Y-Road Landfills
Site Inspection
Bellingham, Washington

TDD: 04-02-0011

Contract: 68-S0-01-01
August 2004

Region 10

START-2

Superfund Technical Assessment and Response Team

Submitted To: Joanne LaBaw, Task Monitor
United States Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Y-ROAD LANDFILLS
SITE INSPECTION REPORT
BELLINGHAM, WASHINGTON

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LIST OF ACRONYMS

Acronym	Definition
BEK	BEK Engineering and Environmental, Inc.
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CLP	Contract Laboratory Program
CLPAS	Contract Laboratory Program Analytical Services
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
DDT	dichlorodiphenyltrichloroethane
DQOs	data quality objectives
DUP	duplicate
E & E	Ecology and Environment, Inc.
EPA	United States Environmental Protection Agency
FID	flame ionization detector
GPS	Global Positioning System
IDW	investigation-derived waste
LEL	lower explosive limit
MDLs	method detection limits
MCLs	Maximum Contaminant Levels
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
NPL	National Priorities List
PA	preliminary assessment
pesticides	chlorinated pesticides
PCBs	polychlorinated biphenyls
PPE	probable point of entry
PRGs	Preliminary Remediation Goals

LIST OF ACRONYMS (CONTINUED)

Acronym	Definition
ppm	parts per million
QA	quality assurance
QC	quality control
RPD	relative percent difference
SI	site inspection
SQAP	sampling and quality assurance plan
SQL	Sample Quantitation Limit
START	Superfund Technical Assessment and Response Team
SVOCs	semivolatile organic compounds
TAL	Target Analyte List
TDD	Technical Direction Document
TDL	target distance limit
VOCs	volatile organic compounds
WDFW	Washington Department of Fish and Wildlife

Y-ROAD LANDFILLS
SITE INSPECTION REPORT
BELLINGHAM, WASHINGTON

1. INTRODUCTION

The United States Environmental Protection Agency (EPA) has tasked Ecology and Environment, Inc. (E & E) to provide technical support and conduct a site inspection (SI) at the Y-Road Landfills site located in Bellingham, Washington. E & E completed the SI activities under Technical Direction Document (TDD) Number 04-02-0011 issued under EPA, Region 10, Superfund Technical Assessment and Response Team (START)-2 Contract Number 68-S0-01-01. The specific goals for this SI were intended to address site assessment objectives and are presented below:

- Collect and analyze samples to characterize the potential sources discussed in subsection 2.6;
- Determine off-site migration of contaminants; and
- Provide the EPA with adequate information to determine whether the site is eligible for placement on the National Priorities List (NPL).

Completion of this SI included reviewing site information, determining regional characteristics, collecting receptor information within the site's range of influence, conducting a site visit, executing a site-specific sampling plan, and producing this report.

This document includes site background information (Section 2), field sampling activities and analytical protocols (Section 3), quality assurance/quality control (QA/QC) criteria (Section 4), analytical results reporting and background sampling (Section 5), potential sources (Section 6), migration/exposure pathways and targets (Section 7), summary and conclusions (Section 8), and references (Section 9).

2. SITE BACKGROUND

This section describes the site location (subsection 2.1), site description (subsection 2.2), site ownership history (subsection 2.3), site operations and waste characteristics (subsection 2.4), site characterization (subsection 2.5), and summary of investigation locations (subsection 2.6).

2.1 SITE LOCATION

Site Name:	Y-Road Landfills
CERCLIS ID No.:	WAN001002494
Location:	Whatcom County, Washington
Latitude:	48˚45'54.50" N
Longitude:	122˚20'39.75" W
Legal Description:	Section 19, Township 38N, Range 4E
County:	Whatcom
Site Owner:	Whatcom County Public Works, Solid Waste Division 322 N. Commercial Street, Suite 210 Bellingham, Washington 98225
Site Contacts:	Bruce Roll Whatcom County Public Works, Solid Waste Division 322 N. Commercial Street, Suite 210 Bellingham, Washington 98225 360-676-7695 Don Vesper Whatcom County Health Department 509 Girard Street P.O. Box 935 Bellingham, Washington 98227 360-815-3365

2.2 SITE DESCRIPTION

The Y-Road Landfills are two former landfills (Y-Road Landfill 1 and Y-Road Landfill 2) that were operated by Whatcom County. The landfills are located east of Bellingham, Washington, on the

east and west sides of Y-Road, south of the intersection of Y-Road and Lindquist Road, in Whatcom County (Figure 2-1).

2.2.1 Y-Road Landfill 1

Y-Road Landfill 1 is located on the west side of Y-Road, approximately 0.125 mile south of the intersection of Y-Road and Lindquist Road. The parcel that contains the landfill is forested with alder and cottonwood trees, bisected by Carpenter Creek, and approximately 11 acres in size (Figure 2-1); however, landfill operations on the parcel appear to have been limited to approximately 2 acres on the east side of the property and east of Carpenter Creek (Figure 2-2). The landfill was developed within an abandoned gravel pit and is situated on a slope that faces west toward Carpenter Creek. The landfill is bounded by forested lands to the north and south, Carpenter Creek to the west, and Y-Road to the east. The property is not fenced. The landfill has been covered, but the type and thickness of the fill is unknown. No structural improvements or surface drainage features exist at the site (BEK 2000).

2.2.2 Y-Road Landfill 2

Y-Road Landfill 2 is located on the east side of Y-Road, immediately east of the intersection of Y-Road and Lindquist Road (Figure 2-1). The parcel that contains the landfill is approximately 10 acres in size, and is a grass-covered field that gently slopes to the west/northwest; however, landfill operations appear to have been limited to approximately 6 acres in the southern portion of the parcel (Figure 2-2). The site is accessible by a gravel road from Y-Road, but the property is fenced. The landfill is bounded by a tree farm to the east and south, forested lands to the north, and a gravel parking area to the west. The landfill area is well graded, and a perimeter ditch channels water toward a ditch along Y-Road. No other structural improvements exist at the site (BEK 2000).

2.3 SITE OWNERSHIP HISTORY

Whatcom County owned and operated the Y-Road Landfills from their initial use in the 1960s until closure in 1989. Whatcom County remains the owner of the landfills.

2.4 SITE OPERATIONS AND WASTE CHARACTERISTICS

Whatcom County operated both landfills under permits issued by the City of Bellingham and Whatcom County Department of Public Health (BEK 2000).

2.4.1 Y-Road Landfill 1

Little information is available regarding operations at Y-Road Landfill 1. The initiation of disposal activities at the site is unknown. A 1971 document entitled *Whatcom County Council of Governments, Solid Waste Management* describes two inspections that occurred at the landfill in 1967 and 1970. The inspection notes describe the landfill as being partially covered and in generally poor condition. The landfill was using long-face disposal techniques, a form of trenching, along the west-facing slope near Carpenter Creek. It is assumed the landfill accepted municipal waste. Based on visual evidence from photographs in the abovementioned report, it is possible that surface mining also occurred at the landfill, presumably before landfill operations commenced. Landfill activities ceased in 1970 or 1971. The landfill was not constructed with a liner to prevent leaching (BEK 2000).

2.4.2 Y-Road Landfill 2

Y-Road Landfill 2 began accepting municipal waste in 1970 or 1971, likely coinciding with the closure of Y-Road Landfill 1. The landfill utilized trenches orientated east-west to dispose of wastes (BEK 2000). Based on schematic drawings of the landfill, it appears that the landfill had five trenches over a 6-acre area in the southern portion of the site (Harper-Owes 1984). Inspection reports on file with the Whatcom County Health and Human Services indicate that daily cover was used intermittently, and that the cover was presumably spoils from the trench excavations (BEK 2000).

Y-Road Landfill 2 accepted waste until June 1984, when it was covered with soils described as glacial till that were obtained from a county borrow pit. The landfill continued to operate, accepting demolition debris under permit until November 1989. The actual volume and location of demolition debris disposed at the site is unknown (BEK 2000).

Y-Road Landfill 2 permanently ceased operations in November 1989 (BEK 2000). A 1990 closure report for the landfill recommended a minimum 18-inch cover with 6 inches of topsoil (HLA 1990). No documentation exists as to the outcome of the recommendations (BEK 2000).

2.5 SITE CHARACTERIZATION

This subsection describes previous investigations and the START-2 site visit.

2.5.1 Whatcom County Assessment

BEK Engineering and Environmental, Inc. (BEK) of Bellingham, Washington, has performed three phases of environmental investigations at the Y-Road landfills. BEK performed the work under

contract to Whatcom County, and presentations were submitted to Whatcom County Public Works. Phase I, completed in 2000, was a preliminary evaluation of site characteristics and local environmental conditions. Phase II, completed in 2001, refined site characteristics by investigating groundwater and surface water quality related to the landfill. Phase III, completed in 2002, assessed impacts to the shallow aquifer by installation and sampling of a monitoring well network, and also assessed methane gas concentrations in Y-Road Landfill 2 by the installation and monitoring of a gas monitoring well network.

The following are project-wide findings for the Y-Road landfills:

- Both landfills have a perched aquifer underlying the site, and there is a likelihood of hydraulic connection between the two perched aquifers. The depths of the perched aquifers vary from approximately 6 feet below ground surface (bgs) in upgradient areas to more than 30 feet bgs in downgradient areas (BEK 2003);
- The perched aquifers appear to be at elevations that allow for contact with landfill waste materials, which were observed to occur as deep as 25 feet bgs (BEK 2003); and
- The perched aquifers (at least the one associated with Y-Road Landfill 1) appear to discharge to Carpenter Creek, which is located on the west side of Y-Road Landfill 1 (BEK 2003).

2.5.1.1 Y-Road Landfill 1

BEK installed four monitoring wells (MW-6, MW-7, MW-8, and MW-9) at Y-Road Landfill 1 in June 2002 to monitor the shallow, perched aquifer beneath the site (Figure 2-2). The wells ranged from 20 to 35 feet bgs. The wells were installed in soils consisting of sand and gravel with some silt. Waste materials were observed at 5 to 7 feet bgs in the soil boring of MW-7 and at the surface for MW-8. The wastes included ceramics, metals, plastics, and wood debris. During the Phase II investigation in 2001, waste materials were observed as deep as 19.5 feet bgs in Geoprobe™ boreholes (BEK 2003).

The depth to groundwater varied from 6 to 15 feet bgs and the aquifer thickness ranged from 4 to 12 feet. Because of these values, it is likely that the waste materials described above occur within the zone of the perched aquifer. The groundwater gradient follows a south/southwesterly direction (BEK 2003).

BEK conducted quarterly groundwater sampling of the four monitoring wells in June 2002, September 2002, December 2002, and March 2003. Low-flow sampling methodology was employed and the samples were analyzed for field and conventional parameters, total metals, herbicides, chlorinated pesticides (pesticides), volatile organic compounds (VOCs), and semivolatile organic compounds

(SVOCs). Low concentrations of total metals, VOCs, and SVOCs consistently were detected in the monitoring wells during the quarterly sampling (BEK 2003).

In addition, BEK collected one surface water sample from Carpenter Creek at a location downgradient of Y-Road Landfill 1 during the September 2002 sampling event (Figure 2-2). The sample was analyzed for field and conventional parameters and total metals. The following metals were detected at the following concentrations in the surface water sample:

- Barium at 0.013 milligrams per liter (mg/L);
- Copper at 0.003 mg/L;
- Manganese at 0.010 mg/L.

None of these results exceed State of Washington surface water quality standards (WAC 2001).

2.5.1.2 Y-Road Landfill 2

BEK installed four monitoring wells (MW-1, MW-3, MW-4, and MW-5) at Y-Road Landfill 2 in June 2002 to monitor the shallow, perched aquifer beneath the site (Figure 2-2). The wells ranged from 15 to 35 feet bgs. The wells were installed in soils consisting of sand and gravel with some silt, except for MW-5, which penetrated into waste material at 3.5 feet bgs. The waste material in the boring for MW-5 was blackened with a soft, ashen consistency, and it became saturated at 15 feet bgs. The waste material was present to the bottom of the boring, which was 25 feet bgs. MW-5 was dry during the June 2002, September 2002, and March 2003 sampling events, and BEK speculates that the sand pack around the well's screen may be plugged by saturated ashen waste (BEK 2003).

The depth to groundwater in the wells varies from 7 to 29 feet bgs and the aquifer thickness ranges from 10 to 18 feet. Based of these values, it is likely that the waste materials described above occur within the zone of the perched aquifer. The groundwater gradient follows a west/southwesterly direction. Because of the close proximity of the two landfills, groundwater flow directions, and similar stratigraphy at the two sites, it is likely that this perched aquifer is hydraulically connected with the perched aquifer under Y-Road Landfill 1 (BEK 2003).

BEK conducted quarterly groundwater sampling of the four monitoring wells in June 2002, September 2002, December 2002, and March 2003. Low-flow sampling methodology was employed and the samples were analyzed for field and conventional parameters, total metals, herbicides, pesticides, VOCs, and SVOCs (BEK 2003). Similar to the monitoring wells at Y-Road Landfill 1, low concentrations of total metals, VOCs, and SVOCs consistently were detected in the monitoring wells

during the quarterly sampling (BEK 2003). In the case of Y-Road Landfill 2, however, benzene was detected above the State of Washington groundwater quality standards in MW-5 (WAC 1990).

In addition, BEK installed seven gas monitoring wells (GMW-1 through GMW-7) around the perimeter of Y-Road Landfill 2 to monitor methane gas concentrations near the landfill (Figure 2-2). The wells were monitored in a pseudo-lognormal pattern (twice daily, daily, weekly, monthly, and quarterly) to track methane concentrations. Only two wells exhibited elevated concentrations of methane: GMW-1 consistently had methane concentrations in excess of the 100% lower explosive limit (LEL) and GMW-2 had methane concentrations generally ranging from 10% to 40% LEL. The other wells had consistent readings of less than 1% LEL (BEK 2003).

2.5.2 START-2 Preliminary Assessment

START-2 conducted a preliminary assessment (PA) during 2003 at the Y-Road Landfills site. The findings of the PA included a summary of the information in the BEK investigations, which is described above. In addition, START-2 identified that data on source characterization of hazardous substances in the landfills and assessment of potential releases of hazardous substances to Carpenter Creek were unavailable. (E & E 2004a)

2.6 SUMMARY OF SI INVESTIGATION LOCATIONS

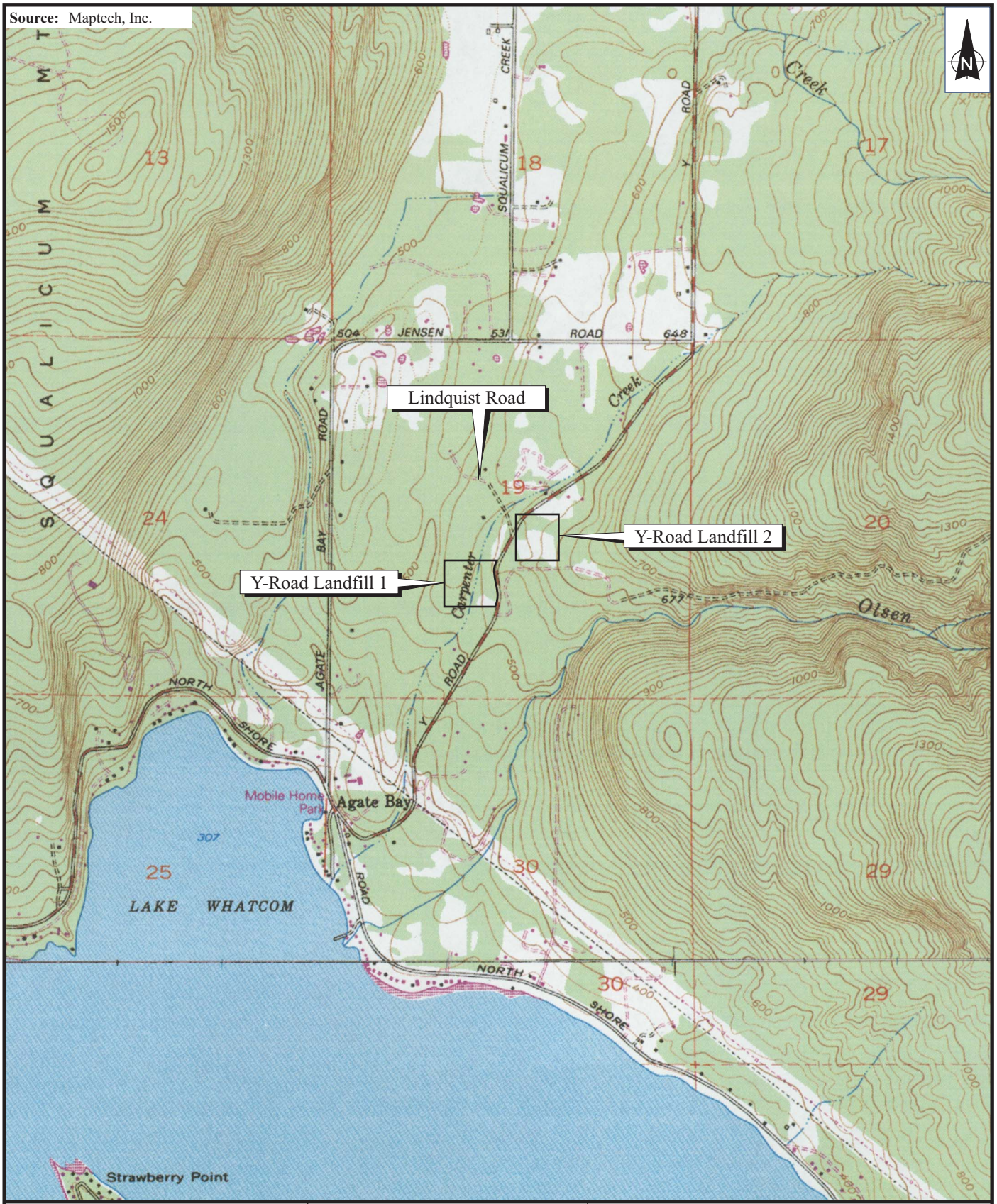
Based on a review of background information and the PA, areas and features within the site were identified for investigation during the SI as potential Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substance sources. In addition, on- and off-site locations were identified as possible receptors of contamination originating from these sources. Those potential sources and receptors are listed below.

