REMEDIAL INVESTIGATION WORK PLAN

Shelton C Street Landfill, Shelton, Washington

Prepared for: City of Shelton

Project No. 150074-04 • April 21, 2017 Final

earth + water

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Acronyms

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
Agreed Order	Agreed Order No. DE 12929
AOC	Administrative Order on Consent
AF/yr	acre-feet per year
ARARs	Applicable Relevant and Appropriate Requirements
bgs	below ground surface
BPA	Bonneville Power Administration
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
City	City of Shelton
CLARC	Cleanup Levels and Risk Calculation
COCs	constituents of concern
COPC	contaminant of potential concern
CSM	conceptual site model
DCA	disproportionate cost analysis
DU	Decision Unit
Ecology	Washington State Department of Ecology
EM	electromagnetic induction
ER	electrical resistivity
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
ISM	incremental sampling methodology
LEL	lower explosive limit
MCL	Maximum Contaminant Level
MFS	Minimum Functional Standards
MTCA	Model Toxics Control Act
NAVD88	North American Vertical Datum 1988

NTU	nephelometric turbidity unit
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PID	photoionization detector
ppb	parts per billion
PQL	practical quantitation limits
QA/QC	quality assurance/quality control
Qa	Quaternary alluvial deposits
Qc	Quaternary undifferentiated sedimentary deposits
Qgo	Quaternary proglacial or recessional outwash
Qgt	Quaternary glacial till
RCW	Revised Code of Washington
RI	Remedial Investigation
RI Work Plan	Remedial Investigation Work Plan
SHA	Site Hazard Assessment
SL	Screening Levels
SVOCs	semivolatile organic compounds
TEQ	toxic equivalent concentration
TPH	total petroleum hydrocarbons
VOC	volatile organic compound
WAC	Washington Administrative Code

1 Introduction

This Remedial Investigation Work Plan (RI Work Plan) presents the objectives and scope of work for a Remedial Investigation (RI) at the Shelton C Street Landfill, a former municipal waste landfill located in Shelton, Washington (the Site; Figure 1). The Site is located on a 16.7-acre parcel owned by the City of Shelton (the Property; Figure 1). The Property is at the west end of West C Street, just west of the overpass across US Highway 101 in Mason County, Washington (Figure 1). The City of Shelton (City) acquired the Property in 1928 and used portions of it as a municipal waste landfill through the early 1980s for disposal of solid waste generated within the City limits and the surrounding areas. The footprint of the landfill is approximately 3.9 acres; the extent of the Model Toxics Control Act Cleanup Regulation (MTCA) 'Site'[1] will be defined as part of the RI.

The RI Work Plan has been prepared to meet the requirements of Agreed Order No. DE 12929 (Agreed Order) between the Washington State Department of Ecology (Ecology) and the City, executed on September 30, 2016. The purpose of the RI is to collect, develop and evaluate sufficient information to select a remedial action. The RI will be conducted in accordance with Revised Code of Washington (RCW) 70.105D.010(1) and the Washington State MTCA, Chapter 173-340 of the Washington Administrative Code (WAC 173-340).

1.1 RI Objectives

The RI is intended to provide sufficient data and evaluation to enable Ecology to select a cleanup action in accordance with MTCA. The specific objectives of the RI are to:

- Obtain data of sufficient quality and quantity to describe the Site history, physical setting, and physical properties of soil, groundwater, and soil vapor;
- Provide a summary of previous investigations conducted at the Site, including existing chemical data relevant to evaluating the extent of contamination and identification of data gaps that require investigation to enable evaluation and selection of a cleanup action;
- Determine the nature and extent of contamination in all relevant media and characterize the fate and transport of identified contaminants, including how contaminants migrate between media;
- Use the information collected to evaluate potential risk to human health and the environment through complete exposure pathways under current and likely future land use scenarios;
- Identify likely cleanup components, cleanup standards and applicable state and federal laws that pertain to the cleanup action; and

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[1] Any area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located (WAC 173-340-200).

- Report the methods and findings of the RI to Ecology, stakeholders, and the local community.

The RI Work Plan describes the project objectives and organization, functional activities, and quality assurance/quality control (QA/QC) protocols that will be used to complete the RI.

1.2 RI Work Plan Organization

The RI Work Plan is presented in Sections 2.0 through 8.0.

- Section 2.0 presents the Shelton C Street Landfill history and background.
- Section 3.0 defines the physical, historical, and geographical setting of the Shelton C Street Landfill.
- Section 4.0 discusses previous investigations and existing data.
- Section 5.0 describes the preliminary conceptual site model for the Site, including sources and preliminary contaminants of potential concern (COPCs), the potential exposure pathways and receptors, and the applicable preliminary Site screening levels for the RI.
- Section 6.0 describes the data gaps the general approach for the RI to address those data gaps.
- Section 7.0 presents the RI deliverables and the project schedule.
- Section 8 presents the references used for the creation of this RI Work Plan.

Several appendices provide additional information:

- Appendix A Sampling and Analysis Plan
- Appendix B Historical Information

2 Project Location and Site History

This section describes the project location and a summary of ownership and operational history, including the documented waste disposal practices and regulatory actions. A significant amount of historical research pertaining to the Shelton C Street Landfill has been completed by others. This section presents a summary of that information. Appendix B includes the historical documents that were relied upon in preparation of this summary.

2.1 Project Location and Description

The Property is currently vacant, undeveloped land, covered by shrub vegetation and trees (Figure 2). The Property is located outside of the city limits, but within the Shelton Urban Growth Area and is zoned Public Institutional, for which permitted uses include government buildings, cultural facilities, churches, public utilities, and parks or open space (Figure 3). A 250-foot-wide strip of land along the eastern edge of the Property is a utility right-of-way and includes transmission towers, overhead electrical transmission lines, and a buried natural gas pipeline (Figure 2). The surface topography indicates a bowl-like depression near the center of the Property that reflects the limits of historical aggregate mining and subsequent landfilling. Portions of a paved access road that was formerly used to access the base of the bowl-like depression remain in place. Public access to the Property is restricted by a locking gate approximately 1,500 feet east of the Property on West C Street and signage indicating restricted access.

The Property is bound to the west and south by active gravel mining operations of the Miles Sand & Gravel Shelton Plant and Pit; to the east by Washington State Department of Transportation right-of-way and US Highway 101, beyond which is more active mining land owned by Miles Sand & Gravel; and to the north by vacant forest land (Figure 2). The land surrounding the Property is mostly zoned Industrial except to the north where it is zoned Rural Residential (Figure 3).

2.2 Site History

This section describes the Site history through property ownership, landfilling history, and regulatory history. To offer some historical context, Figure 4 provides a series of historical aerial photos that depict the landfill activities between 1965 and 1989. Earlier aerial photographs were not located.

2.2.1 Property Ownership

Before 1928, the Property was owned by private owners and mined for sand and gravel aggregate. The Property was purchased by the City in May 1928, including both the parcel and a perpetual easement for access, and landfilling activities started in approximately 1928. In July 1931, the City sold the property to Rainier Pulp and Paper Company, but retained the right to continue to use the land as a garbage dump. Rayonier, Incorporated, successor of Rainier Pulp and Paper Company, sold the property back to the City in July 1949 except for a 250-foot-wide strip for which Rayonier granted an easement to Bonneville Power Administration (BPA) in August 1949. An additional transmission line easement, consisting of 62.5 feet on the west side of the BPA easement, was conveyed from the City to the United States of America in 1956. In 1972, the City transferred 1.44 acres of property, located on the east side of the BPA easement, to the State of Washington for highway improvements and public rights-of-way.

2.2.2 Landfilling History

The landfill received municipal solid waste between approximately 1928 and the mid-1980s. Early on, waste consolidation practices included open burning and on-property incineration, common for the era. Documented waste streams disposed at the landfill and waste management practices included:

- Between 1931 and 1934, the landfill received by-products from the Rainier Pulp and Paper Company pulp mill in Shelton.
- Between 1931 and 1974, the landfill reportedly received waste from the Rayonier research laboratory, demolition debris from decommissioning of the Rayonier pulp mill, and sludge from a Port of Shelton Imhoff tank (a chamber used for reception and processing of sewage).
- From the mid-1950s to the mid-1960s, an incinerator constructed on the landfill property reportedly burned garbage.
- Between 1951 and 1981, the landfill was reportedly used for disposal of the City's wastewater treatment-plant sludge.
- Between 1976 and 1981, processed wastewater sludge containing fly-ash material was disposed of in the landfill. The light, fly-ash baghouse residue (consisting of one-third unburned or charred wood residue and two-thirds salt) was generated by a wood-burning, boiler power plant at the Simpson Timber Company Shelton timber mill. One report documents that approximately 4.5 million gallons of sludge was disposed into a 100- by 150-foot area of the landfill between July 1979 and November 1981 (CH2M Hill, 1986).

Additional details pertaining to historical ownership and regulatory activities are summarized below.

2.2.3 Regulatory History

In September 1973, the US Environmental Protection Agency (EPA) notified Ecology of an August 1973 inspection of the 'Shelton dump site' in which they found it to be in violation of "Regulation I, Section 9.01 of the Olympic Air Pollution Control Authority" and requested any information that EPA should consider prior to issuance of a notice of violation to the "Shelton City Dump" (EPA, 1973). A response letter dated October 15, 1973, from Ecology indicated that an implementation schedule was in place, and approved by the Olympic Air Pollution Control Authority, to work towards cessation of open burning at the Shelton dump (Ecology, 1973). The letter further indicated that open burning at the Shelton dump would stop on January 31, 1974, and that a new central sanitary landfill site would begin operation in August 1974. An EPA Land Disposal Site Modification report, dated May 1975, indicates that the Shelton Dump site has been 'eliminated' with 'rats eradicated, burning stopped, water pollution corrected, and site covered' (EPA, 1975).

In May 1986, EPA and Simpson Timber Company announced that dioxin compounds were detected in baghouse ash from a wood-fueled boiler at the Simpson mill power plant during a national EPA study to evaluate dioxin contamination in the environment (EPA, 1986a). A study to determine whether this contamination was present at the Shelton C Street Landfill is detailed below in Section 4.

A July 2, 1986, Ecology inspection of the Shelton Dump, C-Street indicated that the landfill was still being used for disposal and identified recent dumping of vegetative debris, small quantities of trash and household debris, and disposal of sewage treatment-plant sludge (Ecology, 1986).

EPA issued an Administrative Order on Consent (AOC) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to the Simpson Timber Company, effective September 26, 1986, to investigate potential releases of dioxins and furans to the environment associated with wastewater treatment-plant sludge disposal at three Shelton-area landfills (CH2M Hill, 1986), and to “determine the nature and extent of any threat to the public health or welfare or the environment that may be caused by the release or threatened release of hazardous substances, specifically dioxins and furans…” (EPA, 1986b). One of the specific objectives of the study was to determine the dioxin and furan content of sludge at the Shelton C Street Landfill. A discussion of the activities completed under the AOC is provided in Section 4.

On January 4, 1988, the *Correction and Closure Plan: Shelton Landfill Disposal Facility*, prepared by Brown and Caldwell, provided recommendations to implement corrective actions and landfill closure (Brown and Caldwell, 1988). Specifically, the plan called for placement of 2 feet of soil cover over sludge soils, request for a variance to allow for site closure without a groundwater monitoring system, and recommended new and larger signs as additional access control measures. There is no information that indicates whether these recommendations were implemented.

In a June 8, 2004, letter, Ecology notified the City of a pending Site Hazard Assessment (SHA; Ecology, 2004). SHAs are conducted as a preliminary assessment of a site to assign a hazard ranking; hazard ranking scores range from 1 to 5, where a 1 represents the highest level of risk and a 5 the lowest. These scores are used to help Ecology prioritize cleanup sites to work on. On June 5, 2014, Ecology published the SHA indicating an overall rank of 3, which appears to be based primarily on potential risk to human health through migration of contaminants via groundwater from the landfill to drinking water sources, even though releases to groundwater have not been documented.

2.3 Current and Future Land Use

The current land use for the Property includes the former municipal landfill. A 250-foot-wide strip of land along the eastern edge of the Property is a utility right-of-way and includes a buried natural gas line, electrical transmission towers, and overhead electrical transmission lines. Aside from electrical transmission towers, there are no structures on the Property.

Land use at neighboring parcels is currently limited to mining activities at the Miles Sand & Gravel pit to the south and west.

Future land use for the Property is uncertain, and the Feasibility Study (FS) will assume development consistent with current zoning and easements. The Property is located outside of the city limits, but within the Shelton Urban Growth Area and is zoned Public Institutional, for which permitted uses include government buildings, cultural facilities, churches, public utilities, and parks or open space.

A large development project is being planned for parcels directly to the north and northwest of the Property. This project is anticipated to convert 604 acres of currently vacant, vegetated area into a mixed-use commercial, residential, and recreational development.

3 Site Environmental Setting

The physical characteristics of the Site and its immediate vicinity are described in this section. After overviews of topography, surface drainage, and climate, the text details hydrologic conditions at the Site and notes existing uses of groundwater in the Site vicinity.

3.1 Topography and Surface Drainage

The topography of the area is detailed in the US Geological Survey (USGS) 7.5-minute topographic map *Shelton Valley Quadrangle, Washington—Mason Co* (USGS, 2014). It indicates an estimated 20-foot, bowl-like depression at the approximate center of the Property (not including the transmission line easement) that reflects the limits of historical aggregate mining and subsequent landfill operations. The high points on the property surround the center depression in a bowl and sit at approximately 200 feet relative to the North American Vertical Datum of 1988 (NAVD88). The ground surface within the bowl, corresponding to the current surface of the landfill, is approximately 160 feet NAVD88.

The Property lies within the Kennedy-Goldsborough watershed (Figure 6). The nearest surface water body is Goldsborough Creek that flows to the west and south of the Property, beyond the adjacent gravel mining operations, and drains into Oakland Bay approximately 2 miles east of the Property. Goldsborough Creek is located approximately 0.4-mile from the Property and drops in elevation from approximately 100 feet NAVD88 (west of the Property) to 50 feet NAVD88 south of the Property.

3.2 Climate

The Shelton area lies in a temperate maritime climatic zone characterized by long, wet winters and relatively dry summers. Mean annual precipitation near the Site is 66 inches; historically, July and August are the driest months, and 48 percent of annual precipitation falls in November through January (1948–2002; Washington Regional Climate Center, 2012). The nearest weather station, maintained by the Washington State Department of Transportation, lies approximately 1.5 miles to the north of the Site at the Sanderson Field airport.

3.3 Geology and Hydrogeology

The Site is in a region referred to as the Puget Lowland, characterized by heterogeneous, glacially deposited sediments within a large topographic basin. Geologic maps identify the surface unit at the Site as Quaternary proglacial or recessional outwash (Qgo) deposited during the Vashon Stade of the Fraser Glaciation (Figure 7) (Logan, 2003). These materials are described as heterogeneous, poorly consolidated sand and gravel deposits. Uphill and north of the Site, the surface unit is highly compacted Quaternary glacial till (Qgt), which stratigraphically underlies the Qgo. Southwest of the Site, there are younger alluvial and undifferentiated sedimentary deposits (Qa and Qc, respectively) in the valley containing Goldsborough Creek (Figure 7).

Regionally, the *Final WRIA 14/ Kennedy-Goldsborough Watershed Phase II Hydrogeologic Investigation* indicates that the area contains six main geologic units, three that act as regional groundwater aquifers, and three that act as aquitards (Northwest Land and Water, 2005). The uppermost groundwater aquifer, identified as Unit A in hydrogeologic studies and reports for the Site vicinity, consists of sand and gravel ranging up to 120 feet in thickness that may locally interact with surface water bodies (GeoEngineers, 2013). The groundwater flow direction within Unit A, in the Property vicinity, is estimated to be towards the southeast (GeoEngineers, 2013). Based on the surface water of Goldsborough Creek and observed seasonal ponding on the south-adjacent mining site, groundwater at the Site is estimated to be present at depths ranging from 70 to 100 feet below ground service (bgs), equivalent to elevations ranging from 90 to 60 feet NAVD88.

Hydrogeologic cross sections created for the Final WRIA 14 report pass near the Property and show Unit A overlying a confining layer of till (Unit B) atop an intermediate aquifer (Unit D), a deep aquitard of fine or silty sand (Unit E), and the deepest, highly permeable aquifer (Unit F) overlying bedrock as deep as 600 feet bgs (Northwest Land and Water, 2005). A regional cross-section, prepared partially based on the well logs noted in Section 3.4, is included as Figure 8 and conceptually depicts these units in the Site vicinity.

3.4 Groundwater Use

The shallow aquifers, Units A and D, are the most common groundwater sources of drinking and industrial water supply in the region. These aquifers are high yielding and can deliver water at up to 1,500 gallons per minute (Golder Associates, 2002). Of the private wells in the area, most are sourced out of the Unit A shallower aquifer (Northwest Land and Water, 2005). The City of Shelton municipal water is sourced from the Shelton Springs and from the Unit F aquifer through two deep wells that are located approximately 1.5 miles northeast of the Site (Northwest Land and Water, 2005). The estimated total groundwater usage for the subbasin that contains Goldsborough Creek and the Site is 22,514 acre-feet per year (AF/yr), of which 18,436 AF/yr is for commercial and industrial uses (Golder Associates, 2002).

A query was made on the Ecology well log database to identify water supply wells that lie within ¼ mile of the Site. There are four wells on record that lie to the east or southeast of the Site, presumably downgradient from the Site. The nearest to the property is a well owned by Rayonier, likely for industrial usage. It was completed in 1942, reaches 742 feet bgs into the Unit F aquifer, and exhibits flowing or artesian conditions (GeoEngineers, 2013). To the southeast, the second well is owned by Exceptional Foresters for domestic usage. It was drilled in 1984 to a depth of 190 feet bgs, and had a static water level 70 feet bgs at the time of drilling. The third well is owned by Leroy Saboe, presumably for domestic use. It was drilled in 1983 to a depth of 208 feet bgs, and had a static water level at 14 feet bgs. The last well is an industrial supply well owned by Scott Hilburn. It was drilled to 230 feet bgs, and had a static water level at 15 feet bgs at the time of drilling.

4 Previous Investigations and Existing Data

There has been limited investigation of the Site to date. The only known study is an investigation of the Site conducted following the completion of a national EPA study of dioxin/furan-contaminated sites. This study identified the baghouse ash from the Simpson Timber Company's wood-burning boiler as a source of dioxin.

A 1986 Dioxin Sampling Plan (CH2M Hill, 1986), prepared to meet the requirements of the AOC, indicates that baghouse residue mixed with municipal sludge was discharged into a 100- by 150-foot area of the Shelton C Street Landfill. The Final Dioxin Study Report (CH2M Hill, 1987) documents sampling results, including those collected to "determine the chlorinated dioxin and furan content of the residual sludge at the City of Shelton landfill (the only landfill with uncovered deposits of potentially contaminated sludge)."

Ten surface soil samples, collected from the sludge-disposal area at the landfill, were collected between the ground surface and 4 inches bgs and composited for laboratory analysis of dioxins and furans. The specific sampling locations within the landfill are not documented. In addition, soil samples from outside of the sludge-disposal area were collected from two vertical intervals (0 to 3 inches bgs and 3 to 6 inches bgs) for analysis of particle-size distribution and organic carbon content; the sample locations are depicted on Figure 5.

The results of the investigation are presented in the Final Dioxin Study Report (CH2M Hill, 1987). Based on the particle-size distribution, soils at the Site were classified as gravelly sandy loams to very gravelly sands and contained about 25 percent gravel by volume. The total organic carbon content ranged from 12 to 40 percent, but averaged 35 percent for the gravelly sandy loam that was most prevalent in the samples (CH2M Hill, 1987). The laboratory chemical results detected the principal congener of concern, 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) at 0.17 parts per billion (ppb) with a total 2,3,7,8-TCDD toxic equivalent concentration (TEQ)[2] of 3.1 ppb (CH2M Hill, 1987).

The EPA Report of Dioxin Study Findings and Announcement of Public Meeting, dated April 13, 1987, discussed these results. The conclusions made by EPA based on the investigation results included the following:

- The vertical migration of 2,3,7,8-TCDD was likely limited to 6 inches based on the adsorption capacity of the landfill soils and the expected increased binding capacity over time as organic material decomposes.

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[2] To evaluate cleanup level compliance for mixtures of dioxins and/or furans, the TEQ is calculated by multiplying each dioxin and furan congener by its corresponding toxicity equivalency factor and then adding the toxic equivalent concentrations of all the congeners to obtain a total toxic equivalent concentration of 2,3,7,8-TCDD (WAC 173-340-708[8][d]).

- Leaching of 2,3,7,8-TCDD into groundwater was extremely unlikely given the immobility of dioxins/furans and the presence of organic carbon in landfill soils that further decrease potential leaching.

EPA further concluded that there did not appear to be any exposure to dioxins/furans, given the site conditions, but that potential exposure because of dioxin/furan-containing sludge at the ground surface could not be quantified (EPA, 1987).

5 Preliminary Conceptual Site Model

A preliminary conceptual site model (CSM) for the Shelton C Street Landfill was developed to evaluate potential pathways by which receptors can be exposed to contaminants of potential concern (COPCs). The results of the RI will be used to refine this CSM as basis for identification of the constituents of concern (COCs) and cleanup levels during the FS. The preliminary CSM is described below, followed by more detailed descriptions of potential exposure pathways as the basis for the development of Site Screening Levels (SLs) to be used for the RI.

5.1 Preliminary Constituents of Potential Concern

Except for some old and limited data for dioxins/furans, as discussed above, there has been no investigation into the presence of COPCs at the Site. Because of this, a broad list of COPCs has been developed for evaluation during the RI. The list of COPCs comprises three categories:

- Chemicals commonly associated with municipal landfills and/or included in landfill compliance monitoring and closure requirements;
- Chemicals documented to be present; and
- Chemicals potentially present based on the reported and/or suspected disposal of waste from demolition and operation of local pulp, paper, and timber mills.

A description of each of these categories, and the specific chemicals associated with them, is provided in the following sections.

5.1.1 Landfill Chemicals of Potential Concern

Most waste, by volume, in the Shelton C Street Landfill is assumed to be municipal solid waste, defined by WAC 173-350 as waste consisting of unsegregated garbage, refuse, and similar solid waste materials discarded from residential, commercial, institutional, and industrial sources and community activities. The primary COPCs are those that are either typically associated with municipal waste landfills and/or required to demonstrate compliance with state laws and regulations regarding groundwater quality near the landfill. The preliminary COPC groups include the following:

- Metals, including priority pollutant metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and silver) and geochemical indicator trace metals (calcium, iron, magnesium, manganese, sodium, and zinc).
- Total petroleum hydrocarbons (TPH).
- Volatile organic compounds (VOCs).
- Semivolatile organic compounds (SVOCs), including polycyclic aromatic hydrocarbons (PAHs).
- Pesticides and herbicides.

- Other geochemical indicator parameters, including alkalinity, ammonia, chloride, cyanide, nitrate, nitrite, and sulfate.

The specific chemicals under each COPC group are presented in Tables 1 through 3.

5.1.2 Chemicals Documented to be Present

Based on the site background information compiled and reviewed in preparation of this RI Work Plan, as summarized above, there is little existing chemical data for the Shelton C Street Landfill. The results of limited investigation activities performed in the 1980s identified the presence of dioxins and furans in sludge/surface soil at the Shelton C Street Landfill. Based on this, dioxins and furans are preliminary COPCs.

5.1.3 Chemicals Associated with Mill Waste Disposal and Others

Early in its operation (1931–1934), the landfill reportedly received by-products from the Rayonier (formerly Rainier Pulp and Paper) pulp mill. Additionally, as described in detail in the sections above, dioxins and furans are documented to be present in wastewater treatment-plant sludge that contained baghouse ash from the Simpson Timber Company timber mill and placed in the landfill. The Correction and Closure Plan (Brown and Caldwell, 1988) indicated periodic disposal of waste under special permit, including dredge spoils from Oakland Bay, old dock timbers from rework of one of the mill facilities, demolition debris from decommissioning of the Rayonier pulp mill, and residues from cleanup of a hardware store fire. In addition to those chemicals already presented above, the COPCs associated with these miscellaneous waste disposal activities include:

- Polychlorinated biphenyls (PCBs); and
- Total sulfide.

5.2 Exposure Pathways and Receptors

An exposure pathway describes the mechanisms by which human or ecological exposure to a contaminant can occur under current conditions, assuming no remedial action or protective control is in place. To be considered complete, an exposure pathway has the following characteristics:

- An identified source of contaminants;
- A mechanism for contaminant release and transport from the source;
- An exposure route through which contact with the contaminant can occur; and
- A receptor that can be exposed to the contaminant.

An exposure pathway is considered complete if a human or ecological receptor can be exposed to a contaminant via that pathway. A qualitative evaluation of potential exposure pathways was conducted for this RI Work Plan to assess whether exposure pathways are potentially complete from sources to human or ecological receptors. The RI will characterize potential exposure pathways to determine whether remedial actions are necessary to protect human health and the environment.

Current and potential future exposure pathways and receptors consider reasonably anticipated future site use(s). In contrast to the Public Institutional zoning of the Shelton C Street Landfill property, the surrounding properties are primarily zoned Industrial, where current and future surrounding land use is primarily aggregate mining. Public access to the landfill property, and the surrounding aggregate mining properties, is restricted for safety reasons. However, illegal public access of the landfill property for recreational use is evident by the presence of off-road vehicle trails. With this setting and current and potential future site uses, the following exposure pathways and receptors are applicable:

- Soil/landfill waste leaching to groundwater. Contaminants in soil and landfill waste can leach to groundwater by infiltration of precipitation through contaminated soil and landfill waste, or where groundwater is in contact with contaminated soil or landfill waste.
- Ingestion of groundwater. Human receptors have the potential to contact contaminants in groundwater via ingestion. The presence, nature, and extent of COPCs in groundwater will be evaluated during the RI to determine whether ingestion of groundwater is a complete pathway.
- Direct contact with soil and landfill waste. Human and terrestrial receptors have the potential to contact contaminants in surface and shallow subsurface soil under current exposure scenarios.
- Soil vapor/landfill gas discharge to ambient air. Soil vapor/landfill gas has the potential to be explosive and to migrate and expose ambient air receptors to volatile contaminants.

Groundwater discharge to surface water in Goldsborough Creek is a potential migration pathway, with potential exposure to human and ecological receptors through direct contact. However, the nearest expression of surface water in Goldsborough Creek is located approximately 0.4 mile to the southeast, which is the presumed downgradient location from the landfill. The nature and extent of an impacted groundwater plume emanating from the landfill will be fully characterized during the RI, including potential risks to human health and the environment associated with groundwater discharge to surface water if it is determined to be a complete migration pathway.

5.3 Proposed Site Screening Levels

This section presents the proposed Site SLs, values that will be used to evaluate data collected during the RI to assess the nature and extent of contamination at the Shelton C Street Landfill site. The proposed Site SLs have been developed based on the current and potential future exposure pathways and receptors, as presented in the previous section, and applicable regulatory criteria. The proposed Site SLs are not cleanup levels, they are intentionally conservative, representing the most stringent of the relevant and appropriate criteria for all potential exposure pathways. Site-specific cleanup levels will be developed during the FS following completion of the RI.

5.3.1 Soil

Landfill refuse is heterogeneous and, for purposes of cleanup, assumed to be impacted with regulated hazardous substances. Under MTCA, it is not necessary to investigate the presence, nature, or extent of COPCs in the landfill refuse. Ecology recognizes the need to use engineering controls, such as containment, for sites that contain large volumes of materials containing relatively low levels of hazardous substances (WAC 173-340-370(3)), where treatment or removal is impracticable. MTCA allows for containment to be the preferred remedy for historical landfill sites and uses the Minimum Functional Standards (MFS) established in WAC 173-304 as a relevant and appropriate requirement (WAC 173-340-710(7)(c))[3]. Therefore, the soil criteria, including the proposed Site SLs and final cleanup levels, apply to soil within the MTCA Site, but outside of the refuse footprint of the landfill.

The proposed Site SLs for soil include consideration of the following:

- MTCA Method B cleanup levels from the Ecology Cleanup Levels and Risk Calculation (CLARC) database.
- Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals.
- Natural Background Soil Metals Concentrations in Washington State (Ecology, 1994).
- Natural Background for Dioxins/Furans in Washington soils (Ecology, 2010).

The proposed Site SLs are the lowest published values of the MTCA Method B cleanup level and the Ecological Indicator Soil Concentration, adjusted upward if appropriate when compared to background concentrations and laboratory practical quantitation limits (PQLs), in accordance with MTCA (WAC 173-340-709 and -705(6)). There are no MTCA Method B cleanup levels for TPH, so the MTCA Method A cleanup levels are used. The proposed Site SLs for soil are summarized in Table 1.

