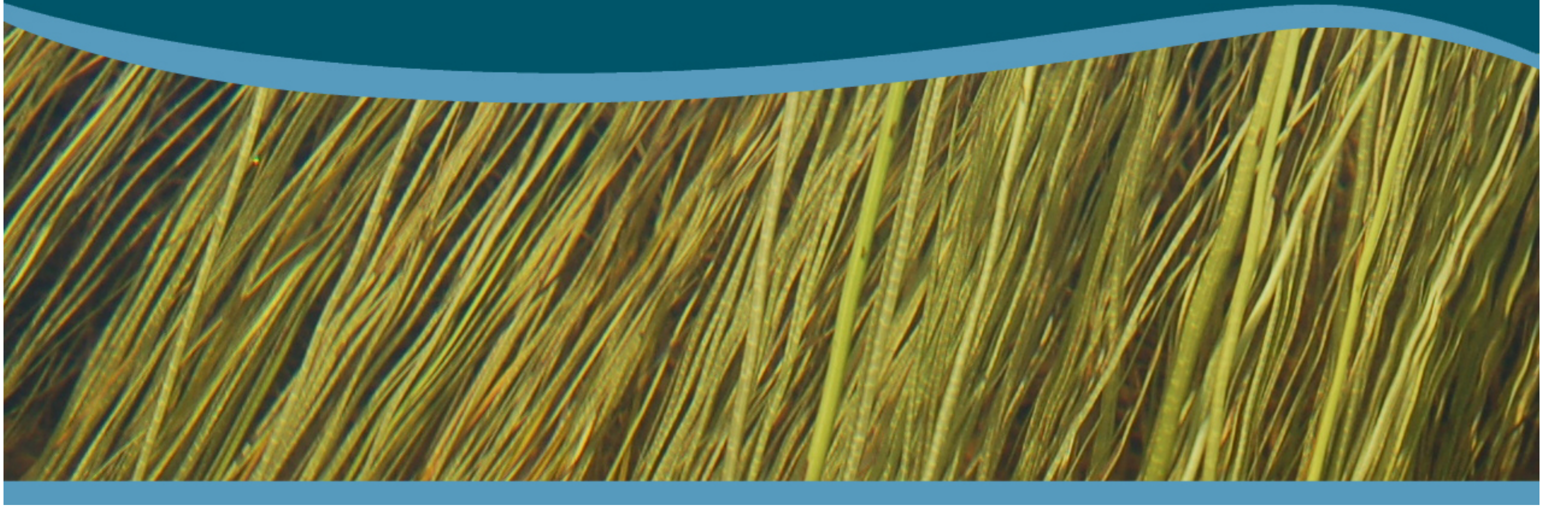
REPORT



DRAFT FINAL FOCUSED FEASIBILITY STUDY
PASCO LANDFILL NATIONAL PRIORITIES LIST SITE

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LIST OF ACRONYMS AND ABBREVIATIONS

1,1-DCE	1,1-dichloroethylene
1,2-DCA	1,2-dichloroethane
2,4-D	2,4-dichlorophenoxyacetic acid
µg/L	micrograms per liter
AIA	Additional Interim Action
AO	Agreed Order No. DE-09240
AOC	Area of Contamination
AQP	Air Quality Program
ARAR	Applicable or Relevant and Appropriate Requirement
ASIL	ambient source impact level
BCS	Bayer CropScience
BFDHD	Benton-Franklin District Health Department
bgs	below ground surface
CAP	Cleanup Action Plan
CD	Consent Decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm/s	centimeters per second
CMP	Compliance Monitoring Plan
COC	chemical of concern
CSM	Conceptual Site Model
CUL	cleanup level
CY	cubic yard
DCA	Disproportionate Cost Analysis
dCUL	draft cleanup level
E&E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology

Ecology Orders	Agreed Order DE-00TCPER-1324, Agreed Order DE-00TCPER-1326, Enforcement Order DE-00TCPER-1325, and Enforcement Order DE-00TCPER-1327, collectively
EDR	Engineering Design Report
EPA	U.S. Environmental Protection Agency
FCPD	Franklin County Planning Department
FFS	Focused Feasibility Study
FFS Work Plan	*Focused Feasibility Study Work Plan*
FR	Federal Register
FS	feasibility study
FS Report	*Final Draft Feasibility Study Report*
GCCS	gas collection and control system
GCE	Gulf Coast Environmental Systems
GCL	geosynthetic clay liner
GPA	Ground Water Protection Area
gpm	gallons per minute
HCl	hydrochloric acid
HDPE	high-density polyethylene
HOC	halogenated organic compound
HOV	higher operating value
IA	Interim Action
IC	institutional control
ICP	Institutional Controls Program
IRM	Interim Remedial Measure
IWA	Industrial Waste Area
IWA/GW Agreed Order	Agreed Order DE-00TCPER-1324
IWAG	Industrial Waste Area Generator Group III
Landfill Agreed Order	Agreed Order DE-00TCPER-1326
LFG	Landfill Group
MCPA	2-methyl-4-chlorophenoxyacetic
MCPP	methylchlorophenoxypropionic acid
mg/kg	milligrams per kilogram

mg/kg/day	milligrams per kilograms per day
MNA	monitored natural attenuation
msl	mean sea level
MSW	municipal solid waste
MSW Landfill	Municipal Solid Waste Landfill
MTCA	Model Toxics Control Act
MTR	minimum technology requirement
NAPL	nonaqueous phase liquid
NAVD 88	North American Vertical Datum of 1988
NCP	National Contingency Plan
NPL	National Priorities List
NPL Site	Pasco Sanitary Landfill National Priorities List Site
NSPS	New Source Performance Standard
NWI	New Waste, Inc.
O&M	operations and maintenance
ORP	oxidation reduction potential
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	perchloroethylene
pg/g	picograms per gram
Phase I RI Report	*Final Draft Phase I Remedial Investigation, Pasco Landfill*
Phase II RI Report	*Final Phase II Remedial Investigation Report, Pasco Landfill*
PLP	potentially liable person
POC	point of compliance
PSLI	Pasco Sanitary Landfill, Inc.
PSL Property	Pasco Sanitary Landfill Property
PSLI Property	Pasco Sanitary Landfill, Inc. Property
QA	quality assurance
QC	quality control
RAA	remedial action alternative
RAO	remedial action objective
RAWP	*Final Interim Remedial Action Work Plan for the Pasco Zone B RCRA-compliant Cap*

RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROI	radius of influence
RRC	Resource Recovery Corporation
RTO	regenerative thermal oxidizer
SCB	soil-cement-bentonite
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TCE	trichloroethylene
TEP	*Final Technical Execution Plan for the Balefill Area Extinguishment and Supplemental Protection Barrier Project*
TEQ	Toxic Equivalents Quotient
TO	thermal oxidizer
UIC	Underground Injection Control
VOC	volatile organic compound
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

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INTRODUCTION

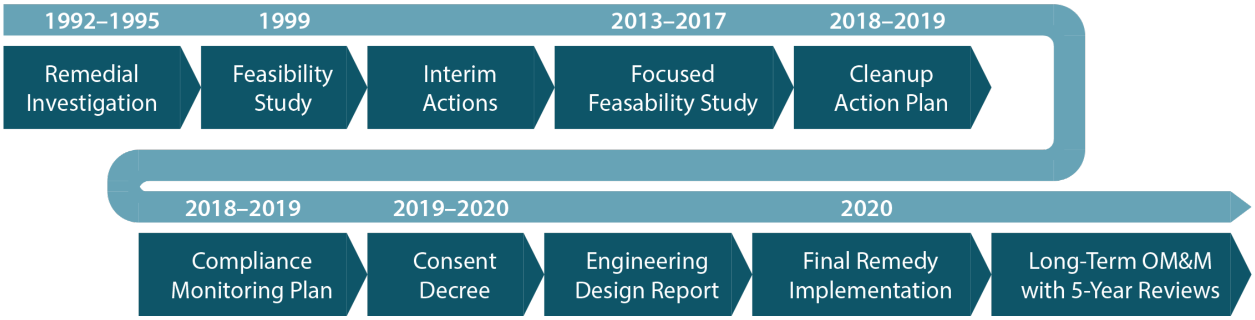
The Focused Feasibility Study (FFS) for the Pasco Sanitary Landfill National Priorities List (NPL) Site (NPL Site) has been prepared by members of the Industrial Waste Area Generators Group III (IWAG) and Bayer CropScience (BCS), designated as Potentially Liable Parties (PLPs) pursuant to Agreed Order No. DE-09240 (AO) issued by the Washington State Department of Ecology (Ecology). This FFS includes information provided by members of the Landfill Group (LFG). Members of the LFG are also designated as PLPs. The NPL Site was formally added to the United States Environmental Protection Agency NPL on February 1990, but Ecology is the lead agency managing the NPL Site. The FFS develops and evaluates cleanup action alternatives for the purpose of selecting a final cleanup action for the NPL Site in accordance with Washington State Model Toxics Control Act (MTCA) and the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines and criteria.

Why is this an FFS?

This FFS is focused because:

- It builds upon the Feasibility Study (FS) conducted in 1999.
- It utilizes information developed during implementation of Interim Actions (IAs) over more than 15 years.
- The nature and extent of environmental impacts at the Site are similar to those presented in the original FS.
- The remedial action objectives (RAOs) are consistent with those identified in the original FS.
- The applicable MTCA cleanup standards have changed, so a focused re-evaluation of remedial alternatives is appropriate.

MTCA CLEANUP PROCESS FOR THE NPL SITE



Remedial Investigation and Feasibility Study

The MTCA cleanup process began with the Remedial Investigation (RI) conducted in two phases between 1992 and 1997 to characterize the environmental conditions at the NPL Site. In 1996 and 1997, several Interim Remedial Measures were implemented to further reduce potential risks to human health and the environment. The PLPs submitted an ecological assessment, a risk assessment/cleanup level (CUL) analysis, and a Final Draft Feasibility Study (FS) Report, in 1997, 1998, and 1999, respectively, which described remedial alternatives to reduce potential risk and identified a preferred remedy. Ecology approved the preferred remedy described in the 1999 Final Draft FS Report (FS Report) as an interim remedy.

Interim Actions

As required by a set of Ecology orders issued in 2000, the PLPs implemented the Interim Actions (IAs) and conducted ongoing operation, maintenance, and monitoring activities. In May 2007, Ecology required additional technical evaluation and actions to enhance performance of the IAs. The PLPs implemented these additional IAs in 2009 and 2011.

Focused Feasibility Study

In October 2012, Ecology issued new orders to the PLPs with a scope of work that included preparation of the FFS and operation, maintenance, and monitoring of the existing interim cleanup systems until a decision is reached regarding a final cleanup remedy for the NPL Site.

2002 Interim Actions

1. Construction of engineered landfill caps at the Municipal Solid Waste Landfill (MSW Landfill) and Zones A, C/D, and E
2. Expansion of the soil vapor extraction (SVE) and NoVOCs™ systems at Zone A
3. Excavation, removal, and off-site treatment and disposal of contaminated soil and drum contents at Zone B
4. Installation of a landfill gas collection system and flare at the MSW Landfill
5. Implementation of institutional controls (ICs) on the Pasco Sanitary Landfill Property (PSL Property) and within the off-property Ground Water Protection Area

2009 to 2011 Additional Interim Actions

1. Installation of additional ground water monitoring wells to better characterize the vertical and spatial extent of the contaminant plume and ground water flow
2. SVE system rehabilitation, testing, and optimization
3. Evaluation of the NoVOCs™ system
4. Geophysical survey of the Zone A area
5. Development of an updated Conceptual Site Model

This FFS develops and evaluates remedial alternatives for each area of the NPL Site and identifies a preferred remedy based on the MTCA requirements and criteria. All FFS remedial alternatives, except the No Action Alternative, meet MTCA minimum requirements specified in the Washington Administrative Code (WAC).

MTCA Minimum Requirements for Alternative Evaluation

Threshold Requirements	• Protect human health and the environment • Comply with cleanup standards • Comply with applicable state and federal laws • Provide for compliance monitoring
Other Requirements	• Use of permanent solutions to the maximum extent practicable • Provide for a reasonable restoration time frame • Consider public concerns
Additional Minimum Requirements	• Require permanent ground water cleanup actions • Do not rely primarily on institutional controls • Prevent or minimize present and future site releases and migration of hazardous substances • Do not rely primarily on dilution and/or dispersion

MTCA requires that preference be given to permanent solutions to the maximum extent practicable (WAC 173-340-360(3)) during remedy selection. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, MTCA requires that costs and benefits of each of the remedial alternatives be balanced using a Disproportionate Cost Analysis (DCA). DCA evaluations have been performed for the FFS remedial alternatives evaluated for each area of the NPL Site. The FFS selects a preferred alternative for each area of the NPL Site that is consistent with MTCA requirements and expectations for high overall environmental benefits and cost effectiveness.

DCA Evaluation Criteria Under MTCA

- Protectiveness
- Permanence
- Cost
- Effectiveness over the long term
- Management of short-term risks
- Technical and administrative implementability
- Consideration of public concerns

Post-FFS and Public Participation

Based upon the FFS, Ecology will select a final cleanup action for the NPL Site in accordance with the MTCA remedy selection criteria after considering comments from the community.

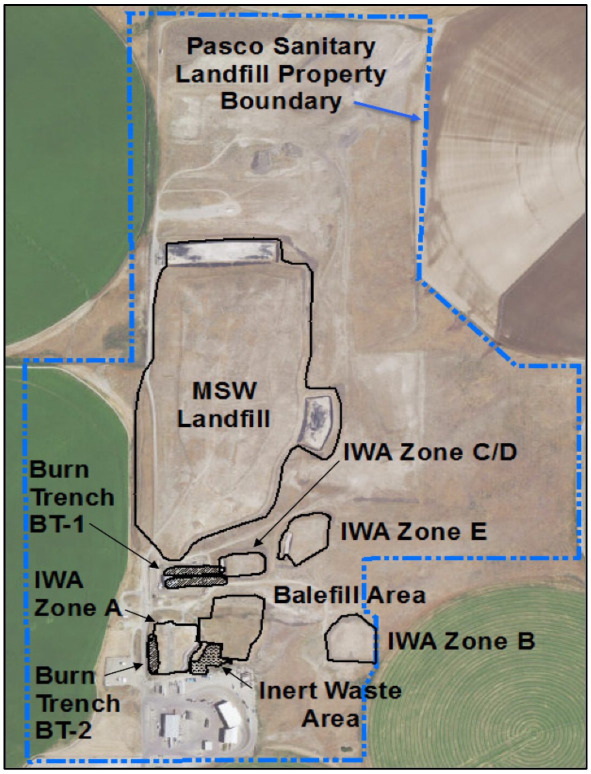
To document their decision, Ecology will prepare a draft Cleanup Action Plan (CAP) for public notice and comment. The draft CAP will describe the selected cleanup actions, cleanup standards for each chemical of concern (COC), implementation schedule, compliance monitoring, and financial assurance requirements. After considering public comments, Ecology will prepare a final CAP identifying the final cleanup action for the NPL Site.

Once the CAP is final, Ecology, the State Attorney General's office, and the PLPs will negotiate and agree to a formal legal agreement in the form of a Consent Decree (CD), requiring the PLPs to carry out the CAP. The terms of the CD will also be subject to public notice and comment. Remedial design phase of the cleanup will begin following finalization of the CAP/CD and documented in an Engineering Design Report (EDR). After remedy implementation, Ecology will conduct periodic reviews (5-year reviews) of NPL Site conditions and monitoring data to ensure that human health and the environment are being protected as intended by the CAP.

BACKGROUND

The Pasco Sanitary Landfill, Inc. Property (PSLI Property) occupies a 200-acre area and consists of several waste disposal areas. Throughout the history of the PSLI Property, waste disposal was conducted under permits issued by the Benton-Franklin District Health Department, the Franklin County Planning Department, and/or Ecology. Permits allowed disposal of municipal solid waste (MSW), commercial waste, industrial waste, and agricultural waste.

Site Map



Location of Waste Disposal Areas

Waste Disposal Areas in the PSL Property

- Industrial Waste Area (IWA) Zones A, B, C/D, and E
- MSW Landfill
- Balefill Area and Burn Trenches (BT-1 and BT-2)
- Inert Waste Disposal Areas
- Historical Landspread Area and Sludge Management Area

Section 2 of the FFS summarizes background information for the NPL Site and includes a summary of the operational history, environmental setting, nature and extent of contamination, and contaminant fate and transport.

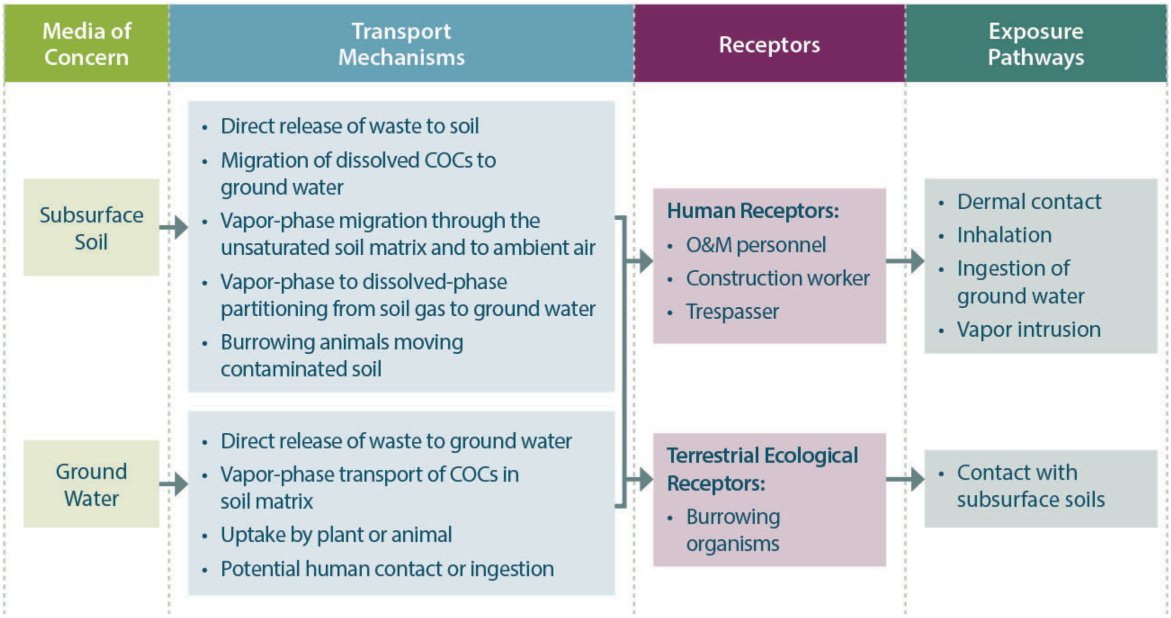
EXPOSURE ASSESSMENT

The following environmental media are impacted by industrial and municipal wastes and represent potential exposure pathways at the NPL Site:

- **Subsurface soil:** Impacted subsurface soils include soils underlying the waste disposal areas, except for areas where they have been covered by a geomembrane. Soil gas also represents an impacted medium in the vicinity of the Municipal Solid Waste Landfill (MSW Landfill) and the Industrial Waste Areas (IWAs).
- **Ground water:** Ground water beneath the NPL Site is impacted as the result of certain historical NPL Site activities.
- **Surface water:** Surface water impacts have not been documented, and the off-property ground water plume attenuates significantly with distance from the PSLI Property.

However, historically there was the potential for impacted ground water to have discharged to surface water.

- **Ambient air:** Ambient air could be affected by emissions of pollutants from the MSW Landfill flare and surface emissions around the Zone A and MSW Landfill covers in the event of extended shutdown of the existing IAs. Vapors extracted from Zone A are treated and discharged under an Approval Order issued by Ecology's Air Quality Department.



Site-wide Exposure Assessment

REMEDIAL GOALS AND OBJECTIVES

Remedial action objectives (RAOs) are general goals to be accomplished by the cleanup action and have been defined for each area of the NPL Site, as detailed in Section 4 of the FFS. RAOs generally include the following: 1) continued minimization of contaminant transport to subsurface soils, ground water, and the atmosphere; and 2) protection of human health and the environment by limiting direct exposure based on an industrial use scenario.

Cleanup actions under MTCA must demonstrate compliance with applicable state and federal laws. Because this is an NPL site, the mutual goal of the PLPs and Ecology is to conduct remedial actions that meet CERCLA requirements, include the identification of the nature and extent of COCs, and select a final cleanup action. Many laws and regulations require that the cleanup action for the NPL Site meet substantive requirements. Other laws establish cleanup standards, including the CULs that must be met once the remedy is completed.

DESCRIPTION OF REMEDIAL ALTERNATIVES

Remedial alternatives have been developed in this FFS for the waste and underlying soils at the MSW Landfill and disposal areas (Balefill Area, Burn Trenches, and Inert Waste Disposal Area), each of the IWA Zones, and for on-property ground water, consistent with the FFS Work Plan and RAOs. Except for the "No Action" alternatives (added for CERCLA compliance), all of the remedial alternatives include some degree of institutional controls (ICs) and ground water compliance monitoring, as well as meet the RAOs. The remedial alternatives considered for each waste area of the NPL Site are described in the following tables.

Remedial Alternatives for MSW Landfill, Balefill and Inert Waste Areas, and Burn Trenches

Area	Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
MSW Landfill	MSW-1	Leave MSW Landfill in place, existing GCCS and enclosed flare system, existing RCRA cover system, monitoring for potential landfill gas migration, ground water performance monitoring, and ICs.	$1.4
	MSW-2	Same as Alternative MSW-1, in addition to expanding the GCCS network to enhance landfill gas capture efficiency.	$1.6
	MSW-3	Same as Alternative MSW-2, in addition to a contingent, active ground water treatment system.	$3.3
Balefill and Inert Waste Areas	BA-1	Leave Balefill and Inert Waste Disposal Areas in place and rehabilitate the existing soil cover.	$0.5
Burn Trenches	BT-A	Leave Burn Trenches in place (with inspection, maintenance, and reporting), with ICs.	$0.01
	BT-B	Same as Alternative BT-A, in addition to confirmation of the soil cover thickness over Burn Trench BT-1, not beneath the engineered cap at Zones C/D.	$0.05
	BT-C	Same as Alternative BT-A, in addition to restoring the cover system for Burn Trench BT-1.	$0.14

Notes:
GCCS = gas collection and control system

IC = institutional control
NPV = net present value
RCRA = Resource Conservation and Recovery Act

Remedial Alternatives for Zone A

Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
A-1	Alternative A-1 consists of monitoring and maintenance of the existing RCRA cap/cover system, existing SVE treatment for Zone A source area, ground water performance monitoring, and ICs.	$16.1
A-2	Same as Alternative A-1 with addition of an enhanced SVE system and a "general ground water contingent treatment remedy" (e.g., air sparging system/ozone to treat ground water impacts prior to leaving the NPL Site).	$18.3
A-3	Same as Alternative A-2 with addition of contingent chemical oxidation treatment of contaminated ground water (instead of air/sparing and ozone treatment).	$17.3
A-4	Same as Alternative A-2 with addition of contingent chemical oxidation treatment of contaminated soil within Zone A (instead of air/sparing and ozone treatment).	$62.4
A-5	Removal of RCRA cap/cover system, excavation of waste and impacted and layback soils to Top of Touchet Beds, on-site disposal of soils/bulked drums in lined AOC cell, off-site disposal of overpacked drum waste, backfill of excavation area and RCRA cap placement, SVE treatment during construction, long-term SVE treatment of Touchet Beds soils, ground water performance monitoring, and ICs.	$56.0
A-6	Same as Alternative A-5, except for thermal treatment of Touchet Beds soils (instead of long-term SVE treatment of Touchet Beds soils).	$62.1
A-7	Same as Alternative A-5, except for excavation and on-site disposal of Touchet Bed soils in a lined AOC cell (instead of long-term SVE treatment of Touchet Beds soils).	$60.3
A-8	Implementation of Alternative A-2 for Years 1 through 10 and contingent implementation of Alternative A-7 for Years 11 through 30 (if the enhanced SVE system and contingent air/sparge and ozone treatment are demonstrated to not be sufficiently protective).	$49.9
A-9	Removal of RCRA cap/cover system, excavation of waste and impacted and layback soils to Top of Upper Pasco Gravels, off-site disposal of all excavated materials (overpacked drum waste, bulked drums and impacted soils with some pre-treatment, geomembrane), backfill and RCRA cap placement in excavation area, SVE treatment during construction, ground water performance monitoring, and ICs.	$128.1

Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
No Action Alternative	Monitoring of the Zone A existing RCRA cap and cover system and of downgradient ground water (both for an assumed 10-year period).	$2.3

Notes:
AOC = Area of Contamination
IC = institutional control
NPV = net present value
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

The nine action alternatives were evaluated with respect to similarity of technologies, scope, and relative costs. For those with similar cleanup action components, one alternative was selected as representative and was carried through the DCA. Alternatives A-2, A-3, and A-4 have similar components but differ in the contingent action to be implemented in the event potential future impacted ground water downgradient of Zone A is identified during ground water compliance monitoring or the 5-year review process. Alternative A-2 is the representative alternative carried forward into the DCA (with a contingent ground water treatment remedy to address potential future conditions) based on reasonable total and contingent action costs ($18.3 million and $444,000, respectively).

Alternatives A-5 and A-6 have similar components but differ in the type of in situ treatment of the impacted soils in the Touchet Beds. Alternative A-6 is the representative alternative carried forward into the DCA (with in situ thermal treatment of the impacted Touchet Bed soils) based on reasonable total and in situ treatment costs ($62.1 million and $6.4 million, respectively) and shorter operational time frame of the thermal treatment system (6 to 8 months, compared to 30 years required for soil vapor extraction [SVE] treatment under Alternative A-5).

Because the No Action Alternative does not meet the Zone A RAOs, it does not comply with the minimum MTCA threshold requirements under WAC 173-340-360(2)(a) and is not carried forward into the DCA for Zone A. The Zone A alternatives carried forward into the DCA are Alternatives A-1, A-2, A-6, A-7, A-8, and A-9.

Remedial Alternatives for Zone B

Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
B-1	Monitoring and maintenance of the existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$2.2
B-2	Same as Alternative B-1 with addition of MNA of waste material in soils below the edges of cap liner.	$2.8
B-3	Same as Alternative B-1 with addition of reagents to sub-cap areas to assist bioremediation of waste material below the floor of the former disposal cell.	$3.2
B-4	Same as Alternative B-1 with addition of reagents to sub-cap areas to assist sorption/solidification of waste material below the floor of the former disposal cell.	$3.1
B-5	Cap removal, excavation, and off-site disposal of contaminated soil below the existing RCRA-compliant cap, placement of an impermeable liner at the base of the remedial excavation, backfill of the remedial excavation to an appropriate elevation, placement of a surface cover system, ground water performance monitoring, and ICs.	$24.3
No Action Alternative	Monitoring of the existing RCRA cap and cover system and downgradient ground water (for an assumed 30-year period).	$1.3

Notes:
IC = institutional control
MNA = monitored natural attenuation
NPV = net present value
RCRA = Resource Conservation and Recovery Act

Remedial Alternatives for Zones C/D and E and On-property Ground Water (Central Area)

Area	Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
Zones C/D	CD-1	Monitoring and maintenance of existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$0.7
	CD-2	Same as Alternative CD-1 with addition of contingent remedy (in situ chemical amendment of impacted soil).	$1.6
	CD-3	Removal of RCRA cap/cover system, excavation and off-site disposal of waste/soil, geomembrane and RCRA cap placement, backfill, ground water performance monitoring, and ICs.	$7.2
	No Action Alternative	Monitoring of existing RCRA cap and cover system (for an assumed 10-year period) and downgradient ground water (for an assumed 5-year period).	$0.2
Zone E	E-1	Monitoring and maintenance of existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$0.8

Area	Remedial Alternative	Cleanup Action Components	Total NPV Cost ($ million)
	E-2	Same as Alternative E-1 with addition of contingent remedy (ex situ stabilization of waste).	$2.2
	E-3	Removal of RCRA cap/cover system, excavation and off-site disposal of waste/soil, geomembrane and RCRA cap placement, backfill, ground water performance monitoring, and ICs.	$20.1
	No Action Alternative	Monitoring of existing RCRA cap and cover system (for an assumed 10-year period) and downgradient ground water (for an assumed 5-year period).	$0.2
On-property Ground Water (Central Area)	ONP-1	Ground water performance monitoring, which is the primary action under this remedy. Focused SVE treatment is a contingent remedy included for cost purposes and may be implemented to capture low-level VOCs in the area between the south end of the MSW Landfill and Zones C/D and E if deemed necessary by ground water monitoring.	$1.5
	No Action Alternative	Ground water compliance monitoring (for an assumed 5-year period).	$0.2

Notes:
IC = institutional control
NPV = net present value
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction
VOC = volatile organic compound

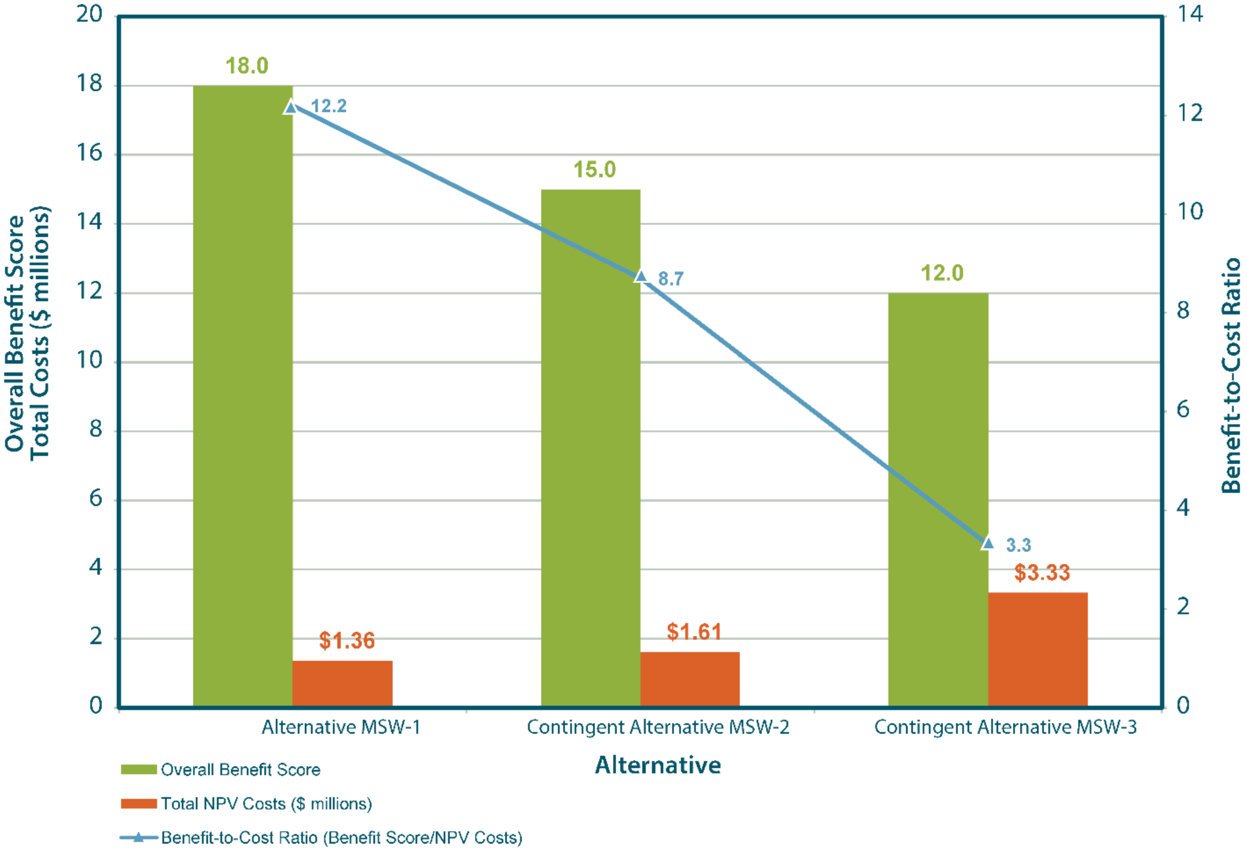
The effectiveness of source control using SVE to clean up the downgradient plume is already evident in the declining off-property ground water concentrations since 2008. Therefore, no active remediation is required off-property. Attenuation of off-property COC concentrations will be demonstrated by continued routine monitoring of wells downgradient of the PSLI Property line (30-year period assumed). Downgradient water users are to be protected by ICs, including the supply of City of Pasco drinking water to affected residents within the historical ground water plume, a City of Pasco ordinance that prohibits new wells in the Ground Water Protection Area south of the NPL Site, and continued monitoring of the existing residential wells in this area.

EVALUATION OF REMEDIAL ALTERNATIVES

All of the remedial alternatives developed for each area (with the exception of the No Action Alternatives for Zones A, C/D, E, and Central Area) are designed to meet the MTCA minimum requirements. DCA evaluations are summarized in this section for each area of the NPL Site. Also included for each area is a graphic summary of the overall environmental benefits and costs for the alternatives compared to a baseline to show the most practicable permanent remedial alternative benefit score for each alternative.

Municipal Solid Waste

Environmental benefits for the MSW Landfill alternatives ranged from 12 (Alternative MSW-3) to 18 (Alternative MSW-1). All three alternatives offer a high degree of protection and long-term effectiveness based on historical observations of the existing engineering systems. They also have similarly high degrees of permanence based on leaving the waste in place and landfill gas destruction. However, Alternatives MSW-2 and MSW-3 have higher corresponding costs of $1.6 and $3.3 million, respectively. The incremental costs associated with these two alternatives are considered disproportionate to no corresponding increase in environmental benefits over Alternative MSW-1. This is consistent with the WAC 173-340-360(3)(e)(i)) definition of disproportionality and is also reflected in the lower benefit-to-cost ratio (defined as the overall environmental benefit score per each million dollars) among all the remedial alternatives. Therefore, Alternative MSW-1 provides the highest overall environmental benefit, is cost effective, meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable, and is identified as the preferred remedial alternative for the MSW.

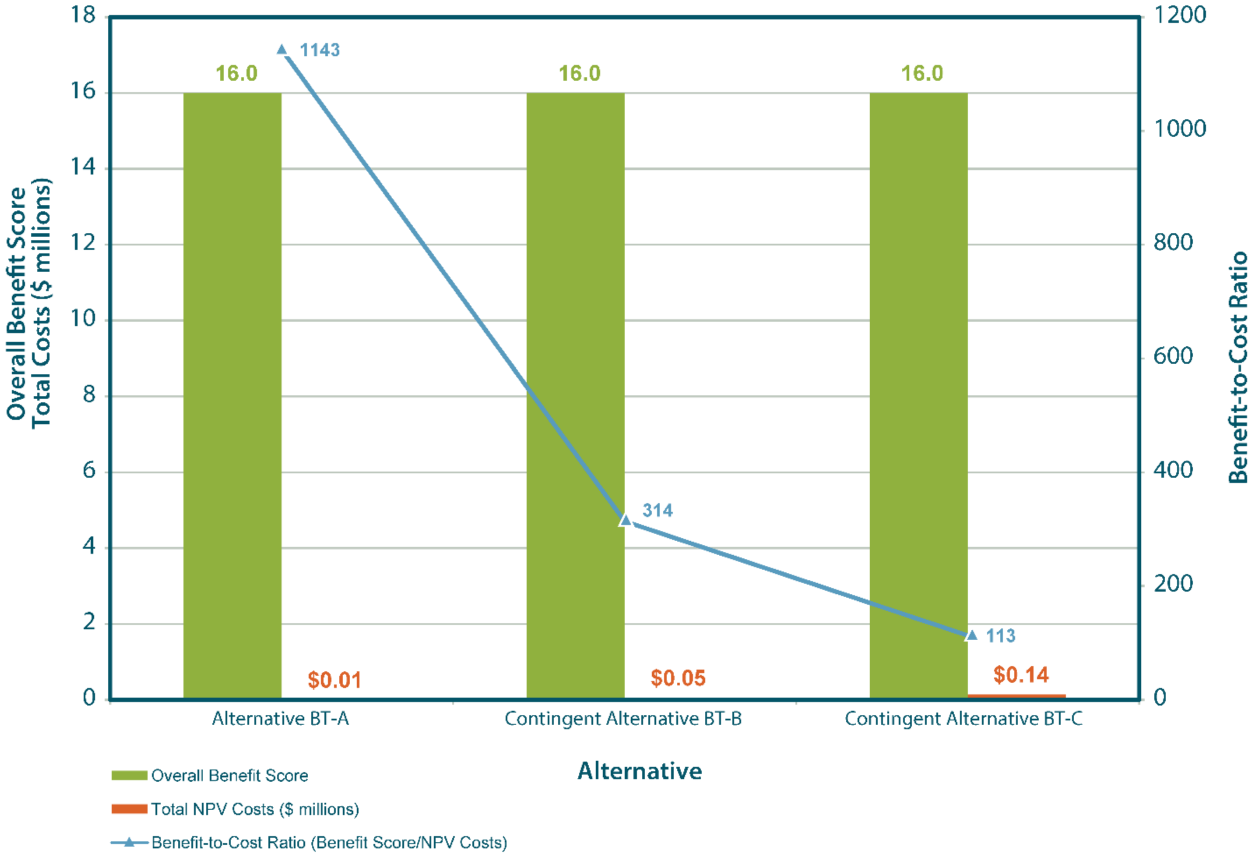


Disproportionate Cost Analysis for MSW Landfill

Burn Trenches

For the Burn Trenches DCA, the overall environmental benefits and costs for the Burn Trenches alternatives are compared to Alternative BT-C, which serves as the baseline and represents the most practicable permanent remedial alternative.

Environmental benefits resulted in an equal score of 16 for the three Burn Trenches alternatives. All three alternatives offer a high degree of protection and long-term effectiveness based on historical observations of the existing engineering systems. They also have similarly high degrees of permanence based on leaving the waste in place. However, Alternatives BT-B and BT-C have higher corresponding costs. The incremental costs associated with these two alternatives are considered disproportionate to no corresponding increase in environmental benefits over Alternative BT-A. This is also reflected in the lowest benefit-to-cost ratio among all the remedial alternatives.



Disproportionate Cost Analysis for Burn Trenches

Alternative BT-A provides a high overall environmental benefit, is cost-effective, meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable, and is identified as the preferred remedial alternative for the Burn Trenches.

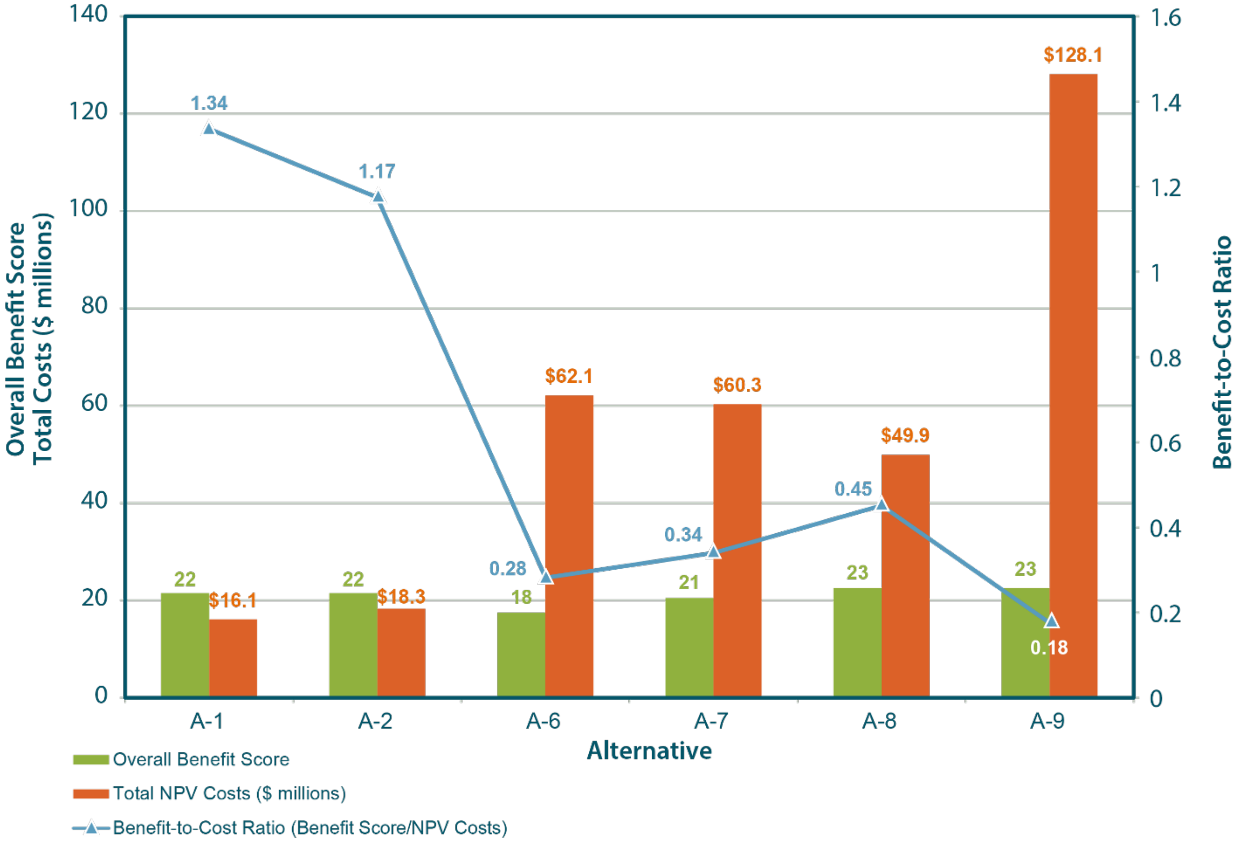
Balefill Area and Inert Waste Areas

Alternative BA-1 meets the MTCA minimum requirements, and therefore, it is identified as the preferred remedial alternative for the Balefill and Inert Waste Areas.

Zone A

The overall environmental benefits and costs for the Zone A alternatives are compared relative to Alternative A-9. Although this remedial alternative serves as the baseline and represents the most practicable permanent remedial alternative for Zone A (because it consists of the full removal of drummed waste and impacted soils to the top of the Upper

Pasco Gravels and off-site disposal and thus has the least remaining residual contamination on site), Alternatives A-1 and A-2 are in essence more permanent than Alternative A-9 (and other removal-based alternatives) because Alternatives A-1 and A-2 involve eliminating COCs, rather than containing COCs at another disposal site.



Disproportionate Cost Analysis for Zone A

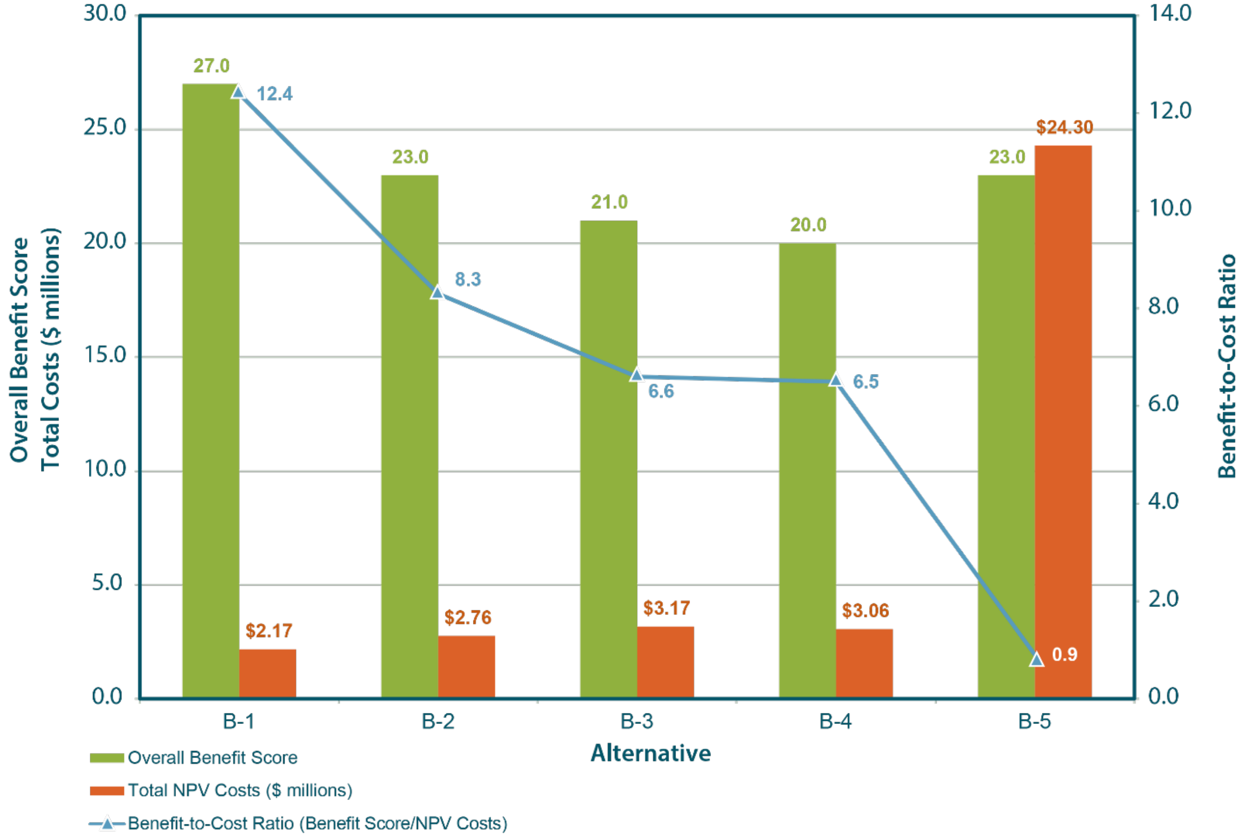
Environmental benefits ranged from 18 (Alternative A-6) to 23 (Alternatives A-8 and A-9). As the most practicable permanent remedial alternative, Alternative A-9 has a relatively high environmental benefit score due to its high degree of protection, permanence, and long-term effectiveness (these criteria alone account for 70% of the overall environmental benefit score) but with the corresponding highest total cost of $128.1 million. However, as previously indicated, Alternatives A-1 and A-2 have the added benefit of eliminating COCs, rather than just containing them at another disposal site. Environmental benefits among all Zone A alternatives are similar, resulting in incremental costs associated with Alternatives A-6, A-7, A-8, and A-9 that are disproportionate compared to Alternative A-2.

This is also reflected in the lower benefit-to-cost ratios of these remedial alternatives versus Alternative A-2 (ratios varied between 0.18 for Alternative A-9 to 0.45 for Alternative A-8).

Therefore, the remaining remedial alternatives for the Zone A evaluation are Alternatives A-1 and A-2. These two remedial alternatives provide high overall environmental benefit scores, but Alternative A-2 is cost-effective and provides distinguishable environmental benefits (enhanced SVE system and the potential contingent action of air sparging and ozone treatment) over Alternative A-1. In addition, the incremental costs for Alternative A-2 are not considered disproportionate with respect to Alternative A-1 because they provide for the following: 1) improved mass removal from the Zone A source area due to the installation and operation of three additional intermediate SVE wells; 2) additional long-term protectiveness afforded by the contingent action in the event of transient releases from the Zone A source; and 3) the treatment and destruction of a different and larger class of contaminants than that accomplished by the SVE system alone. Therefore, the incremental costs for Alternative A-2 are commensurate with the level of added protectiveness when compared to Alternative A-1. Alternative A-2 meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable because cleanup standards are achieved, so it is identified as the preferred remedial alternative for Zone A.

Zone B

For the Zone B DCA, the overall environmental benefits and costs for the Zone B alternatives are compared to Alternative B-5, which serves as the baseline and represents the most practicable permanent remedial alternative.



Disproportionate Cost Analysis for Zone B

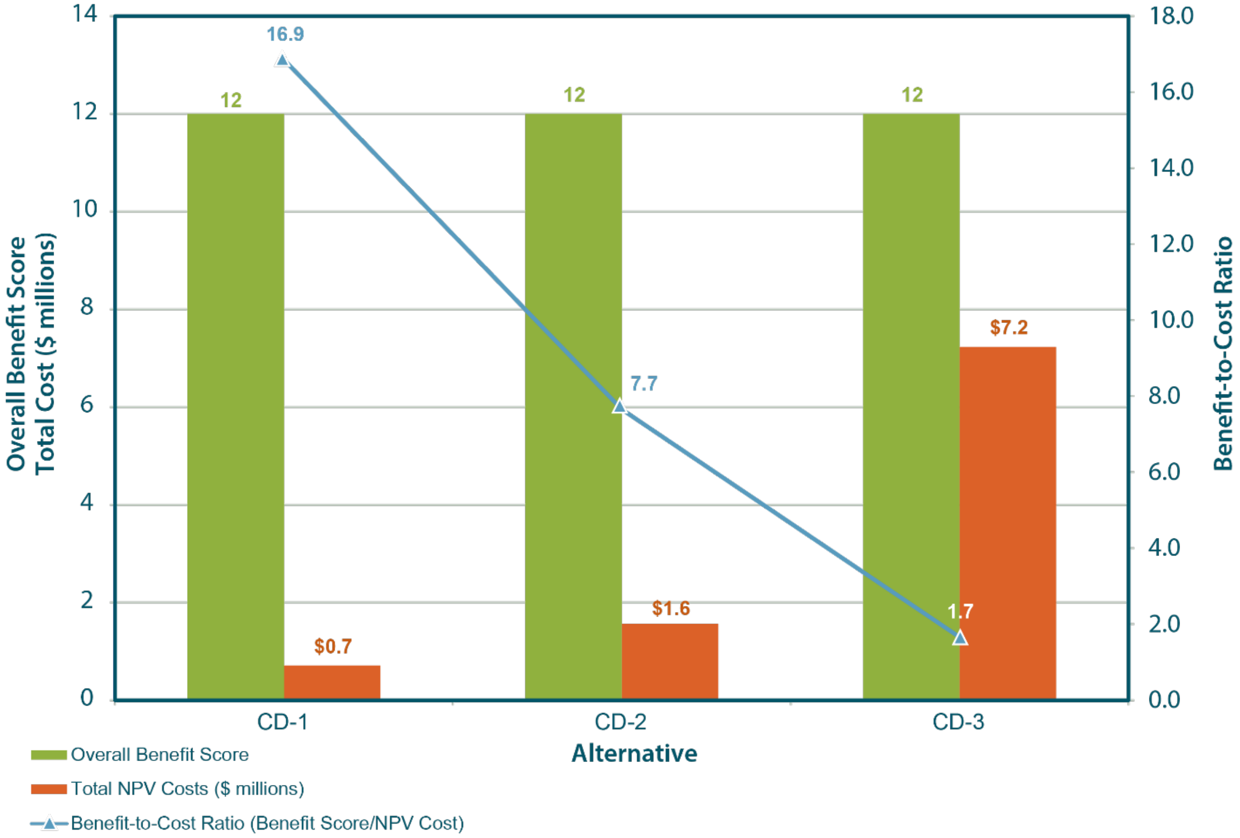
Environmental benefits ranged from 20 (Alternative B-4) to 27 (Alternative B-1). As the most permanent remedial alternative, Alternative B-5 has a relatively high environmental benefit score due to its high degree of protection, permanence, and long-term effectiveness but with the corresponding highest total cost of $24.3 million. Environmental benefits among all Zone B alternatives are similar, resulting in incremental costs associated with Alternatives B-2 through B-5 that are disproportionate compared to Alternative B-1. This is also reflected in the lower benefit-to-cost ratios of these remedial alternatives versus Alternative B-1.

The remaining remedial alternative for the Zone B evaluation is Alternative B-1, which provides the highest overall environmental benefit score, is also cost-effective, meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable, and is identified as the preferred remedial alternative for Zone B.

Zones C/D

The overall environmental benefits and costs for the Zones C/D alternative are compared to Alternative CD-3, which serves as the baseline by which the other remedies are compared.

The environmental benefits for all three Zones C/D alternatives received equal scores of 12. All three alternatives offer a high degree of protection and long-term effectiveness. Alternatives CD-2 and CD-3 also have similarly high degrees of permanence based on treatment (CD-2) or removal and off-site disposal of waste materials (CD-3). However, Alternative CD-3 has the highest corresponding cost without a corresponding increase in environmental benefit. Incremental costs associated with Alternative CD-3 are considered disproportionate for the little, if any, increase in environmental benefits over Alternatives CD-1 and CD-2. This is also reflected in the lowest benefit-to-cost ratio among all the remedial alternatives.



Disproportionate Cost Analysis for Zones C/D

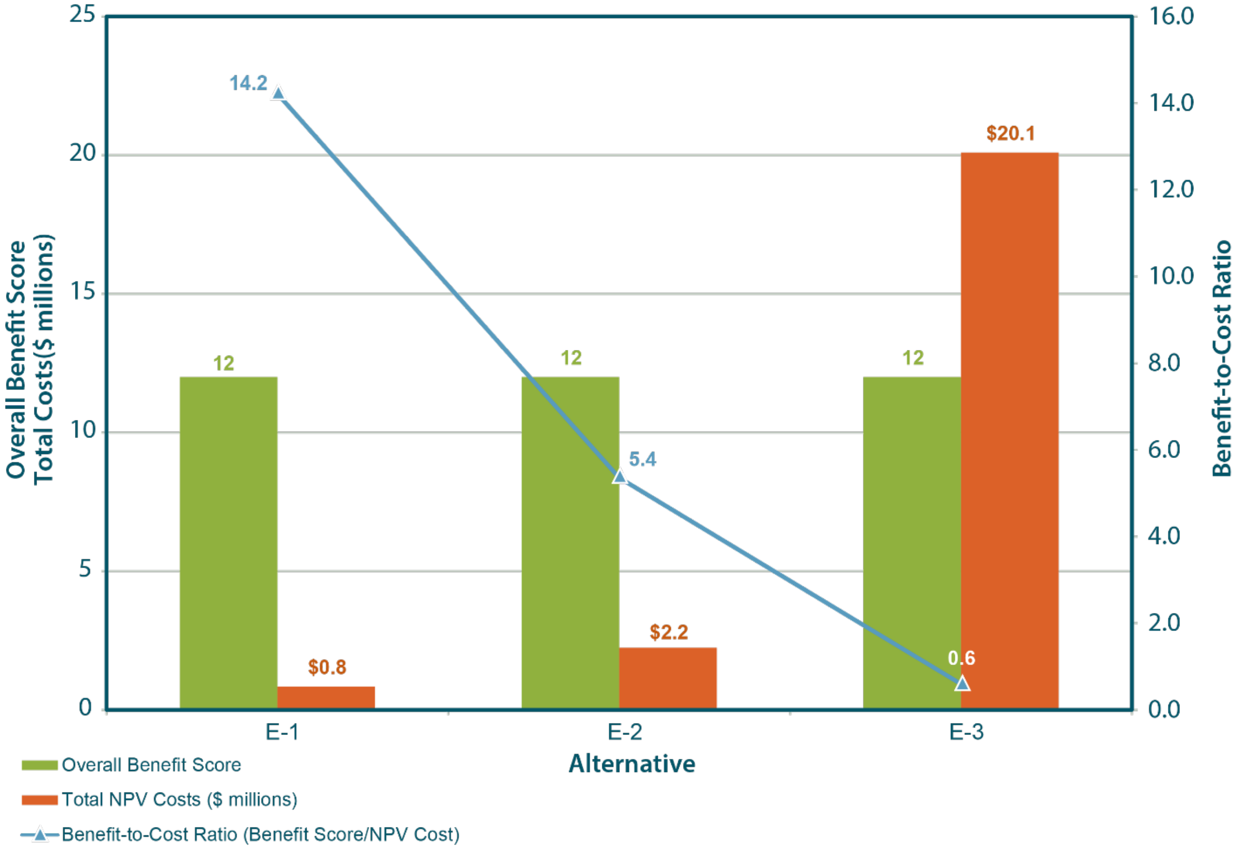
Given that Alternatives CD-1 and CD-2 are equivalent in the overall environmental benefit score because the two remedial alternatives have common engineered controls in their scope, MTCA directs that the less costly remedial alternative be selected. Because the in situ chemical amendment of contaminated soil is included in the scope of Alternative CD-2 only as a contingent remedy (to be implemented to address potential future impacted ground water from COC releases), the incremental costs for the contingency do not provide any discernible environmental benefits in the short-term. The benefit-to-cost ratio for Alternative CD-2 is much lower than that of Alternative CD-1.

Alternative CD-1 provides high overall environmental benefits, is cost-effective, and meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable, so it is identified as the preferred remedial alternative for Zones C/D.

Zone E

Alternative E-3 serves as the baseline for the Zone E DCA and represents the most permanent remedial alternative. Environmental benefits resulted in an equal score of 12 for the three Zone E alternatives. All three alternatives offer a high degree of protection and long-term effectiveness. Alternatives E-2 and E-3 also have similarly high degrees of permanence based on treatment or removal and off-site disposal of waste materials. However, Alternative E-3 has the highest corresponding cost of $20.1 million without a corresponding increase in benefit. Incremental costs associated with Alternative E-3 are considered disproportionate for the small to almost no increase in environmental benefits over Alternatives E-1 and E-2. This is also reflected in the lowest benefit-to-cost ratio among all the remedial alternatives.

Given that Alternatives E-1 and E-2 are equivalent in the overall environmental benefit score because the two remedial alternatives have common engineered controls in their scope, MTCA specifies that the less costly remedial alternative should be selected. Because the ex situ stabilization of contaminated soil is included in the scope of Alternative E-2 only as a contingent remedy (to be implemented to address potential future impacted ground water from COC releases), the incremental costs for the contingency do not provide any discernible environmental benefits in the short term. The benefit-to-cost ratio for Alternative E-2 is much lower than that of Alternative E-1.



Disproportionate Cost Analysis for Zone E

Alternative E-1 provides a high overall environmental benefit, is cost-effective, meets the MTCA threshold requirements and definition of permanent to the maximum extent practicable, and is identified as the preferred remedial alternative for Zone E.

On-property Ground Water (Central Area)

Alternative ONP-1 meets the MTCA minimum threshold requirements and, therefore, it is identified as the preferred and only remedial alternative for on-property ground water in the Central Area.

SUMMARY OF PREFERRED ALTERNATIVES

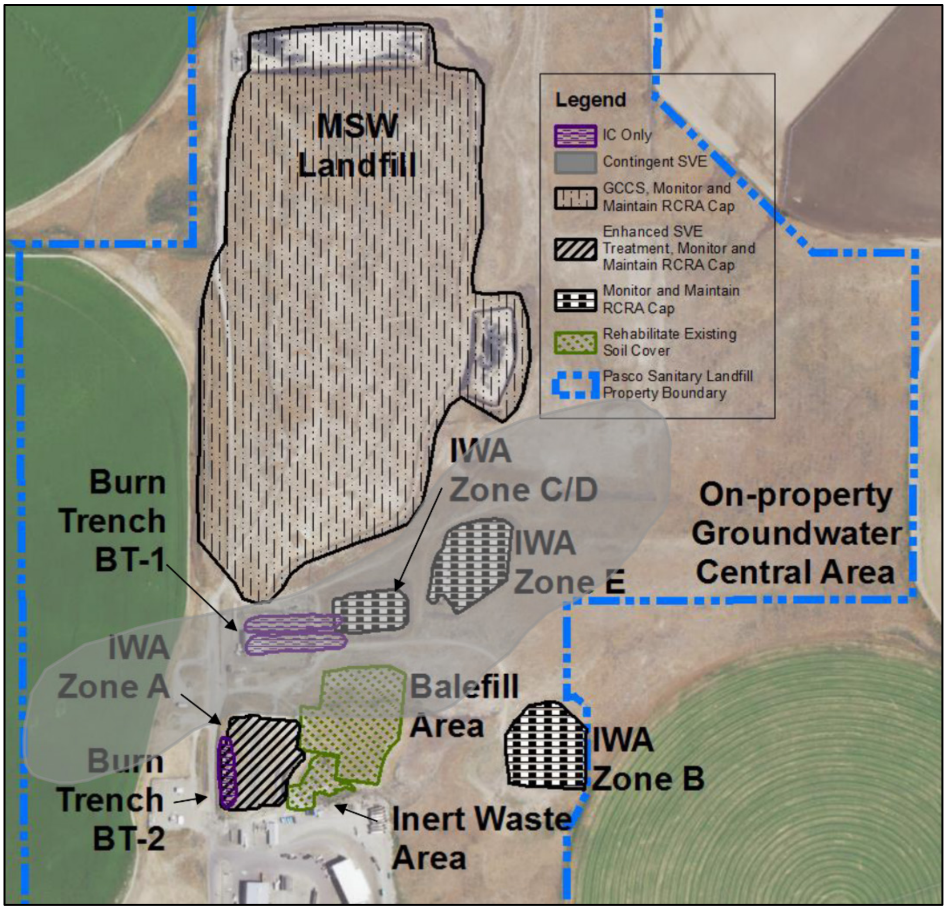
The site-wide preferred alternative is the combination of the preferred remedial alternatives for each of the individual areas of the NPL Site as listed in the following table.

Summary of Preferred Alternatives

Area	Preferred Remedial Alternative	Total NPV Cost ($ million)
MSW Landfill	MSW-1	$1.4
Balefill Area and Inert Waste Disposal Areas	BA-1	$0.5
Burn Trenches	BT-1	$0.01
Zone A	A-2	$18.3
Zone B	B-1	$2.2
Zones C/D	CD-1	$0.7
Zone E	E-1	$0.8
On-property Ground Water (Central Area)	ONP-1	$1.5

All preferred alternatives are consistent with MTCA requirements and expectations for remedial actions because they are protective of human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, provide for compliance monitoring, use permanent solutions to the extent practicable, provide for reasonable restoration time frames, and consider public concerns.

The site-wide preferred alternative recognizes that the PSLI Property has been a landfill for more than a half-century, and it will remain a landfill site permanently. The assumption that the PSLI Property will remain a landfill permanently is embedded in the preferred alternative of each NPL Site area.



Site-wide Cleanup Action Components of Preferred Alternatives

NEXT STEPS

A final cleanup action for the NPL Site will be selected by Ecology and documented in a CAP in accordance with the MTCA remedy selection criteria and Applicable or Relevant and Appropriate Requirements after involving and taking into consideration comments from the community. It is anticipated that the final CAP will describe the selected cleanup actions and include an implementation schedule, a Compliance Monitoring Plan (CMP), and financial assurance requirements.

Following issuance of the final CAP, there are many steps prior to implementation of the selected remedy, as well as periodic reviews after its implementation, to ensure that the final action is continuing to protect human health and the environment. The major tasks following the finalization of the CAP document are as follows:

- **Cleanup Action Plan:** Ecology will issue a draft CAP for a cleanup action, which will include a general description of the proposed cleanup action, rationale for selecting the proposed alternative among the cleanup action alternatives evaluated in the RI/FS, cleanup standards for each medium of concern at the NPL Site, schedule for implementation of the CAP, and applicable state and federal laws for the proposed cleanup action. The public will have an opportunity to comment on the draft CAP.
- **Financial Assurance:** Financial assurance mechanisms are required by Ecology where a cleanup action selected includes engineered controls and/or ICs, unless the PLPs can demonstrate that sufficient financial resources are available and in place to provide for the long-term effectiveness of engineered controls and ICs adopted.
- **Engineering Design Report:** The EDR documents the engineering concepts and design criteria used for design of the cleanup action, including construction plans and specifications, and proposed project schedule. Pre-design activities would be conducted to inform engineering design and will include any invasive testing or surveys where necessary.
- **Consent Decree:** Once a CAP is final, a formal legal agreement in the form of a CD is negotiated and agreed to by the PLPs, Ecology, and the State Attorney General's office, thereby defining the work requirements and the terms under which the CAP must be conducted. Before the CD becomes final, it will undergo a public review and comment period. A CD includes the following: a technical scope of work describing the remedial action to be conducted; data, studies, or any other information upon which the settlement is based; a statement describing the PLPs' ability to conduct or finance the remedial action; and a schedule for implementation of the proposed remedial actions.
- **Compliance Monitoring Plan:** A CMP is required to describe the long-term monitoring program to be implemented as part of the final cleanup action. It should include not only the long-term confirmational monitoring to be performed at the NPL Site to verify that the cleanup action meets the ground water and/or soil cleanup standards defined in the CAP but also the inspection, monitoring, and reporting

activities to be implemented to document the performance and the integrity of engineered controls. Such measures will be required until residual hazardous substance concentrations no longer exceed NPL Site CULs.

5-year Reviews: Ecology will conduct periodic reviews of NPL Site conditions and monitoring data to ensure that human health and the environment are being protected as intended by the CAP.

FOCUSED FEASIBILITY STUDY

1 INTRODUCTION

1.1 Purpose and Objectives

Members of the Industrial Waste Area Generator Group III (IWAG)[1] and Bayer CropScience (BCS), designated as Potentially Liable Parties (PLPs) have prepared this Draft Final version of the Focused Feasibility Study (FFS) for the Pasco Sanitary Landfill National Priorities List (NPL) Site (NPL Site[2]) pursuant to Agreed Order No. DE-09240 (AO) entered into between the PLPs and the Washington State Department of Ecology (Ecology), effective October 31, 2012. This FFS includes information provided by members of the Landfill Group (LFG)[3]. Members of the LFG are also designated as PLPs. This version of the FFS addresses comments made by and discussions with Ecology on the previous Draft FFS submitted to Ecology in September 2014. On behalf of their respective clients, Anchor QEA, LLC, and Environmental Partners, Inc. (IWAG); and Amec Foster Wheeler Environment & Infrastructure, Inc., formerly AMEC (BCS), prepared their respective sections of this Draft Final FFS in conformance with Washington Administrative Code (WAC) 173-340-350(8). This FFS develops and evaluates cleanup action alternatives to support selection of a final cleanup action in accordance with Model Toxics Control Act (MTCA) criteria and consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) guidelines.

The purpose of the FFS is "to evaluate a focused set of remedial alternatives" (Agreed Order DE 9240, p. 3). It builds upon the 1999 *Final Draft Feasibility Study Report* (FS Report; PSC 1999) that included comprehensive screening of remedial alternatives in accordance with then-applicable MTCA criteria. The remedial action objectives (RAOs) in this Draft Final FFS are generally consistent with those identified in the 1999 FS Report. For most of

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[1] The members of IWAG are PPG-Architectural Coatings Canada Inc.; Blount, Inc.; The Boeing Company; Crown Beverage Packaging, LLC; Daimler Trucks North America LLC; Georgia-Pacific, LLC; Goodrich Corporation on behalf of Kalama Specialty Chemicals, Inc.; Intalco Aluminum Corporation; 3M Company; PACCAR Inc.; PCC Structurals, Inc.; Pharmacia LLC; Simpson Timber Company; Union Oil Company of California; and Weyerhaeuser NR Company.

[2] The NPL Site encompasses all of the property currently owned by PSLI, including the areas in which wastes were managed between 1958 and 1992, as well as the downgradient off-site ground water plume area (Figure 1.2-1).

[3] The current members of the LFG are Basin Disposal, Inc.; BNSF Railway Company; and Pasco Sanitary Landfill, Inc (PLSI).

the NPL Site, the known nature and extent of environmental impacts are similar to those presented in the original FS Report. The FFS utilizes information developed during Interim Actions (IAs) since 1997, and reflects changes in applicable MTCA cleanup standards.

1.2 NPL Site Description

The closed Pasco Sanitary Landfill Property (PSL Property) is located along the northeast limit of the City of Pasco in Franklin County, Washington. The location of the entire NPL Site, including the Ground Water Protection Area (GPA), is shown on Figure 1.2-1. The industrial and municipal waste disposal areas are illustrated in Figure 1.2-2. Former waste disposal areas have been excavated and transferred to the existing areas. The existing areas include the following:

- Industrial Waste Areas (IWAs):
    - Zones A
    - Zone B
    - Zones C/D
    - Zone E
- Municipal Solid Waste Landfill (MSW Landfill)
- Balefill Area
- Burn Trenches (BT-1 and BT-2)
- Inert Waste Disposal Area
- Land Application Areas

1.3 Operational History

Throughout the history of the PSL Property, waste disposal and closure activities were conducted under permits issued by the Benton-Franklin District Health Department (BFDHD), the Franklin County Planning Department, and/or Ecology. Municipal solid waste (MSW) landfilling operations began in 1958 and ended in 1993. Industrial waste was disposed at the facility from April 1972 through 1975[4].

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[4] Further historical document review indicates that limited volumes of industrial wastes were disposed of in the IWA of the PSL Property) during 1975.

Additional description of the operational history is presented in Section 2.3 and in the *Final Draft Phase I Remedial Investigation, Pasco Landfill* (Phase I RI Report; Burlington Environmental 1994) and *Final Phase II Remedial Investigation Report, Pasco Landfill* (Phase II RI Report; PSC 1998a).

1.4 Regulatory History

Ecology first investigated the NPL Site in 1973. The final report, issued in November 1973, concluded that the PSL Property was "an excellent location for ground disposal of industrial solid wastes if the proper safeguards are observed" (Ecology 1973).

In 1988, the United States Environmental Protection Agency (EPA) proposed that the Pasco Sanitary Landfill, Inc. Property (PSLI Property)[5] be placed on the NPL for Superfund sites after volatile organic compounds (VOCs) were detected in certain ground water locations.

In 1990, EPA announced that the PSLI Property was listed on the NPL, and Ecology was established as the lead agency. Ecology is overseeing the cleanup under the Washington MTCA, Revised Code of Washington Chapter 70.105D.

In 1992, Ecology issued Agreed Order DE92TC-E105 designating various individuals and entities as PLPs under MTCA, and requiring completion of a Phase I remedial investigation (RI). The PLPs completed and submitted the Phase I RI Report to Ecology in 1994.

In 1994, Ecology issued Enforcement Order DE94TC-E103, requiring work including a Phase II RI Report, a risk assessment/cleanup levels analysis, and a feasibility study. The Enforcement Order was amended in 1996 to address impacts to off-property ground water and an expanded off-property ground water investigation and identification of potentially impacted residential wells located hydraulically downgradient of Zone A. Interim Remedial

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[5] PSLI Property refers to the property under its current ownership by Pasco Sanitary Landfill, Inc., which began in 1981. PSL Property generally refers to the Pasco Sanitary Landfill under past ownership.