Potential Sources:

- **Landfills.** Landfill operations included the disposal of municipal waste and demolition debris below grade. The disposal of these wastes may have impacted subsurface soils. This investigation assisted in determining contaminants associated with the landfill. Contaminants of concern included Target Analyte List (TAL) metals, pesticides/polychlorinated biphenyls (PCBs), VOCs, and SVOCs.

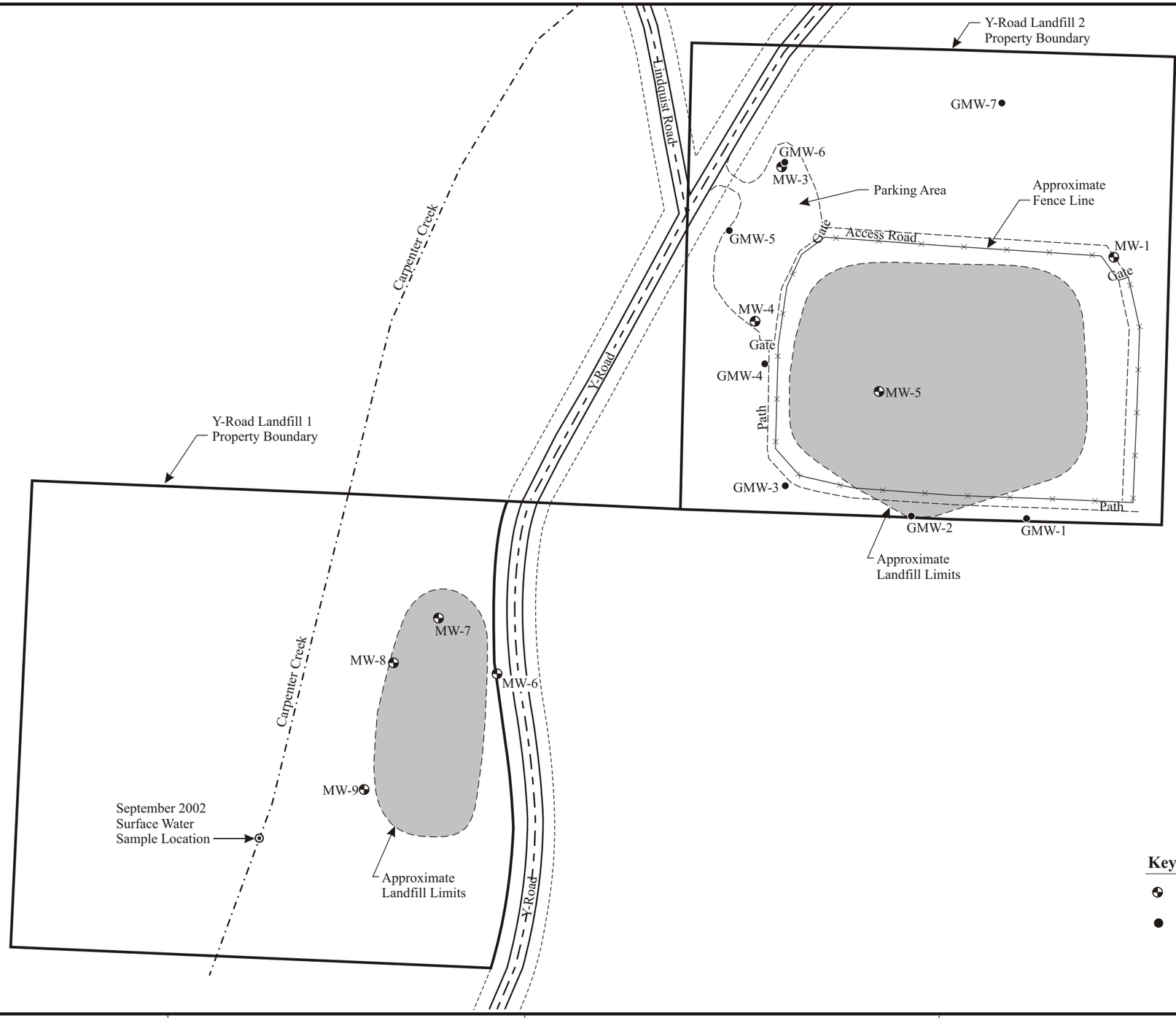
Potential Receptors:

- **Groundwater.** Groundwater potentially has been impacted by the leaching of contaminants from the landfill. This investigation assisted in determining whether the perched aquifers beneath the site and any seeps of groundwater at the surface have elevated concentrations of contaminants. Contaminants of concern included TAL metals, pesticides/PCBs, VOCs, and SVOCs.
- **Carpenter Creek**. Leachates from the landfill may be migrating through the groundwater and discharging to Carpenter Creek, which is the localized hydraulic sink. Carpenter Creek is a critical migratory pathway for anadromous fish. In addition, Carpenter Creek discharges to Lake Whatcom, which is the main drinking water source for Whatcom County. This investigation assisted in determining whether sediments in Carpenter Creek have elevated concentrations of contaminants as a result of migration and deposition of hazardous substances from the landfills. Potential contaminants of concern included TAL metals, pesticides/PCBs, VOCs, and SVOCs.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	Y-ROAD LANDFILLS SI Whatcom County, Washington	Figure 2-1 SITE LOCATION MAP		
	0 0.25 0.5 Approximate Scale in Mile	Date: 8-16-04	Drawn by: AES	10:START-2\04020011\fig 2-1

Source: BEK 2003.



Key:

- Monitoring Well
- Gas Monitoring Well

ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

0 100 200
Approximate Scale in Feet

Y-ROAD LANDFILLS SI
Whatcom County, Washington

Figure 2-2
SITE MAP

Date:	Drawn by:	
8/16/04	AES	10:START-2\04020011\fig 2-2

3. FIELD ACTIVITIES AND ANALYTICAL PROTOCOL

A sampling quality assurance plan (SQAP) was developed by START-2 prior to field sampling (E & E 2004b). The SQAP was based on a review of background information, interviews with site representatives, and a PA conducted by START-2 in 2003. The SQAP describes the sampling strategy, sampling methodology, and analytical program used to investigate potential hazardous substance sources and potential targets. With few exceptions, SI field activities were conducted in accordance with the approved SQAP. Deviations from the SQAP were approved by the EPA and are described, when applicable, in the sampling location discussions in Section 6 (source areas) and Section 7 (target areas). In addition, Appendix A contains a Sample Plan Alteration Form detailing the deviations.

The SI field sampling event was conducted from May 24 to May 26, 2004. A total of 25 samples, including background samples but excluding QA (rinsate and trip blank) samples, were collected from on- and off-site locations. Sample types and methods of collection are described below. A list of all samples collected for laboratory analysis under the SI is contained in Table 3-1. Photographic documentation of SI field activities is included as Appendix B.

Alphanumeric identification numbers applied by the START-2 to each sample location (e.g., SS01SS) are used in the report as the sample location identifiers. Figure 3-1 shows on-site sample locations, while off-site sample locations are displayed in Figure 3-2.

This section describes sampling methodology (subsection 3.1), analytical protocol (subsection 3.2), global positioning system (GPS; subsection 3.3), and investigation-derived waste (IDW; subsection 3.4).

3.1 SAMPLING METHODOLOGY

Grass, leaves and other vegetative material, rocks, and other debris unsuitable for analysis were removed from samples before being placed into sample containers. Sample material for all analyses was homogenized (except VOCs) in dedicated stainless steel bowls prior to containerization. Dedicated stainless steel spoons were used to extract, homogenize, and place sampled material into sample containers. Geoprobe drill rods were decontaminated at the start of the SI and after collection of each

sample. Samples were stored on ice in coolers continuously maintained under the custody of START-2 personnel.

3.1.1 Subsurface Soil Samples

A total of 13 subsurface soil samples, including three background subsurface soil samples, were collected from five borings at the Y-Road Landfills site. The soil samples were discrete-located grab samples collected from intervals in the Geoprobe boreholes. The sample material was contained in dedicated acetate sleeves during drilling of the borehole and extracted from the sleeve using dedicated stainless steel spoons and bowls.

3.1.2 Sediment Samples

A total of five sediment samples (including one background sample) were collected for the Y-Road Landfills SI. Three samples, including a background location, were collected from Carpenter Creek, and one sample each was collected from Smith Creek and Austin Creek (two creeks in the Lake Whatcom watershed) to provide comparison data for similar water bodies in the Lake Whatcom watershed. The samples were collected at a depth of 0 to 6 inches below the sediment surface using dedicated stainless steel spoons and bowls. In Carpenter Creek, sample collection began at the most downstream location and proceeded upstream to prevent disturbance to the sample matrix prior to sampling.

3.1.3 Groundwater Samples

A total of seven groundwater samples, including one background sample, were collected for the Y-Road Landfills SI. Six samples, including the background sample, were collected from monitoring wells located near the landfills. START-2 used dedicated Teflon-lined bailers to evacuate water from the monitoring wells. Samples were collected when two conditions were met: at least three well volumes of water had been evacuated and water quality parameters of the groundwater had stabilized. Water quality parameters were measured using a Horiba U-10 water quality meter to monitor for pH, temperature, and specific conductivity. Stabilization was assumed when, for three successive readings, pH remained within 0.1 units and temperature and specific conductivity remained within a 10% range.

One groundwater sample was collected from the Y Squalicum community well located 2/3-mile north of the site on Jensen Road. START-2 used the well's dedicated pump to evacuate water from the well. After 10 minutes of purging, the sample was collected from a sample port directly at the wellhead.

3.2 ANALYTICAL PROTOCOL

Analytical methods applied to SI samples include Contract Laboratory Program Analytical Services (CLPAS) TAL metals (CLPAS ILM05.3), SVOCs (CLPAS OLM04.3), pesticides/PCBs (CLPAS OLM04.3), and VOCs (CLPAS OLM04.3), except for water samples which were analyzed for VOCs (CLPAS OLM03.2). Analyses of samples for SVOCs, pesticides/PCBs, and VOCs were performed by the Contract Laboratory Program (CLP) laboratory, Envirosystems, located in Columbia, Maryland. Analyses of samples for TAL metals were performed by the CLP laboratory, Ceimic Corporation, located in Narragansett, Rhode Island.

3.3 GLOBAL POSITIONING SYSTEM

Trimble Pathfinder Professional GPS survey units and Corvalis data loggers were used by the START-2 personnel to approximate the sample location coordinates of the SI subsurface soil, groundwater, and sediment samples. Recorded GPS coordinates by sample point are listed in Appendix C. GPS data was not obtained for sample CC01SD because the instrument could not detect satellites in the steep, forested ravine where the sample was located.

3.4 INVESTIGATION-DERIVED WASTE

IDW generated during the SI sampling effort consisted of solid disposable sampling equipment and approximately 50 gallons of decontamination water and monitoring well purge water contained in a 55-gallon drum. The solid IDW was disposed as non-hazardous waste by the START-2 at a Bellingham/Whatcom County landfill. The drum of aqueous IDW was transported off site by Prime Environmental Services of Seattle, Washington, and taken to Emerald Petroleum of Seattle, Washington, for disposal.

Table 3-1

SAMPLE COLLECTION AND ANALYTICAL SUMMARY
Y-ROAD SITE INSPECTION
BELLINGHAM, WASHINGTON

EPA Sample ID	Station Location ID	CLP Organic Number	CLP Inorganic Number	Matrix	Depth (ft bgs)	Sampler	Date	Time	Laboratory/Analysis				Description
									CLP				
									VOCs	SVOCs	Pest/ PCBs	TAL Metals	
04224051	LF01SS10	J44Z2	MJ44Z2	SB	7-10	SG	5/24/2004	1322	X	X	X	X	Boring centrally located in Landfill 2. Silty sand with gravel, garnite.
04224052	LF01SS20	J44Z3	MJ44Z3	SB	16-20	SG	5/24/2004	1344	X	X	X	X	Sandy matrix with paper, plastic, wood, and aftershave odor.
04224053	LF01SS30	J44Z4	MJ44Z4	SB	26-30	SG	5/24/2004	1404	X	X	X	X	Black, gravelly sand to a grayish-brown silt
04224054	AC01SD	J44Z5	MJ44Z5	SD	0-0.5	KS	5/24/2004	1455	X	X	X	X	Sandy gravel with silt, medium brown, saturated.
04224055	LF02SS10	J44Z6	MJ44Z6	SB	4-6	SG	5/24/2004	1505	X	X	X	X	Boring located on west side of Landfill 2. Silty sand with gravel and paper.
04224056	LF02SS20	J44Z7	MJ44Z7	SB	18-20	SG	5/24/2004	1535	X	X	X	X	Fine brown silt and sand with paper.
04224057	LF02SS30	J44Z8	MJ44Z8	SB	26-31	SG	5/24/2004	1615	X	X	X	X	Gray sand with gravel and a black silt residue.
04224058	SC01SD	J44Z9	MJ44Z9	SD	0-0.5	KS	5/24/2004	1545	X	X	X	X	Sandy gravel, coarse, saturated, medium brown.
04224059	TB01WA	J4500	MJ4500	WA	NA	BM	5/24/2004	1630	X				Trip Blank.
04224061	BG02GW	J4502	MJ4502	GW	NA	KS	5/24/2004	1725	X	X	X	X	Collected from MW-1. Light brown color with suspended solids.
04224062	MW01GW	J4503	MJ4503	GW	NA	KS	5/25/2004	0845	X	X	X	X	Collected from MW-4. Light brown color with suspended solids.
04224063	MW02GW	J4504	MJ4504	GW	NA	KS	5/25/2004	0935	X	X	X	X	Collected from MW-6. Light brown color with suspended solids.
04224064	MW03GW	J4505	MJ4505	GW	NA	KS	5/25/2004	1005	X	X	X	X	Collected from MW-7. Light brown color with suspended solids.
04224065	BG01SS10	J4506	MJ4506	SB	6-10	SG	5/25/2004	0950	X	X	X	X	Gray sands intermingled with gravel and silt.
04224066	BG01SS20	J4507	MJ4507	SB	17-20	SG	5/25/2004	1005	X	X	X	X	Sand to clay with intermixed rounded gravel.
04224067	BG01SS30	J4508	MJ4508	SB	27.5-30	SG	5/25/2004	1040	X	X	X	X	Brown clay to gray clay with some gravel.
04224068	MW04GW	J4509	MJ4509	GW	NA	KS	5/25/2004	1105	X	X	X	X	Collected from MW-9. Light brown color with suspended solids.
04224069	MW05GW	J4510	MJ4510	GW	NA	KS	5/25/2004	1155	X	X	X	X	Collected from MW-8. Light brown color with suspended solids.
04224070	CC01SD	J4511	MJ4511	SD	0-0.5	KS	5/25/2004	1335	X	X	X	X	Fine sand with silt, cobbles, organic matter, saturated, brown.
04224071	CC02SD	J4512	MJ4512	SD	0-0.5	KS	5/25/2004	1405	X	X	X	X	Coarse sand with gravel, no organics, brown, saturated.
04224072	LF03SS10	J4513	MJ4513	SB	6-10	SG	5/25/2004	1420	X	X	X	X	Boring located on west side of Landfill 1. Sandy silts and clay with silt; intermingled gravels.
04224073	LF03SS20	J4514	MJ4514	SB	17-20	SG	5/25/2004	1519	X	X	X	X	Coarse sand with silt and gravel.
04224074	BG03SD	J4515	MJ4515	SD	0-0.5	KS	5/25/2004	1445	X	X	X	X	Fine sand and silt, some cobbles, saturated, brown.

