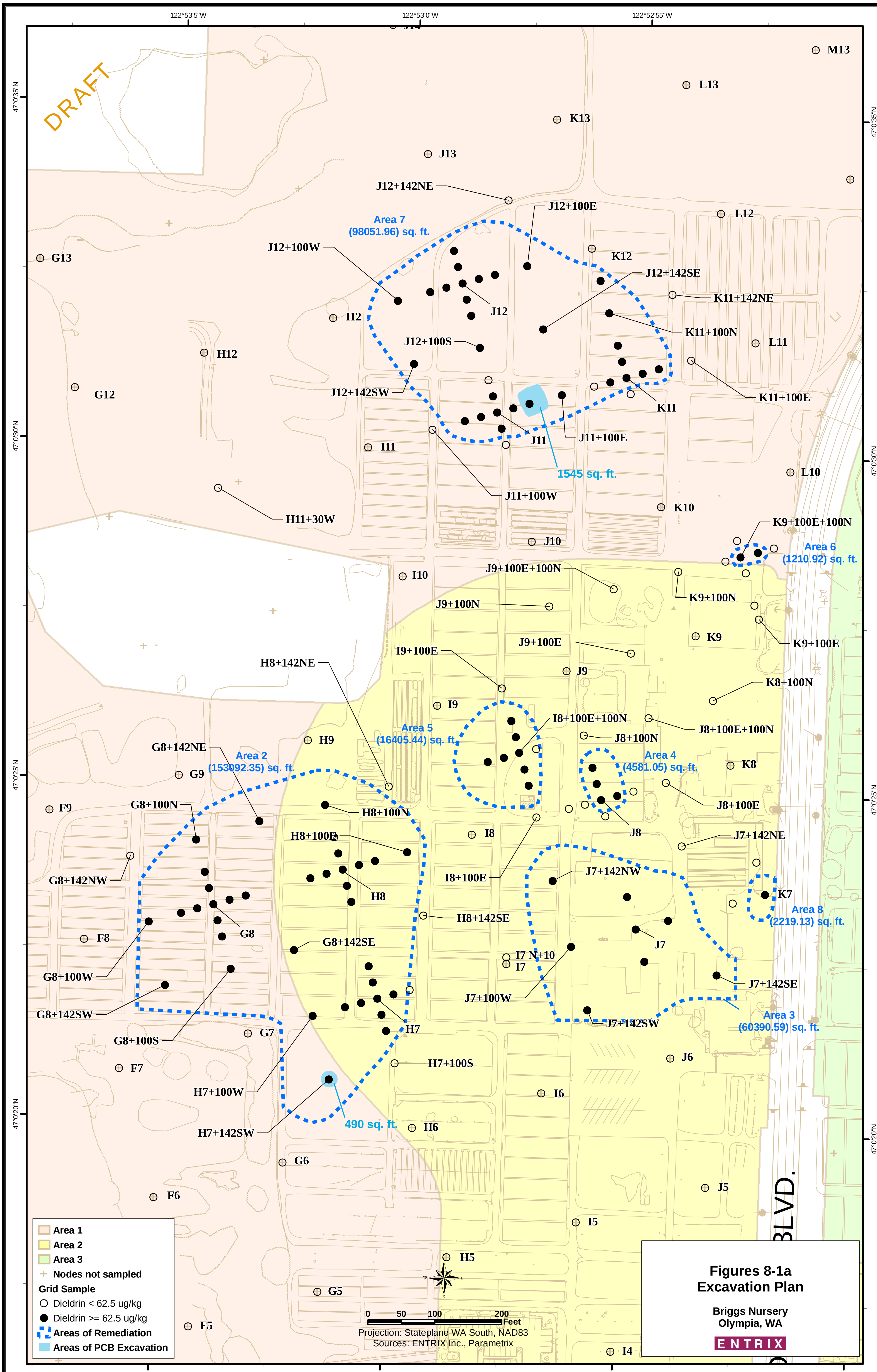


Figure 7-13. Stormwater outfall PCDD/PCDF profile





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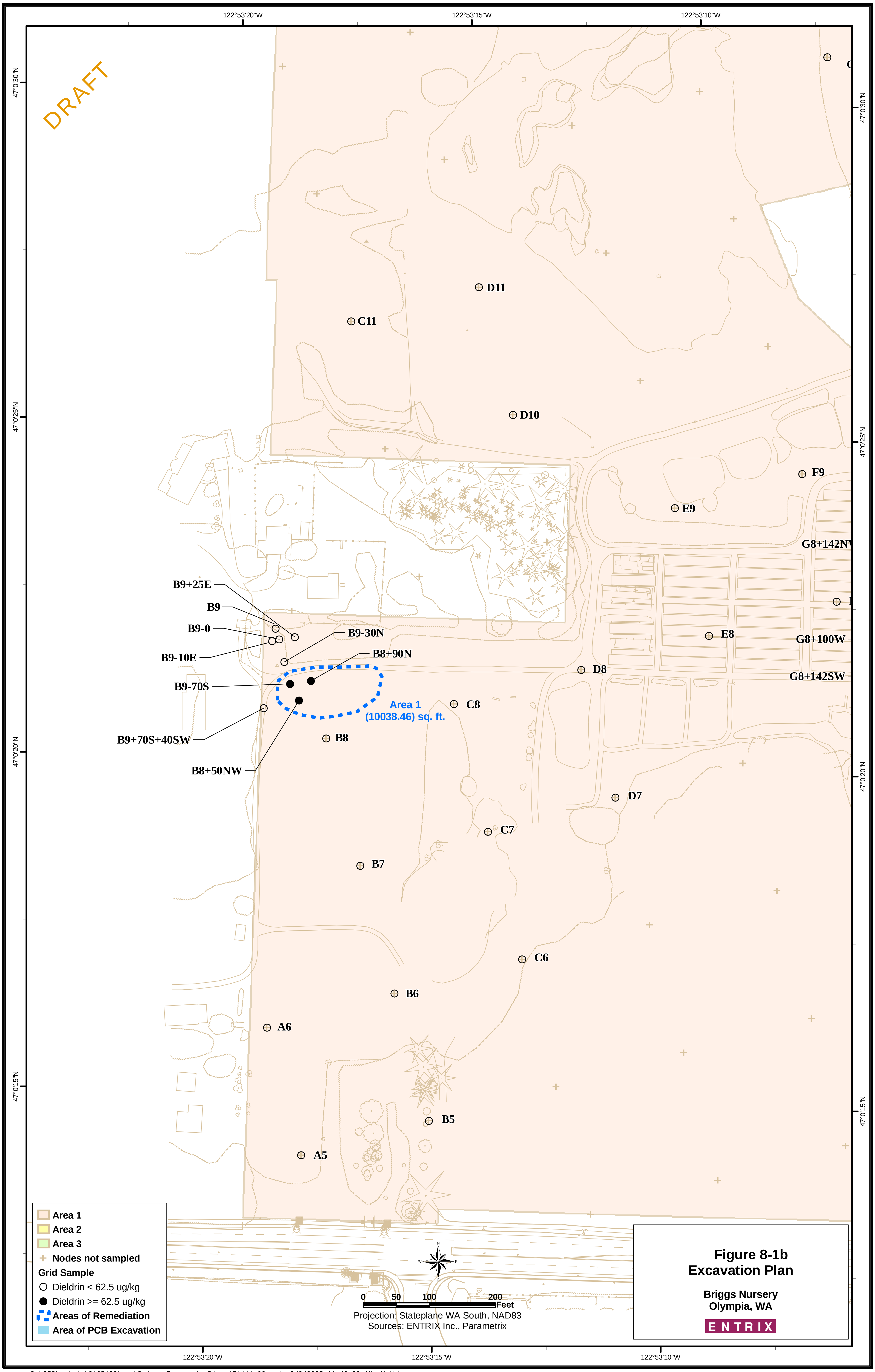

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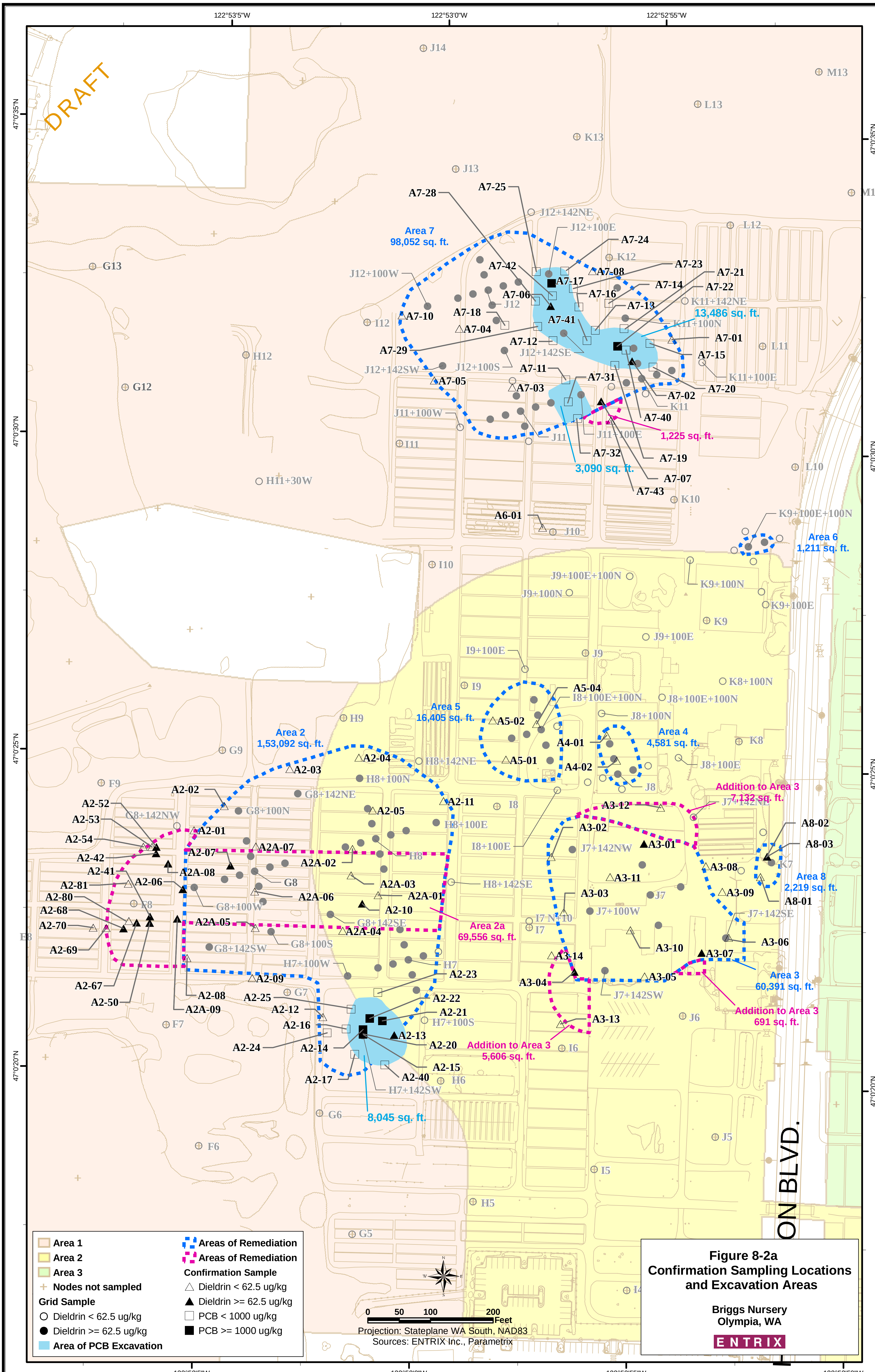