Measures (IRMs) were implemented by the PLPs at the NPL Site to further reduce potential risks to human health and the environment, including the following:

- Provided bottled drinking water to users of drinking water wells located in the area potentially impacted by the ground water plume downgradient of Zone A
- Extension of the City of Pasco municipal water supply system and the connections to the city water system for those properties
- Installation of a pilot-scale soil vapor extraction (SVE) system around Zone A to remove contaminants in soils and soil vapor in 1997
- Installation of a pilot-scale NoVOCs™ system to remove contaminants in the ground water downgradient of Zone A in 1997

A detailed discussion of the IRMs was presented to Ecology in the *Interim Measures Completion Report* (PSC 1998b). The following major documents were submitted under Enforcement Order DE94TC-E103:

- *Pasco Sanitary Landfill Closure Plan* (Woodward-Clyde 1996)
- Phase II RI Report (PSC 1998a)
- *Ecological Assessment – Pasco Landfill* (PSC 1997), which described the potential impacts to plants and animals at the PSLI Property
- *Risk Assessment/Cleanup Level Analysis Report* (PSC 1998c), which described the potential impacts to human health and the environment
- FS Report (PSC 1999), which described remedial alternatives to reduce potential risk at each individual contaminant source area

In 2000, Ecology issued the following two Agreed Orders and two Enforcement Orders directing work at the NPL Site:

- Agreed Order DE-00TCPER-1324 (IWA/GW Agreed Order) for the IWA and the Ground Water Plume Area
- Agreed Order DE-00TCPER-1326 (Landfill Agreed Order) for the Sanitary Landfill Area
- Enforcement Order DE-00TCPER-1325 to certain PLPs who did not sign the IWA/GW Agreed Order

- Enforcement Order DE-00TCPER-1327 to certain PLPs who did not sign the Landfill Agreed Order

Ecology approved the preferred remedy described in the 1999 FS Report as IAs, determining that a final Cleanup Action Plan (CAP) would be deferred until the IAs were in place and performance monitoring data had been generated and reported. The IWA/GW Agreed Order required certain PLPs to perform the following actions:

- Prepare an IA work plan (Task 1)
- Provide industrial waste containment systems design documents (Task 2)
- Implement Zone B removal action (Task 3)
- Implement ground water treatment and IA systems monitoring plan (Task 4)
- Implement institutional controls (ICs; Task 5)
- Prepare a completion report documenting the containment, ground water, and Zone B action (Task 6)

In addition, the IWA/GW Agreed Order required an IA performance monitoring report be prepared after 6 years.

The 2000 Landfill Agreed Order required certain PLPs to put in place a Municipal Closure Cap System at the MSW Landfill (Task 1), which included pre-closure site investigations, a landfill cover system, a landfill gas collection system (GCCS), a landfill runoff control system, and construction assurance, operation, and maintenance plans. Ecology gave notice in March 2013 that the provisions of the Landfill Agreed Order were satisfied.

In Zone B, multiple investigations in 2009 to 2012 delineated the nature and extent of Zone B-related materials around the prior temporary cap. An interim measure that included excavation, waste consolidation, and emplacement of a Resource Conservation and Recovery Act (RCRA)-compliant cap system over Zone B was completed in 2013 (see Section 2.5.4), and quarterly inspections of the cap are ongoing. Wells MW-25SR and MW-26SR at Zone B undergo ground water monitoring as part of the facility-wide ground water sampling program, and data are presented in an annual report.

In 2012, Ecology issued AO (DE-9240), directing the following:

- Ongoing operation, maintenance, and reporting of the IAs (Task 1)
- Preparation of an FFS work plan (Task 2)
- FFS analysis and reporting (Task 3)
- Supplemental data collection and treatability evaluation (as contingency Task 4)

Ecology also issued Enforcement Order DE 9240 to those PLPs that did not sign the AO. The revised *Focused Feasibility Study Work Plan* (Anchor QEA et al., 2013) was approved by Ecology on November 6, 2013. The Draft FFS was submitted to Ecology on September 3, 2014. Ecology provided comments on the Draft FFS on June 13, 2016.

In April 2014, Ecology issued Enforcement Order DE 10651 in response to a subsurface combustion event, requiring the following from PLPs:

- Prepare a Balefill Area fire suppression work plan (Task 1)
- Extinguish and monitor the Balefill Area subsurface fire (Task 2)
- Prepare a Balefill Area combustion prevention work plan (Task 3)

Ecology gave notice to the PLPs in April 2017 that the Enforcement Order was satisfied.

2 BACKGROUND

2.1 Property and Vicinity Description

The NPL Site boundaries, as defined by the IWA/GW Agreed Order, encompass the PSLI Property and the ground water plume area (see Figure 1.2-1). The PSLI Property is located along the northeast limit of the City of Pasco, in the southwest quarter of Section 15, the northeast quarter of Section 21, and the northwest quarter of Section 22, Township 9 North, Range 30 East, Willamette Meridian, in Franklin County, Washington.

The PSLI Property occupies a 200-acre area in an area of gently rolling hills and flat terrain. Prior to landfill operation, aerial photographs show the property was open, unimproved grassland characterized by both stabilized and active sand dunes (Photograph AAU-3P-202). The MSW disposal areas, IWAs, and the New Waste, Inc. (NWI) landfill are located within the PSLI Property (see Figure 1.2-2). The NWI landfill is a modern and fully lined solid waste landfill, opened on May 31, 1993, and closed in 2002, that is located to the north of the MSW Landfill. Based on post-closure monitoring, the NWI landfill is not known to have caused or contributed to any environmental impacts, and no corrective actions have been required.

2.2 Zoning, Local Demographics, and Land Use

Figure 2.2-1 shows the 2010 zoning map for the City of Pasco. The section of the City of Pasco located approximately 1.5 miles south of the PSL Property is triangular in shape and is bordered by A Street on the south, U.S. Highway 12 to the east/northeast, and Cedar Avenue on the west. This area is zoned light industrial (I-1), residential (RT, R-1, and R-2), and general business (C-3).

The U.S. Census Bureau reported 59,781 people living in the City of Pasco in the 2010 census. The city has more than doubled in size since the initiation of RI activities in 1988.

The land use, cultural features, and demography of the areas within 1-mile and 4-mile radii of the PSLI Property were investigated as part of the Phase I RI between 1992 and 1994. Land use changes since the 1990s include the expansion of residential areas to the south and west of U.S. Highway 12; the expansion of the Basin Disposal, Inc. operations center immediately south of the PSLI Property; the installation of evaporation ponds by OXARC, Inc., along the southwest PSLI Property boundary; and the installation of food storage facilities by Bybee Foods, LLC, and Grimmway Farms along Dietrich Road.

2.3 Operational History of the Pasco Sanitary Landfill Property

This section provides a synopsis of the landfill permitting and operations from the mid-1950s to the present. Land ownership history is summarized in Figure 2.3.1. A timeline for each disposal area is provided in Figure 2.3-2, summarizing key dates for waste disposal, facility closure, IRMs, and IAs.

A summary of investigative reports throughout the history of the NPL Site is shown in Table 2.3-1.

2.3.1 Permitting

Throughout the operating history of the PSL Property, waste disposal and closure activities were conducted under permits issued by the BFDHD, the Franklin County Planning Department, and/or Ecology. Permits allowed disposal of MSW, commercial waste, industrial waste, and agricultural waste. Table 3-6 of the Phase I RI Report lists the facility's operating permits (Burlington Environmental 1994).

On May 6, 1958, the Franklin County Planning Commission authorized John Dietrich, d/b/a Pasco Garbage Service, to establish and operate a garbage disposal facility at this property. The PSL Property was operated as a burning dump until 1971, when it converted to a sanitary landfill. John and Marjorie Dietrich individually owned the land where the burning dump operated. Basin Disposal, Inc., never owned any part of the land where facility operations occurred.

Chemical Processors, Inc., and its controlling members recruited John Dietrich in 1971 to form a new company, Resource Recovery Corporation (RRC), which began operating in 1972. Chemical Processors, Inc., and its shareholders controlled the operation of RRC because they owned 55% of the corporation. John Dietrich, Larry Dietrich, and Leonard Dietrich and their marital communities owned the other 45%. RRC was incorporated in

Washington on August 8, 1972. Ecology issued Industrial Waste Discharge Permit No. 5301 to RRC for industrial waste disposal at the PSL Property on March 21, 1973, which was valid until March 21, 1978.

The Board of Commissioners of Franklin County or the BFHD issued special permits for industrial waste disposal at the facility, which were valid from February 1, 1974, through April 25, 1982. However, the Franklin County Board of Commissioners voted in December 1973 to terminate industrial waste disposal at the property and in April 1974 denied a request from RRC for an extension of industrial waste disposal operations beyond May 1974. Between May and December 1974, RRC operated under a performance agreement with the Franklin County Board of Commissioners and Ecology, which terminated industrial waste disposal on December 31, 1974, and required Ecology to supervise and monitor closure activities after that date. RRC operated the facility until 1981, when PSLI was formed, and operated under permits for a sanitary landfill from BFHD through facility closure in mid-1993.

2.3.2 Regulatory History

2.3.2.1 Early Regulatory Oversight

In 1973, Ecology undertook an independent investigation of the RRC operation (Ecology 1973). The final report, issued in December 1973, concluded that the PSL Property was “an excellent location for ground disposal of industrial solid wastes if the proper safeguards are observed” (Ecology 1973).

In 1975, the IWAs were initially closed with soil covers and plastic sheeting, before engineered covers were required by regulation. After initial closure, monitoring by Ecology revealed no air, soil, or ground water impacted with herbicides 2,4-dichlorophenoxyacetic acid (2,4-D) or 2,4,5-trichlorophenoxyacetic acid.

In 1982, the first ground water monitoring wells were installed by JUB Engineers for PSLI, at the direction of Ecology.

As part of the EPA's nationwide dioxin investigation, the PSL Property was investigated in 1984 because of known herbicide wastes buried there. No dioxins or other organic contaminants were identified in ground water during that investigation. Ecology and Environment, Inc. (E&E), performed another investigation in 1985 for EPA. The report identified several VOCs present in the ground water (E&E 1986).

2.3.2.2 EPA Lists Superfund Site

In June 1988, EPA nominated the PSL Property to the NPL of Superfund sites. The facility was formally listed on the NPL in February 1990. Ecology was established as the lead agency for the cleanup investigations and remedial actions taken at the NPL Site.

2.3.2.3 Remedial Investigation and Feasibility Study

A group of PLPs for the NPL Site performed an RI, as required by the 1992 Agreed Order DE92TC-E105 and the 1994 Enforcement Order DE94TC-E103. Phase I of the RI began in 1992 and was completed with the submittal of the Phase I RI Report in 1994. Phase II RI activities began in 1995, during which it was determined that off-property ground water had been impacted by releases from the NPL Site. Consequently, the scope of the Phase II RI was changed to include an expanded off-property ground water investigation and identification of potentially impacted residential wells located hydraulically downgradient of the NPL Site. The Phase II RI Report was completed in 1998 and the FS Report was completed in 1999.

2.3.2.4 Interim Remedial Measures and Interim Actions

In 1996 and 1997, several IRMs were implemented to further reduce potential risks to human health and the environment. Starting in March 1996, as part of the IRMs, the PLPs provided bottled drinking water to users of drinking water wells located on East Lewis Street, in the area potentially impacted by the ground water plume downgradient of the NPL Site, pending an assessment of actual ground water impacts at those wells. The PLPs also funded an extension of the City of Pasco municipal water supply system and the connections to the city water system for those properties that were found to be impacted and where the owners accepted the offer of a connection. The initial short-term bottled drinking water program was terminated at the end of 1997 when it was confirmed that no additional drinking water wells were impacted.[6]

Other IRMs in 1997 included installation of a pilot-scale SVE system to remove contaminants in soils and soil vapor and a pilot-scale NoVOCs™ system to remove contaminants in the ground water. A detailed discussion of the IRMs was presented to Ecology in the *Interim Measures Completion Report*.

As part of the RI/feasibility study (FS) process, the PLPs submitted the following reports:

- *Ecological Assessment – Pasco Landfill*, which described the potential impacts to plants and animals at the PSLI Property
- *Risk Assessment/Cleanup Level Analysis Report*, which described the potential impacts to human health and the environment
- An FS Report, which described remedial alternatives to reduce potential risk at each individual contaminant source area

The recommended preferred remedy for the NPL Site included long-term monitoring and the implementation of remedial measures at the NPL Site. The FS Report recommended remedy for the IWAs included the following:

- Capping and long-term monitoring of the five IWA zones
- Zone A source control in the form of continued operation and expansion of the SVE system, and soil vapor destruction at the MSW Landfill flare with granular activated carbon treatment as backup
- Continued operation and expansion of the Zone A ground water treatment system using NoVOCs™ wells

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[6] The IWAG continues to pay for domestic water for those original properties that are still owned by the original inhabitants and that are still occupied. At the owner's request, one impacted well was equipped with a water treatment system at the tap, which was operated and maintained until 2009, after which the property was unoccupied. That well has since been decommissioned.

The FS Report recommended remedy for the MSW Landfill included the presumptive remedy of installing an engineered cover system and a GCCS, including a flare for treating landfill gas.

Under the IWA/GW Agreed Order, Ecology identified the preferred remedies described in the 1999 FS Report as IAs, determining that a final CAP would be deferred until performance monitoring data had been generated.

2.3.2.5 Institutional Controls]

The PSLI Property is subject to a restrictive covenant that prohibits the use of ground water for domestic and agricultural uses, with the goal of preventing exposure to contamination from the NPL Site; this covenant is enforceable upon property transfer, sale, or ownership change. The NPL Site is also subject to local ordinances that constitute a key element of the Institutional Controls Program (ICP) for the NPL Site. The current Ecology-approved ICP (dated October 7, 2013) is an update to the Pasco Landfill Interim Action Institutional Control Plan (dated December 1, 2000) and is a deliverable specified in the Scope of Work included as Exhibit B to the AO. One component of the ICP was the adoption of ordinances by the City of Pasco and Franklin County that effectively prohibit the installation of new drinking water wells within the GPA. Another component of the ICP provides for an annual survey of existing wells located within the GPA and their uses. The City of Pasco adopted its Pasco Landfill Ground Water Protection Ordinance, Ordinance No. 3469, effective May 7, 2001, codified in Pasco Municipal Code 16.06.040. Franklin County adopted Ordinance No. 2-99, Chapter 28 I-3 Heavy Industrial Zone, repealed in 2003, and replaced by Chapter 17.56, Franklin County Code. In addition, this ordinance includes conducting the completion of an annual "beneficial water user" survey for all residences within the GPA and reporting of the results to Ecology, and, by requirement, taking enforcement action against all ordinance violators. Finally, informational devices (warning notices and signage) have been implemented to inform the public of potential risks of contamination remaining at the NPL Site and restrict access (gates and fencing). These use restrictions would remain in effect indefinitely.

2.3.2.6 *Interim Action Performance Monitoring Report*

In 2007, at the end of the performance monitoring period following 2002 expansion of the SVE and NoVOCs™ systems, the IWAG members presented the *Interim Action Performance Monitoring Report* (EPI 2007a) and an updated *Operations and Maintenance Manual for SVE, NoVOCs™ and Groundwater Monitoring* (EPI 2007b), which were approved by Ecology in May 2007. Ecology identified issues regarding several aspects of the performance of the IAs, specifically related to Zone A. The IWAG members responded to those issues through the preparation of technical memoranda presenting additional technical evaluation and negotiated a scope of work for the necessary additional actions to be performed under the IWA/GW Agreed Order.

2.3.2.7 *Balefill Subsurface Fire and Enforcement Order*

In December 2013, differential settlement was observed in the Balefill Area adjacent to the northeast border of Zone A. The IWAG members immediately ceased shallow and intermediate SVE well operations; the deep SVE wells continued operating. Subsequent monitoring found elevated ground surface and shallow subsurface temperatures, and venting of smoke and water vapor. With these indicators of a subsurface combustion, Ecology issued Enforcement Order No. DE 10651, effective April 28, 2014, directing recipient PLPs to perform the following three tasks:

1. Develop a work plan to promptly extinguish the Balefill Area subsurface fire, including monitoring activities to verify short- and long-term success of proposed actions.
2. Implement the fire extinguishment activities approved by Ecology.
3. Develop a work plan detailing an engineering and/or operational approach to minimize, to the extent practicable, the potential for future subsurface combustion events within waste materials located near the Zone A perimeter.

The IWAG members and the LFG members submitted separate work plans to Ecology with different approaches to extinguish the Balefill Area subsurface fire. Ecology selected the IWAG members' work plan and approved a revised work plan, which included injecting liquid carbon dioxide to extinguish the fire.

When the carbon dioxide injections had failed to extinguish the fire, the IWAG members submitted the *Final Technical Execution Plan for the Balefill Area Extinguishment and Supplemental Protection Barrier Project* (TEP; AECOM et al. 2015) in 2015, which involved quenching the fire using a water/cement-bentonite slurry mixture. The TEP also provided for installing a slurry wall just outside the drummed waste in Zone A, and installing monitoring probes outside the slurry wall. The IWAG members implemented the TEP by June 2016. Further details are provided in the *Revised Construction Summary Report for the Balefill Area Extinguishment and Supplemental Protection Barrier Projects* (IWAG 2016), submitted to Ecology on October 31, 2016. A revised Enforcement Order Task 3 Work Plan was submitted by IWAG members to Ecology on March 6, 2017. Ecology gave notice to the PLPs in April 2017 that the Enforcement Order was satisfied. The IWAG prepared an analysis of the Balefill Area combustion data and evaluated the causation of combustion. The report on that evaluation is presented in Appendix N.

2.3.2.8 Additional Investigations

In 2016, Ecology requested another heating investigation in Zone A under the AO to determine if subsurface combustion was occurring within Zone A (Zone A combustion investigation). To address Ecology's concern, the IWAG conducted an extensive Zone A investigation and data collection consisting of the installation of 18 rotosonic and 6 bucket-auger borings, the installation of 47 subsurface temperature and gas monitoring points, and the collection of 4 weeks of temperature and gas data from within Zone A. The investigation conclusively demonstrated that combustion has not occurred since startup of the expanded SVE system, is not occurring presently, and is not expected to occur in the future. The results of this investigation are provided in the *Zone A Combustion Evaluation Report* (GSI and SCS Engineers 2017) submitted to Ecology on April 24, 2017, provided as Appendix M.

Non-aqueous phase liquid (NAPL) was observed in one well during ground water level monitoring on June 26, 2017. Sampling of the NAPL occurred on June 26, June 27, and July 10, 2017. Sampling results and additional information regarding the nature and extent of the material was pending at the time this FFS was submitted.

2.4 Environmental Setting

2.4.1 Topography

The NPL Site is situated at approximately 400 feet above mean sea level, in an area of flat terrain and gently rolling hills. An aerial topographic survey of the PSLI Property was performed by the IWAG members during the first quarter of 2013 and is displayed in Figure 2.4.1-1.

2.4.2 Geology and Hydrogeology

The NPL Site is located in the central portion of the Columbia Plateau, a broad plain situated between two mountain ranges—the Cascade Range to the west and the Rocky Mountains to the east. The Columbia Plateau occupies an area of about 64,500 square miles, mainly in eastern Washington and northeastern Oregon (see Figure 2.4.2-1).

The dominant rocks of the Columbia Plateau are the Miocene basalts and sedimentary interbeds of the Columbia River Basalt Group, which range in thickness from 4,000 to 12,000 feet in the Pasco Basin. The Columbia River Basalt Group is overlain by the younger Pliocene rocks of the Ringold Formation deposited as mainstream and sidestream facies of the ancestral Columbia River, and the loess deposits of the Palouse Formation. The Ringold Formation is overlain by glaciofluvial sediments of the Hanford Formation, deposited as a result of the catastrophic flooding from glacial Lake Missoula during the Pleistocene. The Hanford Formation is subdivided into the coarse deposits of the Pasco Gravels and the fine-grained slack-water deposits of the Touchet Beds. A detailed description of the regional geology of the NPL Site and adjacent areas is provided in the Phase I RI Report (see Table 2.4.2-1).

Regional aquifers in this part of the Columbia Basin are present in the Columbia River Basalt Group and the unconsolidated deposits of the Hanford Formation. The Columbia River Basalt Group is the principal aquifer of the Columbia Plateau, consisting of a thick sequence of flood basalts with associated interbedded sedimentary layers.

Many basalt flows are interbedded with fine-grained sedimentary deposits. These interbeds often exhibit low permeability and retard the vertical movement of water between interflow zones. The transmissivity in the region has been reported to range from 500 to 7,400 square feet per day, averaging about 2,600 square feet per day (Tanaka et al. 1979).

Stratified clay, silt, sand, and gravel of the Ringold Formation and glaciofluvial deposits of the Hanford Formation overlie the basalt over much of the region. Loess deposits may also overlie the basalt, but they are usually thin when present. Where the saturated thickness of the glaciofluvial deposits is great, high yields of water can be expected. Well yields from 10 to 1,000 gallons per minute (gpm) are reported for the Ringold Formation, while well yields from 100 to 4,000 gpm have been reported for the glaciofluvial sands and gravels.

The hydraulic conductivity of the Ringold Formation has been reported to range from 0.007 to 0.21 centimeter per second (cm/s), and that of the glaciofluvial deposits has been reported to range from 0.18 to 7.0 cm/s (U.S. Department of Energy 1979).

The primary source of recharge water to the confined aquifers of the Columbia River Basalt Group is precipitation in the northeast areas of the Columbia Plateau where precipitation exceeds 18 inches annually, compared to approximately 7 inches at the NPL Site. Regional ground water east of the Columbia River flows to the southwest, following topography, and discharges along the Columbia and Snake rivers (Widness 1986). The unconfined aquifer in the Ringold Formation and the glaciofluvial deposits are also recharged from precipitation in the higher elevations surrounding the Pasco Basin, as well as downward percolation from the tributaries that originate in the hills and mountains (U.S. Department of Energy 1979).

Direct recharge of the unconfined aquifer at the NPL Site occurs from precipitation and from irrigation. Infiltration from precipitation in the Pasco Basin is minimal. Results of water balance studies in the region indicate that infiltration of rainfall contributes between 0.06 and 0.5 inch annually for non-irrigated portions of the Pasco Basin (Fenn et al. 1975; Gephart et al. 1979; Bauer and Vaccaro 1990). Irrigated farmland is located adjacent to the PSLI Property to the south and east and to the west of Dietrich Road. The U.S. Bureau of Reclamation estimated that 20% to 40% of irrigation water reaches the water table during periods of prolonged irrigation (U.S. Bureau of Reclamation 1971). Similarly, Bauer and Vaccaro calculated that, from an estimated 23.7 inches of irrigation water applied to agricultural areas in the Pasco Basin annually, approximately 12 inches reach the regional aquifer system through direct infiltration (Bauer and Vaccaro 1990).

Additional details concerning the regional hydrogeology are provided in the Phase I RI Report. Figure 2.4.2-2 shows typical shallow ground water elevations and general flow direction across the NPL Site.

2.4.3 Surface Water Hydrology

There are no surface water hydrologic features in the vicinity of the PSLI Property. The closest surface waterbodies are the Snake River and the Columbia River located approximately 2.6 miles southeast and southwest, respectively, of the PSLI Property.

2.4.4 Meteorology

The NPL Site is located in an arid region of the Columbia Plateau that is surrounded on the west, north, and northeast by mountain ranges. The Cascade Mountains to the west shield the region from the moist and relatively mild air of the Pacific Ocean, and the northern stretches of the Rocky Mountains in Canada provide a barrier to the southward-moving arctic air. Mean annual precipitation in the Pasco Basin ranges from approximately 4 to 13 inches, with mean precipitation of approximately 7.5 inches. Winter snowfall averages about 14 inches annually.

The Pasco Tri-Cities Airport climate station (National Weather Service station ID KPSC) has been used for local, continuous weather data courtesy of the National Weather Service, and is located approximately 2.5 miles from the PSLI Property. Based on long-term data from KPSC, the following weather conditions have been observed:

- Monthly precipitation ranges from 0.24 inches in August to 1.42 inches in December.
- High temperatures range from 40°F in December to 92°F in July.
- Low temperatures range from 28°F in December to 58°F in July.
- Average winds range from 5 miles per hour to 8 miles per hour. Maximum winds range from 11 to 16 miles per hour. Gusts of over 25 miles per hour have been observed with large storm events.
- Winds are typically out of the northwest or southwest.

- Barometric pressure averages 30 inches mercury, and ranges from 29 to 31 inches mercury. Barometric pressure changes are greatest in November and December, coinciding with large storm events.

According to the *Stormwater Management Manual for Eastern Washington* (Ecology 2004), the precipitation in Pasco during 24-hour rainfall events range from 0.95 inch for a 2-year mean recurrence interval to 2.28 inches for a 100-year mean recurrence interval, and typically occur during thunderstorms between April and October. According to the nearest Washington State University agricultural weather station (CBC Pasco), the potential evapotranspiration ranges from 0.55 inch in December to 7.75 inches in July.

2.4.5 Ecological Setting

An ecological assessment of the NPL Site was carried out in order to provide the most current ecological conditions of the area and to complete a terrestrial ecological evaluation under MTCA. This assessment was based on the review, search, and evaluation of available information from appropriate federal and state agency online tools and historical and 2013 aerial imagery from Google Earth for land, fish, and wildlife habitats in the region of Franklin County. Overall, the habitat within the PSLI Property and adjacent lands appears to be degraded with little diversity in habitat types. Locally, there are no contiguous habitats due to agriculture and transportation uses.

2.4.5.1 Soils

Soils were assessed for classification and physical properties using the 2012 Web Soil Survey (available from the U.S. Department of Agriculture, under the Natural Resources Conservation Service) for an area of interest of 2,700 acres, surrounding the PSLI Property. All mapped soils showed moderate to high infiltration rates and wind erodibilities; no hydric soils were identified within the area of interest.

2.4.5.2 Wetlands

Wetlands were assessed within and adjacent to the PSLI Property boundary using the 2011 Wetland Mapper, available at the U.S. Fish and Wildlife Service. While the U.S. Fish and Wildlife Service National Wetland Inventory did not map any wetlands within the

PSLI Property, two wetlands were identified approximately 0.2 mile from the southeast property boundary. The two wetlands are hydrologically connected and they appear to be excavated ponds that hold agricultural effluent from irrigation. Irrigation return flows and holding ponds are not typically considered “wetlands” or waters of the United States under the Clean Water Act.

2.4.5.3 Flora

The 1997 *Ecological Assessment – Pasco Landfill* reported that the PSLI Property is almost entirely surrounded by agricultural fields—primarily irrigated alfalfa and potatoes—or residential and light industrial properties. Few native plants were found, and only included the species Sandberg bluegrass (*Poa secunda*) and Indian ricegrass (*Oryzopsis hymenoides*). The only shrub identified was gray rabbitbrush. The vegetation is primarily composed of annual grasses and weeds, including cheat grass, tumble mustard, Russian thistle, and species of knapweed.

In addition, the Washington Department of Natural Resources 2013 Natural Heritage Program website was reviewed for “Rare Plants” in the region of Franklin County. None of the state status species within Franklin County have current or known populations within 10 miles of the PSLI Property (WDNR 2013).

2.4.5.4 Fauna

According to the *1997 Ecological Assessment – Pasco Landfill*, fauna in the vicinity of the PSLI Property included very small populations of burrowing owls, long-billed curlews, and ring-necked pheasants. Additional research for Priority Habitats and Species was conducted by Washington Department of Fish and Wildlife using the online 2013 Priority Habitats and Species maps. Within the PSLI Property boundary, only one priority species was identified in 2010: the greater sage-grouse (*Centrocercus urophasianus*). The burrowing owl (*Athene cunicularia*) was found in several breeding locations very close (within 0.2 mile) to the PSLI Property boundary; these mapped breeding areas range in time from 2001 to 2009. Finally, a waterfowl concentration area was mapped approximately 0.5 mile to the southeast of the PSLI Property boundary.

Additionally, the *Ecological Assessment – Pasco Landfill* reported that species that use the area occasionally or seasonally include rough-legged hawks, red-tailed hawks, northern harriers, ducks, geese, American kestrels, and rodents. According to the Washington Department of Fish and Wildlife, the PSLI Property will likely continue to provide habitat for this limited wildlife community as long as some open space is provided.

2.4.6 Historical and Cultural Resources

A literature search of historical and cultural resources did not identify any known historical or cultural resources in the NPL Site area (DAHP 2013).

2.4.7 Off-property and On-property Ground Water Use

Since 2006, the PSLI Property has been subject to a restrictive covenant that prohibits the following: 1) the use of ground water from existing ground water wells for domestic and agricultural uses; 2) the installation of new ground water wells for domestic and agricultural uses; and 3) the use of the PSLI Property for residential purposes.

In 1995, as part of the NPL Site RIs, it was found that off-property ground water contained chemicals of concern (COC) related to operations on the PSL Property. Drinking water wells in the area were potentially impacted by the off-site ground water plume and well users were provided bottled drinking water beginning in March 1996. In 1997, the PLPs funded the extension of the City of Pasco municipal water supply system east along Lewis Street to connect those users, thereby removing these wells as domestic water supply wells. Sampling of former drinking water wells in the area has been performed as part of the ongoing ground water monitoring.

The ICP stipulates that no new wells for drinking water purposes may be installed within the GPA. Irrigation wells were present before the GPA was established, and continue to operate as non-potable water supply. State regulations prohibit the installation of water supply wells within 1,000 feet of the boundary of previously permitted MSW landfills (WAC 173-160-171).

2.5 Overview of Waste Repositories and Waste Management Areas

2.5.1 Municipal Solid Waste Landfill, Burn Trenches, Balefill Area, and Inert Waste Disposal Area

2.5.1.1 Disposal History

For the purposes of the FFS, the following synopsis provides a history leading up to the RI and the IAs for the MSW disposal areas, including the MSW Landfill, Burn Trenches, Balefill Area, and Inert Waste Disposal Area. Table 2.5.1-1 presents the MSW disposal operations chronology in more detail. Figure 2.5.1-1 shows the historical MSW Landfill area. A more comprehensive history is provided in the Phase I RI Report, which was compiled based on aerial photos, permitting and operational records, and interviews. A brief history is provided as follows:

- **1958 to 1993 –** Refuse was disposed at MSW Landfill. Open burning ended in 1971.
- **1959 to 1965 –** Disposal and open burning take place in two east-west trenches (BT-1), and later in two north-south trenches (BT-2).
- **1976 to 1993 –** Baled MSW was accepted at the PSL Property and landfilled in the area east of Zone A. MSW that was considered inert was placed in Inert Waste Disposal Area.

2.5.1.2 Key Remedial Investigation Findings

This section addresses key RI findings relative to the MSW Landfill. Figure 2.5.1-1 shows the locations of the MSW Landfill, Burn Trenches (BT-1 and BT-2), Balefill Area, and Inert Waste Disposal Area. Historical locations of the septic lagoons (SL-1, SL-2, and SL-3), Landspread Area, and Sludge Management Area are also shown on Figure 2.5.1-1. Figure 2.5.1-2 is a north-south cross section depicting the approximate vertical extent of MSW, and maximum observed ground water levels.

MSW Landfill wastes were reportedly placed in topographic low points, with little or no pre-excavation. The deepest MSW is inferred to be present on the north end of the MSW Landfill, based on the depths of landfill gas extraction wells. The current amount of separation between the bottom of MSW Landfill waste and the current water table is uncertain, but is estimated to be no more than 8 feet. The bottom of the wastes in the

Burn Trenches and Balefill Area is uncertain and is estimated to be approximately 30 feet above the ground water table based on current minimum topographic elevations in the vicinity and an evaluation of the sideslopes for the disposal areas.

2.5.1.2.1 Nature of Waste and Contaminants

The nature of waste and contaminants for the MSW disposal areas is addressed within the framework of likely current and future conditions, based on the disposal history described above.

The MSW disposal areas received MSW, light industrial wastes, commercial wastes, and agricultural wastes. Waste consolidation practices included open burning prior to approximately 1971. Daily soil cover included soils from the Landspread Area. The Balefill Area received primarily baled MSW including whole and shredded tires. The Inert Waste Disposal Area received tires, stumps, brush, and construction debris including concrete and wood.

Soil vapor probes were installed during the RI in the vicinity of the MSW Landfill to monitor for potential landfill gas migration. The subsurface monitoring probes were completed in the shallow, intermediate, and deep portion of the vadose zone. Landfill gas migration was observed in 1995 and 1996 at soil vapor probe locations LFG-01, LFG-02, LFG-03, and LFG-04 (Figure 2.5.1-1) based on elevated concentrations of methane, carbon dioxide, and selected VOCs.

2.5.1.2.2 Hydrogeology and Ground Water

Ground water flow direction and velocities were determined during the RI. In the vicinity of the MSW Landfill, ground water flows to the southwest with seepage velocity estimated in the range of 10 to 28 feet per day with an average seepage rate of 21 feet per day. The average seepage velocity was calculated based on an average horizontal hydraulic gradient of 0.0052, a hydraulic conductivity of 1,219 feet per day, and 30% porosity (Phase I RI Report, Section 4.7.6). The hydraulic gradient flattens to the south, potentially resulting in lower ground water velocities downgradient of the MSW Landfill.

The depth to ground water across the NPL Site varies primarily due to topography and the southwesterly ground water gradient (see Figure 2.5.1-2). On the south end of the MSW Landfill, the ground water table is approximately 60 feet below ground surface (bgs) at the mapped extent of waste. On the north end of the MSW Landfill, the ground water table is approximately 15 feet bgs at the mapped extent of waste. Landfill gas extraction well EW-20 was drilled closest to the water table (to approximately 372 feet elevation North American Vertical Datum 1988 [NAVD 88]), and the bottom of waste was not defined at this location. No wells or borings have penetrated the full thickness of waste in the landfill area so the vertical extent and separation between waste and ground water is uncertain, but is estimated to be no more than approximately 8 feet above the water table (see Figure 2.5.1-2).

Seasonal ground water level changes have been observed to fluctuate approximately uniformly and have not significantly affected ground water flow direction or velocity. The seasonal high ground water table is typically observed during the second quarter of the year, and the seasonal low ground water table is typically observed during the fourth quarter of the year. The difference between high and low ground water levels in the vicinity of the MSW Landfill is approximately 2.5 feet on average. The Phase I RI Report (pp. 4–20) referenced the 1954 to 1972 period when ground water levels in the Pasco area rose 20 feet due to changes in agricultural irrigation practices. The Phase I RI Report also indicated that ground water levels did not rise significantly between 1972 and 1993. Figure 2.5.1-3 provides historical measurements of depth-to-water in selected monitoring wells.

VOCs were detected in MSW Landfill monitoring wells at concentrations above the MTCA Method B formula values in effect during the Phase II RI. These VOCs included perchloroethylene (PCE), trichloroethylene (TCE), 1,1-dichloroethylene (1,1-DCE), vinyl chloride, 1,2-dichloroethane (1,2-DCA), 1,2-dichloropropane, 1,4-dichlorobenzene, and acrylonitrile.

The potential for ground water impacts from Burn Trench BT-1, the Balefill Area, or the Inert Waste Disposal Area is considered small given the limited volume of the waste and the limited potential for a contaminant transport pathway in the vadose zone. Any ground water impacts beneath or downgradient of Burn Trench BT-1, Balefill Area, and Inert Waste Disposal Area may be sourced in the proximal IWAs.

2.5.1.2.3 Air Quality Impacts

The potential for air quality impacts was not discussed in the Phase I and Phase II RI reports.

2.5.1.3 Overview of Interim Actions

An overview of historical IAs below provides context for the selection of retained cleanup action alternatives.

2.5.1.4 Overview of Interim Actions

In 2002, under the Landfill Agreed Order, the MSW Landfill was capped with an engineered cover system, an active landfill GCCS was installed, and operations and maintenance (O&M) manuals were prepared (*Operations and Maintenance Manual, Landfill Gas Collection Control and Flare*, PSC 2002a; *Operations and Maintenance Manual for Landfill Caps, Volumes I and II*, PSC 2002b). These IAs were implemented in agreement with the approved closure plan (Woodward-Clyde 1996), and based on the "Presumptive Remedy for CERCLA Municipal Landfill Sites" (EPA 1993). Between 2002 and 2012, the LFG members completed tasks required by the Landfill Agreed Order, including the following examples:

- Balanced landfill gas collection to prevent ground water impacts and address decreasing methane concentrations
- Performed a stack test on the landfill flare to confirm treatment of VOCs
- Operated and maintained the flare to manage landfill gas and optimize treatment of VOCs in landfill gas and from the Zone A SVE system
- Condensate from the GCCS was sent to the flare for destruction until 2010 when a stack test demonstrated lower VOC destruction efficiency during condensate injection. Since 2010, GCCS condensate has been disposed off site as non-hazardous waste.
- Monitored subsurface landfill gas, and expanded the landfill gas monitoring probe network around the perimeter of the MSW Landfill, to ensure landfill gas migration is prevented
- Conducted regular inspections of the landfill cover systems to ensure the cover was in good condition and preventing potential fugitive emissions, infiltration of precipitation, and direct contact by humans or terrestrial receptors

- Prepared routine quarterly and annual reports regarding the MSW disposal areas, and other IA reports, for Ecology[7]

Ecology gave notice in March 2013 that the provisions of the Landfill Agreed Order were satisfied.

Since 2012, the LFG members have completed required tasks under Agreed Order DE-9240, including the following examples:

- Continued operation, maintenance, monitoring, and reporting of IAs for the MSW disposal areas
- Updated the Operations and Maintenance Manual for the MSW Disposal Areas
- Implemented initial response and soil cover repairs in the vicinity of a subsurface fire in the Balefill Area near Zone A
- Installed (then decommissioned) a supplemental fuel system for the flare to continue treating contaminated Zone A soil vapor while methane generation rates decreased
- Installed landfill gas probes in the Balefill Area and Inert Waste Disposal Area to investigate subsurface conditions
- Prepared an FFS for the MSW disposal areas

The IAs for the MSW disposal areas are in good condition, and have demonstrated protection of human health and the environment. The following subsections discuss an overview of IAs to provide context for their selection as preferred remedial alternatives (discussed in Sections 5 and 6).

2.5.1.4.1 Soil Covers

In 1993 most of the MSW disposal areas were initially closed with soil covers, consistent with permitting requirements at the time. The soil covers provided a physical barrier to

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[7] A summary of reports produced by the LFG members since 2005 is provided in Table 2.5.1-2.

MSW, an evapotranspiration cover, and a habitat for methane oxidizing bacteria. The following provides information on soil covers for each MSW disposal area:

- The interim MSW Landfill soil cover was reinforced with an engineered cover system in 2002.
- The Burn Trench BT-1 soil cover is approximately 6 feet thick at the east end based on the monitoring well log for EE-7.
- The Burn Trench BT-2 soil cover was reinforced in 2002 with the engineered cover system for Zone A.
- The Balefill Area and Inert Waste Disposal Area soil covers were originally placed where MSW was leveled to the extent practicable.
  - In the Inert Waste Disposal Area, there is no cover system in place (Aspect 2012).
  - The soil cover for the Balefill Area has been subject to wind erosion and soil cracking in some areas.
  - Near the northeast side of Zone A, the Balefill Area soil cover was repaired between 2013 and 2015 as part of the Balefill Area subsurface fire investigation and extinguishment effort.
  - A soil cover restoration was proposed to Ecology in the *Draft Operations and Maintenance Manual: MSW Disposal Areas* (Aspect 2012).
  - Implementation of the soil cover restoration at the Balefill Area and Inert Waste Disposal Area, as described in the Operations and Maintenance Manual (Aspect 2014a, Aspect 2016), is planned following public review of the CAP (per Ecology 2013).

2.5.1.4.2 Engineered Cover and Landfill Gas Collection and Control System

Pursuant to the Landfill Agreed Order, two IAs for the MSW Landfill were implemented.[8] An engineered cover and a landfill GCCS were designed and installed at the MSW Landfill, consistent with the presumptive remedy for CERCLA municipal landfill sites (EPA 1993); the presumptive remedy is containment with engineering controls to prevent impacts to human health and the environment.

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[8] The Landfill Agreed Order did not specify IAs for the Burn Trenches, the Balefill Area, or the Inert Waste Disposal Area.

The IAs implemented at the MSW Landfill have eliminated direct exposure to MSW or landfill gas, ground water impacts from landfill gas or leachate generation due to precipitation infiltration, and air quality impacts due to fugitive emissions of landfill gas. Construction detail for the engineered cover and the GCCS is provided in the *Operations and Maintenance Manual: MSW Disposal Areas* (Aspect 2014a).

The engineered cover system and the GCCS are in good operating condition. The MSW Landfill cover and associated infrastructure have been inspected and maintained following the *Operations and Maintenance Manual for Landfill Caps*, *Volumes I and II* (PSC 2002b) and the *Operations and Maintenance Manual: MSW Disposal Areas* (Aspect 2014a). The cover condition is observed monthly during landfill gas monitoring events, and reported annually. Stormwater collection infrastructure associated with the cover is inspected monthly and reported annually. Cover surface methane monitoring is conducted quarterly and reported annually. Based on the MSW Landfill cover system design and current status, there is limited potential for precipitation infiltration and subsequent leachate generation. Minor wind erosion of the topsoil layer of the cover has been occasionally observed and repaired. No visually observable differential subsidence or settling of the MSW cover system has been observed since 2002. The GCCS components and operations have been modified to handle decreasing landfill gas generation rates.

The GCCS has been, and will continue to be, operated to optimize methane collection rates, control potential landfill gas migration, and minimize the potential for a subsurface landfill fire.

Monitoring for potential landfill gas migration has been conducted quarterly since 2009 per the O&M manuals (PSC 2002a; Aspect 2014a), and includes surface, structure, and perimeter probe monitoring. The landfill gas migration monitoring probe network was expanded in 2010 to provide three additional monitoring locations around the MSW Landfill perimeter. Stack temperatures during this period varied as a result of barometric influences on landfill collection rates, and the stack occasionally shut down automatically when temperatures exceeded the allowable range. Modifications were made to the flare system in 2009 to allow automated stack temperature control, and in 2010 to measure and control louver inlet flow to the flare. Since these modifications, stack temperatures and landfill collection rates have been relatively stable.

2.5.1.4.3 Subsurface Fire Investigation and Extinguishment Effort

In 2013, a small area of differential settlement in the Balefill Area near the northeast corner of Zone A was observed, and was later associated with the subsurface fire discussed in Section 2.3.2.7. Initial response by the LFG members included repairing the soil cover, recommending reduced SVE system influence, and monitoring the soil cover for additional differential settlement, elevated temperatures, and emissions. Subsequent subsurface fire investigation and extinguishment efforts by the IWAG members were conducted, including installation of subsurface thermocouples and vapor monitoring probes, injection of 128 tons of liquid carbon dioxide, and placing 4,200 cubic yards (CY) of slurry in Zone A, for a barrier wall, and the Balefill Area (IWAG 2016). The extinguishment efforts were successful.

2.5.1.4.4 Balefill and Inert Waste Disposal Areas Investigation

In 2017, the Balefill and Inert Waste Disposal Areas were investigated by drilling to determine MSW thickness and install probes in MSW, and by monitoring landfill gas conditions, subsurface temperatures, and the extent of vacuum influence from the Zone A SVE system. The MSW thickness was approximately 20 to 25 feet thick. Landfill gas contained less than 7% methane and little to no carbon monoxide. Subsurface temperatures were less than 120°F, and found to be warmer near Zone A.

2.5.1.5 Current Environmental Conditions

The current environmental conditions for MSW disposal areas are summarized below:

- The IAs at the MSW disposal areas have achieved RAOs.
- All COCs in ground water have been nondetect or below draft cleanup levels (dCULs) at MSW Landfill monitoring wells since 2014, based on results of protection monitoring.
- Recent monitoring within the Balefill Area and Inert Waste Disposal Area confirms little to no landfill gas is being generated. No methane was detected above the soil cover in 2014.

- Landfill gas collection and treatment at the MSW Landfill has been protective of air quality, based on routine methane monitoring at perimeter gas probes and the MSW Landfill surface, and results of stack tests and analysis.
- Geochemically, ground water quality at the MSW Landfill monitoring wells has remained similar to background water quality since 1995. There has been little to no indication of leachate impacts in ground water.
- Although ground water levels increased between approximately 2000 and 2010, ground water levels have since decreased. Ground water has not come in contact with the bottom of MSW at the north end of the MSW Landfill.
- There has been no indication of subsurface fire in the Balefill Area or the Inert Waste Disposal Area since 2015.

The MSW disposal areas are in compliance with requirements specified in Agreed Order DE 9240. As described above, ground water and air quality have been, and continue to be, protected by closure activities and IAs at the MSW disposal areas. The post-closure O&M of the MSW Landfill are in compliance with applicable MSW regulations, including WAC 173-304 and WAC 173-351.

The following subsections address projected future conditions supporting the preferred remedial alternatives.

2.5.1.5.1 Projected Landfill Gas Generation

Landfill gas generation rates are projected to continue decreasing over time as shown in Figure 2.5.1-3. An assessment of landfill gas generation from the MSW Landfill was included in the final *Pasco Sanitary Landfill Closure Plan* (Woodward-Clyde 1996), and has been updated and compared with actual landfill gas collection rates. Past and future landfill gas generation rates were calculated for the MSW Landfill, the Balefill Area, and the Burn Trenches using EPA's LandGEM model (2005), and reports are provided in Appendix I. Model input included the MSW disposal area mass and age, and model settings were selected based on default values for the arid conditions to best match observed collection rates. In 2017, the calculated methane generation rates for the MSW Landfill, the Balefill Area, and the Burn Trenches were approximately 80, 5, and 0.5 cubic feet per minute, respectively.

Methane collection at the MSW Landfill has been less than one-third of the calculated value, indicating that the LandGEM model results are biased high for the MSW disposal areas.

2.5.1.5.2 Projected Flare Replacement

Because the existing enclosed flare is no longer required to treat SVE off-gas, an alternative treatment technology for landfill gas may be implemented, subject to Ecology approval. An example is the Solar Spark CF-10 flare (http://solar-spark.com/), capable of treating across the range of projected landfill gas generation rates. This treatment technology would be plumbed into the existing infrastructure and the existing enclosed flare would still be available as a backup.

Eventually, treatment of landfill gas will not be required because emissions will decrease to below air quality threshold levels, and the landfill gas may be directly discharged to atmosphere. It is common for older landfills to passively vent small amounts of landfill gas directly to the atmosphere.

2.5.1.5.3 Projected Ground Water Protection

The ground water monitoring wells for the MSW Landfill include an upgradient well (NW-1), on-property wells (MW-16S, 4R, and MW-17SR), and property-boundary wells (MW-22S and MW-23S). These monitoring wells have been used to monitor the effects of IAs at the MSW Landfill on ground water quality. The ground water monitoring well network for the MSW Landfill should be sufficient for future performance and confirmational monitoring.

Ground water levels at the NPL Site have fluctuated over time, likely due to agricultural irrigation practices in the region. Figure 2.5.1-4 shows that observed ground water levels at MSW Landfill monitoring wells are currently going down. The cause of ground water level change at the NPL Site is not related to remedial activities. Projected ground water levels are assumed to remain within the historical range, and the bottom of MSW in the MSW Landfill is assumed to remain above ground water.

Low-level VOC ground water impacts have been present beneath the MSW Landfill and hydraulically downgradient to the west and southwest of the MSW Landfill. VOC concentrations in ground water at the MSW Landfill monitoring wells have decreased significantly since capping and initiation of landfill gas collection. VOC levels near the MSW Landfill have historically been low and have been below dCULs since 2014, as shown in Figure 2.5.1-5. Based on decreasing trends, PCE concentrations are projected to remain below the dCUL in the future. No statistically significant ground water impacts for other contaminants have been observed, supporting the Conceptual Site Model (CSM) in that there is little to no liquid-phase transport from MSW to ground water.

2.5.2 Land Application Areas

All MSW formerly present in the land application areas was excavated and transferred to the MSW Landfill prior to landfill closure. No further action was proposed for the Landspread Area in the Ecology-approved *Focused Feasibility Study Work Plan* (FFS Work Plan; Anchor QEA et al. 2013). No further action is proposed in this FFS. A summary of disposal history and key RI findings is provided below as background information.

2.5.2.1 Disposal History

This section provides a synopsis of the land application disposal history for the MSW Landfill, which included the disposal of liquid and dried septic tank waste, sewage sludges, and animal fat emulsion coolants. A comprehensive history of land application disposal activities is provided in the Phase I RI Report.

Throughout much of the MSW disposal period, the MSW Landfill was permitted for disposal of various non-hazardous bulk liquids such as septic tank waste, sewage sludges, and animal fat emulsion coolants. These materials were disposed at lagoons (approximately 1976 to 1989), applied to the ground in the Landspread Area and Sludge Management Area (approximately 1981 to 1989), and applied directly on the MSW Landfill (approximately 1981 to 1987). The residual non-hazardous waste and associated surface soils from the Landspread Area were used as daily cover for the MSW Landfill or transferred to the MSW Landfill during installation of the interim soil cover by the end of 1993.

2.5.2.2 Key Remedial Investigation Findings

Soils from the land application areas were excavated and transferred to the MSW Landfill as daily cover during operations from the late 1970s through the early 1990s. The RI identified no COCs in soil or ground water for the land application areas. A complete summary of findings relative to the land application areas can be found in Section 3.10 of the Phase II RI Report (PSC 1998a).

No further action was proposed for the Landspread Area in the Ecology-approved FFS Work Plan.

2.5.3 Zone A

2.5.3.1 Disposal History

Table 2.5.3-1 presents a chronology of waste disposal operations in the vicinity of Zone A. A detailed description of waste disposal at Zone A is provided in Section 3.6 of the Final Phase I RI Report.

No other active waste disposal is known to have occurred within Zone A since the end of 1979.

2.5.3.2 Key Remedial Investigation Findings

As noted above, the NPL Site has undergone multiple phases of RI and data collection since 1984. Moreover, Zone A has undergone additional data collection as a component of the Phase I and Phase II Additional Interim Actions (AIAs), the 2012 subsurface heating evaluation (see Appendix K; Anchor QEA et al. 2012), and the 2017 Zone A combustion investigation (see Appendix M; GSI and SCS Engineers 2017).

The key Zone A investigative findings resulting from those multiple data collection efforts are presented below:

- Approximately 35,000 drums of industrial waste were placed in Zone A between April 1972 and December 1974. The drums contained a variety of chemicals including paint waste, metal cleaning and finishing waste, wood preserving waste, metal etching, and pesticides. Drums were initially placed randomly until about mid-1972 followed by placement of stacked drums until mid-1974. Borings through the randomly placed drum area indicated that these drums were likely crushed during or after disposal and lost a significant portion of their liquid fraction after placement. Stacked drums were placed four high and were periodically covered with native soils.

- The Zone A cell was placed on reworked native soils, some of which included burned municipal waste. No leachate collection or control system was constructed beneath the Zone A cell.
- Zone A is bordered on the eastern side with baled MSW, on the southeastern side by inert waste (some of which lies on top of baled MSW), and on the northern side by areas of undocumented MSW. The Balefill Area combustion extinguishment action and installation of the soil-cement-bentonite barrier wall found that a significant number of buried tires, shredded and intact, were disposed in these areas.
- COCs have been detected in the soil beneath Zone A. These COCs include VOCs, semivolatile organic compounds (SVOCs) and herbicides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbon (PAHs), and metals.
- COC concentrations in the soil beneath Zone A potentially are the greatest immediately above or within the Touchet Beds and transition zone soils, with substantial decreases in concentration within the Upper Pasco Gravels.
- Historic migration of COCs in the soil column beneath Zone A potentially occurred through several mechanisms, with the primary mechanisms being the downward liquid migration and vapor-phase migration. Recent soil quality data from beneath Zone A confirm that the current pathway for COCs to reach ground water occurs by vapor-phase transport to the water table, and subsequent vapor to aqueous-phase partitioning. The presence of non-VOCs is considered a remnant from prior releases at the NPL Site that occurred before the IAs were implemented, so no current mechanism of fate and transport is considered significant as long as IAs are maintained and operated.
- The concentration data for soil samples from beneath Zone A are not sufficiently high to suggest saturated contaminant flow through the vadose zone to ground water. Field observations of recovered soil samples also did not indicate saturated conditions or free liquid in the Upper Pasco Gravels between Zone A and ground water.
- Contaminated soils beneath Zone A appear to be biologically active. The biological

activity is indicated by elevated carbon dioxide and temperature with depressed oxygen in SVE extraction wells and in the Zone A combustion investigation temperature and gas monitoring points within Zone A. Biologic activity is also indicated by carbon and oxygen isotope analyses of carbon monoxide, carbon dioxide, and methane; the presence of nitrous oxide beneath Zone A; and the taxonomy of biological growth in a Zone A SVE well. The confirmed biological activity is resulting in degradation and mineralization of some and possibly a significant mass of COCs beneath Zone A.

- The lateral extent of COCs in soil beneath Zone A is limited to the general footprint of the low permeability cap (the cap includes a high-density polyethylene [HDPE] liner with a permeability to water on the order of 10^{-13} cm/s).
- COCs in ground water beneath Zone A are largely limited to VOCs at individual concentrations that currently are well below solubility limits, and are consistent with equilibrium partitioning between soil vapor and ground water. Low concentrations of compounds other than VOCs have also been detected in ground water, but these are well below MTCA Method B concentrations and, therefore, have not been included in development of dCULs (see Section 4). These non-VOCs detections are likely due to water vapor transport in the subsurface as most of the non-VOCs observed in ground water would be solids at environmental temperatures. The IAs are protective of transport by water vapor as the large mass of condensate removed by the SVE system contains concentrations of non-VOCs.
- Degradation of COCs in ground water beneath Zone A is likely also occurring as evidenced by low oxygen and oxidation reduction potential (ORP) at some wells in the vicinity of Zone A and the presence of daughter products such as cis-1,2-dichloroethylene in ground water.
- COCs in ground water near Zone A are largely restricted to the shallow portion of the aquifer. Concentrations of COCs in ground water attenuate with distance from Zone A given the much lower concentrations south of the PSLI Property compared to the historical concentrations on the property. Only limited vertical migration of COCs occurs between Zone A and the property boundary, as confirmed by water quality data from the property boundary wells MW-11S and MW-11I.

2.5.3.3 *Overview of Interim Actions*

Ecology accepted the 1999 FS Report but approved ongoing NPL Site remedies as IAs and specified a 5-year monitoring period to document the effectiveness of the remedies. Following the monitoring period, Ecology specified AIAs to further assess the effectiveness of NPL Site remedies. The performance of IAs and AIAs is detailed in the historical reports listed in Table 2.5.3-2. IAs and AIAs at Zone A consist of the following:

- A cover system was installed in 2002, consisting of, from top to bottom, the following:
  - Vegetative surface layer consisting of native soil fill
  - Woven geotextile
  - Drainage layer consisting of well-sorted coarse sand
  - 40-mil HDPE geomembrane coupled with an underlying geosynthetic clay liner (GCL)
  - Engineered fill material consisting of on-property Touchet Beds soils
  - Geogrid stabilization fabric placed on the original native soil Zone A surface
- Cap maintenance was performed in 2011 in response to differential settlement observed in three isolated areas totaling approximately 0.1 acre. Cap maintenance consisted of regrading, placement of additional fill material, placement of an umbrella HDPE liner in the areas of settlement, and placement of new vegetative cover. The cap is monitored on a bimonthly basis for further differential settlement.
- Installation and operation of extraction wells and operation of an SVE system occurred in 2002. Following modifications to the existing SVE system to maximize capture, the SVE system was expanded to include five extraction wells and three vapor monitoring wells. The system operation was modified in 2010 to operate only with wells VEW-04 and VEW-05, which were shown to provide the most effective area of capture and provided the greatest amount of contaminant mass capture among the SVE wells installed prior to 2010.
- Installation and operation of a NoVOCs™ in situ air sparging and treatment system occurred in 2002. The initial system consisted of two wells followed by a period of operation and observation. The system was later expanded to a total of four NoVOCs™ wells and four observation wells. The use of the NoVOCs™ system was discontinued in 2008, with Ecology's concurrence and approval, due to data

indicating insufficient treatment effectiveness. The NoVOCs™ wells were decommissioned in 2010 as directed by Ecology.

- Expansion and upgrading of the SVE system occurred in 2010 and 2011 to include new wells located within Zone A. These wells are screened within shallow, intermediate, and deeper portions of the vadose zone. The system upgrade also included additional monitoring points beneath the HDPE liner, within the intermediate and deep portions of the vadose zone, and within the saturated zone immediately beneath Zone A. The system upgrades included the addition of two positive-displacement vacuum blowers to the existing regenerative blower and additional controls, instrumentation, and automation of the system.
- Installation of a regenerative thermal oxidizer (RTO) to treat and destroy exhaust VOCs from the SVE occurred in September 2015 as a replacement for the MSW Landfill flare. The RTO was provided by Gulf Coast Environmental Systems (GCE) and was operated from October 2015 through December 2016. The RTO was subject to the Ecology-issued Pasco Sanitary Landfill Approval Order No. 14 AQ-E571 dated July 30, 2015 (Ecology 2015). However, the RTO did not operate as designed, and a Notice of Violation #13230 was issued by Ecology on April 4, 2016, to address permit exceedances.
- Installation of a rental thermal oxidizer (TO) occurred in December 2016 to replace the GCE RTO while a replacement RTO was designed. The rental TO system operated in accordance with Administrative Order Docket #13922, dated November 29, 2016, which outlines the specific operations parameters. A new RTO system designed by Anguil Environmental Systems, Inc. (operating under Approval Order 16AQ-E031) was installed in June 2017.

2.5.3.4 Current Status of Interim Action Operations

The currently active IAs at Zone A include monitoring and maintenance of the existing cap system, O&M of the expanded SVE system, and O&M of the SVE treatment system.

The current cap is fully intact and maintained as required. The cap covers the full extent of Zone A and minimizes any precipitation infiltration from entering Zone A. As noted above, maintenance of the Zone A cap was conducted in 2011 to address subsidence and localized areas of closed depressions. The cap and the former closed depressions are surveyed every 2 months to monitor for differential settlement. In addition, the Zone A cap undergoes a monthly inspection and those inspection reports are provided to Ecology in the annual reports for the NPL Site. Additional information on cap monitoring is available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E* (EPI 2013). Although localized differential settlement has occurred on the cap, there is no indication that the cap has failed with respect to inhibiting precipitation infiltration.

The SVE system at Zone A has been operating since 1997. An SVE system upgrade plan (EPI 2010a) began in 2010 with the objective of providing increased vertical and lateral zones of capture and potentially higher rates of mass removal. This was accomplished by installing multi-depth extraction wells within the Zone A cap. The plan included two groupings of three SVE wells each installed in shallow, intermediate, and deep portions of the vadose zone within the north central and south central areas of Zone A. These wells, VEW-06S/I/D and VEW-07S/I/D, were completed in 2010 and subsequently tested. System modifications have been made to the SVE equipment in response to the testing results.

The extracted soil vapor was sent to the rental TO for treatment through thermal oxidation until July 2017. A new RTO system was installed in June 2017 to treat and destroy exhaust VOCs from the SVE system while meeting mass emission permitted limits. Ecology issued Approval Order No. 16AQ-E031 on May 2, 2017, in response to the Notice of Construction application submitted on October 26, 2016. The Approval Order is not expected to significantly affect overall SVE operations, as all six SVE extraction wells are expected to be operated at flow levels that will be effective for adequate removal of contamination and assurance of continued and long term compliance with cleanup levels (CULs) at the points of compliance (POCs).

2.5.3.5 Current Environmental Conditions

Zone A remains capped and within a signed, fenced, and restricted access enclosure. The cap is maintained and monitored. There are approximately 40 to 50 feet of vadose zone soils between the bottom of Zone A wastes and the water table. There is no physical access or exposure to contaminated soil by humans or terrestrial ecological receptors within Zone A.

Ground water is present at about 60 to 70 feet below grade at an elevation of about 355 feet above mean sea level. Ground water migration is southwesterly in the area of Zone A. There is no direct exposure to human or ecological receptors to ground water beneath Zone A.

Exposure to vapors is not a concern because Zone A is fully capped with an HDPE membrane and is under the influence of an SVE system with a radius of capture that extends beyond the geomembrane. During operation of the SVE system, there are no nearby receptors or occupied buildings within or immediately adjacent to Zone A that would present potentially completed exposure pathways. In the event of an extended SVE shutdown, Zone A-related soil vapors potentially could migrate and create a possible exposure point at or near ground surface at the edge of the cap or within nearby structures. Only one building located on the north end of the Basin Disposal, Inc. facility is within 100 feet of the edge of the Zone A liner and could potentially be considered a point of exposure for vapor intrusion in the event of a long-term shutdown of the SVE system (Ecology 2009a). The current ICs prohibit activities that could compromise the IAs in place, such as building new structures on the PSLI Property.

Current data indicate that certain volatile COCs within Zone A are migrating primarily in the vapor-phase through soil and to ground water. COCs enter ground water primarily through vapor-phase to aqueous-phase partitioning.

Concentrations of VOCs in wells at the NPL Site have overall continued to decrease since January 2011. The COC concentrations observed in ground water at the NPL Site are generally low and throughout the majority of the NPL Site are near or below detection limits. Low COC concentrations of compounds other than VOCs have also been detected in ground water, but these chemicals are well below MTCA Method B values and, therefore, have not been included in development of dCULs for the NPL Site.

Completed in 2012, the SVE system underwent modifications to enhance the recovery of VOCs from within Zone A. Two well clusters (each containing one shallow, one intermediate, and one deep well) were installed within this zone to accelerate the VOC removal and further protect ground water. An automated condensate removal system was constructed within the SVE system to eliminate manual condensate removal and additionally enhance the SVE system's capability. Automated devices were installed within SVE lines to measure and track flows, pressures, temperatures, and other data. Following upgrades to the SVE system, VOC removal rates substantially increased as shown by the cumulative mass removed graph included as Figure 2.5.3-1. Mass removal rates increased substantially in 2012 with the addition of the shallow, intermediate, and deep wells. As presented in Figure 2.5.3-1, approximately 440,000 pounds of VOCs were removed by the SVE system over the 15-year period between 1997 and 2012. Since the 2012 upgrade of the system to present, the SVE system removed an additional 610,000 pounds of VOCs and an approximately equal amount of aqueous liquid as condensate in less than 3 years. The increase in mass removal based on SVE system upgrades also resulted in dramatic improvement of ground water quality downgradient of Zone A. VOC concentrations have decreased to nearly undetectable levels in almost all ground water monitoring wells. Empirical data have validated the CSM for Zone A and demonstrate that the vapor to ground water pathway is successfully interrupted during SVE operation. When operated as designed, the SVE system has proven to remove sufficient volumes of Zone A soil vapors to effectively eliminate ground water impacts. Routine SVE system and ground water monitoring ensures that the SVE system is performing as it is intended and is providing continual benefit to ground water conditions.

The large amount of mass removal has coincided with observed differential settlement of the cap in the vicinity of the stacked drum area. This settlement is likely the result of the successful removal of contaminant mass in the soils surrounding drums and drum degradation and collapse. The Zone A combustion investigation (see Appendix M) found limited amounts of putrescible waste and encountered a predominantly soil matrix as discussed in Section 2.6.1. No substantially intact layers of MSW were encountered in Zone A to account for the observed settlement, leading to the conclusion that decomposition of putrescible waste or combustion of MSW are not factors in the observed settlement.

Prior to October 2015, SVE vapors were treated and destroyed at the flare located adjacent to the MSW Landfill. Due to flow rate and loading limitations at the flare, mass removal by the SVE system was restricted. To overcome the limitations of the flare, the IWAG installed an RTO adjacent to the SVE blower building on the PSLI Property in October 2015. During testing, it was determined that the RTO did not operate as designed and could not achieve permitted emission rates. Consequently, the IWAG commissioned a new RTO and installed a rental TO in December 2016, while the new RTO was designed and built. The new RTO was installed in June 2017 and began operation in July 2017. The new RTO included design enhancements to overcome several limitations that had restricted optimum operation of the SVE system. These design enhancements included the ability to operate the SVE system at higher flow rates and mass loading than those previously achieved by the flare.

Further optimization of mass removal and destruction can be achieved by addressing a number of restrictions imposed on the SVE/RTO system by Ecology. These restrictions include Approval Order limitations on hydrochloric acid (HCl) emissions and SVE well operating temperature. The HCl emission restriction can be addressed by installation of an acid scrubber system at the RTO or by obtaining a Title V Permit under the Federal Clean Air Act.

To-date Ecology has restricted use of SVE wells with vapor temperatures above 140°F. Higher operating temperatures may be allowed by obtaining higher operating values (HOV) for the SVE wells. An HOV is allowed under the New Source Performance Standard (NSPS). The NSPS requires monitoring wellhead temperature, pressure, and oxygen or nitrogen during operation. Temperature, pressure, and oxygen are currently monitored at all operating SVE wells and, therefore, current operation of the SVE wells already meets the NSPS requirements for an HOV. If an HOV is not allowed by Ecology, additional SVE wells could be installed in areas of Zone A where lower vapor temperatures are present to increase mass removal and destruction by targeting those areas with the highest COC concentrations in soil vapor.

As noted above, the SVE system has demonstrated the ability to achieve the objective of protecting ground water quality. Optimization of mass removal and destruction by addressing HCl emissions and operating SVE wells under an HOV provides a means of removing and destroying contaminant mass in Zone A and eventually reaching a point where sufficient mass has been removed to allow shutdown of the SVE system (Appendix J).

2.5.4 Zone B

The general history of disposal at Zone B, an overview and current status of Zone B IAs, and a description of current environmental conditions at Zone B are provided in this section. A general site plan for Zone B is provided in Figure 2.5.4-1a. In reading this section, it should be recognized that the entire area where these activities took place was placed under a RCRA-compliant cap during May and June 2013 as part of an IA approved by Ecology.

2.5.4.1 Disposal History

Between approximately 5,200 and 5,400 drums of 2,4-D tar, 2-methyl-4-chlorophenoxyacetic (MCPA) bleed, and other herbicide manufacturing wastes were disposed of at the former Zone B repository cell by RRC from December 1972 through October 1973 (Burlington Environmental 1994; PSC 1998a, 1999). At the time that this waste was disposed in the Zone B repository cell, the facility was approved by the BFDHD for management of industrial wastes (BFDHD 1972).

A polyethylene cap and a soil cover of unknown thickness were reportedly placed over Zone B in 1976 (PSC 1998a), and a soil cover, approximately 2 feet thick, was placed over Zone B circa 1980 (PSC 1998a). All drums were removed from Zone B as an IA in 2002 (URS 2002), along with visually impacted soil within the former repository cell and visually impacted soil on the floor of the cell. The cell was filled and graded to ensure proper drainage, and an interim cover (12-mil polyethylene cap) was installed. In May and June 2013, an engineered RCRA-compliant cap was installed over the former Zone B drum cell, the interim cover, and nearby residually impacted soil as part of an IA approved by Ecology.

2.5.4.2 Key Remedial Investigation Findings

A number of RI activities have occurred at Zone B since the mid-1990s. A table of soil samples collected and a summary of contaminant groups exceeding dCULs is provided as Table 2.5.4-1. Sample locations are provided in Figure 2.5.4-1b. Sample locations with concentrations of indicator hazardous substances exceeding dCULs are provided in Figure 2.5.4-2 (dioxin Toxic Equivalents Quotient [TEQ]), Figure 2.5.4-3 (chlorinated phenols), and Figure 2.5.4-4 (herbicides). Data summary tables for soil and ground water are provided in Appendix O. Detailed information regarding the sampling events and results can be found in the Phase I and Phase II RI reports and the numerous AMEC-authored reports listed in the References in Section 9.

Key findings from the Phase I and Phase II RIs at Zone B are summarized below:

1. Herbicides were not detected above method reporting limits in either ground water or soils.
2. Detections of SVOCs in soils were limited to phthalates detected below Method C dCULs for soil ingestion at industrial sites.
3. TEQ for 2,3,7,8 tetrachlorodibenzo-p-dioxin in soils were below the Ecology dCUL of 5 picograms per gram (pg/g; Ecology 2007a).
4. Priority pollutant metals detected in Phase I soil samples were at or below NPL Site background levels established during the Phase I RI.

Soil sampling investigations conducted in February 2005, July 2009, December 2010, and spring 2012 evaluated the nature and extent of Zone B-related materials subsequent to completion of the Phase I and II RI reports and the 2002 Zone B drum removal action. Eight soil samples were collected from the bottom of the former Zone B cell following drum and soil removal in 2002; these soil samples likely represent the worst-case concentrations in vadose zone soil remaining in place beneath Zone B. Key post-RI soil sampling results are summarized below:

1. Detected concentrations of chlorinated phenols that exceeded the dCUL occurred only at the floor of the former Zone B cell (see Table 2.5.4-1; Figure 2.5.4-3; Appendix O). Chlorinated phenols exceeding the dCULs were pentachlorophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 2-chlorophenol, 4-chloro-3-methylphenol, 2,4-dimethylphenol, and phenol.
2. PAH compounds detected in soil at Zone B were limited to surface soil samples at the PZB-05 location; these were likely related to a surface fuel spill and not related to the wastes formerly contained in the Zone B landfill.
3. Detected concentrations of 2,4-D that exceeded the dCULs occurred in five samples from the floor of the former drum cell and at one sampling location outside the

former drum cell (see Table 2.5.4-1; Figure 2.5.4-4; Appendix O). Other herbicides were not detected or were detected well below dCULs.

4. Calculated dioxin TEQ that exceeded the dCUL of 5 pg/g (Ecology 2007a) occurred in five primary sampling locations outside the cell (the samples from the 2002 drum removal excavation were not analyzed for dioxins). Spatial extent and location of soils with dioxin TEQ greater than 5 pg/g were fully delineated after a sampling program completed in 2012 (see Table 2.5.4-1; Figure 2.5.4-2; Appendix O; AMEC 2012).
5. VOC analytes were not detected in soil at concentrations exceeding dCULs (Table 2.5.4-1; Appendix O). Concentrations were generally 3 to 4 orders of magnitude below dCULs.

All areas where Zone B-related constituents in soil were detected at concentrations greater than draft screening levels were placed under a RCRA-compliant cap constructed during May and June 2013. The 2002 post-drum removal samples were collected from soil that remains in place beneath the center of the current RCRA-compliant cap and liner. Based on available survey data, it is estimated that these samples were collected from elevations between approximately 397 and 403 feet mean sea level (msl; NAVD 88) and are now currently situated approximately 15 to 18.5 feet below the surface of the cap and approximately 40 to 50 feet above first encountered ground water in nearby monitoring wells MW-25SR and MW-26SR.

Zone B cross section locations are provided in Figure 2.5.4-5, and cross sections are provided in Figures 2.5.4-6 through 2.5.4-9. Well logs from the installation of EE-4, EE-5, MW-25S, MW-26S, MW-25SR, and MW-26SR, as well as boring logs B-05, B-06, B-13, B-14, and B-15, were used to create cross sections for Zone B. The cross sections are based on standard penetration test soil samples collected at 5- or 10-foot intervals and should be considered representative of the general Zone B geology.