Table 3-1

SAMPLE COLLECTION AND ANALYTICAL SUMMARY
Y-ROAD SITE INSPECTION
BELLINGHAM, WASHINGTON

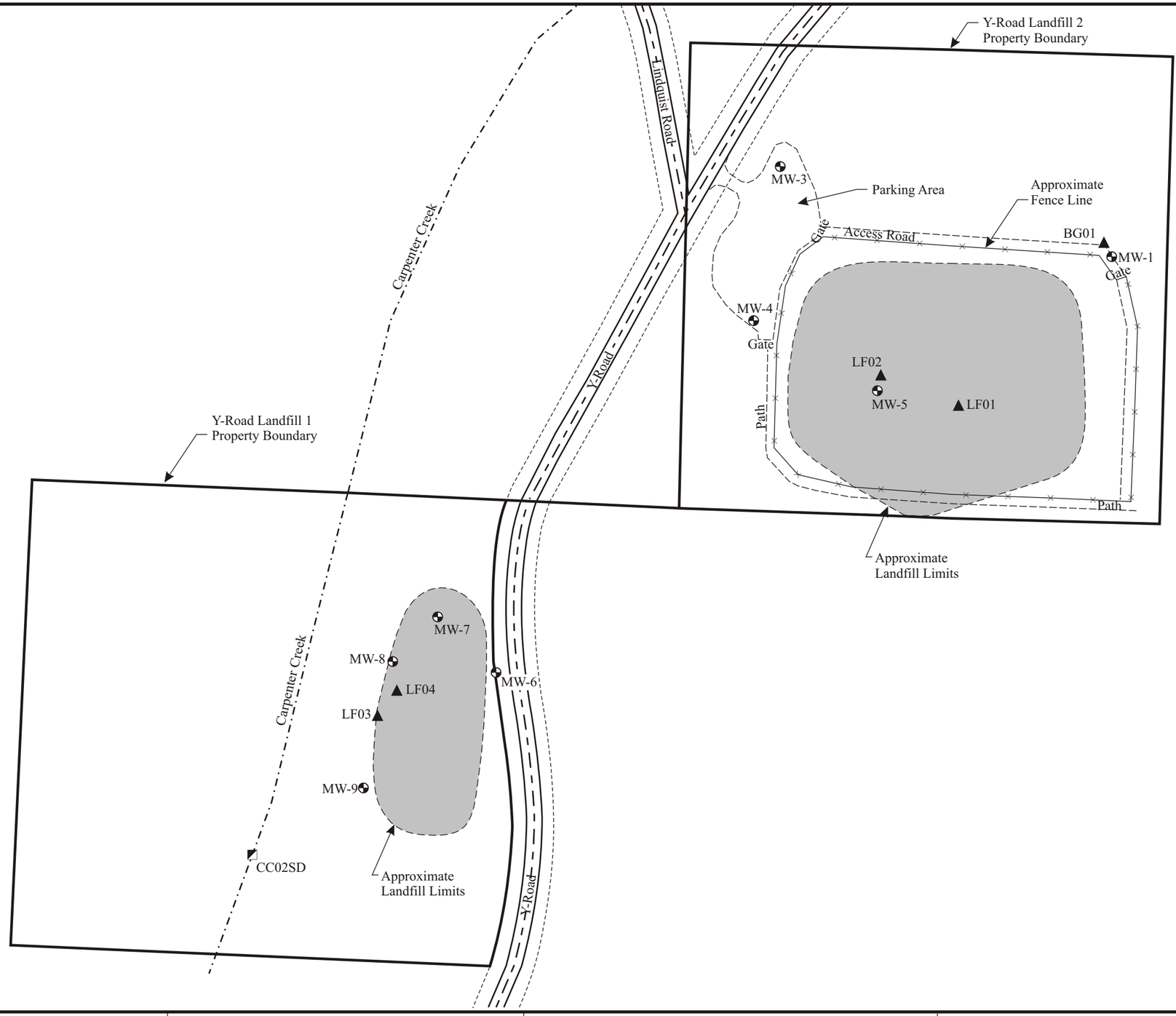
EPA Sample ID	Station Location ID	CLP Organic Number	CLP Inorganic Number	Matrix	Depth (ft bgs)	Sampler	Date	Time	Laboratory/Analysis				Description
									CLP				
									VOCs	SVOCs	Pest/ PCBs	TAL Metals	
04224075	LF04SS10	J4516	MJ4516	SB	7-10	SG	5/25/2004	1600	X	X	X	X	Boring located on west-central side of Landfill 1. Brown sand to light gray clay; duct tape and wood present.
04224076	LF04SS20	J4517	MJ4517	SB	16.5-20.5	SG	5/25/2004	1644	X	X	X	X	Sand and gravel with silt and brownish clay.
04224077	CW01GW	J4518	MJ4518	GW	NA	BM	5/25/2004	1630	X	X	X	X	Collected from Y Squalicum Community Well.
04224078	RS01WA	J4519	MJ4519	WA	NA	KS	5/26/2004	1000	X	X	X	X	Collected from a GeoProbe drill rod.

Key on next page.

Key:

BG = Background.
bgs = Below ground surface.
BM = Ben Martich.
CLP = Contract Laboratory Program.
ft = Feet.
GW = Groundwater.
ID = Identification.
KS = Kerrie Stewart.
MW = Monitoring well.
NA = Not applicable.
Pest/PCBs = Pesticides/Polychlorinated biphenyls.
RS = Rinsate blank.
SB = Subsurface soil.
SD = Sediment.
SG = Susan Gardner.
SVOCs = Semivolatile organic compounds.
TAL = Target Analyte List.
TB = Trip blank.
VOCs = Volatile organic compounds.
WA = Water.

Source: BEK 2003.



Key:

- Monitoring Well
- Gas Monitoring Well
- Soil Boring
- Sediment Sample

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Y-ROAD LANDFILLS SI
Whatcom County, Washington

Figure 3-1
ON-SITE SAMPLE LOCATION MAP

Date:	Drawn by:	
8/19/04	AES	10:START-2\04020011\fig 3-1

Source: Maptech, Inc.,

CW01GW

Lindquist Road

BG03SD

Y-Road Landfill 2

Y-Road Landfill 1

CC01SD

SC01SD

AC01SD

LAKE WHATCOM

Strawberry Point

Sunnyside

Dutch Harbor

Sudden Valley

Lake Louise

Reveille Island

Agate Bay

Mobile Home Park

Solfield Park

Boat Ramp

Golf Course

Picnic Area

Water Tank

Landing Strip

Sudden Valley Campground

Maple Leaf Park

Huckleberry Park

Squalicum Creek

Carpenter Creek

Olsen Creek

Louise Creek

Badger Creek

Agate Bay Road

North Shore Road

Lake Whatcom Road

Y Road

Jensen Road

Lake Louise Road

Whatcom Road

Levees

ecology and environment, inc. International Specialists in the Environment Seattle, Washington	Y-ROAD LANDFILLS SI Whatcom County, Washington	Figure 3-2 OFF-SITE SAMPLE LOCATION MAP		
	0 1000 2000 Approximate Scale in Feet	Date: 8/19/04	Drawn by: AES	10:START-2\04020011\fig 3-2

4. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of sampling equipment, glassware, and reagents. Specific QC requirements for laboratory analyses are incorporated in the Contract Laboratory Program Statements of Work for Organic Analyses (EPA 2000a and 2003a) and the Contract Laboratory Program Statement of Work for Inorganic Analyses (EPA 2004). These QC requirements, or equivalent requirements found in the analytical methods, were followed for analytical work on the project. This section describes the QA/QC measures taken for the project and provides an evaluation of the usability of data presented in this report.

All samples were collected following the guidance of the SQAP (E & E 2004b) and the Sample Plan Alteration Form for the field activities. TAL metals (EPA CLPAS ILM05.3) analyses were performed by the Ceimic Corporation, Narragansett, Rhode Island, a CLP laboratory. VOCs (EPA CLPAS OLC03.2 and/or OLM04.3), SVOCs (EPA CLPAS OLM04.3), and pesticides/PCBs (EPA CLPAS OLM04.3) analyses were performed by Envirosystems, Inc., Columbia, Maryland, a CLP laboratory.

Data validation was conducted by EPA chemists. A secondary review was conducted by a START-2 chemist. Data qualifiers were applied as necessary according to the following guidance:

- EPA (2002) Contract Laboratory Program National Functional Guidelines for Inorganic Data Review; and
- EPA (1999) Contract Laboratory Program National Functional Guidelines for Organic Data Review.

In the absence of other QC guidance, method-specific QC limits were also utilized to apply qualifiers to the data.

4.1 SATISFACTION OF DATA QUALITY OBJECTIVES

The following EPA (EPA 2000b) guidance document was used to establish data quality objectives (DQOs) for this project:

- *Guidance for the Data Quality Objectives Process* (EPA QA/G-4), EPA/600/R-96/055.

The EPA Task Monitor determined that definitive data without error and bias determination would be used for the sampling and analyses conducted during the field activities. The data quality achieved during the fieldwork produced sufficient data that met the DQOs stated in the SQAP (E & E 2004b). A detailed discussion of accomplished project objectives is presented in the following subsections.

4.2 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

QA samples included one rinsate and one trip blank sample. QC samples included matrix spike (MS)/matrix spike duplicate (MSD) samples for organic analyses and MS/duplicate (DUP) samples for inorganic analyses at a rate of one MS/MSD or MS/DUP per 20 samples per matrix per analysis.

4.3 PROJECT-SPECIFIC DATA QUALITY OBJECTIVES

The CLP laboratory data were reviewed to ensure that DQOs for the project were met. The following describes the laboratories' ability to meet project DQOs for precision, accuracy, and completeness and the field team's ability to meet project DQOs for representativeness and comparability. The laboratory and the field team were able to meet DQOs for the project.

4.3.1 Precision

Precision measures the reproducibility of the sampling and analytical methodology. Laboratory and field precision is defined as the relative percent difference (RPD) between duplicate sample analyses. The laboratory duplicate samples or MS/MSD samples measure the precision of the analytical method.

The RPD values were reviewed for all laboratory analyses. No sample results were qualified based on laboratory duplicate QC outliers. The DQO for precision of 85% was met.

4.3.2 Accuracy

Accuracy measures the reproducibility of the sampling and analytical methodology. Laboratory accuracy is defined as the surrogate spike percent recovery for organic analyses or the MS percent recoveries for all analyses. The surrogate percent recovery values were reviewed for all appropriate sample analyses. Three surrogate sample results (approximately 0.1% of the data) were qualified as estimated quantities (UJ) based on surrogate QC outliers. The MS percent recovery values were reviewed for all MS/MSD analyses. Forty six sample results (approximately 1.1% of the data) were qualified as estimated quantities (UJ) based on MS percent recovery outliers. The project DQO for accuracy of 85% was met.

4.3.3 Completeness

Data completeness is defined as the percentage of usable data (usable data divided by the total possible data). All data were reviewed for usability. No sample results were rejected, therefore the project DQO for completeness of 90% was met.

4.3.4 Representativeness

Data representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point or environmental condition. The number and selection of samples were determined in the field to account accurately for site variations and sample matrices. The DQO for representativeness of 85% was met.

4.3.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Data produced for this site followed applicable field sampling techniques and specific analytical methodology. The DQO for comparability was met.

4.4 LABORATORY QUALITY ASSURANCE/QUALITY CONTROL PARAMETERS

The laboratory data also were reviewed for holding times/temperatures, laboratory method blank samples, rinsate blank samples and trip blank samples. These QA/QC parameters are summarized below. In general, the laboratory and field QA/QC parameters were considered acceptable.

4.4.1 Holding Times

All samples were maintained and received within QC temperature limits and all samples were analyzed within QC holding time limits.

4.4.2 Laboratory Blanks

The laboratory method blanks met the frequency criteria. The following potential contaminants of concern were detected in laboratory blanks:

VOCs:	methylene chloride, acetone; and
TAL metals:	aluminum, barium, cadmium, calcium, iron, mercury, sodium.

Associated sample results less than five times the blank results (10 times for common laboratory contaminants) were qualified as not detected (U) in the samples.

4.4.3 Rinsate Blanks

One rinsate blank sample was collected during the START-2 field event. The number of rinsate blanks meets the frequency criteria of one per 20 samples collected by nondedicated sampling equipment. The rinsate blank was collected by pouring distilled water through a Geoprobe rod that had been decontaminated in the field. Chromium, copper, manganese, and nickel were detected in the rinsate blank sample. All associated sample results were greater than five times the rinsate blank sample results, therefore no results were qualified based on rinsate blank contamination.

4.4.4 Trip Blank

One trip blank sample was collected during the START-2 field event, meeting the frequency criteria for VOC analysis of one trip blank sample per VOC cooler. The trip blank was collected from a distilled, deionized water source and was maintained with the sample containers. Dichlorodifluoromethane, acetone, and 1,2-dichloroethane were detected in the trip blank sample. Associated sample results less than five times the blank results (10 times for common laboratory contaminants) were qualified as not detected (U) in the samples. The acetone and 1,2-dichloroethane results in sample J4518 were qualified as not detected based on trip blank results.

5. ANALYTICAL RESULTS REPORTING AND BACKGROUND SAMPLES

This section describes the reporting and methods applied to analytical results presented in Sections 6 and 7 of this report, and discusses background locations and sample results. Table 3-1 lists all samples collected for laboratory analysis.

5.1 ANALYTICAL RESULTS EVALUATION CRITERIA

Analytical results presented in the summary tables in Sections 6 and 7 show all compounds detected above laboratory detection limits in bold type. Analytical results indicating significant concentrations of contaminants in source samples (Section 6) with respect to background concentrations are shown underlined and in bold type. Similarly, analytical results indicating elevated concentrations of contaminants in target samples (Section 7) with respect to background concentrations and attribution to a source area are also shown underlined and in bold type. For the purposes of this investigation, significant/elevated concentrations are those concentrations that are:

- Equal to or greater than the sample's Contract Required Detection Limit/Contract Required Quantitation Limit (CRDL/CRQL) or the sample quantitation limit (SQL) when a non-CLP laboratory was used; and
- Equal to or greater than the background sample's CRDL/CRQL or SQL when the background concentration is below detection limits; or
- At least three times greater than the background concentration when the background concentration equals or exceeds the detection limits.

The analytical summary tables present all detected compounds, but only those detected analytes at potential sources or in targets meeting the significant/elevated concentration criteria are discussed in the report text. All detected concentrations are also discussed for background samples, including those concentrations which were qualified as estimated because they were detected below the SQL (J).

All hazardous substances detected at target locations and meeting evaluation criteria can be used to document an observed release from the site to the target. When samples were diluted for re-analysis at a laboratory, the dilution results were considered for evaluation and are provided in the tables.

5.1.1 Sample Results Reporting

When reporting the analytical results in Sections 6 and 7, the number of analytes/compounds for an analytical suite at a significant/elevated concentration are provided. Based on EPA, Region 10, policy, evaluation of aluminum, calcium, iron, magnesium, potassium, and sodium (common earth crust elements) is generally employed only in water mass tracing, which is beyond the scope of this investigation. For this reason, these elements will not be discussed in this report.

5.2 BACKGROUND SAMPLES

Background samples were collected for each of the naturally occurring media from which SI samples were collected. Those media are subsurface soil, sediment, and groundwater. Results for the appropriate background samples are shown in the first column of the analytical results summary tables in Sections 6 and 7 for comparison against source or target results. In addition, the community well sample is compared to EPA Drinking Water Regulations and Health Advisories, and the analytical table for sediment samples has the results from Austin Creek and Smith Creek on the right side of the table for comparison to the analytical results in Carpenter Creek.