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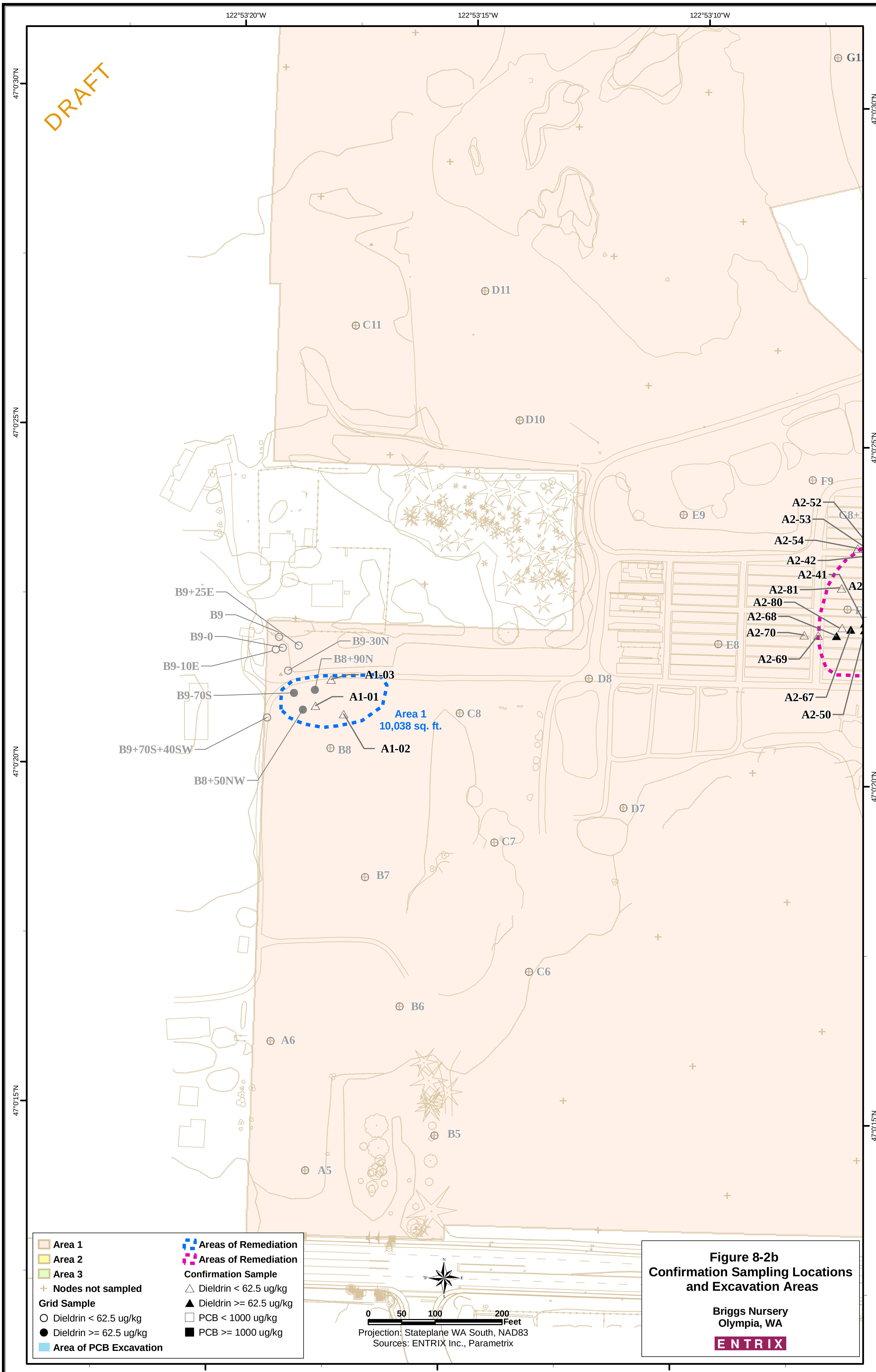

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122°53'20"W
122°53'15"W
122°53'10"W
47°0'30"N
47°0'25"N
47°0'20"N
47°0'15"N
D11
C11
D10
F9
E9
A2-52
A2-53
A2-54
A2-42
A2-41
A2-81
A2-80
A2-68
A2-70
A2-69
A2-67
A2-50
E8
D8
B9+25E
B9
B9-0
B9-30N
B9-10E
B8+90N
A1-03
B9-70S
A1-01
Area 1
10,038 sq. ft.
C8
B9+70S+40SW
B8
A1-02
B8+50NW
D7
C7
B7
C6
B6
A6
B5
A5
Area 1
Area 2
Area 3
Nodes not sampled
Grid Sample
Dieldrin < 62.5 ug/kg
Dieldrin >= 62.5 ug/kg
Area of PCB Excavation
Areas of Remediation
Areas of Remediation
Confirmation Sample
Dieldrin < 62.5 ug/kg
Dieldrin >= 62.5 ug/kg
PCB < 1000 ug/kg
PCB >= 1000 ug/kg
0 50 100 200
Feet
Projection: Stateplane WA South, NAD83
Sources: ENTRIX Inc., Parametrix
Figure 8-2b
Confirmation Sampling Locations and Excavation Areas
Briggs Nursery
Olympia, WA
ENTRIX