Based on historical ground water monitoring records, depth to ground water (or the vadose zone) at Zone B is approximately 45 to 55 feet bgs. Vadose zone soils beneath Zone B, encountered at locations B-14, B-15, MW-25S, MW-26S, MW-25SR, and MW-26SR generally consist of a silty fine sand (Touchet Beds) from 15 to 40 feet bgs, though sandy soils with minimal fines (fines less than 5%, and described as well-graded sand) were encountered from near ground surface to depths of between 16 feet to greater than 47 feet at EE-4 and EE-5. The Touchet Beds overlie a poorly graded fine to medium sand, which has been considered to be the Upper Pasco Gravels of the Hanford Formation, generally below a depth of 40 feet bgs. Coarse gravels with varying amounts of silt and occasional cobbles were encountered in EE-4 and EE-5 at roughly 45 to 50 feet bgs. These gravels are assumed to be the Lower Pasco Gravels. Based on historical ground water monitoring records, depth to ground water at Zone B has varied between approximately 42 and 53 feet bgs and the water table occurs within the Upper or Lower units of the Pasco Gravels.

Monitoring wells associated with Zone B include EE-4, EE-5, MW-25S, and MW-26S; these wells are decommissioned. MW-25SR and MW-26SR are existing replacement wells located outside of the current cap extent. Note that MW-25S was, and MW-25SR is, located upgradient of the former Zone B repository area (Figure 2.5.4-1b).

Key findings from ground water monitoring at Zone B are summarized below:

- A total of 72 SVOCs have been analyzed for in Zone B ground water since 1993, and 13 have been detected in one or more wells. The SVOC detections have been low level, sporadic, and inconsistent over time. Detections of two SVOCs (benzo(a)pyrene at MW-25S, and bis(2-ethylhexyl)phthalate and dibenzo(a,h)anthracene at MW-26S) have exceeded MTCA Method B CULs, with the last occurrence in 2001; benzo(a)pyrene, dibenzo(a,h)anthracene, and phthalates are not related to herbicide manufacturing and are unlikely related to the wastes disposed in Zone B.
- The herbicides 2,4,5-trichlorophenoxyacetic acid, 2,4-D, 4-(2,4-dichlorophenoxy)butyric acid, dalapon, dicamba, dichloroprop, dinoseb, MCPA, methylchlorophenoxypropionic acid (MCPP), and silvex have been consistently analyzed for in ground water from Zone B wells for as long as the wells have been sampled. Herbicides were detected on only one occasion, at monitoring well EE-4 in February 1993, when detected 2,4-D, dicamba, and MCPA concentrations were below the Method B CULs for ground water.

- In April 2009, ground water from MW-26S was analyzed for dioxins and furans; these contaminants were not detected. Dioxins and furans were not detected in ground water sampled from MW-26S in April 2009.
- A total of 77 VOCs have been analyzed in Zone B ground water since early 1995, and 22 have been detected in one or more wells. The VOC detections have been low level, sporadic, and inconsistent over time. Detections of two VOCs, 1,1-dichloroethane at MW-25S (upgradient) and vinyl chloride at MW-25S and MW-26S (upgradient and downgradient, respectively), have exceeded dCULs, with the last occurrence in 1998. Very low detections of VOCs (TCE, 1,1,2-trichloroethane, and 1,1-DCE) at concentrations near reporting limits have occurred at MW-25SR (TCE, once) and MW-26SR (TCE, 1,1,2-trichloroethane, and 1,1-DCE, once each) from 2014 to 2016.

In general, the SVOC and dioxin constituents detected in soil at Zone B have low solubility and tend to adsorb to soil particles, inhibiting migration via dissolution or vapor phase, and ground water results indicate these constituents are not readily migrating to ground water. Herbicides, although more readily dissolved and mobilized, were detected in ground water at Zone B only once approximately 24 years ago. The VOCs detected in ground water, with the exception of 1,1,2-TCA, were not detected in soil samples from the Zone B excavation floor. Low and decreasing frequency and concentration of VOCs in ground water over decades of monitoring, frequency of upgradient VOC detections, and a lack of correlation between VOC constituents detected in soil and ground water, indicate that VOCs in soil at Zone B were not a significant source to ground water prior to completion of remedial actions, and are not currently a significant or ongoing source of VOCs to ground water.

2.5.4.3 Overview of Interim Actions at Zone B

IAs completed at Zone B consist of the 2002 drum removal event, a 2010 soil excavation in anticipation of installation of a RCRA-compliant landfill cap over Zone B, and the installation of the RCRA-compliant landfill cap over Zone B in May and June 2013. These IAs are discussed in the following sections.

2.5.4.3.1 2002 Drum Removal

In March 2002, PSC completed an IA at Zone B, as documented in the *Interim Action Completion Report Zone B Removal, Pasco Sanitary Landfill* (URS 2002). Generally, the work consisted of the excavation and then off-site incineration and disposal of approximately 5,500 CY of drummed herbicide production wastes and impacted soils. Following excavation, the cell was lined with a 6-mil polyliner and then filled with stockpiled soil from the Zone B waste cell, as well as soil from the immediate vicinity of Zone B. These soils were then compacted and graded to assist drainage using soils from surrounding areas. Reinforced 12-mil-thick polyliner was installed as an interim cover over the entire combined footprint of the cell and the IA staging area. The cover was secured at its edges by a perimeter anchor trench and ballasted with sandbags to resist wind uplift.

2.5.4.3.2 2010 Soil Excavation for Resource Conservation and Recovery Act-compliant Cap Completion

In December 2010, an approximately 27,000-square-foot area abutting the southeast, south, and southwest boundaries of Zone B was excavated to a depth of 1 foot, the soil placed on the temporary Zone B cap, and the area covered with a tarp. This excavation was performed as a conservative attempt to both address the limited areas where soil concentrations were known to exceed the interim dCULs and to remove any remaining unidentified localized areas where shallow soil concentrations might exceed the interim dCULs. The excavation work was completed per the Ecology-approved *Final Interim Remedial Action Work Plan for the Pasco Zone B RCRA-compliant Cap* (RAWP; AMEC 2010). Confirmation samples were collected at and surrounding locations of previous (2005 and 2009) dioxin/furan TEQ exceedances of dCULs (PZB-03, -05, -12, -14, -15, and OZB-01) plus two new locations (OZB-11 and OZB-12) (Figure 2.5.4-1b).

Stained soil was encountered near and just below the 1-foot depth at five locations during the excavation. These random areas of stained soil occurred near the drum loading and truck traffic area from the 2002 drum removal event. The stained soil was excavated until no visible evidence of in-place staining remained, and the excavated soil was placed on the stockpile under the tarp for later incorporation under the yet-to-be-constructed

RCRA-compliant cap. The deepest excavations extended to a depth of approximately 3 feet. The excavation area was covered with a 12-mil-thick polyliner secured with sandbags.

Subsequently, in consultation with Ecology, BCS proposed increasing the size of the RCRA-compliant cap to incorporate this excavation area.

2.5.4.3.3 Installation of Resource Conservation and Recovery Act-compliant Cap

During May and June 2013, an approximately 55,250-square-foot RCRA-compliant cap was installed over Zone B, consistent with the RAWP approved by Ecology in April 2013. The cap plan, details, cross sections, and drainage are presented in Figures 2.5.4-10 through 2.5.4-13. The primary cap components, from the base up, consisted of the following:

- GCL: Used as an infiltration barrier, a GCL is a composite geomembrane consisting of bentonite clay sandwiched between geotextile layers. The geotextile layers resist puncture, prevent desiccation of hydrated clay, and act as a reinforcement matrix for the clay. The clay is hydrophilic with known swelling characteristics and, when punctured, can swell around an object and seal against leakage.
- Geomembrane: A 40-mil-thick HDPE geomembrane (Layfield EL6040) placed over the GCL as an impermeable layer.
- Drainage Layer: A 1-foot-thick layer of medium-to-coarse sand, with a minimum permeability of at least 10^{-1} cm/s, placed over the HDPE geomembrane to allow drainage and collection of water from precipitation that infiltrates through the vegetative cover.
- Geotextile Filter Fabric: A geotextile filter fabric placed between the topsoil and the drainage layers to prevent migration of fine-grained particles from the overlying vegetative cover layer into the drainage sand while still allowing water passage.
- Vegetative Cover: A vegetative layer constructed with a 2-foot-thick layer of imported topsoil with sufficient organic content to support seeding with native grasses. The vegetation provides resistance to erosion from wind and rainfall.

The primary functions of caps are water management and the protection of potential receptors by the creation of physical barriers. At a minimum, an RCRA Subtitle C Cap includes a vegetative layer, a drainage layer, a barrier layer, and an underlying fill layer for grading. The components of the Zone B Cap exceed these minimum requirements.

2.5.4.4 Current Status of Interim Action Operations

The currently active IA at Zone B is monitoring and maintenance of the existing RCRA cap system. A Remedial Action Cap Construction Report for the Zone B cap was prepared for and submitted to Ecology in October 2013, in which the Cap Monitoring and Maintenance Plan was included as an appendix. In November 2013, Ecology conditionally approved the Cap Construction Report, pending minor edits, which were submitted to Ecology in the Final Cap Construction Report in December 2013. Two new ground water monitoring wells (MW-25SR and MW-26SR) were installed in May 2013 to replace wells MW-25S and MW-26S, which were within the RCRA cap footprint. Ground water at wells MW-25SR and MW-26SR will be monitored in compliance with the Cap Monitoring and Maintenance Plan.

2.5.4.5 Current Environmental Conditions

In May and June 2013, the RCRA-compliant cap was constructed over soils with concentrations greater than 2007 dCULs for soils, consistent with the RAWP approved by Ecology in April 2013. The RCRA-compliant cap provides the following: 1) a physical surface barrier between Zone B soil and potential human or ecological receptors (minimization of risk by elimination of the "direct contact" exposure pathway); 2) the elimination of stormwater infiltration into Zone B, thereby minimizing the potential for mobilization of residual chemical constituents; and 3) engineering and ICs to limit access to Zone B.

Ground water sampling results from Zone B area monitoring wells from 1993 through 2016 provide direct evidence that mobilization of residual contaminants from the vadose zone to ground water has been limited, even prior to cap installation. Potential for leaching to ground water and mobilization of residual vadose zone contaminants are further minimized by the existing RCRA-compliant cap system and associated Zone B stormwater management practices. Ground water sampling results from wells associated with Zone B demonstrate that Zone B-related waste materials do not represent a threat to potential receptors via a leaching-to-ground water pathway. In addition, as described in Section 5.5, all of the active Zone B remedial alternatives incorporate the existing RCRA compliant cap and associated Zone B stormwater management practices that will prevent or minimize potential for infiltration of water through the waste materials.

2.5.5 Zones C/D

This section discusses soil and waste investigations related to IWA Zones C/D. Ground water in the vicinity of these zones is discussed in Section 2.5.7.1.

2.5.5.1 Disposal History

Waste disposal activities at Zone C began in approximately October 1972 and continued into 1975. Zone D was constructed in approximately August 1973 and probably first received waste in September 1973. A detailed description of waste disposal at Zones C/D is provided in Section 3.6 of the Final Phase I RI Report.

Waste deposited in Zones C/D consisted of approximately 3 million gallons of bulk plywood resin waste, wood treatment and preservative waste, lime sludge, cutting oils, paint and paint solvent waste, and other bulk liquid waste.

2.5.5.2 Key Remedial Investigation Findings

In 1995, bulk soil characterization testing was conducted in Zones C/D. Samples were collected from trenches excavated into the material using a trackhoe. Waste profiling analyses were performed using multiple sample composites. In 1996, two soil borings were installed, one each in Zone C and Zone D, to assess the soil beneath these zones for the presence of VOCs and potential impacts to ground water. Results were reported in the Phase II RI Report.

Six VOCs[9] were detected in soil samples collected from directly beneath the zones. All six compounds were below their respective MTCA Method B formula values for direct-contact exposure. However, acetone was present in soils under Zone C above the MTCA Method B

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[9] Acetone, 2-butanone, 4-methyl-2-pentanone, toluene, m,p-xylenes, and o-xylenes.

formula value for protection of ground water. None of the six VOCs detected in the soil were present above their respective MTCA Method B formula values in ground water samples collected from Zones C/D wells.

Samples were also analyzed for SVOCs, PCBs, and pesticides/herbicides. Low levels of di-n-butyl phthalate, hexachlorobenzene, and hexachloroethane were detected in a sample from one boring. All constituents detected were below their respective MTCA Method B formula values for ground water.

The Phase II RI Report concluded that the evaluation of the location, timing, and concentration of each VOC detected in the bulk waste material in soil from beneath the zones and in adjacent ground water monitoring wells indicates that VOC presence in ground water, with the possible exception of xylenes, is not likely associated with Zones C/D. Together, these data indicate that Zones C/D are not acting as a source of VOCs in ground water. Although the weight of the data suggests to the contrary, Zones C/D surface soils and/or residual contamination in the vadose zone underneath the surface soils may potentially act as a VOC source in ground water but are not expected to cause any future releases to ground water that could exceed CULs. It is possible that contaminants historically detected but below dCULs and MTCA Method B CULs, in the Central Area at MW-15S and MW-24S are due to the MSW Landfill based on vapor analysis at LFG-03D. Monitoring has indicated that all concentrations have been below dCULs in past years other than an anomalous benzene concentration measured in the fourth quarter of 2014.

Wells EE-6R, EE-7R, and MW-18S were originally designated as Zones C/D monitoring wells and were used for assessing ground water conditions in the vicinity of Zones C/D (see Figure 2.5.5-1). As discussed in Section 2.5.5.5, the monitoring well currently used for Zones C/D ground water monitoring is MW-55S. These wells located in the vicinity of Zones C/D are constructed with conventional screen intervals/depths, and pump intakes have been placed in positions close to the water table at Ecology's direction based on Ecology's expectation that pump intakes close to the water table will provide a conservatively high concentration of COCs from the zone.

2.5.5.3 Overview of Interim Actions

The IAs required by the IWA/GW Agreed Order (Agreed Order DE-00TCPER-1324,) the Landfill Agreed Order (Agreed Order DE-00TCPER-1326), Enforcement Order DE-00TCPER-1325, and Enforcement Order DE-00TCPER-1327 (collectively, the "Ecology Orders") that followed the approval of the 1999 FS Report included the installation of engineered landfill caps at Zones C/D. From top to bottom, the cap consists of the following elements:

- Vegetative surface layer consisting of native soil fill
- Woven geotextile
- Drainage layer consisting of well-sorted coarse sand
- 40-mil HDPE geomembrane coupled with an underlying GCL
- Engineered fill material consisting of on-property Touchet Beds soils
- Geogrid stabilization fabric placed on the original native soil

2.5.5.4 Current Status of Interim Action Operations

The Phase I AIA stipulated that ground water monitoring at Zones C/D be extended beyond the initial performance monitoring period, which followed completion of the IAs implemented after Ecology's approval of the 1999 FS Report and ended in 2007. Since that time, ground water monitoring has been conducted quarterly at Zones C/D for the purpose of evaluating ongoing trends and improvements in ground water quality attributed to the IAs.

The Zones C/D caps are inspected monthly to assess for any subsidence. The monthly inspection reports are presented to Ecology in the annual report. Cap inspection is a component of the *Operations and Maintenance Manual for Landfill Caps, Volumes I and II* (PSC 2002b). No subsidence has been observed to date.

2.5.5.5 Current Environmental Conditions

In 2007, the ground water monitoring network for Zones C/D consisted of wells EE-6R and EE-7R. EE-6R was sampled for VOCs, metals, and water quality parameters in the first quarter and hexavalent chromium in the second quarter of 2007. No VOCs or hexavalent chromium were detected, and EE-6R was removed from the Zones C/D monitoring program after the second quarter of 2007, as documented in the *Operations and Maintenance Manual for SVE, NoVOCs™ and Groundwater Monitoring*.

EE-7R was sampled for VOCs quarterly from 2007 through 2011 and was also sampled in 2007 for SVOCs, metals, and water quality parameters in the first quarter and hexavalent chromium in the second quarter of 2007. SVOCs and hexavalent chromium were not detected in 2007. Since 2007, none of the COCs have been detected at concentrations above the dCULs.

MW-55S was installed in April 2012 as a replacement for EE-7R due to Ecology's concern that the screen interval of EE-7R may have been too deep to be representative of shallow ground water. VOCs and total and hexavalent chromium have been sampled quarterly since the second quarter of 2012. TCE was detected in the second quarter 2012 sampling, but the concentration did not exceed the dCUL of 2.5 micrograms per liter (μg/L). No VOCs have been detected in MW-55S in subsequent sampling events. Total chromium has been detected at less than 10 μg/L in the third and fourth quarters of 2012 and the first quarter of 2013, but hexavalent chromium has not been detected.

2.5.6 Zone E

This section discusses soil and waste investigations related to Zone E. Ground water in the vicinity of Zone E is discussed in Section 2.5.7.1.

2.5.6.1 Disposal History

Waste disposal activities at Zone E occurred from approximately July 1973 into 1975 and consisted primarily of the disposal of approximately 11,000 tons of chlor-alkali waste. Zone TS-l was used for temporary storage of chlor-alkali sludge prior to placement in Zone E. It is likely that all chlor-alkali waste shipped to the NPL Site prior to October 1973 was stored temporarily in Zone TS-l or Zone TS-2.

Sometime between early 1975 and late May 1976, the chlor-alkali sludge stored in Zone TS-l was transferred to Zone E. Zone TS-l was then renamed as Sewage Lagoon SL-l and was used for disposal of septic tank and chemical toilet pumpings from May 1976 until its closure in

June 1979 (see Section 2.5.2.1). A detailed description of waste disposal at Zone E is provided in Section 3.6 of the Phase I RI Report.

2.5.6.2 Key Remedial Investigation Findings

In accordance with the Phase II RI/FS Work Plan, further investigation of Zone E was conducted in May 1995 during the Phase II investigation as part of the bulk waste characterization activities. The investigation confirmed the presence of a top liner over the Zone E wastes. In correspondence and plans submitted to Ecology, as well as in its contract with Weyerhaeuser NR Company, RRC was required to install both a top and a bottom liner. However, the investigation was not deep enough to confirm the bottom liner. The cell was opened for visual observation and to take samples. Visually, the material was confirmed to be chlor-alkali waste—sludge, debris, and related electrical components such as anodes and cathodes.

Additional Zone E waste profiling analyses were conducted during May 1997. Six additional samples of the waste materials were taken and were analyzed for VOC and chromium. Analysis of samples taken showed that the material in Zone E was not corrosive, flammable, or reactive.

The results of all tests performed during the Phase II RI bulk waste characterization activities, including toxicity characteristic leaching procedure tests and fish bioassays, were negative. Total metals analyses showed the presence of barium, cadmium, chromium, lead, and mercury, although the concentration of each of these metals was below the MTCA Method B formula values for soil. Hexavalent chromium was not detected in any of the samples. VOCs and halogenated organic compounds (HOC) measured in Zone E did not exceed TCLP screening criteria or Ecology's Dangerous Waste Designation Criteria limits. The bulk waste in Zone E is not a significant source of VOCs in ground water, and current HOC concentrations are non-actionable. Figure 9 in Appendix G shows that the HOC exceedances only occurred in Zone A, and the measured concentrations in Zone E indicate that the bulk waste is neither a current nor future source of HOC contamination in ground water.

Ground water impacted with VOCs and metals has been shown to occur downgradient of Zone E; however, the results of the Phase II bulk waste characterization analyses, the additional Zone E waste profiling analyses conducted during May 1997, and the evaluation of the location, timing, and concentration of each detected VOC and metal indicate that their presence in ground water is not likely associated with Zone E. Together, these data supported the conclusion in the Phase II RI Report that waste material in Zone E is not acting as a significant source of contaminants in ground water. Similarly, the Phase II RI Report concluded that Zone TS-2 was not affecting ground water quality. Additional discussion of the ground water in the Central Area and Zone E is included in Section 3.4.7.

2.5.6.3 Overview of Interim Actions

The IAs required by the Ecology Orders following the approval of the 1999 FS Report included the installation of engineered landfill caps over Zone E. From top to bottom, the cap consists of the following elements:

- Vegetative surface layer consisting of native soil fill
- Woven geotextile
- Drainage layer consisting of well-sorted coarse sand
- 40-mil HDPE geomembrane coupled with an underlying GCL
- Engineered fill material consisting of on-property Touchet Beds soils
- Geogrid stabilization fabric placed on the original native soil

This cap was constructed over the original known top liner, and presumptive bottom liner. The cap was installed in 2002. TS-1/SL-1 is currently situated under native fill.

2.5.6.4 Current Status of Interim Action Operations

The Phase I AIA stipulated that ground water monitoring at Zone E be extended beyond the initial performance monitoring period, which followed completion of the IAs implemented after Ecology's approval of the 1999 FS Report and ended in 2007. Since that time, ground water monitoring has been conducted quarterly at Zone E wells for the purpose of evaluating ongoing trends and improvements in ground water quality that may result from the IAs. In addition, the Zone E cap is inspected monthly to assess for any subsidence. The monthly inspection reports are presented to Ecology in the annual report. Cap inspection is a component of the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*. No subsidence has been observed to date.

2.5.6.5 Current Environmental Conditions

In 2007, the ground water monitoring network within Zone E consisted of wells EE-8R and MW-27SR (Zone E Sentinel). EE-8R was sampled for VOCs in all four quarters of 2007 and was also sampled for metals and water quality parameters in the first quarter. MW-27SR was sampled for VOCs, SVOCs, metals, and water quality parameters in the first quarter and hexavalent chromium in the second quarter. Hexavalent chromium was detected in the second quarter (April) 2007 sample at a concentration below the 2007 dCULs. No exceedances of hexavalent chromium were found in any samples from Zone E wells. After 2007, MW-27SR was no longer used for monitoring of Zone E, as documented in the *Operations and Maintenance Manual for SVE, NoVOCs and Groundwater Monitoring*. MW-27SR became part of the quarterly monitoring program in April 2012 after EE-8R was decommissioned.

From 2007 until October 2011, EE-8R was sampled quarterly for VOCs and total and hexavalent chromium. PCE and TCE have been detected in ground water but only sporadically exceed 2007 dCULs. 1,2-DCA has been detected, but at concentrations below the 2007 dCULs. Hexavalent chromium has been detected, but at concentrations below the 2007 dCULs. There have been no exceedances of dCULs in Zone E area wells since 2004.

From 2007 until April 2012, the ground water monitoring network within Zone E consisted of well EE-8R (Figure 2.5.6-1). At that time, EE-8R was decommissioned and MW-27SR became the monitoring well for Zone E.

2.5.7 Ground Water

Ground water quality in the vicinity of specific waste zones and off-property ground water are discussed in this section. Historical and current environmental conditions for ground water adjacent to Zone B wells (EE-4, EE-5, MW-25S, MW-25SR, MW-26S, MW-26SR) are discussed previously in Section 2.5.4 of this document. See Figure 2.5.7-1 for the locations of these historical and current ground water monitoring wells.

2.5.7.1 On-property Ground Water

On-property ground water is divided into the following three areas based on ground water impacts (Figure 2.5.7-1): the MSW Landfill Area; the Zone A Area; and the Central Area. The MSW Landfill Area and the Zone A Area extend from these waste areas downgradient to the property boundary. The MSW Landfill Area includes the following historical and current monitoring wells: 4, 4R, MW-16S, MW-17S, MW-17SR, MW-22S, and MW-23S. The Zone A Area includes the following historical and current monitoring wells: 2, 2R, 2i, 2d, EE-2, EE-3, MW-10s, MW-11s, MW-11i, MW-12s, MW-12i, MW-12d, MW-13s, MW-47S, MW-47i, MW-47d, MW-48S, MW-48i, MW-48d, MW-49S, MW-49i, MW-49d, MW-50s, MW-51s, MW-52s, MW-53s, NVM-01, NVM-01i, NVM-01d, NVM-02, NVM-03, NVM-04. The Central Area encompasses a number of known water and operational areas that could have acted as sources of ground water contamination of the Central Area ground water in the past. It extends from south of the MSW Landfill and north of Zone A, to the western property boundary, and includes Zones C/D and E. The Central Area includes the following wells: 3, 5, 8, 9, EE-6, EE-6R, EE-7, EE-7R, EE-8, EE-8R, MW-15S, MW-18S, MW-19S, MW-20S, MW-24S, MW-27S, MW-27SR, MW-28S, MW-55S. Current and historical ground water monitoring wells associated with the on-property ground water areas are shown in Figure 2.5.7-1.

2.5.7.1.1 Historical Conditions

MUNICIPAL SOLID WASTE LANDFILL AREA

COCs detected in ground water downgradient of the MSW Landfill have generally included only a limited number of VOCs and total chromium. Remaining low-level ground water impacts sourced by the MSW Landfill may be due to residual landfill gas migration.

ZONE A AREA

COCs in ground water beneath Zone A appear limited to VOCs at concentrations that are historically and currently well below individual solubility limits and are consistent with equilibrium partitioning between soil vapor and ground water. Low concentrations of compounds other than VOCs have also been detected in ground water, but these contaminants are well below MTCA Method B values.

Degradation of COCs in ground water beneath Zone A is likely also occurring as evidenced by low oxygen and negative ORP at some wells in the vicinity of Zone A and the presence of daughter products such as cis-1,2-dichloroethylene in ground water.

COCs in ground water near Zone A are largely restricted to the shallow portion of the aquifer. Concentrations of COCs in ground water attenuate with distance from Zone A, consistent with the much lower concentrations observed south of the PSLI Property compared to the historical concentrations at the property. Only limited vertical migration of COCs occurs between Zone A and the PSLI Property boundary as confirmed by water quality data from PSLI Property boundary wells MW-11S and MW-11I.

CENTRAL AREA

Historically, all the Central Area wells shown in Figure 2.5.7-1 have had detections of VOCs. Twenty different VOCs have been detected in Central Area wells. The most frequently detected VOCs were PCE and TCE, which were detected at almost all wells. The most widely distributed compound was 1,2-DCA, which historically has been detected at all Central Area wells. In addition to VOCs, total chromium, and chromium VI have been detected at some Central Area wells.

The Central Area encompasses a number of known waste and operational areas including the IWA zones and MSW zones, some of which could act as sources of ground water contamination of Central Area ground water. Historical ground water data from the Central Area in the vicinity of Zones C/D and E included only one VOC dCUL exceedance (benzene in 2010), suggesting that Zones C/D and Zone E are not likely contributors to Central Area ground water contamination.

2.5.7.1.2 Current Environmental Conditions

MUNICIPAL SOLID WASTE LANDFILL AREA

The concentrations of all detected VOCs in the MSW monitoring wells have decreased since the MSW Landfill was capped and landfill gas collection implemented. PCE and TCE concentrations in MSW Landfill wells have decreased an average of approximately 95% since before initiation of landfill gas collection in 2002. Monitoring has confirmed that recent PCE and TCE concentrations in wells downgradient of the MSW Landfill have been decreasing, and were approaching or were less than the dCULs in the FFS Work Plan. Elevated concentrations of total chromium have been irregularly detected at MW-22S. The elevated results have not been repeatable, suggesting that the occasional elevated results are not representative of ground water quality in this area. Chromium VI has not been detected at MW-22S. The potential for off-property ground water impacts from the MSW Landfill is considered limited, with continued landfill gas collection in the near-term, and with decreasing landfill gas generation rates in the long-term.

ZONE A AREA

Current data indicate that certain volatile COCs within Zone A are migrating primarily in the vapor-phase through soil and to ground water. COCs enter ground water through vapor-phase to aqueous-phase partitioning.

Concentrations of VOCs in wells at the NPL Site have overall continued to decrease or remain stable since January 2014. The COC concentrations observed in ground water at the NPL Site are generally low and, throughout the majority of the NPL Site, are below or nearing detection limits. This reduction or stabilization of COC concentrations was temporarily disrupted in 2014 by shutting down or reducing the flow rate of certain SVE wells.

In response to emergent settlement and potential subsurface combustion in the Balefill Area, the shallow and intermediate depth vapor extraction wells (VEW-06S, VEW-06I, VEW-07S, and VEW-07I) were shut off from December 2013 to February 2014. Wells VEW-07S and VEW-07I were brought back into operation in February 2014. In November 2014, in response to decreased methane collection at the MSW Landfill, well VEW-07S and well VEW-07I were shut off.

These operational changes in 2014 resulted in an increase of detections and detected concentrations above dCULs of some VOCs in source area wells MW-52S and MW-53S. The detected concentrations decreased after 2014 as various SVE wells were returned to service and the flow rate was modified.

In 2015 and 2016, the only wells that contained VOCs at concentrations exceeding the dCUL were MW-52S and MW-53S, located within Zone A. For these wells, it was observed that the ground water quality generally improved in the second half of 2015 from its elevated levels in 2014. No other wells throughout the NPL Site, including sentinel wells immediately downgradient of Zone A, contained a dCUL exceedance of VOCs during 2015 or 2016.

CENTRAL AREA

Ground water quality in the Central Area has improved since implementing the IAs at Zone A, at Zones C/D and E, and the MSW Landfill. The most commonly detected compounds continue to be PCE and TCE, with sporadic detections of total chromium and chromium VI. PCE and TCE have not exceeded the dCULs for more than 5 years in this area.

2.5.7.2 Off-property Ground Water

Off-property ground water conditions have been characterized at the following historical and current monitoring wells: MW-29s, MW-29i, MW-30s, MW-31s, MW-32s, MW-33s, MW-34s, MW-35s, MW-36s, MW-37s, MW-38s, MW-38i, MW-39s, MW-40s, MW-41s, MW-41SR, MW-42s, MW-43s, MW-43i, MW-44s, MW-45s, MW-46s, and MW-54i.

2.5.7.2.1 Historical Conditions

Preliminary ground water quality data were collected in 1995 in a cone penetrometer investigation conducted hydraulically downgradient from the PSLI Property. The objective of the investigation was to help optimize the placement of off-property ground water monitoring wells. Ground water samples were collected from 11 locations and analyzed for VOCs. Four off-property ground water monitoring wells were also installed at this time and sampled for VOCs, SVOCs, herbicides, metals, and water quality parameters.

Eleven SVOCs were detected in the off-property wells, but were all well below their respective MTCA Method B formula values. Seven VOCs were detected above MTCA Method B formula values in the off-property wells. PCE was the only compound present above MTCA Method B in the furthest downgradient shallow well (MW-42S shown on Figure 2.5.7-2).

2.5.7.2.2 Current Environmental Conditions

Downgradient wells monitor shallow and intermediate ground water quality in the portions of the dissolved-phase plume that extend beyond the downgradient property boundary.

The current downgradient ground water monitoring network for the off-property area includes 13 shallow wells (MW-29S, MW-31S, MW-34S, MW-37S, MW-38S, MW-40S, MW-41SR, MW-42S, MW-43S, MW-44S, MW-45S, and MW-46S) and four intermediate wells (MW-29I, MW-38I, MW-43I, and MW-54I) (see Figure 2.5.7-2). Under the current program, the shallow wells have been sampled for VOCs quarterly since 2007, except for MW-44S and MW-45S, which were sampled semiannually. The intermediate wells were installed in 2011 and sampled monthly from March 2011 to August 2011. Intermediate wells MW-29I and NW-38I are currently sampled semiannually, while intermediate wells MW-43I and MW-54I are sampled quarterly.

In 2007, the wells along the general longitudinal axis of the dissolved-phase plume were selected for monitoring and included MW-29S, MW-38S, MW-41S/MW-41SR, and MW-42S in a progressively downgradient direction. Data from 2006 showed that there had been a distinct improvement in ground water quality downgradient of the PSLI Property since 1996 (Ecology 2009b). The data also indicated a general stabilization in the total VOCs concentrations in MW-29S, the nearest to the PSLI Property. The declining trend in concentrations appears to continue in the farther downgradient wells and is reasonably attributable to natural attenuation processes.

Between 2007 and 2012, the concentration of VOCs has declined in off-property wells. In 2007, concentrations of TCE, 1,1-DCE, and 1,2-DCA exceeded the 2007 dCULs in off-property wells. In 2012, only TCE exceeded the dCULs in off-property wells and the maximum concentration of TCE in off-property wells declined from 1.3 μg/L to 0.92 μg/L.

Off-property intermediate wells were sampled monthly from March to August 2011. Concentrations were generally similar to and lower than the co-located shallow wells. In July 2011, PCE, TCE, and 1,2-DCA were detected at MW-43I and MW-54I but only exceeded the dCULs for TCE. PCE and TCE were detected at MW-38I at concentrations below the dCULs. No VOCs were detected at MW-29I.

In 2014, 2015, and 2016, COC concentrations at off-property downgradient monitoring wells did not exceed the dCULs.

Figure 2.5.7-3 illustrates the reduction in VOC concentrations in the off-property ground water plume through 2013. VOC concentrations in off-property wells have not been detected above dCULs in recent years following upgrades to the SVE system in 2012.

Figure 2.5.7-4 shows a comparison of TCE trends at the Zone A source area monitoring wells (MW-52S and MW-53S) and monitoring wells immediately downgradient from Zone A during operation of historical SVE wells (VEW-04 and VEW-05) and operation of SVE upgrade wells (VEW-06 and VEW-07). The existing and recently upgraded SVE system has been proven to be highly effective and protective of on-site ground water. VOC removal rates have substantially increased and dramatic improvement in ground water quality downgradient of Zone A has been shown to have rapidly decreased to nearly undetectable VOC concentrations in almost all wells.

2.6 Updated Conceptual Site Model (per WAC 173-340-200)

2.6.1 Overview of Recent Conceptual Site Model Changes

The implemented IAs and investigations since the 1999 FS Report have improved the understanding of conditions in each of the disposal areas, thereby leading to a need to update the CSM. The IAs include the following: 1) the installation, maintenance, and operation of engineered landfill caps at Zones A, C/D, and E; 2) an expansion of the SVE and NoVOCs™ systems for contaminants sourced from Zone A (and subsequent termination of the NoVOCs™ system); 3) removal of Zone B drums and installation of an engineered RCRA-compliant cap at Zone B; 4) installation, maintenance, and operation of the engineered cover system and GCCS at the MSW Landfill and investigation of subsurface conditions at the Balefill Area and Inert Waste Disposal Area; and 5) implementation of ICs. Additional investigations in the vicinity of Zone A include completion of the Phase I and II AIA activities, Zone A subsurface heating evaluation in 2012, Balefill Area combustion monitoring and extinguishment activities from January 2014 to June 2016, and Zone A combustion investigation work conducted in 2017.

2.6.2 Vadose Zone Soils and Geology

The general stratigraphic column beneath the NPL Site is well understood and has been well documented. The soil units present at the NPL Site are the Touchet Beds, the Upper Pasco Gravels, the Lower Pasco Gravels, the Middle Ringold Formation, and the Lower Ringold Formation. The water table is located in the bottom of the Upper Pasco Gravels or the top of the Lower Pasco Gravels. The water table aquifer extends from the bottom of the Upper Pasco Gravels into the Lower Pasco Gravels and the Middle Ringold Formation with a saturated thickness of approximately 60 feet. The Lower Ringold formation may serve locally as an aquitard or perching layer for the water table aquifer that exists throughout the area of the NPL Site.

2.6.2.1 Zone A

The ten vertical and four horizontal borings completed through and beneath Zone A during the AIAs and the 18 rotosonic and 6 bucket-auger vertical borings completed as part of the Zone A combustion investigation provide a detailed understanding of the soil conditions present in this area. Vertical borings were drilled through Zone A using a drilling method that provided a continuous core of the soil column. The horizontal borings provided additional information at two relatively fixed depths beneath the north-south length of Zone A. The geology beneath Zone A is consistent with the general stratigraphy described in the RI, with the exception of two units identified during Phase II AIA investigations: a mixed debris layer beneath Zone A and a transition layer between the Upper Pasco Gravels and the Touchet Beds. The transition layer likely is present, but discontinuous, throughout the NPL Site. It is identified visually in soil boring samples as very dense, tightly packed soils with silt or clay fractions at the contact between the Touchet Beds and the Upper Pasco Gravels (EPI 2012). Due to the dense packing and fine-grain fraction of the transition layer, it is expected to have similar impedance to liquid-phase contaminant transport as the

Touchet Beds. The mixed debris layer, localized in the area of Zone A, appears to be a remnant of MSW disposal prior to industrial waste disposal at Zone A. Soil properties of the debris layer suggest that it likely impedes liquid contaminant transport comparably to the Touchet Beds (EPI 2012). The mixed debris is heterogenous and discontinuous both vertically and horizontally. The most significant finding of the 2017 Zone A combustion investigation with respect to NPL Site soils and geology was the absence of a zone of intact drums referred to in previous reports as the randomly placed drum area (EPI 2012, GSI and SCS Engineers 2017). Figure 2.6.2-1 illustrates the updated CSM for Zone A.

2.6.3 Ground Water Occurrence, Flow, and Seasonal Water Level Changes

Ground water occurs at the NPL Site as an unconfined aquifer in the Pasco Gravels. The established and consistent direction of ground water flow beneath the PSLI Property is southwesterly and becomes due south just south of the PSLI Property. The water table is typically first encountered within the Lower Pasco Gravels at an elevation of about 360 feet above mean sea level. The seasonal variation in water level is typically less than 2 feet.

2.6.4 Contaminant Fate and Transport – Key Processes

2.6.4.1 Municipal Solid Waste Landfill

The key contaminant fate and transport processes retained for evaluation in the FFS include vapor-phase migration of landfill gas to ground water. Vapor-phase transport has been documented by improvements in water quality (especially VOCs) that occurred in monitoring wells downgradient of the MSW Landfill after installation and operation of the GCCS.

2.6.4.2 Industrial Waste Area Zones

All IWA Zones are situated in unsaturated soils above the local water table. Potential transport pathways from the IWA Zones are from the waste to soil to ground water by either a liquid or vapor transport pathway. Historical maximum contaminant concentrations in ground water have been less than 1% of the aqueous solubility of the contaminants, which as a general rule indicates that contaminants have not reached ground water as NAPL. The

Zone A SVE system has collected a total of 1.1 million pounds of VOCs and an approximately equal amount of water as condensate.

2.6.4.3 Soil

Subsurface soils under the IWA zones engineered cover systems are impacted with various COCs. Soil impacts, though undocumented, are possible beneath areas of the MSW Landfill, Burn Trenches, Zone A, and Landspread Area. Based on findings from the Sub-Zone A investigations conducted in 2010 and 2011, the highest documented concentrations of contaminants are present in the Touchet Beds and transition layer beneath Zone A.

Potential contaminant leaching due to precipitation may contribute to subsurface soils impacts at Zone A where the cover does not meet design criteria. Aqueous-phase and vapor-phase transport from other IWA zones does appear to be occurring, as evidenced by the low concentrations in ground water in the vicinity of these zones. Non-VOC contaminants have historically been detected below Zone A but in very low concentrations and well below MTCA Method B levels. These detections were typically low-molecular-weight SVOCs that volatilize more easily than high-molecular-weight SVOCs and can mitigate in a vapor phase.

2.6.4.4 Soil Vapor

Soil vapor impacted with VOCs was documented around industrial Zones A, C/D, and E, and the MSW Landfill during the Phase I and Phase II RIs. Contaminated soil vapor remains in some areas of the PSLI Property. In the absence of the Zone A SVE and MSW Landfill gas collection systems, vapors from Zone A and the MSW Landfill could potentially transport contaminants to ground water and vapors could potentially reach the atmosphere. In 2012, soil vapor sampling was conducted at monitoring locations MW-55S and LFG-03D to assess the presence of vapor-phase VOCs in the vicinity of the MSW Landfill and Zones C/D and E. MW-55S and LFG-03D are immediately south of Zones C/D and south of the MSW Landfill, respectively. In LFG-03D, chlorinated compounds are predominant; in MW-55S, toluene, ethylbenzene, and xylenes are the predominant compounds (see Appendix K; Anchor QEA et al. 2012). The distribution of VOCs and their detected concentrations in vapor collected from MW-55S are consistent with the VOCs measured in soil vapor in the IWAs at the

NPL Site. However, the distribution of VOCs at MW-55S is distinct from the distribution of VOCs and concentrations measured at LFG-03D, indicating two distinct and significantly different source areas for the VOCs in soil gas at the two locations. The available data, therefore, strongly indicate that Zones C/D and E are not the source of VOCs measured in soil gas at LFG-03D.

2.6.4.5 Ground Water

Direct contact of ground water with buried industrial wastes does not occur at the NPL Site. Impacts to ground water from IWA Zone A through a dominant soil vapor transport mechanism have been confirmed through extensive ground water monitoring downgradient of the area.

Based on geochemical and leachate parameter monitoring, MSW Landfill effects on ground water quality have been limited, and appear to be declining (Aspect 2014b). This decreasing trend in ground water concentrations indicates that the soil vapor to ground water pathway has been largely attenuated for the MSW Landfill.

Once in ground water, contaminants have historically been transported off-property by the ambient ground water flow conditions. Since 2008, with the optimization and upgrade of the SVE system at Zone A that occurred between 2009 and 2012, COC concentrations in ground water have decreased substantially. These decreasing trends in ground water concentrations indicate that the soil vapor to ground water pathway has been largely attenuated for Zone A. This reduction or stabilization of COC concentrations was disrupted in 2014 by shutting down or reducing the flow rate of certain SVE wells due to the Balefill Area combustion. However, following reimplementation of the wells at a reduced capacity, ground water quality again improved, and only one well has had measured exceedances in 2015 and 2016. Concentrations also increased in January 2017 due to changes in SVE operation and possibly also due to drilling in Zone A in early January 2017 that occurred as part of the Zone A combustion investigation. As with the 2014 increase in concentrations, the January 2017 increase is expected to be temporary and resolved through enhanced SVE operation following installation of the new RTO treatment system in June 2017.

Off-property ground water has decreased (see Figure 2.5.7-3).

2.6.4.6 Air

Contaminant transport from the waste zones to the air may occur by two possible mechanisms: soil vapor transport and treatment system emissions. In the absence of the Zone A SVE and GCCS, vapors from Zone A and the MSW Landfill could potentially reach the atmosphere under changing barometric conditions. These systems maintain a negative pressure under the Zone A cap and the MSW Landfill cover to prevent soil vapor discharge from around the edges of the cap. The MSW Landfill cover and GCCS are described in Section 2.5.1.4. The Zone A cap and SVE system is described in Section 2.5.3.4.

Ambient air monitoring along the edges of the Zones C/D and E caps was initiated as part of monthly cap inspection in March 2017. No detections of organic vapors have been detected in the vicinity of these zones as part of the ongoing monitoring.

2.6.4.7 MSW Disposal Areas

Since the 1999 FS Report was prepared, landfill gas migration has been identified as the key contaminant fate and transport process for the MSW Landfill. Other MSW disposal areas do not generate landfill gas at rates that result in observable landfill gas migration. As landfill gas generation rates continue to decrease over time, the potential for landfill gas migration decreases.

The installation and optimization of the engineered cover system and GCCS as an IA has addressed landfill gas migration from the MSW Landfill, confirmed by results of perimeter vapor probe monitoring, cover monitoring for methane, and ground water protection monitoring. The GCCS has collected only small amounts (less than 1 pound per day of VOCs and only 6 gallons per day of non-hazardous water, on average). Landfill gas collected by the GCCS has been treated at the flare, and emissions have been below the air quality thresholds. The soil cover over the Balefill Area also mitigates fugitive landfill gas emissions, confirmed by cover monitoring for methane.

Liquid-phase transport from the MSW disposal areas to ground water is not a key process at MSW disposal areas primarily due to the arid environment and limited potential recharge. This finding has been confirmed through the following methods:

- Inspecting gas extraction wells at the MSW Landfill and finding no evidence of leachate accumulation
- Evaluating results of protection ground water monitoring near the MSW Landfill and finding no evidence of leachate impacts, and drilling observations in the Balefill Area and finding no evidence of wet MSW or soils

3 EXPOSURE ASSESSMENT

This section evaluates potentially complete exposure pathways for contaminants associated with the NPL Site. The assessment is presented for the NPL Site as a whole and is organized by media, transport mechanisms, and potential current and future receptors (see Figure 3-1). Finally, specific primary sources and COCs are identified by zone or area of the NPL Site.

3.1 Media of Concern

Media impacted by IWA and MSW wastes represent potential exposure pathways at the NPL Site and are described in the following subsections.

3.1.1 Surface Soil

The MSW Landfill and IWAs on the NPL Site have been capped with geomembrane liners and/or clean soil. The thickness of clean soils placed as cover is not documented in some areas. Limited MSW in the Balefill Area and Inert Waste Area has been exposed, due to erosion by the wind or were not initially covered. In general, surface soils meet appropriate industrial direct contact criteria and are not considered to be a medium of concern at the NPL Site.

3.1.2 Soil (Greater than 2 Feet Below Ground Surface)

Subsurface soils have been impacted by the waste materials disposed of at the NPL Site. Impacted subsurface soils are not considered a medium of concern where it has been covered by a geomembrane. Soil gas also represents an impacted medium in the vicinity of the MSW Landfill and the IWA.

3.1.3 Ground Water

Ground water beneath the NPL Site is impacted as the result of certain historical NPL Site activities. Historically, ground water impacts observed during the RI have been prevented or minimized by IAs.

3.1.4 Surface Water

Engineered caps covering the MSW Landfill and Zones A, B, C/D, and E are graded to collect and evaporate runoff. Runoff and localized temporary accumulation of surface water may occur in areas of the NPL Site, but is not considered a medium of concern.

The Columbia River is the nearest surface waterbody, located approximately 3 miles south (hydraulically downgradient) of the PSLI Property. While surface water impacts have not been documented and the off-property ground water plume attenuates significantly at this distance from the PSLI Property, historical ground water monitoring at MW-54I (the downgradient-most NPL Site monitoring well located approximately a half mile from the river) indicates the potential for impacted ground water to have discharged to surface water. However, under present conditions, concentrations at MW-54I indicate that ground water discharge to surface water would be below relevant MTCA Method B values.

3.1.5 Sediment

Nearshore sediments in the Columbia River could come into contact with VOCs dissolved in ground water. However, VOC contamination of sediment is rare and only occurs at sites with extremely high concentrations in ground water associated with potential NAPL in close proximity to or in the sediment. VOCs do not readily adsorb to sediment due to low sediment-water partitioning factors. For these reasons, VOCs are not included in the Washington State Sediment Management Standards. VOC concentrations measured at MW-54I, the downgradient-most well at the NPL Site, are well below concentrations that could indicate a concern with respect to impact to sediments. Therefore, sediment is not a medium of concern for the NPL Site.

3.1.6 Ambient Air

Ambient air could be affected by emissions of pollutants from the MSW Landfill flare. The flare is currently used to treat landfill gas and SVE system emissions. Source testing in 2010 demonstrated that the measured flare emissions did not exceed ambient source impact levels (ASILs) using screening-level air dispersion modeling for relevant air pollutants (WAC 173-460); however, the flare does not have an EPA-compliant Approval Order issued by Ecology's Air Quality Program (AQP). Ambient air could be affected by surface emissions around the Zone A cover in the event of extended SVE system shutdown or by surface emissions around the MSW Landfill cover in the event of extended flare shutdown. An RTO system has been installed to treat and destroy exhaust VOCs from the SVE system in compliance with an Approval Order issued by the AQP.

The Burn Trenches, the Balefill Area, and the Inert Waste Disposal Area do not generate sufficient landfill gas to affect ambient air.

3.2 Transport Mechanisms

3.2.1 Soil (Greater than 2 Feet Below Ground Surface)

Mechanisms of COC transport to and from soil at the NPL Site may include the following:

- Direct release of wastes to soil or leakage of liquid or semi-liquid materials from drums
- Migration of COCs dissolved within accumulated soil moisture to ground water
- Vapor-phase migration through the unsaturated soil matrix
- Vapor-phase migration to ambient air during potential extended interruptions of the Zone A remediation system and/or the MSW Landfill GCCS
- Vapor-phase to dissolved-phase partitioning from soil gas to ground water
- Equipment spreading contaminated soil during construction work
- Burrowing animals moving contaminated soil or opening migration pathways
- Dust blown by wind during construction work

3.2.2 Ground Water

As discussed above, contaminant transport to ground water is primarily from vapor-phase transport of VOCs. Aqueous-phase transport likely occurred historically through unsaturated soil moisture migration to ground water, but the primary current pathway would be through vapor-phase transport of VOCs in soils. In the absence of or inadequate operation of the SVE system and GCCS, aqueous and non-aqueous phase transport could occur as recently shown at MW-52S, but SVE and GCCS operations have been shown to be protective of ground water quality when properly operated. The recent non-aqueous occurrence at MW-52S is likely due to limited operation of shallow SVE wells between June 2016 and September 2017. Downgradient migration of COCs as a dissolved-phase within ground water is subject to natural attenuation (the combined effects of dispersion, dilution, degradation, and volatilization). Non-VOC contaminants have historically been detected below Zone A, though in very low concentrations and well below MTCA Method B levels. These detections were typically light SVOCs that volatilize more easily than heavy SVOCs and can mitigate in a vapor phase.

3.2.3 Surface Water

Surface water transport includes NPL Site runoff and potential discharge of ground water to the Columbia River. There is no off-property runoff, and all on-property precipitation either infiltrates or evapotranspires. Surface water transport mechanisms or pathways of concern in the Columbia River have not been documented, but considering the low concentration of VOCs at the farthest downgradient off-property monitoring well (MW-54I) and the low ground water discharge relative to the Columbia River flow, transport of NPL Site contaminants in the river is not reasonably a significant transport mechanism.

3.3 Exposure Pathways and Receptors

Potentially complete exposure pathways and associated receptors are summarized below.

3.3.1 Human Receptors

Humans can be exposed to NPL Site contaminants either on property or off property by different mechanisms. Since the PSLI Property is zoned industrial and expected to remain industrial for the foreseeable future, the only human receptors that may come into contact with COCs on PSLI Property include the following:

- General maintenance/construction worker. This receptor represents various personnel who may occasionally visit the PSLI Property in connection with routine maintenance or monitoring of the area. This receptor might have contact with shallow surface soil, ground water, soil vapor and air emissions, and condensate. This receptor is expected to access the NPL Site in compliance with the NPL Site Health and Safety Plan, which will minimize the exposure and risk.
- Trespassers. These receptors are assumed to have contact with shallow surface soil or exposed waste.

- Potential current or future construction worker. This receptor may be exposed to contaminants in subsurface soil underlying engineered caps or clean soil cover. This exposure could occur through either ingestion or dermal exposure.
- There is the potential for current and future exposure for all classes of receptors to contaminants in waste materials (i.e., baled wastes) if exposed at the surface by wind erosion. This exposure could occur through either ingestion or dermal exposure.
- There is the potential for current and future exposure for all classes of receptors to methane or VOC contaminants present in air discharge from areas of the NPL Site where SVE or landfill gas control are not occurring; however, this potential is relatively low given the declining VOC levels in Central Area wells following installation and operation of the Zone A SVE system and MSW GCCS and capping of Zones C/D and Zone E. There currently are no data to suggest that additional engineering controls are required to be implemented to further reduce the potential for subsurface soil gas migration or passive gas emission to the atmosphere from the NPL Site.

Potential human exposure pathways to COCs at the NPL Site for all receptors are mitigated by the restrictive covenant that prohibits the following: 1) the use of ground water from existing ground water wells for domestic and agricultural uses; 2) the installation of new ground water supply wells; and 3) the use of the PSLI Property for residential purposes. Incidental contact with NPL Site ground water could occur during sampling, but would be limited to accidental dermal contact by trained NPL Site workers and, therefore, would be of limited exposure and risk.

Off-property exposure is limited to ground water and soil vapors along the ground water transport pathway downgradient from the NPL Site and surface water where the plume potentially reaches the Columbia River. These include following potential exposures:

- Potential future exposure to contaminated ground water for all classes of receptors through the ingestion (drinking water) pathway. This pathway is currently incomplete due to restrictions on ground water use within the GPA.
- Potential current and future exposure to contaminated ground water for all classes of receptors through the dermal exposure pathway, specifically for contact with

irrigation water. This pathway is currently incomplete due to restrictions that are in place regarding ground water use within the GPA.

- Potential current and future exposure to contaminated soil vapors for all classes of receptors through the vapor intrusion pathway.
- Potential exposure to people consuming fish from the Columbia River. This pathway is not significant considering the small area of potential ground water discharge from the NPL Site, the low concentration of a select few VOCs at the downgradient-most monitoring well, the low ground water discharge rate compared to Columbia River flow rates, and the relatively low bioaccumulative properties of the select few VOCs.

Current and future human exposure pathways to off-property ground water are mitigated by ICs. The ingestion of ground water is prevented by prohibiting any future residential well installation in the GPA and the other elements of the ICP Agreement, such as the annual City of Pasco well location survey and the Franklin County IC report (Franklin County 2015). The soil vapor pathway is mitigated by the depth to ground water and low COC concentrations in the off-property area.

3.3.2 Ecological Receptors

Terrestrial ecological receptors such as burrowing animals could be exposed to impacted subsurface soils on the PSLI Property. Wastes and contaminated soils associated with Zones A, B, C/D, and E are individually buried beneath clean soil cover and beneath an HDPE membrane. The engineered cover systems mitigate exposure for terrestrial ecological receptors.

The MSW Landfill is exempt from assessment of terrestrial ecological evaluation consistent with WAC 173-340-7491(1)(b) because all contaminated soil will be below “physical barriers that will prevent plants or wildlife from being exposed to soil contamination.” To qualify for this exemption, an IC is required under WAC 173-340-440. This IC is already required as part of landfill closure and will be confirmed to be in place as part of the MTCA process.

Surface soils within the Landspread Area and Sludge Management Area were moved to the MSW Landfill and are now located beneath the MSW Landfill cover. Terrestrial ecological receptors such as burrowing animals could be exposed to MSW in the Balefill Area and Inert Waste Disposal Area where the soil cover thickness is less than the biologically active zone.

Potential aquatic ecological receptors would be limited to organisms in the immediate area where potentially contaminated ground water from the NPL Site discharges to the Columbia River as discussed in Sections 3.1.4 and 3.2.3, above.

3.4 Sources

3.4.1 Municipal Solid Waste Landfill

The MSW Landfill received MSWs as well as light industrial, commercial, and agricultural wastes. The MSW Landfill engineered cover system prevents direct contact with these wastes.

3.4.2 Balefill Area, Burn Trenches, Land Application, and Inert Waste Disposal Area

The Balefill Area received baled MSW. The Balefill Area and Inert Waste Disposal Area are potential sources of direct contact with non-hazardous waste if wind is permitted to erode the soil cover. Transport of contaminants to soil and/or ground water by infiltrating precipitation has not been documented.

The Burn Trenches likely contain burned and unburned MSW and may potentially contain light industrial, commercial, and agricultural wastes. BT-2 is entirely within the Zone A engineered cap. BT-1 is partially under the engineered cap of Zones C/D, or otherwise covered by soil cover. Infiltration of precipitation through the soil cover could potentially transport contaminants to soil and/or ground water, but impacts by this pathway from the Burn Trenches have not been specifically documented. Some COCs identified in soil beneath the north end of Zone A could potentially be associated with BT-2.

Former land application activities (in the Landspread Area and Sludge Management Area) included landspreading and evaporation of liquid septic tank and portable toilet wastes, landspreading of animal fat emulsion coolant, and sludge spreading. Landspread wastes disposed outside the footprint of the MSW Landfill and underlying surface soils were reportedly excavated and placed within the MSW Landfill prior to or during the 2002 installation of the interim soil cover. Data collected during the Phase I RI confirmed that the former land application areas were not a source of COCs to ground water.

The Inert Waste Disposal Area received only tires, stumps, brush, and construction debris, including concrete and wood. There have been no COCs identified from the inert waste materials.

3.4.3 Zone A

The source of COCs at Zone A is historically placed drums of mixed industrial waste. The drummed wastes primarily include paint wastes, waste solvents, casting sands, and debris and various other types of miscellaneous industrial process waste. These wastes contain a variety of VOCs, SVOCs, herbicides, pesticides, PCBs, and metals.

COCs have entered the environment through spillage and leakage at the time of drum placement and subsequent leakage as drums have corroded over time.

3.4.4 Zone B

The primary potential source of exposure to Zone B-related contaminants is associated with herbicide manufacturing wastes in residual contaminated soils associated with drum storage and disposal activities conducted by RRC, and activities during the IA drum removal. These drums were removed in 2002, and most of the source material was isolated under cover in the area where the original disposal cell was located. In addition, Zone B constituents at concentrations above draft screening levels for soil have been detected in soils around the south side of the former disposal area in the vicinity of a staging area and road used during the 2002 drum removal. No evidence exists that these shallow residual materials have negatively affected deeper soils (more than 3 feet bgs) outside the area of the former disposal cell, or ground water beneath Zone B at concentrations above Method B formula values. In May and June 2013, an RCRA-compliant cap was constructed over residual soils with concentrations greater than the 2007 dCULs.

Lastly, ongoing quarterly ground water monitoring indicates that ground water quality in the vicinity of Zone B has not been affected by waste materials associated with Zone B (EPI 2010b).

3.4.5 Zones C/D

Zones C/D were the disposal locations of more than 3 million gallons of bulk plywood resin waste, wood treatment and preservative wastes, lime sludge, cutting oils, paint and paint solvent waste and other bulk liquid wastes. These wastes have historically released VOCs to subsurface soils and ground water.

3.4.6 Zone E

Approximately 11,000 tons of chlor-alkali wastes were disposed into Zone E. These wastes were characterized in 1997 and found to contain levels of 1,2,4-trichlorobenzene, chloroform, chromium, PCE, and toluene. These compounds are present at levels below MTCA Method A and/or Method B Soil Cleanup Levels for Unrestricted Land Uses.

The only organic compounds detected in Zone E soils are HOCs, as shown in Table 3 of Appendix G. These detections are below Ecology's Dangerous Waste Designation criteria, and the MTCA does not have Method A soil or Method B ground water values. Appendix G supports the findings of the RI and 1999 FS Report that Zone E soils are not a source of VOCs.

Total chromium concentrations in Zone E waste were a fraction of what was measured in the ground water. No hexavalent chromium was detected in any Zone E waste sample. Therefore, Zone E cannot be considered a source of hexavalent chromium.

3.4.7 Ground Water

The historical sources of ground water contamination are industrial and municipal wastes buried on the NPL Site. Impacted ground water is not a primary source of exposure since ICs are in place for the NPL Site to prevent consumption.

4 REMEDIAL GOALS AND OBJECTIVES (SITE-WIDE)

This section identifies the RAOs for waste and underlying soils at the MSW Landfill and each of the IWA Zones, and for ground water site-wide. At Ecology's request, RAOs have been added for MSW Landfill disposal areas not previously identified in the 1999 FS Report. The areas added for development of RAOs include the Balefill Area, Burn Trenches, Landspread Area, and Sludge Management Area. Based on these RAOs, general response actions are described that could be implemented to meet the RAOs.

4.1 Media of Concern

The primary affected environmental media at the NPL Site are soils directly beneath the waste zones, soil vapor, and ground water. A distal medium of potential concern is surface water where potentially contaminated ground water discharges to the Columbia River. Surface soils are a medium of concern at Zone B adjacent to the former disposal area, in the vicinity of a staging area and road used during the 2002 drum removal. In addition, surface soils outside the IA cap areas will be evaluated with respect to terrestrial receptors that were not considered in the 1999 FS Report.

4.2 Chemicals of Concern

4.2.1 Chemicals of Concern in Ground Water

COCs for ground water were identified using a multi-tier screening process as follows:

- Step 1 – Chemicals were analyzed for frequency of detection.
  - Chemicals with a frequency of detection greater than 2% to 5% in all ground water samples collected through the first quarter of 2017 were retained for further consideration.
- Step 2 – Chemicals from Step 1 were screened against the MTCA Method B criteria (standard formula) for carcinogens or non-carcinogens or against the Maximum Concentration Limit in ground water.
- Step 3 – Additionally, the four compounds (1,1-DCE, 1,2-DCA, tetrachloroethene, and TCE) detected in the downgradient-most off-property well (MW-54I) were also screened against MTCA Method B surface water CULs using the procedures in

WAC 173-340-730, which includes consideration of federal and state surface water Applicable or Relevant and Appropriate Requirements (ARARs).

Potential COCs in ground water identified by this process are presented in Table 4.2.1-1. Supporting information on this analysis is presented in Appendix A.

Chemicals in Table 4.2.1-1 carried forward as COCs for development of ground water CULs were selected by a combination of the frequency of detection and the number of exceedances of the screening level. Chemicals with a frequency of detection equal or greater than 2% were considered for inclusion if there was at least one exceedance of the screening level. Chemicals with no exceedances of the screening level or relatively low frequency of detections (less than 2%) were not selected as COCs.

4.2.2 Chemicals of Concern in Soil

Chemicals in soils are a concern with respect to protection of ground water and for protection of human health by direct contact. Cover systems are currently in place in various zones of the NPL Site and effectively prevent direct contact with residual soil contaminants beneath waste repository areas.

To evaluate soil concentrations protective of ground water, the MTCA three-phase partitioning model was applied (WAC 340-747(4)). This model is based on the assumption that rainfall infiltration causes migration of COCs from soil to ground water and consequently, it is only applicable outside of areas that currently have cover systems with geomembranes. This analysis has been performed site-wide to include all IWA and MSW areas and is presented and described in detail in Appendix C. Based on this analysis, no soil CULs are proposed for soils for protection of ground water.

For areas under cover systems, historical ground water data were used to identify COCs as described in Section 4.2.1. Ground water in the vicinity of all waste areas, except for Zone A, currently meets MTCA Method B values and, therefore, no soil CULs for protection of ground water are derived for these areas.

Contaminant transport from Zone A to ground water has occurred to a limited extent during operation of the enhanced SVE system since 2012. This is demonstrated by the exceedances of MTCA Method B values and recent occurrence of NAPL at Zone A well MW-52S (infrequent exceedances of MTCA Method B also occur at Zone A well MW-53S). However, historical ground water monitoring has shown that proper operation of the SVE system can be protective of ground water and, with startup of the new RTO and optimization of the SVE flow rates and subsurface vacuum, it is anticipated that the SVE system will be more protective of ground water than in the past. Reliance on the RTO/SVE system to be protective of ground water at Zone A defers the need for soil CULs until the time frame when the SVE system is proposed for shutdown. This would include shutdown tests to determine that ground water contamination does not reoccur from Zone A COCs and, thereby, demonstrate that residual COC concentrations in Zone A soils are protective of ground water.

Long-term monitoring for soil constituents with the potential to migrate to ground water via liquid or vapor transport will be required to demonstrate that the final cleanup action is protective of ground water quality. This determination will be made in the Compliance Monitoring Plan (CMP), to be prepared after approval of the final CAP.

4.3 Remedial Action Objectives

RAOs are based on minimizing the potential for exposure of human and ecological receptors to any of the wastes placed in the IWA Zones and MSW disposal areas, reducing the potential for migration of contaminants from wastes to ground water, and preventing exposure of human and ecological receptors to wastes, soils and ground water impacted by contaminants on the NPL Site. The objectives presented in the 1999 FS Report are still appropriate, with the addition of RAO development for the Balefill Area, Burn Trenches, and Land Application areas (Landspread Area and Sludge Management Area). Table 4.3-1 summarizes the remedial objectives for the waste zones, subsurface soils, landfill gas, and ground water for the FFS.

Although Zone B was not assigned an RAO for ground water in the 1999 FS Report, based on RI data indicating no downgradient ground water concentrations above established CULs

(PSC 1999), ground water monitoring upgradient and downgradient of Zone B is ongoing as part of the site-wide ground water monitoring program and serves to confirm long-term effectiveness of remedial actions at Zone B.

4.4 Applicable Regulations

Cleanup actions under MTCA must demonstrate compliance with applicable state and federal laws. The NPL Site is on the NPL, so the mutual goal of the Performing PLPs and Ecology is to conduct-remedial actions that meet CERCLA requirements, that include the identification of the nature and extent of COCs, and that select a final cleanup action. Many laws and regulations require that the cleanup action for the NPL Site meet substantive requirements. Other laws establish standards for the cleanup actions and are referred to as action- and chemical-specific requirements. Applicable laws and regulations are presented in Tables 4.4-1 and 4.4-2 for substantive action- and chemical-specific requirements, respectively.

4.5 Development of Cleanup Levels under Model Toxics Control Act

CULs under MTCA are defined as the concentrations of hazardous substances that are protective of human health and the environment under specific exposure conditions. MTCA also requires that CULs be at least as stringent as the concentrations established under applicable state and federal law.

4.5.1 Development of Ground Water Cleanup Levels

Ground water CULs for individual compounds can be developed by either the standard formula known as Method B or using a modified formula based on chemical-specific or site-specific information such as modified risk parameters in the Method B standard formula. Where multiple hazardous substances are present, CULs must be adjusted to achieve an excess cancer risk of $1x10^{-5}$ or hazard index less than 1 for noncarcinogens that have similar toxic effects.

In addition to compliance with Method B values, four compounds were screened in the Indicator Hazardous Substances analysis against surface water criteria based on detections at the downgradient-most off-property monitoring well, MW-54I. These compounds are 1,1-

DCE, 1,2-DCA, tetrachloroethene, and trichloroethene. For these compounds, proposed CULs are based on the more stringent of relevant surface water criteria and Method B standard formula values. Proposed ground water CULs and the basis for the individual CULs are presented in Table 4.5.1-1.

Additional adjustment of the ground water CULs in Table 4.5.1-1 was considered to account for total NPL Site risk due to worker exposure on site. Two pathways were considered: dermal contact with contaminated soils and inhalation of vapors during extended shutdown of the existing GCCS and SVE system. The latter is difficult to assess, as it must consider leakage of vapor around the edges of the cap liner at the MSW Landfill or zone air dispersion from the ground to the breathing zone, and exposure frequency and duration for an NPL Site worker near the edges of the caps. Although the combination of air dispersion and frequency and duration of exposure are expected to result in very low additional risk, the more conservative approach taken has been to stipulate personal protection equipment to mitigate the potential risk. Consequently, NPL Site worker exposure has been addressed in the *Operations and Maintenance Manual, Landfill Gas Collection Control and Flare* and *Operations and Maintenance Manual for SVE, NoVOCs and Ground Water Monitoring*.

Dermal exposure to NPL Site workers was evaluated with respect to standard screening values. The evaluation showed that the increase in carcinogenic risk was on the order of $1x10^{-12}$ and the effect on the hazard quotient for non-carcinogens was on the order of $1x10^{-6}$. These risk levels are too low to affect CULs that are based on risk levels several orders of magnitude higher. The analysis is presented and described in detail in Appendix B.

4.5.2 Development of Zone B Soil Cleanup Levels

CULs for soil will only be developed for surface soils at Zone B.[10] AMEC presented draft soil screening levels for total dioxin TEQ, chlorinated phenols, herbicides, and PAHs in Tables 4.5.2-1 and 4.5.2-2 (from the S*ampling and Analysis Plan Revision 2, Additional Soil*

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[10] IAs completed at Zone B consist of the 2002 Drum Removal event, a 2010 Soil Excavation in anticipation of installation of a RCRA-compliant landfill cap over Zone B, and installation of the RCRA-compliant landfill cap over Zone B in May and June 2013.

Sampling at Zone B of the Pasco Landfill [AMEC 2011]). The sources for the industrial worker human health screening levels are one of the following:

1. MTCA Method C CULs
2. Appropriate surrogate MTCA Method C CULs for constituents that currently do not have Method C CULs
3. The calculated draft screening levels for constituents that do not currently have Method C CULs

Sources for the ecological screening levels are one of the following:

1. EPA Region 4 or 5 Ecological Screening Levels for Soil
2. Ecology Site-specific Terrestrial Ecological Evaluation Screening Levels Appropriate surrogate screening levels for constituents that do not have available reference doses; or the draft Ecology cleanup standard for total dioxin TEQ of 5 pg/g (Ecology 2007a)

In general, the most conservative screening levels are the ecological screening levels.

Human health screening levels for the majority of analytes are sourced from the Ecology Cleanup Level and Risk Calculation website. AMEC calculated draft human health screening levels for the chlorinated herbicides 2,4-D and bromoxynil using Equation 745-1 (for noncarcinogens) from the MTCA Statute and Regulation Publication No. 94-06, revised in November 2007. The calculated draft human health screening levels for 2,4-D and bromoxynil are 35,000 milligrams per kilogram (mg/kg) and 70,000 mg/kg, respectively. The reference doses used in Equation 745-1 for 2,4-D and bromoxynil were obtained from the EPA Integrated Risk Information System website http://www.epa.gov/iris/index.html and were 0.01 milligram per kilogram per day (mg/kg/day) and 0.02 mg/kg/day, respectively. Reference doses are not available for dichloroprop and several chlorinated phenols; therefore, structurally related surrogates were used, as presented in Table 4.5.2-1.

Ecological screening levels for the majority of herbicides and phenols were selected from the EPA Region 4 or 5 Ecological Screening Levels for Soil or the Ecology Site-specific Terrestrial Evaluation Screening Levels. Structurally related surrogates were used for several constituents that did not have available reference doses (see Table 4.5.2-1). The draft screening level for MCPA was calculated based on the model for shrews, as specified in WAC 173-340-900, Table 749-4, using the mammalian chronic No Observed Adverse Effect Level of 4.4 mg/kg/day. To develop a draft screening level for MCPP, AMEC used the draft screening level for MCPA as a structurally related surrogate, because MCPP has no available reference dose or ecological screening level from EPA Region 4 or 5. The draft screening levels for bromoxynil and dichloroprop were also based on the model for shrews, as specified in WAC 173-340-900, Table 749-4, and were calculated using the mammalian chronic No Observed Adverse Effect Levels of 1.5 and 3.6 mg/kg/day, respectively.

4.5.3 Ambient Air Monitoring and Cleanup Levels

Historically, there has been no routine ambient air quality monitoring program at the NPL Site. The flare for the MSW Landfill was used to treat contaminated Zone A soil vapor from 2002 through October 2015. An ASIL assessment of flare emissions was provided in the *Draft 2013 Fourth Quarter and 2013 Annual Report, Pasco Municipal Solid Waste Disposal Areas* for the reporting period. Flare emissions have been less than ASILs, based on results of a source performance test in 2010 and air quality analysis, as reported in quarterly reports. Since October 2015, the flare has treated only landfill gas from the MSW Landfill with trace concentrations of VOCs.

An upgraded RTO system has been installed and is fully operational as of July 2017 to treat and destroy VOCs removed by the SVE system in compliance with the air quality permit obtained for that unit. Ambient air CULs will not be developed for the flare and the RTO because emissions from the flare meet ASILs under WAC 173-460 and emissions from the RTO are regulated by RTO Approval Order #16AQ-E031 issued by Ecology's AQP.