5.2.1 Background Subsurface Soil

5.2.1.1 Sample Locations

One background subsurface soil boring (BG01) was drilled on the northeast side of Y-Road Landfill 2. Samples were collected from three intervals: 6 to 10 feet bgs (BG01SS10), 17 to 20 feet bgs (BG01SS20), and 27.5 to 30 feet bgs (BG01SS30). The sample matrix from the three intervals was consistent with undisturbed sections of the landfill, but different than the landfilled materials, as expected. Figure 3-1 shows the location of the background subsurface soil boring.

5.2.1.2 Sample Results

Sample results are presented in Table 6-1. Thirteen inorganic analytes were detected in background sample BG01SS10, ranging from an estimated concentration of 0.041 J milligrams per kilogram (mg/kg; mercury) to 270 mg/kg (manganese); 14 inorganic analytes were detected in background sample BG01SS20, ranging from an estimated concentration of 0.036 J mg/kg (mercury) to 278 mg/kg (manganese); and 13 inorganic analytes were detected in background sample BG01SS30, ranging from an estimated concentration of 0.029 J mg/kg (mercury) to 349 mg/kg (manganese). No

VOCs, SVOCs, or pesticides/PCBs were detected above method detection limits (MDLs) in background samples BG01SS10, BG01SS20, or BG01SS30.

5.2.2 Background Groundwater

5.2.2.1 Sample Locations

Sample results are presented in Table 7-3. One background groundwater sample (BG02GW) was collected from monitoring well MW-1, located on the northeast side of Y-Road Landfill 2 and hydraulically upgradient of the landfills (Figure 3-1). The sample matrix was brownish in color and contained suspended solids, which is similar to the characteristics of the groundwater in the other wells.

5.2.2.2 Sample Results

Twelve inorganic analytes were detected in background sample BG02GW, ranging from 0.32 micrograms per liter (µg/L; mercury) to 826 µg/L (manganese). No VOCs, SVOCs, or pesticides/PCBs were detected above MDLs in background sample BG02GW.

5.2.3 Background Sediment

5.2.3.1 Sample Locations

Sample results are presented in Table 7-5. One background sediment sample (BG03SD) was collected. It was collected from Carpenter Creek approximately 500 feet upgradient of the Y-Road Landfill 1 (Figure 3-2). The sample was collected from below the low water line at a depth of 0 to 6 inches bgs. The background sample matrix, saturated silty sands, matched the matrices of samples collected near and downstream of the site.

5.2.3.2 Sample Results

Eleven inorganic analytes were detected in background sample BG03SD, ranging from an 0.66 mg/kg (beryllium) to 429 mg/kg (manganese). No VOCs, SVOCs, or pesticides/PCBs were detected above MDLs in background sample BG03SD.

6. POTENTIAL SOURCES

This section describes sample locations and analytical results of SI samples obtained from potential sources. The sampling locations, sampling rationale, and analytical results are summarized in the following subsections; Table 6-1 summarize analytes detected at each potential source location investigated. Laboratory data sheets of analytical results for all samples are provided in Appendix D.

6.1 LANDFILLS

Previous investigations and the PA have identified the two landfills as source areas. The operations at Y-Road Landfill 1 appear to have occurred on two acres, while the operations at Y-Road Landfill 2 appear to have been on six acres (BEK 2000). During drilling of the soil borings, waste materials were observed as deep as 10 feet bgs in Y-Road Landfill 1 and as deep as 20 feet bgs in Y-Road Landfill 2. Based on these observations, Y-Road Landfill 1 has a volume of waste material no greater than 32,000 cubic yards, and Y-Road Landfill 2 has a volume of waste material no greater than 194,000 cubic yards.

6.1.1 Subsurface Soils

6.1.1.1 Sample Locations

Two borings were drilled in each landfill (Figure 3-1). The locations were selected near the center of the landfill debris, based on data from previous studies, and available access to these locations in the field.

For Y-Road Landfill 1, boring LF03 was drilled to a depth of 20 feet bgs, and boring LF04 was drilled to a depth of 20.5 feet bgs. Both borings terminated at a layer of compacted glacial till. Each boring had two samples collected from it. For boring LF03, the sample intervals were 6 to 10 feet bgs and 17 to 20 feet bgs, and no landfill waste was observed in the sample intervals. For boring LF04, the sample intervals were 7 to 10 feet bgs and 16.5 to 20.5 feet bgs. Duct tape and wood debris was observed in the first sample interval, and the second interval had a flame ionization detector (FID) reading of 39 part per million (ppm). An FID is a field instrument used to measure volatile organic vapors and its response is relative to many conditions, such as concentration of contamination, weathered state of

contamination, volatility of contamination, temperature, and moisture content. For this investigation, the FID was used solely as a screening device to indicate the presence of volatile organics and a relative level of concentration. No correlation was performed between FID readings and analytical results of any volatile organic compound.

For Y-Road Landfill 2, boring LF01 was drilled to a depth of 30 feet bgs, and boring LF02 was drilled to a depth of 31 feet bgs. Each boring had three samples collected from it. For boring LF01, the sample intervals were 7 to 10 feet bgs, 16 to 20 feet bgs, and 26 to 30 feet bgs. Wood, glass, bubble wrap, and roofing material were observed in the first sample interval, and paper, plastic, and wood were observed in the second interval. The FID reading in the first sample interval was 20 ppm, and the second sample interval had an odor of aftershave and a FID reading of 64 ppm. For boring LF02, the sample intervals were 4 to 6 feet bgs, 18 to 20 feet bgs, and 26 to 31 feet bgs. Paper was observed in the first and second sample intervals, and a black silty residue was observed in the third sample interval. The second sample interval had a FID reading of 32 ppm.

6.1.1.2 Sample Results

Sample results are summarized in Table 6-1. Figures 6-1 and 6-2 depict the hazardous substances detected at significant concentrations in the first and second sample intervals, respectively.

For boring LF01 in Y-Road Landfill 2, sample LF01SS10 had one inorganic analyte (lead) detected at significant concentration; nine VOCs detected at significant concentrations; and two SVOCs (bis[2-ethylhexyl]phthalate and butylbenzylphthalate) detected at significant concentrations. Sample LF01SS20 had four inorganic analytes detected at significant concentrations; four VOCs detected at significant concentrations; two SVOCs (bis[2-ethylhexyl]phthalate and di-n-octylphthalate) detected at significant concentrations; and five pesticides/PCBs detected at significant concentrations. Sample LF01SS30 had one VOC, acetone, detected at a significant concentration.

For boring LF02 in Y-Road Landfill 2, sample LF02SS10 had three inorganic analytes (lead, mercury, and zinc) detected at significant concentrations; two SVOCs, (bis[2-ethylhexyl]phthalate and dimethylphthalate) detected at significant concentrations; and two pesticides/PCBs (methoxychlor and Aroclor-1248) detected at significant concentrations. Sample LF01SS20 had seven inorganic analytes detected at significant concentrations; seven VOCs detected at significant concentrations; two SVOCs (bis[2-ethylhexyl]phthalate and naphthalene) detected at significant concentrations; and five pesticides/PCBs detected at significant concentrations. Sample LF02SS30 had no compounds detected at significant concentrations.

For boring LF03 in Y-Road Landfill 1, no compounds were detected at significant concentrations in sample LF03SS10 or LF03SS20. For boring LF04 in Y-Road Landfill 1, one inorganic analyte (lead) was detected at a significant concentration, and three pesticides/PCBs (4,4'-dichlorodiphenyltrichloroethane [DDT], alpha-chlordane, and gamma-chlordane) were detected at significant concentrations.

Based on analytical results, Y-Road Landfill 2 appears to contain more hazardous substances across the first two sample intervals, which is supported by field observations made by START-2 during the drilling of the borings in each landfill. The sample intervals in Landfill 2 contained significantly more debris than the sample intervals in Landfill 1. In addition, higher FID readings were recorded in the sample intervals from Landfill 2 than Landfill 1, supporting the analytical results.

Table 6-1

SOURCE SOIL SAMPLES ANALYTICAL RESULTS SUMMARY
Y-ROAD LANDFILLS SITE INSPECTION
BELLINGHAM, WASHINGTON

CLP Number	(M)J4506	(M)J4507	(M)J4508	(M)J4513	(M)J4514	(M)J4516	(M)J4517	(M)J44Z2	(M)J44Z3	(M)J44Z4	(M)J44Z6	(M)J44Z7	(M)J44Z8
EPA Sample Number	04224065	04224066	04224067	04224072	04224073	04224075	04224076	04224051	04224052	04224053	04224055	04224056	04224057
Sample Location	BG01SS10	BG01SS20	BG01SS30	LF03SS10	LF03SS20	LF04SS10	LF04SS10	LF01SS10	LF01SS20	LF01SS30	LF02SS10	LF02SS20	LF02SS30
Depth (feet bgs)	6-10	17-20	27.5-30	6-10	17-20	7-10	16.5-20.5	7-10	16-20	26-30	4-6	18-20	26-31
Description	Background			Source - Y-Road Landfill 1				Source - Y-Road Landfill 2					
Metals (mg/kg)													
Aluminum	**12700**	**12500**	**9020**	**12300**	**10200**	**15900**	**11200**	**12300**	**25700**	**12000**	**16900**	**11500**	**10500**
Arsenic	**3.4**	**2.5**	**2.3**	**3.6**	**2.4**	**2.4**	**3.3**	**2.9**	**3.2**	**2.3**	**2.6**	**8.0**	**2.2**
Barium	**73.7**	**68.0**	**58.3**	**70.2**	**58.7**	**48.4**	**69.3**	**109**	**125**	**68.8**	**89.4**	**155**	**52.2**
Beryllium	**0.77**	**0.77**	**0.69**	**0.86**	**0.74**	**1.1**	**0.74**	**0.82**	0.61 J	**0.78**	**0.64**	0.28 J	**0.68**
Cadmium	0.32 J SQL=0.97	0.31 J SQL=1.05	0.34 J SQL=1.08	0.41 J	0.38 J	**0.52**	0.42 J	0.49 J	**12.4**	0.41 J	**0.71**	**5.0**	0.34 J
Calcium	**3130**	**3270**	**4740**	**4040**	**3690**	**7860**	**4010**	**3810**	**16800**	**4560**	**5200**	**7280**	**3130**
Chromium	**27.1**	**22.8**	**22.8**	**29.3**	**20.6**	**36.3**	**26.0**	**24.0**	**61.3**	**34.4**	**27.7**	**37.1**	**29.5**
Cobalt	**9.9 JL**	**7.9 JL**	**7.0 JL**	**11.5 JL**	**8.2 JL**	**8.3 JL**	**8.6 JL**	**10.7 JL**	**8.5 JL**	**10 JL**	**8.9 JL**	**6.3 JL**	**9.4 JL**
Copper	**22.8**	**19.1**	**17.8**	**24.7**	**20.3**	**19.9**	**22.6**	**22.9**	**40.2**	**22.5**	**29.1**	**63.1**	**22.2**
Iron	**15300**	**14900**	**15600**	**19100**	**15500**	**16300**	**17000**	**19500**	**59900**	**19100**	**22800**	**76200**	**15900**
Lead	**3.1**	**2.8**	**2.4**	**4.2**	**3.3**	**10.3**	**3.8**	**11.1**	**58.5**	**4.8**	**31.5**	**6990**	**3.8**
Magnesium	**5950**	**4300**	**4940**	**5770**	**5060**	**5930**	**5210**	**7420**	**4440**	**5800**	**5570**	**2070**	**5520**
Manganese	**270**	**278**	**349**	**421**	**404**	**273**	**342**	**351**	**508**	**386**	**327**	**459**	**192**
Mercury	0.041 J SQL=0.11	0.036 J SQL=0.12	0.029 J SQL=0.11	0.045 J	0.029 J	0.032 J	0.040 J	0.074 J	**1.3**	0.055 J	**0.48**	**0.54**	0.036 J
Nickel	**47.9**	**27.5**	**20.3**	**59.3**	**30.6**	**49.2**	**32.9**	**55.0**	**43.3**	**42.0**	**48.5**	**30.0**	**59.9**
Potassium	**753**	497 J	**636**	**629**	**633**	**895**	**696**	**1250**	**775**	**556**	487 J	**632**	**621**
Selenium	3.4 U	1.7 J SQL=4.12	3.8 U	3.4 U	3.7 U	3.7 U	3.8 U	3.8 U	2.1 J	3.4 U	4.2 U	**4.5**	3.2 U
Vanadium	**30.3**	**32.8**	**34.8**	**34.0**	**30.5**	**32**	**35.4**	**30.2**	**21.7**	**35.3**	**29.9**	**12.3**	**28.3**
Zinc	**31.1**	**28.6**	**28.2**	**39.3**	**46.4**	**78.2**	**42.7**	**66.3**	**179**	**65.5**	**116**	**349**	**33**
VOCs (ug/kg)													
Cyclohexane	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**62**	15 U	11 U	13 U	12 U	11 U
Methylcyclohexane	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**160**	15 U	3 JQ	13 U	4 JQ	11 U
2-Butanone	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**48**	**38**	10 JQ	13 U	**53**	11 U
Acetone	17 U	31 U	11 U	11 U	11 U	11 U	11 U	**980**	**120**	**35**	13 U	**150**	19 U
Benzene	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**87**	15 U	11 U	13 U	4 JQ	11 U
Carbon Disulfide	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	6 JQ	11 U	13 U	**13**	11 U
Ethylbenzene	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**1500**	9 JQ	11 U	13 U	**18**	11 U
Isopropylbenzene	11 U	11 U	11 U	11 U	11 U	11 U	11 U	300 U	**39**	5 JQ	13 U	**35**	11 U
Tetrachloroethene	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**24**	15 U	11 U	13 U	12 U	11 U
Toluene	11 U	11 U	11 U	5 JQ	11 U	4 JQ	11 U	**49**	8 JQ	5 JQ	6 J	**29**	7 JQ
Xylenes (Total)	11 U	11 U	11 U	11 U	11 U	11 U	11 U	**3900**	**28**	6 JQ	13 U	**560**	11 U
SVOCs (ug/kg)													
Bis(2-ethylhexyl)phthalate	360 U	370 U	350 U	370 U	370 U	360 U	380 U	**580**	**2600**	86 JQ	**11000**	**2000**	360 U
Butylbenzylphthalate	360 U	370 U	350 U	370 U	370 U	360 U	380 U	**440**	250 JQ	350 U	440 JQ	410 U	360 U
Dimethylphthalate	360 U	370 U	350 U	370 U	370 U	360 U	380 U	380 U	490 U	350 U	**3100**	220 JQ	360 U
Di-n-octylphthalate	360 U	370 U	350 U	370 U	370 U	360 U	380 U	380 U	**970**	350 UJK	1800 U	140 JQ	360 UJK
Naphthalene	360 U	370 U	350 U	370 U	370 U	360 U	380 U	380 U	160 JQ	350 U	1800 U	**1200**	360 U