5.3.2 Groundwater

The proposed Site SLs for groundwater are based on the protection of drinking water and include the following:

- MTCA Method B groundwater cleanup levels from the Ecology CLARC database.
- Federal and State Maximum Contaminant Levels (MCLs).

The proposed Site SLs are the lowest published values of these criteria, adjusted upward, if appropriate, so that Site SLs are not lower than the laboratory PQLs. There are not MTCA Method B cleanup levels or MCLs for TPH in groundwater, so the MTCA Method A values are used. The proposed Site SLs for groundwater are summarized in Table 2.

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[3] When Ecology determines that the closure requirements in WAC 173-351 or WAC 173-303 are legally applicable or relevant and appropriate requirements, the more stringent closure requirements under those laws shall also apply to cleanup actions.

5.3.3 Soil Vapor/Landfill Gas

Landfill gas is produced during decomposition of solid waste and typically contains methane and other organic and inorganic gases. MTCA does not provide cleanup levels for methane or landfill gas, but does establish Standard Method B air cleanup levels that do not exceed 10 percent of the lower explosive limit (LEL) of any hazardous substance or mix of hazardous substances (WAC 173-340-750(3)(b)(iii)). The MFS (WAC 173-304) provide air quality and toxic air emissions requirements that may apply to landfill gas at the property, as follows:

- The concentrations of explosive gases cannot exceed 25 percent of the LEL in site structures.
- The concentration of explosive gases cannot exceed the LEL in the subsurface at or beyond the property boundary.
- The concentration of explosive gases cannot exceed 100 parts per million by volume of hydrocarbons (expressed as methane) in off-site structures.

The LEL for methane is 5 percent by volume.

The presence of hazardous substances in landfill waste may provide a source of contaminants to soil vapor. Individual contaminant concentrations in soil vapor will be compared to MTCA Method B soil gas screening levels. The proposed Site SLs for volatile COPCs in soil vapor are summarized in Table 3.

6 Data Gaps and RI/FS Approach

The scope of work for the RI has been developed to address data gaps regarding the nature and extent of contamination to enable selection of cleanup standards, and identification and evaluation of cleanup alternatives. Since there has been very little investigation of the Site to date, the data gaps are broad. As the RI progresses, the work will become progressively focused to address specific data needs to meet the RI objectives. The data gaps and the RI approach to address them are provided in Sections 6.1 and 6.2, respectively. Section 6.3 presents the general approach for the Feasibility Study (FS), which will be conducted following completion of the RI.

6.1 Data Gaps

The data gaps are the basis for definition of the scope of work for the RI. The data gaps for the Site consist of the following:

- The hydrogeologic conditions at the Site, including the presence, thickness, and characteristics of aquifers and aquitards, and groundwater flow direction and gradients.
- The lateral and vertical extent of landfill waste.
- The presence, nature, and extent of COPCs in surface and shallow subsurface soil.
- The relationship between groundwater and the landfill waste, and the potential for contaminants to be leaching from landfill waste to groundwater.
- The presence, nature, and extent of COPCs in groundwater.
- The presence, nature, and extent of landfill gas.

The RI approach to address these data gaps is provided in the following section.

6.2 Remedial Investigation Approach

This section presents the general approach for characterizing the Site and addressing the data gaps identified above. The CSM will be updated as data is collected and evaluated to modify sampling locations and approaches to meet the objectives of each phase of the investigation. The scope of work for the initial RI field program is presented below in detail. Subsequent RI work will be scoped in consultation with Ecology to meet the objectives of the RI after the collection, evaluation, and interpretation of data from the initial RI field program.

6.2.1 Initial RI Field Program

The initial RI field program will consist of four general phases of work, as follows:

1. Geophysical Investigation
2. Surface Characterization
3. Groundwater Evaluation

4. Landfill Gas Investigation

Preliminary RI activities will include clearing and grubbing, as necessary to provide access for sampling, and completion of a detailed boundary and topographic survey of the Site property by a licensed surveyor, as needed. The detailed RI approach and rationale for each of the four initial phases of investigation is summarized below. Section 6.2.2 describes additional RI work that will likely be necessary, but for which the detailed scope of work will require further evaluation following the evaluation of data collected during the initial RI field program.

The specific sampling and analysis details, including field sampling details, laboratory analytical approach, and quality assurance/quality control procedures are presented in Appendix A, Sampling and Analysis Plan.

6.2.1.1 Geophysical Investigation

The geophysical investigation will consist of geophysical surveys to provide preliminary information regarding the extent of landfill waste. The primary objective of the geophysical investigation is to evaluate the Site area to identify anomalous ground conditions that indicate the presence of landfill waste. The geophysical surveys, including the field data collection and interpretation, will be completed by hydroGEOPHYSICS, Inc. Complementary survey methods—consisting of electromagnetic induction, magnetic, and electrical resistivity—will be implemented to meet the investigation objectives. The electromagnetic induction and magnetic survey will delineate the spatial extents of the landfill wastes, and the electrical resistivity provides constraint on the depth of the landfill waste. The details of each geophysical survey are provided below.

Electromagnetic Induction (EM) Survey. The objective of the EM survey is to identify subsurface metallic objects, relative changes in soil moisture content, and variations in ground conductivity that may indicate landfill waste. Electromagnetic field data are collected using portable ground conductivity instrumentation. A transmitting coil induces an electromagnetic field and a receiving coil at a fixed separate distance measures the amplitudes of the in-phase and quadrature components of the electromagnetic field. The in-phase component is most sensitive to metallic objects. The quadrature (also referred to as conductivity) component is sensitive to soil condition variations. High density EM data covering large areas can be collected within a short time and readily processed and visualized for quick interpretation. Depending on subsurface conditions, EM data can evaluate conditions up to 15 feet bgs.

Electromagnetic induction data will be acquired along parallel survey lines over the survey area. The EM data is expected to be collected within one day, and can typically be processed and visualized overnight.

Magnetic Survey. A magnetic survey will be conducted to identify and characterize subsurface metallic features and areas of concentrated debris. This method is highly sensitive to ferrous metallic objects and tends to have a greater investigation depth than EM technology. Depending on subsurface conditions, this technology can detect a single 55-gallon drum at a burial depth of 20 to 30 feet.

Magnetic data will be collected using a cesium-vapor magnetometer along parallel survey lines across the survey area.

Electrical Resistivity Survey. The electrical resistivity (ER) survey will be used to provide high resolution, two-dimensional cross sections through the subsurface of the Site property to determine the lateral limits and depth of landfill waste. The ER technique is assumed to be well suited to meet this objective based on the anticipated contrast in electrical properties between the landfill waste material and the native soil lithology.

The ER survey will be performed using a Supersting^{TM} R8 multichannel electrical resistivity system and 18-inch long electrodes, installed 8 to 10 inches into the ground, on 2-foot spacing along multiple transects across the Site. This will provide high resolution imaging and an expected depth of investigation of approximately 30 feet.

6.2.1.2 Surface Characterization

The surface characterization will be conducted to characterize the presence, nature, and extent of COPCs in surface and shallow subsurface soil. The reported disposal of sewage treatment-plant sludge containing baghouse residue will be evaluated as part of the surface characterization.

The RI will implement incremental sampling methodology (ISM) to determine average concentrations of COPCs within a specific volume of soil. ISM is a structured composite sampling and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling, termed a Decision Unit (DU). ISM may provide a reasonable approach to collect the data necessary to calculate mean contaminant concentrations to assess risks to human and ecological receptors in shallow soil.

The preliminary approach assumes that a sufficient thickness of soil is present over landfill waste to allow for ISM to be implemented. Landfill waste itself will not be sampled. The approach will be refined based on the results of the geophysical investigation, the lateral footprint of landfill waste, and the presence/absence and thickness of soil/sludge overlying landfill waste. The application and appropriateness of ISM at the Site, including its ability to meet investigation objectives, may be reassessed after initial investigations are completed.

If determined to be applicable and appropriate, the preliminary approach for the surface characterization is as follows:

- An estimated total of three DUs will be established based on historical operations, the reported disposal of sludge and the results of the geophysical investigation.
- The sample interval for each DU will be the ground surface to 6 inches bgs unless landfill waste is present at shallower depths.
- A total of 30 soil sample increments will be collected from each DU to form a single, representative sample.
- The representative sample from each DU will be submitted for laboratory processing, subsampling, and analysis of the COPCs expressed below.

The sampling design for the Shelton C Street Landfill site describes two separate sample types: 1) standard ISM samples to be submitted for laboratory analysis of TPH (diesel- and oil-range), metals, SVOCs, PCBs, chlorinated pesticides and herbicides, and dioxins/furans; and 2) discrete samples to be submitted for volatile TPH and VOCs. Discrete samples for volatile TPH (gasoline-range) and VOC analysis will be collected at a frequency of one sample for each 10,000-square-foot of DU. The specific sampling and analytical procedures for the surface characterization are provided in detail in Appendix A.

6.2.1.3 Groundwater Evaluation

The groundwater evaluation will consist of the initial installation of four groundwater monitoring wells outside the footprint of the landfill waste to evaluate hydrogeologic conditions and groundwater quality. Preliminary locations are depicted on Figure 9; the actual locations will be dependent on the results of the geophysical investigation and access considerations. One well will be installed west of the landfill waste, to support the evaluation of groundwater flow direction and evaluate groundwater quality upgradient of the landfill. Two monitoring wells will be installed to the east and south of the thickest part of the landfill waste, as determined by geophysical survey methods, and as near to the lateral boundary of the waste as possible, given access and logistical considerations. One well will be installed near the southeast corner of the Site property, which is presumed to be downgradient of the landfill waste.

As discussed in Section 3.3, groundwater at the Site is estimated to be present at depths of 70 to 100 feet bgs, which is assumed to be below the landfill waste. The four initial deep borings will be advanced to identify and evaluate native soil types and locate and characterize the uppermost water-bearing zone, which is anticipated to be the regional Unit A groundwater aquifer identified by others (Section 3.3). In addition, the borings and soil samples will be field screened for the presence of VOCs, using a photoionization detector (PID), and methane, using a multigas meter, to provide preliminary information in support of the landfill gas investigation (Section 6.2.1.4). The total boring depths will be dependent on the subsurface conditions and presence of groundwater observed at the time of drilling. The borings will be terminated at a depth of 20 feet below the top of the uppermost water-bearing zone, or 10 feet into an aquitard, whichever is shallower.

A monitoring well will be constructed in each of the four borings to evaluate groundwater flow direction and hydraulic conductivity in the uppermost water-bearing zone and characterize groundwater quality. The wells will be constructed with 20 feet of screen set 10 feet above and 10 feet below the water table observed at the time of drilling, unless an aquitard is identified within 10 feet of the water table and then the total depth of the well will correspond to the bottom of the aquifer/top of the aquitard.

The monitoring wells will be developed following installation to remove mobile and artifact particulates introduced through the disturbance of geological materials during drilling. This will ensure property hydraulic connection between the well and the geologic materials surrounding the well to yield groundwater samples of acceptably low turbidity. Well development will include a combination of surging across the well screen combined with pumping and monitoring of field parameters to identify when stabilization occurs and when development can stop. The monitoring wells will be developed until turbidity of groundwater is below 5 Nephelometric Turbidity Units (NTU) and field parameters have met stabilization criteria (Appendix A).

Following installation and well development, an initial groundwater sampling event will be completed to evaluate groundwater quality. Groundwater samples collected from all the wells will be submitted for laboratory analysis of the preliminary COPCs, including geochemical indicator parameters (Appendix A).

Groundwater flow velocities are a necessary component of contaminant transport evaluations as well as a required reporting element under WAC 173-351. Slug tests (both rising head and falling head) will be performed to obtain hydraulic conductivity data for the upper water-bearing zone. The slug tests will be performed at all four of the initial monitoring wells (Appendix A).

The initial RI field program includes monthly measurement of groundwater levels in the four monitoring wells to evaluate seasonal variability in groundwater flow direction and gradient, as well as three additional groundwater sampling events completed quarterly to evaluate seasonal trends in groundwater quality. The analytical approach for these three subsequent water-quality sample events will be modified based on the results of the previous sample results. A COPC group will be eliminated from the groundwater sampling program if none of the chemicals within that group were detected in soil or groundwater samples collected and analyzed during the surface characterization or the first groundwater monitoring and sampling event.

Based on the results of the initial phase of the groundwater evaluation, installation and sampling of additional monitoring wells may be necessary to define the nature and extent of COPCs in groundwater, as discussed further in Section 6.2.2.

6.2.1.4 Landfill Gas Investigation

The landfill gas investigation will evaluate the presence, nature, and extent of landfill gas and COPCs in soil vapor surrounding the landfill waste. The landfill gas investigation will focus on the areas to the north, west, and south of the former landfill. The BPA right-of-way and Highway 101 lies to the east of the former landfill and there are no current or anticipated future land-use scenarios in which landfill gas would present a risk to human health or the environment. The RI will include installation of five landfill gas probes, including three to the north and one each to the west and south of the landfill waste, based on the results of the geophysical investigation. Each landfill gas probe location will include both a shallow (20 feet bgs) and deep (40 feet bgs) probe constructed in the vadose zone, with screened intervals selected in consideration of vadose zone thickness and elevations of the top and bottom of landfill waste. The landfill gas probes will be 3/4-inch-diameter PVC installed as a nested pair in a 4-inch borehole, assuming Ecology will approve a variance request.

Landfill gas monitoring and sampling will occur under falling barometric conditions. During the initial landfill gas sampling event, each landfill gas probe will be monitored for methane, carbon dioxide, oxygen and soil vapor samples will be collected for laboratory analysis of the volatile COPCs for which there are MTCA Method B soil gas screening levels (Table 3). The RI field program includes monthly landfill gas monitoring for methane, carbon dioxide, and oxygen, completed in conjunction with monthly groundwater water level measurements. The analytical approach for subsequent collection of soil vapor samples from the landfill gas probes may be modified based on the results of the previous phases of investigation.

6.2.2 Additional RI Work

In addition to the scope of work defined for the initial RI field program (Section 6.2.1), follow-up work may be required to fully address data gaps identified during the RI and meet the requirements of MTCA for completion of an RI/FS (WAC 173-340-350). The additional RI work may include the following:

- If the results of the geophysical investigation cannot define the lateral and/or vertical extents of landfill waste, subsurface explorations will be advanced around the perimeter of the suspected landfill waste footprint to define the lateral extent, and through the observed and/or suspected thickest portion of landfill waste to define the vertical extent. These explorations may consist of either shallow test pits or soil borings.

- After the groundwater flow direction and quality have been initially evaluated following installation and sampling of the four monitoring wells, additional wells may be required to define the lateral/downgradient extent of COPCs in groundwater. The number, location, and construction details for downgradient groundwater monitoring wells will depend on a variety of factors (access, topography, ownership, land use, etc.) and will be determined in consultation with Ecology. Additional monitoring wells will be installed, as needed, to meet the requirements of MTCA for defining the nature and extent of COPCs in groundwater, and to evaluate potential risks to human health and the environment to allow for evaluation and selection of a cleanup action.

- Once groundwater quality in the uppermost water-bearing zone has been evaluated, additional investigation into the vertical extent of COPCs in groundwater may be necessary. Groundwater samples may be collected from deeper in the uppermost water-bearing zone and/or in a deeper aquifer to define the vertical extent of COPCs in groundwater. The number, location, depth, sampling methods and analytical approach will depend on the results of the groundwater evaluation and will be determined in consultation with Ecology.

- If data from the initial RI indicate the potential for COPCs in groundwater to be migrating towards surface water bodies, samples of sediment and/or surface water may be collected for laboratory analysis to evaluate migration pathways and potential risk to human health and the environment. The number, location, sampling methods, and analytical approach will depend on the results of the initial RI work and will be determined in consultation with Ecology.

- If landfill gas is detected and/or if concentrations of COPCs are detected in soil vapor, additional investigation will be required to evaluate the extent and to evaluate potential risk to human health and the environment. The number, location, sampling methods, and analytical approach will depend on the results of the initial RI work and will be determined in consultation with Ecology.

- Additional information, such as data on physical soil properties, may be necessary to support preparation of the FS and/or to support evaluation and selection of a cleanup remedy. These data gaps will be identified following completion of the RI in preparation for the FS, and the scope of work to address them will be determined in consultation with Ecology.

Any additional RI work will be presented in an addendum to this Work Plan prior to its implementation.

6.3 Feasibility Study Approach

The FS will be conducted to meet the requirements of MTCA to develop and evaluate cleanup action alternatives to enable a preferred cleanup action to be selected for the Site (WAC 173-340-350(8)). The FS will include cleanup action alternatives that protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route.

Ecology identifies the solid waste closure requirements in WAC 173-304 as the minimum requirements for cleanup actions conducted under MTCA at solid waste landfills that stopped receiving waste prior to October 9, 1991 (WAC 173-340-710[7][c]). Ecology may elect to adopt a CERCLA presumptive remedy approach to development of landfill site remedial alternatives. Under this approach, remedial actions may include landfill gas control, landfill cover, surface water management, groundwater control, environmental monitoring, and institutional controls. The presumptive remedy will be considered to focus the evaluation and selection of cleanup action alternatives.

At a minimum, the FS will include the following:

1. **Establishment of Cleanup Standards.** Cleanup standards will be established per WAC 173-340-700(3) to evaluate the sufficiency of cleanup action alternatives to meet Remedial Action Objectives. Cleanup standards consist of cleanup levels, points of compliance, and applicable state and federal laws.

2. **Identification of Applicable Relevant and Appropriate Requirements (ARARs).** MTCA requires that all cleanup actions comply with applicable local, state, and federal laws, which are defined as “legally applicable requirements and those requirements that the department determines…are relevant and appropriate requirements.”

3. **Identification of Cleanup Action Alternatives.** An initial screening of remediation technologies will be completed to determine which technologies are likely to meet the minimum requirements of MTCA for cleanup, and are technically possible. A cleanup action alternative may consist of a combination of remediation technologies or regulatory mechanisms, and will be identified for further evaluation based on the initial screening.

4. **Detailed Analysis of Cleanup Action Alternatives.** The cleanup action alternatives will each be evaluated in detail against the minimum requirements established by MTCA. As defined in WAC 173-340-360, the selected cleanup action must meet the minimum “threshold” requirements, as follows: protect

human health and the environment, comply with cleanup standards, comply with applicable laws, and provide for compliance monitoring.

5. **Disproportionate Cost Analysis.** MTCA requires the use of permanent solutions, defined as a solution in which cleanup standards can be met without further action, to the "maximum extent practicable" as demonstrated through a disproportionate cost analysis (DCA) (WAC 173-340-360(3)(b)). The DCA is a comparative cost analysis of cleanup action alternatives, conducted using evaluation criteria defined in MTCA. The evaluation will provide the basis for selection of a preferred cleanup action alternative. If the preferred cleanup action alternative is clearly the most permanent, a DCA may not be necessary.

The results of the FS will be documented in the Draft FS report and will provide the basis for preparation of a draft Cleanup Action Plan.

7 Schedule, Deliverables, and Reporting

The schedule, deliverables, and reporting requirements are provided in the AO. A summary of the relevant components of these project elements is provided below. The AO should be consulted for requirements beyond the RI phase of the project.

7.1 Schedule

Implementation of the scope of work described herein will commence within 30 days of Ecology's approval of the Final RI Work Plan. The initial field work for the RI, including performance of the geophysical surveys, installation and sampling of the initial four deep monitoring wells, and installation and sampling of landfill gas and soil vapor from the landfill gas probes, will take approximately 60 days to complete.

Field work will be followed by a period of approximately 30 days, during which analytical results will be generated, reviewed, validated, and compiled. The RI Data Memorandum will be prepared to present the results of the initial RI field program.

7.2 Deliverables

The primary RI deliverables are defined in the AO and include an RI Data Memorandum within 45 days of receipt of laboratory analytical data and the Draft RI Report within 180 days of completion of field work. The RI Data Memorandum will provide the basis for developing a scope of work for addressing any additional data gaps, including those described in Section 6.2.2. An addendum to the Final RI Work Plan will be prepared, if necessary, to document the specific scope of work for addressing the additional data gaps.

7.3 Reporting

This section summarizes the elements that will be included in the RI Report per the requirements of the AO and in accordance with the guidance provided in WAC 173-340-350. The RI Report will present the data collected for the RI. The RI will also summarize the sources of contamination, the nature and extent of contamination, and a refined CSM of exposure pathways. The data will be presented in both tabular and map form.

The Draft RI Report will be submitted to Ecology for review. Revisions based on Ecology's review comments will be incorporated into a Final RI Report submitted to Ecology for approval.

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TABLES

Table 1 - Proposed Site Screening Levels for Soil

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

Analyte (by group)	Applicable Soil Criteria				Natural Background Concentration	Practical Quantitation Limit (PQL)[3]	Proposed Site Screening Level
	Human Direct	Protective of Ecological Receptors[2]					
	MTCA Method B[1]	Plants	Soil biota	Wildlife			
Total Petroleum Hydrocarbons (mg/kg)							
tph, diesel range organics	2000[7]		200	6,000		25	200
tph, heavy oils	2000[7]					50	2,000
tph, mineral oil	2000[7]					50	2,000
tph: gasoline range organics, benzene present	100[7]		100	5,000		10	100
tph: gasoline range organics, no detectable benzene	800[7]		100	5,000		10	100
Dioxins/Furans (ng/kg)[4,5]							
tetrachlorodibenzo-p-dioxin (tcdd); 2,3,7,8-	12.8			2.0		0.605	2.0
chlorinated dibenzo-p-dioxins (PCDDs), total				2.0	2.2		2.2
chlorinated dibenzofurans (PCDFs), total				2.0	2.2		2.2
Geochemical Indicator Parameters (mg/kg)							
alkalinity							--
ammonia							--
calcium						50	--
chloride							--
cyanide	48					0.25	--
iron	56,000					20	--
magnesium						20	--
manganese	11,200	1,100		1,500		0.5	--
nitrate	128,000						--
nitrite	8,000						--
sodium						100	--
sulfate							--
sulfide, total							--
Metals (mg/kg)[6]							
arsenic	0.67	10	60	132	7	0.5	7
barium	16,000	500		102		0.5	102
cadmium	80	4	20	14	0.77	0.1	4
chromium (total)		42	42	67	48	0.5	48
chromium(VI)	240					1.0	240
copper	3,200	100	50	217	36	0.5	50
lead		50	500	118	24	0.1	50
mercury		0.30	0.10	5.50	0.07	0.025	0.10
nickel	1,600	30	200	980		0.5	30
selenium	400	1	70	0.30	0.78	0.5	0.78
silver	400	2			0.61	0.2	2
zinc	24,000	86	200	360	85	4	86
Polycyclic Aromatic Hydrocarbons (mg/kg)							
acenaphthene	4,800	20				0.005	20.00
acenaphthylene						0.005	--
anthracene	24,000					0.005	24,000
benzo(g,h,i)perylene						0.005	--
benzo[a]anthracene	1.37					0.005	1.37
benzo[a]pyrene	0.14			12		0.005	0.14
benzo[b]fluoranthene	1.37					0.005	1.37
benzo[k]fluoranthene	13.7					0.005	13.7
chrysene	137					0.005	137
dibenzo[a,h]anthracene	0.14					0.005	0.14
fluoranthene	3,200					0.005	3,200
fluorene	3,200		30			0.005	30
indeno[1,2,3-cd]pyrene	1.37					0.005	1.37
methyl naphthalene;1-	34					0.005	34
methyl naphthalene;2-	320					0.005	320
naphthalene	1,600					0.005	1,600
phenanthrene						0.005	--
pyrene	2,400					0.005	2,400
total cPAHs TEQ	0.14					--	0.14
Polychlorinated Biphenyls (mg/kg)							
aroclor 1016	5.6					0.33	5.6
aroclor 1254	0.50					0.33	0.50
aroclor 1260	0.50					0.33	0.50
Total PCBs	0.50	40		0.65		0.33	0.50
Semivolatile Organic Compounds (mg/kg)							
benzoic acid	320,000					0.67	320,000
benzyl alcohol	8,000					0.33	8,000
bis(2-chloroethyoxy)methane	--					0.067	--
bis(2-chloroethyl)ether	0.91					0.067	0.91
bis(2-ethylhexyl) phthalate	71.4					0.067	71.4
butyl benzyl phthalate	526					0.067	526
chlorophenol;2-	400					0.067	400
cresol;m-	4,000					0.067	4,000
cresol;o-	4,000					0.067	4,000
cresol;p-	8,000					0.067	8,000
dibenzofuran	80					0.067	80
di-butyl phthalate	8,000					0.067	8,000
dichlorobenzene;1,2-	7,200					0.067	7,200
dichlorobenzene;1,3-	--					0.067	--
dichlorobenzene;1,4-	185		20			0.067	20
dichlorobenzidine;3,3'-	2.22					0.067	2.22
dichlorophenol;2,4-	240					0.33	240
diethyl phthalate	64,000	100				0.067	100
dimethylphenol;2,4-	1,600					0.067	1,600
dinitrophenol;2,4-	160	20				0.67	20
dinitrotoluene;2,4-	3.23					0.33	3.23
dinitrotoluene;2,6-	0.667					0.33	0.667
di-n-octyl phthalate	800					0.067	800
dioxane;1,4-	10					0.067	10
hexachlorobenzene	0.625					0.067	0.625
hexachlorocyclopentadiene	480	10				0.33	10
hexachloroethane	25					0.067	25
isophorone	1,053					0.067	1,053
nitroaniline, 2-	800					0.33	800
nitrobenzene	160		40			0.067	40
nitrosodimethylamine;N-	0.02					0.33	0.33
nitroso-di-n-propylamine;N-	0.14					0.067	0.14
nitrosodiphenylamine;N-	204		20			0.067	20
pentachlorophenol	2.5	3	6	4.5		0.33	2.5
phenol	24,000	70	30			0.067	30
trichlorobenzene;1,2,4-	34		20			0.067	20
trichlorophenol;2,4,5-	8,000	4	9			0.33	4
trichlorophenol;2,4,6-	80		10			0.33	10
dimethyl phthalate	--		200			0.067	200
Volatile Organic Compounds (mg/kg)							

Table 1 - Proposed Site Screening Levels for Soil

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

	Applicable Soil Criteria				Natural Background Concentration	Practical Quantitation Limit (PQL)[3]	Proposed Site Screening Level
	Human Direct	Protective of Ecological Receptors[2]					
Analyte (by group)	**MTCA Method B[1]**	**Plants**	**Soil biota**	**Wildlife**			
acetone	72,000					0.005	72,000
benzene	18.2					0.001	18.2
bromodichloromethane	16.1					0.001	16.1
bromoform	127					0.001	127
bromomethane	112					0.001	112
carbon tetrachloride	14					0.001	14
chlorobenzene	1,600		40			0.001	40
chloroform	32					0.001	32
chloromethane	--					0.001	--
cumene (isopropylbenzene)	8,000					0.001	8,000
dibromo-3-chloropropane;1,2-	1.3					0.005	1.3
dibromochloromethane	11.9					0.001	11.9
dichlorodifluoromethane	16,000					0.001	16,000
dichloroethane;1,1-	175					0.001	175
dichloroethane;1,2-	11					0.001	11
dichloroethylene;1,1-	4,000					0.001	4,000
dichloroethylene;1,2-,cis	160					0.001	160
dichloroethylene;1,2-,trans	1,600					0.001	1,600
dichloropropane;1,2-	28		700			0.001	28
dichloropropene,1,3-	--					0.001	--
ethylbenzene	8,000					0.001	8,000
ethylene dibromide (EDB)	0.50					0.001	0.50
hexachlorobutadiene	13					0.005	13
methyl ethyl ketone	48,000					0.001	48,000
methyl isobutyl ketone	6,400					0.005	6,400
methyl tert-butyl ether	556					0.001	556
n-butylbenzene	4,000					0.001	4,000
propylbenzene;n-	8,000					0.001	8,000
sec-butylbenzene	8,000					0.001	8,000
styrene	16,000	300				0.001	300
tert-butylbenzene	8,000					0.001	8,000
tetrachloroethane;1,1,1,2-	38					0.001	38
tetrachloroethane;1,1,2,2-	5					0.001	5
tetrachloroethylene (PCE)	476					0.001	476
toluene	6,400	200				0.001	200
trichloroethane;1,1,1-	160,000					0.001	160,000
trichloroethane;1,1,2-	18					0.001	18
trichloroethylene (TCE)	12					0.001	12
trichlorofluoromethane	24,000					0.001	24,000
trichloropropane;1,2,3-	0.03					0.002	0.03
trimethylbenzene;1,2,4-	--					0.001	--
trimethylbenzene;1,3,5-	800					0.001	800
vinyl chloride	0.67					0.001	0.67
xylene;m-	16,000					0.001	16,000
xylene;o-	16,000					0.001	16,000
xylene;p-	16,000					0.001	16,000
xylenes	16,000					0.002	16,000
Organochlorine Pesticides (mg/kg)							
hexachlorobenzene (BHC)	0.625			17		0.05	0.625
alpha-BHC	--			6		0.05	6
beta-BHC	--			6		0.05	6
gamma-BHC (Lindane)	0.909			6		0.05	0.909
delta-BHC	--			6		0.05	6
heptachlor	0.222					0.05	0.222
aldrin	0.0588			0.1		0.05	0.0588
hHeptachlor epoxide	0.11			0.4		0.05	0.11
trans-chlordane	2.86		1	2.7		0.1	1
cis-chlordane	2.86		1	2.7		0.1	1
endosulfan I	480					0.05	480
dieldrin	0.0625			0.07		0.1	0.1
endrin	24			0.2		0.1	0.2
endosulfan II	480					0.1	480
4,4'-DDE	2.94					0.1	2.94
4,4'-DDD	4.17					0.1	4.17
4,4'-DDT	2.94					0.1	2.94
Total DDT/DDD/DDE	--			0.75		0.1	0.75
endrin aldehyde	--					0.1	--
endosulfan sulfate	--					0.1	--
endrin ketone	--					0.1	--
methoxychlor	400					0.1	400
toxaphene	0.9					0.5	0.9
Chlorinated Herbicides (mg/kg)							
2,4-D	--					0.094	--
2,4-DB	640					0.095	640
2,4,5-T	--					0.095	--
2,4,5-TP (silvex)	640					0.095	640
2,4,6-trichlorophenol	90.9		10			0.047	10
dalapon	2,400					2.300	2,400
dicamba	2,400					0.094	2,400
dichloroprop	--					0.710	--
dinoseb	80					0.095	80
MCPA	--					9.40	--
MCPP	--					9.40	--

Notes

"--" Indicates no applicable criteria.

mg/kg = milligrams per kilogram

Ecology = Washington State Department of Ecology

[1] Model Toxics Control Act Cleanup Regulation (MTCA), Chapter 173-340 of the Washington Administrative Code, Method B standard formula values.