Ambient air monitoring in the vicinity of IWA Zones C/D and E began in March 2017 via a walkaround field photoionization detector survey to assess the potential emissions from these zones. The monitoring is conducted under Addendum No. 1 to the Operations and Maintenance Manual for IWA Caps (PBS 2017a). The field data to date do not show emissions from these capped IWA Zones and, therefore, ambient air CULs will not be developed.

4.5.4 Points of Compliance

4.5.4.1 Points of Compliance for Ground Water

Ground water CULs shall be met at the POC. Ground water CULs must be met throughout the ground water system, except directly below the potential source areas. Ground water CULs based on protection of surface water must be met as close as practicable to the source not to exceed the point or points where the ground water flows to the surface water body (WAC 173-340-720(8)(d)(ii)).

The CAP will determine the POCs; these locations would likely be at the edges of waste for each IWA Zone, which is as close as practicable to the source, consistent with Ecology guidance on POCs for landfills, and compliance would apply everywhere downgradient of these locations. In the case of Zone A, wells MW-52S and MW-53S are within the Zone A perimeter such that the data from those wells will be used as performance monitoring wells. Other wells located downgradient of MW-52S and MW-53S will be designated as conditional POCs established downgradient from the performance monitoring wells, as Ecology will specify in the CAP.

Per MTCA, Ecology may approve an off-property conditional POC when the CULs are based on surface water beneficial uses (WAC 173-340-720(8)(d)(ii)). However, VOC concentrations in off-property wells have not been detected above dCULs in recent years (following upgrades to the SVE system in 2012). Therefore, surface water is currently protected and an off-property conditional POC does not need consideration.

Ecology Focus No. 94-130 provides the following guidance regarding conditional POCs:

> A conditional point of compliance for ground water may only be established where it can be demonstrated that is not practicable (due to technical limitations, environmental conditions, or other factors) to meet the cleanup level throughout the Site within a reasonable restoration timeframe. Attaining cleanup levels directly under a landfill would require the excavation of waste, possibly causing more harm than good. In this case, Ecology may approve a conditional point of compliance, provided that the point is located as close to the source of contamination as possible. Any contamination left on the Site must be contained

within a specified area that protects humans and ecological receptors from exposure to the contaminants (Ecology 2007b).

4.5.4.2 Points of Compliance for Surface Soil

For surface soils, MTCA allows a POC to be set for ecological receptors at the biologically active zone of 6 feet conditional on ICs for the NPL Site. Applicable POCs for surface soil would be designated by Ecology in the CAP.

5 DESCRIPTION OF REMEDIAL ALTERNATIVES

Remedial alternatives have been developed for the waste and underlying soils at the MSW Landfill and disposal areas (Balefill Area, Burn Trenches, and Inert Waste Disposal Area), each of the IWA Zones, and for on-property ground water, consistent with the FFS Work Plan and the RAOs described in Section 4. This section describes the remedial alternatives, and illustrates the range of approaches that can be used to conduct the final cleanup at the NPL Site. These alternatives are carried forward into the detailed MTCA evaluation in Section 6, with the exception of some Zone A alternatives that were eliminated based on similarity of technologies, scope, and relative costs (see Section 5.4.11).

5.1 General Considerations

This section describes the general considerations pertinent to several remedial alternatives. ICs and ground water compliance monitoring would be needed as part of any cleanup action.

5.1.1 Institutional Controls

ICs are controls or actions to “limit or prohibit activities that may interfere with the integrity of an IA or a cleanup action or result in exposure of humans to hazardous substances at the site” (WAC 173-340-200). ICs that can be implemented at cleanup sites are described in MTCA regulations (WAC 173-340-440) and are required to assure both the continued protection of human health and the environment and the integrity of remedial actions due to the presence of hazardous substances remaining at the NPL Site above applicable CULs. As stated in the *Pasco Landfill Site Updated Institutional Control Plan – Revision 1* (Anchor QEA 2013), ICs that have been established for the NPL Site are an integral part of the IA cleanup activities implemented to date, in that specific restrictions supplement the engineering controls to ensure protection of human health and the environment. Similar ICs are anticipated to be an integral part of final cleanup actions as well.

There are three primary entities responsible for implementing the ICs at the NPL Site (i.e., City of Pasco, Franklin County, and PSLI or a successor landowner). Other PLPs, such as the IWAG, BCS, and others, have an overall responsibility of ensuring that the ICs are implemented and maintained. Private parties may have the responsibility for establishing and maintaining ICs, such as signage and other physical measures. PLPs owning the

PSLI Property have the ability and responsibility to place and enforce land use restrictions as the CAP may specify. Financial assurance requirements are not in the category of ICs but the PLPs similarly will be responsible for meeting those requirements.

As part of governmental controls, zoning ordinances in the GPA have been implemented at the NPL Site to limit well water use and conduct annual beneficial use surveys and will remain in place until ground water CULs have been achieved and after confirmation sampling establishes that levels of hazardous substances in ground water no longer pose an unacceptable risk to human health or the environment.

Proprietary controls, in the form of easements and covenants, have also been used at the NPL Site to protect current and future owners of property, tenants, licensees, and guests, from exposure to hazardous substances at the NPL Site and are enforceable by Ecology. Deed restrictions on the PSLI Property are currently in place to prevent ground water usage for domestic and agricultural uses. In addition, informational devices have been implemented to inform the public of potential risks (warning notices and signage) of hazardous substances remaining at the NPL Site and restrict access (gates and fencing). These use restrictions would remain in effect indefinitely.

For remedial alternatives that include capping of the waste zones, restrictions would be included to prevent the penetration of the caps (e.g., by heavy equipment operations) or any site use that could affect their integrity. In addition, ICs are intended to limit general soil excavation and disturbance of any area where waste materials may be covered.

Other specific future ICs could be addressed in the CAP (WAC 173-380(1)(a)(vi)) or an Engineering Design Report (EDR; WAC 173-340-400(4)(a)). Items to be presented or addressed in these reports may include, but are not limited to, the following:

- NPL Site map with selected cleanup action components identified
- Existing engineered controls and ICs
- Engineered controls and/or ICs required by the selected cleanup action
- Activities at the NPL Site that could result in disturbance for the selected cleanup action
- Time frames for establishing engineered controls or ICs

- Federal, state, or local entities responsible for implementation, maintenance, and enforcement of selected engineered controls and ICs
- Actions that may require permitting or other approval by the above entities
- Procedures for prohibiting certain site activities that may affect the selected cleanup action and procedures for reporting improper or unauthorized uses or activities
- Procedures for measuring protectiveness for each implemented engineered control and ICs
- Financial assurance of implemented engineered controls and ICs

5.1.2 Ground Water Compliance Monitoring

Ground water compliance monitoring is expected to be the key element of an overall CMP. The MTCA cleanup regulations describe the following three types of compliance monitoring (WAC 173-340-410):

- Protection monitoring, to confirm that human health and the environment are adequately protected during construction and the operation and maintenance of the cleanup action
- Performance monitoring, to confirm that the cleanup action has attained the CULs and other performance standards
- Confirmational monitoring, to confirm the long-term effectiveness of the cleanup action

Although a ground water CMP will be developed after the CAP is finalized, ground water protection, performance, and confirmational monitoring activities are assumed for cost purposes in this FFS and are developed specifically for the scope of the various alternatives. For alternatives that involve waste removal, compliance monitoring would remain in effect until CULs are achieved. For alternatives that rely on containment, ground water monitoring would continue for longer periods of time.

Gauging and sampling frequency would depend on ground water concentrations, constituent concentration trends, and biodegradation indicators. The ground water monitoring program assumed includes quarterly sampling (to provide a seasonal record of constituent concentrations), with gradual decreases in frequency to semiannual and annual or potentially less frequent sampling intervals when data trends are established.

The CMP will address specific reporting requirements. The following reports are representative of what may be required for this project:

- Routine ground water compliance monitoring and well maintenance plan: describes the long-term ground water monitoring program for the NPL Site to comply with MTCA requirements (Chapter 173-340 WAC).
- Periodic ground water monitoring reports: describes the ground water monitoring results for activities conducted during the previous quarter or half year.
- Annual ground water monitoring report: describes the ground water monitoring results for activities conducted during the previous year. Any modifications to the ground water monitoring program would be recommended in the annual reports.
- Annual cleanup action activity report: describes the cleanup action activities conducted the previous year and associated monitoring results from those activities. This report would include required regulatory reporting for the various cleanup action components implemented at the NPL Site.
- Period (5-year) review report: provides an overall assessment of the activities conducted at the NPL Site during the previous 5 years, as well as any recommendations for modifications to the ground water monitoring and cleanup action activities. This report is typically prepared by Ecology.

5.1.3 No Action Alternative

The NPL Site is an NPL site under CERCLA (see Section 1.1) that is administered under Washington State MTCA. As an NPL site, RI, remedial action alternative (RAA) evaluation, and remedy selection criteria under the CERCLA National Contingency Plan (NCP; Subpart F: 40 Code of Federal Regulations (CFR) 300.61-300.71) apply. MTCA evaluation and remedy selection criteria are generally consistent with those under the NCP. One of the few points of difference is that, unlike CERCLA, MTCA does not require consideration of a No Action Alternative as part of the FS remedial alternative evaluation process (Ecology 2016a). To fulfill the requirements of the NCP, this FFS evaluates the No Action Alternatives for each zone of the NPL Site.

EPA FS guidance specifies the No Action Alternative should not include treatment, engineering controls, measures to reduce the potential for exposure (such as fencing), or ICs (EPA 1989a, 1991). However, guidance specifies that the No Action Alternative may include environmental monitoring.

The No Action Alternatives evaluated for the IWAs and MSW Landfill, where caps have been constructed, include keeping those caps in place. As required independently under the Washington State landfill post-closure regulations (Chapter 173-304 WAC), cap inspections and limited ground water monitoring would continue even if the No Action Alternative were selected for those zones.

5.1.4 Cost Considerations

Cost considerations applicable to all remedial alternatives and detailed in Appendix E (Detailed Cost Estimates and Backup for Zones A, C/D and E) are as follows:

- **FS-level Assumptions:** In order to generate cost estimates, FS-level assumptions were made regarding the remedial technologies and quantities applicable to each alternative. These assumptions were made for cost comparison purposes only and may be subject to refinement and change during remedial design. The expected accuracy for FS-level costs typically ranges from +50% to -30% around the probable cost estimates; this was one of the considerations in developing appropriate contingency factors for NPL Site remedial alternatives (see subsequent Contingency bullet).
- **Sales Tax:** Tax is included at 8.6% to account for Washington State, Franklin County, and the City of Pasco taxes.
- **Discount Rate**: EPA policy on the use of discount rates for RI/FS cost analyses is stated in the preamble to the NCP (55 FR 8722) and in the Office of Solid Waste and Emergency Response Directive 9355.3-20 entitled Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis (EPA 1993). In addition to the NCP and the OSWER Directive policies, EPA guidance on developing and documenting cost estimates during the FS stage (EPA 1996a, 2000) recommends a 7% discount rate for private industry because this represents a “real” discount rate that approximates the marginal pretax rate of return on an average investment in the

private sector and has been adjusted to eliminate the effect of expected inflation. EPA guidance states this rate should be used with "constant" or "real" dollars that have not been adjusted for inflation (i.e., a dollar spent in future years is worth the same as a dollar spent in the present year), which is the typical situation for RI/FS cost analyses. EPA states the 7% discount rate was established through an economic analysis performed by the Office of Management and Budget, specifically for estimation of present net worth value for potential alternatives in the RI and FS and for remedial action (EPA 1993). This guidance goes on to state the following:

> …For Federal facility sites being cleaned up using Superfund authority, it is generally appropriate to apply the real discount rates found in *Appendix C of OMB Circular A-94* [11]. These rates, which are also used in the President's annual budget submission to Congress, are based on interest rates from Treasury notes and bonds. Because the Federal government has a different 'cost of capital' than the private sector, these rates are appropriate to use for adjusting future year expenditures in a present value calculation for Federal facility remediation projects. Although an analogous situation exists for Federal-lead sites that will be cleaned up by USEPA using the Superfund trust fund (i.e., Fund-lead sites), there is always a chance that the site will actually be remediated by a private, or 'potentially responsible party' (i.e., PRP-lead cleanup)… (EPA 1993).

Therefore, EPA guidance states the 7% discount rate should generally be used in calculating net present value costs for all non-federal facility sites.[12]

Long-term cost projections for each of the remedial alternatives in this Draft Final FFS are presented as net present values, using a fixed real discount rate of 3%, because it is considered appropriate and sufficiently conservative for the restoration time frames associated with the various alternatives (i.e., 30 years or less) on a project of the magnitude and complexity of the NPL Site. In addition, Draft Final FFS cost

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[11] See https://obamawhitehouse.archives.gov/omb/circulars_a094/a94_appx-c.

[12] At least one FS conducted in the Eastern Washington Region, for the Kaiser Trentwood Facility Site (Hart-Crowser 2012), used a discount rate of 7% for costing purposes, consistent with the EPA guidance.

estimates have not been adjusted for inflation because it has been minimal since 2014 (average inflation rate is less than 1% between 2014 and 2016).

- **Engineering-related Tasks Under Non-construction Costs:** Two main engineering-related tasks have been identified under non-construction costs: 1) Design, Project Management, and Permitting; and 2) Construction Management and Inspection. Attachment F, Exhibit 1, of Appendix E provides a summary of the basis and rationale for the percentages of the total construction costs (17% and 8%, respectively) used for these engineering-related tasks and is included in the development of non-construction costs for Zones A, C/D, E, and the On-property Ground Water Area alternatives.
- **Contingency:** Contingency must be factored into FS-level cost estimates to cover unknowns, unforeseen circumstances, or unanticipated conditions that are not possible to evaluate from the data on hand at the time the estimate is prepared. The expected accuracy for FS-level costs typically ranges from +50% to -30% around the probable cost estimates, and should account for the two main types of contingency: scope and bid. Scope contingency covers unknown costs due to scope changes that may occur during design. Bid contingency accounts for unforeseen costs associated with constructing or implementing a given project scope.

  Due to the relative complexity of the Zone A alternatives, contingency cost analyses were conducted to account for effects of the two types of contingencies and results are presented in Attachment G to Appendix E (particularly for Zone A Alternatives A-2, A-6, and A-9). Therefore, and for the purposes of the Draft Final FFS, the assumed overall project contingencies for the Zone A alternatives are as follows (see Section 5.4):
  - For Alternatives A-1, A-2, and A-3 (which include long-term operation of the existing or enhanced SVE system): 20%.
  - For Alternatives A-4, A-5, A-6, and A-7 (which have excavation and on-site Area of Contamination [AOC] disposal and/or treatment [other than SVE operation]): 40%.
  - For Alternative A-8: this is a hybrid alternative that includes 20% contingency for the implementation of Alternative A-2 (10-year operation of the enhanced SVE system) and 40% contingency for the implementation of Alternative A-7 (excavation and on-site AOC disposal).

- For Alternative A-9 (which has excavation and off-site disposal): 55%.[13]
- No Action Alternatives and alternatives in other zones (C/D, E, and the On-property Ground Water Area) use the following overall project contingencies (see Sections 5.6, 5.7, and 5.8):
- No Action Alternatives: 20%.[14]
- Alternatives CD-1, E-1, and ONP-1: 20%.[17]
- Alternatives CD-2, CD-3, E-2, and E-3: 40%.[15]

5.2 Municipal Solid Waste Landfill

Three remedial alternatives for the MSW Landfill were proposed for evaluation in the Ecology-approved FFS Work Plan (Anchor QEA et al. 2013). Alternative MSW-1 involves continued operation and maintenance of the existing actions and is the preferred alternative. Alternatives MSW-2 and MSW-3 are contingent alternatives that are not warranted based on current environmental conditions.

Alternatives MSW-1, MSW-2, and MSW-3, discussed in detail below, are all permanent to the maximum extent practicable, and were retained in the FFS Work Plan. The RAOs for, and current status of, the MSW Landfill are presented in Table 4.3-1. In the 1999 FS Report, the no-action alternative was not carried forward for the MSW Landfill, and would not meet the MTCA requirements for addressing state landfill regulations. During the technology screening in the FFS Work Plan, a permanent solution (excavation and disposal of the MSW Landfill at a Subtitle D landfill) was not retained for further evaluation because it is impractical.

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[13] As described in Attachment G to Appendix E, the range of overall project contingencies for Zone A alternatives ranged from 20% to 55%.

[14] A 20% overall project contingency is a standard, FS-level contingency, based on high overall remedy certainty.

[15] A 40% overall project contingency is also within FS-level typical contingencies, and it is used for alternatives with a high level of uncertainty during design and construction.

5.2.1 Alternative MSW-1

Alternative MSW-1 consists of leaving the MSW Landfill in place with existing ICs and including the following:

- Existing GCCS
- Existing engineered cover system and monitoring for potential landfill gas migration
- Existing enclosed flare system
- Existing ground water monitoring wells
- Post-closure care as required under WAC 173-351, and detailed in the *Draft Operations and Maintenance Manual Update: MSW Disposal Areas* (Aspect 2016).

Alternative MSW-1 has historically addressed the RAOs by controlling landfill gas migration and treating collected landfill gas with the existing GCCS. As landfill gas generation at the MSW Landfill decreases over time, changes in how landfill gas is collected and treated are anticipated as described below.

Within 5 years, the existing GCCS may be oversized to meet the objectives of maintaining combustible methane concentrations and controlling potential landfill gas migration. Therefore, MSW Landfill alternatives assume a change in landfill gas treatment technology and O&M specifications as conditions warrant, and with Ecology approval.

Within 15 years, the MSW Landfill will transition from post-closure care to custodial care when landfill stability can be demonstrated (i.e., little to no settlement, gas production, or leachate generation) to Ecology's satisfaction.

The anticipated life cycle for the landfill cover system is greater than 100 years, based on the design of the cover system and the temperatures observed at the wellheads. Therefore, MSW Landfill alternatives assume that the cover system does not need to be replaced.

Table 5.2-1 provides the estimated annual costs over time for Alternative MSW-1, a total cost of $1.475 million, and the total net present value cost of $1.359 million. A detailed cost estimate for Alternative MSW-1 is included as Table 5.2-2. These costs include:

- Continued monitoring, operations, maintenance, and reporting as described in Section 2.5.1.4.
- Replacement of existing flare with alternative treatment system (estimated in 2022).
- Transition from post-closure care to custodial care (estimated in 2031).

5.2.2 Alternative MSW-2

Alternative MSW-2 consists of all elements of Alternative MSW-1, and expanding the GCCS, if necessary. Alternative MSW-2 provides a contingency in the unlikely case that alternative MSW-1 does not meet the RAOs. Alternative MSW-2 addresses the RAOs by installing additional landfill gas extraction wells. However, flows from the GCCS would be increased to improve landfill gas collection under Alternative MSW-1 before any new wells would be installed under Alternative MSW-2.

If necessary, new extraction wells will be located in the MSW to replace or supplement existing wells, such as "Example EW" shown between EW-20 and EW-21 on Figure 2.5.1-2. Or, new SVE wells will be located just beyond the edge of MSW to prevent lateral landfill gas migration, such as the "Example SVE" well shown just north of EW-19 on Figure 2.5.1-2. These example completions are located on the north end of the MSW Landfill, which has the greatest thickness of MSW, and the thinnest vadose zone.

Table 5.2-1 provides the estimated annual costs over time for Alternative MSW-2, the total cost of $1.730 million, and the total net present value cost of $1.608 million. A detailed cost estimate for Alternative MSW-2 is included as Table 5.2-3. These costs include:

- Continued monitoring, operations, maintenance, and reporting as described in Section 2.5.1.4.
- Installation and startup of four new landfill gas extraction wells.
- Replacement of existing flare with alternative treatment system (estimated in 2022).
- Transition from post-closure care to custodial care (estimated in 2031).

5.2.3 Alternative MSW-3

Alternative MSW-3 includes all elements of Alternative MSW-2, and a contingent, active ground water collection and treatment system. Alternative MSW-3 provides a contingency in the unlikely case that Alternative MSW-2 does not meet the RAOs, ground water concentrations at the MSW Landfill monitoring wells exceed CULs due to concentrations not mitigated by the GCCS (expanded under Alternative MSW-2), and potential exposure to impacted ground water cannot be prevented by ICs. The existing NPL Site ICs adequately address the RAO of preventing ingestion, inhalation, or dermal absorption of impacted ground water.

Table 5.2-1 provides the estimated annual costs over time for Alternative MSW-3, the total cost of $3.585 million, and the total net present value cost of $3.329 million. A detailed cost estimate for Alternative MSW-3 is included as Table 5.2-4. These costs include:

- Continued monitoring, operations, maintenance, and reporting as described in Section 2.5.1.4.
- Construction and operation of ground water GCCS for an assumed flow rate of 20 gpm.
- Replacement of existing flare with alternative treatment system (estimated in 2022).
- Transition from post-closure care to custodial care (estimated in 2031).

5.3 Balefill and Inert Waste Area, and Burn Trenches

Remedial alternatives for the Balefill and Inert Waste Disposal Areas and the Burn Trenches are presented below.

5.3.1 Balefill and Inert Waste Disposal Areas

For the purpose of remedial alternative selection, the Balefill Area and the Inert Waste Disposal Area were combined based on the alternatives (BA-1 and IWDA-1, respectively) in the Ecology-approved FFS Work Plan. During the technology screening in the FFS Work Plan, a permanent solution (excavation and disposal of the Inert Waste Disposal Area at a Subtitle D landfill) was not retained for further evaluation due to impracticality.

RAOs were not specified in the 1999 FS Report for the Balefill and Inert Waste Disposal Areas, and IAs have not been previously required by Ecology (PSC 1999). The Balefill and Inert Waste Disposal Areas are approaching or have reached functionally stable conditions, meaning little to no landfill gas generation, leachate production, or settlement. However, a no-action alternative is not appropriate for the Balefill and Inert Waste Disposal Areas because it does not meet the MTCA requirements for addressing landfill regulations.

The RAOs for, and current status of, the Balefill and Inert Waste Disposal Areas are presented in Table 4.3-1. The remedial alternative for the Balefill and Inert Waste Disposal Areas is described below, based on the soil cover restoration described in the *Draft Operations and Maintenance Manual Update: MSW Disposal Areas* (Aspect 2016).

5.3.1.1 Alternative BA-1

Alternative BA-1 consists of leaving the Balefill and Inert Waste Disposal Areas in place and restoring the existing soil cover to a minimum thickness of 30 inches, including a gravel layer to eliminate terrestrial ecological exposure and wind erosion of the soil cover. Currently exposed MSW will be leveled to the extent practical before soil cover restoration. The restored soil cover will store and evaporate precipitation preventing potential liquid-phase transport to subsurface soil and ground water. The *Draft Operations and Maintenance Manual Update: MSW Disposal Areas* (Aspect 2016) describes the soil cover restoration and O&M requirements to demonstrate landfill stability. Existing gas probes and thermocouple arrays completed within the MSW will be decommissioned, as needed. This alternative adequately addresses the RAOs for preventing direct exposure to MSW and soil, minimizing transport of contaminants to subsurface soils and ground water, and will maximize protection from potential surface fires.

Table 5.3-1 provides the estimated annual costs for Alternative BA-1, the total cost of $0.468 million, and the total net present value cost of $0.450 million. A detailed cost estimate for Alternative BA-1 is included in Table 5.3-2. These costs include:

- Restoring the soil cover over approximately 25% of the total Balefill and Inert Waste Disposal Areas (estimated in 2017)
- Monitoring, maintenance, and reporting

- Transitioning to custodial care (estimated in 2031)

5.3.2 Burn Trenches

Two alternatives for Burn Trenches were proposed for evaluation in the Ecology-approved FFS Work Plan. A third alternative is included as a contingency action in the unlikely event that the existing soil cover system over a portion of BT-1 is determined to be inadequate and requires rehabilitation. The RAOs for, and current status of, the Burn Trenches are presented in Table 4.3-1. The three remedial alternatives for the Burn Trenches are described below.

5.3.2.1 Alternative BT-A

This alternative consists of leaving the Burn Trenches in place, and implementing monitoring, maintenance, and reporting before transitioning to custodial care with ICs. The existing covers over the Burn Trenches adequately address the RAOs. Based on historical ground water sampling results, the Burn Trench covers have minimized transport of any contaminants to soil and ground water.

Table 5.3-3 provides the estimated annual costs over time for Alternative BT-A, the total cost of $15,000, and the total net present value cost of $14,000. A detailed cost estimate for Alternative BT-A is included in Table 5.3-4. These costs include:

- Monitoring, maintenance, and reporting
- Transitioning to custodial care (est. in 2031)

5.3.2.2 Alternative BT-B

This contingency alternative includes all elements of Alternative BT-A, and adds confirmation of the soil cover thickness over Burn Trench BT-1 not already beneath the engineered cover system at Zones C/D. Alternative BT-B adequately addresses the RAOs, and the benefit of empirically demonstrating soil cover thickness is balanced by short-term risks in field activities.

Table 5.3-3 provides the estimated annual costs over time for contingency Alternative BT-B, the total cost of $54,000, and the total net present value cost of $51,000. A detailed cost estimate for Alternative BT-B is included in Table 5.3-5. These costs include:

- Confirming the soil cover thickness
- Monitoring, maintenance, and reporting
- Transitioning to custodial care

5.3.2.3 Alternative BT-C

This contingency alternative includes all elements of Alternative BT-B, in addition to restoring the cover system for Burn Trench BT-1 to a thickness of at least 30 inches, if necessary. For purposes of this FFS, it was assumed that approximately 25% of the area of Burn Trench BT-1 would be restored. Alternative BT-C adequately addresses the RAOs, and the benefits of restoring the soil cover thickness are balanced by the short-term risks of construction.

Table 5.3-3 provides the estimated annual costs over time for contingency Alternative BT-C, the total cost of $145,000, and the total net present value cost of $141,000. A detailed cost estimate for Alternative BT-C is included in Table 5.3-6. These costs include:

- Confirming the soil cover thickness
- Soil cover thickness restoration, if needed
- Monitoring, maintenance, and reporting
- Transitioning to custodial care (est. in 2031)

5.4 Zone A

The following alternatives are evaluated for Zone A in this Draft Final FFS.

5.4.1 Alternative A-1

5.4.1.1 Operational Time Frame for Zone A SVE-based Alternatives

Under MTCA, remedial alternatives are evaluated within the framework of minimum requirements, including threshold requirements, other requirements, and additional requirements, the specifics of which are defined in WAC 173-340-360. One of the other MTCA requirements is to "provide for a reasonable restoration time frame" (per WAC 173-340-360(4)). Restoration time frame is defined as the time needed to achieve the required CULs at the POC established for the site (WAC 173-340-200). MTCA presents a number of factors to be considered for determining if the cleanup action provides for a reasonable restoration time frame (see WAC 173-340-360(4)(b) and Section 6.1.2).

MTCA provides no specific reasonable restoration time requirement, but instead allows for a comparison of restoration timeframes among the remedial alternatives. Per Ecology guidance, Ecology places a preference on those alternatives that, while equivalent in other respects, can be implemented in a shorter period of time; however, it "does not require that an alternative with a 'far shorter reasonable restoration time frame be selected' " (Ecology 2016a).

Current conditions at Zone A comply with ground water dCULs outside of the Zone A cap (i.e., ground water monitoring data indicate that COC concentrations in wells at the edge of waste have not been detected above the dCULs in recent years). Future conditions at Zone A are expected to remain in compliance with ground water CULs outside of the Zone A cap with proper operation of the SVE system until the rate of VOC removal has declined and stabilized over multiple years. Accordingly, restoration has been achieved at those points (the proposed conditional POCs as discussed above in Section 4.5.4 and elsewhere in this document).

For the purposes of this FFS, the "SVE operational timeframe" is used when referring to the period of time the SVE system will need to operate to continue to maintain the current level of ground water protection. Although all Zone A alternatives include some level of SVE treatment, it is the primary treatment method of VOCs (and to a lesser degree, low molecular weight SVOCs) in Alternatives A-1 through A-5 (see Sections 5.4.1 through 5.4.5).

Appendix J, *Zone A Restoration Time Frame Assessment*, describes the derivation of the SVE operational time frame, based on the following assumptions, which are described in considerable detail in the appendix:

- All Zone A drums are likely to have pitting corrosion or complete structural failures and have already started leaking flowable liquids by now.
- Between 90% and 99% of the VOC source mass will be required to meet CULs. A 95% reduction is the most likely value to allow the phased shutdown of the SVE system in the future.
- Approximately half the total VOC mass has been removed to date.

Based on two independent analyses, this appendix concludes that the most likely SVE operational time frame is between 14 and 16 years.

For FFS costing purposes, a 30-year period was assumed as the SVE operational time frame for Alternatives A-1 through A-5 (see Sections 5.4.1 through 5.4.5). This 30-year period is a conservative time frame (rounded-up from the estimated value in Appendix J) that accounts for 16 years of SVE operation plus two 5-year review periods during which protection of ground water without SVE operation would be demonstrated before the SVE system could be completely and permanently shut down.

It is anticipated that rebound and other testing would be performed during the 5-year review process to demonstrate that sufficient mass had been removed to be protective of ground water without further operation of the SVE system.

5.4.1.2 Description of Alternative A-1

Alternative A-1 consists of the following cleanup action components:

- Continued operation and monitoring of the existing SVE system (including treatment of the recovered SVE gasses through thermal oxidation) for the Zone A source area. The SVE system would continue to be operated for approximately 30 years or less if the rate of VOC removal has declined and stabilized over a shorter period (see Section 5.4.1.1). The system would then be operated intermittently (through a series of standard rebound tests) initially for at least 1 year, or for a duration allowing sufficient time for diffusion of VOCs adsorbed into surrounding soils during periods when the SVE system is off. The SVE system would then be turned back on and the extent of accumulated soil vapor concentrations will be measured to assess rebound and determine whether further operation of the SVE system is required. If cycled system operation does not result in an increase in the removal rate of VOCs when the system is restarted, individual wells or the entire system may be shut down and terminated. Confirmation ground water sampling would continue during and after SVE system shut down to ensure the absence of contaminant migration into ground water at concentrations above CULs at the POC or any of the performance wells. The SVE system would be restarted if rebound in concentrations is shown at any of the performance wells or any contaminant exceedance of CULs at the POC.

- Monitoring and maintenance of the existing RCRA cap and cover system. Replacement of the cap and cover system under this alternative would occur two times over a 30-year period (at years 1 and 15, following implementation of the CAP).
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC.
- The use of appropriate existing ICs.

With the above cleanup action components, this alternative meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.1-1 and 5.4.1-2 depict the general plan view and schematic cross section, respectively, of Alternative A-1.

The existing Zone A cap and cover system has performed its intended function, preventing direct contact of human or ecological receptors with the wastes and preventing surface water infiltration due to precipitation. Differential settlement has occurred in localized areas of Zone A. It is anticipated that the existing cap will be replaced in the early phase of remedy implementation for this alternative (at year 1) in order to re-establish the original design criteria objectives of the Zone A cover system, and again at approximately year 15, and continued repairs to the cap will be necessary over its lifetime. Routine settlement monitoring, cap evaluation and performance reporting, and cap inspection and maintenance would be performed until confirmatory sampling beneath a cover system indicates that residual soil contamination levels do not pose risks to human health and the environment. These activities would follow the standards provided in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*.

This alternative also assumes continued operation and monitoring of the existing SVE system for the Zone A source area for approximately 30 years, including destruction of the recovered SVE gasses through thermal oxidation. Monthly inspections, maintenance, and equipment replacement of the SVE system, SVE operational costs, vapor sampling and data collection, RTO maintenance (as specified by the manufacturer), and SVE condensate disposal are assumed to occur over a 30-year operational period.

Alternative A-1 would continue to use the current network of monitoring wells adjacent to and downgradient of Zone A. The network would consist of approximately 18 wells during the first 10 years and would be reduced to approximately 12 and 6 wells in each of the following 10-year intervals. For FFS costing purposes, quarterly, semiannual, and annual sampling events are assumed to take place during the 30-year period (10-year intervals are assumed for each proposed reduction in the number of wells sampled).

ICs will continue to be required in Alternative A-1 as described in Section 5.1.1.

The total estimated cost for Alternative A-1 is $16.1 million, which includes estimated construction and non-construction (e.g., long-term monitoring and maintenance) costs of $1.0 million and $12.4 million, respectively, and a 20% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.2 Alternative A-2

Alternative A-2 consists of all of the cleanup action components of Alternative A-1, with the addition of the following:

- An enhanced SVE system, consisting of up to three additional SVE wells installed within the intermediate zone, with the purpose of increasing mass removal.

- Air-sparging and ozone injection, to be implemented as a contingent action to address potential future ground water containing hazardous substances if they are detected downgradient of Zone A at actionable concentrations.

With the above cleanup action components, Alternative A-2 meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.2-1 and 5.4.2-2 depict the general plan view and schematic cross section, respectively, of Alternative A-2.

Alternative A-2 would consist of the same cleanup action components as those described in Alternative A-1 (Section 5.4.1), but would additionally utilize air sparging and ozone injection as a contingent action to be implemented to address potential future impacted ground water downgradient of Zone A, should such impacts be identified. This contingent action would only be operated if the SVE system was not successfully maintaining the protection of ground water quality at the POC. SVE gasses recovered from the vadose zone in the sparged areas would be treated through either GAC or the RTO system. While air sparging would be employed to physically strip VOCs and some SVOCs from the ground water, ozone treatment would be used to oxidize VOCs, SVOCs, and PAHs from the ground water. Although to date no non-VOC compounds have reached ground water at levels exceeding MTCA Method B levels, this component of Alternative A-2 is intended to prevent other non-VOC compounds from reaching the ground water POC in the future.[16]

For costing purposes, it is assumed that eight air sparge and ozone injection wells and three SVE wells would be positioned in a north-south alignment, west of Dietrich Road. The alignment of these wells would be based on the general ground water gradient of east to west, along with ease of installation and maintenance along the road right-of-way. The

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[16] Ozone has been demonstrated to be highly effective in remediation applications because it is one of the strongest oxidizers and can remediate a large variety of organic compounds (ITRC 2005, EPA 2006). With an effective reagent distribution and appropriate number of injections, ozone provides a rapid treatment time frame due to its fast reaction kinetics (Hoigne and Bader 1983, Hong et al. 1996, Kuo and Chen 1996), and brings residual concentrations to very low levels (Wheeler et al 2002, Mitani et al 2002, Masten 1990, Clancy et al 1996, Black 2001). Determination of in situ ozone design parameters would be evaluated through pilot-scale testing.

sparge and ozone injection wells would be assumed to have a radius of influence (ROI) of 33 feet based on a 45-degree cone extending outward from an initial elevation of 322 feet and a 33-foot treatment depth (Middle Ringold). The contingent SVE wells would be conservatively assumed to have an ROI of 100 feet (compared to the 208-foot ROI calculated for the Upper Pasco Gravels in the *Revised 100% Submittal Engineering Design Report for SVE System Upgrades* (EPI 2010c). Prior to full-scale implementation, additional treatability testing may be needed under Alternative A-2 to evaluate the optimum operating conditions for air sparging and ozone injection system. Such considerations as actual ROI and effectiveness of ozone on target compounds would be evaluated as part of a pilot test plan, treatability test plan, and EDR for implementation.

Alternative A-2 includes the costs for the potential future enhancement of the SVE system with the addition of three SVE wells in the intermediate zone to improve mass removal and destruction. This alternative also assumes continued operation and monitoring of the existing SVE system for approximately 30 years, including destruction of the recovered SVE gasses through the RTO. Monthly inspections, maintenance, and equipment replacement for the SVE system, SVE operational costs, vapor sampling and data collection, RTO maintenance (as specified by the manufacturer), and SVE condensate destruction/disposal are assumed to occur over a 30-year operational period.

This alternative includes the same level of cap monitoring and maintenance, inspection, performance evaluation, and cap replacement as Alternative A-1, and assumes these activities would be performed until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment.

To verify the protection of ground water quality, Alternative A-2 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternative A-1.

ICs will continue to be required in Alternative A-2 as described in Section 5.1.1.

The total estimated cost for Alternative A-2 takes into account the enhanced SVE system, and also the possibility that at year 5, following implementation of the CAP, the contingent sparge system and ozone injection system could be implemented and operated for the next 25 years. Under this scenario, the total estimated cost for Alternative A-2 is $18.3 million, which includes estimated construction and non-construction costs of $1.9 million and $13.3 million, respectively, and a 20% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.3 Alternative A-3

Alternative A-3 consists of all of the cleanup action components of Alternative A-2, with the exception of vertical injection well installation and chemical oxidation treatment of contaminated ground water, which will be implemented as a contingent action to address potential future impacted ground water downgradient of Zone A should such occur (instead of the air sparging/ozone injection contingent action in Alternative A-2). A strong oxidizing agent (sodium persulfate) would be applied to promote rapid oxidation of organic compounds other than VOCs.

With the above cleanup action components, Alternative A-3 meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.3-1 and 5.4.3-2 depict the general plan view and schematic cross section, respectively, of Alternative A-3.

The contingent action would be implemented to address potential future impacted ground water downgradient of Zone A, should such impacts be identified during the 5-year period reviews. This contingent action would not be integrated into the existing SVE system and would only be implemented if the SVE system was not successfully maintaining the protection of ground water quality downgradient of Zone A. Further optimization of the SVE system would be performed based on continued ground water monitoring performed in accordance with a future site-wide ground water CMP.

Under this contingency action, chemical oxidation products would be introduced in sufficient quantity and concentration to oxidize PAHs and other SVOCs, should they be present at unacceptable levels in ground water in the future. For FFS costing purposes, the oxidizing agent, sodium persulfate, was selected as an appropriate chemical oxidant due to its oxidation potential, and its relative safety during handling; in addition, ferrous sulfate would be added as an activator for the sodium persulfate to begin the oxidation reaction.[17] The installation of a water line to the existing SVE compound area would be required to provide the ability to dilute the oxidant into liquid form for injection. A mixing station, including a mixing tank, circulation pumps, valves, and gauges, would be constructed to allow for mixing and injection into the wells. Chemical oxidant would be mixed in batches and introduced to each well through aboveground piping.

For FFS costing purposes, it is assumed that the potential release would be treated immediately upon detection within the source zone (assumed 5 years after the implementation of the CAP). The one-time chemical application would treat the top 5 feet of ground water downgradient from Zone A. A soil porosity of 35% and a ground water velocity of 7 feet/day were used to estimate a 43-day residence time in the area to allow for the complete oxidation of the contaminants. Concentration strength was determined using the average maximum concentrations of PAHs detected in ground water to date. If a single application is required (achieved by a conservative 1.5 times oxidant demand applied to ensure complete destruction of contaminants), the total amount of sodium persulfate and ferrous sulfate reagent required for amendment would be 21.8 tons and 15.1 tons, respectively. Additional treatability testing may be needed to evaluate the likelihood of negative effects or potential byproducts. For costing purposes in the Draft Final FFS, a single amendment injection is assumed because the volume of the injection would be sufficient to treat the potential transient event of impacted ground water under Zone A for 1 year. If required, multiple injections are assumed to be included in the overall project cost contingency under Alternative A-3.

This alternative includes the same level of cap monitoring and maintenance, inspection, performance evaluation, and cap replacement as Alternatives A-1 and A-2, and assumes these

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[17] Appendix F, Table 2, describes in detail the technology screening for the contingent action in ground water downgradient of Zone A, rationale for amendment selection, and methodology to estimate reagent concentration, mass, and frequency of application for FFS evaluation and costing purposes. Additional assumptions used in developing these estimates (e.g., soil porosity) are also specified in this appendix.

activities would be performed until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment.

This alternative also assumes similar future enhancement of the SVE system as Alternative A-2, as well as the same level of SVE monthly inspections, maintenance, upgrades, and equipment replacement.

To verify the protection of ground water quality, Alternative A-3 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternatives A-1 and A-2.

ICs will continue to be required in Alternative A-3 as described in Section 5.1.1. An Underground Injection Control (UIC) permit would be required from Ecology in order to perform this alternative.

The total estimated cost for Alternative A-3 is $17.3 million, which includes estimated construction and non-construction costs of $1.8 million and $12.6 million, respectively, and a 20% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.4 Alternative A-4

Alternative A-4 consists of all of the cleanup action components of Alternative A-2, with the exception of horizontal injection well installation and chemical oxidation treatment of contaminated soil within Zone A, which would be implemented as a contingent action (instead of the air sparging/ozone injection contingent action in Alternative A-2). A strong oxidizing agent (sodium persulfate) would be applied to promote rapid oxidation of organic compounds other than VOCs.

With the above cleanup action components, this alternative meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.4-1 and 5.4.4-2 depict the general plan view and schematic cross section, respectively, of Alternative A-4.

The contingent action for soil treatment within Zone A would only be implemented if the SVE system was not successfully maintaining the protection of ground water quality downgradient of Zone A based on the results of, and criteria established in, a future site-wide ground water CMP, and if changes to optimize the SVE system performance were not successful. Similar to Alternative A-3, sodium persulfate would be used to chemically oxidize COCs beneath Zone A that are adsorbed to Touchet Bed soils.

This alternative would treat an estimated total surface area of 2.5 acres (including stacked-drum area, adjacent soils, and a buffer area surrounding the waste within the geomembrane boundary) and an estimated soil volume of 49,022 CY (based on targeted hydraulic flooding of a 12-foot-thick treatment area beneath Zone A, to ensure that the soils are in sufficient contact with the liquid oxidant). This contingent action assumes that benzene, toluene, ethylbenzene, xylene, and ketones are the primary COCs in vadose zone soils beneath Zone A and are present at concentrations consistent with the available soil characterization data; however, the contingent action would also address SVOCs, PAHs, and other organic compounds (other than VOCs). For FFS costing purposes, the oxidizing agent (sodium persulfate, as 30% solution) was selected as an appropriate chemical oxidant due to its oxidation potential, and its relative safety during handling; in addition, ferrous sulfate would be added as an activator for the sodium persulfate to begin the oxidation reaction.[18] If it is assumed that a single application would be required (achieved by a conservative 1.5 times oxidant demand applied to ensure complete destruction of contaminants), the total amount of sodium persulfate and ferrous sulfate reagent required for amendment would be 4,530 tons and 3.6 tons, respectively. Additional treatability testing may be needed to evaluate the likelihood of negative effects within Zone A.

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[18] Appendix F, Table 4, describes in detail the technology screening for the contingent action for Zone A soil, rationale for amendment selection, and methodology to estimate reagent concentration, mass, and frequency of application for FFS evaluation and costing purposes. Additional assumptions used in developing these estimates (e.g., soil porosity) are also specified in Appendix F.

A water line would be installed to provide a sufficient volume of water to mix and inject batches of oxidant consistently until the oxidant is consumed. Infrastructure to complete this alternative would consist of a mixing pad, mixing tanks, recirculation pumps, piping, control valves and pressure gauges to allow for the safe and effective application of the oxidant. It would be necessary to ensure that all of the oxidant was dissolved within the applied liquids to prevent undissolved salts from building up within injection piping and well screens. Liquids would be injected under very low pressures to ensure there is no contact between chemical oxidant and the drums during hydraulic floods.

This alternative includes the same level of cap monitoring and maintenance, inspection, performance evaluation, and cap replacement as Alternatives A-1 through A-3 and assumes these activities would be performed until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment.

This alternative also assumes a similar future enhancement of the SVE system as Alternative A-2, as well as the same level of SVE monthly inspections, maintenance, upgrades, and equipment replacement.

To verify the protection of ground water quality, Alternative A-4 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternatives A-1 through A-3.

ICs will continue to be required in Alternative A-4 as described in Section 5.1.1. A UIC permit would be required from Ecology in order to perform this alternative.

The total estimated cost for Alternative A-4 is $62.4 million, which includes estimated construction and non-construction costs of $26.0 million and $18.6 million, respectively, and a 40% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.5 Alternative A-5

Alternative A-5 (as well as Alternatives A-6 [Section 5.4.6], A-7 [Section 5.4.7], and A-8 [Section 5.4.8]) makes use of the concept of the AOC policy. Brief background information on the AOC policy and specific application of this concept in association with this remedial alternative are provided below.

5.4.5.1 Area of Contamination Policy

The expectations for cleanup action alternatives under MTCA is consistent with EPA policy where hazardous substances remain on site at concentrations that exceed CULs (WAC 173-340-370(5)). In that situation, MTCA requires consolidation of those hazardous substances "to the maximum extent practicable where needed, to minimize the potential for direct contact and migration of hazardous substances." On-site consolidation of bulked drummed waste and contaminated soils excavated from Zone A is included in select remedial alternatives (Alternatives A-5, A-6, A-7, and A-8). None of the drummed waste buried in Zone A is classified as a listed RCRA hazardous waste because waste disposal operations occurred between 1972 and 1975, as reported in the Phase II RI Report, which pre-date RCRA regulations applicable to hazardous waste management activities.

In the preamble to the NCP (55 Federal Register [FR] 8758-8760, March 8, 1990), EPA introduced the AOC policy, which is defined as a "discrete area of generally dispersed contamination that can be equated to a RCRA unit (landfill)." An AOC is usually delineated by the areal extent (or boundary) of contiguous contamination, and such contamination must be continuous, but may contain varying types and concentrations of hazardous substances. Therefore, this policy is particularly useful for consolidation of contiguous units or areas of contaminated soil. Although the AOC concept was initially discussed in the context of the CERCLA program, it applies equally to RCRA corrective action sites, cleanups under state law, and voluntary cleanups.

EPA's AOC policy states that consolidation and in situ treatment of hazardous waste inside the boundaries of the AOC does not create a new point of hazardous waste generation because an AOC is equated to a RCRA land-based unit. The NCP also discusses using the concept of "placement" to determine which requirements might apply with an AOC. The concept of "placement" is important because placement of hazardous waste within AOCs is not considered "land disposal" and does not trigger the RCRA land disposal restrictions, minimum technology requirements (MTRs), or other RCRA requirements (including permitting at a non-CERCLA site, closure, and post-closure). In the NCP, EPA states "placement does not occur when waste is consolidated within an AOC, when it is treated in situ, or when it is left in place." Placement does occur, and additional RCRA requirements may be triggered, when wastes are moved from one AOC to another (e.g., for consolidation) or when waste is actively managed (e.g., treated ex situ) within or outside the AOC and returned to the land.

5.4.5.1.1 Area of Contamination Siting Considerations

Several factors must be considered in evaluating potential locations for constructing an AOC in which consolidation and placement of Zone A waste material would be performed:

1. **Haul distance:** the length of haul can significantly affect the overall design and operation of the AOC. Although minimum distances are desired, other factors must also be considered.
2. **Location restrictions:** the specific federal requirements contained in Subpart B of RCRA (40 CFR Part 258) pertain to location restrictions for RCRA land-based units, such as locations near airports, flood plains, wetlands, fault areas, seismic impact zones, or unstable areas.
3. **Available land area:** it is important to ensure that sufficient land area is available to accommodate site preparation activities, mandatory facilities (i.e., staging, handling, and decommissioning areas), and any auxiliary and temporary facilities. The area must also include an adequate buffer zone to ensure protection of human health and the environment from proximity to the AOC cell.
4. **NPL Site access:** if the AOC is of suitable size (and not near developed roadways and cities), construction of access roadways may be necessary and may be an important factor in the siting.
5. **NPL Site-specific conditions:** site characteristics such as soil, climate, topography, and hydrology must be considered because they affect the AOC operation, the type of equipment to be used, and the need for development of potential mitigation measures.

6. **Local environmental conditions:** it must be ensured that the AOC is environmentally acceptable with respect to traffic, noise, odor, dust, airborne debris, visual impact, vector control, hazards to health, and property values.
7. **Public concerns:** public hearings may be necessary to bring out public concerns about a potential AOC location.

For purposes of Alternatives A-5, A-6,A-7, and A-8[19], it is anticipated that the Zone A wastes would be consolidated into an AOC cell located east of the MSW Landfill and north of the historical Lagoons SL-2 and SL-3. This area is suitable because the land is currently vacant, haul distance would be minimal from the Zone A drum/waste footprint, RCRA-based location restrictions are met, and site access is already in place. Moreover, the AOC is consistent with existing property use because the MSW Landfill and other waste disposal areas will remain in place in perpetuity. The landowner, PSLI, has indicated the AOC on its property is a viable remedy (Aspect 2015). In addition, public concerns regarding the location of the AOC will be considered both during the public review process of the Draft Final FFS and the draft CAP, and public input will be incorporated into the final CAP.

5.4.5.1.2 Area of Contamination Approval Considerations

As stated in the *Use of the Area of Contamination (AOC) Concept During RCRA Cleanups* (EPA 1996b), “Although advance approval at the Federal level is not required for private parties to take advantage of the AOC concept, we encourage them to consult with the appropriate agency to ensure they implement the AOC concept appropriately….” The AOC policy has been applied to MTCA cleanups and Ecology would be the leading regulatory agency responsible for approving and determining that the AOC concept is being properly applied at the NPL Site.

Some of the considerations associated with the implementation of the AOC concept include the following (EPA 1996b):

- The AOC must be fully designated in the Consent Decree (CD).

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[19] Alternative A-8 would only include the contingent excavation action with on-site disposal of the Touchet Beds in the AOC, if the enhanced SVE system and contingent air/sparge and ozone treatment are demonstrated to not be not sufficiently protective (See Section 5.4.8).

- The AOC-eligible wastes must be defined by Ecology, including hazardous waste found below ground in crumbling or unstable containers managed for implementing cleanup and in buried containers that are intact or substantially intact and excavated during cleanup.
- NPL Site-specific in situ treatment criteria within the AOC must be established by Ecology, with the purpose of enhancing the long-term effectiveness of remedial actions by reducing the toxicity, mobility, or volume of wastes that will remain in place after closure of the AOC.
- Minimum design and operating standards of the AOC must be defined by Ecology (more stringent standards may be required at the state level, compared to those established at the federal level).
- Permits and specific federal, state, or local requirements must be determined by Ecology that are applicable or relevant and appropriate to specific circumstances at the NPL Site.

5.4.5.2 Development of Cost Estimates for Zone A Excavation-based Alternatives

Alternatives A-5 through A-9 include removal of Zone A drums and varying degrees of soil removal. The IWAG retained Envirocon, Inc. (Portland, Oregon, office), to assist with scoping of the technical approach and costing for removal scenarios. The IWAG deemed it important to obtain input from an experienced drum removal and remediation contractor on the following:

1. Excavation volume estimates
2. On-site and off-site disposal options
3. Logistical considerations
4. Geotechnical and NPL Site controls considerations (e.g., shoring or stormwater)
5. Health and safety considerations (e.g., worker and public)
6. Schedule considerations (e.g., time required to implement alternatives)
7. Regulatory considerations (e.g., RCRA, MTCA, or local)
8. Permit considerations (i.e., identify necessary permits)

Unit costs, tasks needed for implementation of these remedial alternatives, and associated assumptions were provided by Envirocon, Inc. They collaborated with the IWAG and the technical consulting team over a period of several months to evaluate numerous removal scenarios to develop the cost estimates presented for the Zone A excavation-based alternatives in this FFS. Envirocon, Inc., worked closely with disposal companies and obtained pricing from Pasco-area and regional vendors for disposal and treatment costs. Attachment F, Exhibit 2, of Appendix E provides the Scope of Work Assumptions Memorandum, prepared by Envirocon (and previously distributed to Ecology during the March 26, 2015 All PLP/Ecology meeting), describes the basis and rationale for the level of effort and associated costs for activities such as mobilization, site preparation, demobilization/project closeout, and operations supervisory/support used for Alternative A-9. These bases and rationale were applied to the other Zone A excavation-based alternatives.

5.4.5.3 Description of Alternative A-5

Incorporating the AOC concept, Alternative A-5 consists of the following cleanup action components:

- Mobilization and NPL Site preparation, including staging and equipment lay down area, NPL Site haul roads (to accommodate highway truck lead out), NPL Site controls and work zones (temporary security fencing, personnel decontamination facilities, wheel wash and equipment decontamination stations, truck scales), and surveying.
- Design and construction of new on-site AOC cell prior to drummed waste and impacted soil removal, per EPA's landfill guidance (EPA 1989b, 2005).
- Removal of the current Zone A cover system down to the geomembrane (2-foot vegetative layer, geotextile separator, 1-foot drainage layer, geomembrane) and stockpile for backfill; approximately 13,500 tons (9,000 CY) of assumed clean soil are estimated to be removed.
- Removal of engineered fill and impacted soils from the geomembrane to the top of Visqueen layer (8-foot thickness) and consolidation and disposal in the AOC cell; approximately 46,500 tons (31,000 CY) of assumed impacted soil are estimated to be removed.

- Removal of impacted soils from the top of Visqueen layer to the top of the Touchet Beds (17-foot thickness) and consolidation and disposal in the AOC cell; approximately 93,300 tons (62,200 CY) of assumed impacted soil are estimated to be removed.
- Removal of layback soils at the elevation of the top of Visqueen layer to the top of the Touchet Beds (17-foot thickness and outside of the Zone A drum footprint) and stockpile for backfill; approximately 45,300 tons (30,200 CY) of assumed clean soil are estimated to be removed.
- Removal of approximately 16,100 stacked drums containing hazardous waste (i.e., with liquids and sludges). Individual overpacking of a portion (25%, equivalent to approximately 4,000 drums) of these drums is assumed for transportation and off-site disposal (of which 20% would require incineration and 80% would be directly disposed at a Subtitle C landfill). Remaining drums, when decanted of free liquids, are assumed to be handled as bulked waste, consolidated, and disposed of in the AOC cell (approximately 4,930 tons [3,285 CY]).
- Decant and bulk liquid waste in an on-site designated area, and off-site incineration; a total of 1,000 tons of solvent and aqueous liquids is assumed to be recovered.
- Removal of 8,900 stacked drums containing casting sands (approximately 3,630 tons [2,420 CY]), assumed to be handled as bulked waste, consolidated, and disposed of in the AOC cell.
- Field hazard categorization of 5% of the stacked drums (containing hazardous waste and casting sands) in an on-site staging area and off-site laboratory analysis.
- Placement of bulked drummed waste and impacted soils (approximately 148,400 tons [98,900 CY]) into a newly constructed AOC cell.
- Placement of a 3-foot RCRA-compliant cap (minimum crown slope of 4%) over AOC cell and hydroseed of surface.
- Backfill of the remedial excavation area with stockpiled and clean soil (approximately 138,600 tons [92,400 CY).
- Placement of a 3-foot RCRA-compliant cap (minimum crown slope of 4%) over the Zone A excavation area and hydroseed of surface.
- Well installation and operation and maintenance of the SVE system to address residual soil contamination remaining in place between the top of the Touchet Beds

soils and the water table with appropriate and effective vapor effluent treatment as necessary to ensure protection of ground water.
  - Installation of three new deep horizontal SVE wells to be installed beneath Zone A prior to waste removal for protection of ground water during removal.
  - Installation of two new intermediate wells to be installed during capping.
  - The SVE system would continue to be operated during waste and soil removal, and for an additional 30 years to address contaminants left in place in the Touchet Beds.
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC.
- The use of appropriate existing ICs.

With the above cleanup action components, Alternative A-5 meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.5-1 and 5.4.5-2 depict the general plan view and schematic cross section, respectively, of Alternative A-5.

Alternative A-5 assumes the design and construction of an AOC cell with an estimated area of 7.7 acres (RCRA cap area) and depth of 10 feet (waste placement thickness), for an approximate total capacity of 231,400 tons (154,300 CY; including RCRA cap, bulked waste/impacted soils, double-lined compacted layer, and required laybacks). Figure 5.4.5-3 shows an approximate location of the AOC for the Zone A wastes, which would be east of the MSW Landfill and north of the historical Lagoons SL-2 and SL-3 (where land is currently vacant). Per hazardous waste landfill MTRs (EPA 1989b, 2005), the AOC cell would address design and operating standards, inspection and response actions, and closure and post-closure requirements. With the objective of minimizing the formation and migration of leachate to the adjacent subsurface soil and ground water, the following are the MTRs included in the AOC cell design:

- Double liner, consisting of a top liner (e.g., geomembrane) and a composite bottom liner (synthetic geomembrane and 3 feet of compacted soil material with a hydraulic conductivity of no more of $1x10^{-7}$ cm/s).

- GCCS, operated as a passive venting system due to anticipated low gas migration within the AOC cell. Located above the waste, the GCCS consists of a granular drainage layer (12-inch thickness), capable of control potential VOCs produced by the AOC waste, and necessary lateral piping to vent them out.
- Leachate collection and removal system, located above the top liner and in between liners (immediately above the composite liner). The leachate collection and removal system consists of two granular drainage layers with a bottom slope (at least 4%), a hydraulic conductivity of $1x10^{-2}$ cm/s or more, and a thickness of 12 inches or more, capable of removing liquids at a specified minimum rate. A leak detection system would also be installed to comply with leak sensitivity (daily monitoring of liquid levels and inflow rates) requirements established by EPA (1989b, 2005).
- Sumps and liquid removal methods (e.g., pumps) of sufficient size to collect liquids and prevent liquids from backing up into the drainage layer.
- Stormwater run-off controls to prevent migration of hazardous waste for at least a 25-year storm and a cover to prevent wind dispersal.

A typical schematic cross section of the AOC cell is also presented in Figure 5.4.5-4 with the detailed elements of the top RCRA cap and bottom double-lined compacted layer per hazardous waste landfill MTRs (EPA 1989b, 2005).

Alternative A-5 assumes a total excavation area of 4.61 acres for Zone A, including areas of stacked drums, adjacent and surrounding impacted soils, and associated layback soils, down to the top of the Touchet Beds (approximately 27 feet in depth). The total excavation volume is estimated to be 208,800 tons (139,200 CY), of which 148,400 tons (98,900 CY) of contaminated materials are assumed to be consolidated and disposed of in the AOC cell and 58,800 tons (39,200 CY) are assumed to be used as backfill clean material for either the remedial area or as capping material. The remaining excavated volume of 1,650 tons (1,100 CY) represents the 25% of the stacked drums (containing hazardous waste) that would be overpacked for transport, handling, and disposal off site. Appendix D, Tables 1a through 1c, presents detailed Zone A and AOC area and volume calculations for Alternative A-5.

Drummed waste (containing hazardous waste and casting sands) and impacted soils that are excavated from Zone A would be profiled for disposal. Field hazard categorization of the drummed or bulk waste removed from Zone A would be performed at an on-site staging area. In addition, it is assumed that 5% of the total number of drums will be sampled for waste characterization purposes and sent to an off-site laboratory for analysis. Representative soil sample would be collected for every 1,000 tons (approximately 700 CY) of excavated soil, and samples would be sent to an off-site laboratory for waste characterization analysis. For cost estimating purposes, 25% of the stacked drums containing hazardous waste (approximately 4,000 drums) were assumed to be characteristic RCRA hazardous waste; therefore, these drums would be individually overpacked and either sent off site for direct disposal in a Subtitle C landfill in Arlington, Oregon (approximately 3,200 drums), or for incineration at a facility in Grantsville, Utah (approximately 800 drums).

Alternative A-5 assumes transportation of a total of 1,000 tons of bulked liquid waste (solvents and aqueous phase) and approximately 4,000 intact overpacked drums to off-site landfills or incineration facilities. Off-site truck transportation assumes 60 drums per load, 30 tons per soil/waste load, and 10,000-gallon tanker trucks for liquids for delivery to Grantsville, Utah, for incineration; Arlington, Oregon, for Subtitle C landfill disposal; and Finley Buttes, Washington, for Subtitle D landfill disposal. The various types of wastes and disposals would result in over 120 truck trips through Pasco by way of I182. Total round trip distance to the various disposal facilities involve over 72,400 miles of travel. For large trucks (gross weight greater than 10,000 pounds), the environmental impacts of such transport include vehicle air emissions of approximately 350 metric tons of carbon dioxide emissions and over 12,100 gallons of fuel consumed.

The Zone A excavation would be backfilled with stockpiled and clean soil to the surrounding ground surface elevation. The backfill would be compacted and a new RCRA-compliant cap would be installed at the surface of Zone A. This alternative would continue routine cap inspection, maintenance and monitoring, and cap evaluation and performance reporting, until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*). For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

This alternative assumes the operation of the current SVE system (including treatment of the recovered SVE gasses through the RTO) to address residual soil contamination remaining in place between the top of the Touchet Bed soils and the water table to ensure protection of ground water. Before construction, all shallow and intermediate wells would be removed. During construction,[20] three new deep horizontal SVE wells would be installed (prior to waste and soil removal) in the Upper Pasco Gravels unit (at an approximate elevation of 365 feet) for continued ground water quality protection from potentially migrating COCs, in the event of waste release during drum removal. An additional two new intermediate wells would be installed during final capping. Monthly inspections, maintenance, upgrades, and equipment replacement of the SVE system are assumed to occur over a 30-year operation period.

To verify the protection of ground water quality, Alternative A-5 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternative A-1.[21]

In addition, the scope of this alternative would account for the following activities associated with the Zone A excavation:

- Realignment of Dietrich Road, approximately 50 feet to the west to facilitate the necessary Zone A overexcavation boundary.
- Relocation of the high-pressure natural gas pipeline. The existing natural gas pipeline would be removed and realigned outside the Zone A overexcavation boundary. Therefore, the design and construction of a new 600-foot section of a similar pipeline along Dietrich Road and procurement of a new easement would be required.
- Demolition and reconstruction of a Basin Disposal, Inc. building (approximately 30 feet by 80 feet), located within the Zone A overexcavation boundary.

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[20] It is assumed that the implementation period of Alternative A-5 would be approximately 3 years, including 2 years for the on-site double-lined AOC cell construction and 1 year for site preparation; establishment of an access and haul circulation road through the Balefill Area and Inert Waste Disposal Debris Area; construction of waste handling, staging, stockpiling, and drum inspection areas; and excavation of stacked drum area, adjacent/underlying impacted and layback soils, and their placement into the AOC.

[21] During the 30-year ground water monitoring period, five wells under Alternative A-5 are assumed to be replaced.

ICs will continue to be required in Alternative A-5 as described in Section 5.1.1.

The total estimated cost for Alternative A-5 is $56.0 million, which includes estimated construction and non-construction costs of $20.2 million and $19.7 million, respectively, and a 40% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.6 Alternative A-6

Alternative A-6 is a removal action similar to Alternative A-5, but with in situ thermal treatment of the Touchet Beds rather than long-term SVE operation. The primary components that differ from A-5 are the following:

- Installation, operation, and maintenance of an in situ thermal treatment system to more rapidly remove solvent source mass between the top of the Touchet Beds and the top of the Upper Pasco Gravels (instead of SVE treatment of the Touchet Bed soils under Alternative A-5).
- Well installation and operation and maintenance of the SVE system to address residual soil contamination remaining in place between the top of the Touchet Beds soils and the water table with appropriate and effective vapor effluent treatment as necessary to ensure protection of ground water.
  - Installation of three new deep horizontal SVE wells to be installed beneath Zone A prior to waste removal for protection of ground water during removal.
  - The SVE system would continue to be operated during waste and soil removal, during thermal treatment, and for an additional 10 years after completion of thermal treatment and would consist only of the three new, deep horizontal SVE wells subject to engineering considerations to be developed in the EDR.

With the above cleanup action components, this alternative meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.6-1 and 5.4.6-2 depict the general plan view and schematic cross section, respectively, of Alternative A-6.

Alternative A-6 assumes the same AOC cell design and construction as for Alternative A-5 (the plan view and the typical cross section are presented in Figures 5.4.5-3 and 5.4.5-4, respectively). The design of the AOC cell would address design and operating standards, inspection and response actions, and closure and post-closure requirements, following the hazardous waste landfill MTRs (EPA 1989b, 2005), similar to those described in Section 5.4.5.1.

Alternative A-6 assumes the same total excavation area and volume of Alternative A-5, as presented in Section 5.4.5.3. Appendix D, Tables 1a through 1c, presents detailed Zone A and AOC area and volume calculations for Alternative A-6.

Drummed waste (containing hazardous waste and casting sands) and impacted soils excavated from Zone A would be profiled for disposal in a similar manner as under Alternative A-5 (field hazard categorization of the drummed or bulk waste removed from Zone A, waste characterization, and off-site laboratory analysis). Assumptions for cost estimating purposes regarding type and quantity of waste profiled, characterized, and sent for off-site disposal are also equivalent to those described in Section 5.4.5.3.

Alternative A-6 has the same short-term impacts of Alternative A-5 because they are both AOC-based alternatives and assume the same type and quantity of waste going for off-site disposal (see Section 5.4.5.3).

Alternative A-6 assumes installation of an in situ thermal treatment system to treat the remaining VOC source mass in the impacted Touchet Bed soils following the drum removal described above, prior to backfilling to ground surface and final capping. A 1-foot-thick asphalt cover would be constructed in the Zone A depression to facilitate installation and operation of thermal treatment equipment. This technology heats soil using electrical resistance resulting in the boiling of water and VOCs in soil, the capture of the contaminated steam by a vapor recovery system, and the subsequent thermal destruction of vapors above ground. The thermal treatment system would cover an area of 2.2 acres and an estimated volume of 106,050 tons (70,700 CY; based on a targeted vadose zone treatment depth of 20 feet in the Touchet Beds). The treated area would consist of four subareas, where approximately 380 25-foot-long electrodes and co-located vapor recovery wells would be installed. The operational time frame of the thermal treatment system per subarea is estimated at 6 to 8 months, with an average VOC mass percent reduction of 96% (see Attachment E of Appendix E; also see Fleming 2014).

Following thermal treatment, Zone A would be backfilled with clean and stockpiled soils to ground surface elevation and would be compacted, and a new RCRA-compliant cap would be installed at the surface of Zone A. This alternative would continue routine cap inspection, maintenance and monitoring, and cap evaluation and performance reporting, until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*). For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

This alternative assumes the operation of the SVE system (including treatment of the recovered SVE gasses through the RTO) to address residual soil contamination remaining in place between the top of the Upper Pasco Gravels and the water table. Before construction, all shallow and intermediate wells would be removed. During construction[22], three new deep horizontal SVE wells would be installed (prior to waste and soil removal) in the Upper Pasco Gravels unit (at an approximate elevation of 365 feet) to ensure protection of ground water from potentially migrating COCs, in the event of waste release during drum removal. For FFS costing purposes, SVE operation is assumed to continue for an additional 10 years following completion of the thermal treatment. Monthly inspections, maintenance, upgrades, and equipment replacement of the SVE system are assumed to occur over a 10-year operation period (to account for two 5-year review periods post-cleanup).

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[22] It is assumed that the implementation period of Alternative A-6 would be approximately 3.5 years, including the following: 1) 2 years for the on-site double-lined AOC cell construction; 2) 1 year for site preparation; establishment of an access and haul circulation road through the Balefill Area and Inert Waste Disposal Debris Area; construction of waste handling, staging, stockpiling, and drum inspection areas; excavation of stacked drum areas, adjacent/underlying impacted and layback soils, and their placement into the AOC; and 3) an estimate of 6 to 8 months of operational time frame of the thermal treatment system.

To verify the protection of ground water quality, Alternative A-6 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period. The network would consist of approximately 21 wells during the first 10 years (immediately after waste and soil removal) and approximately seven wells in the following 20 years[23]. Quarterly, semiannual, and annual sampling events would take place during the 30-year period (10-year intervals assumed for each event frequency).

The scope of this alternative would account for the same activities associated with the Zone A excavation, as described in Alternative A-5 (see Section 5.4.5.3).

ICs will continue to be required in Alternative A-6 as described in Section 5.1.1.

The total estimated cost for Alternative A-6 is $62.1 million, which includes estimated construction and non-construction costs of $27.1 million and $17.3 million, respectively, and a 40% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.7 Alternative A-7

Alternative A-7 is a removal action similar to A-6, but with removal of the Touchet Beds and disposal in an on-site AOC rather than in situ thermal treatment. Alternative A-7 differs from Alternatives A-5 and A-6 primarily in the size and volume of the Zone A excavation and the AOC footprint. The primary differences from Alternatives A-5 and A-6 are the following:

- Removal of impacted soils from the top of Touchet Beds to the top of the Upper Pasco Gravels (15-foot thickness) and consolidation and disposal in the AOC cell; approximately 91,500 tons (61,000 CY) of assumed impacted soil are estimated to be removed.
- Removal of layback soils at the elevation of the top of Touchet Beds to the top of the Upper Pasco Gravels (15-foot thickness and outside of the Zone A drum footprint)

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[23] During the 30-year ground water monitoring period, five wells under Alternative A-6 are assumed to be replaced.

and stockpile for backfill; approximately 82,200 tons (54,800 CY) of assumed clean soil are estimated to be removed.

- Placement of bulked drummed waste and impacted soils (approximately 240,000 tons [160,000 CY]) into a newly constructed AOC cell.
- Backfill of the remedial excavation area with stockpiled and clean soil (approximately 312,300 tons [208,200 CY]).

With the above cleanup action components, this alternative meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.7-1 and 5.4.7-2 depict the general plan view and schematic cross section, respectively, of Alternative A-7.

Alternative A-7 assumes an AOC cell with an estimated area of 11.7 acres (RCRA cap area) and a depth of 10 feet (waste placement thickness), for an approximate total capacity of 368,900 tons (246,000 CY; including RCRA cap, bulked waste/impacted soils, double-lined compacted layer, and required laybacks). The same AOC cell design and construction of Alternatives A-5 and A-6 are assumed for this alternative (plan view and typical cross section are presented in Figures 5.4.5-3 and 5.4.5-4). The design of the AOC cell would address design and operating standards, inspection and response actions, and closure and post-closure requirements, following the hazardous waste landfill MTRs (EPA 1989b, 2005), similar to those described in Section 5.4.5.1.

Alternative A-7 assumes a total excavation area of 6.04 acres for Zone A, including areas of stacked drums, adjacent and surrounding impacted soils, and associated layback soils, down to the top of the Upper Pasco Gravels (approximately 42 feet in depth). The total excavation volume is estimated to be 382,500 tons (255,000 CY), of which 240,000 tons (160,000 CY) of contaminated materials are assumed to be consolidated and disposed of in the AOC cell and 141,000 tons (94,000 CY) are assumed to be used as backfill clean material for either the remedial area or as capping material. The remaining excavated volume of 1,650 tons (1,100 CY) represents the 25% of the stacked drums (containing hazardous waste) that would be overpacked for transport, handling, and disposal off site. Appendix D, Tables 1a through 1c, presents detailed Zone A and AOC area and volume calculations for Alternative A-7.

Drummed waste (containing hazardous waste and casting sands) and impacted soils that are excavated from Zone A would be profiled for disposal in a similar manner as under Alternative A-5 (field hazard categorization of the drummed or bulk waste removed from Zone A, waste characterization, and off-site laboratory analysis). Assumptions for cost estimating purposes regarding type and quantity of waste profiled, characterized, and sent for off-site disposal are also equivalent to those described in Section 5.4.5.3.