Table 6-1

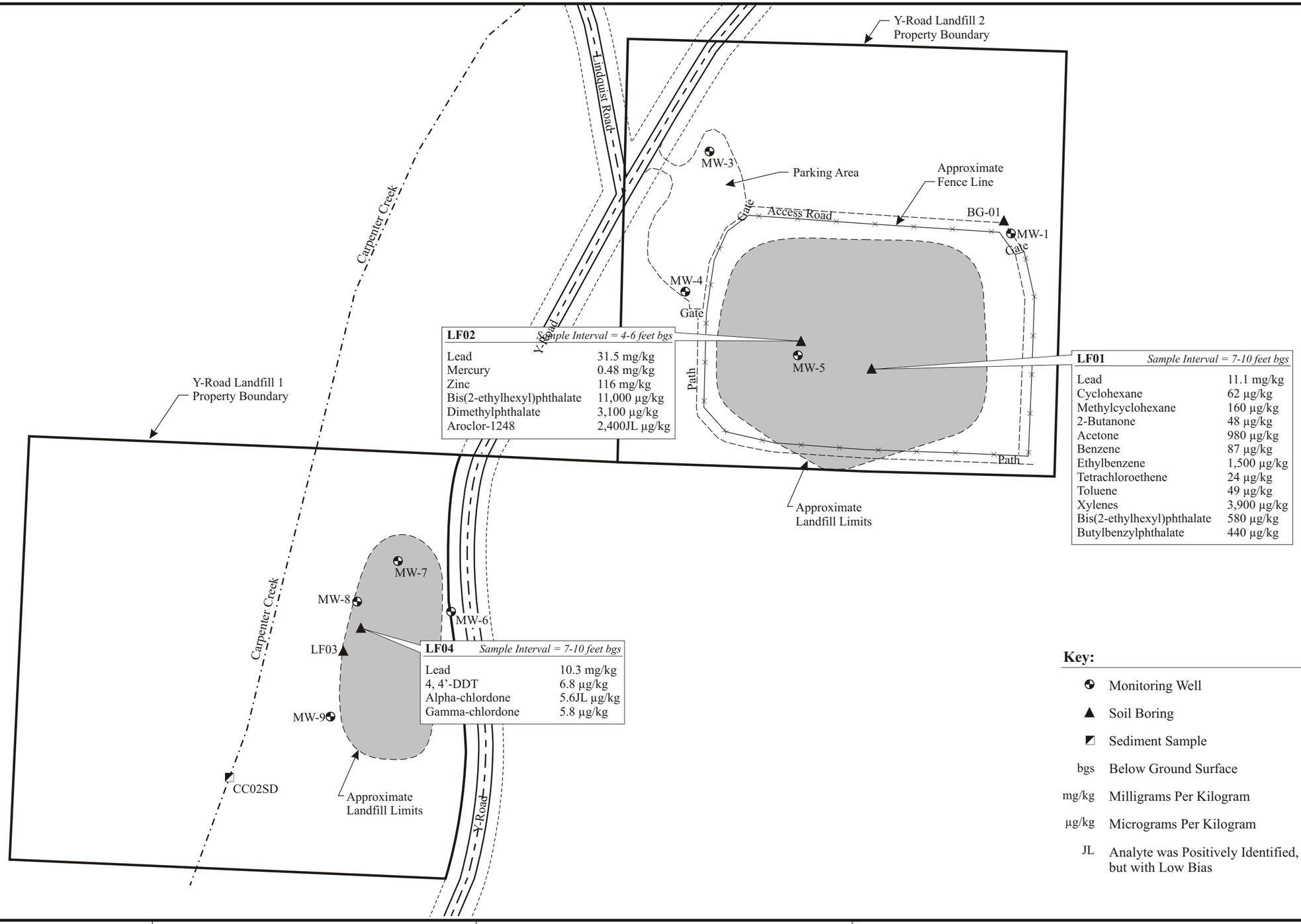
SOURCE SOIL SAMPLES ANALYTICAL RESULTS SUMMARY
Y-ROAD LANDFILLS SITE INSPECTION
BELLINGHAM, WASHINGTON

CLP Number	(M)J4506	(M)J4507	(M)J4508	(M)J4513	(M)J4514	(M)J4516	(M)J4517	(M)J44Z2	(M)J44Z3	(M)J44Z4	(M)J44Z6	(M)J44Z7	(M)J44Z8
EPA Sample Number	04224065	04224066	04224067	04224072	04224073	04224075	04224076	04224051	04224052	04224053	04224055	04224056	04224057
Sample Location	BG01SS10	BG01SS20	BG01SS30	LF03SS10	LF03SS20	LF04SS10	LF04SS10	LF01SS10	LF01SS20	LF01SS30	LF02SS10	LF02SS20	LF02SS30
Depth (feet bgs)	6-10	17-20	27.5-30	6-10	17-20	7-10	16.5-20.5	7-10	16-20	26-30	4-6	18-20	26-31
Description	Background			Source - Y-Road Landfill 1				Source - Y-Road Landfill 2					
Pesticides/PCBs (ug/kg)													
Endosulfan II	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	3.6 U	3.8 U	3.8 U	4.9 U	3.5 U	3.6 U	**32 JL**	3.6 U
4,4'-DDD	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	3.6 U	3.8 U	3.8 U	**35**	3.5 U	39 U	**35 JL**	3.6 U
4,4'-DDE	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	3.6 U	3.8 U	3.8 U	**23 JL**	3.5 U	14 U	**16**	3.6 U
4,4'-DDT	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	**6.8**	3.8 U	3.8 U	10 U	3.5 U	11 U	8.1 U	3.6 U
Alpha-chlordane	1.8 U	1.9 U	1.8 U	1.9 U	1.9 U	**5.6 JL**	2.0 U	3.8 U	20 U	3.5 U	25 U	4.7 U	1.9 U
Aroclor-1248	36 U	37 U	35 U	37 U	37 U	36 U	38 U	38 U	49 U	35 U	**2400 JL**	41 U	36 U
Delta-BHC	1.8 U	1.9 U	1.8 U	1.9 U	1.9 U	1.9 U	2.0 U	2.0 U	2.5 U	1.8 U	1.8 U	**13 JL**	1.9 U
Dieldrin	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	3.6 U	3.8 U	3.8 U	**8.9 JL**	3.5 U	3.6 U	**17 JL**	3.6 U
Endrin	3.6 U	3.7 U	3.5 U	3.7 U	3.7 U	3.6 U	3.8 U	3.8 U	**18**	3.5 U	3.6 U	18 U	3.6 U
Gamma-Chlordane	1.8 U	1.9 U	1.8 U	1.9 U	1.9 U	**5.8**	2.0 U	1.9 JQ	**23 JL**	3.5 U	28 U	2.1 U	1.9 U
Methoxychlor	18 U	19 U	18 U	19 U	19 U	19 U	20 U	20 U	36 U	18 U	**21**	21 U	19 U

Note: Bold type indicates sample concentrations above detection limits.
Underlined type indicates sample result is significant as defined in Section 5.

Key:
bgs = Below ground surface.
CLP = Contract Laboratory Program.
EPA = United States Environmental Protection Agency.
J = The analyte was positively identified. The associated numerical value is an estimate because the concentration is below the Contract Required Quantitation Limit.
L = Low bias.
K = Unknown bias.
ug/kg = Micrograms per kilogram.
mg/kg = Milligrams per kilogram.
Q = The result is estimated because the concentration is below the Contract Required Quantitation Limit.
SQL = Sample quantitation limit.
U = The analyte was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.
UJ = The analyte was analyzed for, but was not detected. The associated numerical value is an estimate.

Source: BEK 2003.



Key:

- ◓ Monitoring Well
- ▲ Soil Boring
- ◩ Sediment Sample
- bgs Below Ground Surface
- mg/kg Milligrams Per Kilogram
- µg/kg Micrograms Per Kilogram
- JL Analyte was Positively Identified, but with Low Bias

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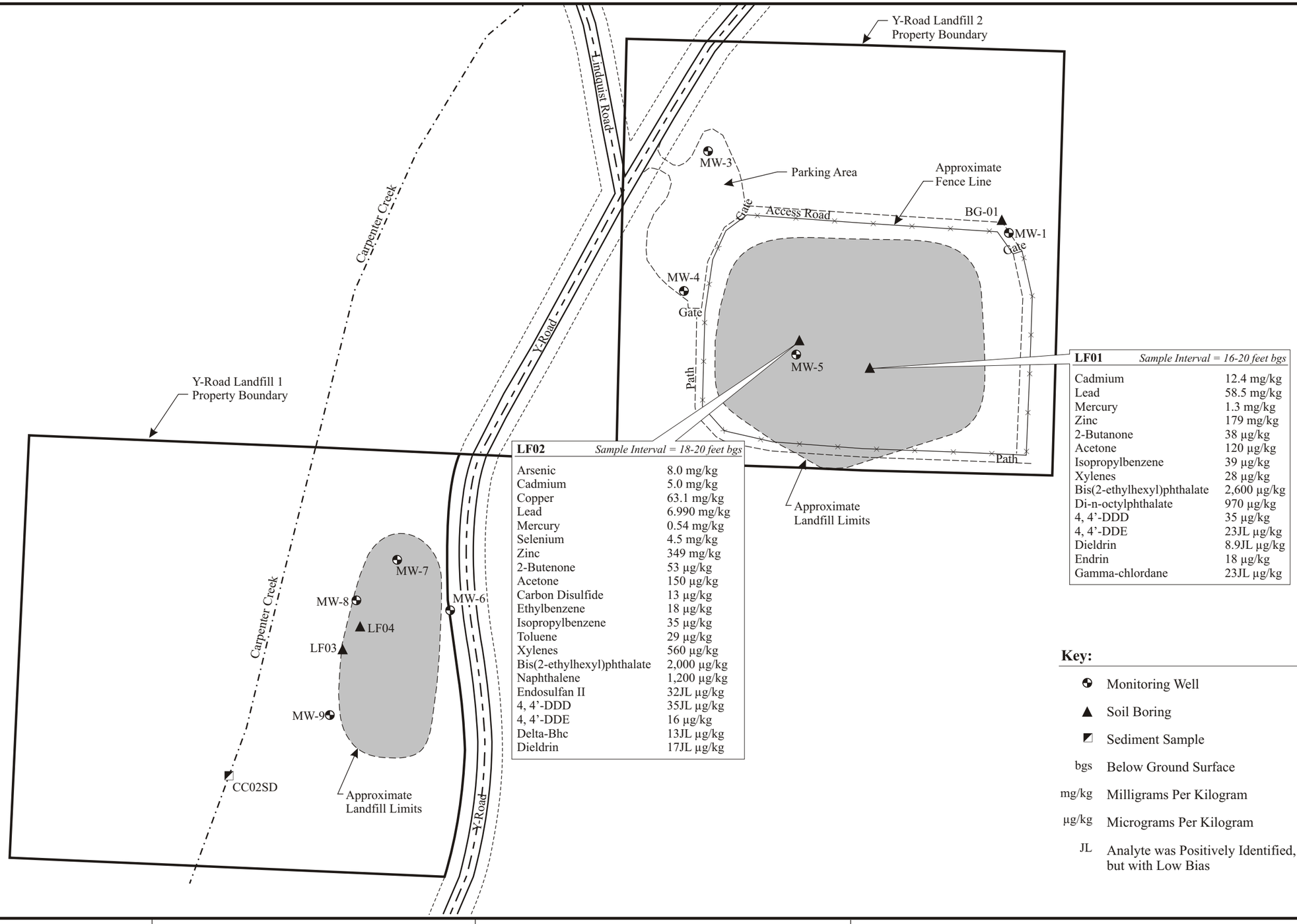
Y-ROAD LANDFILLS SI
Whatcom County, Washington

Figure 6-1
SIGNIFICANT CONCENTRATIONS IN THE FIRST SAMPLE INTERVAL OF SOURCE SAMPLES

Date:	Drawn by:	
8/19/04	AES	10:START-2\04020011\fig 6-1

Source: BEK 2003.



LF01	*Sample Interval = 16-20 feet bgs*
Cadmium	12.4 mg/kg
Lead	58.5 mg/kg
Mercury	1.3 mg/kg
Zinc	179 mg/kg
2-Butanone	38 µg/kg
Acetone	120 µg/kg
Isopropylbenzene	39 µg/kg
Xylenes	28 µg/kg
Bis(2-ethylhexyl)phthalate	2,600 µg/kg
Di-n-octylphthalate	970 µg/kg
4, 4'-DDD	35 µg/kg
4, 4'-DDE	23JL µg/kg
Dieldrin	8.9JL µg/kg
Endrin	18 µg/kg
Gamma-chlordane	23JL µg/kg

LF02	*Sample Interval = 18-20 feet bgs*
Arsenic	8.0 mg/kg
Cadmium	5.0 mg/kg
Copper	63.1 mg/kg
Lead	6.990 mg/kg
Mercury	0.54 mg/kg
Selenium	4.5 mg/kg
Zinc	349 mg/kg
2-Butenone	53 µg/kg
Acetone	150 µg/kg
Carbon Disulfide	13 µg/kg
Ethylbenzene	18 µg/kg
Isopropylbenzene	35 µg/kg
Toluene	29 µg/kg
Xylenes	560 µg/kg
Bis(2-ethylhexyl)phthalate	2,000 µg/kg
Naphthalene	1,200 µg/kg
Endosulfan II	32JL µg/kg
4, 4'-DDD	35JL µg/kg
4, 4'-DDE	16 µg/kg
Delta-Bhc	13JL µg/kg
Dieldrin	17JL µg/kg

Key:

- Monitoring Well
- Soil Boring
- Sediment Sample
- bgs — Below Ground Surface
- mg/kg — Milligrams Per Kilogram
- µg/kg — Micrograms Per Kilogram
- JL — Analyte was Positively Identified, but with Low Bias

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0 100 200
Approximate Scale in Feet

Y-ROAD LANDFILLS SI
Whatcom County, Washington

Figure 6-2
SIGNIFICANT CONCENTRATIONS IN THE SECOND SAMPLE INTERVAL OF SOURCE SAMPLES

Date:	Drawn by:	
8/20/04	AES	10:START-2\04020011\fig 6-2

7. MIGRATION/EXPOSURE PATHWAYS AND TARGETS

The following subsections describe migration/exposure pathways and potential targets within the site's range of influence (Figures 7-1, 7-2, and 7-3). Analytical data QA forms from laboratory analyses are in Appendix D. This section discusses the groundwater migration pathway (subsection 7.1), surface water migration pathway (subsection 7.2), soil exposure pathway (subsection 7.3), and air migration pathway (subsection 7.4).

7.1 GROUNDWATER MIGRATION PATHWAY

7.1.1 Pathway Description

The target distance limit (TDL) for the groundwater migration pathway is a 4-mile radius that extends from the sources at the site. Figure 7-1 depicts the groundwater TDL.

The Y-Road Landfills lie within the Squalicum Lake Valley. The stratigraphic units that exist in the valley are (from the surface): perched aquifers, glacial till, Bellingham Drift, Squalicum Lake Valley Aquifer, and the Chuckanut Formation. The Squalicum Lake Valley Aquifer lies within a 5- to 20-foot layer of sand and gravel that is bounded by the Bellingham Drift from above and the Chuckanut Formation from below. Although the depth of this aquifer varies greatly depending on location and surface topography, the Squalicum Lake Aquifer generally begins between 100 and 150 feet bgs. The silt and clay of the Bellingham Drift and the glacial till above the Bellingham Drift may possibly act as confining layers for migration of groundwater downward to the Squalicum Lake Valley Aquifer. Therefore, the majority of recharge for the aquifer likely is from surface water infiltration at the geologic contact between unconsolidated glacial sediments and the Chuckanut Formation along the east and west margins of the valley, and lateral movement of groundwater through the bedrock headlands of the valley. The aquifer flows in a southwesterly direction and discharges to Lake Whatcom (BEK 2003).

The overlying shallow, perched aquifers consist of sands and gravels that lie above the Squalicum Lake Valley Aquifer, Bellingham Drift, and glacial till. The boundaries of individual perched aquifers are assumed to coincide with surface exposures of unconsolidated glacial sediments in the valley. The perched aquifers are assumed to recharge by infiltration and surface water runoff from the bedrock headlands of the valley, and the discharge locations are assumed to be the gorges of Carpenter Creek in

the center of the valley. The depth to the shallow, perched aquifers generally is 30 feet bgs, but this is dependent on location and surface topography. General flow direction is southwesterly toward Lake Whatcom, but localized conditions may greatly vary flow direction at any one discrete location (BEK 2003).

There is no containment in the landfills to prevent a release from potential source areas to groundwater.

7.1.2 Targets

No drinking water wells are located at the two landfills. The nearest drinking water well to Y-Road Landfill 1 is located approximately 300 feet northeast of the landfill, and the nearest drinking water well to Y-Road Landfill 2 is the same well, which is located approximately 50 feet west of the landfill. This well (Muna well) is set at 160 feet bgs and draws water from the Squalicum Lake Valley Aquifer. The nearest drinking water well (Dooley well) that draws water from the perched shallow aquifer is located approximately 1,200 feet south of Y-Road Landfill 1 and approximately 1,800 feet southwest of Y-Road Landfill 2. It is set at 35 feet bgs. Both the Muna well and the Dooley well were sampled by BEK in October 2001, and the samples were analyzed for VOCs, SVOCs, pesticides/herbicides, PCBs, and total metals (BEK 2002). Table 7-1 shows the analytical results for these two wells. No analyte exceeded the National Primary Drinking Water Regulations Maximum Contaminant Levels (EPA 2003b).

In addition to the nearest drinking water wells, 303 other drinking water wells are located within the 4-mile TDL (Ecology 2003). Fifty-eight of these wells appear to draw water from the shallow aquifer, based on well logs. The rest presumably draw water from the Squalicum Lake Valley Aquifer. Additionally, 10 of the wells set in the Squalicum Lake Valley Aquifer appear to be possible public wells, but contact information was only available for two. Of these two wells, one is owned and operated by Whatcom County Water District 10; is located approximately 0.75-mile northwest from the site; and serves two residences (Anderson 2003). The other well is known as the Y Squalicum community well and it is located approximately 2/3-mile north of the landfills. The well is set at 160 feet bgs in the Squalicum Lake Valley Aquifer. It has 70 connections (Watson 2004). The other eight wells have been counted as domestic.