[2] Ecological Indicator Soil Concentrations for Protection of Terrestrial Plants and Animals, MTCA 173-340-7493, Table 749-3.

[3] Laboratory PQLs provided by Analytical Resources, Inc (ARI) of Tukwila, Washington, except for 2,3,7,8-TCDD (see note 5).

[4] Natural Background for Dioxins/Furans in WA Soils, Ecology Technical Memorandum #8, August 9, 2010.

[5] Dioxins, Furans, and Dioxin-Like PCB Congeners, Addressing Non-Detects and Establishing PQLs for Ecological Risk Assesments in pland Soil, Ecology Implmenetation Memorandum

[6] Background metals concentrations from Ecology Natural Background Soil Metals Concentrations in Washigngton State, October 1994. Puget Sound region values used where established, statewide values used otherwise.

[7] MTCA Method A soil cleanup levels for unrestricted land uses, Table 740-1.

Table 2 - Proposed Site Screening Levels for Groundwater

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

	Applicable Groundwater Criteria				
	Protection of Human Health				
Analyte (by group)	MTCA Method B[1]	Federal MCL[2]	WA State MCL[3]	Practical Quantitation Limit[4]	Proposed Site Screening Level
Total Petroleum Hydrocarbons (µg/L)					
tph, diesel range organics	500[5]			250	500
tph, heavy oils	500[5]			500	500
tph, mineral oil	500[5]			500	500
tph: gasoline range organics, benzene present	800[5]			100	800
tph: gasoline range organics, no detectable benzene	1000[5]			100	1,000
Dioxins/Furans (µg/L)					
tetrachlorodibenzo-p-dioxin (tcdd); 2,3,7,8-	6.73E-07	3.00E-05	3.00E-05	3.00E-05	3.00E-05
Geochemical Indicator Parameters (µg/L)					
alkalinity				1,000	--
ammonia (as nitrogen)				40	--
calcium				50	--
chloride			250,000	50	250,000
cyanide	9.6	200	200	5	9.6
iron	11,200		300	0.4	300
magnesium				20	--
manganese	2,240		50	0.1	50
nitrate	25,600	10,000	10,000	10	10,000
nitrite	1,600	1,000	1,000	10	1,000
sodium				100	--
sulfate			250,000	100	250,000
sulfide, total				50	--
Metals (µg/L)					
arsenic	0.058	10	10	0.2	0.2
barium	3,200	2,000	2,000	0.5	2,000
cadmium	8	5	5	0.1	5
chromium (total)		100	100	0.5	100
chromium(VI)	48			0.01	48
copper	640	1,300	1,300	0.5	640
lead		15	15	0.1	15
mercury		2	2	0.1	2
nickel	320		100	0.5	100
selenium	80	50	50	0.5	50
silver	80		100	0.2	80
zinc	4,800		5,000	4	4,800
Polycyclic Aromatic Hydrocarbons (µg/L)					
acenaphthene	960			0.010	960
acenaphthylene	--			0.010	--
anthracene	4,800			0.010	4,800
benzo(g,h,i)perylene	--			0.010	--
benzo[a]anthracene	0.12			0.010	0.12
benzo[a]pyrene	0.012	0.20	0.20	0.010	0.012
benzo[b]fluoranthene	0.12			0.010	0.12
benzo[k]fluoranthene	1.2			0.010	1.2
chrysene	12			0.010	12
dibenzo[a,h]anthracene	0.012			0.010	0.012
fluoranthene	640			0.010	640
fluorene	640			0.010	640
indeno[1,2,3-cd]pyrene	0.12			0.010	0.12
methyl naphthalene;1-	1.51			0.010	1.51
methyl naphthalene;2-	32			0.010	32
naphthalene	160			0.010	160
phenanthrene	--			0.010	--
pyrene	480			0.010	480
total cPAHs TEQ					0.012
Polychlorinated Biphenyls (µg/L)					
aroclor 1016	1.1			1.0	1.1
aroclor 1254	0.044			1.0	0.044
aroclor 1260	0.044			1.0	0.044
Total PCBs	0.044	0.5	0.5		0.044
Semivolatile Organic Compounds (µg/L)					
benzoic acid	64,000			20	64,000
benzyl alcohol	800			2	800
bis(2-chloroethyoxy)methane	--			1.0	--
bis(2-chloroethyl)ether	0.0398			1.0	1.00
bis(2-ethylhexyl) phthalate	6.3	6	6	1.00	6
butyl benzyl phthalate	46			1.0	46
chlorophenol;2-	40			1.0	40
cresol;m-	400			1.0	400
cresol;o-	400			1.0	400
cresol;p-	800			1.0	800
dibenzofuran	16			1.0	16
di-butyl phthalate	1,600			1.0	1,600
dichlorobenzene;1,2-	720	600	600	1.0	600
dichlorobenzene;1,3-	--			1.0	
dichlorobenzene;1,4-	8.1	75	75	1.0	8.1
dichlorobenzidine;3,3'-	0.19			1.0	1.00
dichlorophenol;2,4-	24			1.0	24
diethyl phthalate	12,800			1.0	12,800
dimethylphenol;2,4-	160			1.0	160
dinitrophenol;2,4-	32			3.0	32
dinitrotoluene;2,4-	0.28			1.0	1.00
dinitrotoluene;2,6-	0.06			1.0	1.00
di-n-octyl phthalate	160			1.0	160
dioxane;1,4-	0.438			2.0	2.0
hexachlorobenzene	0.05	1	1	1.0	1.00

Table 2 - Proposed Site Screening Levels for Groundwater

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

	Applicable Groundwater Criteria				
	Protection of Human Health				
Analyte (by group)	MTCA Method B[1]	Federal MCL[2]	WA State MCL[3]	Practical Quantitation Limit[4]	Proposed Site Screening Level
hexachlorocyclopentadiene	48	50	50	1.0	48
hexachloroethane	1.1			1.0	1.1
isophorone	46			1.0	46
nitroaniline, 2-	160			1.0	160
nitrobenzene	16			1.0	16
nitrosodimethylamine;N-	0.00086			1.0	1.0
nitroso-di-n-propylamine;N-	0.0125			1.0	1.0
nitrosodiphenylamine;N-	17.9			1.0	17.9
pentachlorophenol	0.22	1	1	10	10.0
phenol	2,400			1.0	2,400
trichlorobenzene;1,2,4-	1.5	70	70	1.0	1.5
trichlorophenol;2,4,5-	800			1.0	800
trichlorophenol;2,4,6-	4.0			1.0	4.0
dimethyl phthalate	--			1.0	--
Volatile Organic Compounds (µg/L)					
acetone	7,200			5.0	7,200
benzene	0.8	5	5	0.20	0.8
bromodichloromethane	0.71	80	80	0.20	0.71
bromoform	5.5	80	80	0.20	5.5
bromomethane	11.2			1.0	11.2
carbon tetrachloride	0.63	5	5	0.20	0.63
chlorobenzene	160	100	100	0.20	100
chloroform	1.4	80	80	0.20	1.4
chloromethane	--			0.50	--
cumene	800			0.20	800
dibromo-3-chloropropane;1,2-	0.05	0.2	0.2	0.50	0.50
dibromochloromethane	0.52	80	80	0.20	0.52
dichlorodifluoromethane	1,600			0.20	1,600
dichloroethane;1,1-	7.68			0.20	7.68
dichloroethane;1,2-	0.48	5	5	0.20	0.48
dichloroethylene;1,1-	400	7	7	0.20	7
dichloroethylene;1,2-,cis	16	70	70	0.20	16.00
dichloroethylene;1,2-,trans	160	100	100	0.20	100
dichloropropane;1,2-	1.2	5	5	0.20	1.2
dichloropropene,1,3-	0.438			0.20	0.438
ethylbenzene	800	700	700	0.20	700
ethylene dibromide (EDB)	0.02	0.05	0.05	0.20	0.20
hexachlorobutadiene	0.56			0.50	0.56
methyl ethyl ketone	4,800				4,800
methyl isobutyl ketone	640			5.0	640
methyl tert-butyl ether	24.3			0.50	24.3
n-butylbenzene	400			0.20	400
propylbenzene;n-	800			0.20	800
sec-butylbenzene	800			0.20	800
styrene	1,600	100	100	0.20	100
tert-butylbenzene	800			0.20	800
tetrachloroethane;1,1,1,2-	1.7			0.20	1.7
tetrachloroethane;1,1,2,2-	0.22			0.20	0.22
tetrachloroethylene (PCE)	20.8	5	5	0.20	5
toluene	640	1,000	1,000	0.20	640
trichloroethane;1,1,1-	16,000	200	200	0.20	200
trichloroethane;1,1,2-	0.77	5	5	0.20	0.77
trichloroethylene (TCE)	0.54	5	5	0.20	0.54
trichlorofluoromethane	2,400			0.20	2,400
trichloropropane;1,2,3-	0.0015			0.50	0.50
trimethylbenzene;1,2,4-	--			0.20	--
trimethylbenzene;1,3,5-	80			0.20	80
vinyl chloride	0.029	2	2	0.20	0.20
xylene;m-	1,600			0.20	1,600
xylene;o-	1,600			0.20	1,600
xylene;p-	1,600			0.20	1,600
xylenes	1,600	10,000	10,000	0.20	1,600
Organochlorine Pesticides (µg/L)					
hexachlorobenzene (BHC)	0.0547	1.00	1.00	0.0050	0.0547
alpha-BHC	--			0.0050	--
beta-BHC	--			0.0050	--
gamma-BHC (Lindane)	0.0795	0.2	0.2	0.0050	0.0795
delta-BHC	--			0.0050	--
heptachlor	0.0194	0.4	0.4	0.0050	0.0194
aldrin	0.00257			0.0050	0.0050
hHeptachlor epoxide	0.00481	0.2	0.2	0.0050	0.0050
trans-chlordane	0.25	2	2	0.0050	0.25
cis-chlordane	--			0.0050	--
endosulfan I	96			0.0050	96
dieldrin	0.00547			0.0050	0.0055
endrin	4.8	2	2	0.0050	2
endosulfan II	96			0.0050	96
4,4'-DDE	0.257			0.0050	0.257
4,4'-DDD	0.365			0.0050	0.365
4,4'-DDT	0.257			0.0050	0.257
Total DDT/DDD/DDE	--			0.0050	--
endrin aldehyde	--			0.0050	--
endosulfan sulfate	--			0.0050	--
endrin ketone	--			0.020	--
methoxychlor	80	40	40	0.010	40
toxaphene	0.0795	3	3	0.050	0.0795
Chlorinated Herbicides (µg/L)					
2,4-D				0.047	--
2,4-DB	128			0.071	128

Table 2 - Proposed Site Screening Levels for Groundwater

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

	Applicable Groundwater Criteria				
	Protection of Human Health				
Analyte (by group)	**MTCA Method B[1]**	**Federal MCL[2]**	**WA State MCL[3]**	**Practical Quantitation Limit[4]**	**Proposed Site Screening Level**
2,4,5-T				0.047	--
2,4,5-TP (silvex)	128	50	50	0.048	50
2,4,6-trichlorophenol	3.98			0.019	3.98
dalapon	240	200	200	0.46	200
dicamba	480			0.047	480
dichloroprop				0.047	--
dinoseb	16	7	7	0.047	7
MCPA				7	--
MCPP				4.7	--

Notes

µg/L = micrograms per liter

"--" Indicates no applicable criteria.

[1] Model Toxics Control Act Cleanup Regulation (MTCA), Chapter 173-340 of the Washington Administrative Code, Method B standard formula values.

[2] US Environmental Protection Agency Maximum Contaminant Levels (MCLs), 40CFR 141.

[3] Washington State maximum contaminant levels (MCLs), WAC 246-290-310

[4] Laboratory PQLs provided by Analytical Resources, Inc (ARI) of Tukwila, Washington.

[5] MTCA Method A cleanup levels for groundwter, Table 720-1.

Table 3 - Proposed Site Screening Levels for Soil Vapor

Project No. 150074, Shelton C Street Landfill Remediation, Shelton, WA

	Applicable Soil Vapor/Soil Gas Critiera[1]	
Analyte (by group)	**Subslab Method B**	**Deep Soil Gas Method B**
Total Petroleum Hydrocarbons (µg/m^3)		
APH [EC5-8 aliphatics] fraction	90,000	270,000
APH [EC9-12 aliphatics] fraction	4,700	14,000
APH [EC9-10 aromatics] fraction	6,000	18,000
Metals (µg/m^3)		
mercury	4.6	13.7
Polycyclic Aromatic Hydrocarbons (µg/m^3)		
naphthalene	2.5	7.4
Semivolatile Organic Compounds (µg/m^3)		
dichlorobenzene;1,2-	3,048	9,143
dichlorobenzene;1,4-	7.6	23
trichlorobenzene;1,2,4-	30	91
Volatile Organic Compounds (µg/m^3)		
acrolein	0.3	0.9
benzene	10.7	32.1
bromodichloromethane	2.3	6.8
bromoform	75.8	227
bromomethane	76.2	229
carbon disulfide	10,667	32,000
carbon tetrachloride	13.9	41.7
chlorobenzene	762	2,286
chloroform	3.6	10.9
chloromethane	1,371	4,114
cumene	6,095	18,286
dibromochloromethane	3.1	9.3
dichlorodifluoromethane	1,524	4,571
dichloroethane;1,1-	52.1	156
dichloroethane;1,2-	3.2	9.6
dichloroethylene;1,1-	3,048	9,143
dichloropropane;1,2-	8.3	25.0
dichloropropene,1,3-	20.83	62.50
ethylbenzene	15,238	45,714
ethylene dibromide (EDB)	0.14	0.42
hexachlorobutadiene	3.8	11.4
methyl ethyl ketone	76,190	228,571
methyl isobutyl ketone	45,714	137,143
methyl tert-butyl ether	321	962
methylene chloride	8,333	25,000
styrene	15,238	45,714
tetrachloroethane;1,1,1,2-	11.3	33.8
tetrachloroethane;1,1,2,2-	1.4	4.3
tetrachloroethylene (PCE)	321	962
toluene	76,190	228,571
trichloroethane;1,1,1-	76,190	228,571
trichloroethane;1,1,2-	5.2	15.6
trichloroethylene (TCE)	12.3	37.0
trichlorofluoromethane	10,667	32,000
trimethylbenzene;1,2,4-	107	320
vinyl acetate	3,048	9,143
vinyl chloride	9.3	28
xylene;m-	1,524	4,571
xylene;o-	1,524	4,571

Notes

µg/m^3 = microgram per cubic meter

[1] Washington State Deparment of Ecology Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Table B-1, April 2015 (Ecology, 2016).

FIGURES

Site Vicinity Map

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING	APR-2017	BY: CEB / RAP	FIGURE NO.
	PROJECT NO. 150074	REVISED BY: - - -	1

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\1 Site Vicinity Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

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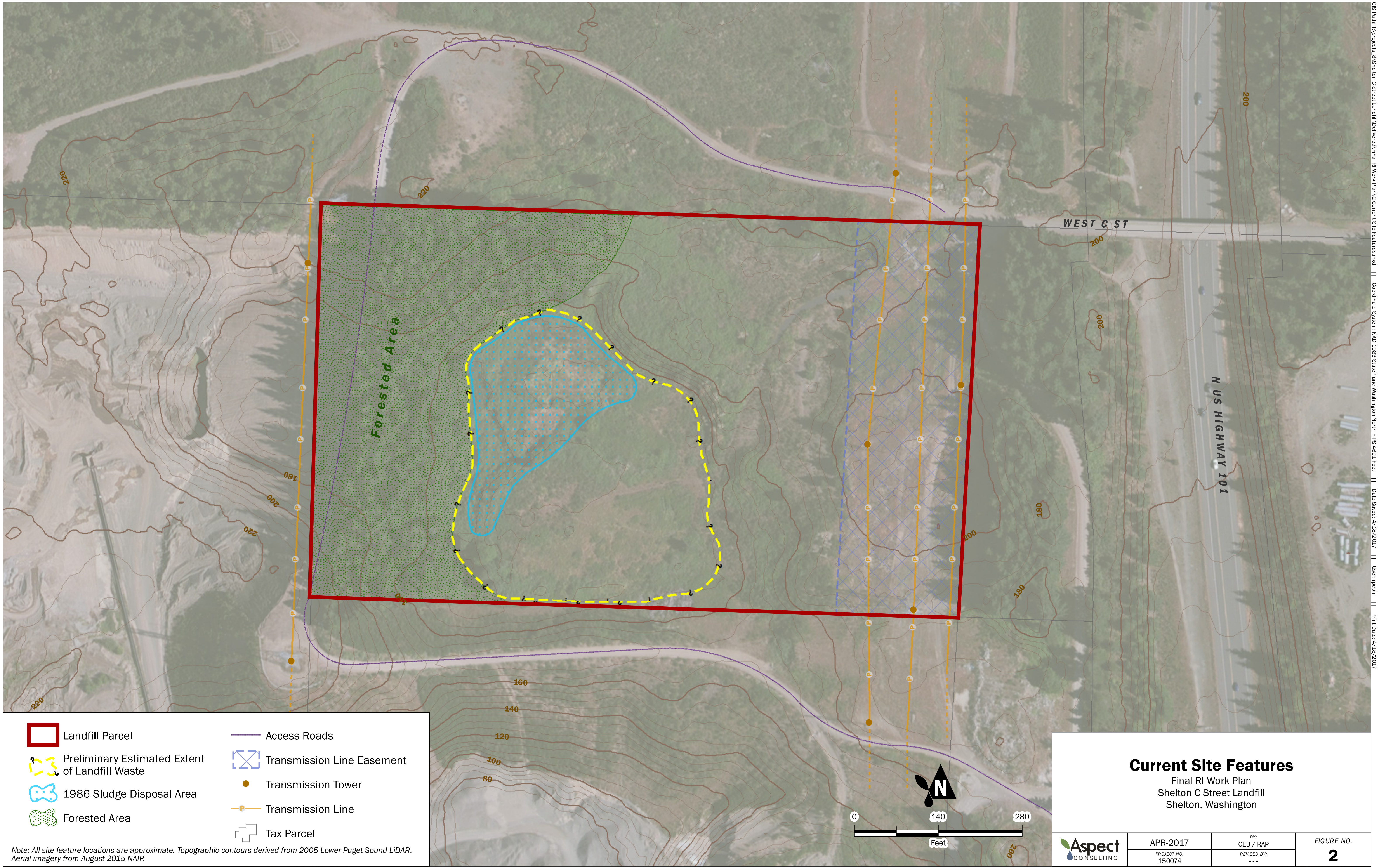

Note: All site feature locations are approximate. Topographic contours derived from 2005 Lower Puget Sound LiDAR. Aerial imagery from August 2015 NAIP.

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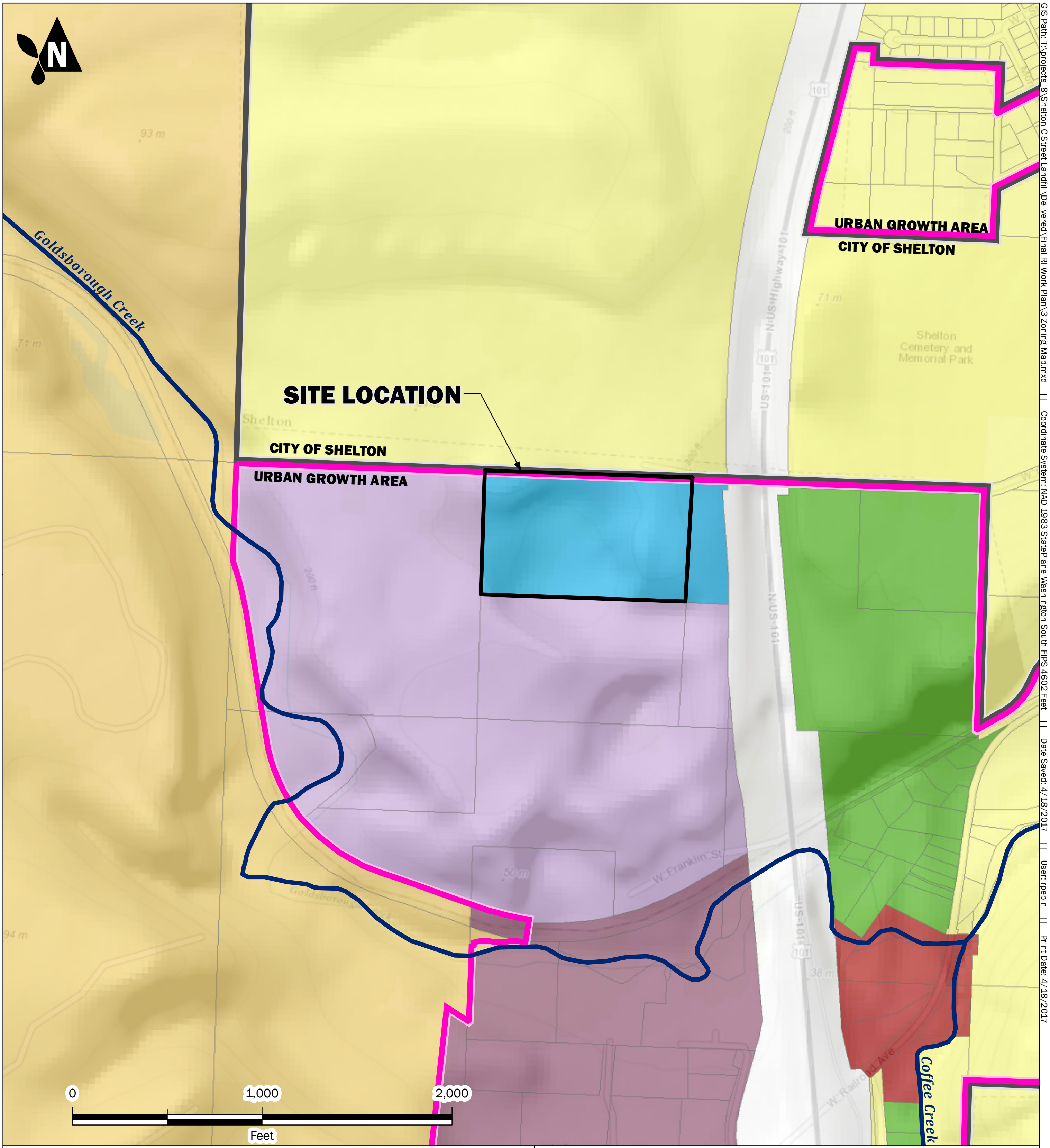
Current Site Features

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING	APR-2017	*BY:* CEB / RAP	*FIGURE NO.* **2**
	PROJECT NO. 150074	*REVISED BY:* - - -	

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\2 Current Site Features.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017



🟫 Commercial Industrial
🟥 General Commercial
🟪 Industrial
🟩 Mixed Use
🟨 Neighborhood Residential
🟦 Public Institutional
🟧 Rural Residential

City Limits
Urban Growth Area
Stream/Water Body
Landfill Parcel
Tax Parcel

Zoning Map

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING

APR-2017	BY: CEB / RAP	FIGURE NO. 3
PROJECT NO. 150074	REVISED BY: - - -	

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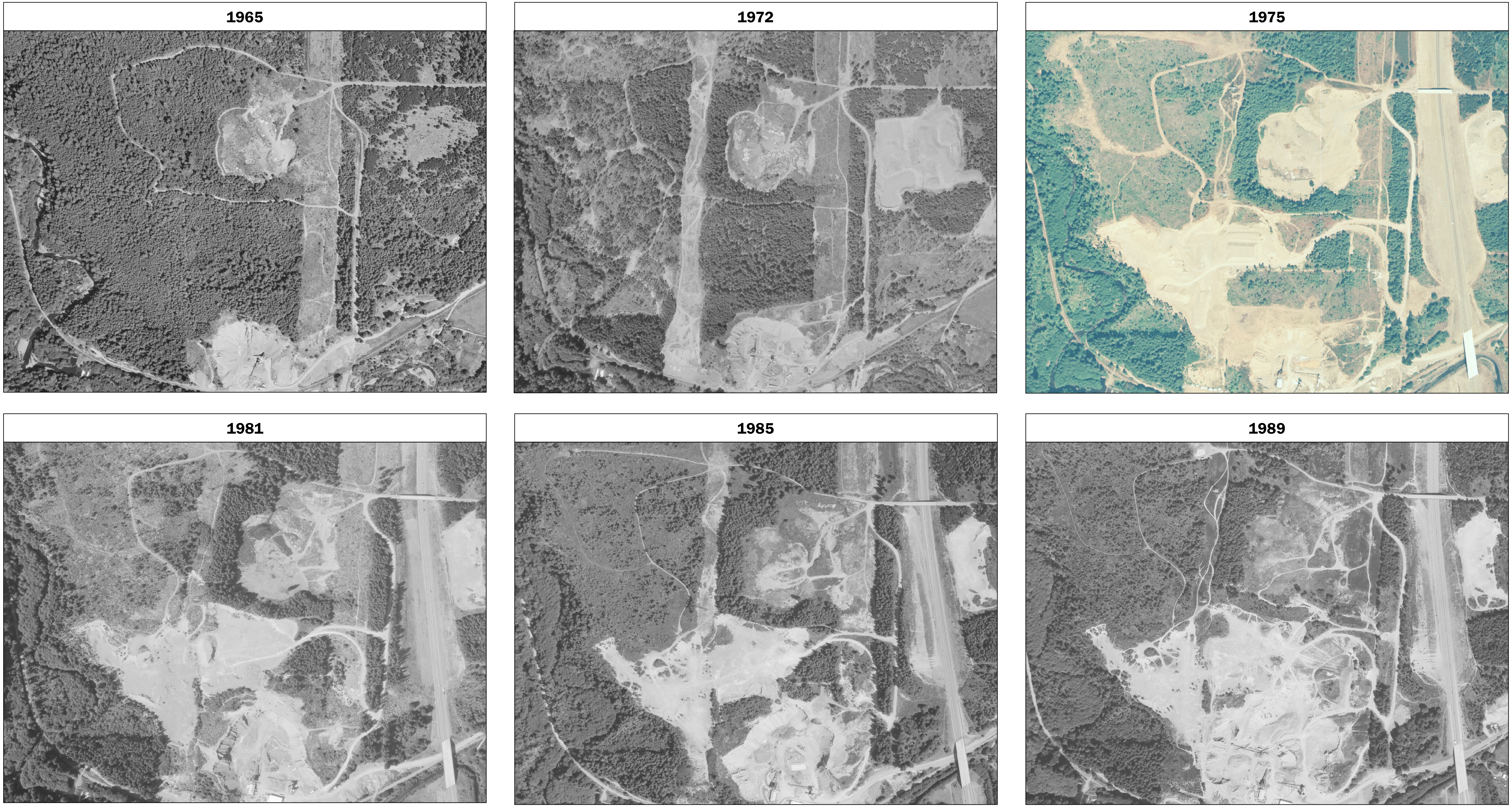
GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\3 Zoning Map.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017