Alternative A-7 has the same short-term impacts of Alternatives A-5 and A-6, as they are AOC-based alternatives and assume the same type and quantity of waste going for off-site disposal (see Section 5.4.5.3).

The Zone A excavation would be backfilled with stockpiled and clean soil to the surrounding ground surface elevation. The backfill would be compacted and a new RCRA-compliant cap would be installed at the surface of Zone A. This alternative would continue routine cap inspection, maintenance, and monitoring, and cap evaluation and performance reporting, until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*). For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

This alternative assumes the operation of the SVE system (including treatment of the recovered SVE vapors through the RTO) to address residual soil contamination remaining in place between the top of the Upper Pasco Gravels and the water table. Before construction, all shallow and intermediate wells would be removed. During construction[24], three new deep horizontal SVE wells would be installed (prior to waste and soil removal) in the Upper Pasco Gravels unit (at an approximate elevation of 365 feet) to ensure protection of ground water from potentially migrating COCs in the event of waste release during drum

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[24] It is assumed that the implementation period of Alternative A-7 would be approximately 3.5 years, including 2 years for the on-site double-lined AOC cell construction and 1.5 years for site preparation; establishment of an access and haul circulation road through the Balefill Area and Inert Waste Disposal Debris Area; construction of waste handling, staging, stockpiling, and drum inspection areas; and excavation of stacked drum area, adjacent/underlying impacted and layback soils, the Touchet Bed soils, and their placement into the AOC.

removal. For FFS costing purposes, SVE operation is assumed to continue for an additional 10 years following completion of the removal action. Monthly inspections, maintenance, upgrades, and equipment replacement of the SVE system are assumed to occur over a 10-year operation period.

To verify the protection of ground water quality, Alternative A-7 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternatives A-5 and A-6.

The scope of this alternative would account for the same activities associated with the Zone A excavation, as described in Alternative A-5 (see Section 5.4.5.3).

ICs will continue to be required in Alternative A-7 as described in Section 5.1.1.

The total estimated cost for Alternative A-7 is $60.3 million, which includes estimated construction and non-construction costs of $25.5 million and $17.5 million, respectively, and a 40% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.8 Alternative A-8

Alternative A-8 is a hybrid alternative incorporating the cleanup action components of Alternative A-2 (cap maintenance with enhanced SVE and possible contingent action involving air-sparging and ozone injection if necessary to address potential future ground water conditions downgradient of Zone A) and possible contingent action involving the cleanup action components of Alternative A-7 (removal with on-site disposal in an AOC) if necessary to address potential conditions as discussed below. Alternative A-8 provides for initial implementation of Alternative A-2 (including contingencies if triggered) with a potential future excavation action at Zone A based on Alternative A-7. The underlying assumption of Alternative A-8 is that Alternative A-2 is the appropriate, preferred Zone A remedy based on current actual data and conditions. However, Zone A conditions may evolve in the future, which may require changes to the SVE system operations that would preclude or severely limit the implementation of the A-2 remedy. Under Alternative A-8, the progressive, iterative transition from enhanced SVE operation (Alternative A-2) to the potential contingent excavation action (Alternative A-7) could occur under a number of potential scenarios—all initiated by "data triggers," and then addressed by draft work plans prepared by the Performing PLPs to address the pertinent scenario(s), and subject to Ecology approvals. Potential scenarios, data triggers, and responses are outlined as follows:

1. If Zone A ground water monitoring data demonstrate that enhanced SVE operation (and progressive modifications of such operations) are not sufficiently protecting ground water downgradient of Zone A at the POC, such data would trigger the implementation of the contingent action of implementing air-sparging and ozone injection. If such action is implemented but ground water monitoring data continue to demonstrate that these activities are not sufficiently protecting ground water downgradient of Zone A at the POC, then the circumstances would trigger implementation of the contingent Alternative A-7 excavation action with on-site disposal in an AOC.
2. If the PLPs find SVE/RTO O&M impracticable to implement despite modifications to SVE/RTO operation, then the circumstances would trigger implementation of the contingent Alternative A-7 excavation action with on-site disposal in an AOC.
3. If monitoring of Zone A results in data and multiple lines of evidence based on the indicator parameters presented in Appendix M (and based on knowledge gained from the 2014 to 2016 Balefill Area combustion response activities[25]) demonstrating subsurface combustion at Zone A, the circumstances would trigger efforts to address the Zone A conditions in situ through modified SVE operation and/or other actions (such as suppression/extinguishment actions). If such actions are demonstrated by data and multiple lines of evidence as described above to be unsuccessful in terminating the subsurface combustion, and if the conditions are determined to pose a substantial risk of adversely affecting human health or the environment, then the circumstances would trigger implementation of the contingent Alternative A-7 excavation action with on-site disposal in an AOC.

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[25] For example, temperatures in the Balefill Area zone of pyrolysis were typically on the order of 300°F or greater as measured by subsurface thermocouples.

To verify the protection of ground water quality, Alternative A-8 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 20-year period after implementation of the excavation action, if such action is triggered and implemented.

ICs will continue to be required in Alternative A-8 as described in Section 5.1.1.

For costing purposes, it is assumed that Alternative A-2 enhanced SVE action would operate for 10 years with the possible implementation of the contingent Alternative A-7 excavation action at year 11. It is likely that some scenarios such as 1 and 3 outlined above would not occur for much longer than 10 years, but 10 years was selected as a reasonable time frame for costing this alternative.

The total estimated cost for Alternative A-8 is $49.9 million, which includes the following: 1) estimated construction and non-construction costs of $1.5 million and $7.3 million, respectively, and a 20% contingency for implementation of Alternative A-2; and 2) construction and non-construction costs of $18.4 million and $9.7 million, respectively, and a 40% contingency for implementation of Alternative A-7 (see Table 5.4-1). All costs are presented as net present value (see Appendix E for details of cost elements of Alternatives A-2 and A-7 under Alternative A-8). However, because Alternative A-8 is a hybrid alternative, with the more expensive contingent action following several years of enhanced SVE operation, the total cost of Alternative A-8 is less than the combined cost of Alternatives A-2 and A-7. Net present value affects costs that are deferred to later years (i.e., implementation of the contingent Alternative A-7 excavation at year 11, after 10 years of enhanced SVE operation).

5.4.9 Alternative A-9

Alternative A-9 is a removal action similar to Alternative A-7 but with off-site disposal of all soils and waste within the Zone A footprint from below the geomembrane to the top of the

Upper Pasco Gravels; consequently, this alternative does not include an on-site AOC. This alternative consists of the following cleanup action components:

- Mobilization and NPL Site preparation, including staging and equipment lay down area, NPL Site haul roads (accommodate highway truck lead out), NPL Site controls and work zones (temporary security fencing, personnel decontamination facilities, wheel wash, and equipment decontamination stations, truck scales), and surveying.
- Removal of the current Zone A cover system down to the geomembrane (2-foot vegetative layer, geotextile separator, 1-foot drainage layer, geomembrane) and stockpile for backfill; approximately 13,500 tons (9,000 CY) of assumed clean soil are estimated to be removed.
- Removal of engineered fill and impacted soils from the geomembrane to the top of Visqueen layer (8-foot thickness) and transportation and off-site disposal at a Subtitle D landfill; approximately 46,500 tons (31,000 CY) of assumed impacted soil are estimated to be removed.
- Removal of impacted soils from the top of Visqueen layer to the top of the Touchet Beds (17-foot thickness) and transportation and off-site disposal at a Subtitle C landfill (assumed at least 50% of impacted soils would need RCRA stabilization prior to disposal); approximately 93,300 tons (62,200 CY) of assumed impacted soil are estimated to be removed.
- Removal of layback soils at the elevation of the top of Visqueen layer to the top of the Touchet Beds (17-foot thickness and outside of the Zone A drum footprint) and stockpile for either backfill or off-site disposal; approximately 45,300 tons (30,200 CY) of soil are estimated to be removed, of which 25% are assumed to be impacted and, therefore, transported and disposed of at a Subtitle D landfill.
- Removal of impacted soils from the top of the Touchet Beds to top of the Upper Pasco Gravels (15-foot thickness). Approximately 91,500 tons (61,000 CY) of assumed impacted soil are estimated to be removed, of which 90% would be disposed of off-site at a Subtitle C landfill (50% for direct disposal and 40% with RCRA stabilization prior to disposal) and 10% would be incinerated.
- Removal of layback soils at the elevation of the top of the Touchet Beds to top of the Upper Pasco Gravels (15-foot thickness and outside of the Zone A drum footprint) and stockpile for either backfill or off-site disposal; approximately 82,200 tons (54,800 CY) of soil are estimated to be removed, of which 25% (equivalent to

20,000 tons) are assumed to be impacted and, therefore, transported and disposed of at a Subtitle D landfill.

- Removal of approximately 16,100 stacked drums containing hazardous waste (i.e., with liquids and sludges). Individual overpacking of a portion (25%, equivalent to approximately 4,000 drums) of these drums is assumed for transportation and off-site disposal (of which 20% would require incineration and 80% would be directly disposed at a Subtitle C landfill). Remaining drums, when decanted of free liquids, would be handled as bulked waste (approximately 4,930 tons [3,285 CY]) and transported and disposed of off site at a Subtitle C landfill (assumed at least 50% of bulked drums would need RCRA stabilization prior to disposal).
- Decant and bulk liquid waste in an on-site designated area, and off-site incineration; a total of 1,000 tons of solvent and aqueous liquids is assumed to be recovered.
- Removal of 8,900 stacked drums containing casting sands (approximately 3,630 tons [2,420 CY]), assumed to be handled as bulked waste, transported, and disposed of off-site at a Subtitle D landfill.
- Field hazard categorization of 5% of the stacked drums (containing hazardous waste and casting sands) in an on-site staging area and waste characterization via off-site laboratory analysis.
- Backfill of the remedial excavation area with stockpiled and clean soil (approximately 312,300 tons [208,200 CY]).
- Placement of a 3-foot RCRA-compliant cap (minimum crown slope of 4%) over the Zone A excavation area and hydroseed of surface.
- Deep well installation and operation and maintenance of the SVE system to ensure protection of ground water. Installation of the new SVE deep wells would be adjacent to the drums under Zone A prior to waste removal. The SVE system would continue to be operated during waste and soil removal, and for an additional 10 years following completion of the removal action.
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC.
- The use of appropriate existing ICs.

With the above cleanup action components, this alternative meets all Zone A RAOs specified in Table 4.3-1.

Figures 5.4.7-1 and 5.4.9-1 depict the general plan view and schematic cross section, respectively, of Alternative A-9.

Alternative A-9 assumes a total excavation area of 6.04 acres for Zone A, including areas of stacked drums, adjacent and surrounding impacted soils, and associated layback soils, down to the top of the Upper Pasco Gravels (approximately 42 feet in depth). The total excavation volume is estimated to be 382,500 tons (255,000 CY), of which approximately 262,600 tons (175,100 CY) are assumed to be disposed of off-site (either at a Subtitle C [with and without RCRA stabilization] or at a Subtitle D landfill) or sent for incineration, depending on field profiling of the drummed waste (containing hazardous waste and casting sands) and impacted soils. The remaining excavated soil volume would be used as clean backfill material for either the remedial area or as capping material. Appendix D, Tables 1a through 1c, presents detailed Zone A area and volume calculations for Alternative A-9.

Drummed waste (containing hazardous waste and casting sands) and impacted soils that are excavated from Zone A would be profiled for disposal in a similar manner as under Alternative A-5 (field hazard categorization of the drummed or bulk waste removed from Zone A, waste characterization, and off-site laboratory analysis). Assumptions for FFS cost estimating purposes regarding type and quantity of waste profiled, characterized, and sent for off-site disposal are also equivalent to those described in Section 5.4.5.3.

Alternative A-9 assumes transportation of a total of 271,000 tons (181,000 CY) of bulked waste, in addition to 1,000 tons of bulked liquid waste (solvents and aqueous phase) and approximately 4,000 intact overpacked drums to off-site landfills or incineration facilities. Off-site truck transportation assumes 60 drums per load, 30 tons per soil/waste load, and 10,000-gallon tanker trucks for liquids for delivery to Grantsville, Utah, for incineration; Arlington, Oregon, for Subtitle C landfill disposal; and Finley Buttes, Washington, for Subtitle D landfill disposal. The various types of wastes and disposals would result in over 9,100 truck trips through Pasco by way of I-182. Total round trip distance to the various disposal facilities involve over 2 million miles of travel. Based on highway statistics (Federal Motor Carrier Safety Administration 2017), this can be expected to result in approximately three truck traffic accidents with an estimated 2.5% probability of a fatal accident. For large trucks (gross weight greater than 10,000 pounds), the environmental impacts of such transport include vehicle air emissions of approximately 10,000 metric tons of carbon dioxide emissions and over 330,000 gallons of fuel consumed.

After backfilling with clean, stockpiled soil and compaction to the surrounding ground surface elevation of the excavation area, a new RCRA-compliant cap would be installed at the surface of Zone A. This alternative would continue routine cap inspection, maintenance, and monitoring, and cap evaluation and performance reporting until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*). For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

This alternative assumes the operation of the SVE system (including treatment of the recovered SVE vapors through thermal oxidation) to address residual soil contamination remaining in place between the top of the Upper Pasco Gravels and the water table. Before construction, all shallow and intermediate wells would be removed. During construction,[26] three new deep horizontal SVE wells would be installed (prior to waste and soil removal) in the Upper Pasco Gravels unit (at an approximate elevation of 365 feet) to ensure protection of ground water from potentially migrating COCs, in the event of waste release during drum removal. For FFS costing purposes, the SVE operation is assumed to continue for an additional 10 years following completion of the removal action. Monthly inspections, maintenance, upgrades, and equipment replacement of the SVE system are assumed to occur over a 10-year operation period.

To verify the protection of ground water quality, Alternative A-9 would continue to use the current network of monitoring wells adjacent and downgradient to Zone A for a 30-year period, as assumed for Alternatives A-5 through A-8.

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[26] It is assumed that the implementation period of Alternative A-9 would be approximately 1.5 years, including site preparation; establishment of an access and haul circulation road through the Balefill Area and Inert Waste Disposal Debris Area; construction of waste handling, staging, stockpiling, and drum inspection areas; and excavation of stacked drum area, adjacent/underlying impacted and layback soils, the Touchet Bed soils, and their profiling, characterization, and off-site disposal.

The scope of this alternative would account for the same activities associated with the Zone A excavation, as described in Alternative A-5 (see Section 5.4.5.3).

ICs will continue to be required in Alternative A-9 as described in Section 5.1.1.

The total estimated cost for Alternative A-9 is $128.1 million, which includes estimated construction and non-construction costs of $60.0 million and $22.7 million, respectively, and a 55% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.10 No Action Alternative for Zone A

A No Action Alternative has been included for Zone A, per CERCLA guidelines through the NCP process as described in Section 5.1.3.

Monitoring of the Zone A existing RCRA cap and cover system and of downgradient ground water (both for an assumed 10-year period) are the only components of this alternative. The reduction of COCs and risks would occur to the degree achieved by ongoing natural recovery processes and would only be tracked with a Zone A long-term monitoring program.

For the Zone A No Action Alternative, all existing subsurface contamination would remain in place, without any active remediation of impacted ground water, soil, or waste. Without SVE treatment or engineering controls, on-site and off-site ground water COC concentrations downgradient of Zone A would exceed CULs; therefore, this alternative would not be protective of human health and the environment and would not comply with cleanup standards. With these considerations, the No Action Alternative for Zone A does not meet the Zone A RAOs specified in Table 4.3-1 and does not meet minimum MTCA threshold requirements (see Section 5.4.11).

The total estimated cost for the No Action Alternative for Zone A is $2.3 million, which includes estimated construction (well decommissioning) and non-construction costs of $42,000 and $1.8 million, respectively, and a 20% project contingency (see Table 5.4-1). All costs are presented as net present value (see Appendix E – Zone A for detailed cost estimates).

5.4.11 Zone A Alternatives Carried Forward into the Disproportionate Cost Analysis

In order to focus the Zone A Disproportionate Cost Analysis (DCA) in Section 6, Zone A alternatives were evaluated with respect to similarity of technologies, scope, and relative costs.

Alternatives A-2, A-3, and A-4 were developed in the FFS Work Plan to have similar cleanup action components but to differ in the contingent action to be implemented for a potential future condition (i.e., to address potential future impacted ground water downgradient of Zone A). These alternatives provide a range of contingent actions that would address COCs that have not been identified as actionable in ground water at the present time. The contingent action would only be triggered by a potential future condition that would be identified during ground water compliance monitoring and/or the 5-year review process, although its implementation would not necessarily be restricted to the 5-year review periods. If the contingent remedy is triggered, the COCs would be identified and an EDR (possibly including pilot and treatability testing), would be developed and approved by Ecology for the specific conditions triggering the contingent action. Although the contingent remedies for these Zone A alternatives have been described in Section 5 as potential future treatment technologies that may allow for different or more cost-effective remedies based on any possible future condition, Alternative A-2 is the representative alternative carried forward into the DCA (with a contingent ground water treatment remedy to address potential future condition) based on reasonable total and contingent action costs ($18.3 million and $444,000, respectively).

Alternative A-5 and A-6 were developed in the FFS Work Plan to have similar cleanup action components but to differ in the type of in situ treatment of the impacted soils in the Touchet Beds. Alternative A-6 is the representative alternative carried forward into the DCA (with an in-situ treatment of the impacted Touchet Bed soils) based on reasonable total and in situ treatment costs ($62.1 million and $6.4 million, respectively) and shorter operational time frame of the thermal treatment system (6 to 8 months, compared to 30 years required for Alternative A-5 because of SVE treatment).

Since the No Action Alternative does not meet the Zone A RAOs specified in Table 4.3-1 (as described in Section 5.4.10), it does not comply with the four minimum MTCA threshold requirements under WAC 173-340-360(2)(a): protection of human health and the environment, compliance with cleanup standards, compliance with applicable state and federal laws, and provision for compliance monitoring. Therefore, the No Action Alternative is not carried forward into the DCA for Zone A.

Following the above considerations, six Zone A alternatives are carried forward into the DCA. The six Zone A alternatives carried forward are as follows:

- **Alternative A-1**, which includes continued operation and monitoring of the SVE system for the Zone A source area; monitoring, maintenance, and replacement of the existing RCRA cap and cover system; ground water performance monitoring; and appropriate use of existing ICs.
- **Alternative A-2**, which includes all Alternative A-1 cleanup action components, in addition to an enhanced SVE system[27] and a contingent ground water treatment remedy (air sparging and ozone treatment).
- **Alternative A-6**, which includes removal of the existing RCRA cap and cover systems, excavation of waste, impacted, and layback soils to the top of the Touchet Beds, on-site disposal of impacted soils and bulked drums in lined AOC cell, off-site disposal of overpacked drum waste, backfill of the remedial excavation area and new RCRA-compliant cap placement, an in situ treatment of the impacted Touchet Bed soils, ground water performance monitoring, and appropriate use of ICs.
- **Alternative A-7**, which includes all Alternative A-6 cleanup action components, but with excavation and on-site disposal of impacted Touchet Bed soils in a lined AOC cell (instead of in situ treatment of the impacted Touchet Bed soils).
- **Alternative A-8**, which is a hybrid alternative incorporating the cleanup action components of Alternative A-2 (cap maintenance with enhanced SVE operation and a

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[27] As described in Section 5.4.2, an enhanced SVE system would consist of three additional SVE wells installed with the intermediate zone with the purpose of increasing mass removal from the Zone A source area.

contingent action [air sparging and ozone treatment if necessary to address potential future ground water conditions downgradient of Zone A]) and a possible contingent action involving the cleanup action components of Alternative A-7 (removal down to the top of the Upper Pasco Gravels with on-site disposal in an AOC) if necessary to address potential conditions, as discussed in Section 5.4.8.

- **Alternative A-9**, which includes removal of the existing RCRA cap and cover systems; excavation of waste, impacted, and layback soils to the top of Upper Pasco Gravels (including underlying impacted Touchet Bed soils); off-site disposal of all excavated materials; ground water performance monitoring; and appropriate use of ICs.

5.5 Zone B

RAAs are assembled from the general response actions, remedial technologies, and process components retained from the identification and screening process above. The objective of this process is to develop RAAs that have a high probability of achieving Zone B RAOs, CULs, and POCs.

The nature and extent of contamination in vadose zone soils is discussed in Section 2.5.4.2. The inferred extent of vadose zone soil contamination remaining after IAs is the basis for conceptual design and cost evaluation for alternatives that address exposure pathways related to soil. The lateral extent of vadose soil contamination at the depth of the former Zone B drum cell is estimated to be roughly the dimensions of the drum cell, with an area of approximately 7,850 square feet. The depth of vadose zone soil contamination is estimated to be a maximum of 10 feet below the bottom of the 2002 drum removal excavation, based on the nature of the constituents present (PSC 1999). This results in a potential impacted soil volume of 78,500 cubic feet, or 2,900 CY. The lateral extent of vadose zone soil contamination near the surface at Zone B is estimated to be well within the extent of the RCRA-compliant cap.

Contaminants remaining in soil beneath the former Zone B cap are chlorinated phenols, herbicides, PAHs (from a very limited area of surface soil near location PZB-05 where a fuel release occurred during the 2002 drum removal activity), and potentially dioxins. These contaminants would be targeted by alternatives that include in situ treatment of vadose zone soils.

The RAAs for Zone B are as follows:

- Alternative B-1 – A fully protective alternative, which includes monitoring and maintaining the RCRA-compliant cap constructed during May and June 2013, ground water monitoring, and ICs.
- Alternative B-2 – The approach shown in Alternative B-1, plus an evaluation of monitored natural attenuation (MNA) (including sorption) of waste material in soils below the edges of the cap liner.
- Alternative B-3 – The approach shown in Alternative B-1, plus sub-cap additions of reagents to assist bioremediation of waste material below the floor of the former disposal cell.
- Alternative B-4 – The approach shown in Alternative B-1, plus sub-cap additions of reagents to assist sorption/solidification of waste material below the floor of the former disposal cell.
- Alternative B-5 – Cap removal, excavation and off-site disposal of contaminated soil below the existing RCRA-compliant cap, placement of an impermeable liner at the base of the remedial excavation, backfill of the remedial excavation to an appropriate elevation, placement of a surface cover system, ground water monitoring, and ICs.
- No Action Alternative – Ongoing inspection and maintenance of the Zone B cap as required by Chapter 173-304 WAC, with ongoing ground water monitoring. This alternative differs from Alternative B-1 as it would discontinue the use of ICs (access restrictions with fencing and warning signs, a limitation of property use to landfill, and maintenance of property deed restrictions that ban construction, control excavation, and restrict ground water use), and cap replacement is not included.

5.5.1 Alternative B-1

Alternative B-1 consists of monitoring and maintaining the RCRA-compliant cap, continued ground water performance monitoring, and operation of ICs. This alternative meets all RAOs.

The RCRA-compliant cap is designed to prevent infiltration of precipitation through contaminated soil, to prevent erosion and dispersal of contaminated soil by water or wind, and to prevent potential receptor contact with soil. It is understood that remedies involving in-place containment of contaminated soil would require maintenance and monitoring in perpetuity, or until confirmatory sampling beneath a cover system indicates that soil contamination is below applicable regulatory thresholds. For cost estimating purposes, monitoring and maintenance of the RCRA-compliant cap would continue throughout a period of 30 years, using methods described in the *Revised Final Cap Monitoring and Maintenance Plan for the Pasco Landfill Zone B Cap* (AMEC 2013). The following is a list of major components of cap monitoring and maintenance:

- Inspection of the cap surface for erosion, deformation, subsidence, intrusion, vegetation health, stormwater or drainage impediments and other irregularities
- Inspection for evidence of security breaches
- Inspection for evidence of damage or irregularities in the NPL Site support infrastructure (i.e., infiltration features and roads)
- Maintaining effective cap drainage
- Maintaining adequate vegetative cover on the cap

Performance monitoring of ground water quality and CUL attainment confirmation at the designated POC would continue, with analysis for VOCs, SVOCs, and herbicides. No soil monitoring would occur under this alternative.

The usable life of the RCRA compliant cap is unknown. However, as requested by Ecology, an estimated cost for replacement of the RCRA-compliant cap has been included in Alternatives B-1 through B-5 at year 30 of the project. Inclusion of this cost should not be construed to indicate that the RCRA-compliant cap will have a lifetime limited to 30 years.

Building a new RCRA compliant cap directly over the existing one would elevate the new cap 4 additional feet above the existing cap, leading to complications in maintaining adequate grade and drainage along the eastern property boundary and west of the cap. The most feasible option for cap replacement that would provide a cap elevation consistent with the original cap includes excavation and reuse of the base rock layer; placement of approximately 88,000 square feet of new geofabric, GCL, and geomembrane; installation of approximately

4,200 tons of drainage layer material; placement of approximately 5,800 tons of topsoil; and hydroseeding and irrigation. The cost estimate includes new materials as shown, but the existing topsoil and drainage layer material would be segregated and reused to the extent possible.

Alternative B-1 will continue use of appropriate ICs, including access restrictions with fencing and warning signs, a limitation to a landfill facility use in Zone B, and maintenance of property deed restrictions that ban construction, control excavation, and restrict ground water use.

The total estimated cost for Alternative B-1 is $2.17 million, consisting of long-term monitoring and maintenance costs for the existing landfill cap over a 30-year time period, including quarterly ground water monitoring, cap inspection and repair, and reporting (see Tables 5.5-1 and 5.5-2). The estimate also accounts for costs for cap replacement at year 30, project management, and a 50% contingency. All costs are presented as net present value.

5.5.2 Alternative B-2

Alternative B-2 consists of the tasks outlined in Alternative B-1, plus demonstration of containment via MNA. As defined by EPA, MNA is a monitored program that relies on natural attenuation processes such as biodegradation, dispersion, dilution, sorption, volatilization, chemical or biological stabilization, transformation, or destruction to achieve site-specific remediation objectives that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil. Assessment of the ability of the soil to sustain natural attenuation of Zone B constituents would occur in two ways:

- Physical mobility, which would evaluate existing soil data for total organic carbon, grain size, and stratigraphy to determine the natural tendency of the soil to limit contaminant transport.
- Biological, which would involve ongoing, periodic evaluation of nutrients and moisture in soil, oxygen and carbon dioxide in soil gas, and soil bacterial enumeration to determine the capacity of the soil environment to biodegrade contaminants, especially VOCs, chlorinated phenols, and the herbicide 2,4-D.

The biological and physical attenuation assessment would require collection of soil from near the floor of the former disposal cell in order to: 1) assess soil properties in the area directly affected by contaminants; and 2) empirically correlate soil properties with constituent biodegradation and with constituent retention.

Drilling to locations beneath the former disposal cell would be required. The drilling could be accomplished via vertical, near-vertical angled, or horizontal methods. Vertical methods would compromise cap integrity. Angled borings would not suffice due the shallowness of the treatment zone combined with the large footprint of the cap. Horizontal borings would require extensive planning and a significant field mobilization. Any borings beneath the former disposal cell bring risk in that preferential pathways for water infiltration and contaminant migration may be formed.

For the estimate of capital cost associated with Alternative B-2, drilling of two horizontal borings passing beneath the former disposal cell floor was assumed. One horizontal boring would pass within about 2 feet beneath the disposal cell floor, and the second horizontal boring would pass within about 10 feet beneath the disposal cell floor. Six soil samples would be collected at approximately 15-foot lateral intervals in each boring, for a total of 12 soil samples to be analyzed for physical, chemical, geochemical, and biological parameters. This drilling, sampling, and monitoring process would be repeated at years 11 and 21.

Waste generated during drilling would be segregated, containerized, characterized, and properly disposed at a facility licensed to handle the waste. For purposes of cost estimating, the drilling waste was assumed to require treatment at the Clean Harbors Aragonite, Utah, incinerator.

The total estimated cost for Alternative B-2 is $2.76 million. Alternative B-2 consists of the long-term monitoring and maintenance costs presented in Alternative B-1 ($2.17 million), plus drilling, sampling of soils, drilling waste disposal, and interpretation of MNA trends, along with repairs due to drilling below the cap ($0.59 million) (see Tables 5.5-1 and 5.5-2). The estimate accounts for costs for contingencies and project management. All costs are presented as net present value.

5.5.3 Alternative B-3

Alternative B-3 consists of the tasks outlined in Alternative B-1; evaluation of the physical, chemical, geochemical, and biological parameters; and use of reagents delivered to the soil below the disposal cell to enhance biodegradation of constituents such as VOCs, phenols, and herbicides.

For stimulation of biodegradation, a nutrient blend supplying available forms of nitrogen, phosphorus, possibly potassium, and possibly carbon would be applied. The nutrients could be delivered in a liquid dissolved form, or in a gaseous form, or some mix of the two forms.

The nutrient addition would be made in such a way as to allow for the spread of nutrients and some moisture throughout the 10-foot-thick target treatment zone, while not injecting so much liquid as to cause lateral or vertical spread of the contamination. This would be accomplished by understanding the field saturation capacity of the vadose soil and adding liquid to the point at which the volume of soil within the target treatment zone would continue to soak up the liquid. The cost estimate assumes three injection rounds will occur, with 4-month intervals between injections. Soil gas monitoring before and after nutrient injection would allow for detection of changes in microbial metabolism (depletion of oxygen coupled with carbon dioxide production).

Reagent delivery could occur through either vertical delivery points that pierce the cap or via horizontal well screens that would be installed using remote directional drilling techniques. The former would compromise the cap integrity, and the latter would require extensive planning and a significant field mobilization. Angled borings would not suffice due the shallowness of the treatment zone combined with the large footprint of the cap. Any borings beneath the former disposal cell increase risk in that preferential pathways for contaminant migration may be formed. Injection of liquid amendments could cause saturation of the otherwise dry semi-arid steppe vadose zone and result in the risk of increased leaching and mobilization of contaminants. Injection of liquid could also result in differential settling of the cap and potential compromise of the liner system, and would require a UIC permit from Ecology in order to inject materials into the subsurface.

For the estimate of capital cost associated with Alternative B-3, placement of seven horizontal wells beneath the former disposal cell floor was assumed. Each horizontal well would be on average approximately 400 feet long, daylighting beyond each end of the cap liner, with perforated screen below the former disposal cell. Under the best case scenario, six horizontal well screens (acting as injection well screens) would occur at a lateral spacing of roughly 15 feet and at an elevation of approximately 400 feet msl (approximately at the floor elevation of the former disposal cell). The seventh horizontal well would occur at a depth approximately 10 feet deeper than the injection well screens and would be used for initial soil sampling and as a monitor point for nutrient or moisture movement through the vadose zone. Up to 12 soil samples would be collected during the horizontal drilling process for baseline analysis of physical, chemical, geochemical, and biological parameters. In years 11 and 21, two 300-foot horizontal borings would be advanced below the target area to monitor soil for bioremediation parameters. The treatment zone is assumed to extend to 10 feet below the former disposal cell, in an area of approximately 7,850 square feet, for a total of approximately 2,900 CY of soil treated below the floor of the former disposal cell.

Waste generated during drilling would be segregated, containerized, characterized, and properly disposed at a facility licensed to handle the waste. For purposes of cost estimating, the drilling waste was assumed to require treatment at the Clean Harbors Aragonite, Utah, incinerator.

The total estimated cost for Alternative B-3 is $3.17 million. Alternative B-3 consists of the long-term monitoring and maintenance costs presented in Alternative B-1 ($2.17 million), plus drilling, sampling of soils, and injection of amendments to stimulate Zone B waste biodegradation, drilling waste disposal, and interpretation of biodegradation and MNA trends, along with repairs due to drilling below the cap ($1.0 million) (see Tables 5.5-1 and 5.5-2). The estimate accounts for costs for contingencies and project management. All costs are presented as net present value.

5.5.4 Alternative B-4

Alternative B-4 consists of the tasks outlined in Alternative B-1, evaluation of physical, chemical, and geochemical parameters, and use of reagents delivered to the soil below the disposal cell to enhance sorption or stabilization of COCs, including VOCs, phenols, herbicides, and dioxins.

For soil solidification, a pressure grout would be injected to form either a contaminant absorbing quality within the soil or to physically block pore space, thereby entrapping contaminants within the soil.

Reagent delivery would occur through vertical delivery points that pierce the cap. Angled borings from the edge of the liner would not suffice due the shallowness of the treatment zone combined with the large footprint of the cap. The number of vertical borings required to treat below the footprint of the former disposal cell would be approximately 40 based upon a boring spacing of 15 feet on center. The vertical borings would extend to 20 to 25 feet below the top of the cap. The treatment zone is assumed to extend to 10 feet below the former disposal cell, in an area of approximately 7,850 square feet, for a total of approximately 2,900 CY of soil treated below the floor of the former disposal cell.

Due to the extensive piercing of the cap, the cap overburden and liner in the area undergoing injection would require preparation and restoration. The NPL Site would be prepared for the injection work by placing a layer of rock on the north and south cap approaches to minimize damage to the unaffected parts of the cap, then by excavating an area of the cap overburden slightly larger than the injection footprint, with adequate side sloping of the surrounding cap materials. The contractor would remove all of the topsoil layer, the geofabric delineation layer, and the underlying drainage layer to reveal the top of the HDPE liner. The liner and underlying GCL layer would be cut out to reveal the crushed rock layer. At least 1 lateral foot of excess liner/GCL material at the edge of the injection area would be rolled back and protected during the work. A ramp down into the excavation would be constructed to allow access for the drilling rig, and the injection work would be conducted on the top of the crushed rock layer. Sand and topsoil from the original cap would be stockpiled on-site and re-used, if appropriate.

Once the injection work has been completed, the contractor would repair and restore the cap in accordance with the original design. The crushed rock drilling surface would be re-compacted and brought back to the design grade, the replacement GCL layer will be overlapped with and mated to the rolled back excavation perimeter GCL, and the HDPE patch liner would be installed in sheets and welded to the existing HDPE liner to return the liner to a single continuous barrier. A 1-foot thick layer of sand material would be placed and compacted over the liner to the original design grade, thus restoring the drainage layer, and a geofabric demarcation material would be placed over the drainage layer and tied into the existing geofabric material at the excavation edges. The topsoil layer would be placed in a compacted 2-foot thick lift over the geofabric, to bring the excavation area back to the original design grade, the irrigation system would be restored, and a native hydroseed application would be made over the restored topsoil.

Borings beneath the former disposal cell bring risk in that preferential pathways for contaminant migration may be formed. Injection of liquid amendments saturating the otherwise dry semi-arid steppe vadose zone will bring the risk of increased leaching and mobilization of contaminants, and injection of liquid could also result in differential settling of the cap and potentially compromise the liner system. The preparation and restoration of the portion of the cap in the drilling area brings construction risk. In addition, a UIC permit would be required from Ecology in order to perform this alternative.

The total estimated cost for Alternative B-4 is $3.06 million. Alternative B-4 consists of the long-term monitoring and maintenance costs presented in Alternative B-1 ($2.17 million), plus injection of amendments to sorb and solidify Zone B waste, along with repairs due to drilling through the cap ($0.89 million) (see Tables 5.5-1 and 5.5-2). The estimate accounts for costs for contingencies and project management. All costs are presented as net present value.

5.5.5 Alternative B-5

Alternative B-5 consists primarily of the excavation and off-site disposal of the wastes remaining within Zone B. Alternative B-5 includes the following actions:

- Complete removal of the RCRA-compliant cap constructed during May and June 2013, with no liner being salvageable, assuming an average of 10 feet of cap and overburden soil, generating approximately 44,000 tons of material

- Excavation, handling, categorization, transportation, and disposal of contaminated soils from Zone B, including Washington State Dangerous Waste and RCRA Hazardous Waste; significant environmental and health and safety precautions would be required
- Excavation of contaminated soil to an average depth of 10 feet below the former Zone B cell floor, generating approximately 29,500 tons of waste
- Identification of appropriate and permissible disposal options for land banned materials excavated from Zone B (for purposes of evaluation, it has been assumed 20% of the excavated waste will be incinerated at the Clean Harbors Aragonite, Utah, facility and 80% of the waste would be interred at the Chemical Waste Management Arlington, Oregon, Subtitle C landfill)
- Collection and analysis of approximately 60 soil confirmation samples in the base and walls of the remedial excavation
- Placement of an impermeable liner at the base of the remedial excavation
- Backfill of the remedial excavation to an appropriate elevation and placement of a new surface cap and cover system
- Establishment of a new vegetative layer across the cap surface, by means of hydroseeding and irrigation watering events
- Performance monitoring, for a limited time, of ground water quality and CUL attainment confirmation at the designated POC; performance monitoring may consider natural attenuation as a component of ground water quality protection
- Use of appropriate ICs

The total estimated cost for Alternative B-5 is $24.3 million. Alternative B-5 consists of the long-term monitoring and maintenance costs presented in Alternative B-1 ($2.17 million), plus removal of the existing cap, excavation of the Zone B waste, disposal of the Zone B waste, backfill of the excavation, and building and vegetation of a new cap ($22.13 million) (see Tables 5.5-1 and 5.5-2). The estimate accounts for costs for contingencies and project management. The estimate accounts for costs for contingencies and project management. All costs are presented as net present value.

5.5.6 No Action Alternative for Zone B

A No Action Alternative has been included for Zone B, per CERCLA guidelines through the NCP process as described in Section 5.1.3. This alternative is based on the existence and maintenance of the existing RCRA-compliant cap and ongoing ground water monitoring, but without the ICs or potential for cap replacement. The reduction of COCs and risks would occur to the degree achieved by ongoing natural recovery processes and would only be tracked with a Zone B long-term ground water monitoring program.

For the Zone B No Action Alternative, all existing subsurface contamination would remain in place, without any active remediation (treatment or engineering controls) of impacted soil or waste. COC concentrations in ground water downgradient of Zone B are below dCULs and largely not detected. To protect human health and the environment from contaminated soil/waste left in place, the use of ICs (access restrictions with fencing and warning signs, a limitation of property use to landfill, and maintenance of property deed restrictions that ban construction, control excavation, and restrict ground water use) would be required, and this No Action Alternative does not continue these ICs, nor does it include cap replacement. The lack of ICs in this alternative presents a risk, however unlikely, that future development could occur, resulting in breach of the cap. With these considerations, the No Action Alternative for Zone B does not meet the Zone B RAOs specified in Table 4.3-1 and does not meet minimum MTCA threshold requirements, and is therefore not carried forward into the comparative evaluation of alternatives for Zone B.

The estimated net present value cost for the No Action Alternative for Zone B is $1.26 million (see Table 5.5-1). All costs are presented as net present value.

5.6 Zones C/D

The following alternatives are evaluated for Zones C/D in this Draft Final FFS.

5.6.1 Alternative CD-1

Alternative CD-1 consists of the following cleanup action components:

- Monitoring and maintenance of the existing RCRA cap and cover system

- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC
- The use of appropriate existing ICs

With the above cleanup action components, this alternative meets all Zones C/D RAOs specified in Table 4.3-1.

Figures 5.6.1-1 and 5.6.1-2 depict the general plan view and schematic cross section, respectively, of Alternative CD-1. Appendix D, Table 2a, presents the general dimensions for the existing Zones C/D.

The existing cap and cover system over the waste of Zones C/D is fully intact, has been maintained as required, has prevented direct contact to human or ecological receptors with wastes contained in the zone and prevented leaching of contaminants to ground water due to precipitation. This alternative would continue routine settlement monitoring, cap evaluation and performance reporting, and cap inspection and maintenance, until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*) and would provide for repair or replacement if failures occur in the future. The current cap was installed in 2002 and, assuming a 30-year design life, cap replacement is assumed to occur at year 15 (after CAP implementation). Additional cap replacements would be addressed during the 5-year review process. For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

In addition, as part of the 5-year review process, and in the event of a CUL exceedance of COCs over a consistent period of time (e.g., several quarters, consistent with the site-wide ground water CMP to be developed in the future), a field program would be conducted to identify the source of release and appropriate actions that would be taken to treat/reduce these COC concentrations to below CULs. Costs for post-remedy source evaluation are included in the scope of the Central Area Alternative ONP-1 (see Section 5.8.1.1).

If the source evaluation identifies VOCs from Zones C/D as the source of COCs in ground water, a focused SVE system to capture low-level VOCs in soil gas would be implemented as a contingent action as part of the Central Area in Alternative ONP-1 (see Section 5.8.1.1). Costs for the focused SVE treatment are included in the scope of the Central Area Alternative ONP-1.

To verify the protection of ground water quality, ground water compliance monitoring is assumed to occur over a 15-year period within a network of four wells adjacent and downgradient of Zones C/D.

ICs will continue to be required in Alternative CD-1 as described in Section 5.1.1.

The total estimated cost for Alternative CD-1 is $712,000, which includes estimated construction and non-construction (e.g., long-term monitoring and maintenance) costs of $177,000 and $416,000, respectively, and a 20% project contingency (see Table 5.6-1). All costs are presented as net present value (see Appendix E – Zones C/D for detailed cost estimates).

5.6.2 Alternative CD-2

Alternative CD-2 consists of all of the cleanup action components of Alternative CD-1, with the addition of an in situ chemical amendment of the contaminated soil, to be implemented as a contingent action in the vadose zone to address the potential for future impacted ground water where ground water concentrations exceed CULs over a consistent period of time (several quarters, consistent with the site-wide ground water CMP to be developed in the future) downgradient of Zones C/D, should such occur. A strong oxidizing agent, sodium persulfate, would be applied to promote rapid oxidation of acetone and VOCs and further stabilize the waste.

With the above cleanup action components, this alternative meets all Zones C/D RAOs specified in Table 4.3-1.

Figures 5.6.2-1 and 5.6.2-2 depict the general plan view and schematic cross section, respectively, of Alternative CD-2.

The existing cap and cover system over the waste of Zones C/D is fully intact, has been maintained as required, and has prevented direct contact to human or ecological receptors with wastes contained in the zone to date. This alternative would continue routine settlement monitoring, cap evaluation and performance reporting, and cap inspection and maintenance, until confirmatory sampling beneath a cover system indicates residual soil contamination levels do not pose risks to human health and the environment (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*) and would provide for repair or replacement if failures occur in the future. The current cap was installed in 2002 and, assuming a 30-year design life, cap replacement is anticipated to occur at year 15 (after CAP implementation). For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

Alternative CD-2 would consist of the same cleanup action components as those described in Alternative CD-1 (Section 5.6.1), but this alternative would include an in situ chemical amendment of the contaminated soil as a contingent action to be implemented to address potential future impacted ground water downgradient of Zones C/D, should such impacts be identified during the 5-year period reviews. If ground water quality in Zones C/D is considered not protected after an evaluation over a consistent period of time (e.g., several quarters, consistent with the site-wide ground water CMP to be developed in the future), then the contingency remedy would be implemented and an EDR would be prepared to address design details of the contingent action, possibly including treatability studies.

This alternative would treat an estimated total surface area of 0.70 acres (approximately 175 feet by 175 feet, including areas of waste, soils in between zones, and a buffer area surrounding the waste within the geomembrane boundary) and an estimated soil volume of 11,293 CY (based on a targeted vadose zone treatment depth of 10 feet; see Table 2b of

Appendix D). The addition of the selected oxidizing agent[28] (sodium persulfate, as 9% solution) would require an activator (ferrous sulfate, at 250 milligrams per liter) to target acetone and other VOCs (methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, xylenes, toluene, etc.) through a strong oxidation process. With an assumed single application required (achieved by a conservative 1.5 times oxidant demand applied to ensure complete destruction of contaminants), the total reagent amount of sodium persulfate and ferrous sulfate required for amendment would be 105 tons and 4.1 tons, respectively. Additional treatability testing may be needed to evaluate the likelihood of negative effects (e.g., potential conversion of chromium III to hexavalent chromium, which has previously been detected in ground water in Zones C/D) or potential byproducts. A mixing station including a mixing tank, circulation pumps, valves, and gauges would be constructed to allow for mixing and injection into the wells; chemical oxidant would be mixed in batches and introduced to each well through aboveground piping.

This alternative includes the same level of cap monitoring and maintenance, inspection, performance evaluation and cap replacement as Alternative CD-1. Additional cap replacements would be addressed during the 5-year review process.

To verify the protection of ground water quality, ground water compliance monitoring is assumed with the same frequency of events as under Alternative CD-1.

ICs will continue to be required in Alternative CD-2 as described in Section 5.1.1.

The total estimated cost for Alternative CD-2 is $1.6 million, which includes estimated construction and non-construction costs of $599,700 and $522,000, respectively, and a 40% project contingency (see Table 5.6-1). All costs are presented as net present value (see Appendix E – Zones C/D for detailed cost estimates).

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[28] Appendix F, Table 6, describes in detail the technology screening for the contingent action in the Zones C/D vadose zone, rationale for amendment selection, and methodology to obtain estimate reagent concentration, mass, and frequency of application for FFS evaluation and costing purposes. Additional assumptions used in developing these estimates (e.g., soil porosity) are also specified in this appendix.

5.6.3 Alternative CD-3

Alternative CD-3 consists of the following cleanup action components:

- Removal of the current Zones C/D cover system (2-foot vegetative layer, geotextile separator, drainage layer, geomembrane) and stockpile
- Removal of waste (6 feet of waste material in Zone C, 9 feet of waste material in Zone D), exposed soils (2 feet engineered fill, side-slopes, access ramp), and contaminated underlying soils (2 to 5 feet overexcavation)
- Waste and soil characterization (including composite sampling for waste/exposed soils and confirmational sampling for underlying soils)
- Transportation and disposal of all waste and soils in a Subtitle C landfill (assumed waste and contaminated soils are handled as bulk waste and classified as hazardous waste for disposal in a landfill in Arlington, Oregon)
- Placement of an impermeable membrane at base of remedial excavation (assumed geomembrane liner 40-mil-thick HDPE)
- Backfill of the remedial excavation with stockpiled and clean soil and engineered fill (assumed 2 feet)
- Placement of a 3-foot RCRA-compliant cap (minimum crown slope of 4%)
- Hydroseed of surface
- Installation of new ground water monitoring wells (assumed four wells adjacent and downgradient to Zones C/D)
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC
- The use of appropriate existing ICs

With the above cleanup action components, this alternative meets all Zones C/D RAOs specified in Table 4.3-1.

Figures 5.6.3-1 and 5.6.3-2 depict the general plan view and schematic cross section, respectively, of Alternative CD-3.

Alternative CD-3 assumes a total excavation area of 0.63 acre for Zones C/D, including areas of waste, soils in between zones, and associated side-slopes. The total excavation volume is estimated to be 20,428 tons (13,619 CY), of which 16,882 tons (11,255 CY) are assumed waste and impacted soil materials to be bulked for transport, handling, and disposal. The remaining excavated volume of 3,546 tons (2,364 CY; soil overburden from the existing cap and cover system) would be used as backfill because it is considered relatively clean material. Additional backfill material would be brought from off-site borrow. Appendix D, Tables 2c and 2d, presents detailed excavation area and volume calculations and new dimensions for Zones C/D Alternative CD-3.

Excavated waste and underlying contaminated soils from Zones C/D would be profiled for disposal. For FFS costing purposes, these materials were assumed to be characteristic RCRA hazardous waste (based on rationale provided in Appendix G) and, therefore, their off-site disposal would occur at the Subtitle C hazardous waste landfill in Arlington, Oregon.

After placement of a geomembrane at the base of the excavation footprint, and backfilling and compaction to surrounding ground surface elevation, a new RCRA-compliant cap for Zones C/D would be installed with a 30-year design life.

This alternative includes the same level of cap monitoring and maintenance, inspection, and performance evaluation as Alternative CD-1. For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

To verify the protection of ground water quality, Alternative CD-3 anticipates the installation of four new monitoring wells adjacent and downgradient to Zones C/D and ground water compliance monitoring with a frequency of events to occur over a 10-year period (including quarterly, semiannual, and annual sampling for 5, 3, and 2 years, respectively).

ICs will continue to be required in Alternative CD-3 as described in Section 5.1.1.

The total estimated cost for Alternative CD-3 is $7.2 million, which includes estimated construction and non-construction costs of $3.9 million and $1.3 million, respectively, and a 40% project contingency (see Table 5.6-1). All costs are presented as net present value (see Appendix E – Zones C/D for detailed cost estimates).

5.6.4 No Action Alternative for Zones C/D

A No Action Alternative has been included for Zones C/D, per CERCLA guidelines through the NCP process as described in Section 5.1.3.

Monitoring of the Zones C/D existing RCRA cap and cover system (for an assumed 10-year period) and of downgradient ground water (for an assumed 5-year period) are the only components of this alternative. The reduction of COCs and risks would occur to the degree achieved by ongoing natural recovery processes and would be tracked with a Zones C/D long-term monitoring program.

For the Zones C/D No Action Alternative, all existing subsurface contamination would remain in place, without any active remediation (treatment or engineering controls) of impacted soil or waste. Although ground water COC concentrations downgradient of Zones C/D are not currently detected (thus not exceeding dCULs), a minimum IC (deed restriction) would still be required for contaminated soil/waste left in place. Because ICs are not part of the scope of the No Action Alternative, this alternative would not be protective of human health and the environment. With these considerations, the No Action Alternative for Zones C/D does not meet the Zones C/D RAOs specified in Table 4.3-1 and does not meet minimum MTCA threshold requirements.

The total estimated cost for the No Action Alternative for Zones C/D is $233,000, which includes estimated construction (well decommissioning) and non-construction costs of $10,900 and $183,600, respectively, and a 20% project contingency (see Table 5.6-1). All costs are presented as net present value (see Appendix E – Zones C/D for detailed cost estimates).

5.7 Zone E

The following alternatives are evaluated for Zone E in this Draft Final FFS.

5.7.1 Alternative E-1

Alternative E-1 consists of the following cleanup action components:

- Monitoring and maintenance of the existing RCRA cap and cover system

- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC
- The use of appropriate existing ICs

With the above cleanup action components, this alternative meets all Zone E RAOs specified in Table 4.3-1.

Figures 5.7.1-1 and 5.7.1-2 depict the general plan view and schematic cross section, respectively, of Alternative E-1. Appendix D, Table 2a, presents the general dimensions for the existing Zone E.

The existing cap and cover system over the waste of Zone E is fully intact, has been maintained as required, has prevented direct contact to human or ecological receptors with wastes contained in the zone, and prevented leaching of contaminants to ground water due to precipitation. This alternative would continue routine settlement monitoring, cap evaluation and performance reporting, and cap inspection and maintenance, until confirmatory sampling beneath a cover system indicates residual soil contamination levels (following the standards available in the *Operations and Maintenance Manual for Industrial Waste Area Caps – Zones A, C/D, and E*) and would provide for repair or replacement if failures occur in the future. The current cap was installed in 2002 and assuming a 30-year design life, cap replacement is assumed to occur at year 15 (after CAP implementation). Additional cap replacements would be addressed during the 5-year review process. For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

In addition, as part of the 5-year review process, and in the event of a CUL exceedance of COCs over a consistent period of time (e.g., several quarters, consistent with the site-wide ground water CMP to be developed in the future), a field program would be conducted to identify the source of release and appropriate actions that would be taken to treat/reduce these COC concentrations to below CULs. Costs for post-remedy source evaluation are included in the scope of the Central Area Alternative ONP-1 (see Section 5.8.1.1).

If the source evaluation identifies VOCs from Zone E as the source of COCs in ground water, a focused SVE system to capture low-level VOCs in soil gas would be implemented as a contingent action as part of the Central Area in Alternative ONP-1 (see Section 5.8.1.1). Costs for the focused SVE treatment are included in the scope of the Central Area Alternative ONP-1.

To verify the protection of ground water quality, ground water compliance monitoring is assumed with a frequency of events to occur over a 15-year period within a network of two wells adjacent to and downgradient of Zone E.

ICs will continue to be required in Alternative E-1 as described in Section 5.1.1.

The total estimated cost for Alternative E-1 is $844,000, which includes estimated construction and non-construction (e.g., long-term monitoring and maintenance) costs of $312,000 and $392,000, respectively, and a 20% project contingency (see Table 5.7-1). All costs are presented as net present value (see Appendix E – Zone E for detailed cost estimates).

5.7.2 Alternative E-2

Alternative E-2 consists of all of the following cleanup action components:

- Removal and stockpiling of the current Zone E cover system (2-foot vegetative layer, geotextile separator, drainage layer, and geomembrane).
- Removal and stockpiling of clean overburden soils (2-foot engineered fill).
- Removal and stockpiling of waste.
- Ex situ stabilization of waste to limit mobility of COCs. This treatment would be implemented as a contingent remedy action to be implemented to address potential future impacted ground water at Zone E, should such occur. A chemical stabilization agent (Portland cement) would be mixed in 1-foot lifts with waste in the excavation area.
- Backfill of the remedial excavation with stockpiled clean soil (assumed 2 feet).
- Placement of an impermeable membrane (assumed geomembrane liner 40-mil-thick HDPE) and topsoil (assumed 2 feet).
- Hydroseed of surface.

Appendix H provides a detailed description of the cleanup components and quantities of Alternative E-2.

With the above cleanup action components, this alternative meets all Zone E RAOs specified in Table 4.3-1.

Alternative E-2 would consist of the same cleanup action components as those described in Alternative E-1 (Section 5.7.1), but would include the ex situ stabilization of waste, to be implemented to address potential future impacted ground water at Zone E, should such impacts be identified during the 5-year period reviews and with the purpose of limiting mobility of COCs. If ground water quality in Zone E is considered not protected after an evaluation over a consistent period of time (e.g., several quarters, consistent with the Site-wide ground water CMP to be developed in the future), then the contingency remedy would be implemented and an EDR would be prepared to address design details of the contingent action, possibly including treatability studies.

This alternative would treat an estimated total surface area of 1.3 acres. The existing Zone E cover system and clean overburden soil would be removed and stockpiled in the vicinity of Zone E for backfill reuse. A power rake would be pulled through the stockpile to remove the geotextile and geomembrane debris; the debris would be disposed of at an MSW landfill. An estimated waste volume of 10,000 CY (15,000 tons) would be excavated and stockpiled in the vicinity of Zone E using a bulldozer. It would then be placed back in the excavation area in 1-foot lifts to be mixed with a stabilization agent (Portland cement) with a power tiller/shedder. The cement used for treatment of the Zone E waste could be a mixture of Portland cement (10%), slag cement (12%), and bentonite (4%), such as in the Balefill Area protection barrier (AECOM et al. 2016). However, laboratory testing would be needed prior to application to ensure stabilization of the Zone E waste material and would evaluate structural stability and leachability of the treated waste material. Appendix H presents rationale and assumptions for waste and stabilization agent quantities for Zone E Alternative E-2.

After completing placement of the lifts of waste material mixed with cement, backfilling, and compaction to ground surface elevation with the stockpiled clean soil, a new geomembrane liner and topsoil would be installed.

This alternative includes the same level of cap monitoring and maintenance, inspection, and performance evaluation, as Alternative E-1. For FFS costing purposes, long-term cap monitoring, maintenance, and inspection are carried out for a 30-year period.

To verify the protection of ground water quality, ground water compliance monitoring is assumed with the same frequency of events as under Alternative E-1.

ICs will continue to be required in Alternative E-2 as described in Section 5.1.1.

The total estimated cost for Alternative E-2 is $2.2 million, which includes estimated construction and non-construction costs of $1.0 million and $580,000, respectively, and a 40% project contingency (see Table 5.7-1). All costs are presented as net present value (see Appendix E – Zone E for detailed cost estimates).

5.7.3 Alternative E-3

Alternative E-3 consists of the following cleanup action components:

- Removal of the current Zone E cover system (2-foot vegetative layer, geotextile separator, drainage layer, and geomembrane) and stockpile
- Removal of waste (10 to 16 feet of waste material and synthetic liner), exposed soils (2-foot engineered fill, side-slopes, access ramp), and contaminated underlying soils (2 feet overexcavation)
- Waste and soil characterization (including composite sampling for waste/exposed soils and confirmational sampling for underlying soils)
- Transportation, treatment, and disposal of all waste and soils in a Subtitle C landfill (assumed waste and contaminated soils are handled as bulk waste, and classified as hazardous waste, of which 80% would be directly disposed of in a landfill in Arlington, Oregon, and 20% would require RCRA stabilization prior to disposal)

- Placement of an impermeable membrane at base of remedial excavation (assumed geomembrane liner 40-mil-thick HDPE)
- Backfill of the remedial excavation with stockpiled and clean soil and engineered fill (assumed 2 feet)
- Placement of a 3-foot RCRA-compliant cap (minimum crown slope of 4%)
- Hydroseed of surface
- Installation of new ground water monitoring wells (assumed two wells adjacent and downgradient to Zone E)
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC
- The use of appropriate existing ICs

With the above cleanup action components, this alternative meets all Zone E RAOs specified in Table 4.3-1.

Figures 5.7.3-1 and 5.7.3-2 depict the general plan view and schematic cross section, respectively, of Alternative E-3.

Alternative E-3 assumes a total excavation area of 1.32 acres for Zone E, including area of waste and associated side-slopes. The total excavation volume is estimated to be 52,208 tons (35,203 CY), of which 45,620 tons (30,413 CY) are assumed to be waste and impacted soil materials to be bulked for transport, handling, and disposal. The remaining excavated volume of 7,184 tons (4,789 CY; soil overburden from the existing cap and cover system) would be used as backfill because it is considered relatively clean material. Appendix D, Tables 2c and 2d, presents detailed excavation area and volume calculations and new dimensions for Zone E Alternative E-3.

Excavated waste and underlying contaminated soil from Zone E would be profiled for disposal. For FFS costing purposes, these materials were assumed to be characteristic RCRA hazardous waste (based on rationale provided in Appendix G) and, therefore, their off-site disposal would occur at the Subtitle C hazardous waste landfill in Arlington, Oregon. Approximately 20% of the bulked waste and soil would require pre-treatment (RCRA stabilization) because of the known presence of heavy metals in the waste, in particular, mercury.

After placement of a geomembrane at the base of the remedial excavation, and backfilling and compaction to ground surface elevation, a new RCRA-compliant cap for Zone E would be installed with a 30-year design life.

This alternative includes the same level of cap monitoring and maintenance, inspection, and performance evaluation as Alternative E-1.

To verify the protection of ground water quality, Alternative E-3 anticipates the installation of two new monitoring wells adjacent and downgradient to Zone E and ground water compliance monitoring with a frequency of events to occur over a 10-year period (including quarterly, semiannual, and annual sampling for 5, 3, and 2 years, respectively).

ICs will continue to be required in Alternative E-3 as described in Section 5.1.1.

The total estimated cost for Alternative E-3 is $20.1 million, which includes estimated construction and non-construction costs of $11.3 million and $3.0 million, respectively, and a 40% project contingency (see Table 5.7-1). All costs are presented as net present value (see Appendix E – Zone E for detailed cost estimates).

5.7.4 No Action Alternative for Zone E

A No Action Alternative has been included for Zone E, per CERCLA guidelines through the NCP process as described in Section 5.1.3.

Monitoring of the Zone E existing RCRA cap and cover system (for an assumed 10-year period) and of downgradient ground water (for an assumed 5-year period) are the only components of this alternative. Reduction of COCs and risks would occur to the degree achieved by ongoing natural recovery processes and would be tracked with a Zone E long-term monitoring program.

For the Zone E No Action Alternative, all existing subsurface contamination would remain in place without any active remediation (treatment or engineering controls) of impacted soil or waste. Although ground water COC concentrations downgradient of Zone E are not currently detected (thus not exceeding dCULs), a minimum IC (deed restriction) would still be required for contaminated soil/waste left in place. Because ICs are not part of the scope of the No Action Alternative, this alternative would not be protective of human health and the environment. With these considerations, the No Action Alternative for Zone E does not meet the Zone E RAOs specified in Table 4.3-1 and does not meet minimum MTCA threshold requirements.

The total estimated cost for the No Action Alternative for Zone E is $194,000, which includes estimated construction (well decommissioning) and non-construction costs of $5,400 and $156,600, respectively, and a 20% project contingency (see Table 5.7-1). All costs are presented as net present value (see Appendix E – Zone E for detailed cost estimates).

5.8 Ground Water

Specific remedial actions for ground water are discussed below with the objective of ensuring source control objectives for on-property and off-property ground water are met if other remedial actions at the NPL Site are inadequate.

5.8.1 On-property Ground Water

On-property ground water is presented in Section 2.5.7.1 as representative of three areas of ground water contamination: the MSW Landfill Area, the Zone A Area, and the Central Area. Remedies to address ground water contamination in the MSW Landfill Area and Zone A Area are discussed in Sections 5.2 and 5.4, respectively. This section addresses remedial actions to address ground water contamination in the Central Area, which includes the southern end of the MSW Landfill southward to north of Zone A and from the western property boundary to east of the Landspread Area.

The following alternative is evaluated for the Central Area in this Draft Final FFS.

5.8.1.1 Alternative ONP-1

Alternative ONP-1 consists of the following primary cleanup action components:

- Focused SVE treatment to capture low-level VOCs in soil gas, to be implemented as a contingent action in the area between the southern end of the MSW Landfill, the northern end of Zone A, and from the western property boundary to the east of the Landspread Area (i.e., upgradient of Zones C/D and E)
- Performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC
- The use of appropriate ICs

With the above cleanup action components, this alternative meets all on-property ground water RAOs specified in Table 4.3-1.

Figure 5.8.1.1-1 depicts the general plan view of Alternative ONP-1.

The contingent focused SVE remedy would be integrated into the existing SVE system (including treatment of the recovered SVE gasses through the RTO system[29]) and would only be operated if VOCs are detected consistently at levels of concern (i.e., concentrations that would result in off-property CUL exceedances) in ground water in the Central Area monitoring wells. For FFS costing purposes, installation of SVE wells is assumed to occur at year 5, with SVE operation for 1 full year every 5 years, to remove potential future downgradient releases. Monthly inspections, maintenance, and operation of the SVE system are anticipated to occur, but upgrades and equipment replacement are accounted for in the scope of Zone A alternatives.

In addition, as part of the 5-year review process, and in the event of a CUL exceedance of COCs over a consistent period of time (e.g., several quarters, consistent with the site-wide ground water CMP to be developed in the future), a field program would be conducted to identify the source of release and determine any appropriate actions that would be taken to

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[29] Treatment requirements for VOCs captured through the SVE system are equivalent to those established for treatment of Zone A recovered gases.

treat/reduce these COC concentrations to below CULs. Costs for post-remedy source evaluation are included in Alternative ONP-1 costs.

To verify the protection of ground water quality, ground water compliance monitoring is anticipated for the Central Area and is assumed with a frequency of events to occur over a 15-year period within a network of four wells in the Central Area.

ICs will continue to be required as described in Section 5.1.1. Costs for the use of appropriate ICs were already included in the scope of Zones C/D and E Alternatives CD-1 and E-1.

The total estimated cost for Alternative ONP-1 is $1.5 million, which includes estimated construction and non-construction (e.g., long-term monitoring and maintenance) costs of $767,000 and $461,000, respectively, and a 20% project contingency (see Table 5.8-1). All costs are presented as net present value (see Appendix E – On-property Ground Water [Central Area] for detailed cost estimates).

5.8.1.2 No Action Alternative for the Central Area

A No Action Alternative has been included for the Central Area, per CERCLA guidelines through the NCP process as described in Section 5.1.3.

Ground water compliance monitoring is the only component of this alternative. Reduction of COCs and risks would occur to the degree achieved by ongoing natural recovery processes and would be tracked with a long-term monitoring program in the Central Area.

The No Action Alternative in the Central Area does not include any active remediation of ground water; wastes remain in this area in IWA Zones C/D and E, in former MSW Burn Trenches, and potentially within the Landspread Area. Consequently, a minimum IC (deed restriction) would still be required for contaminated soil/waste left in place. Because ICs are not part of the scope of the No Action Alternative, this alternative would not be protective of human health and the environment. Therefore, this alternative does not meet the on-property ground water RAOs specified in Table 4.3-1 and does not meet minimum MTCA threshold requirements.

The total estimated cost for the No Action Alternative for the Central Area is $187,000, which includes estimated construction (well decommissioning) and non-construction costs of $10,900 and $144,800, respectively, and a 20% project contingency (see Table 5.8-1). All costs are presented as net present value (see Appendix E – On-property Ground Water [Central Area] for detailed cost estimates).

5.8.2 Off-property Ground Water

Off-property VOC concentrations are already below the proposed CULs (see Figure 2.5.7-3); therefore, no active remediation is required. It is expected that with continued on-property source control, off-property ground water will continue to meet CULs and remaining detectable VOCs found below CULs will eventually dissipate. The effectiveness of source control using SVE to clean up the downgradient plume is already evident in the declining concentrations in the off-property plume since 2008. Attenuation of off-property COC concentrations will be demonstrated by continued routine monitoring of off-property wells because the NPL Site has been a landfill for over a half century and it will remain a landfill site. For FFS purposes, an assumed 30-year period was used to estimate ground water monitoring cost in the long-term. The ground water monitoring network would consist of approximately 16 wells during the first 20 years and approximately 8 wells in the following 10 years.

Tables 5.8-2a and 5.8-2b present the ground water monitoring and reporting costs associated with the active off-property monitoring wells (see Figure 2.5.7-2 for off-property well locations). The total estimated cost for actions for off-property ground water is $445,800, assuming 30 years of monitoring, which includes costs for all sampling events adjusted for net present value.

During this time period when natural attenuation is occurring, downgradient water users will be protected by ICs, including the City of Pasco GPA ordinance and continued monitoring of residential wells in this area, as described in Section 5.1.1.

6 EVALUATION OF REMEDIAL ALTERNATIVES

This section performs the comparative evaluation of the remedial alternatives for the cleanup of the NPL Site, based on MTCA evaluation criteria presented below.

6.1 Model Toxics Control Act Minimum Requirements

Under MTCA, remedial alternatives are evaluated within the framework of minimum requirements, including threshold requirements, other requirements, and additional minimum requirements, as specified in WAC 173-340-360.

6.1.1 Model Toxics Control Act Threshold Requirements

The following are the four threshold requirements (WAC 173-340-360(2)(a)) for all cleanup actions:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal laws
- Provide for compliance monitoring

All of the remedial alternatives developed for each zone and contained in this FFS (with the exception of the No Action Alternatives for Zones A, C/D, E, and Central Area) are designed to meet the threshold requirements.

6.1.2 Model Toxics Control Act Other Requirements

After meeting the threshold requirements, MTCA requires that a cleanup action alternative meet three other requirements (WAC 173-340-360(2)(b):

- **Use permanent solutions to the maximum extent practicable** (WAC 173-340-360(3)): MTCA specifies that when selecting a cleanup action, preference is given to permanent solutions to the maximum extent practicable. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, MTCA requires that costs and benefits of each of the remedial alternatives be balanced using a DCA. The criteria for conducting this analysis are described in Section 6.2.

- **Provide for a reasonable restoration time frame** (WAC 173-340-360(4)): A reasonable restoration time frame is the period needed to achieve the required CULs at the POC (WAC 173-340-200). MTCA stipulates a series of factors that need to be considered for determining if the cleanup action provides for a reasonable restoration time frame, as follows:
  - Potential risks posed by the NPL Site to human health and the environment
  - Practicability of achieving a shorter restoration time frame
  - Current use of the NPL Site, surrounding areas, and associated resources that are, or may be, affected by releases from the NPL Site
  - Potential future use of the NPL Site, surrounding areas, and associated resources that are, or may be, affected by releases from the NPL Site
  - Availability of alternative water supplies
  - Likely effectiveness and reliability of ICs
  - Ability to control and monitor migration of hazardous substances from the NPL Site
  - Toxicity of the hazardous substances at the NPL Site
  - Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the NPL Site or under similar NPL Site conditions

  Although MTCA guidance places a preference on those alternatives that, while equivalent in other respects, can be implemented in a shorter period of time, it "does not require that an alternative with a 'far shorter reasonable restoration time frame be selected.'" (Ecology 2016b). Determining reasonable time to achieve cleanup standards based upon requirements and procedures in MTCA provides no specific reasonable restoration time requirement, but allows for a comparison of restoration time frames among the remedial alternatives.
- **Consider public concerns** (WAC 173-340-600): Public concerns will be addressed following the public comment periods for both the Draft Final FFS and the draft CAP.

6.1.3 Model Toxics Control Act Additional Requirements

Additional requirements are considered under WAC 173-340-360(2)(c) to (g) for the evaluation of alternatives:

- Require permanent ground water cleanup actions
- Do not rely primarily on ICs
- Prevent or minimize present and future site releases and migration of hazardous substances
- Do not rely primarily on dilution and/or dispersion

6.2 Model Toxics Control Act Disproportionate Cost Analysis

MTCA requires that remedial alternatives use permanent solutions to the maximum extent practicable. To evaluate practicality, MTCA considers cost effectiveness. Costs are disproportionate to benefits if the incremental costs of a more permanent remedial alternative are greater than the incremental degree of environmental benefits achieved by that alternative over that of lower cost remedial alternatives (WAC 173-340-360(3)(e)(i)). Remedial alternatives, which exhibit such disproportionate costs, are considered "impracticable." This determination is made based on the DCA process in which: 1) the most practicable, permanent remedial alternative serves as the baseline; and 2) the benefits of the remedial alternatives to human health and the environment are evaluated and compared to the costs. Where the qualitative and quantitative benefits of two remedial alternatives are equivalent, MTCA specifies that Ecology will select the less costly alternative (WAC 173-340-360(3)(e)(ii)(c)).

6.2.1 Disproportionate Cost Analysis Evaluation Criteria

The following criteria are used in completing a DCA under MTCA:

- **Protectiveness:** Per WAC 173-340-360(3)(f)(i), the overall protectiveness of human health and the environment includes "…the degree to which existing risks are reduced, the time required to reduce risk at the facility and attain cleanup standards, the on-site and off-site risks resulting from implementing the alternative, and the improvement of the overall environmental quality".
- **Permanence:** Per WAC 173-340-360(3)(f)(ii), the long-term success of a permanent alternative can be measured by "…the degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substance releases and sources

of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated."

- **Cost:** Per WAC 173-340-360(3)(f)(iii), cost considerations for the alternative include "…cost of construction, the net present value of any long-term costs, and agency oversight costs that are cost recoverable. Long-term costs include operation and maintenance costs, monitoring costs, equipment replacement costs, and the cost of maintaining ICs. Cost estimates for treatment technologies shall describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action shall be estimated and the cost of replacement or repair of major elements shall be included in the cost estimate."
- **Effectiveness Over The Long-Term:** Per WAC 173-340-360(3)(f)(iv): Per WAC 173-340-360(3)(f)(iv), an alternative's long-term effectiveness includes "…the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed CULs, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes." When assessing the relative degree of long-term effectiveness, MTCA provides guidance on the hierarchy of cleanup action components (preference of technologies), in descending order:
  - Reuse or recycling
  - Destruction, treatment, or detoxification
  - Immobilization or solidification
  - On-site or off-site disposal in an engineered, lined, and monitored facility
  - On-site isolation or containment with attendant engineering controls
  - ICs and monitoring
- **Management of Short-term Risks:** Per WAC 173-340-360(3)(f)(v), management of short-term risks evaluates "…the risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks."
- **Technical and Administrative Implementability:** Per WAC 173-340-360(3)(f)(vi), an alternative's implementability is evaluated on "…its ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory

requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions." The implementability also depends upon the ability to measure the remedy's effectiveness and its consistency with MTCA and other regulatory requirements.