START-2 totaled the number of individuals using groundwater for drinking water by multiplying the average person per household statistic for Whatcom County (2.51) by 375, the number of estimated households that have a domestic drinking water well (USDC 2001). Therefore, the estimated number of

individuals drinking groundwater in the TDL is 941. Table 7-2 shows the number of individuals using groundwater for drinking water per target distance ring within the TDL.

Based on the presence of irrigation wells within the 4-mile TDL, START-2 assumes that groundwater is used for watering of at least 5 acres of commercial forage crops and commercial livestock (Ecology 2003). No wellhead protection area is located within 4 miles of the site (EPA 2003c).

7.1.3 Sample Locations

Five groundwater monitoring wells and the Y Squalicum community well were sampled during the SI. The monitoring wells that were sampled are depicted on Figure 3-1, and the location of the community well is on Figure 3-2. Monitoring well MW-5 was scheduled to be sampled, but at the time of the field event it contained no groundwater.

The location of the Y Squalicum community well most likely places it hydraulically upgradient of the landfills, but START-2 was tasked to sample this well because of concerns of nearby residents.

7.1.4 Groundwater Well Sample Results

Sample results are summarized in Table 7-3. EPA's Maximum Contaminant Levels (MCLs) for drinking water have been included on Table 7-3 for comparison to results from the Y Squalicum community well. Figure 7-4 depicts the analytes that were detected at elevated concentrations in the monitoring well groundwater samples.

Thirteen inorganic analytes were detected at elevated concentrations in the five monitoring well samples from the landfills; however, only 6 of the 13 analytes also were detected at significant concentrations in source samples from the landfills. Of these six analytes:

- arsenic was detected at an elevated concentration in monitoring well MW-6;
- cadmium was detected at an elevated concentration in monitoring well MW-6;
- copper was detected at elevated concentrations in monitoring wells MW-4 and MW-6;
- lead was detected at an elevated concentrations in monitoring wells MW-6, MW-7, and MW-8;
- mercury was detected at an elevated concentration in monitoring well MW-6; and
- zinc was detected at an elevated concentration in monitoring well MW-6.

The VOC, trichloroethene, was detected in monitoring well MW-9 at an elevated concentration; however, the compound was not detected at significant concentrations in source samples. Therefore, it is not attributable to the landfills. No SVOCs or pesticides/PCBs were detected at elevated concentrations in the five monitoring wells. No TAL metals, SVOCs, or pesticides/PCBs were detected at elevated concentrations in the Y Squalicum community well. The VOC, trichloroethene, was detected at an elevated concentration in the community well; however, the compound was not detected at significant concentrations in source samples. Therefore, it is not attributable to the landfills. In addition, all detections of compounds or analytes in the community well are less than EPA's MCLs for drinking water.

7.2 SURFACE WATER MIGRATION PATHWAY

7.2.1 Pathway Description

The TDL for the surface water pathway is a 15-mile segment that begins at the farthest downgradient probable point of entry (PPE), which is the point at which the overland segment of a hazardous migration path intersects with surface water. Figure 7-2 depicts the surface water pathway TDL for Y-Road Landfill 1, and Figure 7-3 depicts the surface water pathway TDL for Y-Road Landfill 2.

Surface water runoff from Y-Road Landfill 1 flows in a west-southwest direction to the base of the landfill, which is approximately 30 feet in elevation above and 125 feet overland from Carpenter Creek. From the southern base of the landfill, surface water enters Carpenter Creek (the PPE) by overland flow and infiltration, based on the elevation of the landfill above the creek. Carpenter Creek flows approximately 1.06 miles to Lake Whatcom. All of Lake Whatcom is included within the surface water TDL. In addition, Whatcom Creek flows out of Lake Whatcom at the lake's northwestern end, which is located approximately 3.83 miles from the mouth of Carpenter Creek. The surface water pathway continues another 3.96 miles in Whatcom Creek until the creek empties into Bellingham Bay. The surface water TDL extends in radial directions another 6.15 miles into Bellingham Bay.

Surface water runoff from Y-Road Landfill 2 is collected in perimeter ditches that surround the landfill and channeled through a culvert underneath the parking area on the east side of the landfill. The culvert flows into an intermittent drainage ditch along the east side of Y-Road. The drainage ditch flows southerly along Y-Road until it empties into Lake Whatcom, the PPE for Y-Road Landfill 2; however, most of the runoff is assumed to be lost to infiltration before reaching Lake Whatcom. The overland distance from the landfill to the PPE is approximately 1.2 miles, and the intermittent drainage ditch along Y-Road is not considered a segment of the surface water pathway because mean annual precipitation in

the area exceeds 20 inches per year (WRCC 2003). All of Lake Whatcom is included within the surface water TDL. In addition, Whatcom Creek flows out of Lake Whatcom at the lake's northwestern end, which is located approximately 3.83 miles from the mouth of the drainage ditch. The surface water pathway continues another 3.96 miles in Whatcom Creek until the creek empties into Bellingham Bay. The surface water TDL extends in radial directions another 7.21 miles into Bellingham Bay.

For June through September 2002, Carpenter Creek had a flow rate of less than 1 cubic feet per second (cfs). Therefore, START-2 assumes that the annual average flow rate for the creek is less than 10 cfs. Whatcom Creek had an annual average flow rate of 88 cfs over 11 years of record between 1946 and 1968. START-2 estimates an average annual flow in Lake Whatcom of 15 cfs by combining the individual annual average flows for seven identified creeks that empty into Lake Whatcom and subtracting the average annual flow of Whatcom Creek (USGS 2003). The seven creeks are: Carpenter Creek, Olsen Creek, Smith Creek, Anderson Creek, Brannian Creek, Silver Beach Creek, and Austin Creek.

Although both landfills have an earthen cover, there is no maintained engineered cover or maintained storm water management system for the landfills. The two-year, 24-hour probable maximum rainfall for the Bellingham area is 2.5 inches (NOAA 1973). BEK estimated that the drainage area for Y-Road Landfill 1 is 12 acres, and for Y-Road Landfill 2 is 14 acres (BEK 2000). Surface soils at the landfills are classified as Everett Series, which consists of deep and very deep, somewhat excessively drained soils formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till (USDA 1992). START-2 assumes these soils are medium-textured soils with moderate infiltration rates. Based on the flood insurance maps, the landfills are not located in a floodplain (FEMA 1977).

7.2.2 Targets

Lake Whatcom is the drinking water source for the city of Bellingham. The city has a single water intake located in Lake Whatcom near the community of Geneva (Figures 7-2 and 7-3). The intake operates continuously through the year and supplies water to approximately 17,000 hook-ups (Evans 2003). The Whatcom County Water Resources Department estimates that 85,700 people obtain their drinking water through the public supply. In addition, another 250 residences draw their drinking water directly from the lake (Whatcom 2003). START-2 estimates that these 250 domestic intakes serve an additional 627.5 individual (250 intakes multiplied by 2.51, the average number of persons per household for Whatcom County). Therefore, the total count of individuals obtaining their drinking water

from Lake Whatcom is 86,328. In addition, Lake Whatcom is popular for boating, and therefore is considered a major water recreation area.

Sport fishing is also a popular activity in Lake Whatcom. The lake is a productive fishery for small and large mouth bass, kokanee, cutthroat trout, rainbow trout, mackinaw, and perch; however, the Washington Department of Fish and Wildlife (WDFW), the regulatory agency over sport fishing in the state of Washington, does not track harvest data in Lake Whatcom. Whatcom Creek also is fished, and the WDFW tracks the salmon harvest in the creek. During 1999, the most recent year of data, 672 salmon were harvested from Whatcom Creek for an estimated total harvest of 6,108 pounds (WDFW 2002; Wydoski and Whitney 1979). Lastly, Bellingham Bay also is fished for salmon. Bellingham Bay is part of the WDFW's statistical Area 7, which comprises the area of the Strait of Georgia. The 1999 harvest for salmon in statistical Area 7 was 88,560 pounds (WDFW 2002). START-2 estimates that the portion of the surface water TDL that lies within statistical Area 7 is approximately 2%. Therefore, 2% of the salmon harvest (1,773 pounds) from statistical Area 7 is assumed to occur in the surface water TDL. Table 7-4 shows the harvest data by waterbody segment and fish type.

The WDFW maintains a database of habitat and species that tracks sensitive environments. Based on *Habitat and Species Maps*, the following sensitive environments are located within the surface water pathway TDL:

- Carpenter Creek is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Lake Whatcom is a critical migratory pathway for anadromous fish (WDFW 2003b);
- Whatcom Creek is a critical migratory pathway for anadromous fish (WDFW 2003b); and
- Bellingham Bay has portions that are known to be used as habitat by the bald eagle, *Haliaeetus leucoceohalus*, a federal listed threatened species (WDFW 2003c).

It is estimated from National Wetland Inventory maps that 3.50 miles of wetland frontage occur along the 15-mile surface water pathway TDL. Lake Whatcom has 0.33 mile of wetland frontage, Whatcom Creek has 0.06 mile of wetland frontage, and Bellingham Bay has the remaining 3.11 miles of wetland frontage (USFWS 1997a, 1997b, 1997c, 1997d, 1997e, 2001).

7.2.3 Sample Locations

Two sediment samples (CC01SD and CC02SD) were collected from Carpenter Creek, excluding the background sample, and one sediment sample each was collected from Smith Creek (SC01SD) and Austin Creek (AC01SD), two creeks with similar characteristics to Carpenter Creek in the Lake Whatcom watershed. Figure 3-2 shows these sample locations.

The sediment samples in Carpenter Creek were collected from locations downstream from, and adjacent to, Y-Road Landfill 1 (Figure 3-1). The sediment samples from Smith Creek and Austin Creek were collected for comparison to analytical results from Carpenter Creek, in addition to and separate from the background sediment sample from Carpenter Creek.

7.2.4 Sediment Sample Results

Sample results are summarized in Table 7-5. No TAL metals, VOCs, SVOCs, or pesticides/PCBs were detected at elevated concentrations with respect to background concentrations in the two samples from Carpenter Creek. Analytical results for samples from Austin Creek and Smith Creek were comparable with results of the background sample and Carpenter Creek samples.

7.3 SOIL EXPOSURE PATHWAY

The soil exposure pathway is evaluated based on the threat to resident and nearby populations from soil contamination within the initial 2 feet bgs, for which START-2 is assuming that contamination is present. No residence, school, daycare center, or workplace is located on the two properties. No terrestrial sensitive environments are located on a potential source area (WDFW 2003a). Y-Road Landfill 1 is not fenced, but START-2 expects that the property has no public recreation use given that it is forested. Y-Road Landfill 2 is fenced with no use by the public. START-2 assumes that the approximate surface area of the landfill source area for Y-Road Landfill 1 is 2 acres (87,120 square feet), and the approximate surface area of the landfill source area for Y-Road Landfill 2 is 6 acres (261,360 square feet). The nearest residence is located approximately 50 feet west of Y-Road Landfill 2 (BEK 2002). An estimated 393 people live within a 1-mile travel distance of the landfills (UM 2003).

7.4 AIR MIGRATION PATHWAY

The air migration pathway TDL is a 4-mile radius that extends from the sources at the site (Figure 7-1). The landfills have an earthen cover, but there is no report indicating that the landfills were closed to any specification. Therefore, there is a possibility of biogas releases from the landfill. The nearest

individual is located approximately 50 feet west of the Y-Road Landfill 2. There are 18,370 residents within a 4-mile radius of the site (UM 2003; BEK 2002). Commercial silviculture by Georgia Pacific Corporation occurs within 0.5 mile to the east. Based on WDFW *Habitat and Species Maps*, the following sensitive environments are located within the air migration pathway TDL:

- Carpenter Creek, within 0.25 mile of the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Olsen Creek, between 0.25 and 0.5 mile from the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Lake Whatcom, between 0.5 and 1 mile from the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Anderson Creek, between 1 and 2 miles from the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Smith Creek, between 2 and 3 miles from the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- Squalicum Creek, between 2 and 3 miles from the site, is a critical migratory pathway for anadromous fish (WDFW 2003a);
- An unnamed creek, between 2 and 3 miles from the site, that drains to Lake Whatcom is a critical migratory pathway for anadromous fish (WDFW 2003b);
- Three critical habitat areas for the bald eagle, *H. leucoceohalus*, a federal listed threatened species, occur between 3 and 4 miles from the site (WDFW 2003b, 2003d);
- Lake Whatcom, between 3 and 4 miles from the site, contains habitat known to be used by the bald eagle, *H. leucoceohalus*, a federal listed threatened species (WDFW 2003d); and
- Three unnamed creeks, between 3 and 4 miles from the site, that drain to Lake Whatcom are critical migratory pathways for anadromous fish (WDFW 2003b, 2003d).

In addition, there are 243.28 acres of designated wetlands within 4 miles of the site (USFWS 1997a, 1997b, 1997c, 1997d, 1997e, 2001). Wetland acreage and population within 4 miles of the site are presented in Table 7-6.

Table 7-1

DOMESTIC WATER WELL SAMPLING SUMMARY
Y-ROAD LANDFILLS PRELIMINARY ASSESSMENT
WHATCOM COUNTY, WASHINGTON

Well	Muna Well	Dooley Well	
Well Depth	160 feet	35 feet	EPA Maximum
Analyte			Contaminant Level
Total Metals (µg/L)			
Arsenic	**0.9**	0.2 U	10
Barium	**14**	**10**	2000
Copper	**33**	**6**	1300
Iron	**210**	50 U	---
Lead	**1**	1 U	15
Manganese	**5**	1 U	---
Tin	**20**	10 U	---
Zinc	**447**	**133**	---
Semivolatile Organic Compounds (µg/L)			
Dimethylphthalate	**0.013**	0.010 U	---

Source: BEK 2002.

Notes: Bold type indicates sample concentrations above detection limits.
MCLs obtained from EPA, Office of Water, Fact Sheet, July 2002 (EPA 816-F-02-013).
Internet address: http://www.epa.gov/safewater/mcl.html#mcls.

Key:

--- = No standard promulgated.
µg/L = Micrograms per liter.
U = The analyte was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

Table 7-2

GROUNDWATER DRINKING WATER POPULATION WITHIN A 4-MILE RADIUS
Y-ROAD LANDFILLS SITE INSPECTION
WHATCOM COUNTY, WASHINGTON

Distance (Miles)	Wells	Population*
Shallow Aquifer		
0 to 0.25	1 (Domestic)	2.51
0.25 to 0.5	2 (Domestic)	5.02
0.5 to 1	14 (Domestic)	35.14
1 to 2	28 (Domestic)	70.28
2 to 3	13 (Domestic)	32.63
3 to 4	0 (Domestic)	0
Total	**58 (Domestic)**	**145.58**
Squalicum Lake Valley Aquifer		
0 to 0.25	12 (Domestic)	30.12
0.25 to 0.5	20 (Domestic)	50.2
0.5 to 1	57 (Domestic) 2 (Public)	143.07 180.72
1 to 2	85 (Domestic)	213.35
2 to 3	59 (Domestic)	148.09
3 to 4	13 (Domestic)	32.63
Total	**246 (Domestic)** **1 (Public)**	**719.18**
Total	**304 (Domestic)** **1 (Public)**	**864.76**

Sources: Watson 2004; Ecology 2003; BEK 2002.

* Domestic well population was estimated based on the average number of persons per household for Whatcom County of 2.51 people (USDC 2001).