Aerial photo source: Washington Department of Natural Resources

Aerial Photos 1965-1989

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING	APR-2017	BY: CEB / RAP	FIGURE NO. 4
	PROJECT NO. 150074	REVISED BY: - - -	

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\4 Aerial Photos 1965-1989.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

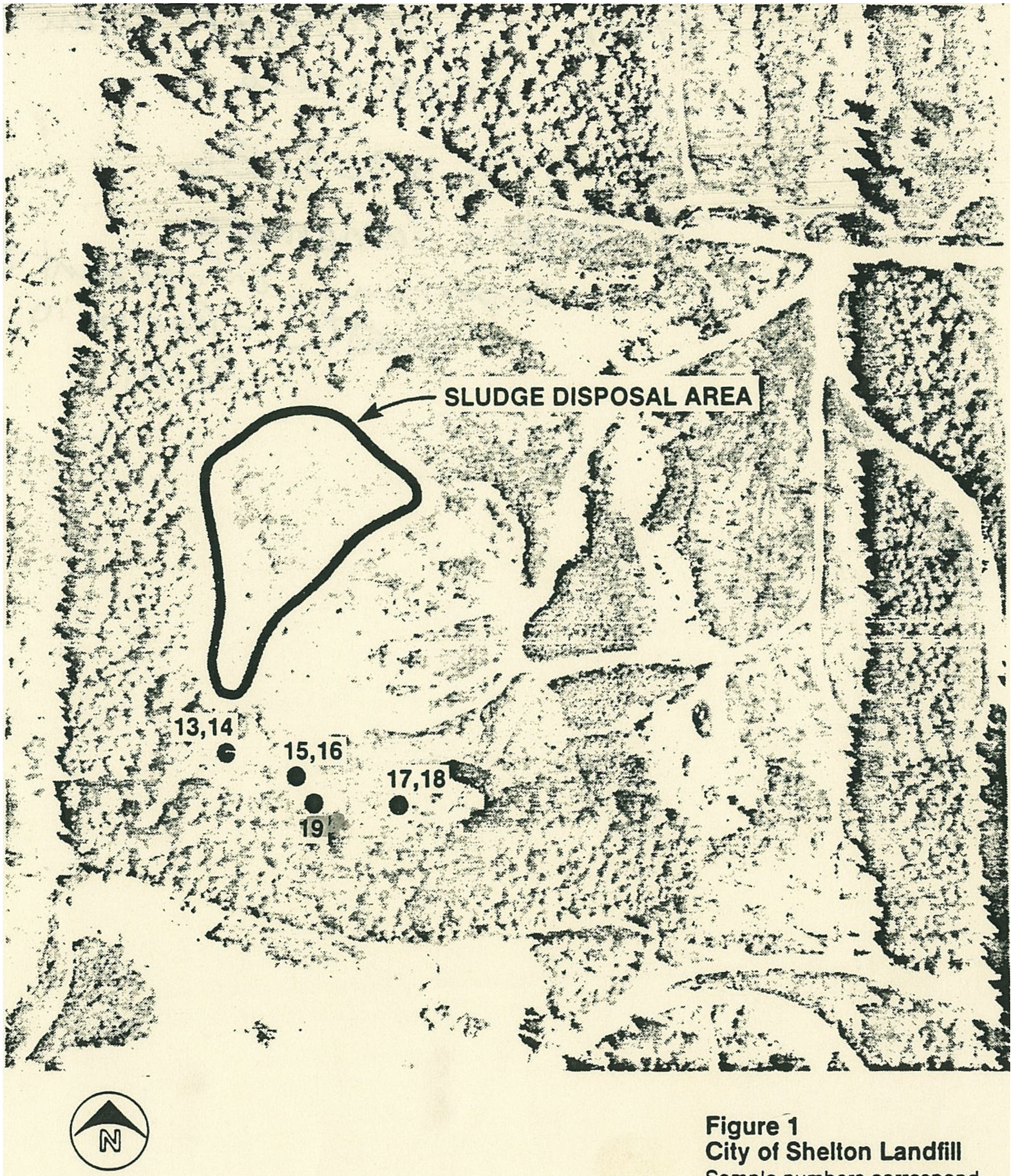


Figure 1
City of Shelton Landfill
Sample numbers correspond to the digit portion of sample numbers shown in Table 1.

1986 Map Showing Sludge and Sampling Locations

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

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APR-2017	BY: CEB / RAP	FIGURE NO. **5**
PROJECT NO. 150074	REVISED BY: - - -	

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\5 1986 Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

⊕ Well
Stream/Water Body
WRIA Boundary
🟥 Landfill Parcel

Note: Aerial imagery from August 2015 NAIP.

Surface Water and Groundwater Use Map

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

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APR-2017	BY: CEB / RAP	FIGURE NO. **6**
PROJECT NO. 150074	REVISED BY: - - -	

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\6 Surface Water Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

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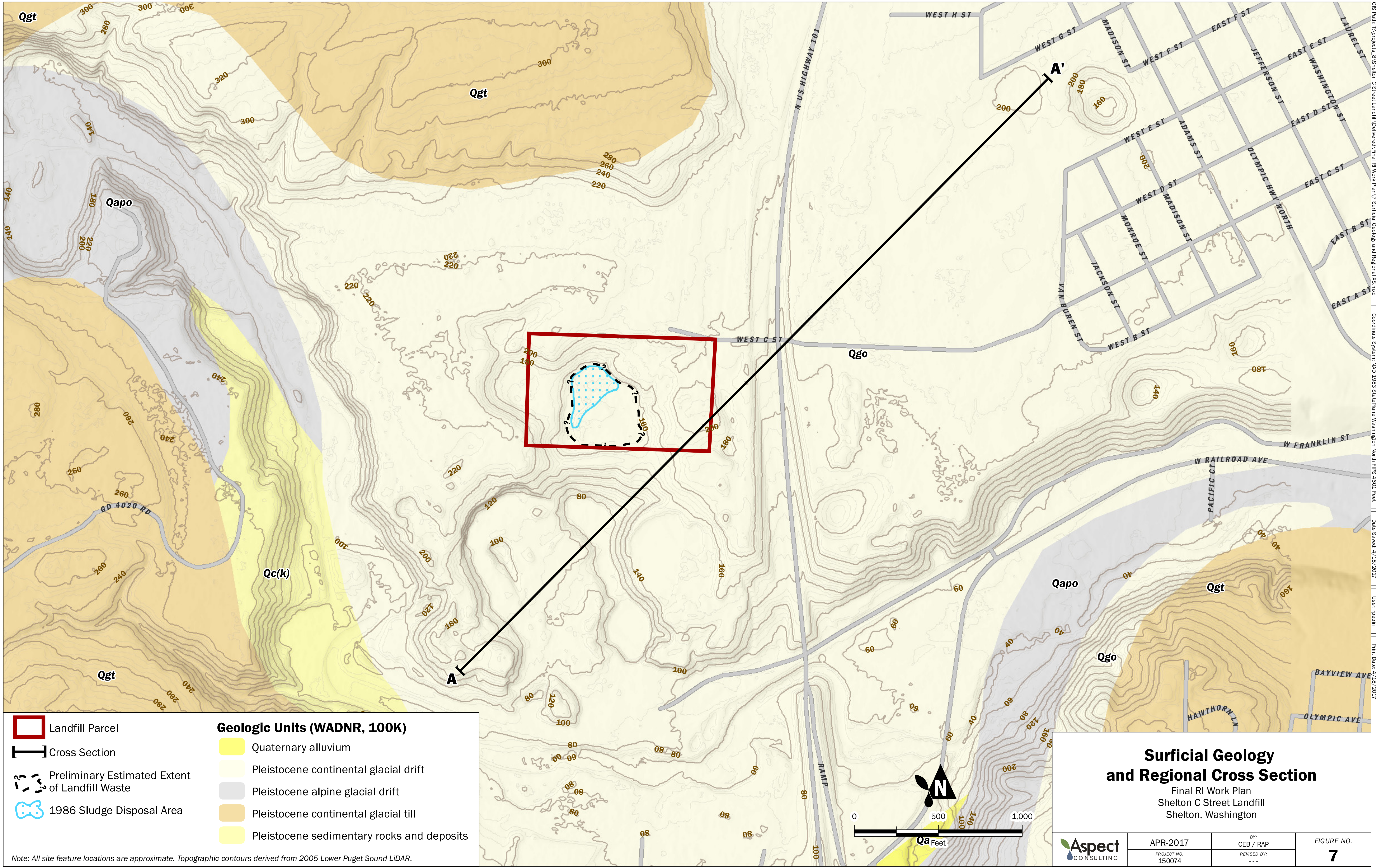

Landfill Parcel

Cross Section

Preliminary Estimated Extent of Landfill Waste

1986 Sludge Disposal Area

Geologic Units (WADNR, 100K)

🟨	Quaternary alluvium
▢	Pleistocene continental glacial drift
⬜	Pleistocene alpine glacial drift
🟧	Pleistocene continental glacial till
🟨	Pleistocene sedimentary rocks and deposits

Note: All site feature locations are approximate. Topographic contours derived from 2005 Lower Puget Sound LiDAR.

Basemap Layer Credits || USGS, NGA, NASA, CGIAR,N Robinson,NCEAS,NLS,OS,NMA,Geodatastyrelsen

Surficial Geology and Regional Cross Section

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

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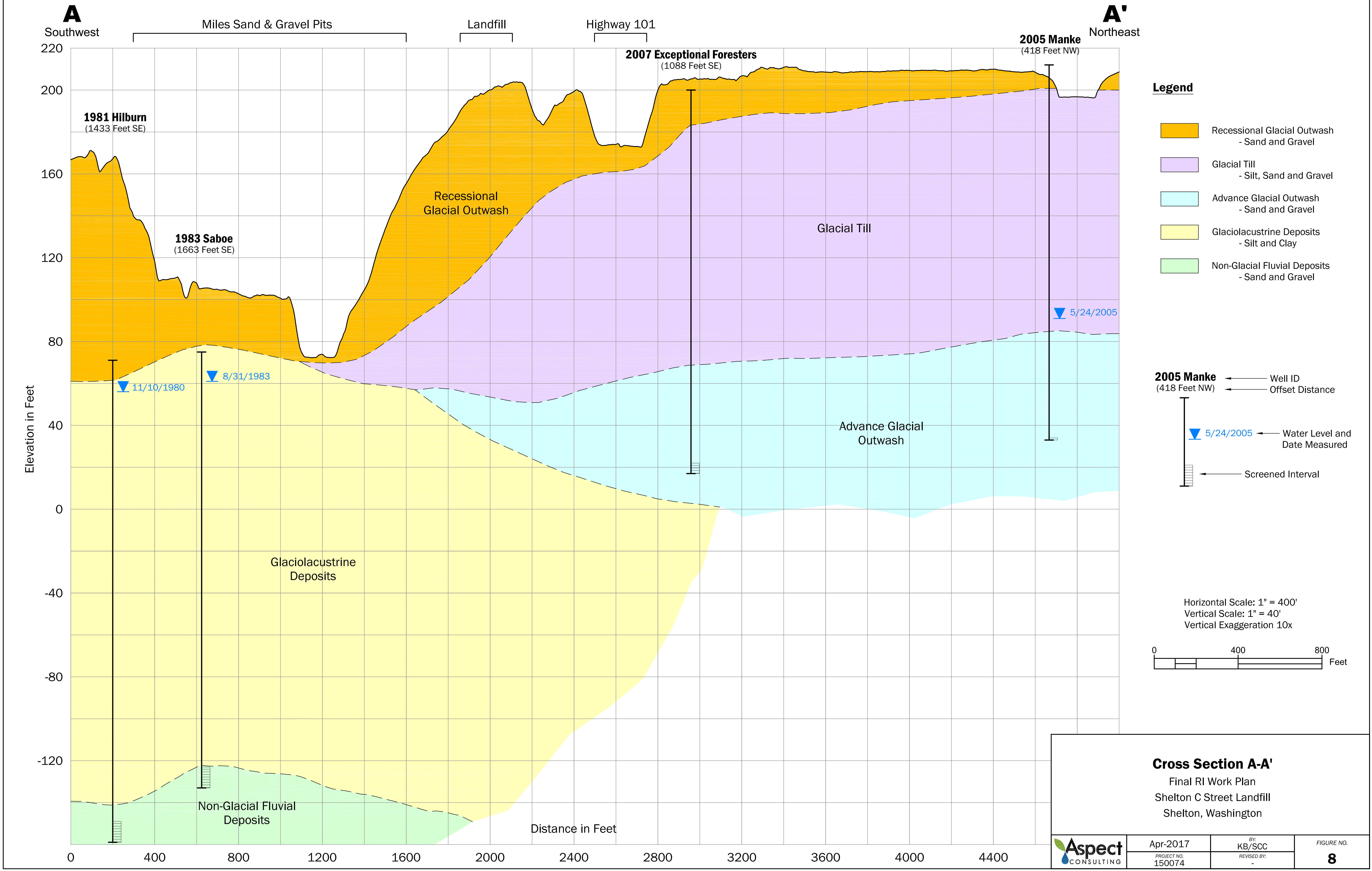
APR-2017	BY: CEB / RAP	FIGURE NO.	7
PROJECT NO. 150074	REVISED BY: - - -		

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\7 Surficial Geology and Regional XS.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017



Cross Section A-A'

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

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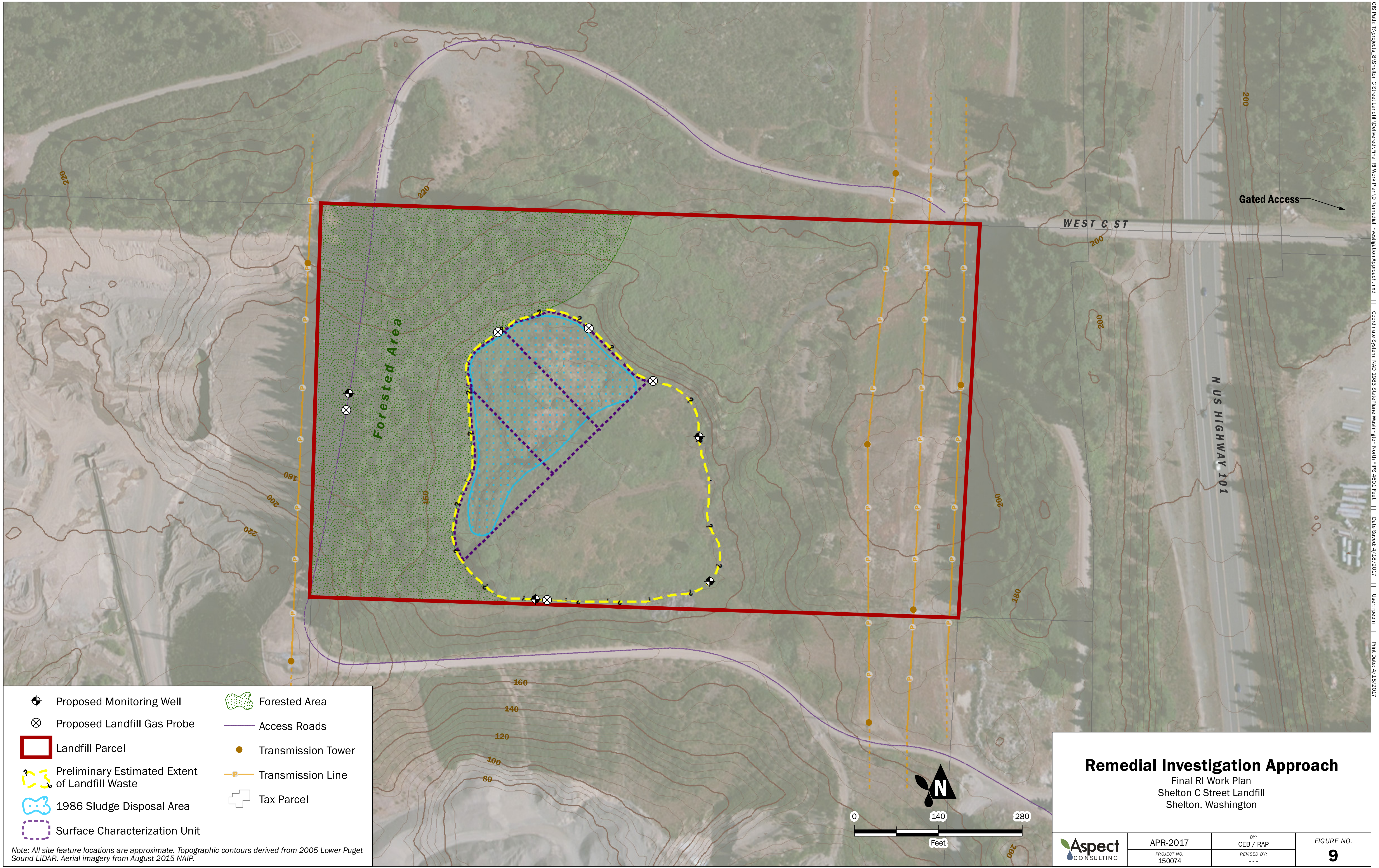
Apr-2017	BY: KB/SCC	FIGURE NO.	
PROJECT NO. 150074	REVISED BY: -	8	

CAD Path: Q:\City of Shelton\150074 Shelton C Street Landfill\2017-04 Final RI Work Plan\150074-AA Final.dwg Section A-A' || Coordinate System: NAD 1983 State Plane Washington North FIPS 4601 Feet || Date Saved: Apr 17, 2017 4:51pm || User: scudd



Note: All site feature locations are approximate. Topographic contours derived from 2005 Lower Puget Sound LiDAR. Aerial imagery from August 2015 NAIP.

Remedial Investigation Approach

Final RI Work Plan
Shelton C Street Landfill
Shelton, Washington

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GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\9 Remedial Investigation Approach.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

APPENDIX A

Sampling and Analysis Plan

Contents – Appendix A

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A.1. Introduction

The City of Shelton (City) is conducting a Remedial Investigation (RI) at the Shelton C Street Landfill, a former municipal waste landfill located in Shelton, Washington (the Site; Figure A-1). The work is being completed under the direction of the Washington State Department of Ecology (Ecology). The former municipal waste landfill is located on a 16.7-acre parcel owned by the City at the west end of West C Street, just west of the overpass across US Highway 101 in Mason County, Washington (the Property; Figure A-1). This Sampling and Analysis Plan (SAP) has been prepared as Appendix A to the RI Work Plan to describe specific sampling and analysis protocols for field sampling and quality assurance for chemical and physical analysis. The work is being conducted in accordance with the Agreed Order No. DE 12929 (Agreed Order) between Ecology and the City.

The purpose of this SAP is to ensure that field sample collection, handling, and laboratory analysis conducted during the Shelton C Street RI will generate data to meet project-specific data quality objectives (DQOs) in accordance with the Model Toxics Control Act (MTCA) requirements (Washington Administrative Code [WAC] 173-340-350). This SAP is comprised of two major components: a Field Sampling Plan (FSP) defining field protocols, and a Quality Assurance Project Plan (QAPP) defining analytical protocols. It is the responsibility of Aspect Consulting, LLC (Aspect) personnel and subcontracted analytical laboratory personnel performing the RI sampling and analysis activities to adhere to the requirements of the FSP and QAPP. The FSP (Section A.2) and QAPP (Section A.3) are presented below.

A.2. Field Sampling Plan

A.2.1. Geophysical Investigation

Three separate geophysical surveys will be conducted by hydroGEOPHYSICs, Inc., to evaluate the extent of landfill waste. The geophysical investigation will consist of an electromagnetic induction (EM) survey, a magnetic survey, and an electrical resistivity (ER) survey. Together, the surveys will be completed to identify subsurface metallic objects and variations in soil conductivity that may indicate the presence of landfill waste. The EM survey will be completed in one day with data compiled, processed, and visualized overnight. An ER survey will be completed following the EM and magnetic surveys to evaluate the lateral limits and depth of landfill waste. The ER data will be compiled, processed, and visualized by the geophysical contractor in the office following completion of the field data collection. The results and interpretations of the geophysical surveys will be provided to Ecology prior to subsequent phases of investigation.

A.2.2. Surface Characterization

The surface characterization will consist of soil sampling using the incremental sampling method (ISM) to assess the presence, nature, and extent of the contaminants of potential concern (COPCs) in surface and shallow subsurface soil in an area of the Shelton C Street Landfill, where wastewater treatment-plant sludge was reportedly dumped (Figure

A-2). ISM is a structured composite sampling and processing protocol that reduces data variability and provides a reasonably unbiased estimate of mean contaminant concentrations in a volume of soil targeted for sampling, termed a “Decision Unit” (DU; ITRC, 2012). ISM will be implemented at the Site if a sufficient thickness of soil is present over landfill waste.

For the purposes of this SAP, we have assumed that ISM will be implemented in the documented and suspected areas of historical disposal of wastewater treatment-plant sludge. The study area will be divided into three DUs; the preliminary DUs are shown on Figure A-3. The orientation of the DUs may be modified based on the results of the geophysical investigation and/or other preliminary site preparation activities, if appropriate. Each DU will include sampling of the upper 6 inches of soil, unless landfill waste is present at shallower depths. Municipal landfill waste will not be collected or sampled as part of the surface characterization. The sampling procedures described below will be consistent between all DUs.

The sampling design for the surface characterization at the Site describes two separate sample types: 1) standard ISM samples to be submitted for laboratory analysis of total petroleum hydrocarbons (TPH) in the diesel- and oil-range, metals, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), chlorinated pesticides and herbicides, and dioxins/furans; and, 2) discrete samples to be submitted for volatile organic compounds (VOCs) and TPH in the gasoline-range. Discrete samples will be collected at a frequency of one sample for each 10,000 square feet (ft^2) of DU. The sampling and analysis procedures are described in the following sections.

A.2.2.1. Sampling Design

Each DU will be subdivided by an internal grid consisting of approximately 35 equally sized subareas to accommodate the collection of at least 30 incremental samples across the full DU. This subdivision allows for elimination of grid squares that field personnel decide are not sampleable (due to shallow landfill waste, vegetation, inaccessible or unsafe areas, etc.). One bulk sample of at least 30 increments will be collected from each DU. Each of the 30 increments obtained should weigh approximately 50 grams to ensure adequate replicate sample mass required for the specified laboratory analyses (1.5 kilogram).

In addition to the ISM samples described above, discrete samples specifically obtained for VOC analysis will be collected at a frequency of one sample per 10,000 ft^2, for a total of eight samples.

Figure A-3 presents the preliminary sampling design for the surface characterization. The proposed locations of the DUs and the preliminary layout of the interior sampling grids were established using ArcGIS 10 to allow field personnel to locate and stake out (as needed) the grid intersections within each DU using a portable global positioning (GPS) unit during sampling. Similarly, a global information system (GIS) was used to generate random locations for collection of the sample increment within each sampling grid. The increment locations comprising each random sample location will be located and documented by field personnel using the GPS unit.

A.2.2.2. Soil Sampling Procedures

ISM soil samples will be obtained using a hand-held 6-inch-long split-spoon sampler with a drive shoe, advanced manually using a slide hammer. The samples will be collected from the ground surface, or just beneath any surface asphalt or gravel, to a depth of 6 inches below ground surface (bgs). If landfill waste is encountered, the sample location will be abandoned and additional sample collection will not be performed. All incremental samples collected from within a DU will be placed together in a single gallon-sized Ziploc bag.

All ISM samples will be double bagged and stored and transported in coolers with internal temperatures maintained at 4 degrees Celsius (ºC). Before 5 PM of each field day, sample coolers will be transported by field personnel to the laboratory under standard chain-of-custody procedures (discussed below). The laboratory will facilitate shipping of the ISM samples to the applicable analysis laboratory location for ISM sample processing, subsampling, and analysis, as needed. Samples will be identified per the procedure outlined in A.2.2.5 below.

A.2.2.3. Discrete VOCs Sampling Procedures

GIS will be used to identify select sample locations located at a frequency of approximately every 10,000 ft^2 across the Site that will also be sampled for VOCs and gasoline-range TPH (7 locations; Figure A-3). In the selected sample locations, discrete samples will be obtained from soil in the split-spoon sampler immediately upon soil exposure (before collecting ISM samples), using laboratory-provided Terracore sampling kits and volatile organic analysis (VOA) containers in accordance with US Environmental Protection Agency (EPA) Method 5035A.

All discrete volatiles samples will be stored and transported in separate coolers from the ISM samples, with internal temperatures maintained at 4ºC. Before 5 PM of each field day, sample coolers will be transported by field personnel or couriered to the laboratory under standard chain-of-custody (COC) procedures (discussed below).

A.2.2.4. Sample Equipment Decontamination

Within an individual DU, any soil and mud adhered to reusable sampling equipment (such as the split-spoon sampler, drive shoe, and any hand tools used for separating the soil cores) will be wiped off the equipment prior to use at another incremental sampling location. Between DUs, all reusable sampling equipment or other field equipment (hand auger, pin flags, or stakes, etc.) will be washed in a 5-gallon bucket containing a Liqui-nox solution and double rinsed with deionized water. After air drying, sampling equipment will be wrapped in aluminum foil prior to use at the next DU, or departing the Site.

A.2.2.5. Soil Sample Identification

Each sample container (Ziploc bag or VOAs) will be labeled with the following using permanent, nonvolatile ink: unique sample identification, date, time, and project number. The unique sample identification format is “YYMM-XX” for which:

- YY is the year the sample was obtained;
- MM is the month the sample was obtained; and
- XX is the two-digit DU number (01 for Decision Unit #1, for example).

Discrete samples will be named similarly, with a sequential sample number substituted for the DU number.

A.2.3. Groundwater Evaluation

A.2.3.1. Drilling Methods and Field Screening

Soil borings completed for the installation of monitoring wells will be completed using a rotary vibratory drill (sonic drilling). Soil samples will be collected continuously from the soil borings for observation, lithologic description, and field screening. A geologist from Aspect will oversee the drilling activities and preparation of a geologic boring log for each of the explorations. The field representative will visually classify the soils in accordance with the American Society for Testing and Materials (ASTM) *Standard Practice for Description and Identification of Soils* (Visual-Manual Procedure, ASTM Method D2488 (ASTM, 2009) and record soil descriptions, field screening results, and other relevant details (e.g., staining, debris, odors, etc.) on the boring log form.

In addition to soil classification, the field representative will screen each soil sample using a photoionization detector (PID) to monitor for the presence of VOCs. A portion of the soil sample will be placed into a resealable plastic bag for headspace vapor screening. Ambient air will be captured in the bag; the bag will be sealed and then shaken gently to expose the soil to the air trapped in the bag. Vapors present within the sample bag's headspace will be measured by inserting the probe of a PID through a small opening in the bag, ensuring that the probe doesn't contact the soil. The PID will be calibrated daily in the field using the manufacturer's calibration standard (100 parts per million [ppm] isobutylene gas). A calibration test, referred to as a "bump test," will be performed as necessary in the field using the calibration gas to check that the PID remains properly calibrated throughout the day.

In addition to field screening for VOCs, a multigas meter will be used to monitor methane, carbon dioxide, and oxygen concentrations, and a hydrogen sulfide (H_2S) meter will be used to monitor H_2S concentrations. The gas and H_2S measurements will be taken from the top of the drill casing after each sample run, and as periodic ambient air measurements as part of health and safety monitoring. The PID, gas, and H_2S readings will be recorded on the boring log form. In the case of elevated levels of methane, drilling will cease and a fan will be used to clear the immediate area of dangerous gasses. Drilling will resume after mitigation plans, approved by Aspect's Health and Safety Officer, are implemented to ensure safe drilling operations. The Site Health and Safety Plan (HASP) provides more details (Attachment 1).

A.2.3.2. Monitoring Well Installation and Development

Monitoring wells will be constructed by a state-licensed, resource-protection well driller and in accordance with Chapter 173-160 WAC. An Aspect field geologist will oversee and document installation of each monitoring well, including completion of an As-Built Well Completion Diagram.

New monitoring wells will be constructed with 4-inch-diameter threaded Schedule 40 PVC slotted screen and blank casing. Well screens will be 0.020-inch (20 slot) slotted screen, estimated to be 20 feet long with 10 feet extending below the water table and 10 feet above. An artificial filter pack consisting of 10/20 silica sand will be placed around the well screen, and a minimum 3-foot-thick annular bentonite seal will be placed above the filter pack. A concrete surface seal will be set at grade for each new monitoring well. The finished monitoring wells will be protected with a steel aboveground monument surrounded by bollards.