- **Consideration of Public Concerns:** Per WAC 173-340-360(3)(f)(vii), potential public concerns include "…whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, tribes, federal and state agencies, or any other organization that may have an interest in or knowledge of the site."

6.2.2 Disproportionate Cost Analysis Methodology

Due to relative complexity of the IWAs relative to other disposal areas at the NPL Site, the DCA evaluation criteria presented above were individually evaluated at the sub-criterion level for Zones A, C/D and E, per the WAC 173-340-360 (3)(f) criteria definitions.[30] Sub-criteria emphasize the core purpose of the alternatives of protecting human health and the environment, providing a tool for assessing environmental benefits, evaluating potential tradeoffs, and overall, comparing and ranking remedial alternatives with objectivity, clarity, and transparency. The use of sub-criteria reflects site-specific considerations for each activity and task included in the remedial alternatives, such as the size, complexity, constructability, or associated level of uncertainty.

Table 6.2-1 presents the sub-criteria considered under each DCA evaluation criteria under MTCA.

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[30] A similar DCA methodology was successfully applied in 2012 for the Final FS of the Lower Duwamish Waterway Superfund Site (AECOM 2012), a joint EPA/Ecology site in Seattle, Washington. The Lower Duwamish Waterway FS considered several quantitative and qualitative metrics associated with each sub-criterion to assess the environmental benefits achieved by the alternatives and, therefore, assign a score. The scores associated with each sub-criterion provided a useful, unbiased tool for comparing remedial alternatives, but it was acknowledged that even the quantitative metrics did not provide an absolute or precise measurement of benefits, and included some level of best professional judgment.

The range in rankings at the sub-criterion level was based on the total number of alternatives in the specific zone (e.g., rankings for the Zone A DCA ranged from 1 to 6, based on six Zone A alternatives carried forward into the DCA, per Section 5.4.11). The lowest ranking (1) represented a relatively poor-performing alternative for that sub-criterion compared to other alternatives, and the highest ranking (e.g., 6 for the Zone A DCA evaluation) represented the best-performing alternative for that sub-criterion compared to other alternatives. The rankings are not intended to provide an absolute or precise measurement of benefit, but rather a relative assessment of environmental benefits among alternatives. It is important to note the following:

1. The alternatives did not always cover the full ranking range (e.g., rankings range of 1 to 6 for the Zone A DCA evaluation) if there was a high degree of similarity among alternatives with respect to a sub-criterion.
2. Some alternatives were assigned the same ranking if they had equivalent levels of environmental performance or benefits for a specific sub-criterion.
3. A uniform ranking was applied to the criterion of "Consideration of Public Concerns" to give equal importance regarding public concerns to all the considered alternatives (until public comments/input are actually received). The uniform ranking for the "Consideration of Public Concerns" criterion was represented as the median value of the ranking range (e.g., in the Zone A DCA evaluation, the median value between 1 and 6 is 4, so a ranking of 4 was assigned to all Zone A alternatives).

For each alternative, the rankings received (to the nearest integer) at the sub-criteria level were averaged for each criterion. The averages were then summed as an overall environmental benefit score for each of the alternatives. The final environmental benefit score was then compared to the estimated cost of each alternative to determine which alternative provides the incrementally greatest degree of environmental benefit, while considering the most cost-effective use of technology (i.e., which alternative uses permanent solutions to the maximum extent practicable).

Cost was not a ranked criterion, but was used in the DCA to evaluate the overall environmental benefit of each remedial alternative relative to its cost (as net present value). This is particularly useful when the qualitative and/or quantitative benefits of two remedial alternatives are equivalent; MTCA specifies that Ecology will select the less costly alternative (WAC 173-340-360(3)(e)(ii)(C)).

6.3 Comparative Evaluation of Alternatives

This section presents the comparative evaluation of the remedial alternatives for each zone (described in Section 5) against the MTCA minimum requirements and DCA criteria. A preferred remedial alternative under MTCA is therefore identified for each zone.

6.3.1 Municipal Solid Waste Landfill

Alternative MSW-1 has been demonstrated to meet all MTCA requirements, and is the preferred alternative. Alternatives MSW-2 and MSW-3 are unnecessary at this time, and will likely remain so in the future, because the MSW Landfill is becoming more stable over time. Alternatives MSW-2 and MSW-3 are provided as contingencies in the unlikely event that Alternative MSW-1 does not address the RAOs at some time in the future. Table 6.3.1-1 summarizes the evaluation criteria for MSW Landfill alternatives by the threshold, other, and additional requirements under MTCA.

6.3.1.1 Comparison to MTCA Requirements

As described in Section 2.5.1, Alternative MSW-1 has been demonstrated to meet MTCA threshold requirements, including: protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring. Based on historical performance of the IAs at the MSW Landfill, Alternative MSW-1 has been demonstrated to meet Other Requirements and Additional Requirements stipulated in MTCA.

Alternative MSW-1 has been, and is expected to remain, protective of human health and the environment through engineering controls already implemented as IAs, including the engineered cover system and the GCCS. Historical environmental monitoring has demonstrated that Alternative MSW-1 has been effective at complying with cleanup standards for ground water and air quality without relying on dilution or dispersion. Ground water cleanup actions at the MSW Landfill are unnecessary, and will likely remain unnecessary in the future, because ground water at MSW Landfill monitoring wells has met all dCULs since 2014.

All of the MSW Landfill alternatives will contain the MSW in-place, and are equally permanent. Based on predictable, decreasing trends in landfill gas generation and collection, a restoration time frame of 15 years is assumed for all of the MSW Landfill alternatives, incorporating a downsized landfill gas treatment technology in approximately 5 years, and a transition from active to passive landfill gas collection in approximately 5 to 15 years. None of the alternatives can alter the restoration time frame, since the rate of decomposition at the MSW Landfill is dictated by the age, volume, and methane generating capacity of the MSW.

All alternatives for the MSW Landfill comply with applicable state and federal laws, and include compliance monitoring to ensure RAOs are addressed. All of the MSW Landfill alternatives will include IC consistent with landfill regulations, such as covenants and deed restrictions, to prevent public access and/or land use that may compromise the cover system or GCCS. In the unlikely event that MTCA requirements are not met by Alternative MSW-1 in the future, then contingent Alternatives MSW-2 and/or MSW-3 would be implemented, consistent with landfill regulations.

6.3.1.2 MTCA Disproportionate Cost Analysis

Benefit evaluations and cost summaries for Alternatives MSW-1, MSW-2, and MSW-3 are presented in Table 6.3.1-2. Figure 6.3.2-1 provides a graphical comparison of the benefits, costs, and benefit-to-cost ratios for each of the three alternatives. The benefits of the MSW Landfill alternatives were ranked from 3 (most beneficial) to 1 (least beneficial) for each of the MTCA-established criteria, as shown in Table 6.3.1-2. The benefits for Alternative MSW-1 rank highest because the IAs have been successfully demonstrated, and it is the most straight-forward alternative to implement and operate in the long term.

Both Alternatives MSW-2 and MSW-3 are more complex than Alternative MSW-1. The benefits for contingency Alternative MSW-2 rank lower than MSW-1 because expanding the landfill gas collection system potentially involves greater risks than simply increasing the flow rate using the existing GCCS. The benefits for contingency Alternative MSW-3 rank lower than MSW-2 because installing and operating a ground water treatment system potentially involves greater risks and less long term effectiveness than expanding the landfill gas collection system.

The detailed cost estimates for Alternatives MSW-1, MSW-2, and MSW-3 are provided in Table 5.2-1. Alternative MSW-1 includes replacement of the existing flare with an alternative landfill gas treatment system at a capital cost of $30,000. Alternative MSW-2 includes Alternative MSW-1 elements and installation, hookup, and operation of four additional landfill gas extraction wells with an estimated capital cost of $140,000. Alternative MSW-3 includes Alternative MSW-2 elements and design, installation, and operation of a ground water treatment system with an estimated capital cost of $500,000.

Long-term costs were estimated for a 15-year time frame and categorized as O&M costs or equipment replacement costs. O&M costs in Table 5.2-1 also include costs for monitoring, maintaining ICs, and Agency oversight. Annual O&M costs are forecasted to decline in 2020 when the existing flare will be replaced with an alternative landfill gas treatment system that is easier to operate. All assumptions for long-term cost estimates are provided in Table 5.2-1.

6.3.1.3 Preferred MSW Landfill Alternative

The preferred remedial alternative for the MSW Landfill is Alternative MSW-1. Selection of Alternative MSW-1 is supported by the performance of the existing systems and the results of the DCA. There is no technical rationale to implement Alternative MSW-2 or Alternative MSW-3.

6.3.2 Balefill and Inert Waste Disposal Areas, and Burn Trenches

6.3.2.1 Balefill and Inert Waste Disposal Areas

For the purpose of remedial alternative selection, the Balefill and Inert Waste Disposal Areas were combined based on the alternatives (BA-1 and IWDA-1, respectively) in the Ecology-approved FFS Work Plan (Anchor QEA et al. 2013). Alternative BA-1 is the preferred remedy, and will adequately meet the RAOs and MTCA requirements (see Table 6.3.1-1).

6.3.2.1.1 Comparison to MTCA Requirements

Alternative BA-1 adequately addresses the RAOs for preventing direct exposure to MSW and soil, minimizing transport of any contaminants to subsurface soils and ground water, and will minimize the risk of a surface fire. Alternative BA-1 is a solution that is permanent to the maximum extent practicable. Based on the need to observe and demonstrate the adequacy of the soil cover, a restoration time frame of 15 years is assumed for Alternative BA-1. This would provide observation of soil cover erosion and maintenance requirements for three consecutive 5-year review periods.

Alternative BA-1 will include ICs consistent with landfill regulations, such as covenants and deed restriction to prevent public access and/or land use that may compromise the soil cover.

Terrestrial ecological receptors could potentially be exposed to MSW below the soil cover or in areas where the MSW is exposed. As described in the Ecology-approved *Operations and Maintenance Manual: MSW Disposal Areas* (Aspect 2014a) and in Alternative BA-1, the Balefill and Inert Waste Disposal Areas soil cover will be restored and maintained at a minimum of 30 inches thick.

The detailed cost estimates for Alternative BA-1 is provided in Table 5.3-1. Alternative BA-1 has an estimated capital cost of $310,000. No DCA was necessary.

6.3.2.1.2 Preferred Balefill and Inert Waste Disposal Area Alternative

The preferred remedial alternative for the Balefill Area is Alternative BA-1.
Alternative BA-1 consists of leaving the Balefill and Inert Waste Disposal Areas in place and restoring the existing soil cover to a minimum thickness of 30 inches, including a gravel layer to address terrestrial ecological exposure and wind erosion of the soil cover. Currently exposed MSW will be leveled to the extent practical before soil cover restoration. As described in Section 2.5.1, restoration of the existing soil cover across the Balefill and Inert Waste Disposal Areas was first proposed in 2012. The *Draft Operations and Maintenance Manual Update: MSW Disposal Areas* (Aspect 2016) describes the soil cover restoration and O&M requirements to demonstrate landfill stability.

6.3.2.2 Burn Trenches

Alternative BT-A meets all MTCA requirements, and is the preferred alternative. Alternatives BT-B and BT-C are unnecessary at this time, and will likely remain so in the future because the Burn Trenches are protective of human health and the environment, are stable, and are becoming more stable over time. Alternatives BT-B and BT-C are provided as contingencies in the unlikely event that Alternative BT-A does not address the RAOs at some time in the future. Table 6.3.2-1 summarized the evaluation criteria for remedial alternatives for the Burn Trenches by the Threshold, Other and Additional Requirements under MTCA.

6.3.2.2.1 Comparison to MTCA Requirements

As described in Section 2.5.1, Alternative BT-A has been demonstrated to meet MTCA requirements. Alternative BT-A has been, and is expected to remain, protective of human health and the environment through engineering controls implemented at the time the Burn Trenches were initially covered with soil. Because the MSW in the Burn Trenches is generating little if any landfill gas or leachate, Alternative BT-A is effective at complying with cleanup standards for ground water and air quality without relying on dilution or dispersion. All alternatives for the Burn Trenches comply with applicable state and federal laws, and include compliance monitoring to ensure RAOs are addressed.

All of the Burn Trench alternatives will contain the MSW in-place, and are equally permanent. Based on the need to observe and demonstrate the adequacy of the soil cover, a restoration time frame of 15 years is assumed for all of the Burn Trench alternatives. This would provide observation of soil cover erosion and maintenance requirements for three consecutive 5-year review periods.

All of the Burn Trench alternatives will include ICs consistent with landfill regulations, such as covenants and deed restriction to prevent public access and/or land use that may compromise the soil covers.

Terrestrial ecological receptors could potentially be exposed to MSW in the Burn Trenches below the soil covers. With Alternative BT-A, the MSW over a portion of Burn Trench BT-1 remains covered by soil. In the unlikely event that the RAOs are not met with Alternative BT-A, the soil cover thickness would be confirmed to be a minimum of 30 inches thick with contingency Alternative BT-B. Under contingency Alternative BT-C, it is assumed 25% of the soil cover would be restored to a minimum thickness of 30 inches.

6.3.2.2.2 MTCA Disproportionate Cost Analysis

Benefit evaluations and cost summaries for Alternatives BT-A, BT-B, and BT-C are presented in Table 6.3.2-1. Figure 6.3.2-1 provides a graphical comparison of the benefits, costs, and Benefit-to-Cost Ratios for both alternatives. The benefits of the Burn Trench alternatives were ranked from 3 (most beneficial) to 1 (least beneficial) for each of the established criteria, as shown in Table 6.3.2-2. Overall, the alternatives for the Burn Trenches were judged to provide approximately equal benefit since there has been no demonstrated impact.

The detailed cost estimates for Burn Trench Alternatives are provided in Table 5.3-4 through Table 5.3-6. Alternative BT-A has no capital cost, whereas Alternative BT-B includes assessment of the soil cover, with an estimated capital cost of $24,000. Alternative BT-C includes capital effort to rehabilitate the soil cover at an estimated capital cost of $108,000.

6.3.2.2.3 Preferred Burn Trench Alternative

The preferred remedial alternative for the Burn Trenches is Alternative BT-A. Selection of Alternative BT-A is supported by the results of the DCA and the limited potential for exposure. As shown in Table 6.3.2-1 and Figure 6.3.2-1, Alternative BT-A had the highest benefit-to-cost ratio compared to Alternatives BT-2 and BT-3.

Given that cover system of the Burn Trenches is comprised partially of the Zone A cover system and the range of alternatives considered for Zone A (including removal), a future condition of the Burn Trench area may include the need to restore the soil cover which would be addressed with contingency Alternatives BT-B and if necessary, BT-C.

6.3.3 Zone A

6.3.3.1 Comparison to Model Toxics Control Act Requirements

As described in Section 5.4.11, the six Zone A alternatives carried forward for the comparative evaluation based on MTCA criteria for the cleanup of the NPL Site are Alternatives A-1, A-2, A-6, A-7, A-8, and A-9.[31] Table 6.3.3-1 summarizes the evaluation of the Threshold, Other, and Additional Requirements under MTCA for the remedial alternatives carried forward for Zone A.

6.3.3.1.1 Comparison to Threshold Requirements

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Each of the remedial alternatives carried forward for Zone A achieves the protection of human health and the environment through various combinations of engineered controls and ICs. Ground water conditions at Zone A currently comply with draft cleanup standards outside of the Zone A cap. Ground water monitoring data indicate that VOC concentrations in the off-property wells have not been detected above the 2014 dCULs in recent years. The SVE system removes VOCs and low molecular weight SVOCs in the vapor phase and VOCs, SVOCs, and metals are also captured in the SVE condensate.

Alternatives A-1, A-2, and A-8[32] rely on the SVE system operation as the primary removal method of VOCs. The existing SVE system has been effective in protecting on-site and off-site downgradient ground water (see Figures 2.5.7-3 and 2.5.7-4). Since the 2012 SVE upgrade, VOC and low molecular weight SVOC removal rates have demonstrably increased,[33] and a clear improvement in ground water quality downgradient of Zone A has been quickly achieved as evidenced by nearly undetectable VOC/SVOC concentrations in

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[31] Detailed cleanup action components of these six Zone A alternatives are summarized in Section 5.4.11.

[32] As described in Section 5.4.8, the enhanced SVE action under Alternative A-8 would operate for the first 10 years.

[33] As presented in Figure 2.5.3-1, approximately 440,000 pounds of VOCs were removed by the SVE system over the 15-year period between 1997 and 2012. Since the 2012 SVE system upgrade to present, the SVE system removed an additional 610,000 pounds of VOCs in approximately 5 years, for a total cumulative VOC mass removal of 1,048,000 pounds between May 1997 and April 2017 (PBS 2017b). In addition to removal of VOCs and low molecular weight SVOCs in the vapor phase through the operation of the SVE system, VOCs, SVOCs, and metals are also captured in the SVE condensate (a total of 11,140 gallons of SVE condensate were generated in 2016; it was designated as hazardous waste and transported to Burlington Environmental, LLC, in Kent, Washington, for treatment and disposal; PBS 2017a).

almost all wells. Performance monitoring data show that the vapor to ground water pathway is sufficiently interrupted during SVE operation, even with only shallow and deep SVE wells operating (consistent with the period from 2013 to 2016). It is anticipated that the additional capacity of the Anguil RTO will allow an increase in inlet flow rates with a corresponding increase in mass removal of contaminants through the SVE system. Maximizing SVE mass removal provides a demonstrated means for removal and destruction of COCs and protection of ground water quality in the long-term.

Under Alternatives A-1 and A-2, the VOC mass would be largely removed and treated by the SVE system, and residual waste and impacted soils would be addressed through SVE system operation, physical containment, and natural attenuation. However, Alternative A-2 would also include the operation of an enhanced SVE system[34] and a potential contingent action (an air sparging system and ozone treatment). The enhanced SVE system will increase mass removal and therefore shorten the operational time frame of the Zone A SVE treatment system. The purpose of the contingent action in Alternative A-2 (to be implemented to address potential future impacted ground water downgradient of Zone A, identified during the 5-year reviews by Ecology) is to provide additional long-term protectiveness in the event of transient releases from the Zone A source area, necessitating treatment and/or destruction of a different and larger class of contaminants than that remediated by the SVE system alone.[35]

Under Alternative A-8, the VOC mass would be largely removed and treated by the enhanced SVE system for the first 10 years, and if that and the contingent action of implementing air-sparging and ozone injection are not sufficiently protective, a contingent excavation action with on-site disposal of the Touchet Beds in an AOC would be implemented. As described in Section 5.4.8, the progressive, iterative transition from enhanced SVE operation (Alternative A-2) to the potential contingent excavation action

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[34] As described in Section 5.4.2, the enhanced SVE system would consist of three additional SVE wells installed within the intermediate zone.

[35] While air sparging would be employed to physically strip VOCs and some SVOCs from the ground water, ozone treatment would be used to oxidize VOCs, SVOCs, and PAHs from the ground water. Although to date no such compounds have reached ground water at levels that would exceed MTCA Method B levels, this Alternative A-2 component is designed to prevent other non-VOC compounds from reaching ground water any time in the future (see Section 5.4.2).

(Alternative A-7) could occur under a number of potential scenarios (all initiated by the data triggers), and then addressed by draft work plans prepared by the Performing PLPs to address the pertinent scenario(s), and subject to Ecology approvals.

In Alternatives A-1, A-2, and A-8, the existing Zone A cap has performed as intended and would continue to minimize the risk of direct contact with wastes and contamination for humans and ecological receptors, prevent leaching of contaminants to ground water due to precipitation, and thereby reduce the potential for mobilization of residual contaminants. Negligible risks to on-site and off-site receptors are expected through implementation of these three alternatives.

Alternatives A-6, A-7, and A-9 rely on excavation, transport, and either on-site or off-site disposal of waste and impacted soils. Alternative A-6 includes removal of drummed waste and partial removal of impacted soils (down to the top of the Touchet Beds), on-site disposal of bulked inert drums and impacted soils in a double-lined newly constructed AOC cell, off-site disposal of some overpacked drummed waste, off-site incineration of decanted liquid solvents, thermal treatment of the Touchet Bed soils, and deep SVE treatment between the top of the Upper Pasco Gravels and the water table. Alternative A-7 is a removal action similar to Alternative A-6, but with removal of the Touchet Beds and disposal in an on-site AOC rather than in situ thermal treatment. Alternative A-7 differs from Alternative A-6 primarily in the size and volume of the Zone A excavation and the AOC footprint. Alternative A-9 includes full source removal (down to the top of the Upper Pasco Gravels) and off-site disposal of all waste and impacted soils and deep SVE treatment between the top of the Upper Pasco Gravels and the water table. Alternative A-8 would only include the contingent excavation action with on-site disposal of the Touchet Beds in the AOC, if the enhanced SVE system and contingent air/sparge and ozone treatment are demonstrated to not be sufficiently protective.

Within the engineered controls for these excavation-based alternatives, the permanent removal of wastes and contaminated soils and the placement of a new RCRA cap over the backfilled Zone A remedial area significantly decreases the future risks associated with direct exposure to remaining residual wastes. However, due to the complexity and magnitude of the excavation activities and substantial uncertainty of current drum conditions, short-term risks to workers, the community, and the environment associated with excavation, transport, and either on-site or off-site disposal, are significantly higher than for Alternatives A-1 and A-2, and include risks of exposure and COC mobilization outside the PSLI Property.

ICs are expected to remain in place for all remedial alternatives carried forward for Zone A to ensure protection of human health and the environment over the long-term.

COMPLIANCE WITH CLEANUP STANDARDS

Current ground water conditions at Zone A already comply with draft cleanup standards at the POC outside of the Zone A cap. Ground water monitoring data indicate that VOC concentrations in the off-property wells have not been detected above the 2014 dCULs in recent years, confirming that source control at the NPL Site has been achieved (accomplished by the ongoing successful operation of the existing SVE system). Future ground water conditions at Zone A are expected to remain in compliance with draft cleanup standards outside of the Zone A cap with continued successful operation of the SVE system until the rate of VOC removal has declined and stabilized over several years. With the installation and full operation of the upgraded RTO, which has design capabilities to treat higher mass loadings, the effectiveness of the SVE system in terms of mass removal will be increased, providing added protection of ground water quality and, therefore, human health and the environment.

Alternative A-2 provides not only for an enhanced SVE system (to increase mass removal from the Zone A source area), but an additional level of potential contingent protection (through the air sparging system and ozone treatment) for contaminated ground water in the event of transient releases of compounds other than VOCs.[36] Although to date no such compounds have reached ground water at levels that would exceed MTCA Method B levels, this cleanup action component in Alternative A-2 is designed to treat non-VOC compounds should they occur in ground water in the future.

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[36] In addition to removal of VOCs and low molecular weight SVOCs in the vapor phase through the operation of the SVE system, VOCs, SVOCs, and metals are also captured in the SVE condensate.

Ground water monitoring will continue to be required outside the new Zone A cap (applicable to all Zone A alternatives) and also outside the newly constructed AOC cell (applicable to Alternatives A-6, A-7, and A-8[37]).

COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS

The remedial alternatives carried forward for Zone A will comply with applicable state and federal laws identified in Section 4.4. These alternatives incorporate commonly accepted technical practices of waste containment, treatment, removal, and ICs to maintain long-term protectiveness. ICs will be addressed in detail as part of the CAP and project implementation measures. All cleanup action components will be conducted under approved project work plans to ensure project quality control (QC).

Alternatives A-6, A-7, and A-8[38] will require additional regulatory approval for the implementation and construction of the on-site AOC cell. Ecology would be the lead regulatory agency responsible for approving and determining that the AOC concept is being properly applied at the NPL Site. AOC approval considerations are described in Section 5.4.5.1.2. In addition, NPL Site access for an on-site AOC would need to be arranged with PSLI.

The Draft Final FFS will undergo public review as required by state law. Ecology will incorporate public input on the remedial alternatives presented in this document so that a proposed cleanup remedy can be selected as part of the forthcoming draft CAP.

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[37] The implementation of contingent excavation action with on-site disposal of the Touchet Beds in an AOC would be implemented only if the enhanced SVE system and contingent air sparge/ozone treatment are demonstrated to not be sufficiently protective.

[38] The excavation action with on-site disposal of the Touchet Beds in an AOC is a potential contingent action for Alternative A-8 that could be implemented at year 11.

PROVISION FOR COMPLIANCE MONITORING

A ground water CMP will be developed after the CAP is finalized. All remedial alternatives carried forward for Zone A include ground water compliance monitoring (as described in Section 5.1.2) for an assumed total period of 30 years (from the implementation of the CAP) with quarterly, semiannual, annual, and potentially less frequent sampling events.[39] Alternatives that rely primarily on SVE operation and containment (Alternatives A-1 and A-2 for 30 years, and Alternative A-8 for 10 years) are assumed to require the existing network of ground water monitoring wells (18 wells) for the first 10 years to ensure compliance of ground water quality, with the number of wells scaling down by half the existing number in the following 10-year intervals (see Section 5.4.1). For remedial alternatives that involve the partial or full excavation of drummed waste and impacted soils and some degree of SVE operation (Alternatives A-6 through A-9), ground water compliance monitoring is assumed to still remain in effect with the existing well network for an assumed 10 years, due to residual contaminated soils in either Touchet Beds and/or Upper Pasco Gravels, with the number of wells scaling down by a third of the existing number in the following 10-year intervals (see Section 5.4.6).

Performance monitoring of the SVE system will continue with monthly inspections, maintenance, upgrades, and equipment replacement, all of which are assumed to occur over 30-year (Alternatives A-1 and A-2)[40] and 10-year (Alternatives A-6 through A-9) SVE operational periods. Alternatives A-2 and A-8 include a potential contingent action (an air sparging system and ozone treatment) to be implemented in the event that the SVE system must be supplemented in order to maintain the protection of ground water quality downgradient of Zone A. The contingent action would be triggered by a potential future condition that would be identified during ground water compliance monitoring and the 5-year review process, although its implementation would not necessarily be restricted to the 5-year review periods. If the contingent remedy is triggered, the COCs would be identified and an EDR (possibly including pilot and treatability testing) would need to be developed and approved by Ecology for the specific conditions triggering the contingent action.

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[39] The period of ground water compliance monitoring corresponds with the estimated SVE operational time frame of 30 years as described in Section 5.4.1.1.

[40] The period for SVE system performance monitoring corresponds with the estimated SVE operational time frame of 30 years as described in Section 5.4.1.1.

Cap evaluation, monitoring, maintenance, and inspection are contemplated as part of the scope of Alternatives A-1 through A-9. In addition, Alternatives A-6, A-7, and A-8 will require the routine inspection, monitoring, and maintenance of the newly constructed on-site double-lined AOC cell and RCRA-compliant cap over the AOC cell.[41]

Therefore, all remedial alternatives carried forward for Zone A meet the MTCA threshold requirements.

6.3.3.1.2 Comparison to Other Requirements

PROVISION OF PERMANENT SOLUTION TO MAXIMUM EXTENT PRACTICABLE

The DCA evaluation, described in Section 6.2.1, determines whether remedial alternatives use permanent solutions to the maximum extent practicable. The DCA evaluation compares an alternative's costs and benefits, applying six overall criteria. Section 6.3.3.2 evaluates the Zone A remedial alternatives against those criteria.

PROVISION OF REASONABLE RESTORATION TIME FRAME

The MTCA regulations define restoration time frame as "the period of time needed to achieve the required CULs at the points of compliance established for the site" (WAC 173-340-200). dCULs have been established for the site and are set forth in Section 4.5.1. The conditional POCs with respect to the Zone A ground water are defined in Section 4.5.4. At the proposed Zone A conditional POCs, dCULs have been achieved.

Thus, unless the locations of the proposed conditional POCs are moved closer to the Zone A wastes and/or the ground water CULs are made more stringent than the dCULs, restoration at Zone A already has been achieved and this MTCA criterion is already met. Although continued operation of the SVE system or other remediation at Zone A is needed to maintain the achievement of dCULs, it does not change the fact that, as defined in the MTCA regulations, restoration has already been achieved.

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[41] The excavation action with on-site disposal of the Touchet Beds in an AOC is a potential contingent action for Alternative A-8 that could be implemented at year 11.

The following paragraphs describe the implementation time each alternative would require. Based on the MTCA principles outlined previously, this is not an evaluation of each alternative against the restoration time frame criterion, but rather a description of the expected implementation timelines.

All remedial alternatives carried forward for Zone A are assumed to require ground water compliance monitoring for an estimated period of 30 years (with potentially lower sampling frequency over time).

Under Alternatives A-1 and A-2, the SVE system will continue to reduce contaminant mass within Zone A, and its operation is assumed to continue for 30 years. However, this time frame could be considerably shorter with the installation of additional SVE wells (Alternative A-2) and full operation of the new RTO, which has design capabilities that allow it to treat higher mass loadings and thus provide capacity for gas extraction from the intermediate SVE wells. Adding the intermediate wells to the SVE program would maximize mass removal rates (see Section 5.4.1.1 and Appendix J).

Under Alternatives A-6, A-7, and A-9, the SVE system is assumed to operate for 10 years to protect ground water quality from potential release of waste and associated COCs during drum removal and excavation activities. SVE operation under these alternatives also would address residual soil contamination between the top of the Upper Pasco Gravels and the water table.

Under Alternative A-8, the enhanced SVE system will continue to reduce contaminant mass within Zone A for the first 10 years. If this and the contingent air sparge/ozone treatment are not sufficiently protective, the contingent excavation action would be implemented; however, the SVE system is assumed to operate for another 10 years (years 10 to 20) to protect ground water quality from potential release of waste and associated COCs during drum removal and excavation activities, as for the other removal-based alternatives.

Conducting drummed waste and soil removal under Alternatives A-6 is estimated to last 1 year and approximately 1.5 years for Alternatives A-7 through A-9. The timelines differ because, while all of these alternatives would include removal of the drummed waste, they would involve different degrees of impacted soil excavation (the latter three alternatives include removal of the Touchet Beds to the top of the Upper Pasco Gravels). Implementing removal would include site preparation; establishment of an access and haul circulation road through the Balefill Area and Inert Waste Disposal Area; construction of waste handling, staging, stockpiling, and drum inspection areas; and partial or full excavation and disposal of drummed waste and impacted soils. In addition to the time needed to implement these removal activities, Alternatives A-6, A-7, and A-8 would require two additional years to construct the on-site double-lined AOC cell, and Alternative A-6 would require 6 to 8 months of thermal treatment of the Touchet Beds.

As described previously, Zone A ground water already has been restored within the MTCA meaning of the term “restored” (ground water conditions at Zone A currently comply with draft cleanup standards outside of the Zone A cap). This makes the WAC 173-304-360(4)(b) factors inapplicable for determining whether a given restoration time frame is “reasonable.” Nevertheless, it is useful to evaluate the Zone A alternatives against these factors, not as a measure of their respective restoration timelines, but as another means of characterizing them. Therefore, all remedial alternatives in Zone A satisfy the following factors, as cited in WAC 173-340-360(4)(b):

- Potential risks posed by Zone A to human health and the environment are currently successfully prevented with Alternative A-1, but are further minimized with more aggressive engineered controls in Alternatives A-2, A-6, A-7, A-8, and A-9.
- Alternatives A-6 through A-9, involving waste removal and/or destruction (through thermal treatment), would take less time to complete than the SVE operational period associated with Alternatives A-1 and A-2.
- The current and potential future uses of the NPL Site (a closed, permanent landfill site) will not be significantly affected by any of the Zone A remedial alternatives.
- The ground water quality at Zone A already meets dCULs at the proposed conditional POCs outside the Zone A cap (achieved by Alternative A-1), will continue to comply with dCULs under any of the alternatives except for the No Action Alternative, and will not be adversely affected by any of the alternatives.
- ICs will likely continue to be effective and reliable, and are an element of all the Zone A remedial alternatives.

- Hazardous substances are currently and successfully controlled by Alternative A-1, and the migration of COCs would be monitored and mitigated under all the Zone A alternatives.
- Natural processes are likely to either stabilize or continue reducing Zone A concentrations of hazardous substances under all the Zone A alternatives.

CONSIDERATION OF PUBLIC CONCERNS

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process. Ecology will incorporate public input on the remedial alternatives presented in this document and take into account public input in developing the draft CAP that will identify the proposed NPL Site remedy.

6.3.3.1.3 Comparison to Additional Requirements

Because ground water monitoring to-date shows compliance with cleanup standards outside of the existing Zone A cap, these alternatives do not require permanent ground water cleanup actions. None of the Zone A remedial alternatives carried forward will require more than performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC.[42]

Each of the remedial alternatives carried forward for Zone A rely on various combinations of engineered controls (containment, SVE treatment, thermal treatment, removal and either on-site or off-site disposal, ground water performance, or compliance monitoring). ICs are not the primary remedial action for these remedial alternatives, but rather are used to ensure that the integrity of the cap and cover system are maintained (in addition to the RCRA cap for the AOC cell under Alternatives A-6, A-7, and A-8).

Present and future migration of hazardous substances in the environment will be minimized by all Zone A remedial alternatives carried forward, based on the various combinations of engineered controls and ICs in their remedy scopes. Current and future agricultural uses of ground water are unlikely to be impacted by a release.

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[42] Although a ground water CMP will be developed after the CAP is finalized, ground water protection, performance, and confirmational monitoring activities were assumed for cost purposes in this Draft Final FFS and were developed specifically for the scope of the various alternatives.

None of the remedial alternatives carried forward for Zone A rely primarily on dilution and/or dispersion.

6.3.3.2 *Model Toxics Control Act Disproportionate Cost Analysis*

Table 6.3.3-2 presents a detailed summary of the MTCA DCA evaluation criteria for each of the remedial alternatives carried forward for Zone A, with the individual and overall environmental benefit scores, total costs (as net present value), and the resulting benefit-to-cost ratios.

As described in Section 6.2.2, DCA criteria were evaluated and ranked at the sub-criterion level[43] and presented in Tables 6.3.3-3a through 6.3.3-3e. The range in rankings at the sub-criterion level was based on the total number of alternatives in Zone A (i.e., 1 to 6, based on six Zone A alternatives carried forward into the DCA, per Section 5.4.11). In general, the lowest ranking (1) represented a relatively poor-performing alternative for that sub-criterion compared to other alternatives, and the highest ranking (6) represented the best-performing alternative for that sub-criterion compared to other alternatives.

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process, and Ecology will incorporate public input on the remedial alternatives presented in this document. At the request of Ecology, a uniform ranking was applied to the criterion of “Consideration of Public Concerns” to give equal importance regarding public concerns to all the considered alternatives (until public comments/input are actually received). The uniform ranking for “Consideration of Public Concerns” criterion was represented as the median value of the ranking range (e.g., in the Zone A DCA evaluation, the median value between 1 and 6 is 4, thus, a ranking of 4 was assigned to all six Zone A alternatives).

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[43] As described in Section 6.2.2, each alternative was ranked (to the nearest integer) at the sub-criteria level and then averaged for each criterion. The averages were then summed as an overall environmental benefit score for each of the alternatives. The final environmental benefit score was then compared to the estimated cost of each alternative to determine which alternative provides the incrementally greatest degree of environmental benefit, while considering the most cost-effective use of technology (i.e., which alternative uses permanent solutions to the maximum extent practicable).

6.3.3.2.1 Relationship Between Benefits and Costs

Figure 6.3.3-1 depicts a graphic summary of the DCA and compares overall environmental benefits and costs for each alternative relative to Alternative A-9. Consistent with MTCA requirements, Alternative A-9 serves as the baseline against which other alternatives shall be evaluated for the purpose of selecting the cleanup action that is permanent to the maximum extent practicable. Alternative A-9 represents the most practicable permanent remedial alternative for Zone A because it consists of the full removal of drummed waste and impacted soils to the top of the Upper Pasco Gravels and off-site disposal, and thus has the least remaining residual contamination on NPL Site. However, it should be observed that Alternatives A-1 and A-2 are in essence more "permanent" than Alternative A-9 (and other removal-based alternatives) because Alternatives A-1 and A-2 involve destruction of COCs, rather than containment of COCs.

Environmental benefit ranges from 18 (Alternative A-6) to 23 (Alternatives A-8 and A-9). As the most practicable permanent remedial alternative, Alternative A-9 has a relatively high environmental benefit score due to its high degree of protection, permanence, and long-term effectiveness (these criteria alone account for 70% of the overall environmental benefit score), but with the corresponding highest total cost of $128.1 million. However, as indicated above, Alternatives A-1 and A-2 have the added benefit of destroying COCs, rather than just containing them. The breakpoint at which incremental costs begin to outweigh incremental environmental benefits is illustrated on Figure 6.3.3-1. Environmental benefits among all Zone A alternatives are similar, resulting in incremental costs associated with Alternatives A-6, A-7, A-8, and A-9 that are disproportionate compared to Alternative A-2 (WAC 173-340-360(3)(e)(i)). This is also reflected in the lower benefit-to-cost ratios (defined as the overall environmental benefit score per each $100,000 dollars) of these remedial alternatives versus Alternative A-2 (ratios varied between 1.8 for Alternative A-9 to 4.5 for Alternative A-8).

Therefore, the remaining remedial alternatives for the Zone A evaluation are Alternatives A-1 and A-2. These two remedial alternatives provide high overall environmental benefit scores (22), but Alternative A-2 is cost-effective (with a low cost of $18.3 million and a high benefit-to-cost ratio of 11.7), and provides distinguishable environmental benefits (enhanced SVE system and the potential contingent action of air sparging and ozone treatment) over Alternative A-1. In addition, the incremental costs for Alternative A-2 are not considered disproportionate with respect to Alternative A-1, because they provide for the following: 1) improved mass removal from the Zone A source area due to the installation and operation of three additional intermediate SVE wells; 2) additional long-term protectiveness afforded by the contingent action in the event of transient releases from the Zone A source; and 3) the treatment and destruction of a different and larger class of contaminants than that accomplished by the SVE system alone. Therefore, the incremental costs for Alternative A-2 are commensurate with the level of added protectiveness, when compared to Alternative A-1. Alternative A-2 meets the MTCA threshold requirements and the definition of permanent to the maximum extent practicable, per WAC 173-340-360(3)(e), because cleanup standards are achieved.

Based on the MTCA DCA, Alternative A-2 is identified as the preferred remedial alternative for Zone A.

6.3.4 Zone B

6.3.4.1 Individual Analysis of Alternatives

In this section, the waste/soil RAAs described in Section 5.5 are individually evaluated, using the MTCA threshold requirements and other MTCA requirements (as presented in Section 6.1). The DCA is addressed when RAAs are compared against one another in Section 6.3.4.2. A summary of this evaluation for each of the RAAs is presented in Table 6.3.4-1.

As shown in Table 6.3.4-1, Alternatives B-1, B-2, B-3, B-4, and B-5 all meet Ecology's threshold requirements (WAC 173-340-360(2)(a)) in that each of the alternatives does the following: 1) protects human health and the environment; 2) complies with cleanup standards; 3) complies with applicable state and federal laws; and 4) provides for compliance monitoring. The alternatives also meet the other requirements described in WAC 173-340-360(2)(b), including providing for a reasonable restoration time frame and considering public concerns. The requirement of using a permanent solution to the maximum extent practicable can only be fully met after a DCA, which is performed in the comparison of alternatives presented in Section 6.3.4.2.

It should be noted that remedial actions completed to date, as described in Section 2.5.4.3 and including drum removal and cap installation and ongoing operation and maintenance, have prevented degradation of soil and ground water quality.

The satisfaction of the following four additional requirements has been assessed:

1. **Does the alternative require ground water cleanup actions?**
   The ground water beneath Zone B has not had a detection of a COC since 2001. None of the alternatives requires anything more than ground water performance monitoring (Alternative B-1, B-2, B-3, and B-4) or compliance monitoring (Alternative B-5 at an off-site landfill location). Therefore, the alternatives do not require ground water cleanup actions.
2. **Does the alternative rely primarily on ICs?**
   The four alternatives all rely on containment and control of the waste, with ground water performance or compliance monitoring, and active operation, monitoring, and maintenance of the containment structures. Therefore, the alternatives do not rely primarily on ICs.
3. **Does the alternative minimize present and future site releases and migration?**
   All four alternatives rely on containment and control of the waste, with ground water performance or compliance monitoring, and active operation, monitoring, and maintenance of the containment structures. Therefore, the alternatives minimize present and future site releases and migration.
4. **Does the alternative rely primarily on dilution and/or dispersion?**
   The ground water beneath Zone B has not had a detection of a COC since 2001. The COCs do not present a vapor phase exposure threat. Therefore, dilution and dispersion do not play a role in the remedy.

6.3.4.1.1 Protection of Human Health and the Environment

In Alternatives B-1, B-2, and B-3, human health and the environment are continually protected by providing a physical surface barrier between soil within cell B and potential human or ecological receptors (minimization of risk by elimination of the direct contact exposure pathway); reducing stormwater infiltration into cell B, thereby reducing the potential for mobilization of residual chemical constituents; and providing engineering and

ICs to limit access to Zone B. In Alternatives B-4 and B-5, partial or wholesale removal of the existing cap would occur, which increases risks of exposure and mobilization.

Alternative B-2 relies on passive natural processes to either sorb or biodegrade constituents. The natural sorption is potentially effective for all COCs and may already be responsible for maintaining ground water quality. Natural, non-stimulated biodegradation would potentially degrade several COC classes, but not the dioxins/furans that have the strongest influence over residual exposure risk. Implementation of Alternative B-2 would involve drilling either through the cap, or beneath the cap from the cap edges, both of which impart risk. Horizontal, vertical, or near-vertical angled borings beneath the former disposal cell bring risk in that preferential pathways for water infiltration and contaminant migration may be formed. Vertical boring methods could compromise cap integrity. Additionally, longer term monitoring of the progress of MNA in removing contaminant mass would mean collection of additional soil samples in the future, which would further endanger the cap's integrity.

Alternatives B-2, B-3, and B-4 would involve drilling either through the cap or beneath the cap from the cap edges, both of which impart risk. Any disturbance of soil beneath the cap would increase chances of potential cap deformation or subsidence. Contaminated waste would be generated during a drilling program.

Additional factors applicable toward evaluation of Alternatives B-3 and B-4 include the following:

- Biodegradation monitoring would be difficult for the large area under the cap, due to the need to access soils immediately below the disposal cell floor (explained in more detail in Section 5.5.2).
- Dioxins, furans, and PAHs do not biodegrade readily even under the strongest of stimulus, thus the residual exposure risk would not be significantly reduced.
- Given that the existing cap minimizes infiltration of precipitation to the area of the former disposal cell, stabilization would not provide greater containment protectiveness than the existing cap.
- The addition of a liquid stabilization solution or nutrient solution over a large area under the cap would difficult and likely would occur unevenly.

- Amendment delivery using drilling and injection tooling may create preferential subsurface transport pathways by piercing or compromising the liner (explained in further detail in Section 5.5.3).

Liquids introduced beneath the cap as part of the bioremediation or stabilization remedy may dissolve and mobilize COCs and could potentially cause settling and compromise of the liner (explained in further detail in Section 5.5.3).

Alternative B-5 removes most or all of the remaining contaminated soil from Zone B, thus minimizing long-term risk by the direct contact exposure pathway and reducing the potential for mobilization of residual chemical constituents. However, short-term risks of excavation, transport, and off-site disposal of the waste outweigh the long-term risk reduction considering that Alternative B-1 already provides a minimization of direct contact exposure pathways and reduces the potential for mobilization of residual chemical constituents.

6.3.4.1.2 Compliance with Cleanup Standards

All alternatives ensure contaminants from within the entirety of Zone B are managed with soil and ground water POCs and in compliance with MTCA site-specific goals as presented in the FFS Work Plan.

The current cap overlies waste that was excavated from areas abutting the former Zone B disposal cell. Closure sampling within those excavations demonstrated compliance with the Method B goals, and the cap has been extended well past the boundaries of the former disposal cell to conservatively encompass the footprint of contamination (see Figures 2.5.4-1a to 2.5.4-13).

6.3.4.1.3 Compliance with Applicable State and Federal Laws

Cleanup actions under MTCA must demonstrate compliance with applicable state and federal laws, including CERCLA requirements. For many laws and regulations, the cleanup action for the NPL Site must meet the substantive requirements. Other laws are applicable because they establish standards for the cleanup actions and are referred to as action-specific requirements. Applicable laws and regulations are presented in Tables 4.4-1 and 4.4-2 for substantive and action-specific requirements, respectively (Anchor QEA et al. 2013).

The alternatives incorporate commonly accepted technical practices of waste containment, POCs, remedial action, and institutional and engineering control to maintain long-term protectiveness of the waste disposal area. All activities will be conducted under approved project work plans to ensure project QC. The IWAG and Ecology will provide a public participation plan. The selected alternative will be documented in a CAP.

6.3.4.1.4 Provision for Compliance Monitoring

All alternatives involve monitoring of the containment infrastructure (either an on-site cap in Alternatives B-1, B-2, B-3, and B-4, or an off-site Subtitle C landfill in Alternative B-5) with a long-term operation, monitoring, and maintenance plan to ensure that infrastructure erosion, deformation, subsidence, intrusion, poor vegetation health, stormwater or drainage impediments, and other irregularities do not occur unabated.

All alternatives incorporate long-term monitoring of ground water within the vicinity of the waste containment.

6.3.4.1.5 Provide a Reasonable Restoration Time Frame

Alternative B-1 provides control and containment of the waste in a suitable environment in an immediate time frame, given that the on-site cap and ICs are already in place. Therefore, as cited in WAC 173-340-360(4), the following factors are satisfied:

- Potential risks posed by the NPL Site to human health and the environment are currently minimized by preventing contact with surface soil.
- There is no practicable way to achieve a shorter restoration time frame, as the remedy is currently in place.
- The current and potential future uses of the NPL Site (a closed landfill) will not be affected by the Zone B remedy.
- Ground water is not adversely affected by the Zone B remedy, as the sporadic and limited number of detected COCs in ground water are at concentrations significantly below dCULs.

- ICs will continue to be effective and reliable.
- Hazardous substances are controlled and the migration of the substances can be monitored.
- Natural processes are likely to either stabilize or reduce the concentrations of hazardous substances at the NPL Site, based on the nature of the COCs remaining beneath the existing cap.

Alternatives B-2, B-3, B-4, and B-5 involve intrusive work that may potentially compromise the waste containment system, thus, these alternatives would not rank as highly as Alternative B-1. Alternatives B-4 and B-5 take somewhat longer than the other alternatives to provide the control and containment of the waste because a significant construction project will be necessary to remove and replace the existing on-site cap. In addition, Alternative B-5 will involve excavation of the remaining waste, loading and transportation of the waste, and treatment or disposal of the waste at distant facilities, which increases transportation-related, short-term risks.

6.3.4.1.6 Consider Public Concerns

All remedial alternatives consider that NPL Site ground water downgradient of Zone B is not currently impacted above dCULs. Alternatives B-1, B-2, B-3, and B-4 consider that over the long-term the on-site cap will prevent overland, subsurface, and airborne migration of the waste. The drilling proposed in Alternatives B-2, B-3, and B-4 increase risk for contaminant migration below the cap. Alternatives B-4 and B-5 involve removal and reconstruction of the cap, with attendant potential dust generation and complicated stormwater control mechanisms needed during construction. Alternative B-5 would involve potential tracking of waste away from the former disposal cell, plus risk of highway releases of the waste due to sifting from trucks or from truck rollovers (although proper planning and implementation of best management practices and engineering controls could address, or allow for reasonable management of, most perceived risks related to waste transport). Based on these factors, the public is more likely to have an increased concern for Alternatives B-2 and B-3, and heightened concerns for Alternatives B-4 and B-5.

6.3.4.2 *Comparison of Zone B Alternatives*

In this section, the RAAs are compared to one another and given a relative ranking for each of the evaluation criteria presented in Section 6.2. A summary of this evaluation is presented in Table 6.3.4-2.

6.3.4.2.1 Protectiveness

All alternatives generally provide protectiveness and improve the overall environmental quality in that they reduce the long-term direct exposure risk. Alternatives B-1, B-2, B-3, and B-4 provide protectiveness faster than Alternative B-5. Alternative B-5 has relatively increased on- and off-site risks due to waste excavation, on-site handling, on- and off-site transport, and off-site handling. Alternatives B-2, B-3, and B-4 also involve investigative and (for B-3 and B-4) treatment requirements that may risk contaminant mobilization and thereby reduce effectiveness.

6.3.4.2.2 Permanence

All alternatives provide permanence, in that containment and control of the waste minimizes or eliminates waste mobility. The on-site releases of hazardous substance have been eliminated. The on-site material does not appear to have affected Zone B ground water, or if it has historically, then that affect has not been observed since 2001, and control of infiltration by the cap will ensure that over the long-term. Alternatives B-2, B-3, and B-4 rely on biodegradation or adsorption methods to contain or destroy waste, but performing the necessary field work to either document or institute these methods introduces risk that undermine the permanence or effectiveness of the existing containment approach. Alternative B-5 does not lead to waste destruction, but it does irreversibly remove the waste from Zone B. Therefore, Alternative B-5 scores higher on permanence.

6.3.4.2.3 Effectiveness Over the Long-term

Alternatives B-1 and B-5 provide the highest degrees of certainty of success, reliability over long periods, and long-term minimization of risk to on-and off-site receptors.
Alternatives B-2, B-3, and B-4 risk compromising the cap, provide channels for potential contaminant mobility below the cap, and potentially upset existing adsorptive capabilities of

residual chlorophenoxy phenol polymers that exist below the cap and help minimize the potential for contaminant mobility. Alternatives B-3 and B-4 introduce liquid below the cap, which may increase COC leaching and mobility.

6.3.4.2.4 Management of Short-term Risks

Alternatives B-2, B-3, and B-4 risk compromising the cap, provide channels for potential contaminant mobility below cap, and generate waste during drilling activities. Alternatives B-3 and B-4 introduce liquid below the cap, which may increase contaminant leaching and mobility or result in differential settling. Alternative B-4 leads to cap rebuilding, which will lead to a potential for increased human health and environmental exposures. Alternative B-5 has relatively increased on- and off-site, short-term exposure risks due to waste excavation, on-site handling, on- and off-site transport, and off-site handling. Alternative B-1 provides the lowest short-term risk, and the fastest implementation.

6.3.4.2.5 Technical and Administrative Implementability

All the alternatives are implementable. Alternatives B-2, B-3, and B-4 are less technically implementable than B-1 because the need for sample collection and reagent distribution below the existing cap is technically challenging, if not impracticable; will require a great deal of oversight and cost to implement; is difficult to monitor for effectiveness; and presents risks to the containment structure. Alternatives B-4 and B-5 require a comprehensive construction project, including removal and replacement of the existing containment and security infrastructure, and coordination of construction and transportation with NPL Site neighbors. Alternative B-5 requires coordination of treatment and disposal of large quantities of waste at long distances from Zone B.

6.3.4.2.6 Consideration of Public Concerns

All alternatives would address public concerns seeking secure long-term waste containment. Alternatives B-2, B-3, B-4, and B-5 may be perceived as less desirable due to the necessity of compromising the cap and generating additional waste. Alternative B-5 may be perceived as less desirable due to the perceived risks of long-distance over-the-road waste transportation, and the potential generation of contaminated dust during a large removal project; however, proper planning and implementation of best management practices and engineering controls could address, or allow for reasonable management of, most perceived risks related to waste transport.

6.3.4.3 Capital Cost, Long-term Cost, and Disproportionate Cost Analysis

The detailed cost estimates for Alternatives B-1 through B-5 are provided in Tables 5.5-1 and 5.5-2. As shown in Table 6.3.4-2 and Figure 6.3.4-1, the costs of the alternatives vary. Alternative B-1 has the lowest total capital and long-term O&M costs. The need for costly drilling techniques, and cap maintenance and repair due to the drilling compromising the cap largely drive the increases to the capital and long-term costs for Alternatives B-2, B-3, and B-4. Alternative B-5 involves a large capital cost for controlled excavation; expensive waste transport, treatment, and disposal requirements; and NPL Site restoration.

Based upon a ratio of total costs versus perceived overall benefit score, Alternative B-1 clearly achieves the best benefit-to-cost-ratio, and Alternatives B-2, B-3, B-4, and B-5 each are disproportionately costly and add risk.

6.3.4.4 Preferred Zone B Alternative

On the basis of the examination of the alternatives and DCA, Alternative B-1 is the preferred alternative. Alternative B-1 consists of monitoring and maintaining the RCRA-compliant cap, continued ground water performance monitoring, and operation of ICs. This alternative meets all RAOs.

Monitoring and maintenance of the RCRA-compliant cap constructed during May and June 2013 would continue in perpetuity or until confirmatory sampling beneath a cover system indicates that soil contamination is below regulatory thresholds. For cost estimating purposes, a period of 30 years has been considered, using methods described in the *Revised Final Cap Monitoring and Maintenance Plan for the Pasco Landfill Zone B Cap* (AMEC 2013). Performance monitoring of ground water quality and CUL attainment confirmation at the designated POC would continue.

Alternative B-1 will continue use of appropriate ICs, including access restrictions with fencing and warning signs, and maintenance of property deed restrictions that ban residential construction, control excavation, and restrict ground water use.

Implementation of the components of Alternative B-1 has been underway since RCRA cap completion in summer 2013, including quarterly inspections, quarterly ground water monitoring, and maintenance of the cap vegetative cover.

Due to the predominantly static nature of this landfill cap, and the lack of any need for a leachate collection system, which is typical of many caps, the maintenance issues are relatively confined to the following natural and anthropogenic origins:

- Wind/rain erosion
- Vegetation degradation
- Burrowing
- Material
- Earthquake
- Vandalism
- Road wear

The prescribed monitoring and maintenance program will result in minimization of risk to the cap and includes quarterly monitoring of the cap surface, the erosion protection rock, the drainage system, and the fence and gates. Surface elevation surveys can be performed, if needed, to check the shape and elevation of the cap components when the regularly scheduled inspections detect a potential change.

Monitoring and maintenance reports summarizing the NPL Site activities are submitted to Ecology annually (scheduled for late September each year). These reports will include copies of completed monitoring reports, the photographic log, a brief summary of the condition of the cap components, and a description of any repairs performed.

6.3.5 Zones C/D

6.3.5.1 Comparison to Model Toxics Control Act Requirements

Table 6.3.5-1 summarizes the evaluation of the Threshold, Other, and Additional Requirements under MTCA for the remedial alternatives in Zones C/D.

6.3.5.1.1 Comparison to Threshold Requirements

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Protection of human health and the environment is achieved by each of the remedial alternatives in Zones C/D through various combinations of engineered controls (waste removal, containment, performance monitoring of the RCRA cap, ground water compliance monitoring, and natural attenuation), and ICs. The existing Zones C/D RCRA cap has performed its intended function since 2002 and will continue to minimize the risk of direct contact to human or ecological receptors with wastes contained in the zones to date, prevent leaching of contaminants to ground water due to precipitation, and thereby reduce the potential for mobilization of residual contaminants.

COMPLIANCE WITH CLEANUP STANDARDS

Current ground water conditions at Zones C/D already comply with cleanup standards because ground water compliance monitoring conducted outside and downgradient of the existing cap (at MW-55S) indicate that COCs (total chromium and VOCs) have been either undetected or have not exceeded the 2014 dCULs.

COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS

Assuming compliance with appropriate project permitting requirements, the remedial alternatives in Zones C/D are expected to comply with applicable state and federal laws identified in Section 4.4. These alternatives incorporate commonly accepted remediation approaches of waste containment, treatment, removal, and ICs to maintain long-term protectiveness. ICs will be addressed as part of the CAP and project implementation measures. All cleanup action components will be conducted under approved project work plans to ensure project QC.

PROVISION FOR COMPLIANCE MONITORING

Although a ground water CMP will be developed after the CAP is finalized, all the remedial alternatives in Zones C/D have a provision for ground water compliance monitoring, as described in Section 5.1.2. For Alternative CD-3, which involves waste removal, compliance monitoring would remain in effect for 10 years. For alternatives that rely primarily on containment, in situ treatment, and/or natural attenuation (Alternatives CD-1 and CD-2), ground water monitoring would continue for a 15-year period. Additional cap evaluation, monitoring, maintenance, and inspection are contemplated as part of the scope of Alternatives CD-1 through CD-3.

Therefore, all remedial alternatives in Zones C/D meet the MTCA threshold requirements.

6.3.5.1.2 Comparison to Other Requirements

PROVISION OF PERMANENT SOLUTION TO MAXIMUM EXTENT PRACTICABLE

To determine whether the remedial alternatives in Zones C/D use permanent solutions to the maximum extent practicable, costs and benefits of each are balanced using a DCA with the evaluation of the six criteria described in Section 6.2.1. The DCA for this zone is discussed in Section 6.3.5.2.

PROVISION OF REASONABLE RESTORATION TIME FRAME

Since all of the remedial alternatives in Zones C/D already comply with cleanup standards, they provide for reasonable restoration time frames. While Alternatives CD-1 and CD-2 would require ground water compliance monitoring for an estimated period of 15 years, Alternative CD-3 is estimated to be implemented within a year of active remedial measures, in addition to ground water compliance monitoring for a period of 10 years.

Therefore, all remedial alternatives in Zones C/D provide for reasonable restoration time frames and satisfy the following factors, as cited in WAC 173-340-360(4)(b):

- Potential risks posed by Zones C/D to human health and the environment are currently successfully prevented with Alternative CD-1. Alternatives CD-2 and CD-3 further minimize the risk beyond MTCA's threshold for protection of human health and the environment with more aggressive engineered controls.

- The restoration time frame is already achieved by all Zones C/D alternatives because dCULs have been met outside of the Zones C/D cap at the POC.
- The current and potential future uses of the NPL Site (a closed, permanent landfill site) will not be significantly affected by any of the Zones C/D remedial alternatives.
- Ground water quality conditions already comply with draft cleanup standards outside of the Zones C/D cap (Alternative CD-1), will continue to comply, and will not be adversely affected by any of the Zones C/D remedial alternatives.
- ICs will likely continue to be effective and reliable, and applicable to all Zones C/D remedial alternatives.
- Hazardous substances are currently and successfully controlled by Alternative CD-1 and the migration of COCs can be monitored and mitigated by any of the Zones C/D remedial alternatives.
- Natural processes are likely to either stabilize or continue reducing concentrations of hazardous substances at Zones C/D with any of the Zones C/D remedial alternatives.

CONSIDERATION OF PUBLIC CONCERNS

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process and Ecology will incorporate public input on the remedial alternatives presented in this document so that a proposed cleanup remedy can be selected as part of the forthcoming draft CAP.

6.3.5.1.3 Comparison to Additional Requirements

Because ground water monitoring to date shows compliance with cleanup standards outside of the existing Zones C/D cap, none of the remedial alternatives in Zones C/D will require more than performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC. Therefore, these alternatives do not require permanent ground water cleanup actions.

Each of the remedial alternatives in Zones C/D rely on various combinations of engineered controls (containment, in situ treatment, removal, ground water performance, or compliance monitoring). ICs are not the primary remedial action for Zones C/D, but rather are used to ensure that the integrity of the cap and cover system are maintained.

Present and future releases and migration of hazardous substances in the environment will be prevented and minimized by all remedial alternatives in Zones C/D. Current and future agricultural uses of ground water are unlikely to be impacted by a release.

None of the remedial alternatives for Zones C/D rely primarily on dilution and/or dispersion.

6.3.5.2 Model Toxics Control Act Disproportionate Control Analysis

Table 6.3.5-2 presents a summary of the MTCA DCA evaluation criteria for each of the remedial alternatives in Zones C/D with the individual and overall environmental benefit scores, total costs (as net present value), and the resulting benefit-to-cost ratios.

As described in Section 6.2.2, DCA criteria were evaluated and ranked at the sub-criterion level and summarized in Tables 6.3.5-3a through 6.3.5-3e with associated individual sub-criterion rankings. The range in rankings at the sub-criterion level was based on the total number of alternatives in Zones C/D (i.e., 1 to 3, based on three Zones C/D alternatives carried forward into the DCA). In general, the lowest ranking (1) represented a relatively poor-performing alternative for that sub-criterion compared to other alternatives, and the highest ranking (3) represented the best performing alternative for that sub-criterion relative to other alternatives.

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process, and Ecology will incorporate public input on the remedial alternatives presented in this document. At the request of Ecology, a uniform ranking was applied to the criterion of "Consideration of Public Concerns" to give equal importance regarding public concerns to all the considered alternatives (until public comments/input are actually received). The uniform ranking for "Consideration of Public Concerns" criterion was represented as the median value of the ranking range (e.g., in the Zones C/D DCA evaluation, the median value between 1 and 3 is 2; thus, a ranking of 2 was assigned to all three Zones C/D alternatives).

6.3.5.2.1 Relationship Between Benefits and Costs

Figure 6.3.5-1 depicts a graphic summary of the DCA and compares overall environmental benefits and total costs of each remedial alternative to Alternative CD-3, which represents the most practicable permanent remedial alternative, because it consists of the full removal of waste and impacted soils and off-site disposal and thus has the least remaining residual contamination on site. Consistent with MTCA requirements, Alternative CD-3 serves as the baseline against which the relationship between incremental remedy benefits and incremental costs are evaluated.

Overall, environmental benefits resulted in an equal score of 12 for the three Zones C/D alternatives. All three alternatives offer a high degree of protection and long-term effectiveness. Alternatives CD-2 and CD-3 also have similarly high degrees of permanence based on treatment or removal and off-site disposal of waste materials. However, Alternative CD-3 has the highest corresponding cost of $7.2 million without a corresponding increase in benefit. Incremental costs associated with Alternative CD-3 are considered disproportionate for the small to almost no increase in environmental benefits over Alternatives CD-1 and CD-2; this is consistent with the WAC 173-340-360(3)(e)(i)) definition of disproportionality. This is also reflected in the lowest benefit-to-cost ratio (defined as the overall environmental benefit score per each million dollars) among all the remedial alternatives (ratio for Alternative CD-3 is 1.7).

Given that Alternatives CD-1 and CD-2 are equivalent in the overall environmental benefit score because the two remedial alternatives have common engineered controls in their scope, MTCA specifies that the less costly remedial alternative should be selected (WAC 173-340-360(e)(ii)(c)). Because the in situ chemical amendment of contaminated soil is included in the scope of Alternative CD-2 only as a contingent remedy (to be implemented to address potential future impacted ground water from COC releases), the incremental costs for the contingency do not provide any discernible environmental benefits in the short-term. The benefit-to-cost ratio for Alternative CD-2 is 7.7, which is much lower compared to the one for Alternative CD-1, which results in a ratio of 16.9.

Therefore, Alternative CD-1 provides a high overall environmental benefit (score of 12), is cost-effective (with the lowest cost of $0.7 million and the highest benefit-to-cost ratio of

16.9 of all Zones C/D alternatives), and meets the MTCA threshold requirements and the definition of permanent to the maximum extent practicable, per WAC 173-340-360(3)(e).

Based on the MTCA DCA, Alternative CD-1 is identified as the preferred remedial alternative for Zones C/D.

6.3.6 Zone E

6.3.6.1 Comparison to Model Toxics Control Act Requirements

Table 6.3.6-1 summarizes the evaluation of the Threshold, Other, and Additional Requirements under MTCA for the remedial alternatives in Zone E.

6.3.6.1.1 Comparison to Threshold Requirements

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Protection of human health and the environment is achieved by each of the remedial alternatives in Zone E through various combinations of engineered controls (waste removal, containment, performance monitoring of the RCRA cap, ground water compliance monitoring, and natural attenuation), and ICs. The existing Zone E RCRA cap has performed its intended function since 2002 and will continue to minimize the risk of direct contact to human or ecological receptors with wastes contained in Zone E. The Zone E cap also prevents infiltration of precipitation and associated leaching of contaminants to ground water, and thereby reduces the potential for mobilization of residual contaminants.

COMPLIANCE WITH CLEANUP STANDARDS

All remedial alternatives developed for Zone E already comply with cleanup standards. As shown by ground water compliance monitoring conducted outside and downgradient of the existing cap in the vicinity of Zone E (at MW-27SR), COCs (total chromium and VOCs) have been either undetected or have not exceeded the 2014 dCULs.

COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS

Assuming compliance with appropriate project permitting requirements, the remedial alternatives developed for Zone E are expected to comply with applicable state and federal laws identified in Section 4.4. These alternatives incorporate commonly accepted remediation approaches of waste containment, treatment, removal, and ICs to maintain long-term protectiveness. ICs will be addressed as part of the CAP and project implementation measures. All cleanup action components will be conducted under approved project work plans to ensure project QC.

PROVISION FOR COMPLIANCE MONITORING

Although a ground water CMP will be developed after the CAP is finalized, all the remedial alternatives in Zone E have a provision for ground water compliance monitoring, as described in Section 5.1.2. For Alternative E-3, which involves waste removal, compliance monitoring would remain in effect for 10 years. For alternatives that rely primarily on containment, ex situ stabilization, and/or natural attenuation (Alternatives E-1 and E-2), ground water monitoring would continue for a 15-year period. Additional cap evaluation, monitoring, maintenance, and inspection are contemplated as part of the scope of Alternatives E-1 through E-3.

Therefore, all Zone E remedial alternatives meet the MTCA threshold requirements.

6.3.6.1.2 Comparison to Other Requirements

PROVISION OF PERMANENT SOLUTION TO MAXIMUM EXTENT PRACTICABLE

To determine whether the remedial alternatives for Zone E use permanent solutions to the maximum extent practicable, costs and benefits of each are balanced using a DCA with the evaluation of six criteria described in Section 6.2.1. The DCA for this zone is described in Section 6.3.6.2.

PROVISION OF REASONABLE RESTORATION TIME FRAME

Since all of the remedial alternatives in Zone E already comply with cleanup standards, they provide for reasonable restoration time frames. While Alternatives E-1 and E-2 would require ground water compliance monitoring for an estimated period of 15 years, Alternative E-3 is estimated to be implemented within a year of active remedial measures, in addition to ground water compliance monitoring for a period of 10 years.

Therefore, all remedial alternatives in Zone E provide for reasonable restoration time frames and satisfy the following factors, as cited in WAC 173-340-360(4)(b):

- Potential risks posed by Zone E to human health and the environment are currently successfully prevented with Alternative E-1. Alternatives E-2 and E-3 further minimize the risk beyond MTCA's threshold for protection of human health and the environment with more aggressive engineered controls.
- The restoration time frame is already achieved by all Zone E alternatives because dCULs have been met outside of the Zones C/D cap at the POC.
- The current and potential future uses of the NPL Site (a closed, permanent landfill site) will not be significantly affected by any of the Zone E remedial alternatives.
- Ground water quality conditions already comply with draft cleanup standards outside of the Zone E cap (Alternative E-1), will continue to comply and will not be adversely affected by any of the Zone E remedial alternatives.
- ICs will likely continue to be effective and reliable, and applicable to all Zone E remedial alternatives.
- Hazardous substances are currently and successfully controlled by Alternative E-1 and the migration of COCs can be monitored and mitigated by any of the Zone E remedial alternatives.
- Natural processes are likely to either stabilize or continue reducing concentrations of hazardous substances at Zone E with any of the Zone E remedial alternatives.

CONSIDERATION OF PUBLIC CONCERNS

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process, and Ecology will incorporate public input on the remedial alternatives presented in this document so that a proposed cleanup remedy can be selected as part of the forthcoming draft CAP.

6.3.6.1.3 Comparison to Additional Requirements

Since ground water monitoring to date shows compliance with cleanup standards outside of the existing Zone E cap, none of the remedial alternatives in Zone E will require more than performance sampling of ground water quality and confirmation of continued attainment of

CULs at the designated POC. Therefore, these alternatives do not require permanent ground water cleanup actions.

Each of the remedial alternatives in Zone E rely on various combinations of engineered controls (containment, ex situ stabilization, removal, ground water performance, or compliance monitoring). ICs are not the primary remedial action for Zone E, but rather are used to ensure that the integrity of the cap and cover system are maintained.

Present and future releases and migration of hazardous substances in the environment will be prevented and minimized by all remedial alternatives in Zone E. Current and future agricultural uses of ground water are unlikely to be impacted by a release.

None of the remedial alternatives for Zone E rely primarily on dilution and/or dispersion.

6.3.6.2 Model Toxics Control Act Disproportionate Cost Analysis

Table 6.3.6-2 presents a summary of the MTCA DCA evaluation criteria for each of the remedial alternatives in Zone E with the individual and overall environmental benefit scores, total costs (on a net present value basis), and the resulting benefit-to-cost ratios.

As described in Section 6.2.2, DCA criteria were evaluated and ranked at the sub-criterion level and summarized in Tables 6.3.6-3a through 6.3.6-3e with associated individual sub-criterion rankings. The range in rankings at the sub-criterion level was based on the total number of alternatives in Zone E (i.e., 1 to 3, based on three Zone E alternatives carried forward into the DCA). In general, the lowest ranking (1) represented a relatively poor-performing alternative for that sub-criterion compared to other alternatives, and the highest ranking (3) represented the best performing alternative for that sub-criterion compared to other alternatives.

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process, and Ecology will incorporate public input on the remedial alternatives presented in this document. At the request of Ecology, a uniform ranking was applied to the criterion of "Consideration of Public Concerns" to give equal importance regarding public concerns to all the considered alternatives (until public comments/input are actually received). The uniform ranking for "Consideration of Public Concerns" criterion was represented as the median value of the ranking range (e.g., in the Zone E DCA evaluation, the median value between 1 and 3 is 2, thus, a ranking of 2 was assigned to all three Zone E alternatives).

6.3.6.2.1 Relationship Between Benefits and Costs

Figure 6.3.6-1 depicts a graphic summary of the DCA and compares overall environmental benefits and total costs of each remedial alternative to Alternative E-3, which represents the most practicable permanent remedial alternative, because it consists of the full removal of waste and impacted soils and off-site disposal, and thus has the least remaining residual contamination on site. Consistent with MTCA requirements, Alternative E-3 serves as the baseline against which the relationship between incremental remedy benefits and incremental costs are evaluated.