Table 7-3

GROUNDWATER SAMPLES ANALYTICAL RESULTS SUMMARY
Y-ROAD LANDFILLS SITE INSPECTION
BELLINGHAM, WASHINGTON

CLP Number	(M)J4502	(M)J4503	(M)J4504	(M)J4505	(M)J4509	(M)J4510	(M)J4518	
EPA Sample Number	04224061	04224062	04224063	04224064	04224068	04224069	04224077	
Sample Location	BG02GW	MW01GW	MW02GW	MW03GW	MW04GW	MW05GW	CW01GW	
Well	MW01	MW-4	MW-6	MW-7	MW-9	MW-8	Y Squalicum Community Well	EPA MCL
Description	Background	Target - Groundwater						
Metals (ug/L)								
Aluminum	**60700**	**80800**	**236000**	**61300**	**52600**	**61400**	52.7 U	---
Arsenic	**12.2**	**35**	**300**	**15.2**	**11.9**	**16.6**	10 U	10
Barium	**451**	**988**	**2040**	**484**	**538**	**652**	22.2 J	2000
Beryllium	2.6 J SQL=5.0	5.0 J	**11.1**	3.5 J	2.7 J	4.1 J	5.0 U	4
Cadmium	0.77 U	2.1 J	**10.1**	1.7 J	1.4 J	2.0 J	5.0 U	5
Calcium	**11600**	**62600**	**68400**	**42800**	**47700**	**52200**	**21000**	---
Chromium	**68.8**	**173**	**989**	**123**	**100**	**117**	10 U	100
Cobalt	22.9 J SQL=50	**73.5**	**527**	46.7 J	**52.7**	48.5 J	50 U	---
Copper	**92.7**	**295**	**1110**	**126**	**126**	**144**	2.6 J	1300
Iron	**46500**	**110000**	**516000**	**83600**	**65200**	**91000**	71.3 U	---
Lead	**13.1**	**28.6**	**142**	**90.4**	**22.1**	**40.0**	10 U	15
Magnesium	**13000**	**34700**	**117000**	**36600**	**26500**	**40200**	**10700**	---
Manganese	**826**	**7330**	**18100**	**3920**	**2290**	**4310**	**246**	---
Mercury	**0.32**	**0.67**	**3.4**	0.33 U	0.42 U	0.37 U	0.11 U	2
Nickel	**101**	**409**	**2440**	**175**	**190**	**174**	40 U	---
Potassium	3520 J	**10600**	**12700**	**5490**	**5540**	**6620**	1350 J	---
Sodium	**6370**	**9080**	**7920**	**11300**	**8300**	**15600**	**6100**	---
Vanadium	**96.3**	**208**	**889**	**153**	**118**	**163**	50.0 U	---
Zinc	**108**	**321**	**1230**	**248**	**203**	**256**	60.0 U	---
VOCs (ug/L)								
Chloromethane	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	0.50 U	**0.82**	---
Trichloroethene	0.50 U	0.50 U	0.50 U	0.50 U	**0.67**	0.50 U	0.50 U	5

Note: Bold type indicates sample concentrations above detection limits.
Underlined type indicates sample result is elevated as defined in Section 5 and attributable to sources.
MCLs obtained from EPA, Office of Water, Fact Sheet, July 2002 (EPA 816-F-02-013). Internet address: http://www.epa.gov/safewater/mcl.html#mcls.

Key:

--- = No standard promulgated.
CLP = Contract Laboratory Program.
EPA = United States Environmental Protection Agency.
J = The analyte was positively identified. The associated numerical value is an estimate because the concentration is below the Contract Required Quantitation Limit.
ug/L = Micrograms per liter.
MCL = Maximum Contaminant Level.
SQL = Sample quantitation limit.
U = The analyte was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

Table 7-4

FISH HARVEST WITHIN THE 15-MILE TARGET DISTANCE LIMIT
Y-ROAD LANDFILLS SITE INSPECTION
WHATCOM COUNTY, WASHINGTON

Stream Segment	Fish Species	Number Harvested	Average Pound per Fish *	Pounds Harvested
Lake Whatcom	Small Mouth Bass	At least 1	At least 1	At least 1
	Large Mouth Bass	At least 1	At least 1	At least 1
	Kokanee	At least 1	At least 1	At least 1
	Cutthroat Trout	At least 1	At least 1	At least 1
	Rainbow Trout	At least 1	At least 1	At least 1
	Mackinaw	At least 1	At least 1	At least 1
	Perch	At least 1	At least 1	At least 1
Whatcom Creek	Chinook Salmon	6	22	132
	Chum Salmon	660	9	5,940
	Coho Salmon	3	8	24
	Pink Salmon	3	4	12
Bellingham Bay	Chinook Salmon	61	22	1,342
	Chum Salmon	2	9	18
	Coho Salmon	50	8	400
	Pink Salmon	2	4	8
	Sockeye Salmon	1	5	5
	Total	**At least 795**		**At least 7,888**

Source: WDFW 2002.

* Average pound per fish gathered from Wydoski and Whitney 1979.

Table 7-5

SEDIMENT SAMPLES ANALYTICAL RESULTS SUMMARY
Y-ROAD LANDFILLS SITE INSPECTION
BELLINGHAM, WASHINGTON

CLP Number	(M)J4515	(M)J4511	(M)J4512	(M)J44Z5	(M)J44Z9
EPA Sample Number	04224074	04224070	04224071	04224054	04224058
Sample Location	BG03SD	CC01SD	CC02SD	AC01SD	SC01SD
Water Body	Carpenter Creek	Carpenter Creek	Carpenter Creek	Austin Creek	Smith Creek
Description	Background	Target - Sediment		Watershed Comparison	
Metals (mg/kg)					
Aluminum	**11400**	**10400**	**8460**	**12200**	**10600**
Arsenic	**2.9**	**2.3**	**2.6**	**3.3**	**2.0**
Barium	**85.7**	**65.1**	**35.3**	**68.2**	**47.9**
Beryllium	**0.66**	**0.69**	**0.57**	0.61 U	**0.66**
Calcium	**3140**	**2520**	**2580**	**3130**	**3440**
Chromium	**29.3**	**25.4**	**18.5**	**27.1**	**26.0**
Cobalt	**9.9 JL**	**8.3 JL**	**7.8 JL**	**8.3 JL**	**7.8 JL**
Copper	**12.2**	**9.5**	**8.7**	**11.1**	**10.4**
Iron	**16100**	**15300**	**14000**	**14300**	**14700**
Lead	**5.2**	**5.4**	**3.9**	**2.6**	**3.3**
Magnesium	**4710**	**4510**	**4260**	**5740**	**8130**
Manganese	**429**	**293**	**310**	**246**	**238**
Nickel	**40.0**	**34.3**	**26.4**	**31.1**	**59.7**
Potassium	442 J	471 J	298 J	**910**	564 J
Vanadium	**29.2**	**27.8**	**26.4**	**26.5**	**25.3**
Zinc	**42.4**	**37**	**27.5**	**31.1**	**29.1**

Note: Bold type indicates sample concentrations above detection limits.

Key:

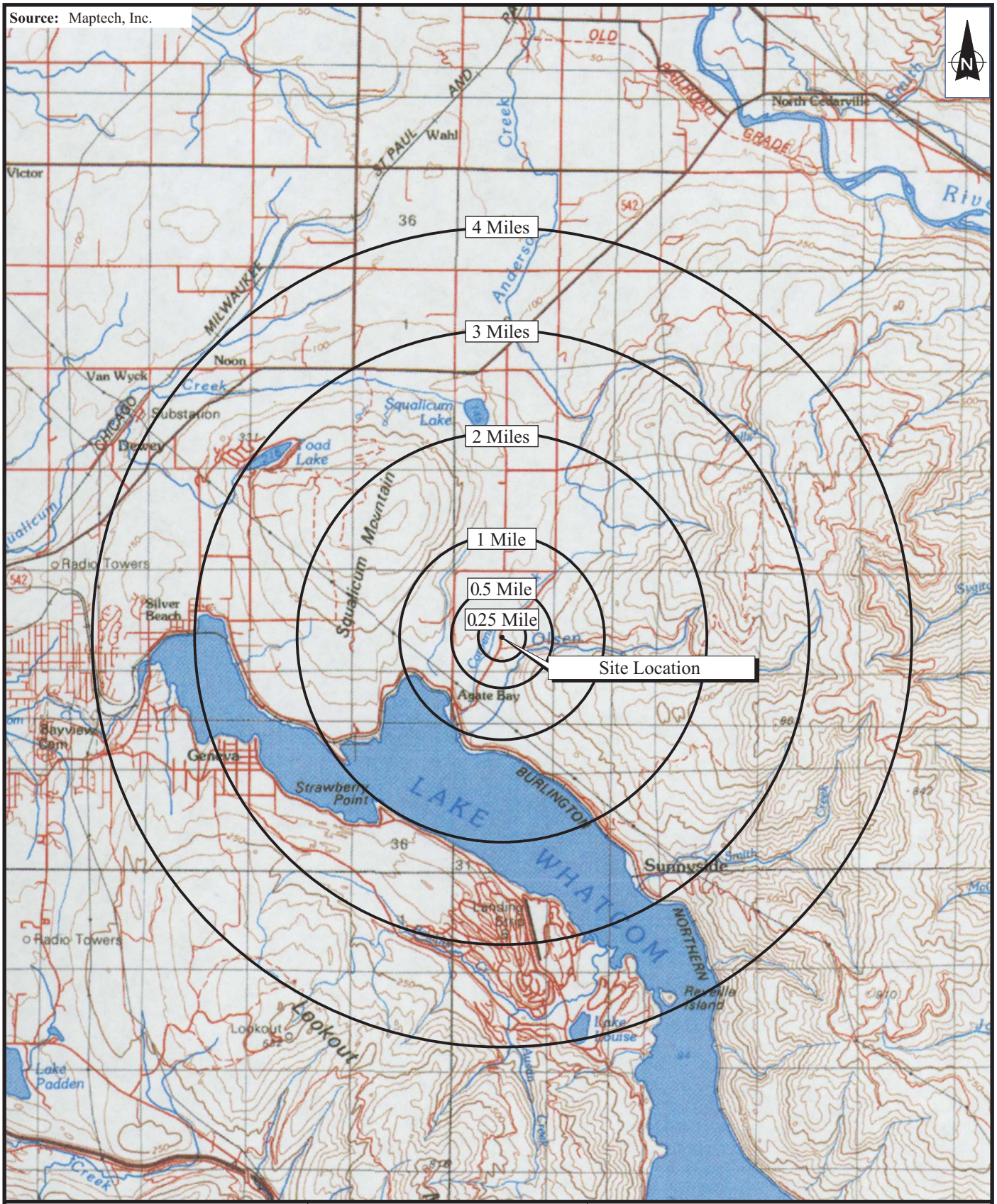
CLP = Contract Laboratory Program.
EPA = United States Environmental Protection Agency.
J = The analyte was positively identified. The associated numerical value is an estimate because the concentration is below the Contract Required Quantitation Limit.
L = Low bias.
mg/kg = Milligrams per kilogram.
U = The analyte was analyzed for, but was not detected. The associated numerical value is the sample quantitation limit.

Table 7-6

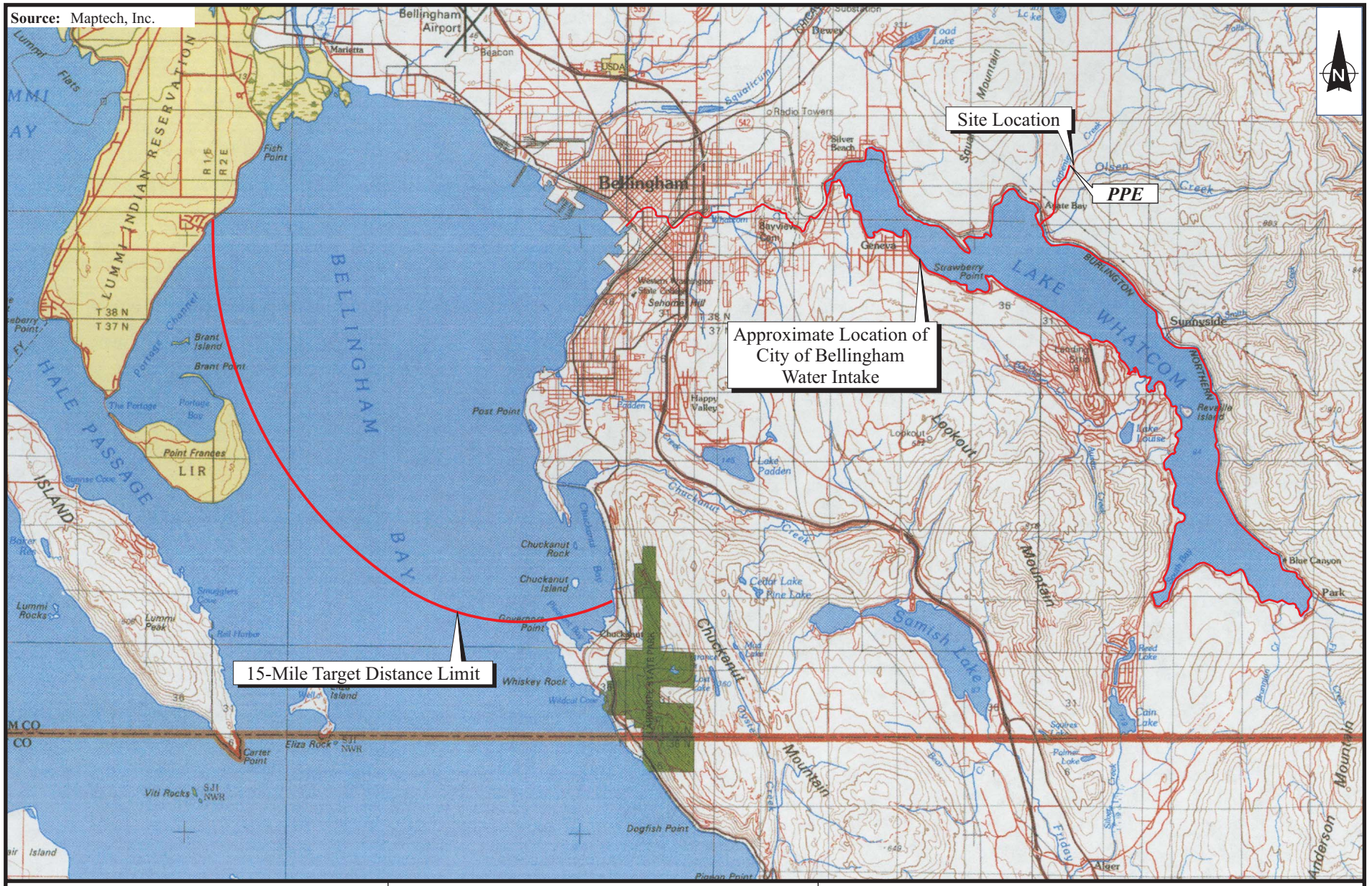
POPULATION AND WETLANDS ACREAGE WITHIN A 4-MILE RADIUS
Y-ROAD LANDFILLS SITE INSPECTION
WHATCOM COUNTY, WASHINGTON

Distance Ring (Miles)	Population	Wetlands (Acreage)
On site	0	0
0 to 0.25	33	0
0.25 to 0.5	55	0.317
0.5 to 1	305	15.135
1 to 2	708	23.725
2 to 3	4,078	135.045
3 to 4	13,191	69.058
Total	**18,370**	**243.28**

Sources: BEK 2002, USFWS 1997a, 1997b, 1997c, 1997d, 1997e, 2001, UM 2003.