Following installation, each new monitoring well will be developed to remove fine-grained material from inside the well casing and filter pack to the extent practical, and to improve hydraulic communication between the well screen and the surrounding water-bearing formation. Well development will include a combination of surging across the well screen combined with pumping and monitoring of field parameters to identify when stabilization occurs and when development can stop. A downhole submersible well-development pump will be used to purge groundwater until visual turbidity is reduced to minimal levels (below 5 nephelometric turbidity units [NTU] if practical) and field parameters have stabilized, or until a minimum of 15 casing volumes of water has been removed. During purging, field parameters (temperature, pH, specific electrical conductance, dissolved oxygen, and oxidation-reduction potential [ORP]) will be monitored and recorded at regular intervals using a YSI meter and flow-through cell, or equivalent. Stabilization is defined as three successive readings where the parameter values vary by less than 10 percent (or 0.5 milligrams per liter [mg/L] dissolved oxygen if the readings are below 1 mg/L).

A.2.3.3. Groundwater Monitoring and Sampling

Depth-to-groundwater measurements will be conducted in monitoring wells using an electric well sounder, graduated to 0.01 foot. Groundwater samples will be collected and handled in accordance with the procedures described below:

- The locking well cap will be removed and the depth-to-groundwater will be measured from the surveyed location on the top of the monitoring well casing to the nearest 0.01 foot using an electronic water level measuring device. The depth to the bottom of the monitoring well will also be measured to evaluate siltation of the monitoring well. The water level indicator will be decontaminated between wells.
- Each monitoring well will be purged at a low-flow rate less than 0.5 liter per minute (Puls and Barcelona, 1996) using a dedicated bladder pump and tubing, left in the monitoring wells between sampling events. The tubing intake will be placed just below the center of the saturated section of well screen. During

purging, field parameters will be monitored using a YSI meter and flow-through cell, or equivalent. These field parameters will be recorded at 2- to 4-minute intervals throughout well purging until they stabilize. Stabilization is defined as three successive readings where the parameter values vary by less than 10 percent (or 0.5 mg/L dissolved oxygen if the readings are below 1 mg/L). However, no more than three well-casing volumes will be purged prior to groundwater sample collection. Three turbidity measurements will also be made before collecting the sample (using Hach 2100Q turbidimeter).

- Samples with a field-measured specific electrical conductance greater than 1,000 microsiemens per centimeter (µS/cm) or turbidity greater than 25 NTU will be denoted as such on the COC form, so that the laboratory can employ appropriate sample preparation techniques to avoid analytical interferences for specific analyses (refer to Sections A3.3.2 and A3.3.3).
- If the monitoring well is completely dewatered during purging, samples will be collected when sufficient recharge has occurred to allow filling of all sample containers.
- Once purging is complete, the groundwater samples will be collected using the same low-flow rate directly into laboratory-supplied sample containers. Samples for dissolved metals analyses will be filtered using an inline 0.45-micrometer (µm) filter; at least 0.5 liter of water will be purged through the filter prior to sample collection.
- Quality control groundwater samples (e.g., field duplicates and trip blanks) will be collected at the respective frequencies prescribed in Section A3.5.1.
- Groundwater samples collected from all the wells will be submitted for laboratory analysis of the preliminary COPCs, including geochemical indicator parameters.

Following sampling, the wells cap and monument cap will be secured. Any damaged or defective well caps or monuments will be noted and scheduled for replacement, if necessary.

A.2.3.4. Groundwater Sample Identification

Each groundwater sample will be assigned a unique sample identification number that includes the well number and the six-digit date on which the sample was collected. For example, a groundwater sample collected from monitoring well MW-1 on May 30, 2017, would be identified as MW-1-053017.

A.2.3.5. Hydraulic Conductivity Testing

Slug tests will be performed to obtain hydraulic conductivity data for the upper water-bearing zone. The slug tests will initially be performed at all four of the initial monitoring wells. This method consists of quickly lowering or raising the water level in a well or borehole from equilibrium and measuring its subsequent rate of rise or fall, respectively. The slug test method is an efficient, cost-effective method to estimate the hydraulic conductivity of the hydrogeologic unit in which a well is completed. The slug tests will be completed following well installation, development, and the first groundwater sampling event.

A.2.3.5.1. Field Procedures

The slug tests produce a change in water level within a well and measure the rate of return to the static water level. This rate of water level change in the well is used to compute the hydraulic conductivity of the water-bearing zone. Depending on the location of the monitoring well screen relative to the water table, either a slug bar or a pneumatic slug apparatus will be used to induce a water level change in the well. For monitoring wells with unsaturated or partially saturated screens, wells where the water table is less than 3 feet above the top of the screen, or for wells where the casing will not hold pressure; a slug bar of known volume will be used to displace water. For monitoring wells with fully saturated screens, where the water level is greater than 3 feet above the top of the screen; a pneumatic slug apparatus will be used to displace water. For either test method, the displacement volume (size of the slug bar or the operating pressure of the pneumatic apparatus) will be chosen based on the expected hydraulic conductivity of the screened aquifer interval. The specific test methods will be determined following installation of the monitoring wells and measurement of groundwater levels in the wells.

To test the results for dependency of hydraulic head, slug tests will be performed using a minimum of two different displacement volumes at each well. To test for repeatability, a minimum of two slug tests will be performed at each displacement volume.

A.2.3.5.2. Slug Bar Testing Methods

Slug bars will be 2 inches in diameter to allow passage of the transducer cable inside a standard 4-inch-diameter well casing. Two different slug bar lengths will be used at each well to result in different displacement volumes. To test for repeatability, two slug tests will be performed with each slug test bar.

The water level in the well will be measured using a vented pressure transducer (5 or 15 psi range) and collected electronically on a data logger set to a nearly continuous time interval (1 second or less). Manually collected water level measurements, taken periodically throughout the test with a water level indicator, will be used to confirm results collected from the pressure transducer. Prior to the testing, the pressure transducer will be installed to avoid contact with the slug bars. Once the transducer is in place and the data logger is programmed, the slug bar will be lowered on a line until it is fully submerged and the water level in the well has returned to near static conditions.

Rising Head Test. The rising head test will be initiated at this time by quickly raising the slug bar completely out of water without disturbing the pressure transducer. Water in the well will rapidly fall and then rise to meet the initial static water level over time. The pressure will be monitored to confirm that initial displacement was relatively instantaneous compared to the response. When the pressure transducer indicates that water levels have recovered 80 percent (for low hydraulic conductivity [low-K] formations) to 95 percent (for high hydraulic conductivity [high-K] formations) of the initial displacement, the test will be concluded, at which time the water level will be confirmed manually.

Falling Head Test. If appropriate, a falling head test may also be conducted. To initiate the falling head test, the slug bar will be dropped into the groundwater so it is fully submerged. The insertion should be done quickly, and with care taken not to disturb the pressure transducer. Water in the well will rapidly rise, then slowly fall to meet the initial static water level over time. The pressure will be monitored to confirm initial displacement was relatively instantaneous compared to the response. When the pressure transducer indicates that water levels have recovered 80 percent (for low-K formations) to 95 percent (for high-K formations) of the initial displacement, the test will be concluded, at which time the water level will be confirmed manually.

A.2.3.5.3. Pneumatic Testing Methods

The pneumatic slug apparatus creates an airtight seal with the well casing and uses compressed nitrogen to displace water in the well casing. The apparatus consists of the following items:

- 22 cubic-foot compressed nitrogen bottle with primary regulator and secondary (0-10 psi) low-pressure regulator; and
- PVC wellhead assembly with pressure relief valve, analog pressure gauge (0-100 inches of water range), pressure transducer cable compression fitting, and flexible rubber PVC coupling.

Like the slug bar testing method, the water level in the well will be measured using a vented pressure transducer (5- or 15-psi range) and collected electronically on a data logger set to a nearly continuous time interval (1 second or less).

Rising Head Test. The pneumatic slug test is initiated by closing the pressure relief valve and slowly adjusting the low-pressure regulator to the desired pressure (displacement). As the headspace in the well is being pressurized and the water level is equilibrating, the pressure transducer will read an elevated pressure. Following equilibration of the water level, the pressure transducer reading will be consistent with pretest readings. After the transducer readings have stabilized, the pressure relief valve is then opened quickly to allow the water level in the well to return to static conditions. The valve should be opened quickly without disturbing the pressure transducer. When the pressure transducer indicates that water levels have recovered 80 percent (for low-K formations) to 95 percent (for high-K formations) of the initial displacement, the test will be concluded.

Falling Head Test. The pneumatic slug testing apparatus does not support falling head slug testing. The initial pressurization of the well casing is functionally equivalent to a falling head test. Equilibration time is dependent on hydraulic conductivity, and the equilibration time of a given pressure (displacement) will be equivalent to the recovery time for a rising head test.

A.2.3.5.4. Data Analysis

The recovery data of the slug tests will be used to estimate the hydraulic conductivity of the formation adjacent to screened interval of each monitoring well through the comparison of theoretical models. Theoretical models such as Hvorslev (1951), Cooper et al. (1967), Bouwer and Rice (1976), and Dagan (1978) will be used for typical water level recovery curves. The appropriate model for each well will be determined after data is plotted and inspected. The use of a curve-matching computer software program may be used for effective analysis. Potential well skin effects will be assessed using methods described in Butler (1996).

A.2.4. Landfill Gas Investigation

The historical information reviewed in preparation of the RI Work Plan suggests that the landfill waste may be as thick as 35 to 40 feet. To evaluate potential landfill gas and concentrations of COPCs in soil vapor surrounding the landfill waste, shallow (20 feet bgs) and deep (40 feet bgs) landfill gas monitoring probes will be installed in the vadose zone at each landfill gas monitoring location. The landfill gas probes will be a nested pair in a 4-inch-diameter borehole, assuming Ecology will approve a variance request.

Like the groundwater evaluation, the landfill gas probes will be installed using sonic drilling technologies and soil samples will be collected continuously from the ground surface to the total depth of each boring for observation, lithologic description, and field screening (see Section A.2.2.2 for detailed procedures).

A.2.4.1. Landfill Gas Probe Installation

Five landfill gas probes will be installed around the perimeter of the Site. Each probe location will include both shallow (20 feet bgs) and deep (40 feet bgs) probes. The proposed locations of the landfill gas wells are depicted on Figure A-2.

Based on geologic conditions observed in the south-adjacent gravel mining operations, it is assumed that the native soil at the Site consists of at least 60 feet of sand and gravel. The construction details provided herein for the landfill gas probes assume the following:

- The landfill waste is less than 45 feet thick; and
- The native subsurface lithology around the landfill waste consists of sand and gravel to depths of 60 feet bgs or greater.

The screen lengths for the landfill gas probes will be approximately 10 feet, with the shallow probe constructed with a screened interval set from 10 to 20 feet bgs and the deep probe constructed with a screened interval set from 30 to 40 feet bgs. A minimum five-foot seal comprised of either bentonite or tremied grout t will be placed between the screened intervals in the borehole. The landfill gas probes will be completed with a 3/4-inch-diameter, Schedule 40 PVC well casing, a 0.020-slot PVC screen, and a pea gravel filter pack. The landfill gas probes will be completed with aboveground monuments and a valved sampling port. The final construction details, including total depth and screened interval will be dependent on the results of the geophysical survey and the groundwater evaluation.

A.2.4.2. Landfill Gas and Soil Vapor Sampling

Each landfill gas and soil vapor sampling event will be scheduled to evaluate conditions during falling barometric pressure. Methane, carbon dioxide and oxygen, well pressure and barometric pressure will be measured using a GEM 5000 portable gas meter. Parameters will be recorded at regular intervals while purging a minimum of three casing volumes from the well to ensure representative soil vapor conditions during sampling.

Soil gas grab samples will be collected from each landfill gas monitoring well for laboratory analysis of the COPCs. The samples will be collected in 6-liter Summa canisters for analysis by EPA Method TO-15 for volatile compounds and the MassDEP APH Method for aliphatic petroleum compounds.

A.2.5. Sample Custody and Field Documentation

A.2.5.1. Sample Custody

Upon collection, soil and groundwater samples will be placed upright in a cooler. Ice or blue ice will be placed in each cooler to meet soil and groundwater sample preservation requirements. Vapor samples will be packed at room temperature in a box or shipping container. Inert cushioning material will be placed in the remaining space surrounding the sample containers, as needed, to limit movement during shipping. If the sample coolers/containers are being shipped, not hand carried, to the laboratory, the COC form will be placed in a waterproof bag taped to the inside lid of the cooler/container for shipment.

After collection, samples will be maintained in Aspect's custody until formally transferred to the analytical laboratory. For purposes of this work, custody of the samples will be defined as follows:

- In plain view of the field representatives;
- Inside a cooler that is in plain view of the field representative; or
- Inside any locked space such as a cooler, locker, car, or truck to which the field representative has the only immediately available key(s).

A COC record provided by the laboratory will be initiated at the time of sampling for all samples collected. The record will be signed by the field representative and others who subsequently take custody of the sample. Couriers or other professional shipping representatives are not required to sign the COC form; however, shipping receipts will be collected and maintained as a part of custody documentation in project files. A copy of the COC form with appropriate signatures will be kept by Aspect's project manager.

Upon sample receipt, the laboratory will fill out a cooler receipt form to document sample delivery conditions. A designated sample custodian will accept custody of the shipped samples and will verify that the COC form matches the samples received. The laboratory will notify the Aspect project manager, as soon as possible, of any issues noted with the sample shipment or custody.

A.2.5.2. Field Documentation

While conducting field work, the field representative will document pertinent observations and events, specific to each activity, on field forms (e.g., boring log form, as-built well completion form, well development form, groundwater sampling form, etc.) and/or in a field notebook, and, when warranted, provide photographic documentation of specific sampling efforts. Field notes will include a description of the field activity, sample descriptions, and associated details such as the date, time, and field conditions.

A.2.6. Location Positioning

Horizontal coordinates for each soil sampling location will be recorded using a hand-held GPS instrument with real-time differential correction. The horizontal coordinates and elevations of monitoring wells will be surveyed by a licensed surveyor relative to Washington State Plane coordinates (horizontal) and NAVD88 (vertical). Monitoring well top-of-casing and ground surface elevations will be surveyed to the nearest 0.01 foot, and horizontal coordinates to the nearest 0.1 foot, or better. Each well will be surveyed at the marked spot on the top of the PVC well casing from which depth-to-water measurements are collected.

A.3. Quality Assurance/Quality Control Project Plan

This QAPP identifies quality assurance and quality control (QA/QC) procedures and criteria required to ensure that data collected during the RI are of known quality and acceptable to achieve project objectives. Specific protocols and criteria are also set forth in this QAPP for data quality evaluation, upon the completion of data collection, to determine the level of completeness and usability of the data. It is the responsibility of the project personnel performing or overseeing the sampling and analysis activities to adhere to the requirements of the FSP and this QAPP.

A.3.1. Purpose of the QAPP

As stated in Ecology Guidelines for Preparation of Quality Assurance Project Plans for Environmental Studies (Ecology Publication No. 04-03-030, December 2016), specific goals of this QAPP are as follows:

- Focus project manager and project team to factors affecting data quality during the planning stage of the project;
- Facilitate communication among field, laboratory, and management staff as the project progresses;
- Document the planning, implementation, and assessment procedures for QA/QC activities for the investigation;
- Ensure that the DQOs are achieved; and
- Provide a record of the project to facilitate final report preparation.

The DQOs for the project include both qualitative and quantitative objectives, which define the appropriate type of data, and specify the tolerable levels of potential decision errors that will be used as a basis for establishing the quality and quantity of data needed to support the environmental assessment. To ensure that the DQOs are achieved, this QAPP details aspects of data collection, including analytical methods, QA/QC procedures, and data quality reviews. This QAPP describes both quantitative and qualitative measures of data to ensure that the DQOs are achieved. DQOs dictate data collection rationale, sampling and analysis designs that are presented in the main body of the RI Work Plan, and sample collection procedures that are presented in the FSP (Section A.2 of this Appendix).

A.3.2. Analytical Methods and Reporting Limits

Analytical methodologies applied to the analyses of samples collected during the RI are in accordance with the following documents:

- EPA SW Methods: EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, December 1996.
- EPA Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, Office of Water, U.S. Environmental Protection Agency, August 2002, EPA-821-R-02-019.
- EPA Method 1688A: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, August 2003.
- Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20th Edition, 1995.
- Ecology Analytical Methods for Petroleum Hydrocarbons. Publication No. ECY 97-602, June 1997.

Table A-1 lists the laboratory analytical methods for soil and groundwater analyses to be performed during the RI, along with samples containers, preservation, and analytical holding times for each analysis.

A.3.2.1. Method Detection Limit and Method

The method detection limit (MDL) is the minimum concentration of a compound that can be measured and reported with a 99 percent confidence that the analyte concentration is greater than zero. MDLs are established by the laboratory using prepared samples, not samples of environmental media.

Estimated detection limit (EDL), as defined in SW846 Method 8290 (dioxins/furans), is the minimum concentration a compound can be reported as detected using the high-resolution gas chromatography (HRGC)/high resolution mass spectrometry (HRMS) methodology.

EDL is a sample- and analyte-specific detection limit that is based on the signal-to-noise ratio present in the sample for each analyte at the time of analysis. EDL is defined as follows:

$$\mathrm{EDL} = \frac{2.5 \times \mathrm{H}_{x} \times \mathrm{Q}_{is}}{\mathrm{H}_{is} \times \mathrm{W} \times \overline{\mathrm{RF}}_{n}}$$

where:

EDL = estimated detection limit for homologous 2,3,7,8-substituted dioxins/furans.

H*x* = sum of the height of the noise level for each quantitation ion for the unlabeled target compound.

H*is* = sum of the height of the noise level for each quantitation ion for the labeled internal standard.

W = weight of the sample, in gram.

RF = calculated mean relative response factor for the analyte.

Q*is* = quantity of the internal standard added to the sample before extraction, in pictogram.

The method reporting limit (RL) is defined as the lowest concentration at which a chemical can be accurately and reproducibly quantified, within specified limits of precision and accuracy, for a given environmental sample. The RL can vary from sample to sample depending on sample size, sample dilution, matrix interferences, moisture content, and other sample-specific conditions. As a minimum requirement for organic analyses, the RL should be equivalent to or greater than the concentration of the lowest calibration standard in the initial calibration curve. The expected MDLs (EDLs for dioxins/furans) and RLs are summarized in Table A-3 and A-4 for soil and water samples, respectively.

A.3.3. Data Quality Objectives

DQOs, including the Measurement Quality Indicators (MQIs)—precision, accuracy, representativeness, comparability, completeness, and sensitivity (namely PARCCS parameters)—and sample-specific RLs are dictated by the data quality objectives, project requirements, and intended uses of the data. For this project, the analytical data must be of sufficient technical quality to determine whether contaminants are present and, if present, whether their concentrations are greater than or less than applicable screening criteria based on protection of human health and the environment.

The quality of data generated through this RI will be assessed against the MQIs set forth in this QAPP. Specific QC parameters associated with each of the MQIs are summarized in Table A-2. Specific MQI goals and evaluation criteria (i.e., MDLs, RLs, percent recovery (%R) for accuracy measurements, relative percent difference (RPD) for precision measurements, are defined in Table A-3 and A-4. Definitions of these parameters and the applicable QC procedures are presented below.

A.3.3.1. Precision

Precision measures the reproducibility of measurements under a given set of conditions. Specifically, it is a quantitative measure of the variability of a group of measurements compared with their average values. Analytical precision is measured through matrix spike/matrix spike duplicate (MS/MSD) samples and laboratory control samples/laboratory control sample duplicate (LCS/LCSD) for organic analysis and through laboratory duplicate samples for inorganic analyses.

Analytical precision is quantitatively expressed as the RPD between the LCS/LCSD, MS/MSD, or laboratory duplicate pairs and is calculated with the following formula:

$$RPD\ (\%) = 100 \times \frac{\left|S - D\right|}{\left(S + D\right)/2}$$

where:
S = analyte concentration in sample
D = analyte concentration in duplicate sample

Analytical precision measurements will be carried out at a minimum frequency of 1 per 20 samples for each matrix sampled, or 1 per laboratory analysis group. Laboratory precision will be evaluated against laboratory quantitative RPD performance criteria as defined in Tables A-3 and A-4 for specific analytical methods and sample matrices. If the control criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. The RPD will be evaluated during data review and validation. The data reviewer will note deviations from the specified limits and will comment on the effect of the deviations on reported data.

A.3.3.2. Accuracy

Accuracy measures the closeness of the measured value to the true value. The accuracy of chemical test results is assessed by “spiking” samples with known standards (surrogates, blank spikes, or matrix spikes) and establishing the average recovery. Accuracy is quantified as the %R. The closer the %R is to 100 percent, the more accurate the data.

Surrogate recovery will be calculated as follows:

$$\text{Recovery}\ (\%) = \frac{MC}{SC} \times 100$$

where:

SC = spiked concentration
MC = measured concentration

MS percent recovery will be calculated as follows:

$$\text{Recovery}\ (\%) = \frac{MC - USC}{SC} \times 100$$

where:

SC = spiked concentration
MC = measured concentration
USC = unspiked sample concentration

Accuracy measurements on MS samples will be carried out at a minimum frequency of 1 in 20 samples per matrix analyzed. Blank spikes will also be analyzed at a minimum frequency of 1 in 20 samples (not including QC samples) per matrix analyzed. Surrogate recoveries for organic compounds will be determined for each sample analyzed for respective compounds. Laboratory accuracy will be evaluated against the performance criteria defined in Table A-3 and A-4. If the control criteria are not met, the laboratory will supply a justification of why the limits were exceeded and implement the appropriate corrective actions. Percent recoveries will be evaluated during data review and validation, and the data reviewer will comment on the effect of the deviations on the reported data.

A.3.3.3. Representativeness

Representativeness measures how closely the measured results reflect the actual concentration or distribution of the chemical compounds in the matrix sampled. The FSP sampling techniques and sample handling protocols (e.g., homogenizing, storage, preservation, and use of duplicates and blanks) have been developed to ensure representative samples. Only representative data will be used in the RI. Sampling locations for RI activities are described in Section 6 of the RI Work Plan. The RI field sampling procedures are described in the FSP (Section A.2) of this SAP.

The representativeness of a data point is determined by assessing the integrity of the sample upon receipt at the laboratory (e.g., consistency of sample ID and collection date/time between container labels vs. COC forms, breakage/leakage, cooler temperature, preservation, headspace for VOA containers, etc.); compliance of method required sample preparation, and analysis holding times; the conditions of blanks (trip blank, rinsate blank, field blank, method/preparation blank, and calibration blank) associated with the sample; and the overall consistency of the results within a field duplicate pair.

A.3.3.4. Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. This goal will be achieved using standard techniques to collect samples, EPA-approved standard methods to analyze samples, and consistent units to report analytical results. Data comparability also depends on data quality. Data of unknown quality cannot be compared.

A.3.3.5. Completeness

Completeness is defined as the percentage of measurements made that are judged to be valid. Results will be considered valid if the precision, accuracy, and representativeness objectives are met, and if RLs are sufficient for the intended uses of the data. Completeness is calculated as follows:

$$Completeness\ (\%) = \frac{V}{P} \times 100$$

where:

V = number of valid measurements
P = number of measurements taken

Valid and invalid data (i.e., data qualified with the R flag [rejected]) will be identified during data validation. The target completeness goal for this project is 95 percent.

A.3.3.6. Sensitivity

Sensitivity depicts the level of ability an analytical system (i.e., sample preparation and instrumental analysis) of detecting a target component in a given sample matrix with a defined level of confidence. Factors affecting the sensitivity of an analytical system include: analytical system background (e.g., laboratory artifact or method blank contamination), sample matrix (e.g., mass spectrometry ion ratio change, coelution of peaks, or baseline elevation), and instrument instability.

A.3.4. Quality Control Procedures

Field and laboratory QC procedures are outlined below.

A.3.4.1. Field Quality Control

Beyond use of standard sampling protocols defined in the FSP, field QC procedures include maintaining the field instrumentation used. Field instruments (e.g., PID for evaluating presence of VOCs in soil samples, multigas meter for landfill gas monitoring, and the YSI meter for measuring field parameters during groundwater sampling) are maintained and calibrated regularly prior to use, in accordance with manufacturer recommendations.

In addition, field QC samples will be collected and submitted for analyses to monitor the precision and accuracy associated with field procedures. Field QC samples to be collected and analyzed for this RI include field duplicates, trip blanks, and equipment rinsate blanks. The definition and sampling requirements for field QC samples are presented below.

A.3.4.1.1. Blind Field Duplicates

Blind field duplicate samples are used to check for sampling and analysis reproducibility; however, the field duplicate sample results include variability introduced during both field sampling and laboratory preparation and analysis, and EPA data validation guidance provides no specific evaluation criteria for field duplicate samples. Advisory evaluation criteria are set forth at 35 percent for RPD (if both results are greater than five times the RL) and two times the RLs for concentration difference (if either of the result is less than five times the RL) between the original and field duplicate results.

Field duplicates will be submitted “blind” to the laboratory as discrete samples (i.e., given unique sample identifiers to keep the duplicate identity unknown to the laboratory), but will be clearly identified in the field log. Field duplicate samples will be collected at a frequency of 5 percent (1 per 20) of the field samples for each matrix and analytical method, but not less than one duplicate per sampling event per matrix.

If a given soil sample depth interval lacks sufficient volume (recovery) to supply material for a planned analysis and its field duplicate analysis, the field duplicate aliquot will be collected for that analysis from another depth interval in that same location if practical.

A.3.4.1.2. Trip Blank

Trip blank samples will be used to monitor possible VOC cross contamination occurring during sample transport. Trip blank samples are prepared and supplied by the laboratory using organic-free reagent-grade water into a VOC vial prior to the collection of field samples. The trip blank sample vials are placed with and accompany the VOC and gasoline-range TPH samples through the entire transporting process. One trip blank will be collected for each soil sampling round and each groundwater sampling round, where VOC or gasoline-range TPH analyses are conducted.

In case a target compound is present in a trip blank, results for all samples shipped with this trip blank will be evaluated and data qualified accordingly if determined that the results are affected.

A.3.4.1.3. Equipment Rinsate Blank

Equipment rinsate blanks are collected to determine the potential of cross-contamination introduced by soil sampling equipment that is used between samples. Groundwater sampling is conducted using dedicated equipment; therefore, rinsate blanks are not needed for groundwater sampling QC. The deionized water used for soil sampling equipment decontamination is rinsed through the decontaminated sampling equipment and collected into adequate sample containers for analysis of VOCs, low-level PAHs, and metals. The blank is then processed, analyzed, and reported as a regular field sample. **One rinsate blank will be conducted for each round of soil sampling.** The rinsate blank sampled will be labeled with a “RB-” prefix and the date it is collected (e.g., RB-053017).

A.3.4.2. Laboratory Quality Control

The laboratories’ analytical procedures must meet requirements specified in the respective analytical methods or approved laboratory standard operating procedures (SOPs), e.g., instrument performance check, initial calibration, calibration check, blanks, surrogate spikes, internal standards, and/or labeled compound spikes. Specific laboratory QC analyses required for this project will consist of the following at a minimum:

- Instrument tuning, instrument initial calibration, and calibration verification analyses as required in the analytical methods and the laboratory standard operating procedures (SOPs);
- Laboratory and/or instrument method blank measurements at a minimum frequency of 5 percent (1 per 20 samples) or in accordance with method requirements, whichever is more frequent; and
- Accuracy and precision measurements as defined in Table A-2, at a minimum frequency of 5 percent (1 per 20 samples) or in accordance with method requirements, whichever is more frequent. In cases where a pair of MS/MSD or MS/laboratory duplicate analyses are not performed on a project sample, a set of LCS/LCSD analyses will be performed to provide sufficient measures for analytical precision and accuracy evaluation.

The laboratory's QA officers are responsible for ensuring that the laboratory implements the internal QC and QA procedures detailed in their Quality Assurance Manual.

A.3.5. Corrective Actions

If routine QC audits by the laboratory result in detection of unacceptable conditions or data, actions specified in the laboratory SOPs will be taken. Specific corrective actions are outlined in each SOP used and can include the following:

- Identifying the source of the violation;
- Reanalyzing samples if holding-time criteria permit;
- Resampling and analyzing;
- Evaluating and amending sampling and analytical procedures; and/or
- Accepting, but qualifying data to indicate the level of uncertainty.