Overall, environmental benefits resulted in an equal score of 12 for the three Zone E alternatives. All three alternatives offer a high degree of protection and long-term effectiveness. Alternatives E-2 and E-3 also have similarly high degrees of permanence based on treatment or removal and off-site disposal of waste materials. However, Alternative E-3 has the highest corresponding cost of $20.1 million without a corresponding increase in benefit. Incremental costs associated with Alternative E-3 are considered disproportionate for the small to almost no increase in environmental benefits over Alternatives E-1 and E-2; this is consistent with the WAC 173-340(3)(e)(i) definition of disproportionality. This is also reflected in the lowest benefit-to-cost ratio (defined as the overall environmental benefit score per each million dollars) among all the remedial alternatives (ratio for Alternative E-3 is 0.6).

Given that Alternatives E-1 and E-2 are equivalent in in the overall environmental benefit score because the two remedial alternatives have common engineered controls in their scope, MTCA specifies that the less costly remedial alternative should be selected (WAC 173-340-360(e)(ii)(c)). Because the ex situ stabilization of contaminated soil is included in the scope of Alternative E-2 only as a contingent remedy (to be implemented to address potential future impacted ground water from COC releases), the incremental costs for the contingency do not provide any discernible environmental benefits in the short-term. The benefit-to-cost ratio for Alternative E-2 is 5.4, which is much lower compared to Alternative E-1, which results in a ratio of 14.2.

Therefore, Alternative E-1 provides a high overall environmental benefit (score of 12), is cost-effective (with the lowest cost of $0.8 million and the highest benefit-to-cost ratio of 14.2 of all Zone E alternatives), and meets the MTCA threshold requirements and the definition of permanent to the maximum extent practicable, per WAC 173-340-360(3)(e).

Based on the MTCA DCA, Alternative E-1 is identified as the preferred remedial alternative for Zone E.

6.3.7 On-property Ground Water (Central Area)

6.3.7.1 Comparison to Model Toxics Control Act Requirements

Table 6.3.7-1 summarizes the evaluation of the Threshold, Other, and Additional Requirements under MTCA for the remedial alternative for on-property ground water in the Central Area (on-property ground water outside of the Central Area is addressed as part of the remedial alternatives for each NPL Site area, where applicable).

6.3.7.1.1 Comparison to Threshold Requirements

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Protection of human health and the environment is achieved by Alternative ONP-1 in the Central Area through a contingent remedy consisting of focused SVE treatment.

COMPLIANCE WITH CLEANUP STANDARDS

Current ground water conditions in the Central Area already comply with cleanup standards, as shown by on-property ground water compliance monitoring. Recent ground water monitoring data in the Central Area indicate that COCs (total chromium and VOCs) have been either undetected or have not exceeded the 2014 dCULs.

A ground water CMP will be developed after the CAP is finalized and is already part of the scope of remedial alternatives for the MSW Landfill and Zones A, B, C/D, and E, which have provisions for ground water compliance monitoring, as described in Section 5.1.2. Ground water monitoring would continue for an estimated 15-year period for Alternative ONP-1.

Therefore, Alternative ONP-1 in the Central Area meets the MTCA threshold requirements.

6.3.7.1.2 Comparison to Other Requirements

PROVISION OF PERMANENT SOLUTION TO MAXIMUM EXTENT PRACTICABLE

Since no other remedial alternatives were retained for consideration in the Central Area in this Draft Final FFS, Alternative ONP-1 is considered a permanent solution to the maximum extent practicable.

PROVISION OF REASONABLE RESTORATION TIME FRAME

Because Central Area ground water already complies with cleanup standards, Alternative ONP-1 provides for a reasonable restoration time frame.

Alternative ONP-1 in the Central Area satisfies the following factors, as cited in WAC 173-340-360(4)(b):

- Potential risks posed by the Central Area to human health and the environment are currently successfully prevented with Alternative ONP-1.
- The practicability of achieving a shorter restoration time frame is fulfilled with Alternative ONP-1 and its potential contingent action.
- The current and potential future uses of the NPL Site (a closed, permanent landfill site) will not be significantly affected by Alternative ONP-1.
- Ground water quality conditions already comply and will continue to comply with draft cleanup standards in the Central Area.
- Natural processes are likely to either stabilize or continue reducing concentrations of hazardous substances in the Central Area with Alternative ONP-1.

CONSIDERATION OF PUBLIC CONCERNS

The Draft Final FFS will undergo public review as a critically important step to the overall FFS process, and Ecology will incorporate public input on the remedial alternatives presented in this document so that a proposed cleanup remedy can be selected as part of the forthcoming draft CAP.

6.3.7.1.3 Comparison to Additional Requirements

Because ground water monitoring to date shows compliance with cleanup standards in the Central Area, Alternative ONP-1 will require performance sampling of ground water quality and confirmation of continued attainment of CULs at the designated POC. Therefore, this alternative does not require permanent ground water cleanup actions.

ICs are not the primary remedial action and are not included in Alternative ONP-1 in the Central Area.

Present and future releases and migration of hazardous substances in the environment will be prevented and minimized by Alternative ONP-1 in the Central Area. Current and future agricultural uses of ground water are unlikely to be impacted by a release.

Alternative ONP-1 does not rely primarily on dilution and/or dispersion.

6.3.7.2 Preferred Alternative in Central Area

Alternative ONP-1 meets the MTCA minimum requirements and, therefore, it is identified as the preferred remedial alternative for on-property ground water in the Central Area.

7 SUMMARY OF PREFERRED ALTERNATIVES

The site-wide preferred alternative is the combination of the preferred remedial alternatives for each of the individual areas and zones of the NPL Site as summarized in Table 7-1. All preferred alternatives are consistent with MTCA requirements and expectations for remedial actions because they are protective of human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, provide for compliance monitoring, use permanent solutions to the extent practicable, provide for reasonable restoration time frames, and consider public concerns.

The site-wide preferred alternative recognizes that the PSLI Property was an active landfill from 1953 to 1993, and it will remain a closed landfill permanently. The assumption that the PSLI Property will remain a landfill permanently is embedded in the preferred alternative of each NPL Site area.

7.1 Municipal Solid Waste Areas

The preferred alternative for each of the MSW areas includes leaving the existing wastes in place. Of the MSW areas, only one remedial alternative was developed for each of the Balefill and Inert Waste Disposal areas. In both cases, the remedial alternative provides for ICs and rehabilitating the existing soil cover over the wastes, which would remain in place in perpetuity.

For the MSW Landfill and the Burn Trenches, multiple remedial alternatives were developed in Section 5, but none of those alternatives included removal of these waste zones.

The primary remedial action in the preferred alternatives for MSW areas is cover using either an evapotranspiration soil cover for the Balefill and Inert Waste Disposal areas and Burn Trenches or a RCRA-type cover at the MSW Landfill. The only active engineering control for the MSW areas is the GCCS at the MSW Landfill. Active engineering controls are not specified for other areas because COC concentrations in ground water are below dCULs and cover systems alone are adequate for protection of ground water.

7.2 Industrial Waste Area Zones B, C/D and E

The preferred alternatives for IWA Zones B, C/D, and E includes long-term monitoring and leaving existing wastes in place. Removal alternatives were considered for each of these areas, but rejected in the DCA (Section 6) due to the high cost and little incremental environmental benefit compared to non-removal alternatives.

Each of these IWAs primarily relies on RCRA-type cap systems to be protective of ground water. Active engineering controls are not specified for these areas because COC concentrations in ground water are below dCULs and cover systems alone are adequate for continued protection of ground water.

7.3 Industrial Waste Area Zone A

As for all other waste zones, the preferred alternative for Zone A includes leaving existing wastes capped and in place. Several excavation alternatives were considered and most of these would also leave the majority of Zone A wastes on site. Excavation alternatives were not selected in the DCA due to the high cost and little incremental environmental benefit compared to non-excavation alternatives.

Similar to the MSW Landfill, the preferred alternative for Zone A includes an active engineering control in addition to a RCRA-type cap system. Where the preferred alternative for the MSW Landfill relies on the GCCS to control contaminant migration, the preferred Zone A alternative includes the operation of an SVE system to control migration of COCs to ground water. The SVE system was designed with the objectives of protecting ground water quality and, secondarily, removing and destroying the contaminant mass in Zone A. The SVE system has achieved both objectives as demonstrated by water quality improvement and the high level of mass removal and destruction before and since the upgraded SVE system was started in 2012. The proposed enhancements in the preferred remedy will add additional extraction wells to further protect ground water and remove/destroy additional contaminant mass.

Proper and effective operation of the SVE system is protective of downgradient ground water quality and, within a reasonable time frame, will remove/destroy sufficient COC mass such that the SVE system can be shut down without risk of rebound (see Appendix J).

The key to effective SVE operation is implementing strategies that calibrate and optimize the operation of the system and account for the environmental conditions present in Zone A. The strategies will rely on the extensive monitoring system within Zone A and the SVE/RTO system. The current monitoring system components include the following:

- Forty-seven subsurface thermocouples to monitor temperatures within the zone
- Forty-seven soil vapor monitoring points co-located with the thermocouples
- Flow meters and vacuum sensors on each SVE well
- Thermocouples on each SVE well to monitor vapor temperature
- LEL meters on the SVE system
- Thermocouples in the RTO to monitor temperatures within the unit
- VOC sampling at each SVE well and at the combined flow to the RTO

This monitoring system, which may be modified if operational conditions warrant, constitutes a robust and effective tool and process for managing and adjusting as necessary the removal and destruction of contaminant mass based on measured conditions within Zone A. The following sections present strategies for controlled SVE operation using the existing monitoring system.

7.3.1 Flow Rate and Mass Removal Rates as a Condition of the RTO Permit

As presented in Section 2.5.3, mass removal increased substantially with operation of the SVE upgrade system with more mass removed from 2012 through 2014 than in the previous 15 years combined. The greatest constraints on the system at that time were the flow rate and benzene limitations of the MSW flare, which was used to treat the SVE effluent.

The new RTO was designed to handle approximately four times the flare-limited flow rate at very high mass loadings. Consequently, the SVE/RTO system is capable of removing and treating a greater mass removal rate than before on the NPL Site and, as such, is no longer limited in that regard.

As with any properly designed system, the SVE/RTO system design takes into account typical operating constraints. Some of these constraints, such as the ability to destroy a variety of contaminants and the amount of HCl generated and emitted into the atmosphere, are addressed in terms of the air quality emissions rates in the RTO Approval Order.

For example, the HCl emission requirement in the RTO Approval Order is due to the SVE/RTO system being specified as a Synthetic Minor Source, which restricts HCl emissions to 10 tons per year. Installation of an HCl scrubber to reduce HCl emissions or application for a Title V permit that provides for higher HCl emissions rates would allow the SVE/RTO system to operate at approximately four times the mass removal capacity under the current RTO Approval Order. At this time, there is no consideration of the system as other than a Synthetic Minor Source.

7.3.2 SVE Well Vapor Temperature

Due to concerns about potential combustion of wastes in Zone A, Ecology has to-date stipulated that SVE wells with vapor temperature above 140°F cannot be operated. However, landfill gas extraction wells can be run safely at HOV. EPA has a demonstration program to allow use of HOV. Appendix L (SVE Performance Evaluation) cites EPA's 1996 NSPS for MSW Landfills, which addresses the issue of elevated extracted gas temperatures (see 40 CFR Part 60, Subpart WWW). EPA allows for an HOV demonstration to be performed at a landfill location specifically to ensure combustion will not result from operation. When demonstrated accordingly to its protocols, EPA indicates that operations at higher temperatures can be safe. It should be noted that since 1996, EPA has approved hundreds of HOV demonstration projects through state air agencies or local air districts, with vapor temperatures approved up to 200°F. As such, HOV may be considered for the Zone A vapor extraction wells to allow operation at vapor temperatures greater than 140°F.

7.3.3 Potential Subsurface Combustion Associated with Temperature and Gas Composition

Potential subsurface combustion concerns at Zone A in 2012 and again in 2016, due to several other measured parameters, have also been considered. In 2012, the IWAG conducted a heating evaluation at Zone A to address questions about vapor temperatures at

VEW-06I and elevated carbon monoxide concentrations at VEW-07I (see Appendix K; Anchor QEA et al. 2012). Multiple lines of evidence including various field parameters (i.e., temperature, carbon monoxide, carbon dioxide, oxygen, and methane) were collected over a 4-week period, and a number of geochemical indicators were also analyzed in extracted gases to distinguish between potential combustion-related heat and heat generated by normal biodegradation of organic wastes that are present in Zone A. Vapor temperatures typically ranged from 120°F to 125°F in VEW-06I, 85°F to 97°F in VEW-07I, and 95°F to 100°F in VMW-51I. The temperature and carbon monoxide results were not consistent with combustion as a cause because all three wells had temperatures well below 140°F, and the well with the highest temperatures had relatively low carbon monoxide concentrations. This evaluation concluded that there was "…no evidence that the elevated subsurface temperature and elevated carbon monoxide concentrations are due to combustion processes. In addition, the geochemical data indicate that the heating can be attributed to biochemical reactions in the vicinity of Zone A…" (see Appendix K; Anchor QEA et al. 2012).

Similar questions were raised about Zone A in 2016. In response, the IWAG conducted a comprehensive study of subsurface (in situ) conditions in Zone A in early 2017 (see Section 1.4). The findings of this study are presented in Appendix M. The thermocouples and gas monitoring points installed as part of this study are now part of the overall SVE monitoring system described above.

Seven lines of evidence, including the data generated in the 2012 study (Appendix K) and 2017 study (Appendix M), were used to evaluate the potential for subsurface combustion. The evaluation concluded through the multiple lines of evidence process that subsurface combustion has not occurred since startup of the upgraded SVE system, is not presently occurring within Zone A, and is highly unlikely to occur in the future (see Appendix M; GSI Environmental, Inc.).

The current thermocouple and gas monitoring network provides a comprehensive and responsive means of monitoring subsurface conditions within Zone A during operation of the SVE system.

7.3.4 SVE/RTO Enhancements

The preferred alternative for Zone A includes enhancements to improve mass removal and protection of ground water, if it is deemed necessary to do so based on monitored data. The two enhancements for Alternative A-2 to be considered are a Title V permit to address HCl emissions (should they be found to be a significant limitation) and installation of additional SVE wells to further mass removal; both of these are included in the cost estimate of the preferred alternative.

7.4 Summary and Conclusions

All preferred remedial alternatives for all waste zones specify that the wastes remain as is, under proper cover and with engineering controls to remove methane and/or VOCs from the subsurface, as applicable. This recognizes that the PSLI Property was and forever will be designated a landfill and require ICs in perpetuity.

Both the GCCS and the SVE system at the MSW Landfill and Zone A have demonstrated their effectiveness and that proper operation of each system can achieve protection of ground water at the proposed conditional POC at the edge of waste.

Any operational limitation with the SVE/RTO system can be effectively addressed as discussed above in Section 7.3. These may include additional SVE wells strategically located based on subsurface temperature and vapor concentration data, demonstration of HOV to operate wells above 140°F, and/or addressing HCl emissions limits through a Title V permit or installation of an HCl scrubber.

Overall, however, the combination of preferred alternatives among all waste areas of the NPL Site will achieve site-wide protection of ground water and of human health and the environment.

8 NEXT STEPS

A final cleanup action for the NPL Site will be selected by Ecology and documented in a CAP in accordance with the MTCA remedy selection criteria and ARARs after involving and taking into consideration comments from the community. It is anticipated the final CAP will describe the selected cleanup actions and will include an implementation schedule, a CMP, and financial assurance requirements. In addition, the State Environmental Policy Act (SEPA) requires the "lead agency" to conduct a review of any proposal that involves government "action" (WAC 197-11-704), using the Environmental Checklist under WAC 197-11-315, in order to assist in making threshold determinations and consider any environmental impacts.

Following issuance of the final CAP, there are many steps prior to implementation of the selected remedy as well as periodic reviews after its implementation to ensure that the final action is continuing to protect human health and the environment. The major tasks following the finalization of the CAP document are described in detail subsequently.

8.1 Cleanup Action Plan

Per WAC 173-340-380, Ecology will issue a draft CAP for a cleanup action. The draft CAP should include the following:

- A general description of the proposed cleanup action developed in accordance with WAC 173-340-350 through 173-340-390
- A summary of the rationale for selecting the proposed alternative
- A brief summary of other cleanup action alternatives evaluated in the RI/FS
- Cleanup standards and, where applicable, remediation levels, for each hazardous substance and for each medium of concern at the NPL Site
- The schedule for implementation of the CAP (including the restoration time frame)
- ICs required as part of the proposed cleanup action
- Applicable state and federal laws for the proposed cleanup action
- A preliminary determination by Ecology that the proposed cleanup action will comply with WAC 173-340-360

- Where the cleanup action involves on-site containment, specification of the types, levels, and amounts of hazardous substances remaining on site and the measures that will be used to prevent migration and contact with those substances

After public review and consideration of the comments received during the public comment period, Ecology will issue a final CAP and publish notice of its availability in the *Site Register*.

8.1.1 Financial Assurance

Financial assurance mechanisms are required by Ecology where a cleanup action selected includes engineered controls and/or ICs, unless the PLPs can demonstrate that sufficient financial resources are available and in place to provide for the long-term effectiveness of engineered controls and ICs adopted. Financial assurances should be of sufficient amount to cover all costs associated with the operation and maintenance of the cleanup action, including ICs, compliance monitoring, and corrective measures.

Financial assurance mechanisms may include one or more of the following: a trust fund, a surety bond, a letter of credit, financial test, guarantee, standby trust fund, government bond rating test, government financial test, government guarantee, or government fund.

8.1.2 Engineering Design Report

The EDR documents the engineering concepts and design criteria used for design of the cleanup action and includes sufficiently detailed information for the development and review of construction plans and specifications (WAC 173-340-400). The following information should be included in the EDR:

- Goals of the cleanup action including specific cleanup or performance requirements
- General information on the NPL Site, including a summary of the RI/FS updated as necessary to reflect the current conditions
- Identification of the parties who will own, operate, and maintain the cleanup action during and following construction
- Facility maps showing existing NPL Site conditions and the proposed location of the cleanup action

- Characteristics, quantity, and location of materials to be treated or otherwise managed, including ground water containing hazardous substances
- A schedule for final design and construction
- A description and conceptual plan of the actions, treatment units, facilities, and processes required to implement the cleanup action, including flow diagrams
- Engineering justification for design and operation parameters, including:
  - Design criteria, assumptions, and calculations for all components of the cleanup action
  - Expected treatment, destruction, immobilization, or containment efficiencies and documentation on how that degree of effectiveness is determined
  - Demonstration that the cleanup action will achieve compliance with cleanup requirements by citing pilot or treatability test data, results from similar operations, or scientific evidence from the literature
- Design features for control of hazardous materials spills and accidental discharges
- Design features to assure long-term safety of workers and local residences
- A discussion of methods for management or disposal of any treatment residuals or other waste materials containing hazardous substances generated as a result of the cleanup action
- A general description of construction testing that will be used to demonstrate adequate QC
- A general description of compliance monitoring that will be performed during and after construction to meet the requirements of WAC 173-340-410
- A general description of construction procedures proposed to assure that the safety and health requirements of WAC 173-340-810 are met
- Any information not provided in the RI/FS needed to fulfill the applicable requirements of SEPA (Revised Code of Washington Chapter 43.21C)
- Any additional information needed to address the ARARs, including the substantive requirements for any exempted permits and property access issues that need to be resolved to implement the cleanup action

Pre-design activities would be conducted to inform engineering design and will include any invasive testing or surveys where necessary (through coordinated documents and approvals including work plan, sampling and analysis plan, quality assurance project plan, and health and safety plan). The draft EDR would include engineering plans describing the proposed methods for implementation of the cleanup action, including proposed project schedule, documenting the data collected as part of pre-design activities.

8.1.3 Consent Decree

Once a CAP is final, a formal legal agreement in the form of a CD is negotiated and agreed to by the PLPs, Ecology, and the State Attorney General's office, thereby defining the work requirements and the terms under which the CAP must be conducted. Before the CD can become final, it must undergo a public review and comment period.

A CD includes the following detailed information:

- A technical scope of work describing the remedial action to be conducted
- The data, studies, or any other information upon which the settlement is based
- A statement describing the PLPs' ability to conduct or finance the remedial action
- A schedule for implementation of the proposed remedial actions.

8.1.4 Compliance Monitoring Plan

A CMP is required to describe the long-term monitoring program to be implemented as part of the final cleanup action. It should include not only the long-term confirmational monitoring to be performed at the NPL Site to verify that the cleanup action meets the ground water and/or soil cleanup standards defined in the CAP, but also the inspection, monitoring, and reporting activities to be implemented to document the performance and the integrity of engineered controls. Such measures will be required until residual hazardous substance concentrations no longer exceed NPL Site CULs established under WAC 173-340-700 through 173-340-760.

CMPs must be specific for the media being tested and must contain the following elements:

- A sampling and analysis plan meeting the requirements of WAC 173-340-820, including:
  - A statement on the purpose and objectives of data collection
  - Organization of the sampling and analysis activities

  - Requirement for sampling activities (project schedule; identification and justification of location, frequency of sampling, and parameters to be sampled and analyzed; procedures for installation of sampling devices, for sample collection and handling, and for management of waste material generated by sampling activities; quality assurance (QA) and QC samples; and protocols for sample labeling and chain of custody)
  - Procedures for analysis of samples and reporting of results (detection or quantitation limits; analytical techniques and procedures; QA/QC procedures; data reporting procedures)
- Data analysis and evaluation procedures used, to demonstrate and confirm compliance and justification for these procedures, including the description of one or more reliable statistical methods to demonstrate and confirm compliance

8.1.5 5-year Reviews

Per WAC 173-340-420, Ecology will conduct periodic reviews of NPL Site conditions and monitoring data to ensure that human health and the environment are being protected as intended by the CAP. Periodic reviews are applicable: a) where an IC and/or financial assurance is required as part of the cleanup action; b) where the CUL is based on a practical quantitation limit as provided for under WAC 173-340-707; and (c) where Ecology considers additional review is necessary to ensure long-term protection of human health and the environment.

Reviews will be conducted by Ecology at least every 5 years after the initiation of a cleanup action. Ecology will consider the following factors when evaluating protection of human health and the environment:

- The effectiveness of ongoing or completed cleanup actions, including the effectiveness of engineered controls and ICs in limiting exposure to hazardous substances remaining at the NPL Site
- New scientific information for individual hazardous substances or mixtures present at the NPL Site
- New applicable state and federal laws for hazardous substances present at the NPL Site

- Current and projected site and resource uses
- The availability and practicability of more permanent remedies
- The availability of improved analytical techniques to evaluate compliance with CULs

Ecology will publish a notice of all periodic reviews in the NPL Site Register, provide an opportunity for public comment, and notify the Performing PLPs of the results of the periodic review. Ecology will determine whether additional reviews are necessary, taking into consideration the factors described above. Sites with ICs are expected to remain subject to periodic reviews as long as the ICs are required.

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TABLES

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Jan-85	Preliminary Site Inspection	Ecology and Environment, Inc.
Jun-86	Final Report for Resource Recovery Corporation, Pasco, Washington	Ecology and Environment, Inc.
Oct-87	Field Investigation Report for Pasco Sanitary Landfill/Resource Recovery Corporation, Pasco, Washington	Ecology and Environment, Inc.
Oct-89	Groundwater Monitoring Results at the Pasco Sanitary Landfill (3rd quarter 1989)	Technico Environmental Services
Apr-91	Pasco Sanitary Landfill 1st Quarter 1992 Monitoring Results	Technico Environmental Services
Jun-91	Groundwater Monitoring Results at the Pasco Sanitary Landfill (2nd quarter 1991)	Technico Environmental Services
Sep-91	1991 Annual Water Quality Results	Technico Environmental Services
Nov-91	Groundwater and Gas Monitoring Results at the Pasco Sanitary Landfill	Technico Environmental Services
Jul-92	Pasco Sanitary Landfill 2nd Quarter 1992 Monitoring Results	Technico Environmental Services
Dec-93	Final Draft Phase I Remedial Investigation Report - Pasco Landfill - Pasco, Washington, Volumes I to IV	Burlington Environmental Inc. (Prepared for Pasco Landfill PLP Group)
Jul-95	Pasco Landfill Soil Vapor Extraction Treatability Study	Phillip Environmental Services Corporation (Prepared for Pasco Landfill PLP Group)
Sep-97	Ecological Assessment - Pasco Landfill - Pasco, Washington	Phillip Services Corp. (Prepared for Pasco Landfill PLP Group)
Mar-98	Final Phase II Remedial Investigation Report, Pasco Landfill, Pasco, Washington	Phillip Environmental Services Corporation (Prepared for Pasco Landfill PLP Group)
Sep-98	Risk Assessment/Cleanup Level Analysis - Pasco Landfill - Pasco, Washington	Phillip Services Corp. (Prepared for Pasco Landfill PLP Group)
Jul-99	Updated Evaluation of Remedial Investigation Conclusions and Interim Remedial Measures Performance	Phillip Services Corp. (Prepared for Pasco Landfill PLP Group)
Jul-02	Site Air Monitoring Report, Zone B Removal Operations, Pasco Sanitary Landfill, Pasco Washington	Phoenix Health and Safety, Inc.

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Mar-04	2003 Annual Groundwater Monitoring and Interim Action Performance Monitoring Report	Environmental Partners, Inc. (EPI)
Jun-04	First Quarter Groundwater Monitoring and Interim Action Performance Monitoring Report	EPI
Sep-04	Second Quarter 2004 Groundwater Monitoring Rpt.	EPI
Dec-04	Third Quarter Groundwater Monitoring Report	EPI
Mar-05	2004 Annual Groundwater Monitoring and Interim Action Performance Monitoring Report; EDD on CD	EPI
Jun-05	First Quarter 2005 Groundwater Monitoring and Interim Action Performance Monitoring Report	EPI
Jul-05	Zone B Confirmation Surface Soil Sampling Technical Memo, Pasco Landfill, Pasco, Washington	Amec Earth & Environmental, Inc.
Sep-05	Second Quarter 2005 Monitoring Report	EPI
Dec-05	Third Quarter 2005 Groundwater Monitoring and Interim Action Performance Report and EDD	EPI
Mar-06	2005 Annual Groundwater Report	EPI
Jun-06	First Quarter 2006 Quarterly Groundwater Monitoring and Interim Performance Monitoring Report	EPI
Sep-06	Second Quarter 2006 Groundwater Monitoring and IM Performance Monitoring Report	EPI
Dec-06	Third Quarter 2006 Groundwater Monitoring Report	EPI
Jan-07	Interim Action Performance Monitoring Report - Pasco Landfill Site - Pasco Washington	EPI (Prepared for IWAG Group II)
Jan-07	O&M Manual and Interim Action Performance Report	EPI
Mar-07	2006 Annual Groundwater Monitoring and Interim Action Performance Monitoring Report	EPI
Jun-07	Q1-2007 Groundwater Monitoring and Interim Action Performance Monitoring Report	EPI
Sep-07	Q2-2007 Groundwater Monitoring Report	EPI
Dec-07	Third Quarter 2007 Groundwater Monitoring Report	EPI
Mar-08	2007 Annual Groundwater Monitoring and Interim Action Performance Report	EPI
Jun-08	GeoPhysical Surveys, Phase II RI/FS	EPI
Jun-08	Draft First Quarter 2008 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Aug-08	First Quarter 2008 Groundwater Monitoring Report and Response Letter	EPI
Sep-08	Draft Second Quarter 2008 Groundwater Monitoring Report	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Sep-08	2007 Annual Ground Water Monitoring and Interim Action Performance Monitoring Report Volume 1 of 2 and Response to Comments	EPI (Prepared for IWAG Group II)
Oct-08	Zone A Subsidence Investigation Letter lll SCS's Pasco Landfill Zone A Cover Evaluation	EPI
Dec-08	Third Quarter 2008 Draft for Ecology	EPI
Feb-09	Technical Memo Re: Monthly Status Report No. 8 for January 2009 Phase I of the AIA	EPI
Feb-09	Technical Memo Re: Phase I AIA Interim Findings and Conclusions-Soil Vapor Extraction System Testing	EPI
Mar-09	Pasco Landfill Zone A Cover Evaluation	SCS Engineers (Prepared for EPI)
Mar-09	Request for Scope Modification Additional Surface Geophysical Surveys of Zone A	EPI
Mar-09	Technical Memo Re: Monthly Status Report No. 9 for February 2009 Phase I of the AIA	EPI
Mar-09	Technical Memo - Phase I AIA	EPI
Mar-09	Revised Second Quarter 2008 Groundwater Monitoring Report and Response Letter	EPI
Apr-09	Technical Memo Re: Monthly Status Report No. 10 for February 2009 Phase I of the AIA	EPI
May-09	2008 Annual Report - Ground Water Monitoring and Phase I Additional Interim Actions- Volumes 1 to 3	EPI (Prepared for IWAG Group II)
May-09	2008 Annual Groundwater Monitoring and Interim Action Performance Monitoring Report and Phase I AIA Report Volumes 1-3	EPI
Jun-09	First Quarter 2009 Ground Water Monitoring Report (for Ecology)	EPI
Sep-09	Second Quarter 2009 Ground Water Monitoring Report (for Ecology)	EPI
Dec-09	Third Quarter 2009 Ground Water Monitoring Report (for Ecology)	EPI
Mar-10	Revised Final Phase II AIA FINAL - Volume 1 SVE Upgrades and Response to Ecology Comments	EPI
Apr-10	Draft 2009 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring, Pasco Landfill Site, Pasco, Washington	EPI
Jun-10	First Quarter 2010 Ground Water Monitoring Report (for Ecology)	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Jul-10	Revised 100% Submittal Engineering Design Report for SVE System Upgrades – Phase II Additional Interim Actions, and Response to Comments	EPI (Prepared for IWAG Group II)
Sep-10	Second Quarter 2010 Ground Water Monitoring Report (for Ecology)	EPI
Nov-10	Revised First Quarter 2010 Groundwater Monitoring and Interim Action Performance Monitoring Report; and Response to Ecology Comments Letter	EPI
Dec-10	Revised Phase II AIA Work Plan Vol 2; Response to Comments	EPI
Dec-10	Third Quarter 2010 Ground Water Monitoring Report (Draft for Ecology)	EPI
Dec-10	Final First Quarter 2010 Ground Water Monitoring Report	EPI
Dec-10	Final Second Quarter 2010 Ground Water Monitoring Report	EPI
Feb-11	Technical Memo Re: Monthly Status Report No. 15 for January 2011 Phase II Vol 1 and 2 of AIA	EPI
Mar-11	2010 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring, Pasco Landfill Site, Pasco, Washington	EPI and Anchor QEA (Prepared for IWAG Group III)
Mar-11	Technical Memo Re: Monthly Status Report No. 16 for February 2011 Phase II Vol 1 and 2 of AIA	EPI
Mar-11	Technical Memo Re: Monthly Status Report No. 17 for March 2011 Phase II Vol 1 and 2 of AIA	EPI
May-11	Technical Memo Re: Monthly Status Report No. 18 for April 2011 Phase II Vol 1 and 2 of AIA	EPI
Jun-11	Technical Memo Re: Monthly Status Report No. 19 for May 2011 Phase II Vol 1 and 2 of AIA	EPI
Jun-11	First Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Jun-11	Technical Memo Re: Monthly Status Report No. 20 for June 2011 Phase II Vol 1 and 2 of AIA	EPI
Aug-11	Technical Memo Re: Monthly Status Report No. 21 for July 2011 Phase II Vol 1 and 2 of AIA	EPI
Sep-11	Phase II Additional Interim Actions - Sub-Zone A Investigation and Downgradient Well Installation Report, Volumes I and II	EPI (Prepared for IWAG Group III)
Sep-11	Final First Quarter 2011 Ground Water Monitoring and Interim	EPI
Sep-11	Technical Memo Re: Monthly Status Report No. 22 for August 2011 Phase II Vol 1 and 2 of AIA	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Sep-11	Second Quarter 2011 Ground Water Monitoring and Interim Actin Performance Monitoring	EPI
Oct-11	Technical Memo Re: Upgraded SVE System Testing Pre-Testing System Evaluation	EPI
Oct-11	Technical Memo Re: Monthly Status Report No. 23 for September 2011 Phase II Vol 1 and 2 of AIA	EPI
Nov-11	Technical Memo Re: Monthly Status Report No. 24 for	EPI
Nov-11	Revised 2010 Annual Ground Water Monitoring and Interim Action Performance Monitoring and Response to Comments Letter	EPI
Dec-11	Technical Memo Re: Monthly Status Report No. 25 for Nov 2011 Phase II Vol 1 and 2 of AIA	EPI
Dec-11	Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Feb-12	Revised 2010 Annual Report - Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Mar-12	2011 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI (Prepared for IWAG Group III)
Apr-12	Revised Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report and Response to Ecology Comments	EPI
May-12	Revised Phase II Additional Interim Actions Sub-Zone A Investigation and Downgradient Well Installation Report Vol 1 of 2	EPI (Prepared for IWAG Group III)
Jun-12	Technical Memo Re: Monthly Status Report No. 26 for April and May 2012	EPI
Jun-12	First Quarter 2012 Groundwater Monitoring and Interim Action Performance Monitoring Report	EPI
Jun-12	Technical Memo Re: Recent Data Qualifiers or Tetrachloroethene Results	EPI
Jul-12	Technical Memo Re: Monthly Status Report No. 27 for June 2012	EPI
Aug-12	Technical Memo Re: Monthly Status Report No. 28 for July 2012	EPI
Sept-12	Technical Memo Re: Monthly Status Report No. 29 for August 2012	EPI
Oct-12	Technical Memo Re: Monthly Status Report No. 30 for September 2012	EPI
Oct-12	Zone A Heating Evaluation, Pasco Sanitary Landfill Site	Anchor QEA, LLC

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Nov-12	Technical Memo Re: Monthly Status Report No. 31 for October 2012	EPI
Dec-12	Technical Memo Re: Monthly Status Report No. 32 for November 2012	EPI
Jan-13	Technical Memo Re: Monthly Status Report No. 33 for December 2012	EPI
Feb-13	Technical Memo Re: Monthly Status Report No. 34 for January 2013	EPI
Mar-13	Technical Memo Re: Monthly Status Report No. 35 for February 2013	EPI
Mar-13	2012 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Apr-13	Technical Memo Re: Monthly Status Report No. 36 for March 2013	EPI
May-13	Technical Memo Re: Monthly Status Report No. 37 for April 2013	EPI
Jun-13	Technical Memo Re: Monthly Status Report No. 38 for May 2013	EPI
Jun-13	First Quarter 2013 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Jun-13	Revised Third Quarter 2012 Ground Water Monitoring and Interim Action Performance Monitoring Report and Response to Comments Letter	EPI
Jul-13	Technical Memo Re: Monthly Status Report No. 39 for June 2013	EPI
Jul-13	Revised 2012 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Aug-13	Technical Memo Re: Monthly Status Report No. 40 for July 2013	EPI
Sept-13	Technical Memo Re: Monthly Status Report No. 41 for August 2013	EPI
Sept-13	Second Quarter 2013 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Oct-13	Technical Memo Re: Monthly Status Report No. 42 for September 2013	EPI
Nov-13	Technical Memo Re: Monthly Status Report No. 43 for October 2013	EPI
Dec-13	Technical Memo Re: Monthly Status Report No. 44 for November 2013	EPI
Dec-13	Third Quarter 2013 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Jan-14	Technical Memo Re: Monthly Status Report No. 45 for December 2013	EPI
Feb-14	Technical Memo Re: Monthly Status Report No. 46 for January 2014	EPI
Mar-14	Technical Memo Re: Monthly Status Report No. 47 for February 2014	EPI
Apr-14	Technical Memo Re: Monthly Status Report No. 48 for March 2014	EPI
May-14	Technical Memo Re: Monthly Status Report No. 49 for April 2014	EPI
May-14	2013 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Jun-14	Technical Memo Re: Monthly Status Report No. 50 for May 2014	EPI
Jun-14	First Quarter 2014 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Jul-14	Technical Memo Re: Monthly Status Report No. 51 for June 2014	EPI
Aug-14	Technical Memo Re: Monthly Status Report No. 52 for July 2014	EPI
Sept-14	Technical Memo Re: Monthly Status Report No. 53 for August 2014	EPI
Sept-14	Second Quarter 2014 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Oct-14	Technical Memo Re: Monthly Status Report No. 54 for September 2014	EPI
Nov-14	Technical Memo Re: Monthly Status Report No. 55 for October 2014	EPI
Dec-14	Technical Memo Re: Monthly Status Report No. 56 for November 2014	EPI
Dec-14	Third Quarter 2014 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Jan-15	Technical Memo Re: Monthly Status Report No. 57 for December 2014	EPI
Feb-15	Technical Memo Re: Monthly Status Report No. 58 for January 2015	EPI
Mar-15	Technical Memo Re: Monthly Status Report No. 59 for February 2015	EPI
Mar-15	2014 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Apr-15	Technical Memo Re: Monthly Status Report No. 60 for March 2015	EPI
May-15	Technical Memo Re: Monthly Status Report No. 61 for April 2015	EPI
May-15	Engineering Design Report for SVE System with Regenerative Thermal Oxidation Upgrade	EPI
Jun-15	Technical Memo Re: Monthly Status Report No. 62 for May 2015	EPI
Jun-15	First Quarter 2015 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Jul-15	Technical Memo Re: Monthly Status Report No. 63 for June 2015	EPI
Aug-15	Technical Memo Re: Monthly Status Report No. 64 for July 2015	EPI
Sept-15	Technical Memo Re: Monthly Status Report No. 65 for August 2015	EPI
Sept-15	Second Quarter 2015 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Oct-15	Technical Memo Re: Monthly Status Report No. 66 for September 2015	EPI
Nov-15	Technical Memo Re: Monthly Status Report No. 67 for October 2015	EPI
Dec-15	Technical Memo Re: Monthly Status Report No. 68 for November 2015	EPI
Dec-15	Third Quarter 2015 Ground Water Monitoring and Interim Action Performance Monitoring Report	EPI
Jan-16	Technical Memo Re: Monthly Status Report No. 69 for December 2015	EPI
Jan-16	Revised 2014 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Feb-16	Technical Memo Re: Monthly Status Report No. 70 for January 2016	EPI
Mar-16	Technical Memo Re: Monthly Status Report No. 71 for February 2016	EPI
Mar-16	2015 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	EPI
Mar-16	Engineering Test Plan	EPI
Apr-16	Technical Memo Re: Monthly Status Report No. 72 for March 2016	EPI

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Apr-16	Construction Summary Report for the Balefill Area Extinguishment and Supplemental Protection Barrier Project at the Pasco Landfill NPL Site	
Apr-16	Draft Enforcement Order Task 2 Technical Memorandum - Pasco Sanitary Landfill National Priorities List Site	
May-16	Technical Memo Re: Monthly Status Report No. 73 for April 2016	EPI
May-16	High Operating Values, Zone A, Pasco Sanitary Landfill, Pasco, WA	SCS Engineers
Jun-16	Technical Memo Re: Monthly Status Report No. 74 for May 2016	EPI
Jun-16	First Quarter 2016 Ground Water Monitoring and Interim Action Performance Monitoring Report	PBS
Jun-16	Performance Test Plan: Engineering/Optimization and Compliance Tests at the Pasco Sanitary Landfill	
Jun-16	Assessment of Pasco Sanitary Landfill RTO Performance	
Jun-16	Proposed Modifications to the Existing Interim Actions Ground Water Monitoring Program	
Jun-16	Technical Memo Re: Proposed Modifications to the Existing Interim Actions Ground Water Monitoring Program	IWAG III Technical Committee
Jul-16	Technical Memo Re: Transmittal of As-Built Documentation and Specification One-way Air Intake Valves	
Jul-16	Addendum No. 1 to Volume 3 - As-Built Report for SVE System Upgrades - Attachment A - Sampling and Analysis Plan	
Jul-16	Technical Memo Re: Monthly Status Report No. 75 for June 2016	EPI
Aug-16	Technical Memo Re: Monthly Status Report No. 76 for July 2016	EPI
Sept-16	Technical Memo Re: Monthly Status Report No. 77 for August 2016	EPI
Sept-16	Second Quarter 2016 Ground Water Monitoring and Interim Action Performance Monitoring Report	PBS
Sept-16	Conceptual Combustion Evaluation Workplan	
Oct-16	Technical Memo Re: Monthly Status Report No. 78 for September 2016	EPI
Oct-16	Technical Memo Re: Enforcement Order Task 2	Anchor QEA, LLC

Table 2.3-1
Summary of Investigative Reports
Pasco Landfill NPL Site

Date	Title	Author
Oct-16	Detailed Work Plan to Evaluate Potential Combustion in Zone A	
Oct-16	Revised Construction Summary Report for the Balefill Area Extinguishment and Supplemental Protection Barrier Project at the Pasco Landfill NPL Site	
Oct-16	Revised Draft Enforcement Order Task 2 Technical Memorandum - Pasco Sanitary Landfill National Priorities List Site	AECOM, Anchor QEA LLC, Clearcreek Contractors Inc., EPI, PBS Engineering and Environmental Inc.
Nov-16	Technical Memo Re: Monthly Status Report No. 79 for October 2016	EPI
Nov-16	Revised Detailed Work Plan to Evaluate Potential Combustion in Zone A	
Nov-16	Technical Memo Re: GCE RTO Unit Repairs	
Dec-16	Second Revised Detailed Work Plan to Evaluate Potential Combustion in Zone A	
Dec-16	Technical Memo Re: Monthly Status Report No. 80 for November 2016	EPI
Dec-16	Third Quarter 2016 Ground Water Monitoring and Interim Action Performance Monitoring Report	PBS
Jan-17	Technical Memo Re: Monthly Status Report No. 81 for December 2016	EPI
Feb-17	Technical Memo Re: Monthly Status Report No. 82 for January 2017	PBS
Mar-17	Technical Memo Re: Monthly Status Report No. 83 for February 2017	PBS
Mar-17	2016 Annual Report Ground Water Monitoring and Interim Action Performance Monitoring	PBS
Apr-17	Zone A Combustion Evaluation Report, Zone A Combustion Evaluation Report	GSI and SCS Engineers
Apr-17	Technical Memo Re: Monthly Status Report No. 84 for March 2017	PBS
Apr-17	Technical Memo Re: Monthly Status Report No. 84 for March 2017 - Revised	PBS

Table 2.4.2-1
Regional Stratigraphy

Pasco Landfill Phase II RI

GEOLOGIC TIME SCALE			GEOLOGIC CHARACTERISTICS			
ERA	PERIOD	EPOCH	STRATIGRAPHY	BED OF FLOW UNIT	LITHOLOGIC DESCRIPTION	APPROXIMATE THICKNESS (FEET)
Cenozoic	Quarternary	Holocene	Eolian Deposits	- - - -	Sands, silts, gravels and clays modified by wind erosion	Dunes to 50
		Pleistocene	Glaciofluvial Deposits	Touchet Beds	Fine-grained glaciofluvial slack-water deposits	0 - 40
			(Hanford Formation)	Pasco Gravels	Predominately cobbles, course-grained gravels, and sands	0 - 300
	Tertiary	Pliocene	Loess Deposits	Palouse Soil	Where present, calcareous sand and silt deposits mainly derived from Ringold Formation	0-80
				Upper Ringold	Mostly well-bedded fluvial silts and sands with some gravels locally capped by caliche	0 - 100
			Ringold Formation	Middle Ringold	Sands and gravels well-sorted, compact, but variably cemented	0 - 400
				Lower Ringold	Silts and clays with interbedded gravels and sands	0 - 400
		Miocene		Saddle Mountains	Basalt flows with interflow zones. Several sedimentary interbeds are present	900
			Columbia River Basalt Group	Wanapum	Basalt flows with interflow zones. Few interbeds are present	1,000
				Grande Ronde	Basalt flows with interflow zones. Interbeds are infrequent and very thin when present	3,000

Table 2.5.1-1
Chronology of MSW Disposal Operations
Pasco Sanitary Landfill NPL Site

Time Period	Description of MSW Disposal Operations (based on description in Phase I RI)
1958	In May 1958, John Dietrich, doing business as Pasco Garbage Service, commenced refuse disposal at the facility under a disposal permit issued by the FCPD. No MSW management activities took place at the facility prior to 1958. Disposal of MSW started at the south end of the MSW Landfill area, shown on Figure 2.5.1-1. The MSW Landfill progressively expanded to the north and east. MSW consolidation practices included open burning on the MSW Landfill between 1958 and 1971. By 1972, the MSW Landfill area covered the southwest quadrant of the final MSW Landfill area. By 1979, the MSW Landfill area covered the southern half of the final MSW Landfill area. Starting in 1958, disposal and open burning of MSW also took place in two east-west trending burn trenches to the south of the MSW Landfill area. These burn trenches are denoted as BT-1 in Figure 2.5.1-1. Burning MSW was reportedly cooled using water from the facility's water supply well. By May 1963, BT-1 was nearly full. All disposal in the BT-1 area appears to have ceased before May 1965. BT-1 was covered with soil to the current grade.
1961-1965	Beginning in 1961, disposal and open burning of MSW also began in a north-south trending burn trench along Dietrich Road. This is denoted as BT-2 in Figure 2.5.1-1. Disposal and burning of MSW in BT-2 may have continued until 1965. Unburned MSW had reportedly been placed over the BT-2 trench by this time. Based on data from vertical borings installed in Zone A, it is possible that MSW in BT-2 was re-graded prior to accepting industrial waste at Zone A. BT-2 is beneath the western edge of the engineered cap system installed at Zone A.
Circa 1969-1973	In 1969, the MSW Landfill was approved for disposal of pesticides and empty pesticide containers by the BFDHD. Available photographs and interviews with Mr. Larry Dietrich indicate that disposal of empty pesticide containers continued through at least mid-1973 (pers. comm. 2011).
1976-1989	As part of the landfill operations, PSL Inc. was permitted for disposal of various non-hazardous bulk liquids. These bulk liquids included septic tank waste, sewage sludges, and animal fat emulsion coolants, and were accepted for disposal at lagoons (approximately 1976 to 1989), applied to the ground in the Landspread Area and Sludge Management Area (approximately 1981 to 1989), and applied directly on the MSW Landfill (approximately 1981 to 1987). The waste and surface soils from lagoons, landspread, and sludge managment areas outside the MSW Landfill area, depicted in Figure 2.5.1-1, were subsequently moved to the MSW Landfill for use as daily cover and/or the interim soil cover.
1976-1993	Beginning some time in 1976, baled MSW was accepted at the facility, and was landfilled in the area east of Zone A called the Balefill Area. Until 1990, the Balefill Area received primarily baled MSW, but also received tires and other loose MSW. The final extent of the Balefill Area is shown in Figure 2.5.1-1. From 1986 until the facility closed in mid-1993, MSW considered inert was segregated and disposed in an area south of the Balefill Area and southeast of Zone A called the Inert Waste Disposal Area. By the end of 1993, a soil cover was placed across the Balefill Area and the leveled portion of the Inert Waste Disposal Area.
1993	In fall 1992, Ecology and BFDHD authorized PSL Inc. to continue municipal landfill activity until June 1, 1993. The MSW Landfill operated through May 1993 under a 10-year conditional use permit from the FCPD in accordance with the Minimum Functional Standard (MFS) requirements specified by Ecology, and allowed acceptance of domestic waste, and light commercial, non-hazardous industrial, and non-toxic agricultural wastes. Pesticide containers rinsed in accordance with USDA standards were included in the non-toxic agricultural waste designation. On May 31, 1993, PSL Inc. commenced closure with placement of an interim cover consisting of a minimum of 3 feet of native soil on the MSW Landfill.

Table 2.5.1-2
Summary of Reports – MSW Disposal Areas
Pasco Sanitary Landfill NPL Site

Date:	Title:	Author:
5/03/2004	Pasco Municipal Solid Waste Landfill – 2003 Fourth Quarter and Annual Report	Craig S. Trueblood
7/03/2005	Pasco Municipal Solid Waste Landfill – 2004 Fourth Quarter and Annual Report	Craig S. Trueblood
3/15/2006	Pasco Municipal Solid Waste Landfill – 2005 Fourth Quarter and Annual Report	Craig S. Trueblood
9/15/2006	Pasco Municipal Solid Waste Landfill – 2006 Second Quarter Report	Craig S. Trueblood
3/14/2007	Pasco Municipal Solid Waste Landfill – 2006 Fourth Quarter and Annual Report	Craig S. Trueblood
6/15/2007	Pasco Municipal Solid Waste Landfill – 2007 First Quarter Report	Craig S. Trueblood
9/14/2007	Pasco Municipal Solid Waste Landfill – 2007 Second Quarter Report	Craig S. Trueblood
12/17/2007	Pasco Municipal Solid Waste Landfill – 2007 Third Quarter Report	Aspect Consulting, LLC
3/14/2008	Pasco Municipal Solid Waste Landfill – 2007 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
6/13/2008	Pasco Municipal Solid Waste Landfill – 2008 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
9/15/2008	Pasco Municipal Solid Waste Landfill – 2008 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
12/15/2008	Pasco Municipal Solid Waste Landfill – 2008 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
12/03/2009	Supplemental Technical Memorandum - Soil Vapor Extraction System Testing	Aspect Consulting, LLC
1/04/2009	Pasco Municipal Solid Waste Landfill – 2008 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
4/17/2009	Draft Memorandum re: Addendum to Pasco Municipal Solid Waste Landfill Operations and Maintenance Manual	Aspect Consulting, LLC
5/15/2009	Pasco Municipal Solid Waste Landfill Flare Rehabilitation	Aspect Consulting, LLC
6/15/2009	Pasco Municipal Solid Waste Landfill – 2009 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
9/15/2009	Pasco Municipal Solid Waste Landfill – 2009 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
12/15/2009	Pasco Municipal Solid Waste Landfill – 2009 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
12/15/2009	Work Plan for Installation of Supplemental Landfill Gas Probes	Aspect Consulting, LLC
7/22/2010	Pasco Municipal Solid Waste Landfill – 2009 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
9/22/2010	Pasco Municipal Solid Waste Landfill – 2010 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
9/22/2010	Proposal for Flare Stack Tests at the Pasco Landfill Site	Aspect Consulting, LLC
4/11/2010	Pasco Municipal Solid Waste Landfill – 2010 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
1/14/2011	Pasco Municipal Solid Waste Landfill – 2010 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
4/21/2011	Modified Louver Design for the Flare at the Pasco Landfill Site	Aspect Consulting, LLC
4/25/2011	Pasco Municipal Solid Waste Landfill – 2010 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
6/29/2011	Revised Flare Performance Report	Aspect Consulting, LLC
6/29/2011	Modified Louver Assembly Installation	Aspect Consulting, LLC
9/19/2011	Pasco Municipal Solid Waste Landfill – 2011 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
10/11/2011	Pasco Municipal Solid Waste Landfill – 2011 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
1/12/2011	Additional Documentation Related to Untreated SVE Vapor Discharge at the Landfill Flare - Pasco Landfill Site	Aspect Consulting, LLC

Table 2.5.1-2
Summary of Reports – MSW Disposal Areas
Pasco Sanitary Landfill NPL Site

Date:	Title:	Author:
10/02/2012	Pasco Municipal Solid Waste Landfill – 2011 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
7/16/2012	Pasco Municipal Solid Waste Landfill – 2012 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
1/25/2013	Pasco Municipal Solid Waste Landfill – 2012 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
3/12/2013	Pasco Municipal Solid Waste Landfill – 2012 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
8/12/2013	Pasco Municipal Solid Waste Landfill – 2012 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
9/27/2013	Pasco Municipal Solid Waste Landfill – 2013 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
11/11/2013	Pasco Municipal Solid Waste Landfill – 2013 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
2/07/2014	Pasco Municipal Solid Waste Landfill – 2013 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
2/19/2014	Operations and Maintenance Manual : MSW Disposal Areas	Shasta Environmental Services and Aspect Consulting, LLC
5/13/2014	Balefill Area Fire Suppression/Extinguishment Work Plan	Aspect Consulting, LLC
8/21/2014	Work Plan to Monitor Carbon Dioxide at Zone A SVE Wellheads on Daily Basis	Aspect Consulting, LLC
11/11/2014	Pasco Municipal Solid Waste Landfill – 2013 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
11/26/2014	Memorandum re: Influence of the Modified SVE System on the Balefill Area	Aspect Consulting, LLC
1/06/2015	Memorandum re: Supplemental Fuel System Work Plan	Aspect Consulting, LLC
2/18/2015	Pasco Municipal Solid Waste Landfill – 2014 First Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
4/20/2015	Pasco Municipal Solid Waste Landfill – 2014 Second Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
12/04/2015	Pasco Municipal Solid Waste Landfill – 2014 Third Quarter Report	Shasta Environmental Services and Aspect Consulting, LLC
3/22/2016	Pasco Municipal Solid Waste Landfill – 2014 Fourth Quarter and Annual Report	Shasta Environmental Services and Aspect Consulting, LLC
4/15/2015	Addendum to O&M Manual, Supplemental Fuel System	Aspect Consulting, LLC
6/12/2015	Pasco Municipal Solid Waste Landfill – 2015 First Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
9/15/2015	Pasco Municipal Solid Waste Landfill – 2015 Second Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
12/22/2015	Pasco Municipal Solid Waste Landfill – 2015 Third Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
3/29/2016	Pasco Municipal Solid Waste Landfill – 2015 Fourth Quarter and Annual Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
4/14/2016	Addendum to O&M Manual for MSW Disposal Areas, Supplemental Fuel System and SVE Conveyance Line Decommissioning	Aspect Consulting, LLC
4/15/2016	Memorandum re: Zone A SVE Effluent Carbon Monoxide and Temperature Data	Aspect Consulting, LLC
4/29/2016	Operations and Maintenance Manual Update: MSW Disposal Areas, Draft	Shasta Environmental Services and Aspect Consulting, LLC
6/15/2016	Pasco Municipal Solid Waste Landfill – 2016 First Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
6/28/2016	Pasco Landfill Group Concerns Regarding HOVs for SVE Wells and Implications for SVE-Only Remedy	Aspect Consulting, LLC
7/06/2016	Memorandum re: Landfill Group Comments on Regenerative Thermal Oxidation (RTO) System	Aspect Consulting, LLC

Table 2.5.1-2
Summary of Reports – MSW Disposal Areas
Pasco Sanitary Landfill NPL Site

Date:	Title:	Author:
9/15/2016	Pasco Municipal Solid Waste Landfill – 2016 Second Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
12/15/2016	Pasco Municipal Solid Waste Landfill – 2016 Third Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
1/23/2017	Addendum to O&M Manual for MSW Disposal Areas, Balefill Area Subsurface Monitoring	Aspect Consulting, LLC
3/15/2017	Pasco Municipal Solid Waste Landfill – 2016 Fourth Quarter and Annual Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
3/31/2017	Balefill Area Subsurface Monitoring Technical Memorandum	Aspect Consulting, LLC
6/15/2017	Pasco Municipal Solid Waste Landfill – 2017 First Quarter Report, Draft	Shasta Environmental Services and Aspect Consulting, LLC
6/30/2017	Addendum to O&M Manual for MSW Disposal Areas, Balefill Area Supplemental Subsurface Monitoring	Aspect Consulting, LLC

Table 2.5.3-1
Chronology of Waste Disposal Operations in the Vicinity of Zone A

Time Period	Description of Waste Disposal Operations
1962	Disposal and burning of refuse in the area of Zone A commences (see discussion of BT-2 in Section 2.5.1).
Circa 1970	Sometime between 1970 and 1972, Benton-Franklin District Health Department (BFDHD) authorizes the PSL Property to receive "containers, product, or derivatives of pesticide, fungicide, herbicide, defoliant, or fertilizer waste."
1972	The first drums arrive at Zone A in April 1972. Initially, drums are placed in BT-2 along Dietrich Road without stacking. Many drums release their contents upon being placed. Drums are placed randomly for a period of about 6 months.
Fall 1972	Drum stacking begins and operations change in response to the incorporation of Resource Recovery Corporation (RRC). Previously randomly placed drums are consolidated and covered with soil and/or garbage, and the Zone A cell is created.
Late 1972 into 1974	Drums are stacked up to four high on a flat soil surface. The bottom of the cell has been graded flat and appears to consist of native soil with mixed debris from the former burn trench. An area of soil is present to the west of the drums. Drums arrive on a flatbed tractor-trailer, one level high, and are stacked in Zone A. (Based on drum color evident in period photographs, the drums are generally heterogeneously distributed, do not appear to be in "new" condition, and receive a periodic cover of soil.)
March 21, 1973	Ecology issues RRC a 5-year industrial waste discharge permit for the PSL Property.
December 31, 1974	Franklin County Board of Commissioners (FCBOC) denies RRC's request for an extension of industrial waste disposal operations.
Mid-1975	Zone A is covered with plastic sheeting and native soil as a cap in support of landfill closure.
1975 to 1979	Baled waste is placed around the eastern and northern portions of Zone A.

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Soil	RI Phase I (Burlington Environmental Inc.)	B-05	02/04/93	11	11	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-05	02/04/93	21	21	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-05	02/04/93	31	31	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-05	02/04/93	41	41	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-06	02/04/93	11	11	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-06	02/04/93	21	21	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-06	02/04/93	31	31	X	X	X	X			Y		X	
Soil	RI Phase I (Burlington Environmental Inc.)	B-06	02/04/93	46	46	X	X	X	X			Y		X	
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-01	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-02	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-03	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-04	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-05	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-06	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-07	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-08	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-09	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-10	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-11	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-12	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-13	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-14	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-15	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	BKG-16	04/27/95	0.5	0.5	X	X					N		NA	surface background, outside project area
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-13	05/01/95	10	10	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-13	05/01/95	15	15		X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-13	05/01/95	20	20	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-13	05/01/95	25	25		X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-14	05/01/95	10	10	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-14	05/01/95	15	15		X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-14	05/01/95	20	20	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-14	05/01/95	25	25		X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-15	05/01/95	10	10	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-15	05/01/95	15	15		X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-15	05/01/95	20	20	X	X					Y		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	B-15	05/01/95	25	25		X					Y		X	
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-25S	05/01/95	10	10	X						N		X	considered subsurface background
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-25S	05/01/95	20	20	X						N		X	considered subsurface background
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-25S	05/01/95	30	30	X						N		X	considered subsurface background

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Background Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-25S	05/01/95	40	40	X						N		X	considered subsurface background
Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-26S	05/01/95	5	5	X						N		X	
Soil	RI Phase II (Philip Env. Serv. Corp.)	MW-26S	05/01/95	15.5	15.5	X						N		X	
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-01-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-02-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-03-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-04-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-05-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-06-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-96-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	2002, Post Drum Removal (Philip Env. Serv. C	PLF-ZBR-07-30	03/13/02	0	0.5		X		X	X		Y		X	collected at drum excavation floor
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0201	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0401	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0901	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1101	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1102	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1401	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1601	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0101	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0301	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0501	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0601	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0701	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0801	02/28/05	0	0.5		X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB0801	02/28/05	0	0.5	X						Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1001	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1201	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1301	02/28/05	0	0.5	X	X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1501	02/28/05	0	0.5		X		X		X	Y	X		
Soil	Confirmation Post-Drum Removal (AMEC)	PZB1501	02/28/05	0	0.5	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-05_6-12	07/16/09	0.5	1				X			Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-05_6-12Du	07/16/09	0.5	1				X			Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-03_6-12	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-10_0-6	07/16/09	0	0.5	X						N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-09_0-6	07/16/09	0	0.5	X			X			N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-08_0-6	07/16/09	0	0.5	X			X			N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-07_0-6	07/16/09	0	0.5	X			X			N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-06_0-6	07/16/09	0	0.5	X						N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-05_0-6	07/16/09	0	0.5	X						N		X	

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	**Event**	**Sample ID**	**Date Sampled**	**Start Depth (ft)**	**End Depth (ft)**	**Dioxins**	**Herbicides**	**Metals**	**SVOCs**	**VOCs**	**WetChem**	**Beneath Liner (in 2013)?**	**Soil Removed?**	**Soil In Place?**	**Notes**
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-04_0-6	07/16/09	0	0.5	X						N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-03_0-6	07/16/09	0	0.5	X						N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-15_6-12	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-02_0-6	07/16/09	0	0.5	X						N		X	
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-01_0-6	07/16/09	0	0.5	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	OZB-01_6-12	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-12_6-12	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-12_6-12Du	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-14_6-12	07/16/09	0.5	1	X						Y	X		
Soil	Pre-Excavation for Cap Installation (AMEC)	PZB-14_12-18	07/16/09	1	1.5	X						Y		X	
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-03A	12/20/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-03B	12/20/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-03C	12/20/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-03D	12/20/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-05A	12/20/10	0	0.5				X			Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-05A Dup	12/20/10	0	0.5				X			Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-05B	12/20/10	0	0.5				X			Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-05C	12/20/10	0	0.5				X			Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-05D	12/20/10	0	0.5				X			Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-01A	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-01B	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-01C	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-01D	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-11A	12/21/10	0	0.5	X						Y		X	
Soil	Post-Excavation for Cap Installation (AMEC)	OZB-12A	12/21/10	0	0.5	X						Y		X	
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-12A	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-12A Dup	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-12B	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-12C	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-12D	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-14A	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-14B	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-14C	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-14D	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-15A	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-15B	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-15C	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	Post-Excavation for Cap Installation (AMEC)	PZB-15D	12/21/10	0	0.5	X						Y	X		confirmation below 2010 1' excav
Soil	ZoneB_April2012 (AMEC)	B001-0-3	04/10/12	0	3	X	X		X		X	Y		X	

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Soil	ZoneB_April2012 (AMEC)	B002-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B003-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B004-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B005-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B006-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B007-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B008-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B009-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B010-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B011-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B012-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B013-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B014-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B015-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B016-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B017-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B018-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B019-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B019-3-6	04/10/12	3	6	X						Y		X	
Soil	ZoneB_April2012 (AMEC)	B020-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B020-0-3D	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B021-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B022-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B023-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B024-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B025-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B026-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B027-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B028-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B029-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B030-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B030-3-6	04/10/12	0	3	X						Y		X	
Soil	ZoneB_April2012 (AMEC)	B031-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B032-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B033-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B034-0-3	04/10/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B035-0-3	04/10/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B036-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B037-0-3	04/11/12	0	3	X	X		X		X	N		X	

Table 2.5.4-1

Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Soil	ZoneB_April2012 (AMEC)	B038-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B039-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B040-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B040-0-3D	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B041-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B042-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B043-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B044-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B045-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B046-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B047-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B048-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B049-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B050-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B051-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B052-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B053-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B054-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B055-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B056-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B057-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B058-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B059-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B060-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B060-0-3D	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B061-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B062-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B063-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B064-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B065-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B066-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B067-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B068-0-3	04/11/12	0	3	X	X		X		X	N	X		Soil excavated and placed beneath cap liner.
Soil	ZoneB_April2012 (AMEC)	B068-3-6	04/11/12	3	6	X						N		X	
Soil	ZoneB_April2012 (AMEC)	B069-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B070-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B071-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B071-3-6	04/11/12	3	6	X						Y		X	
Soil	ZoneB_April2012 (AMEC)	B072-0-3	04/11/12	0	3	X	X		X		X	N		X	

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Soil	ZoneB_April2012 (AMEC)	B073-0-3	04/11/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B074-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B075-0-3	04/11/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B076-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B077-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B078-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B079-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B080-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B080-0-3D	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B081-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B082-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B083-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B083-3-6	04/12/12	3	6	X						Y		X	
Soil	ZoneB_April2012 (AMEC)	B084-0-3	04/12/12	0	3	X	X		X		X	N	X		Soil excavated and placed beneath cap liner.
Soil	ZoneB_April2012 (AMEC)	B085-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B086-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B087-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B088-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B089-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B089-3-6	04/12/12	3	6	X						Y		X	
Soil	ZoneB_April2012 (AMEC)	B090-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B091-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B092-0-3	04/12/12	0	3	X	X		X		X	N	X		Soil excavated and placed beneath cap liner.
Soil	ZoneB_April2012 (AMEC)	B092-3-6	04/12/12	3	6	X						N		X	
Soil	ZoneB_April2012 (AMEC)	B093-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B094-0-3	04/12/12	0	3	X	X		X		X	N	X		Soil excavated and placed beneath cap liner.
Soil	ZoneB_April2012 (AMEC)	B094-3-6	04/12/12	3	6	X						N		X	
Soil	ZoneB_April2012 (AMEC)	B095-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B096-0-3	04/12/12	0	3	X	X		X		X	N	X		Soil excavated and placed beneath cap liner.
Soil	ZoneB_April2012 (AMEC)	B097-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B098-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B099-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B100-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B100-0-3D	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B101-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B102-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B103-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B104-0-3	04/12/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B105-0-3	04/12/12	0	3	X	X		X		X	N		X	

Table 2.5.4-1
Summary of Pasco Landfill Zone B Soil Sampling and Results (1993-2012)

Sample Info				Depth		Analytical Suite						Location Status			
Matrix	Event	Sample ID	Date Sampled	Start Depth (ft)	End Depth (ft)	Dioxins	Herbicides	Metals	SVOCs	VOCs	WetChem	Beneath Liner (in 2013)?	Soil Removed?	Soil In Place?	Notes
Soil	ZoneB_April2012 (AMEC)	B106-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B107-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B108-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B109-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B110-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B111-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B112-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B113-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B114-0-3	04/12/12	0	3	X	X		X		X	Y		X	
Soil	ZoneB_April2012 (AMEC)	B115-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B116-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B117-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B118-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B119-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B120-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B120-0-3D	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B121-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B122-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B123-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B124-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B125-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B126-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B127-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B128-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B129-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B130-0-3	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B130-0-3D	04/13/12	0	3	X	X		X		X	N		X	
Soil	ZoneB_April2012 (AMEC)	B131-0-3	05/23/12	0	3	X						N		X	
Soil	ZoneB_April2012 (AMEC)	B131-0-3D	05/23/12	0	3	X						N		X	
Soil	ZoneB_April2012 (AMEC)	B132-0-3	05/23/12	0	3	X						N		X	

🟧 Orange highlight indicates an exceedance of the draft cleanup action level in this sample for one or more analytes in this suite, and the sample location remains in place.

🟩 Green highlight indicates an exceedance of the draft cleanup action level in this sample for one or more analytes in this suite, and the sample location has been excavated.

Sample depths are at time of sampling, and do not represent current depths

AMEC = AMEC Earh & Environmental, Inc. (now Amec Foster Wheeler Environment & Infrastructure, Inc.)

NA = Not applicable

Philip Env. Serv. Corp. = Philip Environmental Services Corporation

Table 4.2.1-1
Potential Chemicals of Concern in Ground Water

Compound	CAS Number	Frequency of Detection (%)	Number of Exceedances	Indicator	Comments
1,1,1-Trichloroethane	71-55-6	14	25	Yes	Based on Maximum Concentration Level as screening level
1,1,2-Trichloroethane[1]	79-00-5	3	41	No	Low frequency of detection, low number of exceedances, and not considered a chemical of concern by Ecology in the 2007 screening
1,1-Dichloroethene	75-35-4	17	845	Yes	Suspected carcinogen
1,2-Dichloroethane	107-06-2	28	1,220	Yes	Suspected carcinogen
cis-1,2-Dichloroethene	156-59-2	42	648	Yes	Non-carcinogen; exceedance based on hazard index
Acetone	67-64-1	2	1	No	Only one exceedance on record (1998); current CLARC Method B value higher than value used in Ecology 2007a analysis
Benzene	71-43-2	5	86	Yes	Suspected carcinogen
Chloroform	67-66-3	9	1	No	Only one exceedance on record (1997)
Ethylbenzene	100-41-4	3	1	No	Low frequency of detection and only one exceedance on record
Methylene chloride	75-09-2	5	103	Yes	Suspected carcinogen
Tetrachloroethene	127-18-4	31	969	Yes	Suspected carcinogen
Toluene	108-88-3	5	38	Yes	Non-carcinogen; exceedance based on hazard index
Trichloroethene	79-01-6	43	937	Yes	Suspected carcinogen
Vinyl chloride	75-01-4	11	209	Yes	Suspected carcinogen
Chromium (Total)	7440-47-3	80	17	Yes	Chromium not affected by interim actions except for capping; screening based on 2007 to 2012 data

Notes:

1 = The screening level for 1,1,2-Trichloroethane is 5 µg/L based on the Maximum Concentration Level. Three of four exceedances were at 6 µg/L and two of those results were from monthly monitoring, which did not use selective ion measurement or as extensive data validation as in quarterly sampling and analysis.

CLARC = Cleanup Levels and Risk Calculation

Table 4.3-1
Summary of Remedial Action Objectives

Zone	Remedial Action Objectives		Status
A	Waste	Prevent direct exposure. Prevent contaminant releases to the atmosphere. Minimize transport of contaminants to subsurface soils and ground water.	Direct exposure protection achieved by capping. Prevention of VOC release to atmosphere achieved by SVE system installation and operation. Minimizing transport of VOCs from waste to ground water is in progress with operation of the enhanced SVE system.
	Soil	Prevent direct exposure. Remove and destroy contaminants from beneath waste. Minimize transport of contaminants from soil to ground water.	Direct exposure protection achieved by capping. Minimization of transport of VOCs from soil to ground water is in progress with operation of the enhanced SVE system.
	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through institutional controls.
	Air	Prevent inhalation of contaminated exhaust air emissions from treatment systems.	Minimization of contaminated exhaust air emissions is in progress with operation of the RTO pursuant to an air permit for the enhanced SVE system.
B	Waste	Prevent direct exposure. Prevent contaminant releases to the atmosphere. Minimize transport of contaminants to subsurface soils and ground water.	Achieved by drum removal in 2002 and construction of a RCRA-compliant cap over all soils with COC concentrations greater than draft screening levels during May and June 2013, along with institutional controls.
	Soil	Prevent direct exposure.	Achieved via construction of a RCRA-compliant cap over all soils with COC concentrations greater than draft screening levels during May and June 2013, along with institutional controls.
C/D	Waste	Prevent direct exposure. Prevent contaminant releases to the atmosphere. Minimize transport of contaminants from Zone C/D to subsurface soils and ground water.	Achieved by capping, institutional controls, and natural attenuation.
	Soil	Prevent direct exposure. Remove and destroy contaminants from beneath waste.	Achieved by capping, institutional controls, and natural attenuation.
	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through institutional controls.