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	Y-ROAD LANDFILLS SI Whatcom County, Washington	Figure 7-1 4-MILE MAP		
	0 1 2 Approximate Scale in Miles	Date: 8-16-04	Drawn by: AES	10:START-2\04020011\fig 7-1



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

Y-ROAD LANDFILLS SI
Whatcom County, Washington

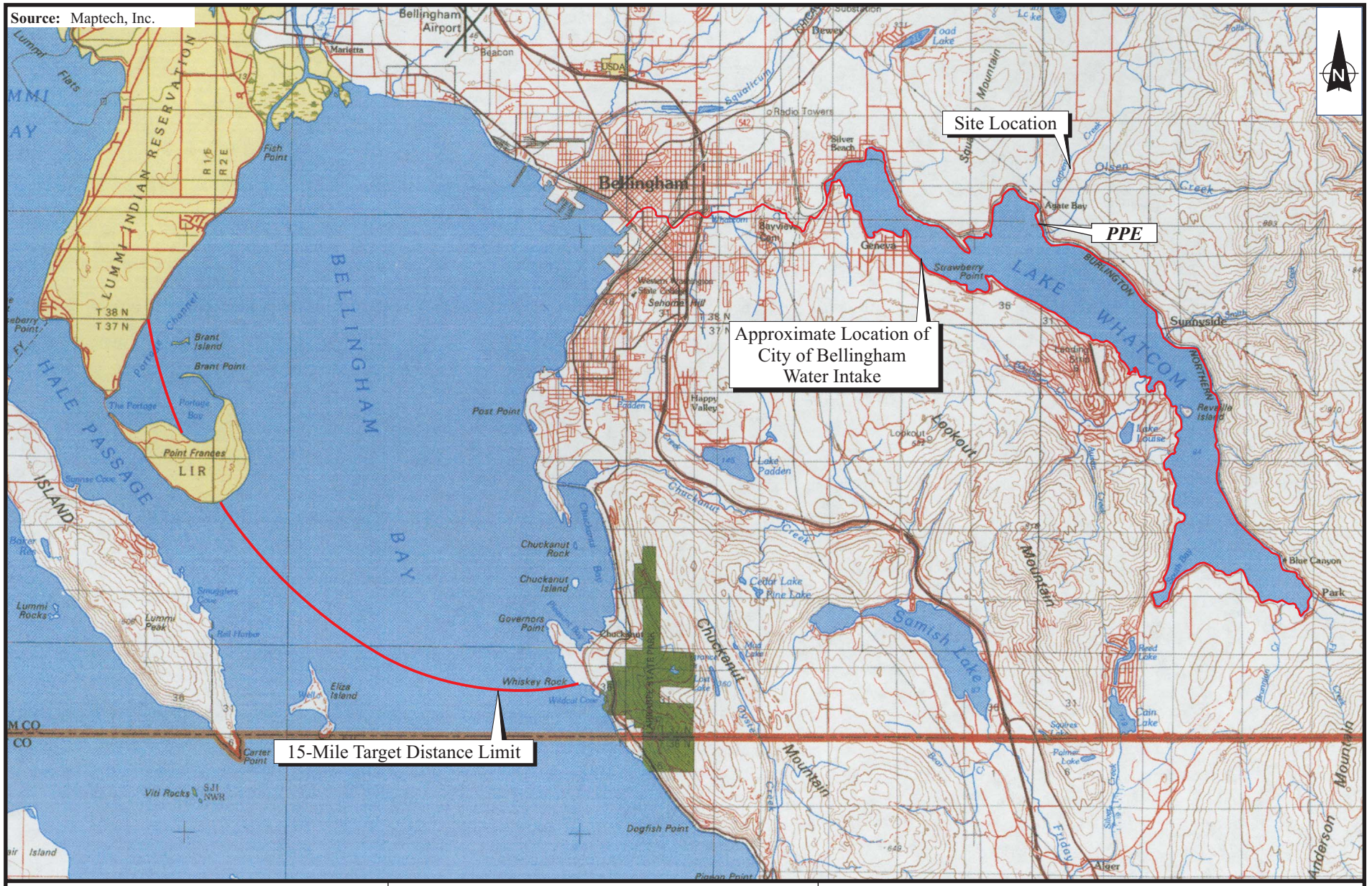
Figure 7-2
15-MILE MAP
FOR Y-ROAD LANDFILL 1

0 1 2
Approximate Scale in Miles

Date: 8/16/04

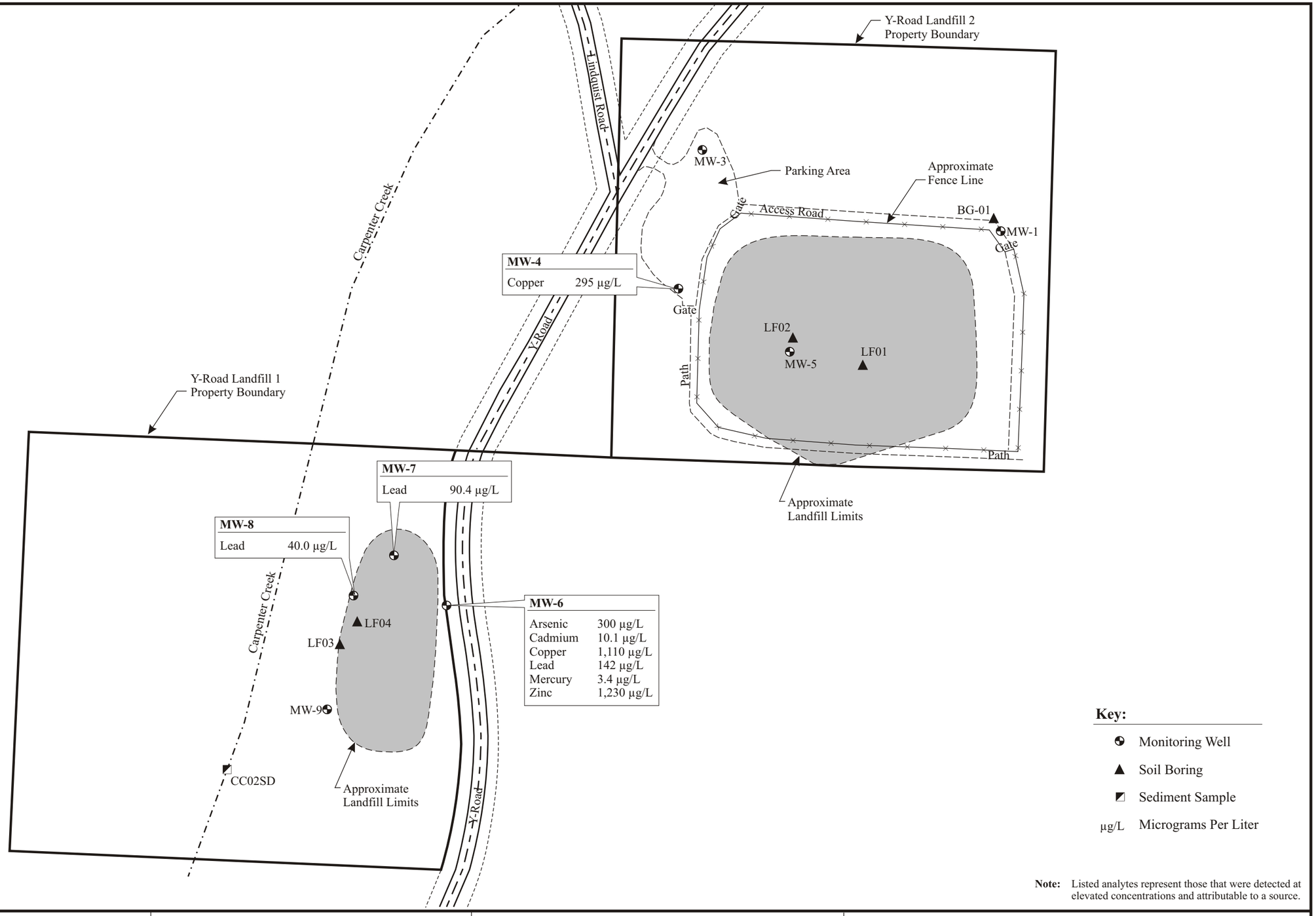
Drawn by: AES

10:START-2\04020011\fig 7-2



ecology and environment, inc. International Specialists in the Environment Seattle, Washington	Y-ROAD LANDFILLS SI Whatcom County, Washington	Figure 7-3 15-MILE MAP FOR Y-ROAD LANDFILL 2		
	0 1 2 Approximate Scale in Miles	Date: 8/16/04	Drawn by: AES	10:START-2\04020011\fig 7-3

Source: BEK 2003.



Key:

- Monitoring Well
- Soil Boring
- Sediment Sample
- µg/L Micrograms Per Liter

Note: Listed analytes represent those that were detected at elevated concentrations and attributable to a source.

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International Specialists in the Environment
Seattle, Washington

0 100 200
Approximate Scale in Feet

Y-ROAD LANDFILLS SI
Whatcom County, Washington

Figure 7-4
ELEVATED CONCENTRATIONS IN MONITORING WELL SAMPLES

Date:	Drawn by:	
8/20/04	AES	10:START-2\04020011\fig 7-4

8. SUMMARY AND CONCLUSIONS

In May 2004, START-2 conducted SI sampling activities at the Y-Road Landfills site located east of Bellingham, Washington. The Y-Road Landfills are two former landfills (Y-Road Landfill 1 and Y-Road Landfill 2) that were operated by Whatcom County. The landfills are located on the east and west sides of Y-Road, south of the intersection of Y-Road and Lindquist Road, in Whatcom County, Washington.

The SI involved the collection of samples from potential hazardous substance sources on site and from target areas potentially impacted through contaminant migration. A total of 27 samples were collected for the SI, including background and QA samples. Subsurface soil samples were collected from the landfills, as well as groundwater and sediments in target areas. Additionally, one community well sample was collected to be compared to EPA drinking water standards. Samples were analyzed by CLP laboratories.

8.1 SOURCES

Subsurface soil samples were collected from two borings in each landfill. For Y-Road Landfill 1, one TAL metal (lead) and three pesticides (4,4'-DDT, alpha-chlordane, gamma-chlordane) were detected at significant concentrations. These detections occurred in boring LF04 from the sample interval from 7 to 10 feet bgs. For Y-Road Landfill 2, six TAL metals, 11 VOCs, five SVOCs, and nine pesticides/PCBs were detected at significant concentrations. Nearly all of these significant detections occurred in the first two sample intervals (6 to 10 feet bgs and 16 to 20 feet bgs), while the third interval (26 to 30 feet bgs) had only a single significant concentration of acetone in LF01. Of particular note, lead and Aroclor-1248 were detected at 6,990 mg/kg and 2,400 mg/kg, respectively, in LF02 at 18 to 20 feet bgs, which contained visible paper residue during sample activities. These values exceed EPA Region Preliminary Remediation Goals (PRGs) for residential and industrial soil.

8.2 TARGETS

Five groundwater samples were collected from monitoring wells on or adjacent to the landfills, and one groundwater sample was collected from a community well located 2/3-mile north of the landfills.

The community well had no compounds or analytes detected at elevated concentrations that are attributable to the landfills, and no compounds or analytes detected above MCLs. Six TAL metals (arsenic, cadmium, copper, lead, mercury, and zinc) were detected at elevated concentrations in the monitoring wells, and also were detected at significant concentrations in the source samples. All six metals were detected at elevated concentrations in monitoring well MW-6; monitoring wells MW-4, MW-7, and MW-8 each had a single analyte detected at elevated concentrations; and monitoring well MW-9 had no analytes detected at elevated concentrations. The nearest well that presumably is drawing water from the same shallow aquifer as the monitoring wells is located approximately 1,200 feet south of Y-Road Landfill 1 and approximately 1,800 feet southwest of Y-Road Landfill 2. This well was not sampled by START-2 because a previous investigation by BEK in October 2001 indicated no concentrations of concern in this well. Results for TAL metals from that sample event were equivalent or less than background results for groundwater from this SI and also less than EPA MCLs for drinking water.

Two sediment samples were collected from Carpenter Creek below the PPE for the surface water pathway. No TAL metals, VOCs, SVOCs, or pesticides/PCBs were detected at elevated concentrations in these samples.

8.3 CONCLUSIONS

Results of the Y-Road Landfills SI indicate that the two landfills are sources of hazardous substance contamination, but that Y-Road Landfill 2 appears to have more abundant and greater concentrations of contaminants. The data indicate that contaminants from the landfills are leaching to the shallow, perched aquifers beneath the landfills, but the contaminants do not appear to be reaching Carpenter Creek, the localized hydrological low near the landfills.

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APPENDIX B
PHOTOGRAPHIC DOCUMENTATION

PHOTOGRAPH IDENTIFICATION SHEET

Camera Serial #: Kodak FunSaver 35 mm **TDD #: 04-02-0011**
Lens Type: 35 mm **Site Name: Y-Road Landfills SI**

Photo No.	Date	Time	By	Direction	Description
1-1	5/24/04	1313	SG	NW	Drilling location for LF01.
1-2	5/24/04	1322	SG	NA	Sample LF01SS10.
1-3	5/24/04	1344	SG	NA	Sample LF01SS20.
1-4	5/24/04	1404	SG	NA	Sample LF01SS30.
1-5	5/24/04	1458	SG	SW	Drilling location for LF02.
1-6	5/24/04	1458	SG	NW	Drilling location for LF02 with parking area for trail in background.
1-7	5/24/04	1505	SG	NA	Sample LF02SS10.
1-8	5/24/04	1540	SG	NA	Sample LF02SS20.
1-9	5/24/04	1615	SG	NA	Sample LF02SS30.
1-10	5/25/04	0838	SG	NE	Drilling location for BG01.
1-11	5/25/04	0910	SG	NA	Sample BG01SS10.
1-12	5/25/04	1015	SG	NA	Sample BG01SS20.
1-13	5/25/04	1040	SG	NA	Sample BG01SS30.
1-14	5/25/04	1409	SG	NE	Drilling location for LF03.
1-15	5/25/04	1420	SG	NA	Sample LF0SS10.
1-16	5/25/04	1520	SG	NA	Sample LF03SS20.
1-17	5/25/04	1550	SG	NE	Drilling location for LF04.
1-18	5/25/04	1605	SG	NA	Sample LF04SS10.
1-19	5/25/04	1645	SG	NA	Sample LF04SS20.
2-1	5/24/04	1456	BM	NW	Sample AC01SD.
2-2	5/24/04	1547	BM	E	Sample SC01SD.
2-3	5/25/04	0955	KS	S	Bailing MW-7.
2-4	5/25/04	1130	KS	E	Bailing MW-8.
2-5	5/25/04	1337	BM	E	Sample CC01SD.
2-6	5/25/04	1406	BM	S	Sample CC02SD.
2-7	5/25/04	1446	BM	NW	Sample BG03SD.

Key:

BM = Ben Martich.
E = East.
KS = Kerrie Stewart.
N = North.
NA = Not applicable.
S = South.
SG = Susan Gardner.
TDD = Technical Direction Document.
W = West.


1-1


Y-Road Landfill
0357 01SI
05/24/04 13:22
LF015510
1-2


Y-Road Landfill
0357 01SI
05/24/04 13:44
LF015520
1-3


1-4

1-5

1-6


Y-Road Landfill
D357 OISI
05/24/04 14:04
LF025510

1-7


Y-Road Landfill
D357 OISI
05/24/04 15:40

1-8

1-9


1-10

1-11

1-12


Y-Road Landfill
0357 0151
05/2 /04 10:32
BG0155 30
1-13


1-14


Y-Road Landfill
0357 0151
05/2 /04 4:20
1-15


Y-Road Landfill
0357 0151
05/2 /04 15:2
1-16

1-17

1-18

1-19

2-1


Y-Road Landfills
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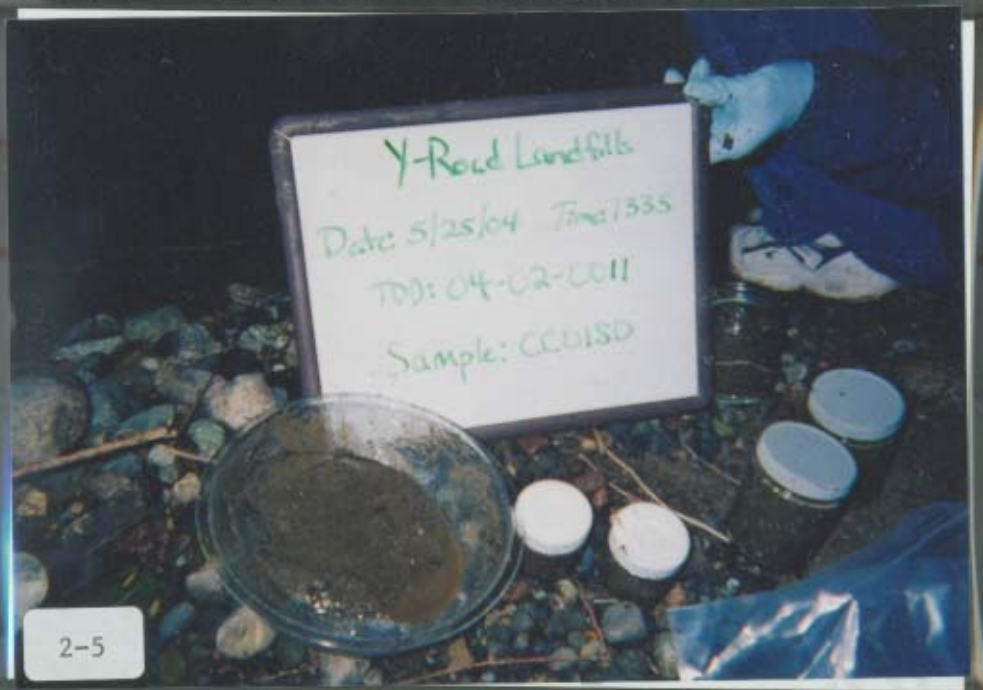
TDD: 04-02-0011
Sample: SC01SD
2-2


2-3


2-4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2-5


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TOD: 04-02-0011
Sample: CC0250
2-6


Y-Road Landfills
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TOD: 04-02-0011
Sample: 3C455D
2-7