If unacceptable conditions occur, the laboratory will contact Aspect's project manager to discuss the issues and determine the appropriate corrective action. Corrective actions taken by the laboratory during analysis of samples for this project will be documented by the laboratory in the case narrative associated with the affected samples.

In addition, the project data quality manager will review the laboratory data generated for this investigation to ensure that project DQOs are met. If the review indicates that nonconformances in the data have resulted from field sampling or documentation procedures or laboratory analytical or documentation procedures, the impact of those nonconformances on the overall project data usability will be assessed. Appropriate actions, including resampling and/or reanalysis of samples may be recommended to the project manager to achieve project objectives.

A.3.6. Data Reduction, Quality Review, and Reporting

All data will undergo a QA/QC evaluation at the laboratory, which will then be reviewed by the Aspect database manager and the project data quality manager. Initial data reduction, evaluation, and reporting at the laboratory will be carried out in full compliance with the method requirement and laboratory SOPs. The laboratory internal review will include verification (for correctness and completeness) of electronic data deliverable (EDD) accompanied with each laboratory report. The Aspect database manager will verify the completeness and correctness of all laboratory deliverables (i.e., laboratory report and EDDs) before releasing the deliverables for data validation.

A.3.6.1. Minimum Data Reporting Requirements

The following sections specify general and specific requirements for analytical data reporting to provide sufficient deliverables for project documentation and data quality assessment.

General Requirements
The following requirements apply to laboratory reports for all types of analyses:

- A laboratory report will include a cover page signed by the laboratory director, the laboratory QA officer, or his/her designee to certify the eligibility of the reported contents and the conformance with applicable analytical methodology.
- Definitions of abbreviations, data flags, and data qualifiers used in the report.
- Cross reference of field sample names and laboratory sample identity for all samples in the sample delivery group (SDG).
- Completed COC document signed and dated by parties of acquiring and receiving.
- Completed sample receipt document with record of cooler temperature and sample conditions upon receipt at the laboratory. Anomalies such as inadequate sample preservation, inconsistent bottle counts, and sample container breakage, and communication record and corrective actions in response to the anomalies will be documented and incorporated in the sample receipt document. The document will be initialed and dated by personnel that complete the document.
- Case narrative that addresses any anomalies or QC outliers in relation to sample receiving, sample preparation, and sample analysis on samples in the SDG. The narrative will be presented separately for each analytical method and each sample matrix.
- All pages in the report are to be paginated. Any insertion of pages after the laboratory report is issued will be paginated with starting page number suffixed with letters (e.g., pages inserted between pages 134 and 135 should be paginated as 134A, 134B, etc.)
- Any resubmitted or revised report pages will be submitted to Aspect with a cover page stating the reason(s) and scope of resubmission or revision, and signed by laboratory director, QA officer, or the designee.

Specific Requirements

The following presents specific requirements for laboratory reports:

- Sample results: Sample results will be evaluated and reported down to the MDLs. Detections at levels greater than the MDLs, but less than the RLs, will be reported and flagged with “J.” Results less than the MDLs (or EDLs) will be reported at the RLs and flagged with “U.” All soil sample results will be reported on a dry-weight basis. The report pages for sample results (namely Form 1s) will, at minimum, include sample results, RLs, unit, proper data flags, dates of sample collection, preparation, and analysis, dilution factor, percent moisture (for solid samples), and sample volume (used for analysis).
- Instrument run log: The run log will list, in chronological order, all analytical runs on field samples, QC samples, calibrations, and calibration verification analyses in the SDG with data file name (and/or legible laboratory codes) and analysis date/time for each analytical run.
- Original sample preparation and analyst worksheet: Initialed and dated by analyst and reviewer.

- GC/MS and inductively coupled plasma (ICP)/MS tune report: Including ion abundance ratios and criteria for all required ions.
- Initial calibration summary: Including data file name for each calibration standard file; response factor (RF) or calibration factor (CF) for each calibration standard and each target and surrogate compound; average RF or CF, percent relative standard deviation (%RSD), correlation coefficient, or coefficient of determination; and absolute and relative retention times and ion ratios for HRGC/HRMS methods for each target compound and surrogate (labeled) compounds. As applicable and if required by the methods, initial calibrations should be verified with a second-source standard (namely the initial calibration verification [ICV]) at the mid-point concentration of the initial calibration. ICV results should be reported as part of the initial calibration.
- Calibration verification summary: Including true amount, calculated amount, and percent difference (%D), or percent drift (%D_f) as applicable, for target compounds.
- Method blank and calibration blank (as applicable such as metals analyses) results.
- LCS and LCSD (if matrix spike duplicate analysis is not performed) results with laboratory acceptance criteria for %R and RPD.
- Surrogate spike results with laboratory acceptance criteria for %R.
- MS and MSD results with laboratory acceptance criteria for %R and RPD. In cases where MS/MSD analyses were not performed on a project sample, LCS/LCSD analyses should be performed and reported instead.
- Internal standard (as applicable) results: Internal standard absolute retention times and response areas in field samples, QC analyses, and associated calibration verification analyses.
- Labeled compound (HRGC/HRMS methodology only) results, ion abundance ratios, and recovery.

A.3.7. Data Quality Verification and Validation

Reported analytical results will be qualified by the laboratory to identify QC concerns in accordance with the specifications of the analytical methods. Additional laboratory data qualifiers may be defined and reported by the laboratory to more completely explain QC concerns regarding a particular sample result. All data qualifiers will be defined in the laboratory’s narrative reports associated with each case.

A Level 4 validation (as defined in EPA, 2009) will be performed on dioxins/furans data. A Level 2b data validation will be performed on the remaining data. In cases where a systematic QC problem is suspected, such as unusual detections of an analyte or consistent outlying results of a QC parameter, a more detailed review, including a Level 4 validation, will be performed on laboratory records pertinent to the concerned analysis to further evaluate the extend of the QC issue and the final data quality and usability. The actual level of validation for each data point will be entered in the electrical database submitted to the Ecology Environmental Information Management system (EIMs). Data validation will be conducted following the guidance below:

- EPA Contract Laboratory Program National Functional Guidelines for Chlorinated Dibenzo-*p*-Dioxins (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, September 2011, EPA 540/R-11/016.
- EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, January 2010, EPA 540/R-10/011.
- EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, Office of Superfund Remediation and Technical Innovation, U.S. Environmental Protection Agency, June 2008, EPA-540-R-08-01.
- EPA Region 10 Standard Operating Procedure for the Validation of Polychlorinated Dibenzo-p-Dioxin (PCDD) and Polychlorinated Dibenzofuran (PCDF) Data, January 1996.
- EPA Region 10 Standard Operating Procedure for the Method 1668 Toxic, Dioxin-like, PCB Data, December 1995.

The data validation will examine and verify the following parameters against the method requirements and laboratory control limits specified in Tables A-3 and A-4:

- Sample management and holding times;
- Instrument performance check, calibration, and calibration verification;
- Laboratory and field blank results;
- Detection and reporting limits;
- Laboratory replicate results;
- MS/MSD results;
- LCS and/or standard reference material results;
- Field duplicate results;
- Surrogate spike recovery (organic analyses only);
- Internal standard recovery (internal calibration methods only);
- Inter-element interference check (ICP analyses only);
- Serial dilution (metals only);
- Labeled compound recovery (isotope dilution methods only); and
- Ion ratios for detected compounds (high resolution GC/MS methods only).

Data qualifiers will be assigned based on outcome of the data validation. Data qualifiers are limited to and defined as follows:

- U = The analyte was analyzed for but was determined to be nondetect above the reported sample quantitation limit, or the quantitation limit was raised to the concentration found in the sample due to blank contamination.
- J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- UJ = The analyte was not detected above the reported quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R = The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet QC criteria. The presence or absence of the analyte cannot be verified.
- DNR = Do not report from this analysis; the result for this analyte is to be reported from an alternative analysis.

In cases of multiple analyses (such as an undiluted and a diluted analysis) performed on one sample, the optimal result will be determined and only the determined result will be reported for the sample.

The scope and findings of the data validation will be documented and discussed in the Data Validation Report(s). The Data Validation Report(s) will be appended to the RI report.

A.3.8. Preventative Maintenance Procedures and Schedules

Preventative maintenance in the laboratory will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. Details of the maintenance procedures are addressed in the respective laboratory SOPs.

Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to change as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet one or another of the method-specific QC criteria.

Maintenance and calibration of instruments used in the field for sampling (e.g., PID for evaluating presence of VOCs in soil samples, and the YSI meter for measuring field parameters during groundwater sampling) will be conducted regularly in accordance with manufacturer recommendations prior to use.

A.3.9. Performance and System Audits

The Aspect project manager has responsibility for reviewing the performance of the laboratory QA program; this review will be achieved through regular contact with the analytical laboratory’s project manager. To ensure comparable data, all samples of a given matrix to be analyzed by each specified analytical method will be processed consistently by the same analytical laboratory.

A.3.10. Data and Records Management

Records will be maintained documenting all activities and data related to field sampling and chemical analyses.

A.3.10.1. Field Documentation

Inspection and monitoring results will be documented on field report forms and/or in field notebooks. Adequate records will be maintained for each sample collected. The field representative will document pertinent observations and events specific to each activity and specific to each sample collected and, when warranted, provide photographic documentation of specific sampling efforts. Field notes will include the following:

- Date, time, weather conditions, project location, and sampler’s name;
- Sample location, sample type, and sample number;
- Description of the field activity;
- Sample descriptions and sampling method;
- Size, type, and quantity of sample containers;
- Field equipment used; and
- Field parameters.

Pertinent observations of the sample condition that are worthy of noting in the field documentation include the following:

- Sample color,
- Sedimentation or turbidity,
- Oil or sheen,
- Separate phase liquids,
- Odor,
- Effervescence,
- Beginning canister vacuum (soil gas samples only), and
- Ending canister vacuum (soil gas samples only).

Other information to be included in the field notebook includes the following:

- Reason for sampling,
- Problems encountered due to unusual conditions, and

- Communications with Ecology, City staff, laboratory, or field staff.

A.3.10.2. Analytical Data Management

Raw data received from the analytical laboratory will be reviewed, entered into a computerized database, and verified for consistency and correctness. The database will be updated based on data review and independent validation, if necessary.

The following field data will be included in the database:

- Sample location coordinates;
- Sample type (i.e., groundwater or soil); and
- Soil or groundwater sampling depth interval.

Information regarding whether concentrations represent total phase (unfiltered samples) or dissolved phase (filtered samples) will be compiled and stored in the database. Data will be submitted to Ecology's Environmental Information Management (EIM) database once data have been reviewed and validated.

A.4. References for Appendix A

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TABLES

Table A-1. Analytical Methods, Sample Containers, Preservation, and Holding Times

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Sample Matrix	Analytical Parameter	Analytical Method	Sample Container	No. Containers	Preservation Requirements	Holding Time
Soil	Gasoline-Range TPH	NWTPH-GX	8 ounce jar, 3 40-ml vials	4	4°C ±2°C, Freeze within 48 hours to <-7^{o}C	14 days for extraction; 40 days for analysis
	Diesel-Range TPH	NWTPH-Dx/SW846 Method 3630 (Silica Gel Cleanup)	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	VOCs	EPA 8260C	Method 5035A, 40-ml vials, 2 ounce jar	5	4°C ±2°C, Freeze within 48 hours to <-7°C, Methanol, Sodium Bisulfate	14 days
	Metals[1]	EPA 200.8/6010/7471A	4 ounce jar	1	4°C ±2°C	6 months, Hg-28 days
	Mercury	EPA 1631E	4 ounce jar	1	4°C ±2°C	28 days
	SVOCs w/low-level PAHs	EPA 8270D/8270D-SIM	8 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	Pesticides	EPA 8081B	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	PCBs	EPA 8082	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	Herbicides	EPA 8151	4 ounce jar	1	4°C ±2°C	14 days for extraction; 40 days for analysis
	Cyanide	EPA 9012	4 ounce jar	1	4°C ±2°C	14 days
	Dioxins/Furans	EPA 1613	4 ounce jar	1	4°C ±2°C	1 year
Groundwater	Gasoline-Range TPH	NWTPH-Gx	40-mL VOA vial	3	4°C ±2°C, HCl	14 days
	Diesel-Range TPH	NWTPH-Dx/SW846 Method 3630 (Silica Gel Cleanup)	500-mL Amber Glass	2	4°C ±2°C	7 days for extraction, 40 days for analysis
	VOCs	EPA 8260C	40-mL VOA Vials	3	4°C ±2°C, 2 with HCl pH < 2, 2 without HCl	14 days for analysis
	Metals[1], total/dissolved (field filter)	EPA 200.7/200.8	500-mL HDPE	1	4°C ±2°C, HNO3 pH < 2 (after filtration)	180 days
	Mercury, total dissolved (field filter)	EPA 7470/245.1	500-mL HDPE	1	4°C ±2°C, HNO3 pH < 2 (after filtration)	28 days for analysis
	SVOCs with low-level PAHs	EPA 8270D/8270D-SIM	500-mL Amber Glass	2	4°C ±2°C	7 days for extraction, 40 days for analysis
	Pesticides	EPA 8081	1-L Amber Glass	2	≤6°C	7 days for extraction, 40 days for analysis
	PCBs	EPA 8082	1-L Amber Glass	2	≤6°C	7 days for extraction, 40 days for analysis
	Herbicides	EPA 8151	1-L Amber Glass	2	≤6°C	7 days for extraction, 40 days for analysis
	Dioxins/Furans	EPA 1613	1-L Amber Glass	2	≤6°C	1 year for analysis
	Ammonia	Method 350.1	500-mL HDPE	1	4°C ±2°C, H2SO4 pH < 2	28 days
	Dissolved Sulfide	Method 376.2	500-mL HDPE	1	4°C ±2°C, Zinc Acetate and NaOH pH > 9 (after filtration)	7 days
	Chloride	SM4500-Cl	250-mL HDPE	1	none	28 days
	Cyanide, Total	SM4500-CN	500-mL HDPE	1	NaOH, pH>12	14 days
	Dissolved Organic Carbon	SM5310B	250-mL Amber glass	1	H2SO4 ph<2, ≤6^{o}C, (after filtration)	28 days
	Nitrogen as Nitrate	353.2/9056	500-mL HDPE	1	≤6^{o}C	48 hours
	Nitrogen as Nitrite	353.2/9056	500-mL HDPE	1	≤6^{o}C	48 hours
	Sulfate	300.0/9056	500-mL HDPE	1	≤6^{o}C	28 days
	Manganese, dissolved	Method 200.7/200.8	500-mL HDPE	1	4°C ±2°C, HNO3 pH < 2 (after filtration)	180 days
	Alkalinity	SM 2320B-97	500-mL HDPE	1	≤6^{o}C	14 days
Soil Gas	VOCs/APH	EPA TO-15/MassDEP APH	6-L Summa Canister	1	na	30 days

Notes

[1] Metals include arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, sodium, nickel, selenium, silver and zinc

Table A-2. Quality Control Parameters

Project No. 150074, Shelton C Street Landfill

Shelton, Washington

Data Quality Indicators	QC Parameters
Precision	RPD values of:
	(1) LCS/LCS Duplicate
	(2) MS/MSD
	(3) Field Duplicates
Accuracy/Bias	Percent Recovery (%R) or Percent Difference (%D) values of:
	(1) Initial Calibration and Calibration Verification
	(2) LCS
	(3) MS
	(4) Surrogate Spikes
	Results of:
	(1) Instrument and Calibration Blank
	(2) Method (Preparation) Blank
	(3) Trip Blank
	(4) Equipment Rinsate Blank
Representativeness	Results of All Blanks
	Sample Integrity (CoC and Sample Receipt Forms)
	Holding Times
Comparability	Sample-specific reporting limits
	Sample Collection Methods
	Laboratory Analytical Methods
Completeness	Data qualifiers
	Laboratory deliverables
	Requested/Reported valid results
Sensitivity	MDLs and MRLs

Notes:

LCS = Laboratory Control Sample

MDL = Method detection limit

MRL = Method reporting limit

MS/MSD = Matrix spike/matrix spike duplicate

Table A-3. Measurement Quality Objectives for Soil Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Analyte Name	MDL$^{(A)}$	MRL	LCS/LCS %R$^{(A)}$	MS/MSD %R$^{(A)}$	RPD (%)	Surrogate %R$^{(A)}$
Metals by EPA 200.8 (mg/kg)						
Arsenic	0.15	1.0	79-112	56-125	20	n/a
Cadmium	0.046	1.0	88-114	85-117	20	n/a
Chromium (Total)	0.23	1.0	81-117	63-120	20	n/a
Copper	0.02	1.0	86-116	46-133	20	n/a
Lead	0.041	1.0	83-118	64-139	20	n/a
Nickel	0.017	1.0	86-118	54-125	20	n/a
Selenium	0.14	1.0	83-113	64-118	20	n/a
Silver	0.02	1.0	85-113	83-112	20	n/a
Zinc	0.35	1.0	84-121	49-129	20	n/a
Mercury by EPA 1631 (mg/kg)						
Mercury	0.00037	0.1	73-131	54-156	20	n/a
Cyanide, Total by EPA 9014 (mg/kg)						
Cyanide	0.03	0.05	75 - 120	75 - 125	20	n/a
Volatile Organic Compounds (VOCs) by SW8260C (mg/kg)						
1,1,1,2-Tetrachloroethane	0.0065	0.05	69-135	31-143	20	n/a
1,1,1-Trichloroethane	0.0038	0.05	62-131	10-156	20	n/a
1,1,2,2-Tetrachloroethane	0.0048	0.05	56-143	28-140	20	n/a
1,1,2-Trichloroethane	0.0049	0.05	75-113	30-142	20	n/a
1,1-Dichloroethane	0.0018	0.05	68-115	19-140	20	n/a
1,1-Dichloroethene	0.0062	0.05	47-128	10-160	20	n/a
1,1-Dichloropropene	0.0038	0.05	69-128	17-140	20	n/a
1,2,3-Trichlorobenzene	0.022	0.25	62-130	20-144	20	n/a
1,2,3-Trichloropropane	0.0059	0.05	61-137	25-144	20	n/a
1,2,4-Trimethylbenzene	0.0095	0.25	76-125	10-182	20	n/a
1,2-Dibromo-3-chloropropane	0.012	0.5	61-136	11-161	20	n/a
1,2-Dibromoethane (EDB)	0.0054	0.05	74-132	28-142	20	n/a
1,2-Dichloroethane (EDC)	0.0042	0.05	56-135	12-160	20	n/a
1,2-Dichloropropane	0.004	0.05	72-127	30-135	20	n/a
1,3,5-Trimethylbenzene	0.004	0.05	76-126	18-149	20	n/a
1,3-Dichloropropane	0.0044	0.05	72-130	31-137	20	n/a
2,2-Dichloropropane	0.0035	0.05	57-133	10-158	20	n/a
2-Butanone	0.022	0.5	57-123	19-147	20	n/a
2-Chlorotoluene	0.0052	0.05	74-121	31-134	20	n/a
2-Hexanone	0.015	0.5	33-152	15-166	20	n/a
4-Chlorotoluene	0.0053	0.05	75-122	31-136	20	n/a
4-Methyl-2-pentanone	0.036	0.5	45-145	24-155	20	n/a
Acetone	0.077	0.5	52-141	10-163	20	n/a
Benzene	0.002	0.03	68-114	29-129	20	n/a
Bromobenzene	0.0035	0.05	72-122	34-130	20	n/a
Bromodichloromethane	0.0033	0.05	72-130	23-155	20	n/a
Bromoform	0.0069	0.05	56-132	21-156	20	n/a
Bromomethane	0.02	0.5	38-114	10-163	20	n/a
Carbon tetrachloride	0.0045	0.05	60-139	9-164	20	n/a
Chlorobenzene	0.0034	0.05	76-111	32-129	20	n/a
Chloroethane	0.0087	0.5	20-153	10-176	20	n/a
Chloroform	0.0023	0.05	66-120	21-145	20	n/a
Chloromethane	0.004	0.5	27-133	10-126	20	n/a
cis -1,2-Dichloroethene (DCE)	0.0024	0.05	72-113	25-135	20	n/a
cis-1,3-Dichloropropene	0.003	0.05	75-136	28-144	20	n/a
Dibromochloromethane	0.0052	0.05	74-125	28-150	20	n/a
Dibromomethane	0.0047	0.05	70-120	23-145	20	n/a
Dichlorodifluoromethane	0.0047	0.5	10-146	10-142	20	n/a
Ethylbenzene	0.0033	0.05	64-123	32-137	20	n/a
Hexachlorobutadiene	0.021	0.25	50-153	19-142	20	n/a
Isopropylbenzene	0.0031	0.05	76-127	31-142	20	n/a
m,p -Xylenes	0.0054	0.1	78-122	34-136	20	n/a
Methyl tert-butyl ether (MTBE)	0.0027	0.05	60-123	21-145	20	n/a
Methylene chloride	0.13	0.5	42-132	10-156	20	n/a
n -Propylbenzene	0.0033	0.05	74-124	23-146	20	n/a
o -Xylene	0.0037	0.05	77-124	33-134	20	n/a
p-Isopropyltoluene	0.005	0.05	70-132	21-149	20	n/a
sec -Butylbenzene	0.0052	0.05	71-130	23-145	20	n/a
Styrene	0.0024	0.05	74-126	35-137	20	n/a
tert -Butylbenzene	0.0041	0.05	73-130	30-137	20	n/a
Tetrachloroethene (PCE)	0.0054	0.025	72-114	20-133	20	n/a
Toluene	0.0014	0.05	66-126	35-130	20	n/a
trans -1,2-Dichloroethene	0.005	0.05	67-127	14-137	20	n/a
trans -1,3-Dichloropropene	0.0051	0.05	72-132	26-149	20	n/a
Trichloroethene (TCE)	0.0063	0.03	68-114	21-139	20	n/a
Trichlorofluoromethane	0.0022	0.5	10-196	10-176	20	n/a
Vinyl chloride	0.0038	0.05	22-139	10-138	20	n/a

Table A-3. Measurement Quality Objectives for Soil Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Analyte Name	MDL$^{(A)}$	MRL	LCS/LCS %R$^{(A)}$	MS/MSD %R$^{(A)}$	RPD (%)	Surrogate %R$^{(A)}$
1,2-Dichloroethane-d4	n/a	n/a	n/a	n/a	n/a	62-142
Toluene-d8	n/a	n/a	n/a	n/a	n/a	55-145
4-Bromofluorobenzene	n/a	n/a	n/a	n/a	n/a	65-139
Semivolatile Organic Compounds (SVOCs) by SW8270D (mg/kg)						
1,2,4-Trichlorobenzene	0.0033	0.03	67-100	50-150	20	n/a
1,2-Dichlorobenzene	0.0047	0.03	62-103	50-150	20	n/a
1,3-Dichlorobenzene	0.00395	0.03	66-101	50-150	20	n/a
1,4-Dichlorobenzene	0.0032	0.03	63-105	50-150	20	n/a
2,4,5-Trichlorophenol	0.0195	0.3	53-119	50-150	20	n/a
2,4,6-Trichlorophenol	0.0095	0.3	48-126	50-150	20	n/a
2,4-Dichlorophenol	0.013	0.3	53-113	50-150	20	n/a
2,4-Dimethylphenol	0.0405	0.3	39-110	50-150	20	n/a
2,4-Dinitrophenol	0.05	0.9	38-127	50-150	20	n/a
2,4-Dinitrotoluene	0.00165	0.03	59-113	50-150	20	n/a
2,6-Dinitrotoluene	0.0027	0.03	65-115	50-150	20	n/a
2-Chloronaphthalene	0.0038	0.03	60-106	50-150	20	n/a
2-Chlorophenol	0.0145	0.3	64-109	50-150	20	n/a
2-Methylnaphthalene	0.0034	0.03	56-114	50-150	20	n/a
2-Methylphenol	0.016	0.3	41-106	50-150	20	n/a
2-Nitroaniline	0.0055	0.03	53-121	50-150	20	n/a
2-Nitrophenol	0.0145	0.3	49-121	50-150	20	n/a
3 & 4 Methylphenol	0.029	0.6	30-178	50-150	20	n/a
3-Nitroaniline	0.01	3	18-91	50-150	20	n/a
4,6-Dinitro-2-methylphenol	0.0405	0.9	47-127	50-150	20	n/a
4-Bromophenyl phenyl ether	0.0035	0.03	72-102	50-150	20	n/a
4-Chloro-3-methylphenol	0.0105	0.3	65-113	50-150	20	n/a
4-Chloroaniline	0.7	3	10-75	50-150	20	n/a
4-Chlorophenyl phenyl ether	0.0027	0.03	69-111	50-150	20	n/a
4-Nitroaniline	0.03	3	10-167	50-150	20	n/a
4-Nitrophenol	0.048	0.9	54-118	50-150	20	n/a
Benzoic acid	0.115	1.5	56-125	50-150	20	n/a
Benzyl alcohol	0.005	0.3	48-120	50-150	20	n/a
Benzyl butyl phthalate	0.0029	0.03	61-117	50-150	20	n/a
bis (2-Chloro-1-methylethyl) ether	0.0048	0.03	59-103	50-150	20	n/a
bis(2-Chloroethoxy)methane	0.00235	0.03	63-111	50-150	20	n/a
bis (2-Chloroethyl) ether	0.00475	0.03	43-116	50-150	20	n/a
bis (2-Ethylhexyl) phthalate	0.19	0.48	65-118	50-150	20	n/a
Carbazole	0.007	0.03	73-105	50-150	20	n/a
Dibenzofuran	0.00335	0.03	48-114	50-150	20	n/a
Diethyl phthalate	0.0034	0.03	66-105	50-150	20	n/a
Dimethyl phthalate	0.00265	0.03	67-101	50-150	20	n/a
Di-n-butyl phthalate	0.0049	0.03	67-107	50-150	20	n/a
Di-n-octyl phthalate	0.0042	0.03	71-120	50-150	20	n/a
Hexachlorobenzene	0.003	0.03	52-116	50-150	20	n/a
Hexachlorobutadiene	0.00345	0.03	66-104	50-150	20	n/a
Hexachlorocyclopentadiene	0.0055	0.09	39-119	50-150	20	n/a
Hexachloroethane	0.00345	0.03	55-117	50-150	20	n/a
Isophorone	0.00205	0.03	65-116	50-150	20	n/a
Nitrobenzene	0.0055	0.03	65-103	50-150	20	n/a
N-Nitroso-di-n-propylamine	0.00315	0.03	61-105	50-150	20	n/a
N-Nitrosodiphenylamine	0.0033	0.03	51-104	50-150	20	n/a
Pentachlorophenol	0.027	0.3	50-130	50-150	20	n/a
Phenol	0.0135	0.3	60-108	50-150	20	n/a
2-Fluorophenol	n/a	n/a	n/a	n/a	n/a	50-150
Phenol-d6	n/a	n/a	n/a	n/a	n/a	50-150
Nitrobenzene-d5	n/a	n/a	n/a	n/a	n/a	50-150
2-Fluorobiphenyl	n/a	n/a	n/a	n/a	n/a	50-150
2,4,6-Tribromophenol	n/a	n/a	n/a	n/a	n/a	50-150
Terphenyl-d14	n/a	n/a	n/a	n/a	n/a	50-150
Polycyclic Aromatic Hydrocarbons by SW8270D-SIM (mg/kg)						
Acenaphthene	0.00028	0.01	56-109	49-109	20	n/a
Acenaphthylene	0.00029	0.01	53-110	44-116	20	n/a
Anthracene	0.00044	0.01	57-103	41-104	20	n/a
Benz(a)anthracene	0.00115	0.01	50-106	42-114	20	n/a
Benzo(a)pyrene	0.0021	0.01	49-111	48-109	20	n/a
Benzo(b)fluoranthene	0.0029	0.01	56-122	49-123	20	n/a
Benzo(g,h,i)perylene	0.00315	0.01	57-124	14-132	20	n/a
Benzo(k)fluoranthene	0.003	0.01	57-122	46-122	20	n/a
Chrysene	0.0014	0.01	47-114	38-118	20	n/a
Dibenzo(a,h)anthracene	0.002	0.01	59-127	24-138	20	n/a
Fluoranthene	0.000325	0.01	60-118	41-117	20	n/a
Fluorene	0.0011	0.01	55-114	48-112	20	n/a

Table A-3. Measurement Quality Objectives for Soil Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Analyte Name	MDL$^{(A)}$	MRL	LCS/LCS %R$^{(A)}$	MS/MSD %R$^{(A)}$	RPD (%)	Surrogate %R$^{(A)}$
Indeno(1,2,3-cd)pyrene	0.0031	0.01	59-123	23-130	20	n/a
Naphthalene	0.00055	0.01	61-110	22-137	20	n/a
Phenanthrene	0.000435	0.01	61-108	40-110	20	n/a
Pyrene	0.00065	0.01	60-116	48-115	20	n/a
Anthracene-d10	n/a	n/a	n/a	n/a	n/a	18-150
Benzo(a)anthracene-d12	n/a	n/a	n/a	n/a	n/a	40-143
Nitrobenzene-d5	n/a	n/a	n/a	n/a	n/a	50-150
2-Fluorobiphenyl	n/a	n/a	n/a	n/a	n/a	50-150
Terphenyl-d14	n/a	n/a	n/a	n/a	n/a	50-150
Polychlorinated Biphenyls (PCBs) Aroclors by SW8082A (mg/kg)						
Aroclor 1016	0.026	0.1	50-150	50-150	20	n/a
Aroclor 1221	0.026	0.1	n/a	n/a	20	n/a
Aroclor 1232	0.026	0.1	n/a	n/a	20	n/a
Aroclor 1248	0.026	0.1	n/a	n/a	20	n/a
Aroclor 1254	0.026	0.1	n/a	n/a	20	n/a
Aroclor 1260	0.021	0.1	50-150	50-150	20	n/a
Decachlorobiphenyl	n/a	n/a	n/a	n/a	n/a	50-150
Tetrachloro-meta-xylene	n/a	n/a	n/a	n/a	n/a	50-150
Gasoline-Range Hydrocarbons by NWTPH-Gx (mg/kg)						
Gasoline Range Hydrocarbons	0.064	2	58-142	53-117	20	n/a
Bromofluorobenzene	n/a	n/a	n/a	n/a	n/a	58-139
Diesel- and Motor Oil-Range Hydrocarbons by NWTPH-Dx (mg/kg)						
Diesel Range Hydrocarbons	1.2	50	63-142	50-150	20	n/a
Oil Range Hydrocarbons	1.1	250	50-150	50-150	20	n/a
o-Terphenyl	n/a	n/a	n/a	n/a	n/a	50-150
Dioxins and Furans by SW8290C (ng/kg)						
2,3,7,8-TCDD	EDL	0.5	50-150	50-150	20	n/a
1,2,3,7,8-PeCDD	EDL	2.5	50-150	50-150	20	n/a
1,2,3,4,7,8-HxCDD	EDL	2.5	50-150	50-150	20	n/a
1,2,3,6,7,8-HxCDD	EDL	2.5	50-150	50-150	20	n/a
1,2,3,7,8,9-HxCDD	EDL	2.5	50-150	50-150	20	n/a
1,2,3,4,6,7,8-HpCDD	EDL	2.5	50-150	50-150	20	n/a
OCDD	EDL	5	50-150	50-150	20	n/a
2,3,7,8-TCDF	EDL	0.5	50-150	50-150	20	n/a
1,2,3,7,8-PeCDF	EDL	2.5	50-150	50-150	20	n/a
2,3,4,7,8-PeCDF	EDL	2.5	50-150	50-150	20	n/a
1,2,3,4,7,8-HxCDF	EDL	2.5	50-150	50-150	20	n/a
1,2,3,6,7,8-HxCDF	EDL	2.5	50-150	50-150	20	n/a
1,2,3,7,8,9-HxCDF	EDL	2.5	50-150	50-150	20	n/a
2,3,4,6,7,8-HxCDF	EDL	2.5	50-150	50-150	20	n/a
1,2,3,4,6,7,8-HpCDF	EDL	2.5	50-150	50-150	20	n/a
1,2,3,4,7,8,9-HpCDF	EDL	2.5	50-150	50-150	20	n/a
OCDF	EDL	5	n/a	n/a	20	n/a
TCDD, Total	EDL	0.5	n/a	n/a	20	n/a
PeCDD, Total	EDL	2.5	n/a	n/a	20	n/a
HxCDD, Total	EDL	2.5	n/a	n/a	20	n/a
HpCDD, Total	EDL	2.5	n/a	n/a	20	n/a
TCDF, Total	EDL	0.5	n/a	n/a	20	n/a
PeCDF, Total	EDL	2.5	n/a	n/a	20	n/a
HxCDF, Total	EDL	2.5	n/a	n/a	20	n/a
HpCDF, Total	EDL	2.5	n/a	n/a	20	n/a
2,3,7,8-TCDD-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,7,8-PeCDD-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,6,7,8-HeCDD-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,4,6,7,8-HpCDD-C13	n/a	n/a	n/a	n/a	n/a	40-135
OCDD-C13	n/a	n/a	n/a	n/a	n/a	40-135
2,3,7,8-TCDF-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,7,8-PeCDF-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,4,7,8-HeCDF-C13	n/a	n/a	n/a	n/a	n/a	40-135
1,2,3,4,6,7,8-HpCDF-C13	n/a	n/a	n/a	n/a	n/a	40-135
2,3,7,8-TCDD-Cl37	n/a	n/a	n/a	n/a	n/a	40-135
Organichlorine Pesticides by EPA 8081B (μg/kg)						
alpha-BHC	0.17	1.7	39-120	39-120	30	n/a
beta-BHC	0.318	1.7	43-120	43-120	30	n/a
gamma-BHC (Lindane)	0.175	1.7	46-120	46-120	30	n/a
delta-BHC	0.3	1.7	31-132	31-132	30	n/a
Heptachlor	0.218	1.7	40-120	40-120	30	n/a
Aldrin	0.218	1.7	40-120	40-120	30	n/a
Heptachlor Epoxide	0.286	1.7	46-126	46-126	30	n/a
trans-Chlordane	0.264	1.7	44-125	44-125	30	n/a
cis-Chlordane	0.282	1.7	43-127	43-127	30	n/a
Endosulfan I	0.273	1.7	41-130	41-130	30	n/a

Table A-3. Measurement Quality Objectives for Soil Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Analyte Name	MDL[(A)]	MRL	LCS/LCS %R[(A)]	MS/MSD %R[(A)]	RPD (%)	Surrogate %R[(A)]
4,4'-DDE	0.568	3.3	60-134	60-134	30	n/a
Dieldrin	0.563	3.3	44-129	44-129	30	n/a
Endrin	0.518	3.3	56-120	56-120	30	n/a
Endosulfan II	0.561	3.3	56-120	56-120	30	n/a
4,4'-DDD	0.575	3.3	60-120	60-120	30	n/a
Endrin Aldehyde	0.963	3.3	32-120	32-120	30	n/a
4,4'-DDT	0.572	3.3	63-120	63-120	30	n/a
Endosulfan Sulfate	0.844	3.3	47-120	47-120	30	n/a
Methoxychlor	3.52	17	58-120	58-120	30	n/a
Chlorinated Herbicides						
2,4-D	5.01	9.4	27-102	24-98	24	n/a
2,4-DB	5.47	9.5	41-104	23-103	32	n/a
2,4,5-T	3.48	9.5	34-105	25-104	23	n/a
2,4,5-TP (silvex)	3.61	9.5				n/a
2,4,6-trichlorophenol	1.94	4.7				n/a
dalapon	43.6	230				n/a
dicamba	5.15	9.4	42-94	25-109	17	n/a
dichloroprop	6.38	71				n/a
dinoseb	2.77	9.5				n/a
MCPA	523	940				n/a
MCPP	500	940				n/a
DCAA (surrogate)						18-111

Notes

[(A)] = Based on current laboratory control criteria. Some values may vary slightly between instruments and can be subject to change as the laboratory updates the charted values periodically.

%R - Percent recovery

EDL = Estimated detection limit; value is calculated based on actual instrument response on a sample-specific basis.

LCS/LCSD = Laboratory control samples and laboratory control sample duplicate

MDL = Method detection limit

mg/kg = milligram per kilogram

MRL = Method reporting limit

MS/MSD = Matrix spike and matrix spike duplicate

n/a = not applicable

ng/kg = nanogram per kilogram

RPD = Relative percent difference

µg/kg = micrograms per kilogram

Table A-4. Measurement Quality Objectives for Groundwater Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Analyte Name	MDL(A)	MRL	LCS/LCSD %R(A)	MS/MSD %R(A)	RPD (%)	Surrogate %R(A)
Gasoline-Range Hydrocarbons by NWTPH-Gx (µg/L)						
Gasoline Range Hydrocarbons	5.7	100	58-142	53-117	20	n/a
Bromofluorobenzene	n/a	n/a	n/a	n/a	n/a	51-134
Diesel- and Motor Oil-Range Hydrocarbons by NWTPH-Dx (µg/L)						
Diesel Range Hydrocarbons	6.1	50	63-142	50-150	20	n/a
Oil Range Hydrocarbons	23	250	50-150	50-150	20	n/a
o-Terphenyl	n/a	n/a	n/a	n/a	n/a	50-150
Conventional Chemical Parameters (mg/L)						
Total Suspended Solids	4	10	80-120	75-125	20	n/a
Total Dissolved Solids	4	10	80-120	75-125	20	n/a
Cyanide	3	5	75 - 120	75 - 125	20	n/a
Sulfide	0.02	0.05	80-120	75-125	20	n/a
Ammonia as Nitrogen	0.2	0.5	80-120	75-125	20	n/a
Total and Dissolved Metals by EPA 200.8 (µg/L)						
Arsenic	0.072	1.0	81-118	51-167	20	n/a
Cadmium	0.043	1.0	86-118	86-115	20	n/a
Chromium (Total)	0.15	1.0	80-119	71-130	20	n/a
Copper	0.051	1.0	81-120	52-134	20	n/a
Lead	0.039	1.0	84-120	85-115	20	n/a
Nickel	0.11	1.0	83-119	71-120	20	n/a
Selenium	0.039	1.0	77-124	41-185	20	n/a
Silver	0.042	1.0	85-116	73-114	20	n/a
Zinc	0.32	1.0	82-120	51-142	20	n/a
Total and Dissolved Mercury by EPA 1631 (µg/L)						
Mercury	0.0002	0.1	78-123	78-124	20	n/a
Volatile Organic Compounds (VOCs) by SW8260C (µg/L)						
1,1,1,2-Tetrachloroethane	0.23	1	84-127	73-137	20	n/a
1,1,1-Trichloroethane	0.061	1	83-130	60-146	20	n/a
1,1,2,2-Tetrachloroethane	0.048	1	66-126	51-154	20	n/a
1,1,2-Trichloroethane	0.054	1	75-124	68-131	20	n/a
1,1-Dichloroethane	0.054	1	79-121	70-128	20	n/a
1,1-Dichloroethene	0.13	1	67-136	60-136	20	n/a
1,1-Dichloropropene	0.096	1	77-129	69-133	20	n/a
1,2,3-Trichlorobenzene	0.21	1	65-136	69-148	20	n/a
1,2,3-Trichloropropane	0.074	1	67-124	53-150	20	n/a
1,2,4-Trimethylbenzene	0.097	1	82-125	59-146	20	n/a
1,2-Dibromo-3-chloropropane	0.12	10	57-141	32-164	20	n/a
1,2-Dibromoethane (EDB)	0.12	1	82-125	69-134	20	n/a
1,2-Dichloroethane (EDC)	0.078	1	73-132	69-133	20	n/a
1,2-Dichloropropane	0.079	1	77-123	78-125	20	n/a
1,3,5-Trimethylbenzene	0.078	1	80-126	66-137	20	n/a
1,3-Dichloropropane	0.06	1	76-126	71-128	20	n/a
1,4-Dioxane	tbd	10	30-160	30-160	20	n/a
2,2-Dichloropropane	0.12	1	55-143	36-154	20	n/a
2-Butanone	0.43	10	57-149	10-129	20	n/a
2-Chlorotoluene	0.04	1	77-127	66-127	20	n/a
2-Hexanone	0.25	10	64-152	10-185	20	n/a
4-Chlorotoluene	0.073	1	78-128	65-130	20	n/a
4-Methyl-2-pentanone	0.39	10	70-140	10-185	20	n/a
Acetone	0.9	10	60-155	10-182	20	n/a
Benzene	0.045	0.35	69-134	76-125	20	n/a
Bromobenzene	0.069	1	80-121	75-124	20	n/a
Bromodichloromethane	0.067	1	81-133	61-150	20	n/a
Bromoform	0.11	1	74-136	65-142	20	n/a
Bromomethane	0.048	1	55-143	47-169	20	n/a
Carbon tetrachloride	0.1	1	75-158	56-152	20	n/a
Chlorobenzene	0.08	1	83-114	77-122	20	n/a
Chloroethane	0.2	1	58-146	46-160	20	n/a
Chloroform	0.071	1	80-121	65-132	20	n/a
Chloromethane	0.11	10	45-156	25-166	20	n/a
cis-1,2-Dichloroethene (DCE)	0.09	1	80-123	71-127	20	n/a
cis-1,3-Dichloropropene	0.095	1	82-132	72-132	20	n/a
Dibromochloromethane	0.071	1	84-133	70-139	20	n/a
Dibromomethane	0.077	1	82-125	66-141	20	n/a
Dichlorodifluoromethane	0.12	1	25-158	10-172	20	n/a
Ethylbenzene	0.058	1	77-124	69-135	20	n/a
Hexachlorobutadiene	0.37	1	53-141	60-143	20	n/a
Isopropylbenzene	0.046	1	87-122	65-142	20	n/a
m,p-Xylenes	0.77	2	83-125	69-135	20	n/a
Methyl tert-butyl ether (MTBE)	0.063	1	64-147	74-127	20	n/a
Methylene chloride	1.5	5	39-148	67-132	20	n/a
n-Propylbenzene	0.11	1	74-126	58-144	20	n/a
o-Xylene	0.085	1	86-121	68-137	20	n/a
p-Isopropyltoluene	0.16	1	82-127	65-141	20	n/a
sec-Butylbenzene	0.18	1	80-125	64-140	20	n/a
Styrene	0.11	1	85-127	71-133	20	n/a
tert-Butylbenzene	0.11	1	85-127	65-137	20	n/a
Tetrachloroethene (PCE)	0.082	1	76-121	73-129	20	n/a
Toluene	0.052	1	72-122	76-122	20	n/a
trans-1,2-Dichloroethene	0.062	1	68-128	72-129	20	n/a
trans-1,3-Dichloropropene	0.1	1	80-136	76-130	20	n/a
Trichloroethene (TCE)	0.18	1	80-120	66-135	20	n/a
Trichlorofluoromethane	0.083	1	50-150	44-165	20	n/a
Vinyl acetate	tbd	10	30-160	30-160	20	n/a
Vinyl chloride	0.075	0.2	50-154	36-166	20	n/a
1,2-Dichloroethane-d4	n/a	n/a	n/a	n/a	n/a	57-121
Toluene-d8	n/a	n/a	n/a	n/a	n/a	63-127
4-Bromofluorobenzene	n/a	n/a	n/a	n/a	n/a	60-133

Table A-4. Measurement Quality Objectives for Groundwater Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Semivolatile Organic Compounds (SVOCs) by SW8270D (µg/L)						
1,2,4-Trichlorobenzene	0.155	1	67-102	67-115	20	n/a
1,2-Dichlorobenzene	0.12	1	56-110	50-150	20	n/a
1,3-Dichlorobenzene	0.155	1	59-105	50-150	20	n/a
1,4-Dichlorobenzene	0.17	1	59-107	50-150	20	n/a
2,4,5-Trichlorophenol	1	10	53-117	50-150	20	n/a
2,4,6-Trichlorophenol	0.95	10	65-116	50-150	20	n/a
2,4-Dichlorophenol	1.1	10	55-114	50-150	20	n/a
2,4-Dimethylphenol	1.35	10	44-103	50-150	20	n/a
2,4-Dinitrophenol	6.5	30	53-123	50-150	20	n/a
2,4-Dinitrotoluene	0.215	1	44-128	50-150	20	n/a
2,6-Dinitrotoluene	0.14	1	54-123	50-150	20	n/a
2-Chloronaphthalene	0.145	1	49-118	50-150	20	n/a
2-Chlorophenol	0.8	10	61-108	50-150	20	n/a
2-Methylnaphthalene	0.21	1	55-119	50-150	20	n/a
2-Methylphenol	0.9	10	41-95	50-150	20	n/a
2-Nitroaniline	1.25	3	59-126	50-150	20	n/a
2-Nitrophenol	0.9	10	53-116	50-150	20	n/a
3 & 4 Methylphenol	1.5	20	24-138	50-150	20	n/a
3-Nitroaniline	0.95	3	34-112	50-150	20	n/a
4,6-Dinitro-2-methylphenol	1.65	30	58-124	50-150	20	n/a
4-Bromophenyl phenyl ether	0.12	1	57-115	50-150	20	n/a
4-Chloro-3-methylphenol	1.15	10	49-123	50-150	20	n/a
4-Chloroaniline	0.265	3	24-106	50-150	20	n/a
4-Chlorophenyl phenyl ether	0.15	1	59-113	50-150	20	n/a
4-Nitroaniline	1	10	23-173	50-150	20	n/a
4-Nitrophenol	2.95	10	10-102	50-150	20	n/a
Benzoic acid	18.5	50	10-59	50-150	20	n/a
Benzyl alcohol	1	10	52-106	50-150	20	n/a
Benzyl butyl phthalate	0.14	1	50-128	50-150	20	n/a
bis (2-Chloro-1-methylethyl) ether	0.09	10	53-113	50-150	20	n/a
bis(2-Chloroethoxy)methane	0.26	1	52-122	50-150	20	n/a
bis (2-Chloroethyl) ether	0.18	10	44-117	50-150	20	n/a
bis (2-Ethylhexyl) phthalate	0.185	10	50-127	50-150	20	n/a
Carbazole	0.325	1	33-140	50-150	20	n/a
Dibenzofuran	0.14	1	39-128	50-150	20	n/a
Diethyl phthalate	0.2	1	48-121	50-150	20	n/a
Dimethyl phthalate	0.165	1	54-115	50-150	20	n/a
Di-n-butyl phthalate	0.155	1	51-121	50-150	20	n/a
Di-n-octyl phthalate	0.12	1	54-129	50-150	20	n/a
Hexachlorobenzene	0.14	1	66-109	50-150	20	n/a
Hexachlorobutadiene	0.2	1	57-112	50-150	20	n/a
Hexachlorocyclopentadiene	0.2	3	24-132	50-150	20	n/a
Hexachloroethane	0.165	1	56-115	50-150	20	n/a
Isophorone	0.17	1	66-121	50-150	20	n/a
Nitrobenzene	0.25	1	55-116	50-150	20	n/a
N-Nitroso-di-n-propylamine	0.18	10	34-102	50-150	20	n/a
N-Nitrosodiphenylamine	0.135	1	62-111	50-150	20	n/a
Pentachlorophenol	1.35	10	52-129	50-150	20	n/a
Phenol	0.43	10	22-64	50-150	20	n/a
2-Fluorophenol	n/a	n/a	n/a	n/a	n/a	10-137
Phenol-d6	n/a	n/a	n/a	n/a	n/a	10-100
Nitrobenzene-d5	n/a	n/a	n/a	n/a	n/a	11-153
2-Fluorobiphenyl	n/a	n/a	n/a	n/a	n/a	21-159
2,4,6-Tribromophenol	n/a	n/a	n/a	n/a	n/a	10-210
Terphenyl-d14	n/a	n/a	n/a	n/a	n/a	51-143

Table A-4. Measurement Quality Objectives for Groundwater Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Polycyclic Aromatic Hydrocarbons (PAHs) by SW8270D-SIM (µg/L)						
Acenaphthene	0.001	0.05	45-122	54-131	20	n/a
Acenaphthylene	0.000425	0.05	50-119	29-148	20	n/a
Anthracene	0.00065	0.05	50-121	32-132	20	n/a
Benz(a)anthracene	0.00065	0.01	48-117	53-86	20	n/a
Benzo(a)pyrene	0.001475	0.01	46-126	55-88	20	n/a
Benzo(b)fluoranthene	0.000475	0.01	49-128	44-100	20	n/a
Benzo(g,h,i)perylene	0.0006	0.05	47-127	44-82	20	n/a
Benzo(k)fluoranthene	0.000975	0.01	54-122	63-80	20	n/a
Chrysene	0.000625	0.01	52-117	54-87	20	n/a
Dibenzo(a,h)anthracene	0.000525	0.01	52-130	52-90	20	n/a
Fluoranthene	0.00035	0.05	49-123	42-131	20	n/a
Fluorene	0.00095	0.05	52-121	40-134	20	n/a
Indeno(1,2,3-cd)pyrene	0.00075	0.01	51-129	46-84	20	n/a
Naphthalene	0.000775	0.05	50-117	57-114	20	n/a
Phenanthrene	0.000875	0.05	50-116	31-146	20	n/a
Pyrene	0.00075	0.05	44-125	50-83	20	n/a
Anthracene-d10	n/a	n/a	n/a	n/a	n/a	36-135
Benzo(a)anthracene-d12	n/a	n/a	n/a	n/a	n/a	36-136
Nitrobenzene-d5	n/a	n/a	n/a	n/a	n/a	50-150
2-Fluorobiphenyl	n/a	n/a	n/a	n/a	n/a	50-150
Terphenyl-d14	n/a	n/a	n/a	n/a	n/a	50-150
PCB Aroclors by SW8082A (µg/L)						
Aroclor 1016	0.049	0.2	50-103	25-144	30	n/a
Aroclor 1221	0.049	0.4	n/a	n/a	n/a	n/a
Aroclor 1232	0.049	0.2	n/a	n/a	n/a	n/a
Aroclor 1242	0.049	0.2	n/a	n/a	n/a	n/a
Aroclor 1248	0.049	0.2	n/a	n/a	n/a	n/a
Aroclor 1254	0.049	0.2	n/a	n/a	n/a	n/a
Aroclor 1260	0.049	0.2	56-100	40-127	30	n/a
Tetrachloro-m-xylene	n/a	n/a	n/a	n/a	n/a	50-150
Dioxins and Furans						
2,3,7,8-TCDD	0.178	5.00	70.0-130	n/a	n/a	n/a
1,2,3,7,8-PeCDD	0.289	25.0	70.0-130	n/a	n/a	n/a
1,2,3,4,7,8-HxCDD	0.311	25.0	70.0-130	n/a	n/a	n/a
1,2,3,6,7,8-HxCDD	0.370	25.0	70.0-130	n/a	n/a	n/a
1,2,3,7,8,9-HxCDD	0.324	25.0	70.0-130	n/a	n/a	n/a
1,2,3,4,6,7,8-HpCDD	0.393	25.0	70.0-130	n/a	n/a	n/a
OCDD	1.10	50.0	70.0-130	n/a	n/a	n/a
2,3,7,8-TCDF	0.174	5.00	70.0-130	n/a	n/a	n/a
1,2,3,7,8-PeCDF	0.300	25.0	70.0-130	n/a	n/a	n/a
2,3,4,7,8-PeCDF	0.311	25.0	70.0-130	n/a	n/a	n/a
1,2,3,4,7,8-HxCDF	0.290	25.0	70.0-130	n/a	n/a	n/a
1,2,3,6,7,8-HxCDF	0.264	25.0	70.0-130	n/a	n/a	n/a
2,3,4,6,7,8-HxCDF	0.318	25.0	70.0-130	n/a	n/a	n/a
1,2,3,7,8,9-HxCDF	0.359	25.0	70.0-130	n/a	n/a	n/a
1,2,3,4,6,7,8-HpCDF	0.346	25.0	70.0-130	n/a	n/a	n/a
1,2,3,4,7,8,9-HpCDF	0.484	25.0	70.0-130	n/a	n/a	n/a
OCDF	0.858	50.0	70.0-130	n/a	n/a	n/a
TCDD, Total	0.178	5.00	n/a	n/a	n/a	n/a
PeCDD, Total	0.289	25.0	n/a	n/a	n/a	n/a
HxCDD, Total	0.370	25.0	n/a	n/a	n/a	n/a
HpCDD, Total	0.393	25.0	n/a	n/a	n/a	n/a
TCDF, Total	0.174	5.00	n/a	n/a	n/a	n/a
PeCDF, Total	0.311	25.0	n/a	n/a	n/a	n/a
HxCDF, Total	0.359	25.0	n/a	n/a	n/a	n/a
HpCDF, Total	0.484	25.0	n/a	n/a	n/a	n/a
Internal Standard QA/QC [(B)]				*(VER %R)*		
2,3,7,8-TCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,7,8-PeCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,4,7,8-HxCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,6,7,8-HxCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,4,6,7,8-HpCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
OCDD-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
2,3,7,8-TCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,7,8-PeCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
2,3,4,7,8-PeCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,4,7,8-HxCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,6,7,8-HxCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,7,8,9-HxCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
2,3,4,6,7,8-HxCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,4,6,7,8-HpCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
1,2,3,4,7,8,9-HpCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
OCDF-C13	n/a	n/a	40.0-135	70.0-130	n/a	40.0-135
Organichlorine Pesticides by EPA 8081B (ug/L)						
alpha-BHC	0.000795	0.0050				n/a
beta-BHC	0.00131	0.0050				n/a
gamma-BHC (Lindane)	0.00174	0.0050	33-107	24-118	20	n/a
delta-BHC	0.00246	0.0050				n/a
Heptachlor	0.00128	0.0050	32-109	22-123	18	n/a
Aldrin	0.00372	0.0050	30-114	20-115	20	n/a
Heptachlor Epoxide	0.00148	0.0050				n/a
trans-Chlordane	0.000970	0.0050				n/a
cis-Chlordane	0.000734	0.0050				n/a
Endosulfan I	0.000619	0.0050				n/a
4,4'-DDE	0.000637	0.0050				n/a
Dieldrin	0.000725	0.0050	63-100	45-120	17	n/a
Endrin	0.000502	0.0050	66-105	34-137	18	n/a
Endosulfan II	0.00110	0.0050				n/a
4,4'-DDD	0.00108	0.0050				n/a

Table A-4. Measurement Quality Objectives for Groundwater Samples

Project No. 150074, Shelton C Street Landfill
Shelton, Washington

Endrin Aldehyde	0.00202	0.0050				n/a
4,4'-DDT	0.00145	0.0050	55-112	27-140	33	n/a
Endosulfan Sulfate	0.000356	0.0050				n/a
Methoxychlor	0.00347	0.010				n/a
TCMX (surrogate)						41-98
DCB (surrogate)						42-128
Chlorinated Herbicides						
2,4-D	0.0720	0.094	25-97	60-140	20	n/a
2,4-DB	0.0310	0.071	31-98	60-140	20	n/a
2,4,5-T	0.0575	0.071	33-96	60-140	20	n/a
2,4,5-TP (silvex)	0.0133	0.048				n/a
2,4,6-trichlorophenol	0.0263	0.019				n/a
dalapon	0.413	0.46				n/a
dicamba	0.0327	0.047	30-133	60-140	20	n/a
dichloroprop	0.0160	0.047				n/a
dinoseb	0.0346	0.047				n/a
MCPA	3.08	7.0				n/a
MCPP	4.97	7.0				n/a
DCAA (surrogate)						30-132

Notes

[(A)] = Based on current laboratory control criteria. Some values may vary slightly between instruments and can be subject to change as the laboratory updates the charted values periodically.

[(B)] = Internal standard QA/QC for dioxins/furans to evaluate matrix effects, VER = verification standards.

%R = Percent recovery
LCS/LCSD = Laboratory control samples and laboratory control sample duplicate
MDL = Method detection limit
mg/L = milligram per liter
MRL = Method reporting limit
MS/MSD = Matrix spike and matrix spike duplicate
n/a = not applicable
RPD = Relative percent difference
tbd = to be determined
µg/L = microgram per liter

FIGURES

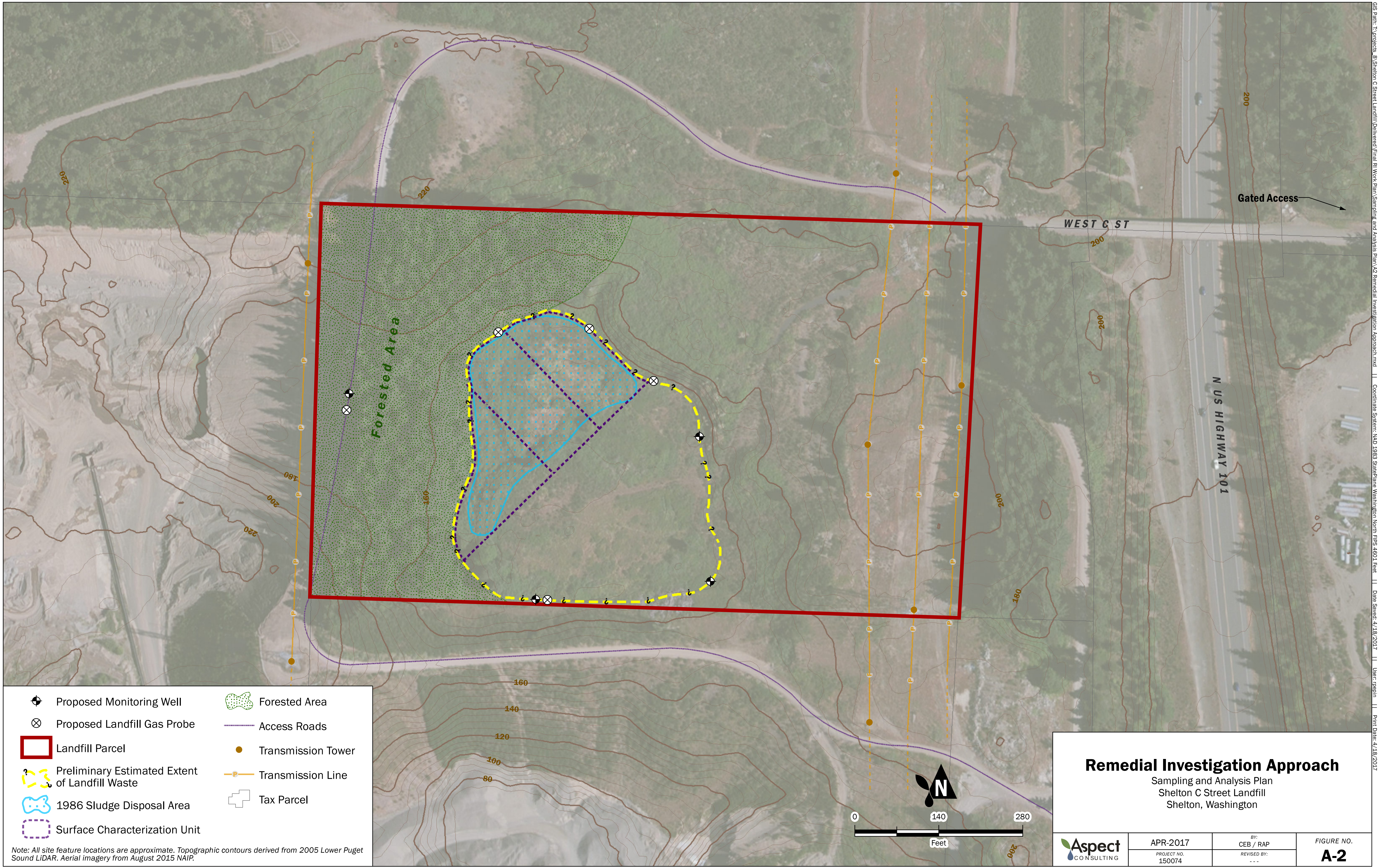
Site Vicinity Map

Sampling and Analysis Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING	APR-2017	BY: CEB / RAP	FIGURE NO.
	PROJECT NO. 150074	REVISED BY: - - -	A-1

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\Sampling and Analysis Plan\A1 Site Vicinity Map.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



- ⯐ Proposed Monitoring Well
- ⊗ Proposed Landfill Gas Probe
- 🟥 Landfill Parcel
- Preliminary Estimated Extent of Landfill Waste
- 1986 Sludge Disposal Area
- Surface Characterization Unit
- Forested Area
- Access Roads
- ● Transmission Tower
- Transmission Line
- Tax Parcel

Note: All site feature locations are approximate. Topographic contours derived from 2005 Lower Puget Sound LiDAR. Aerial imagery from August 2015 NAIP.

Basemap Layer Credits || Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

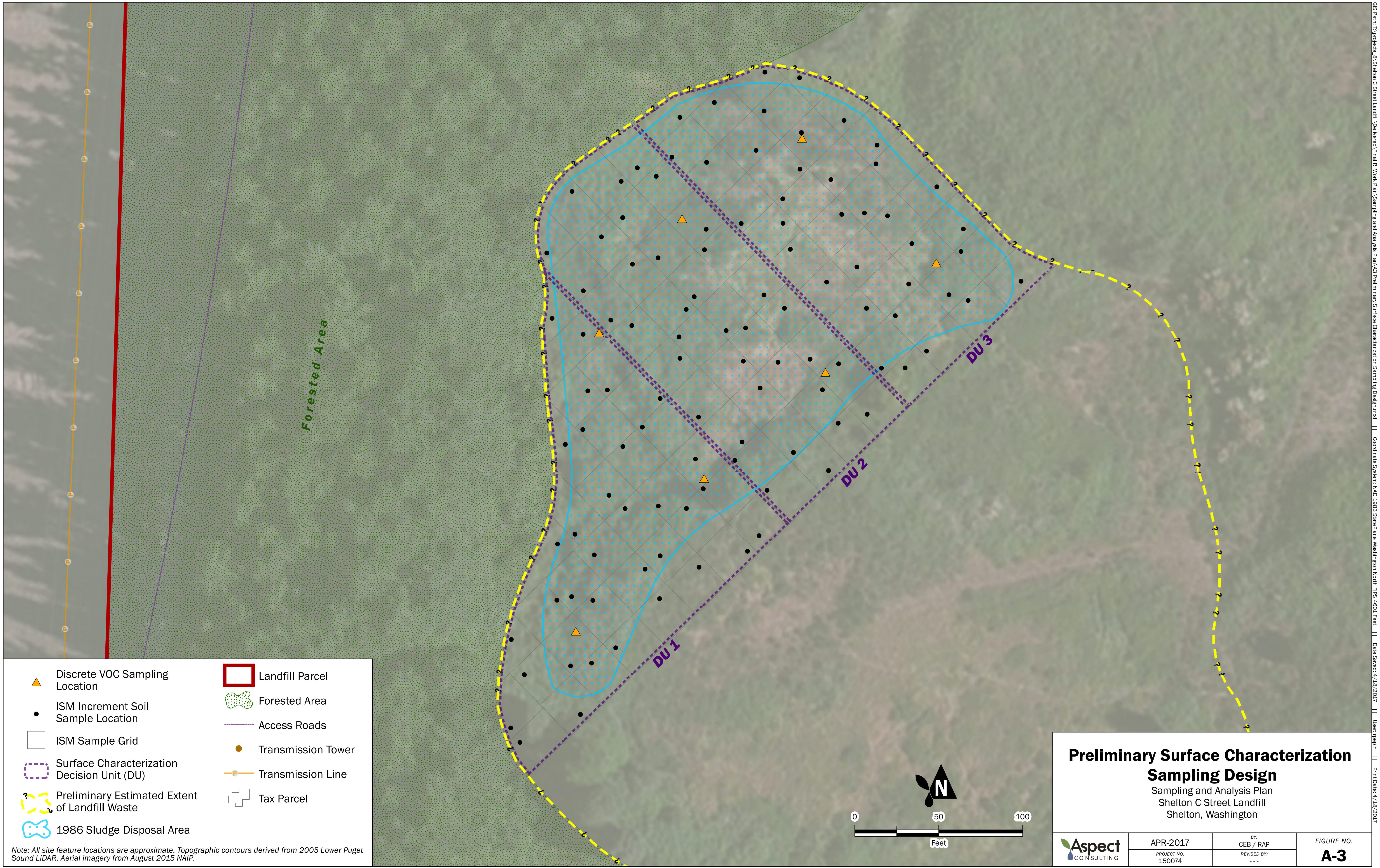
Remedial Investigation Approach

Sampling and Analysis Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING

APR-2017	BY: CEB / RAP	FIGURE NO. **A-2**
PROJECT NO. 150074	REVISED BY: - - -	

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\Sampling and Analysis Plan\A2 Remedial Investigation Approach.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017



Note: All site feature locations are approximate. Topographic contours derived from 2005 Lower Puget Sound LiDAR. Aerial imagery from August 2015 NAIP.

Preliminary Surface Characterization Sampling Design

Sampling and Analysis Plan
Shelton C Street Landfill
Shelton, Washington

Aspect CONSULTING	APR-2017	BY: CEB / RAP	FIGURE NO. **A-3**
	PROJECT NO. 150074	REVISED BY: - - -	

Basemap Layer Credits || Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

GIS Path: T:\projects_8\Shelton C Street Landfill\Delivered\Final RI Work Plan\Sampling and Analysis Plan\A3 Preliminary Surface Characterization Sampling Design.mxd || Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet || Date Saved: 4/18/2017 || User: rpepin || Print Date: 4/18/2017

ATTACHMENT 1

Site-Specific Health and Safety Plan

PROJECT-SPECIFIC HEALTH AND SAFETY PLAN

Property Name	Shelton C Street Landfill		
Project Number	150074		
Prepared by	Bob Hanford	Date	April 17, 2017
Reviewed by		Date	

INTRODUCTION

This project-specific health and safety plan establishes procedures and practices to protect employees of Aspect Consulting, LLC (Aspect) from potential hazards posed by field activities at the subject site. In this health and safety plan, measures are provided to minimize potential exposure, accidents, and physical injuries that may occur during daily activities and adverse conditions. Contingency arrangements are also provided for emergency situations.

EMERGENCY CONTACT INFORMATION

PROPERTY LOCATION	West end of West C Street, just west of the overpass across US Highway 101 in Mason County, Washington
NEAREST HOSPITAL	Mason General Hospital 901 Mountain View Dr. Shelton, WA 98584 360 426-1611 **Figure 1 shows the route to hospital.**
EMERGENCY RESPONDERS	Police, Ambulance, Fire 911
OTHER CONTACTS	Carla Brock, Aspect Consulting (office) .... (206) 838-6593 Aspect Consulting, Bainbridge Office .... (206) 780-9370 John Strunk, Aspect Consulting………………..... (206) 780-7719
IN EVENT OF EMERGENCY, CALL FOR HELP AS SOON AS POSSIBLE	Give the following information: ✓ **Where You Are**. Address, cross streets, or landmarks ✓ **Phone Number** you are calling from ✓ **What Happened**. Type of accident, injury ✓ **How many persons** need help ✓ **What is being done** for the victim(s) ✓ **You hang up last.** Let whomever you called hang up first

In case of serious injuries or other emergency, the Aspect Consulting Corporate Safety Officer must be notified immediately (Bob Hanford; 206-780-7729 or 206-276-9256). If no response, call Doug Hillman at 206-328-7443 or Tim Flynn at 206-780-9370.

PERSONNEL ORGANIZATION AND CHAIN OF COMMAND

The Aspect Project Manager assigns the Site Safety Supervisor and other field personnel for this project, and has ultimate responsibility for developing this project-specific health and safety plan and ensuring it is complied with during project execution. The Aspect Site Safety Supervisor has responsibility and authority for Aspect employees' safety during site activities. Other Aspect personnel on site have responsibility to comply with this project-specific health and safety plan in coordination with the Site Safety Supervisor.

Aspect Consulting Personnel			
Role	**Name**	**Office Telephone**	**Mobile (Cell) Phone**
Aspect Project Manager	Carla Brock	206-838-6593	425-269-7255
Aspect Site Safety Supervisor	Bob Hanford	206-780-7729	206 276-9256
Aspect Hydrogeologist	John Strunk	206-780-7719	206-200-7199
Aspect Field Geologist	Kristin Beck	206-838-5838	253-906-5928
Field Hydrogeologist	Matthew Lewis	206-812-4745	206-353-6617

Subcontractors Working On Site			
Name	**Task/Role**	**Contact**	**Telephone**
Holocene Drilling	Drilling/Well Development	Jim Pender	253-848-6500
Hydro Geophysics	Geophysical survey	Nigel Crook	206-669-3730
DH Environmental	IDW	Dave Hill	206-293-3126

Aspect will inform its subcontractors working on site of potential fire, explosion, health, safety or other hazards associated with planned site activities, and can make available to them this project-specific health and safety plan. However, **all subcontractors are solely responsible for preparation of their own health and safety plan, and for the safety of their employees.**

Aspect Consulting Training and Medical Monitoring

Aspect employees who perform site work are responsible for understanding potential health and safety hazards of the site. All Aspect site workers will have health and safety training for hazardous waste operations, in accordance with WAC 296-843-200. In addition, Aspect Consulting requires medical monitoring for all employees potentially exposed to chemical hazards in concentrations in excess of the PEL for more than 30 days per year, as required under WAC 296-843-210. Employees who use respirators for their work will have a respirator medical evaluation as required under Chapter 296-842 WAC. Documentation of this training and medical monitoring is kept on file at Aspect's office. All subcontractors are solely responsible for providing appropriate safety training to their employees.

SITE CONTROL PLAN

Property Description

Property name:	Shelton C Street Landfill		
Property location or address:	West end of West C Street, just west of the overpass across US Highway 101 in Mason County, Washington		
Owners/tenants:	City of Shelton		
Current property use:	Vacant Landfill Property		
Past use of property (if different):	Active Landfill		
Designated hazardous waste site?	No	(federal, state, other):	State
Industrial facility?	No		
Topography:	Relatively flat in former Landfill area 15% to 20% slopes surrounding landfill		
Surrounding land use/nearest population:	Commercial, gravel mine operations		
Drinking water/sanitary facilities:	Portable sanitary facilities will be delivered and maintained on site for duration of field work		
Site Map:	Available on site.		

Site Access Control

Describe controls to be used to prevent entry by unauthorized persons:

The property is closed to the public (fenced; secured gate). Drill and well areas will be designated using traffic cones and caution tape.

Describe how exclusion zones and contamination reduction zones will be designated:

The geophysical survey and Incremental grid sampling in the former landfill area will be the exclusion zone with the contamination reduction zone established on the paved access road. Drilling will be performed at numerous locations outside of the former landfill. The area immediately adjacent to each boring/monitoring well and gas probe will be considered an exclusion zone. The subcontractor will mark the limits of the exclusion zone using cones, caution tape, etc. The contamination reduction zone will be located adjacent to the driller’s mobile decontamination trailer, and will include steam cleaning equipment for equipment decontamination. Aspect Consulting field personnel will remain vigilant about preventing unauthorized persons from approaching the exclusion zone.

Worker Hygiene Practices

Aspect Consulting personnel will employ the following hygiene practices while working on site:

- No person will eat, drink, or chew gum or tobacco in potentially contaminated areas. Drinking of replacement fluids for heat stress control will be permitted only in areas that are free from contamination, except in emergency situations.
- Smoking is prohibited except in designated areas of the site.
- Long hair will be secured away from the face so that it does not interfere with any activities.
- All personnel leaving potentially contaminated areas will wash their hands and face prior to entering any eating areas.
- Personnel leaving potentially contaminated areas will shower (including washing hair) and change to clean clothing as soon as practical after leaving the property.

Emergency Communications

Aspect workers on site will have a mobile (cell) phone on site, which will be used for communications should an emergency arise. Phone numbers for Aspect site personnel are listed under Project Personnel Organization.

Nearest Medical Assistance

The route from the site to the nearest hospital is attached as Figure 1.

WORK PLAN

Proposed work activities on site:	• Geophysical survey • Incremental soil sampling • Well drilling and installation • Gas probe installation • Gas probe and groundwater monitoring
Objectives of site activities:	Investigation to fill data gaps for remedial investigation
Proposed work dates:	May 2017 through August 2017 with monitoring through December 2017.
Will on-site personnel potentially be exposed to hazardous substances?	yes
If yes, describe:	Based on previous sampling analyses and similar landfill site information, the following chemicals that have potential toxic effects may be present in the drilling areas: <u>Volatile Organic Compounds</u> • Benzene • Vinyl chloride • Other volatile organics <u>Dioxins</u> <u>Heavy Metals</u> • Arsenic <u>Gases</u> • Hydrogen sulfide • Methane <u>Corrosives</u> • Acids • Bases Pertinent health effects and physical properties of these chemicals are discussed below. This information generally covers potential health effects that may occur from relatively significant acute and/or chronic exposures, and is not meant to indicate that such effects will occur from the planned site activities.
Do personnel conducting site activities have training in accordance with WAC 296-843-200?	Yes

Decontamination

To prevent the distribution of contaminants outside the exclusion zone or cross-contamination of samples, the following procedures will be used to decontaminate sampling equipment:

Decontamination process involving alconox wash, tap water rinse, and deionized water rinse (w/ air dry).

To minimize or prevent worker exposure to hazardous substances, all personnel working in the exclusion zone and contamination reduction zones will comply with the following decontamination procedures:

Wash boots and rain gear that has come into contact with soil or groundwater with alconox/tap water, air dry. Dispose of disposable PPE (gloves, Tyvek) into DOT-approved 55-gallon drums, labeled appropriately. To prevent the distribution of contaminants outside the exclusion zone, unnecessary vehicles will not be allowed inside the exclusion zone.

Well development water will be managed in the following manner:

- Decontamination wastewater with no visual or other evidence of contamination will be discharged to the ground. Decontamination wastewater with evidence of contamination and well development water will be combined in DOT-approved 55-gallon drums at the property for future disposal by owner.

HAZARD ANALYSIS

The potential hazards and corresponding control measures for planned site work activities are as follows:

Work Activity	Primary Potential Hazards	Control Measures
Geophysical survey	• Rough terrain, blackberry and other vegetation, bees and hornets	• Wear appropriate PPE including proper footwear, heavy clothing and leather gloves. Be alert for bees and hornet nests
Incremental grid sampling	• Rough terrain, blackberry and other vegetation, bees and hornets. • Disturbed soil potential for skin contact, inhalation and ingestion.	• Wear appropriate PPE including proper footwear, coveralls or Tyvek suits Proper gloves. Be alert for bees and hornet nests. • Avoiding creation of dust.
Well drilling and installation Gas Probe drilling, installation and monitoring	• Getting hit by drilling equipment, especially from overhead • Excessive noise. • Chemical exposure (skin contact, ingestion, inhalation). • Explosive gases	• Stay back from rig whenever possible, and stay alert. Keep hands and arms away from moving equipment. • Wear hearing protection • Modified Level D PPE (w/ hard hat, traffic vest, steel toe boots). • Air monitoring and brush fan
IDW onsite transport to lay down area	Skid steered earth moving equipment or lift gate to move drums	• Stay alert, be aware of operator site restrictions, maintain eye contact with operator

Potentially hazardous chemicals known or suspected at the property and permissible exposure limits (air):

As a point of reference, standards for occupational exposures to these chemicals are included when available. Site exposures are generally expected to be of short duration and well below the level of any of these exposure limits. These standards are presented using the terminology defined by the Washington State General Occupational Health Standards (WAC 296-62, Part H) as follows:

- **PEL** Permissible exposure limit—time weighted average (TWA) exposure limit for any 8-hour work shift of a 40-hour work week.
- **REL** Recommended exposure limit—TWA concentrations for up to a 10-hour workday during a 40-hour work week.
- **STEL** Short-term exposure limit—expressed as a 15-minute TWA and not to be exceeded at any time during a work day.
- **IDLH** Immediately dangerous to life and health—maximum concentration above which only a highly reliable breathing apparatus providing maximum worker protection is permitted.

In general, the chemicals that may be encountered at this site are not expected to be present at concentrations that could produce significant exposures. The plan describes approaches to additionally minimize exposures. Work practices, engineering controls, appropriate protective equipment, and air monitoring used in accordance with the plan by properly trained individuals should effectively protect persons on-site.

Volatile Organic Compounds

Benzene is a central nervous system depressant that is a potential carcinogen. The Washington Department of Labor and Industries (WISHA) has set a 1 part per million (ppm) 8-hour TWA with a 5 ppm short-term PEL.

Acute effects from benzene exposure are generally seen at concentrations above 5,000 ppm. Since these concentrations are unlikely to occur on this site, acute short-term exposures are not a significant concern. The only likely concern is from potential chronic exposures to benzene.

Chronic exposures to approximately 10 ppm have been associated with an increased risk for leukemia, a cancer of the bone marrow; benzene therefore is considered a confirmed human carcinogen. No noticeable acute health effects occur at 10 ppm and the odor threshold for benzene is variable. Therefore, there are no warning properties to indicate exposures in this range.

Vinyl Chloride is a known component of landfill gases. Vinyl chloride is a known human liver carcinogen and has a PEL of 1 ppm (short-term PEL 5 ppm) based on this potential chronic health effect.

Other Volatile Organics—ethylbenzene (PEL 100 ppm), toluene (PEL 100 ppm, STEL 150 ppm), xylene (PEL 100 ppm), and other volatile organics all have PELs above 100 ppm. They all are narcotic at concentrations in excess of the PEL and affect the central nervous system. At the concentrations identified, there are no known or suspected health effects that could arise.

Dioxins

Dioxins and dioxin-like compounds (DLCs) are compounds that are highly toxic environmental persistent organic pollutants (POPs). They are mostly by-products of various industrial processes. They include: Polychlorinated dibenzo-p-dioxins (PCDDs), or simply dioxins. PCDDs are derivatives of dibenzo-p-dioxin. There are 75 PCDD congeners, differing in the number and location of chlorine atoms, and seven of them are especially toxic, the most dangerous being 2,3,7,8-Tetrachlorodibenzodioxin (TCDD) Polychlorinated dibenzofurans (PCDFs), or furans. PCDFs are derivatives of dibenzofuran. There are 135 isomers, ten have dioxin-like properties.

There is no PEL or REL for Dioxins. In animal testing target organs include: eyes, skin, liver, and kidneys Dioxins are considered an occupational carcinogen. Symptoms include irritated eyes, allergic dermatitis, chloracne, porphyria, GI tract, and reproductive system.

Heavy Metals

Arsenic occurs naturally in the environment as an element of the earth's crust. Arsenic is combined with other elements such as oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Exposure to higher-than-average levels of arsenic occurs mainly in workplaces, near or in hazardous waste sites, and areas with high levels naturally occurring in soil, rocks, and water. Exposure to high levels of arsenic can cause death. Exposure to arsenic at low levels for extended periods of time can cause a discoloration of the skin and the appearance of small corns or warts.

The PEL for arsenic (as As) is 0.5 mg/m^3. The IDLH for arsenic is 5 mg/m^3.

Methane

Methane commonly found in landfills is defined as a simple asphyxiant. High concentrations of methane so as to exclude an adequate supply of oxygen to the lungs causes dizziness, deeper breathing due to air hunger, possible nausea and eventual unconsciousness. Methane is inactive biologically and essentially nontoxic; therefore, the majority of symptoms is from the exclusion of an adequate supply of oxygen to the lungs. Methane is not listed in the IARC, NTP, or by OSHA as a carcinogen or potential carcinogen.

Gases

Hydrogen sulfide (H_2S) gas is found in soils due to the degradation of organic matter. The potential route of exposure is inhalation. Hydrogen sulfide presents a serious potential health hazard from acute exposure, but probably not from chronic exposures. At 0.005 ppm most (but not all) individuals notice the characteristic rotten egg odor of hydrogen sulfide. Because of an inability of certain individuals to smell H_2S and loss of the ability to smell H_2S that occurs following exposure, odor warning properties are not considered reliable.

Hydrogen sulfide presents a serious acute hazard. Twenty minutes of exposure at 300 ppm can cause unconsciousness. Respiratory paralysis and loss of the ability to smell hydrogen sulfide can also occur at concentrations above 75 ppm. Concentrations of 10 to 25 ppm for several hours irritates the eyes, causes headache, loss of appetite, and dizziness. The PEL is 10 ppm and short-term PEL is 15 ppm based upon the acute hazards.

Corrosives

The potential for low pH (acids) or high pH (basics) may exist in the site area. Upon contact, a corrosive material may destroy body tissues, metals, plastics, and other materials. Skin irritation and burns are typical results when the body contacts an acidic or basic material. When corrosives are anticipated pH paper shall be used to identify the pH concentration. Concentrations less than 4 and greater than 10 shall always be handled with protective gloves and clothing.

Characteristics of chemicals known or suspected on site:	**Known**	**Possible**	**Unlikely**
Corrosive			X
Ignitable		X	
Reactive			X
Volatile		X	
Radioactive			X
Explosive			X
Biological agent			X
Particulate or fibers			X
If known or likely, describe:			

Could the following conditions be expected? If so, specify.

- Corrosive? If yes, specify No
- Ignitable?   Yes__X_ No___ : Methane Gas.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Based on the hazards identified above, the following personal protective equipment will be required for the following field activities. Specify both an initial level of protection and a more protective (contingency) level of protection in the event conditions should change (e.g., based on air monitoring results). The contingency defines the PPE that will be available on site.

	Level of Protection	
Work Activity	**Initial**	**Contingency**

Geophysical Survey	D	
Incremental soil sampling	Mod. D	
Well and gas probe drilling and installation	D	Mod. D or C
Sample handling	D	Mod. D or C
Other activities (list) aquifer and gas probe testing	D	Mod. D or C

Each level of protection will incorporate the following equipment (specify type of coveralls, boots, gloves, respiratory cartridges or other protection, safety glasses, hardhat, and hearing protection):

Level D:	Work clothing, traffic vest, rubber (nitrile) gloves, steel toe and shank boots, safety glasses, hearing protection, hard hat, PID, decontamination equipment, first aid kit.
Modified D:	Level D plus Tyvek coveralls or rain gear, and neoprene outer gloves.
Level C:	Level D plus air-purifying respirator with combination organic vapor/HEPA dust cartridges.

NOTE: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the Site Safety Supervisor. A traffic vest is not needed if work clothes worn are suitably visible (e.g., orange or yellow rain gear).

Safety Equipment

The following safety equipment will be on site during the proposed field activities:

Air Monitoring (Check the items required for this project)

Combined Gas/O_2 meter X	Well and probe drilling and testing
H_2S meter X	Well and probe drilling and testing

Other Required Items (Check the items required for this project)

First Aid Kit X	Wind sock X
Eyewash (e.g., bottle water) X	Brush fan X
Drinking water X	Other
Fire extinguisher X	

Air Monitoring

Air monitoring will be conducted at the well head to identify potentially hazardous environments and determine reference or background concentrations. Air monitoring can be used to define exclusion zones. Air monitoring can also be conducted to evaluate relative concentrations of volatile organic chemicals in samples.

The following equipment will be used to monitor air quality in the breathing zone during work activities:

Monitoring Instrument	**Calibration Frequency**	**Parameters of Interest**	**Sampling Frequency**
H_2S meter	Daily or as recommended by manufacturer	H_2S	Each sample interval while drilling. Monitor breathing zone
Combined Gas/O_2 meter	Daily or as recommended by manufacturer	All	Each sample interval while drilling. Monitor breathing zone.
PID	Daily or as recommended by manufacturer	VOCs	Each sample interval while drilling. Monitor breathing zone.

The following action levels are established to determine the appropriate level of personal protection to be used during field activities:

Instrument	**Reading in Breathing Zone**	**Action**	**Comments**
H_2S meter	>10 ppm	Leave location pending further evaluation by Aspect Corporate Safety Officer.	
Combine gas/O2 meter methane	>5 ppm	Implement engineering controls i.e. Brush fan	
PID	100 PID units above background for 5 minutes	Leave location pending further evaluation by Aspect Corporate Safety Officer.	

SPILL CONTAINMENT

Will the proposed field work include the handling of bulk chemicals?	Yes	No X
If yes, describe spill containment provisions for the property:		

CONFINED SPACE ENTRY

Will the proposed field work include confined space entry?	Yes	No X
If yes, attach to this plan the confined space entry checklist and permit.		

DISCLAIMER

Aspect Consulting, LLC does not guarantee the health or safety of any person entering these property. Because of the potentially hazardous nature of these properties and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at these properties. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other property without prior evaluation by trained health and safety personnel.

ATTACHMENTS

Field Safety Plan Consent Agreement

Field Safety Meeting Minutes Form

Figure 1 – Hospital Map

S:\City of Shelton\C Street Landfill 150074\Report Drafts\HASP City of Shelton C Street LF.docx

Aspect
CONSULTING

FIELD SAFETY PLAN CONSENT AGREEMENT

Aspect Consulting Employees

I have reviewed the project-specific health and safety plan, dated April 17, 2017 for the C Street Landfill Site. I understand the purpose of the plan and I consent to adhere to its procedures and guidelines while conducting activities on site that are described in the plan.

Employee signature____Date________

Employee signature____Date ______

Employee signature____Date ______

Employee signature____Date________

Site Visitors

I have been briefed on the contents of the project-specific health and safety plan. I am responsible for my own health and safety.

Visitor signature_____________________Organization____________________Date________

Visitor signature_____________________Organization____________________Date________

Visitor signature_____________________Organization____________________Date________

Aspect
CONSULTING

FIELD SAFETY MEETING MINUTES

Site Name ________________________________ Project No. ______________________

Meeting Location ____

Meeting Date __________ Time ___________ Conducted by ______________________

Pre-field Work Orientation ___ Weekly Safety Meeting ___ Other ___________________

Subjects Discussed ____

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Site Safety Supervisor Comments ____

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Name and Signature of Participating Personnel (list company name if subcontractor)

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APPENDIX B

Historical Information

(Included on CD)