Table 4.3-1
Summary of Remedial Action Objectives

Zone	Remedial Action Objectives		Status
E	Waste	Prevent direct exposure. Prevent contaminant releases to the atmosphere. Minimize transport of contaminants to from Zone E subsurface soils and ground water.	Achieved by capping, institutional controls, and natural attenuation.
	Soil	Prevent direct exposure. Remove and destroy contaminants from beneath waste.	Achieved by capping, institutional controls, and natural attenuation.
	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through institutional controls.
Municipal Solid Waste Landfill	Municipal Waste/ Landfill Gas	Prevent direct exposure. Prevent contaminant releases to the atmosphere. Minimize transport of contaminants to subsurface soils and ground water.	Direct exposure protection achieved by capping and fencing. Contaminant release to atmosphere prevented by capping and ongoing operation of GCCS, and verified by landfill gas migration monitoring. Transport of contaminants mobilized by precipitation infiltration minimized by capping. Minimizing transport of volatile contaminants to soil and ground water is demonstrated with operation of the existing GCCS.
	Soil	Prevent direct exposure. Minimize transport of contaminants from soil to ground water.	Direct exposure protection achieved by capping and fencing. Transport of contaminants mobilized by precipitation infiltration minimized by capping.
	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through institutional controls.
Balefill Areas/Inert Waste Disposal Area	Municipal Waste	Prevent direct exposure to waste and soil. Minimize transport of contaminant to subsurface soils and ground water.	No RAOs were specified in the 1999 FS. Applicable and substantive post-closure requirements have been addressed in the draft O&M Manual for MSW Disposal Areas (Aspect 2012).
	Soil		
	Ground Water		
Burn Trenches	Municipal Waste	Prevent direct exposure to waste and soil. Minimize potential release of any residual contaminants to soil or ground water.	No RAOs were specified in the 1999 FS. Portions of the Burn Trenches are beneath the IWA caps for Zone A or Zone C/D. The remaining portions of the Burn Trenches are beneath soil caps.
	Soil		
	Ground Water		

Table 4.3-1
Summary of Remedial Action Objectives

Zone	Remedial Action Objectives		Status
Land Application Areas	Municipal Waste	Prevent direct exposure. Minimize potential release of any residual contaminants to soil or ground water.	These zones were adequately characterized during the Phase I RI, and no RAOs were specified in the 1999 FS. Surface soils associated with Land Application Areas were excavated and transferred to the MSW Landfill, and this remediation was verified by confirmation sampling. Direct exposure to waste addressed through removal and confirmation sampling (shallow soils). Release of residual contaminants to soil or ground water addressed through removal and confirmation sampling (shallow and deep soils).
On-property Ground Water	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through institutional controls.
Off-property Ground Water	Ground Water	Prevent ingestion, inhalation, or dermal absorption.	Achieved through GPA, ICP, and institutional controls.

Notes:
COC = chemical of concern
FS = Feasibility Study
GCCS = gas collection and control system
GPA = Ground Water Protection Area
ICP = Institutional Controls Program
IWA = Industrial Waste Area
MSW = Municipal Solid Waste
O&M = Operations and Maintenance
RAO = remedial action objective
RCRA = Resource Conservation and Recovery Act
RI = Remedial Investigation
RTO = regenerative thermal oxidizer
SVE = soil vapor extraction
VOC = volatile organic compound

Table 4.4-1
Potentially Applicable Requirements – Substantive Requirements

Authorizing Statute	Implementing Regulation	Rationale
Safe Drinking Water Act 42 USC 300	Primary Drinking Water Standards 40 CFR 141 Secondary Drinking Water Standards 40 CFR 143	Ground water is a potential source of drinking water
Clean Water Act 33 USC 1251	Water Quality Standards 40 CFR 131	Ground water discharge to surface water, which supports aquatic life and potentially a source of drinking water
Resource Conservation and Recovery Act 42 USC 6901	Criteria for Classification of Solid Waste Disposal Facilities and Practices 40 CFR 257 Air Emission Standards for Process Vents, Air Emission Standards for Equipment Leaks, and Air Emission Standards for Tanks, Surface Impoundments, and Containers 40 CFR 265AA, 265BB, and 265CC	Excavated wastes and soils may contain listed wastes Applies to vapor treatment systems
Clean Air Act 42 USC 7401	National Ambient Air Quality Standards 40 CFR 50 Ambient Air Quality Monitoring 40 CFR 58 Standards of Performance for New Stationary Sources 40 CFR 60 National Emission Standards for Hazardous Air Pollutants 40 CFR 61 National Emission Standards for Hazardous Air Pollutants for Source Categories 40 CFR 63	Applies to vapor treatment systems
Hazardous Materials Transportation Act 49 USC 1801	Hazardous Materials Regulation 49 CFR 171 Hazardous Materials Tables, Communications Requirements, and Emergency Response Information Requirements 49 CFR 172	May apply to excavated wastes and soils

Table 4.4-1
Potentially Applicable Requirements – Substantive Requirements

Authorizing Statute	Implementing Regulation	Rationale
Clean Air Act RCW 70.94 and 43.21A	General Regulations for Air Pollution Sources WAC 173-400 Controls for New Sources for Toxic Air Pollutants WAC 173-460 Ambient Air Quality Standards for Particulate Matter WAC 173-470 Emission Standards and Controls for Sources Emitting Volatile Organic Compounds (VOCs) WAC 173-490	Applies to vapor treatment systems
Solid Waste Management Act RCW 70.95	Criteria for Municipal Solid Waste Landfills WAC 173-351 Minimum Functional Standards for Solid Waste Handling WAC 173-304	WAC 173-351 applies to the MSW Landfill post-closure activities WAC 173-304 applies to the Balefill cover design criteria
Model Toxics Control Act RCW 70.105D	Model Toxics Control Act Cleanup Regulation WAC 173-340	Establishes cleanup standards for soil, ground water, surface water and air
Comprehensive Environmental Response, Compensation, and Liability Act	Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA	Meets CERCLA requirements
Water Pollution Control/Water Resource Act RCW 90.48 and 90.54	Surface Water Quality Standards WAC 173-201A Protection of Upper Aquifer Zones WAC 173-154 State Waste Discharge Program WAC 173-216	Establishes narrative and numeric standards for waters of the state No water discharge permits are anticipated for the Site
Water Pollution Control Act RCW 90.48	Ground Water Quality Standards for the State of Washington WAC 173-200	Cleanup actions under MTCA are exempt from State ground water standards
Public Water Supplies RCW 90.48	Maximum Contaminant Levels WAC 246-290	Ground water potential source of drinking water
State Environmental Policy Act RCW 43.21C	SEPA Rules WAC 197-11	Cleanup actions under MTCA are exempt from SEPA

Notes
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
MSW = Municipal Solid Waste
MTCA = Model Toxics Control Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
USC = United States Code
WAC = Washington Administrative Code

Table 4.4-2
Potentially Applicable Requirements – Action- and Chemical-specific Requirements

Authorizing Statute	Implementing Regulation	Rationale
Hazardous Waste Management Act RCW 70.105	Dangerous Waste Regulations WAC 173-303	Generation, storage and treatment requirements may apply to condensate
Model Toxics Control Act RCW 70.105D	Model Toxics Control Act Cleanup Regulation WAC 173-340	Sets minimum requirements for cleanup actions
Resource Conservation and Recovery Act Subtitle C 42 USC 6901	Identification and Listing of Wastes 40 CFR 261 Closure and Post-Closure 40 CFR 265	Excavated wastes and soils may contain listed wastes May apply to cleanup actions
Water Well Construction RCW 18.104	Minimum Standards for Construction and Maintenance of Wells WAC 173-160 Rules and Regulations Governing the Licensing of Well Contractors and Operators WAC 173-162	Minimum standards for design and installation of wells
Washington Industrial Safety and Health RCW 49.17	General Occupational Health Standards WAC 296-62	Applies to on-site workers involved in cleanup implementation
Franklin County Code Chapter 17.56	Heavy Industrial Zone I-3	Zoning applies to Future Site use
City of Pasco Municipal Code Chapter 16.06	Utility Service Requirements for Building Permits	Applies to future construction
Federal Insecticide, Fungicide, and Rodenticide Act 40 CFR 150	FIFRA Rules 40 CFR 150	May apply if rodent control and/or application of insecticide is required for Site maintenance
Occupational Safety and Health Act 29 USC 651	Safety and Health Rules 29 CFR 1910	Applies to on-site workers involved in cleanup implementation
Toxic Substances Control Act 15 USC 2601	15 USC s/s 2601 et seq. [1976]	Tracks industrial chemicals, such as PCBs, in the United States and regulates intrastate and interstate commerce
Washington Clean Air Act RCW 70.94 and 43.21A	General Regulations for Air Pollution Sources WAC 173-400 Emission Standards and Controls for Sources Emitting VOCs WAC 173-490	Establishes air quality standards for protection of human health. Applies to emissions from vapor treatment systems constructed as part of the cleanup

Table 4.4-2
Potentially Applicable Requirements – Action- and Chemical-specific Requirements

Notes:
CFR: Code of Federal Regulations
FIFRA = Federal Insecticide, Fungicide, and Rodenticide Act
PCB = polychlorinated biphenyl
RCW = Revised Code of Washington
USC = United States Code
VOC = volatile organic compound
WAC = Washington Administrative Code

Table 4.5.1-1
Ground Water Cleanup Levels

Compound	Cleanup Level (µg/L)	Basis for Cleanup Level
1,1,1-Trichloroethane	200	Federal maximum concentration limit (MCL)
1,1-Dichloroethene	0.057	Surface Water Applicable or Relevant and Appropriate Requirement – Human Health – Fresh Water – National Toxics Rule, 40 CFR 131
1,2-Dichloroethane	0.38	Surface Water Applicable or Relevant and Appropriate Requirement – Human Health – Fresh Water – Clean Water Act §304
cis-1,2-Dichloroethene	16	Ground Water, Method B, Non-carcinogen, Standard Formula Value
Benzene	0.79	Ground Water, Method B, Carcinogen, Standard Formula Value adjusted total cancer risk
Methylene chloride	5	Ground Water, Method B, Carcinogen, Standard Formula Value adjusted total cancer risk
Tetrachloroethene	0.69	Surface Water Applicable or Relevant and Appropriate Requirement – Human Health – Fresh Water – Clean Water Act §304
Toluene	615	Ground Water, Method B, Non-carcinogen, Standard Formula Value adjusted for a hazard quotient of 1.
Trichloroethene	2.5	Surface Water Applicable or Relevant and Appropriate Requirement – Human Health – Fresh Water – Clean Water Act §304
Vinyl chloride	0.069	Ground Water, Method B, Carcinogen, Standard Formula Value adjusted for the MCL and total cancer risk
Total Chromium	100	Federal MCL

Notes:

µg/L = micrograms per liter

CFR = Code of Federal Regulations

Table 4.5.2-1
Soil Draft Cleanup Level Values - Chlorinated Herbicides, Phenols, Dioxins and Furans
Pasco Zone B

Analytical Suite	Analyte	CAS	Human Health Screening Level		Ecological Screening Level	
			Draft Screening Level and Source	Units	Draft Screening Level and Source	Units
Chlorinated Herbicides	2,4,5-T	93-76-5	35,000 (a)	mg/kg	-- **	--
	2,4,5-TP (Silvex)	93-72-1	28,000 (a)	mg/kg	0.109 (g)	mg/kg
	2,4-D	94-75-7	35,000 (b)	mg/kg	0.0272 (g)	mg/kg
	2,4-DB	94-82-6	28,000 (a)	mg/kg	-- **	--
	Bromoxynil	1689-84-5	70,000 (b)	mg/kg	3.16 (h)	mg/kg
	Dalapon	75-99-0	105,000 (a)	mg/kg	-- **	--
	Dicamba	1918-00-9	105,000 (a)	mg/kg	-- **	--
	Dichlorprop	120-36-5	-- *	mg/kg	7.59 (i)	mg/kg
	Dinoseb	88-85-7	3,500 (a)	mg/kg	0.0218 (g)	mg/kg
	MCPA	94-74-6	1,750 (a)	mg/kg	9.27 (j)	mg/kg
	MCPP	93-65-2	3,500 (a)	mg/kg	9.27 (s)	--
Phenols	2,4-Dinitrophenol	51-28-5	7,000 (a)	mg/kg	1.28 (g)	mg/kg
	2-Chlorophenol	95-57-8	17,500 (a)	mg/kg	0.243 (g)	mg/kg
	2,4-Dichlorophenol	120-83-2	10,500 (a)	mg/kg	87.5 (g)	mg/kg
	2,3,4,6-Tetrachlorophenol	58-90-2	105,000 (a)	mg/kg	0.199 (g)	mg/kg
	2,3,5,6-Tetrachlorophenol	935-95-5	105,000 (c)	mg/kg	0.199 (k)	mg/kg
	2,4,5-Trichlorophenol	95-95-4	350,000 (a)	mg/kg	14.1 (g)	mg/kg
	2,4,6-Trichlorophenol	88-06-2	3,500 (a)	mg/kg	9.94 (g)	mg/kg
	2,6-Dichloro-4-methylphenol	2432-12-4	62,000 (d)	mg/kg	1.17 (l)	mg/kg
	2,6-Dichlorophenol	87-65-0	10,500 (e)	mg/kg	1.17 (g)	mg/kg
	3-Chlorophenol	108-43-0	17,500 (f)	mg/kg	7.0 (m)	mg/kg
	4,6-Dichloro-o-cresol	1570-65-6	17,500 (f)	mg/kg	9.94 (n)	mg/kg
	4-Chloro-3-Methylphenol	59-50-7	62,000 (d)	mg/kg	7.0 (o)	mg/kg
	4-Chloro-o-cresol	1570-64-5	17,500 (f)	mg/kg	7.95 (p)	mg/kg
	4-Chlorophenol	106-48-9	17,500 (f)	mg/kg	7.0 (o)	mg/kg
	Pentachlorophenol	87-86-5	328 (aa)	mg/kg	4.5 (q)	mg/kg
Dioxins/ Furans	Total Dioxin TEQ	--	--	--	5 (r)	pg/g

Table 4.5.2-1
Soil Draft Cleanup Level Values - Chlorinated Herbicides, Phenols, Dioxins and Furans
Pasco Zone B

Notes:

* = Constituent has no listed reference dose as specified in WAC 173-340-708(7). No screening level available from EPA Region 3,6,9 Harmonized Regional Screening Level for Industrial Soil.

** = Constituent has no listed reference dose as specified in WAC 173-340-900 Table 749-3. No ecological screening level available from EPA Regions 4 or 5.

a = Value is Noncarcinogen, Soil, Standard Formula Value, Direct Contact (ingestion only), Industrial Land Use, from Department of Ecology Cleanup Levels and Risk Calculation (CLARC) website: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

aa = Value is Carcinogen, Soil, Standard Formula Value, Direct Contact (ingestion only), Industrial Land Use, from Department of Ecology Cleanup Levels and Risk Calculation (CLARC) website: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

b = Value is calculated using Equation 745-1 (noncarcinogen) from the Model Toxics Control Act Statute and Regulation, Publication No. 94-06, Revised November 2007.

c = No reference dose available. 2,3,4,6-Tetrachlorophenol used as a structurally related surrogate.

d = EPA Region 3,6,9 Harmonized Regional Screening Level for Industrial Soil, accessed June 2010.

e = No reference dose available. 2,4-Dichlorophenol used as a structurally related surrogate.

f = No reference dose available. 2-Chlorophenol used as a structurally related surrogate.

g = EPA Region 5 Ecological Screening Level for Soil, dated August 22, 2003.

h = Based on model for shrews as specified in WAC 173-340-900 Table 749-4 using mammalian chronic NOAEL of 1.5.

i = Based on model for shrews as specified in WAC 173-340-900 Table 749-4 using mammalian chronic NOAEL of 3.6.

j = Based on model for shrews as specified in WAC 173-340-900 Table 749-4 using mammalian chronic NOAEL of 4.4.

k = No reference dose available. 2,3,4,6-Tetrachlorophenol used as a structurally related surrogate.

l = No reference dose available. 2,6-Dichlorophenol used as a structurally related surrogate.

m = EPA Region 4 Ecological Screening Level for Soil, accessed September, 2011.

n = No reference dose available. 2,4,6-Trichlorophenol used as a structurally related surrogate.

o = No reference dose available. 3-Chlorophenol used as a structurally related surrogate.

p = No reference dose available. 4-Chloro-m-cresol value (from EPA Region 5) used as a structurally related surrogate.

q = Site Specific Terrestrial Ecological Evaluation Screening Level, Washington State Department of Ecology.

r = Pasco Sanitary Landfill Site - Draft Cleanup Standards, Department of Ecology, April 24, 2007.

s = No reference dose available. MCPA used as a structurally related surrogate.

-- = Not applicable

Table 4.5.2-2
Soil Draft Cleanup Level Values - Polycyclic Aromatic Hydrocarbons
Pasco Zone B

PAH Analyte	**CAS**	**Human Health Screening Level**		**Ecological Screening Level**	
		Draft Screening Level and Source	**Units**	**Draft Screening Level and Source**	**Units**
Acenaphthene	83-32-9	210,000 (a)	mg/kg	100 (c)	mg/kg
Acenaphthylene	208-96-8	-- *	--	100 (c)	mg/kg
Anthracene	120-12-7	1,050,000 (a) ***	mg/kg	100 (c)	mg/kg
Benzo(a)anthracene	56-55-3	180 (aa)	mg/kg	1.1 (d)	mg/kg
Benzo(a)pyrene	50-32-8	18 (aa)	mg/kg	12 (e)	mg/kg
Benzo(b)fluoranthene	205-99-2	180 (aa)	mg/kg	1.1 (d)	mg/kg
Benzo(g,h,i)Perylene	191-24-2	-- *	--	1.1 (d)	mg/kg
Benzo(k)Fluoranthene	207-08-9	1,800 (aa)	mg/kg	1.1 (d)	mg/kg
Chrysene	218-01-9	18,000 (aa)	mg/kg	1.1 (d)	mg/kg
Dibenzo(a,h)anthracene	53-70-3	18 (aa)	mg/kg	1.1 (d)	mg/kg
Dibenzofuran	132-64-9	3,500 (b)	mg/kg	-- **	--
Fluoranthene	206-44-0	140,000 (a)	mg/kg	1.1 (d)	mg/kg
Fluorene	86-73-7	140,000 (a)	mg/kg	30 (f)	mg/kg
Indeno(1,2,3-cd)pyrene	193-39-5	180 (aa)	mg/kg	1.1 (d)	mg/kg
Naphthalene	91-20-3	70,000 (a)	mg/kg	100 (c)	mg/kg
Phenanthrene	85-01-8	-- *	--	100 (c)	mg/kg
Pyrene	129-00-0	105,000 (a)	mg/kg	1.1 (d)	mg/kg
BaP TEQ	--	434	mg/kg	--	--

a = Value is Noncarcinogen, Soil, Standard Formula Value, Direct Contact (ingestion only), Industrial Land Use, from Department of Ecology Cleanup Levels and Risk Calculation (CLARC) website: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

aa = Value is Carcinogen, Soil, Standard Formula Value, Direct Contact (ingestion only), Industrial Land Use, from Department of Ecology Cleanup Levels and Risk Calculation (CLARC) website: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

b = Value is calculated using Equation 745-1 (noncarcinogens) from the Model Toxics Control Act Statute and Regulation, Publication No. 94-06, Revised November 2007.

c = EPA Ecological Soil Screening Level (Eco-SSL) for Low Molecular Weight PAHs based on Wildlife

d = EPA Ecological Soil Screening Level (Eco-SSL) for High Molecular Weight PAHs based on Wildlife

e = Site Specific Terrestrial Ecological Evaluation Screening Level, Washington State Department of Ecology.

f = MTCA Statute and Regulations document (Publication No. 94-06, Revised November 2007), Table 749-3.

* = constituent has no listed Reference Dose as specified in WAC 173-340-708(7)

** = Constituent has no listed reference dose as specified in WAC 173-340-900 Table 749-3. No ecological screening level available.

*** = Screening level exceeds 100%.

-- = Not applicable

BaP = Benzo(a)pyrene

CAS = Chemical Abstracts Service

mg/kg = milligrams per kilogram

PAH = Polycyclic Aromatic Hydrocarbon

TEQ = toxicity equivalent

Table 5.2-1 - MSW Landfill - Alternative Cost Comparison

Project No. 060255, MSW Landfill, Pasco Landfill, Pasco, WA

Alternative MSW-1

Continued operation of the existing landfill gas collection and flare system.

Contingent Alternative MSW-2

Expanded operation of landfill gas collection with addition of four new landfill gas extraction wells.

Contingent Alternative MSW-3

Continued operation of the existing landfill gas collection and flare system. As a Contingency: construction and operation of a groundwater extraction and treatment system

	Alternative MSW-1			Contingent Alternative MSW-2			Contingent Alternative MSW-3		
	Capital	**O&M**	**Total Annual Costs**	**Capital**	**O&M**	**Total Annual Costs**	**Capital**	**O&M**	**Total Annual Costs**
2017	$ -	$ 135,000	$ 135,000	$ 140,000	$ 156,000	$ 296,000	$ 640,000	$ 233,000	$ 873,000
2018	$ -	$ 135,000	$ 135,000	$ -	$ 156,000	$ 156,000	$ -	$ 233,000	$ 233,000
2019	$ -	$ 135,000	$ 135,000	$ -	$ 156,000	$ 156,000	$ -	$ 233,000	$ 233,000
2020	$ -	$ 135,000	$ 135,000	$ -	$ 156,000	$ 156,000	$ -	$ 233,000	$ 233,000
2021	$ -	$ 135,000	$ 135,000	$ -	$ 156,000	$ 156,000	$ -	$ 233,000	$ 233,000
2022	$ 30,000	$ 77,000	$ 107,000	$ 30,000	$ 78,000	$ 108,000	$ 30,000	$ 175,000	$ 205,000
2023	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2024	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2025	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2026	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2027	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2028	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2029	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2030	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000
2031	$ -	$ 77,000	$ 77,000	$ -	$ 78,000	$ 78,000	$ -	$ 175,000	$ 175,000

Total MSW-1 Cost: $ 1,475,000
Total MSW-1 Cost (NPV): $ 1,359,000

Total MSW-2 Cost: $ 1,730,000
Total MSW-2 Cost (NPV): $ 1,608,000

Total MSW-3 Cost: $ 3,585,000
Total MSW-3 Cost (NPV): $ 3,329,000

Notes:

1. Capital costs include design, installation, hookup, and initial testing costs and includes a 20-percent contingency to account for uncertainity in the final design and construction.
2. Long-term costs provided annually for 15-year period.
3. O&M costs also include costs for landfill gas operations and monitoring, compliance groundwater monitoring, maintaining Institutional Controls, and Agency oversight.
4. All alternatives assume replacement of the existing landfill gas flare with a utility flare in year 5 and corresponding reduction in O&M costs in subsequent years.
5. Net Present Value (NPV) calculated using a real discount rate of 1.2 percent according to the Federal Office of Management and Budget (https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).
6. These cost estimates are approximately +50/-30 percent of actual costs.

Table 5.2-2 - Alternative MSW-1 - Detailed Cost Estimate

Project No. 060255, MSW Landfill, Pasco Landill, Pasco, WA

TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]: $0

Direct Annual Operating Costs (Years 0-5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	LS	$10,000	$10,000	
Sampling/Operator & Maintenance Labor (OL)	624	Man Hours	$75	$46,800	12 hours per week, 52 weeks per year
Field Supplies	12	Month	$1,000	$12,000	
Quarterly Reporting	4	Each	$10,000	$40,000	
Condensate Disposal	1	LS	$2,500	$2,500	
Laboratory Analytical	1	LS	$12,000	$12,000	
Electricity	12,000	kwh	$0.10	$1,200	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi-annually
			TOTAL ANNUAL COST (Years 0-5):	**$135,000**	

Landfill Gas Flare Replacement (Year 5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Utility Flare	1	LS	$10,000	$10,000	Quote from Parnel Biogas
Taxes (9% of EQ)	1	Lump	$900	$900	
Freight (5% of EQ)	1	Lump	$500	$500	
Miscellaneous Process and Mechanical	1	Lump	$5,000	$5,000	
Engineering Design & Startup	1	LS	$7,500	$7,500	
		Flare Replacement (Subtotal):		$23,900	
		Contingency (20% Subtotal):		$4,780	
		TOTAL Flare Replacement (Year 5):		**$30,000**	

Direct Annual Operating Costs (Years >5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	Lump	$5,000	$5,000	
Sampling/Operator & Maintenance Labor (OL)	416	Man Hours	$75	$31,200	8 hours per week, 52 weeks per year
Field Supplies	1	LS	$1,500	$1,500	
Quarterly Reporting	2	Each	$10,000	$20,000	Assume reduction to semi-annual reporting
Condensate Disposal	1	LS	$1,500	$1,500	
Laboratory Analytical	1	LS	$6,000	$6,000	
Electricity (100 kVA assumed)	1	LS	$1,500	$1,500	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi-annually
			TOTAL ANNUAL COST (Years >5):	**$77,000**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs
2. The Landfill Gas Collection and Flare system would continue current operations for 5 years; After 5 years it is asumed that the existing flare would be decommisioned and transitioned to a utility flare to adapt the flare treatment consistent with changes in Landfill Gas collection and loading to the flare.

Revision Date: July 2017.

Table 5.2-3 - Alternative MSW-2 - Detailed Cost Estimate

Project No. 060255, MSW Landfill, Pasco Landfill, Pasco, WA

Landfill Gas Collection System - Purchased Equipment	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Extraction Well Mechanical	4	Each	$500	$2,000	
Valves, and appurtenances	4	Each	$250	$1,000	
Instrumentation and Controls	1	LS	$7,500	$7,500	
Equipment Subtotal (EQ):				***$11,000***	
Taxes (9% of EQ)	1	Lump	$990	$990	
Freight (2% of EQ)	1	Lump	$220	$220	
Total Purchased Equipment Cost (PEC):				***$12,000***	

Landfill Gas Collection System - Direct Installation Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Install Landfill Gas Extraction Wells	4	Each	$10,500	$42,000	
1" HDPE Extraction System Piping	1,000	LF	$10	$10,000	
Process and Mechanical Installation	1	Lump	$20,000	$20,000	
Total Direct Installation Cost (DI):				***$72,000***	
TOTAL DIRECT COST (DC) [PEC + DI]:				**$80,000**	

Landfill Gas Collection System - Indirect Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Engineering Design	1	LS	$15,000	$15,000	
Start Up and Influence Testing	1	LS	$25,000	$25,000	
Total Indirect Cost (IC):				***$40,000***	
Total Capital Investment (Subtotal):				$120,000	
Contingency (20% Subtotal):				$24,000	
TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]:				**$140,000**	

Direct Annual Operating Costs (Years 0-5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	Lump	$10,000	$10,000	
Sampling/Operator & Maintenance Labor (OL)	1,000	Man Hours	$75	$75,000	~20 hours per week, 52 weeks per year
Field Supplies	1	LS	$3,000	$3,000	
Quarterly Reporting	4	Each	$10,000	$40,000	
Condensate Disposal	1	LS	$4,000	$4,000	
Laboratory Analytical	1	LS	$12,000	$12,000	
Electricity	15,000	kwh	$0.10	$1,500	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi annually
TOTAL ANNUAL COST (Years 0-5):				**$156,000**	

Landfill Gas Flare Replacement (Year 5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Utility Flare	1	LS	$10,000	$10,000	Quote from EPG
Taxes (9% of EQ)	1	Lump	$900	$900	
Freight (5% of EQ)	1	Lump	$500	$500	
Miscellaneous Process and Mechanical	1	Lump	$5,000	$5,000	
Engineering Design & Startup	1	LS	$7,500	$7,500	
Flare Replacement (Subtotal):				$23,900	
Contingency (20% Subtotal):				$4,780	
TOTAL Flare Replacement (Year 5):				**$30,000**	

Direct Annual Operating Costs (Years >5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	Lump	$5,000	$5,000	
Sampling/Operator & Maintenance Labor (OL)	416	Man Hours	$75	$31,200	16 hours per week, 52 weeks per year
Field Supplies	1	LS	$1,500	$1,500	
Quarterly Reporting	2	Each	$10,000	$20,000	Reporting to include required reporting of GW Treatment System
Condensate Disposal	1	LS	$2,500	$2,500	
Laboratory Analytical	1	LS	$6,000	$6,000	
Electricity (100 kVA assumed)	1	LS	$3,000	$1,500	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi annually
TOTAL ANNUAL COST (Years >5):				**$78,000**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30% of actual costs
2. Four new Landfill Gas collection wells would be installed and tied into the existing collection systen
3. Startup and Influence Testing would include two weeks of field activities for influence testing and flow adjustments and summary memorandum describing results
4. The Landfill Gas Collection and Flare system would continue current operations for 5 years; After 5 years it is asumed that the existing flare would be decommisioned and transitioned to a utility flare to adapt the flare treatment consistent with changes in Landfill Gas collection and loading to the flare

Revision Date: July 2017.

Table 5.2-4 - Alternative MSW-3 - Detailed Cost Estimate

Project No. 060255, MSW Landfill, Pasco Landfil, Pasco, WA

GW Treatment System - Purchased Equipment	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
GW Extraction Pumps and Appurtenances	5	Each	$2,250	$11,250	Grundfos 25E6 4" Submersible (1HP, 110 TDH)
Valve Vaults w/ Hinged Locking Covers	5	Each	$1,000	$5,000	
Extraction System Instrumentation (flow and level)	5	Each	$1,000	$5,000	
10,000 Gal Aeration/Sedimentation Basin	1	Each	$12,000	$12,000	For oxidation of reduced, dissolved metals forms
Blower and Diffuser Equipment	1	LS	$5,000	$5,000	
1.5HP Porgressive Cavity Transfer Pump	1	Each	$2,500	$2,500	
30 GPM Ion Exchange Skid	2	Each	$25,000	$50,000	
Control Panel	1	Each	$10,000	$10,000	
Power Drop	1	Each	$15,000	$15,000	
Piping, valves, and appurtenances (4% EQ)	1	Lump	$35,000	$35,000	
Instrumentation, Controls and SCADA	1	LS	$20,000	$20,000	Instrumentation for fully-automated operated
Equipment Subtotal (EQ):				***$171,000***	
Taxes (9% of EQ)	1	Lump	$15,390	$15,390	
Freight (3% of EQ)	1	Lump	$5,130	$5,130	
Total Purchased Equipment Cost (PEC):				***$192,000***	

GW Treatmetn System - Direct Installation Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Permitting	1	LS	$10,000	$10,000	
10'x20' Treatment System Control/Storage Building	200	SF	$150	$30,000	
Install GW Extraction Wells (50' deep x 6" dia.)	5	Each	$12,000	$60,000	
1" HDPE Extraction System Piping on Surface w heat trace	1,800	LF	$30	$54,000	
2" HDPE Discharge Piping	300	LF	$28	$8,400	Estimated. Unknown discharge point
Extraction System Conduit and Wiring	1,800	LF	$25	$45,000	
Set Process Equipment (4% of EQ)	1	Lump	$6,840	$6,840	
Process Piping (3% of EQ)	1	Lump	$5,130	$5,130	
Heating and Lighting (1% of EQ)	1	Lump	$1,710	$1,710	
Electrical (4% of EQ)	1	Lump	$6,840	$6,840	
Total Direct Installation Cost (DI):				***$227,920***	

TOTAL DIRECT COST (DC) [PEC + DI]: $420,000

GW Treatment System - Indirect Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Engineering (12% of EQ)	1	LS	$20,520	$20,520	
Treatment - Bench Scale Testing	1	LS	$50,000	$50,000	
NPDES Permitting	1	LS	$7,500	$7,500	
Construction Oversight (3.5% of DC)	1	LS	$14,700	$14,700	
Start Up (3% of DC)	1	LS	$12,600	$12,600	
Total Indirect Cost (IC):				***$105,320***	
Total Capital Investment (Subtotal):				$530,000	
Contingency (20% Subtotal):				$106,000	

TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]: $640,000

GW Treatment System - Direct Annual Operating Costs (All years)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Maintenance and Replacement Parts (2.5% EQ)	1	Lump	$4,275	$4,275	
Sampling/Operator & Maintenance Labor (OL)	624	Man Hours	$75	$46,800	12 hours per week, 52 weeks per year
Field Supplies	12	Month	$1,000	$12,000	
Reporting	0	LS	$20,000	$0	Assumes reporting within routine reporting
Laboratory Analytical	1	LS	$6,000	$6,000	Anticipated compliance and operational sampling at approx. $500/month
Electricity	25,000	kwh	$0.10	$2,500	Estimated based on components described above
NPDES Reporting	12	Month	$500	$6,000	
Sedimentation Basin - Solids Removal and Disposal	1	LS	$10,000	$10,000	
Ion Exchange Resin Replacement and Disposal	1	LS	$10,000	$10,000	
GW Treatment System - Total Direct Annual Operating Cost (DAC1):				***$97,575***	

Direct Annual Operating Costs (Years 0-5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	Lump	$10,000	$10,000	
Sampling/Operator & Maintenance Labor (OL)	624	Man Hours	$75	$46,800	12 hours per week, 52 weeks per year
Field Supplies	12	LS	$1,000	$12,000	
Quarterly Reporting	4	Each	$10,000	$40,000	Reporting to include required reporting of GW Treatment System
Condensate Disposal	1	LS	$2,500	$2,500	
Laboratory Analytical	1	LS	$12,000	$12,000	
Electricity	12,000	kwh	$0.10	$1,200	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi-annually
Total Direct Annual Operating Cost, Years 0-5 (DAC2):				***$135,000***	

TOTAL ANNUAL COST (DAC1 + DAC2; Years 0-5): $233,000

Landfill Gas Flare Replacement (Year 5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Utility Flare	1	LS	$10,000	$10,000	Quote from Parnel Biogas
Taxes (9% of EQ)	1	Lump	$900	$900	
Freight (5% of EQ)	1	Lump	$500	$500	
Miscellaneous Process and Mechanical	1	Lump	$5,000	$5,000	
Engineering Design & Startup	1	LS	$7,500	$7,500	
Flare Replacement (Subtotal):				$23,900	
Contingency (20% Subtotal):				$4,780	

TOTAL Flare Replacement (Year 5): $30,000

Direct Annual Operating Costs (Years >5)	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Landfill Gas Collection and Flare System					
Maintenance and Replacement Parts	1	Lump	$5,000	$5,000	
Sampling/Operator & Maintenance Labor (OL)	416	Man Hours	$75	$31,200	8 hours per week, 52 weeks per year
Field Supplies	1	LS	$1,500	$1,500	
Quarterly Reporting	2	Each	$10,000	$20,000	Assume reduction to semi-annual reporting
Condensate Disposal	1	LS	$1,500	$1,500	
Laboratory Analytical	1	LS	$6,000	$6,000	
Electricity (100 kVA assumed)	1	kwH	$1,500	$1,500	
Groundwater Monitoring					
Compliance GW Monitoring	1	LS	$10,000	$10,000	Two wells quarterly; Six wells semi-annually
Total Direct Annual Operating Cost (DAC4; Years >5):				***$77,000***	

TOTAL ANNUAL COST (DAC1 + DAC4; Years >5): $175,000

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs
2. Cost estimate assumes construction of a new building to house the treatment system. Building would be sited next Landfill Gas Flare
3. Miscellaneous electrical costs include costs associated with distributing power as required for the extraction and treatment system components, and electrical installation of lighting, ventilation, and treatment equipment
4. The groundwater extraction system includes 5 extraction wells equipped with centrifugal submersible pumps, level control systems, and flow meters
5. Treated groundwater will be discharged under an NPDES permit
6. Total groundwater extraction flow rate is assumed to be approximately 20 gallons per minute (gpm).
7. Pricing and treatment technologies are subject to change based on further site investigations
8. Electrical conduit will be installed in trench according to NFPA code.
9. The treatment system will be capable of treating at flow rates up to 30 gpm
10. System startup includes a two week operation/troubleshooting period and preparation of an O&M Manual
11. The Landfill Gas Collection and Flare system would continue current operations for 5 years; After 5 years it is asumed that the existing flare would be decommisioned and transitioned to a utility flare to adapt the flare treatment consistent with changes in Landfill Gas collection and loading to the flare

Revision Date: July 2017.

Table 5.3-1 - Balefill Area Cost Summary

Project No. 060255, Balefill Area, Pasco Landfill, Pasco, WA

Alternative BA-1

	Capital	O&M	Total Annual Costs
2017	$ 310,000	$ 10,500	$ 320,500
2018	$ -	$ 10,500	$ 10,500
2019	$ -	$ 10,500	$ 10,500
2020	$ -	$ 10,500	$ 10,500
2021	$ -	$ 10,500	$ 10,500
2022	$ -	$ 10,500	$ 10,500
2023	$ -	$ 10,500	$ 10,500
2024	$ -	$ 10,500	$ 10,500
2025	$ -	$ 10,500	$ 10,500
2026	$ -	$ 10,500	$ 10,500
2027	$ -	$ 10,500	$ 10,500
2028	$ -	$ 10,500	$ 10,500
2029	$ -	$ 10,500	$ 10,500
2030	$ -	$ 10,500	$ 10,500
2031	$ -	$ 10,500	$ 10,500
		Total BA-1 Cost:	**$ 467,500**
		Total BA-1 Cost (NPV):	**$ 450,000**

Notes:

1. Alternative assumes a cover rehabilitation of approximately 25% of the total Balefill and IWDA areas.
2. The cover consists of 30 inches of 10-6 cm/s soil, geotextile seperation barrier, and a crushed rock surface layer to inhibit vegetation.
3. Long-term costs provided annually for 15-year period.
4. O&M costs include inspections and maintenance of existing cover system.
5. Capital costs include design, installation, hookup, and initial testing costs and includes a 20-percent contingency to account for uncertainity in the final design and construction.
6. Net Present Value (NPV) calculated using a real discount rate of 1.2% according to the Federal Office of Management and Budget (https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).
7. These cost estimates are approximately +50/-30 percent of actual costs.

Table 5.3-2 - Balefill and Inert Waste Area - Detailed Cost Estimate

Project No. 060255, Balefill and Inert Waste Area, Pasco Landfill, Pasco, WA

Landfill Soil Cover - Direct Installation Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Consolidate and cover waste & Site prep	5,000	CY	$8	$40,000	
Import, place and compact cover soils (30" soil cover)	4,000	CY	$33	$132,000	
Crushed rock (6" cover)	1,000	tons	$25	$25,000	
Geotextile (Seperation Barrier)	5,000	SY	$6	$30,000	
TOTAL DIRECT COST (DC):				**$230,000**	

Landfill Soil Cover - Indirect Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Engineering	1	LS	$12,000	$12,000	
Construction Oversight (3.5% of DC)	1	LS	$8,050	$8,050	
Bidding and Contractor Management (2.5% of DC)	1	LS	$5,750	$5,750	
Probe and thermocouple decommissioning	1	LS	$2,500	$2,500	
Total Indirect Cost (IC):				***$28,300***	
Total Capital Investment (Subtotal):				$260,000	
Contingency (20% Subtotal):				$52,000	
TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]:				**$310,000**	

Landfill Soil Cover - Direct Annual Operating Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Cover Inspection and Maintenance	1	LS	$2,500	$2,500	
Probe and thermocouple monitoring, download, reporting	1	LS	$8,000	$8,000	
TOTAL ANNUAL COST (DAC1 + DAC2; Years 0-5):				**$10,500**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs.
2. Landfill Soil Cover would consists of a 30-inch soil cover with maximum permeability of $1x10^{-5}$ cm/sec, 6 inches of crushed rock and a geotextile between soil and rock as seperation barrier.
3. The quantities assume that approximately 25 percent of the total Balefill Area and Inert Waste Disposal Areas will require the engineered cover system.

Revision Date: July 2017.

Table 5.3-3 - Burn Trenches - Alternative Cost Comparison

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco, WA

	Alternative BT-A			Alternative BT-B			Alternative BT-C		
	Capital	**O&M**	**Total Annual Costs**	**Capital**	**O&M**	**Total Annual Costs**	**Capital**	**O&M**	**Total Annual Costs**
2017	$ -	$ 1,000	$ 1,000	$ 24,000	$ 2,000	$ 26,000	$ 108,000	$ 2,500	$ 110,500
2018	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2019	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2020	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2021	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2022	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2023	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2024	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2025	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2026	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2027	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2028	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2029	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2030	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
2031	$ -	$ 1,000	$ 1,000	$ -	$ 2,000	$ 2,000	$ -	$ 2,500	$ 2,500
		Total BT-A Cost:	**$ 15,000**		**Total BT-B Cost:**	**$ 54,000**		**Total BT-C Cost:**	**$ 145,500**
		Total BT-A Cost (NPV):	**$ 14,000**		**Total BT-B Cost (NPV):**	**$ 51,000**		**Total BT-C Cost (NPV):**	**$ 141,000**

Notes:

1. Alternative BT-B assumes a cover investigation to verify the integrity and thickensss of the existing cover system.
2. Alternative 3 assumes a cover investigation, and cover rehabilitation of approximately 25 percent of the total Burn Trench Areas.
3. Long-term costs provided annually for 15-year period.
4. O&M costs include inspections and maintenance of existing cover system.
5. Capital costs include design, installation, hookup, and initial testing costs and includes a 20-percent contingency to account for uncertainity in the final design and construction.

6. Net Present Value (NPV) calculated using a real discount rate of 1.2 percent according to the Federal Office of Management and Budget (https://www.whitehouse.gov/omb/circulars_a094/a94_appx-c).
7. These cost estimates are approximately +50/-30 percent of actual costs.

Table 5.3-4 - Burn Trench Alternative BT-A - Detailed Cost Estimate

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco, WA

Landfill Soil Cover - Direct Annual Operating Costs	Quantity	Units	Unit Cost	Extension	Description
			TOTAL CAPITAL INVESTMENT:	**$0**	
Cover Inspection and Maintenance	1	LS	$1,000	$1,000	
			TOTAL ANNUAL COST:	**$1,000**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs.
Revision Date: July 2017.

Table 5.3-5 - Burn Trench Alternative BT-B - Detailed Cost Estimate

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco, WA

Landfill Soil Cover - Indirect Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Cover Soil Investigation	3	day	$2,500	$7,500	
Investigation Oversight	1	LS	$7,500	$7,500	
Investigation Summary Report	1	LS	$5,000	$5,000	
			Total Indirect Cost (IC):	***$20,000***	
			Contingency (20% Subtotal):	$4,000	
			TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]:	**$24,000**	

Landfill Soil Cover - Direct Annual Operating Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Cover Inspection and Maintenance	1	LS	$2,000	$2,000	
			TOTAL ANNUAL COST:	**$2,000**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs.
2. Cover Soil Investigation would involve installation of direct-push borings across the BT area to verify thickness and integrity of existing soil cover.
3. Costs assume that no required improvements would be identified by investigation.

Revision Date: July 2017.

Table 5.3-6 - Burn Trench Alternative BT-C - Detailed Cost Estimate

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco. WA

Landfill Soil Cover - Direct Installation Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Consolidate and cover waste & Site prep	1,000	CY	$8	$8,000	
Import, place and compact cover soils (30" soil cover)	1,210	CY	$33	$39,940	
Crushed rock (6" cover)	315	tons	$25	$7,867	
Geotextile (Seperation Barrier)	1,452	SY	$6	$8,714	
			TOTAL DIRECT COST (DC):	**$60,000**	

Landfill Soil Cover - Indirect Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Cover Soil Investigation	3	day	$2,500	$7,500	
Investigation Oversight	1	LS	$7,500	$7,500	
Engineering	1	LS	$6,000	$6,000	
Construction Oversight (5% of DC)	1	LS	$2,100	$2,100	
Bidding and Contractor Management (5% of DC)	1	LS	$1,500	$1,500	
Investigation Summary Report	1	LS	$5,000	$5,000	
			Total Indirect Cost (IC):	***$29,600***	
			Total Capital Investment (Subtotal):	$90,000	
			Contingency (20% Subtotal):	$18,000	
			TOTAL CAPITAL INVESTMENT (TCI) [DC + IC+ Contingency]:	**$108,000**	

Landfill Soil Cover - Direct Annual Operating Costs	**Quantity**	**Units**	**Unit Cost**	**Extension**	**Description**
Cover Inspection and Maintenance	1	LS	$2,500	$2,500	
			TOTAL ANNUAL COST:	**$2,500**	

Notes:

1. The costs presented are preliminary estimates based on existing information and are estimated to be within +50/-30 percent of actual costs.
2. Cover Soil Investigation would involve installation of direct-push borings across the BT area to verify thickness and integrity of existing soil cover.
3. The quantities assume that approximately 25 percent of the BT-1 area will require an engineering cover system.
4. Landfill Soil Cover would consists of a 30-inch soil cover with maximum permeability of 1x10 $^{-5}$ cm/sec, 6 inches of crushed rock and a geotextile between soil and rock as seperation barrier.

Revision Date: July 2017.

Table 5.4-1
Zone A
Alternative Cost Summary

	Alternative									
	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	
Task	**On-going SVE**	**Enhanced SVE + Air Sparging/ Ozone Treatment**	**Enhanced SVE + GW Contingency**	**Enhanced SVE + Soil Contingency**	**On-Site AOC to Top of Touchet Beds + SVE Treatment in Touchet Beds**	**On-Site AOC to Top of Touchet Beds + Thermal Treatment in Touchet Beds**	**On-Site AOC to Top of Upper Pasco Gravels**	**Implementation of A-2 for Years 1-10 and A-7 for Years 11-30**	**Excavation to Top of Upper Pasco Gravels + Off-site Disposal**	**No Action Alternative**
Construction Costs										
Mobilization/Demobilization/Site Preparation	$130,137	$240,261	$234,887	$3,302,665	-	-	-	$192,099	-	$5,357
Air Sparging and Ozone Treatment	-	$443,627	-	-	-	-	-	$457,276	-	-
In Situ Amendments	-	-	$410,037	$19,594,815	-	-	-	-	-	-
Contractor Planning, Mobilization, and Project Support	-	-	-	-	$5,798,841	$5,861,738	$5,847,353	$4,224,032	$6,164,957	-
Excavation and Disposal	-	-	-	-	$6,567,178	$6,567,178	$8,846,803	$6,391,118	$48,066,204	-
Additional Activities Associated with Excavation	-	-	-	-	$456,598	$456,598	$456,598	$329,856	$456,598	-
Construction and Placement in On-site AOC	-	-	-	-	$5,096,316	$5,096,316	$7,776,569	$5,617,959	-	-
Thermal Treatment	-	-	-	-	-	$6,384,000	-	-	-	-
SVE Well Drilling	-	-	-	-	$620,486	$453,544	$453,544	$327,650	$453,544	-
Ground Water Well Installation and/or Decommissioning	$23,521	$23,521	$23,521	$12,360	$48,521	$58,253	$58,253	$45,733	$58,253	$33,484
Additional SVE Well Installation (for Enhanced SVE)	-	$244,651	$244,651	$244,651	-	-	-	$244,651	-	-
Cap Replacement	$782,933	$782,933	$782,933	$782,933	-	-	-	$471,329	-	-
Institutional Controls (Fencing, Signage, EC)	$6,900	$6,900	$6,900	$6,900	$56,172	$56,172	$56,172	$42,495	$56,172	-
Subtotal - Construction Costs	**$943,491**	**$1,741,893**	**$1,702,928**	**$23,944,323**	**$18,644,111**	**$24,933,798**	**$23,495,291**	**$18,344,197**	**$55,255,728**	**$38,842**
Sales Tax (8.6%)	$81,140	$149,803	$146,452	$2,059,212	$1,603,394	$2,144,307	$2,020,595	$1,577,601	$4,751,993	$3,340
Total - Construction Costs	**$1,025,000**	**$1,892,000**	**$1,849,000**	**$26,004,000**	**$20,248,000**	**$27,078,000**	**$25,516,000**	**$19,922,000**	**$60,008,000**	**$42,000**
Non-Construction Costs										
Design, Project Management, and Permitting	$174,250	$321,640	$314,330	$4,420,680	$3,442,160	$4,603,260	$4,337,720	$3,386,570	$10,201,360	$4,200
Construction Management and Inspection	$82,000	$151,360	$147,920	$2,080,320	$1,619,840	$2,166,240	$2,041,280	$1,593,680	$4,800,640	-
Ground Water Monitoring and Reporting	$1,232,272	$1,232,272	$1,232,272	$1,232,272	$1,232,272	$1,247,794	$1,247,794	$1,211,363	$1,247,794	$839,703
Cap Monitoring, Maintenance, and Inspection	$2,377,378	$2,377,378	$2,377,378	$2,377,378	$2,059,129	$2,059,129	$2,059,129	$2,269,825	$2,059,129	$1,002,896
AOC RCRA Cap Monitoring and Maintenance	-	-	-	-	$2,890,057	$2,890,057	$3,501,914	$1,678,409	-	-
SVE Operation, Maintenance, and Repairs	$7,862,938	$7,862,938	$7,862,938	$7,862,938	$7,862,938	$3,724,189	$3,724,189	$6,002,126	$3,724,189	-
Air Sparge and Ozone Operation/Maintenance	-	$752,619	-	-	-	-	-	$228,065	-	-
Institutional Controls Operation and Maintenance	$621,334	$621,334	$621,334	$621,334	$621,334	$621,334	$621,334	$621,334	$621,334	-
Total - Non-Construction Costs	**$12,350,000**	**$13,320,000**	**$12,556,000**	**$18,595,000**	**$19,728,000**	**$17,312,000**	**$17,533,000**	**$16,991,000**	**$22,654,000**	**$1,847,000**
Total Project Costs										
Total Project Costs (Excluding Contingency)	**$13,375,000**	**$15,212,000**	**$14,405,000**	**$44,599,000**	**$39,976,000**	**$44,390,000**	**$43,049,000**	**$36,913,000**	**$82,662,000**	**$1,889,000**
Contingency (variable)	$2,675,000	$3,042,400	$2,881,000	$17,839,600	$15,990,400	$17,756,000	$17,219,600	$13,001,200	$45,464,100	$377,800
Total Project Costs (Including Contingency)	**$16,100,000**	**$18,300,000**	**$17,300,000**	**$62,400,000**	**$56,000,000**	**$62,100,000**	**$60,300,000**	**$49,900,000**	**$128,100,000**	**$2,300,000**

Notes:
1. Total costs are presented on a net present value basis (assuming a 3% discount rate).
2. Rationale for a variable contingency applied to the Zone A alternatives is described in Appendix E, Attachment G.

AOC = area of contamination
EC = environmental covenant
GW = ground water
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

Table 5.5-1
Zone B
Summary of Cost Details

Task	Alternative					
	B-1	B-2	B-3	B-4	B-5	No Action Alternative
Long-term O&M Costs						
Annual O&M Management & Reporting	$ 35,666	$ 35,666	$ 35,666	$ 35,666	$ 35,666	$ 35,666
Annual O&M Subcontractor Costs	$ 4,800	$ 4,800	$ 4,800	$ 4,800	$ 4,800	$ 2,400
Semiannual Groundwater Laboratory (2 points x VOCs/SVOCs/Herbs)	$ 1,760	$ 1,760	$ 1,760	$ 1,760	$ 1,760	$ 1,760
Annual Signage/Fence/Tumbleweed/Irrigation/Misc Materials	$ 3,350	$ 3,350	$ 3,350	$ 3,350	$ 3,350	$ -
8.6% Sales Tax on Subcontractor, Laboratory, Maintenance	$ 852	$ 852	$ 852	$ 852	$ 852	$ 358
Ecology Annual Oversight Charges	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500
Annual O&M Budget (with rounding)	$ 48,928	$ 48,928	$ 48,928	$ 48,928	$ 48,928	$ 42,684
Years of Operation	30	30	30	30	30	30
Long-term O&M Costs	**$ 1,467,854**	**$ 1,467,854**	**$ 1,467,854**	**$ 1,467,854**	**$ 1,467,854**	**$ 1,280,519**
Capital Costs needing Sales Tax						
Drilling	$ -	$ 210,000	$ 463,600	$ 98,000	$ -	$ -
Excavation	$ -	$ -	$ -	$ -	$ 1,478,075	$ -
Waste Transportation & Disposal	$ -	$ 22,680	$ 45,360	$ -	$ 9,758,429	$ -
Rebuild Cap at End of Life (Task 1b)	$ 837,731	$ 837,731	$ 837,731	$ 837,731	$ 837,731	$ -
Fill, Rebuild, Seed, Irrigate Liner/Cap in Intrusive Work Area	$ -	$ -	$ -	$ 227,386	$ 800,000	$ -
Equipment Rental, Bioremediation or Stabilization Amendment	$ -	$ 2,950	$ 25,775	$ 6,150	$ 2,480	$ -
Laboratory	$ -	$ 31,680	$ 37,080	$ -	$ 52,800	$ -
8.6% Sales Tax	$ 72,045	$ 95,034	$ 121,221	$ 100,557	$ 1,111,938	$ -
Capital Costs not needing Sales Tax						
Design and Management	$ -	$ 217,333	$ 260,676	$ 245,742	$ 2,058,522	$ -
Design and Management for Rebuild Cap at End of Life (Task 1b)	$ 257,895	$ 257,895	$ 257,895	$ 257,895	$ 257,895	$ -
Ecology Remedial Event Oversight	$ 10,000	$ 30,000	$ 30,000	$ 20,000	$ 20,000	$ -
Total Capital Costs	**$ 1,177,671**	**$ 1,705,302**	**$ 2,079,338**	**$ 1,793,461**	**$ 16,377,870**	**$ -**
Total Project Cost (with rounding)	**$ 2,645,524**	**$ 3,173,156**	**$ 3,547,192**	**$ 3,261,314**	**$ 17,845,723**	**$ 1,280,519**
Total Project Cost (NPV) (with rounding)	**$ 1,444,000**	**$ 1,837,000**	**$ 2,115,000**	**$ 2,042,000**	**$ 16,202,000**	**$ 837,000**
Contingency (+50% as NPV)	$ 722,000	$ 918,500	$ 1,057,500	$ 1,021,000	$ 8,101,000	$ 418,500
Total Project Cost (NPV), including Contingency	**$ 2,166,000**	**$2,756,000**	**$3,173,000**	**$3,063,000**	**$24,303,000**	**$1,256,000**

Notes:

1. Capital costs include remedy design, installation, and sampling
2. Annual costs include monitoring, general operation and maintenance, maintaining institutional controls, and reporting
3. Cap replacement inserted as capital cost at 30 years in each scenario

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Table 5.5-2
Zone B
Summary of Net Present Value Calculations

	Alternative B-1			Alternative B-2			Alternative B-3			Alternative B-4			Alternative B-5			No Action Alternative		
Year	**Capital**	**Annual**	**Total**	**Capital**	**Annual**	**Total**	**Capital**	**Annual**	**Total**	**Capital**	**Annual**	**Total**	**Capital**	**Annual**	**Total**	**Capital**	**Annual**	**Total**
1	$ -	$ 48,928	$48,928	$ 175,877	$ 48,928	$224,806	$ 300,556	$ 48,928	$349,484	$ 615,790	$ 48,928	$664,719	$ 15,200,199	$ 48,928	$15,249,127	$ -	$ 42,684	$42,684
2	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
3	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
4	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
5	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
6	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
7	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
8	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
9	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
10	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
11	$ -	$ 48,928	$48,928	$ 175,877	$ 48,928	$224,806	$ 300,556	$ 48,928	$349,484	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
12	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
13	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
14	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
15	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
16	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
17	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
18	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
19	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
20	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
21	$ -	$ 48,928	$48,928	$ 175,877	$ 48,928	$224,806	$ 300,556	$ 48,928	$349,484	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
22	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
23	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
24	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
25	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
26	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
27	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
28	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
29	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 48,928	$48,928	$ -	$ 42,684	$42,684
30	$ 1,177,671	$ 48,928	$1,226,599	$ 1,177,671	$ 48,928	$1,226,599	$ 1,177,671	$ 48,928	$1,226,599	$ 1,177,671	$ 48,928	$1,226,599	$ 1,177,671	$ 48,928	$1,226,599	$ -	$ 42,684	$42,684
Total	$ 1,178,000	$ 1,470,000	$ 2,650,000	$ 1,705,000	$ 1,470,000	$ 3,173,000	$ 2,079,000	$ 1,470,000	$ 3,550,000	$ 1,793,000	$ 1,470,000	$ 3,261,000	$ 16,378,000	$ 1,470,000	$ 17,850,000	$ -	$ 1,280,000	$ 1,280,000
Net Present Value	**$1,444,000**			**$1,837,000**			**$2,115,000**			**$2,042,000**			**$16,202,000**			**$837,000**		

Key Assumptions:

1. Capital costs include remedy design, installation, and sampling
2. Annual costs include monitoring, general operation and maintenance, maintaining institutional controls, and reporting
3. Cap replacement inserted as capital cost at 30 years in each scenario

Table 5.6-1
Zones C and D
Alternative Cost Summary

Task	Alternative			
	CD-1	CD-2	CD-3	No Action Alternative
Construction Costs				
Mobilization/Demobilization/Site Preparation	$ 22,527	$ 76,035	$ 493,412	$ 1,380
Contingent In situ Amendments	$ -	$ 334,426	$ -	$ -
Ground to Geomembrane - Clean Excavation	$ -	$ -	$ 9,692	$ -
Geomembrane to Bottom of Over-excavation - Excavation	$ -	$ -	$ 55,946	$ -
Waste Characterization - Lab Testing	$ -	$ -	$ 407,531	$ -
Transportation and Disposal of Waste/Soils - Subtitle C Landfill (100%)	$ -	$ -	$ 2,090,570	$ -
Backfill and Capping	$ -	$ -	$ 448,234	$ -
Ground Water Well Installation and/or Decommissioning	$ 6,419	$ 6,419	$ 27,441	$ 8,626
Cap Replacement (Year 15)	$ 128,372	$ 128,372	$ -	$ -
Institutional Controls (Fencing, Signage, and/or Environmental Covenant)	$ 6,000	$ 6,000	$ 35,710	$ -
Subtotal - Construction Costs	***$ 163,318***	***$ 551,251***	***$ 3,568,536***	***$ 10,006***
Sales Tax (8.6%)	$ 14,045	$ 47,408	$ 306,894	$ 861
Total - Construction Costs	***$ 177,363***	***$ 598,659***	***$ 3,875,430***	***$ 10,867***
Non-Construction Costs				
Design, Project Management, and Permitting	$ 30,152	$ 101,772	$ 658,823	$ 1,090
Construction Management and Inspection	$ 14,189	$ 47,893	$ 310,034	$ -
Groundwater Monitoring and Reporting	$ 258,795	$ 258,795	$ 208,654	$ 141,213
Cap Monitoring, Maintenance, and Inspection	$ 80,390	$ 80,390	$ 80,390	$ 41,329
Institutional Controls Operation and Maintenance	$ 32,830	$ 32,829	$ 32,829	$ -
Total - Non-Construction Costs	***$ 416,356***	***$ 521,679***	***$ 1,290,731***	***$ 183,631***
Total Project Costs				
Contingency (variable)	$ 118,744	$ 448,135	$ 2,066,464	$ 38,900
Total Project Cost (Excluding Contingency)	**$ 593,718**	**$ 1,120,338**	**$ 5,166,161**	**$ 194,498**
Total Project Cost (Including Contingency)	**$ 712,000**	**$ 1,568,000**	**$ 7,233,000**	**$ 233,000**

Notes:

1. Total costs are presented on a net present value basis (assuming a 3% discount rate).
2. Rationale for a variable contingency applied to the Zones C/D alternatives is described in Section 5.1.4.

Table 5.7-1
Zone E
Alternative Cost Summary

	Alternative			
Task	**E-1**	**E-2**	**E-3**	**No Action Alternative**
Construction Costs				
Mobilization/Demobilization/Site Preparation	$ 39,574	$ -	$ 1,439,300	$ 690
Contingent Ex situ Stabilization	$ -	$ 938,963	$ -	$ -
Ground to Geomembrane - Clean Excavation	$ -	$ -	$ 19,637	$ -
Geomembrane to Bottom of Over-excavation - Excavation	$ -	$ -	$ 153,778	$ -
Waste Characterization - Lab Testing	$ -	$ -	$ 1,149,417	$ -
Transportation and Disposal of Waste/Soils - Subtitle C Landfill (80%)	$ -	$ -	$ 4,519,445	$ -
Transportation and Disposal of Waste/Soils - Subtitle C Landfill with RCRA Stabilization (20%)	$ -	$ -	$ 2,030,405	$ -
Backfill and Capping	$ -	$ -	$ 1,058,723	$ -
Ground Water Well Installation and/or Decommissioning	$ 3,209	$ 3,209	$ 13,720	$ 4,313
Cap Replacement (Year 15)	$ 238,131	$ -	$ -	$ -
Institutional Controls (Fencing, Signage, and/or Environmental Covenant)	$ 6,000	$ 6,000	$ 41,800	$ -
Subtotal - Construction Costs	***$ 286,915***	***$ 948,172***	***$ 10,426,224***	***$ 5,003***
Sales Tax (8.6%)	$ 24,675	$ 81,543	$ 896,655	$ 430
Total - Construction Costs	***$ 311,589***	***$ 1,029,715***	***$ 11,322,879***	***$ 5,433***
Non-Construction Costs				
Design, Project Management, and Permitting	$ 52,970	$ 175,052	$ 1,924,889	$ 540
Construction Management and Inspection	$ 24,927	$ 82,377	$ 905,830	$ -
Groundwater Monitoring and Reporting	$ 200,638	$ 200,638	$ 164,852	$ 114,727
Cap Monitoring, Maintenance, and Inspection	$ 80,390	$ 80,390	$ -	$ 41,329
Institutional Controls Operation and Maintenance	$ 32,829	$ 32,829	$ 32,829	$ -
Total - Non-Construction Costs	***$ 391,754***	***$ 571,286***	***$ 3,028,401***	***$ 156,596***
Total Project Costs				
Contingency (variable)	$ 140,669	$ 640,400	$ 5,740,512	$ 32,406
Total Project Cost (Excluding Contingency)	**$ 703,343**	**$ 1,601,001**	**$ 14,351,281**	**$ 162,029**
Total Project Cost (Including Contingency)	**$ 844,000**	**$ 2,241,000**	**$ 20,092,000**	**$ 194,000**

Notes:

1. Total costs are presented on a net present value basis (assuming a 3% discount rate).
2. Rationale for a variable contingency applied to the Zone E alternatives is described in Section 5.1.4.

RCRA = Resource Conservation and Recovery Act

Table 5.8-1
On-property Ground Water (Central Area)
Alternative Cost Summary

Task	Alternative	
	ONP-1	No Action Alternative
Construction Costs		
Mobilization/Demobilization/Site Preparation	$ 97,458	$ 1,380
Contingent SVE Treatment	$ 302,691	$ -
Post-remedy Source Evaluation	$ 300,000	$ -
Ground Water Well Decommissioning	$ 6,419	$ 8,626
Subtotal - Construction Costs	***$ 706,568***	***$ 10,006***
Sales Tax (8.6%)	$ 60,765	$ 861
Total - Construction Costs	***$ 767,300***	***$ 10,900***
Non-Construction Costs		
Design, Project Management, and Permitting	$ 130,441	$ 1,090
Construction Management and Inspection	$ 61,384	$ -
Groundwater Monitoring and Reporting	$ 268,829	$ 143,704
Total - Non-Construction Costs	***$ 460,700***	***$ 144,800***
Total Project Costs		
Contingency (+20%)	$ 245,600	$ 31,140
Total Project Cost (Excluding Contingency)	**$ 1,228,000**	**$ 155,700**
Total Project Cost (Including Contingency)	**$ 1,474,000**	**$ 187,000**

Notes:

1. Total costs are presented as net present value (assuming a 3% discount rate).
2. Rationale for contingencies applied to the Central Area alternatives is described in Section 5.1.4.

Tables 5.8-2
Off-property Ground Water

Table 5.8-2a
Off-property Ground Water
Ground Water Monitoring and Reporting Cost Summary

Task	Unit	Unit Assumption	Quantities/Costs	Source/Notes
			Off-property GW	
Assumed No. of monitoring wells	-	Years 1-10	16	A site-wide ground water compliance monitoring program will be developed after the CAP is finalized. Ground water protection, performance, and confirmational monitoring activities are anticipated for cost purposes in this FFS.
		Years 11-20	16	
		Years 21-30	8	
Construction Costs				
Well decommisionning	$/well	$2,500	$2,500	Well decommissioning assumed to occur at years 20 and 30 for off-property ground water.
Year 10	NPV $	-	-	
Year 20	NPV $	-	$11,074	
Year 30	NPV $	-	$8,240	
Subtotal Construction Costs	**NPV $**	**-**	**$19,313**	-
Sales Tax	%	8.6%	$1,661	-
Total Construction Costs	**$**	-	**$20,974**	-
Non-Construction Costs (Labor, Analytical & Data Validation)				
Semiannual monitoring (Years 1 to 10)	$/year	-	$31,316	Current semiannual monitoring assumed to remain during years 1 to 10, based on Groundwater Monitoring Program (Ecology, December 2016).
Year 1	NPV $	-	$30,404	
Year 2	NPV $	-	$29,518	
Year 3	NPV $	-	$28,659	
Year 4	NPV $	-	$27,824	
Year 5	NPV $	-	$27,013	
Year 6	NPV $	-	$26,227	
Year 7	NPV $	-	$25,463	
Year 8	NPV $	-	$24,721	
Year 9	NPV $	-	$24,001	
Year 10	NPV $	-	$23,302	
Total Net Present Value (Years 1 to 10)	**NPV $**	**-**	**$267,132**	
Semiannual monitoring (Years 11 to 20)	$/year	-	$15,658	Annual monitoring assumed to occur during years 11 to 20.
Year 11	NPV $	-	$11,312	
Year 12	NPV $	-	$10,982	
Year 13	NPV $	-	$10,662	
Year 14	NPV $	-	$10,352	
Year 15	NPV $	-	$10,050	
Year 16	NPV $	-	$9,758	
Year 17	NPV $	-	$9,473	
Year 18	NPV $	-	$9,197	
Year 19	NPV $	-	$8,930	
Year 20	NPV $	-	$8,669	
Total Net Present Value (Years 11 to 20)	**NPV $**	**-**	**$99,386**	

Tables 5.8-2
Off-property Ground Water

Task	Unit	Unit Assumption	Quantities/Costs	Source/Notes
			Off-property GW	
Annual monitoring (Years 21 to 30)	$/year	-	$12,354	Annual monitoring assumed to occur during years 21 to 30.
Year 21	NPV $	-	$6,641	
Year 22	NPV $	-	$6,447	
Year 23	NPV $	-	$6,260	
Year 24	NPV $	-	$6,077	
Year 25	NPV $	-	$5,900	
Year 26	NPV $	-	$5,728	
Year 27	NPV $	-	$5,562	
Year 28	NPV $	-	$5,400	
Year 29	NPV $	-	$5,242	
Year 30	NPV $	-	$5,090	
Total Net Present Value (Years 21 to 30)	**NPV $**	**-**	**$58,348**	
TOTAL GROUND WATER MONITORING COSTS (NPV $)			**$445,800**	**Total ground water monitoring costs for years 1 to 30.**

Notes:

1. Total costs are presented as net present value (assuming a 3% discount rate).

CAP = Cleanup Action Plan

FFS = Focused Feasibility Study

NPV = net present value

Tables 5.8-2
Off-property Ground Water

Table 5.8-2b
Off-property Ground Water
Ground Water Monitoring and Reporting Costs Per Year (for quarterly, semiannual, and annual monitoring events)

			Quantities/Costs			
			Years 1 to 10	Years 11 to 20	Years 21 to 30	
Task	**Unit**	**Unit Assumption**	**Semiannual Monitoring**	**Annual Monitoring**	**Annual Monitoring**	**Reference/Comments**
Assumed No. of monitoring wells	-	-	16	16	8	Applicable wells are located off-property of PSL. Current No. of wells and sampling frequency based on 2016 GW Monitoring Program (Ecology, December 2016).
Sampling frequency	events/year	-	2	1	1	
Annual Labor Costs						
Preparation time	hr/event	7	14	7	7	Based on current labor for Pasco ground water monitoring. Preparation time includes field notebook, labels, reservations, bottle order, etc. Assumed 3 persons needed per event.
Sample collection time	hr/well	0.75	24	12	6	
Equipment load/unload & calibration time	hr/event	5	10	5	5	
Drive to/from Pasco Landfill Site (roundtrip)	hr/event	8	16	8	8	
Truck rental/return	hr/event	2.5	5	2.5	2.5	
Total Labor Time	**hr**	-	**69.0**	**34.5**	**28.5**	
Field staff billing rate	$/hr	$100	$6,900	$3,450	$2,850	
No. of field staff	person	3.0	3.0	3.0	3.0	
Total Field Work Costs	**$**	-	**$20,700**	**$10,350**	**$8,550**	
Data management, reporting, and production	$/hr	$115	$4,600	$2,300	$2,300	Assumed a total of 40 hours (years 1-10) and 20 hours (years 11-30).
Total Labor Costs (Field work, Data Management & Reporting)	**$**	-	**$25,300**	**$12,650**	**$10,850**	-
Annual Analytical Costs						
VOCs (Method EPA-8260 and 8260-SIM)	$/sample	$168	$5,376	$2,688	$1,344	Analytical costs based on agreed rates with ALS, valid through 2017.
Total Analytical Costs	**$**	-	**$5,376**	**$2,688**	**$1,344**	
Annual Data Validation Costs						
Third party validation	$/sample	$20	$640	$320	$160	Includes validation data costs for the specified analytes only.
Total Data Validation Costs	**$**	-	**$640**	**$320**	**$160**	
GROUND WATER MONITORING COSTS PER YEAR ($)			**$31,316**	**$15,658**	**$12,354**	-

Notes:
ALS = Analytical Laboratory Services
hr = hour
VOC = volatile organic compound

Table 6.2-1
DCA Evaluation Criteria and Subcriteria

	DCA Evaluation Criteria				
	Protectiveness	**Permanence**	**Effectiveness over the Long-term**	**Management of Short-term Risks**	**Technical and Administrative Implementability**
Subcriteria	Degree to which existing risks are reduced	Destruction of hazardous substances	Degree of certainty that the alternative will be successful	Risk to human health and the environment associated with the alternative during construction and implementation	Alternative is technically possible
	Time required to reduce risk at the facility and attain cleanup standards	Reduction or elimination of releases	Reliability of the alternative during the period of time hazardous substances are expected to remain on site at concentrations that exceed cleanup levels	Effectiveness of measures that will be taken to manage such risk	Availability of necessary off-site facilities, services, and materials
	On-site risks resulting from implementing the alternative	Reduction or elimination of sources of releases	Magnitude of residual risk		Administrative and regulatory requirements
	Off-site risks resulting from implementing the alternative	Irreversibility of the waste treatment process	Effectiveness of controls required to manage treatment residues or remaining wastes		Scheduling, size, complexity, and access for construction of the alternative
	Improvement of the overall environmental quality	Characteristics and quantity of treatment residuals generated			Monitoring requirements

Notes:

DCA evaluation criteria and subcriteria as defined in Washington Administrative Code 173-340-360 (3)(f).

DCA = disproportionate cost analysis

Table 6.3.1-1 MTCA Requirements – Alternatives for MSW Disposal Areas

Remedial Alternative	**MSW Landfill**			**Balefill Area**	**Burn Trenches**		**Inert Waste Disposal Area**
	MSW-1	**MSW-2**	**MSW-3**	**BA-1**	**BT-1**	**BT-2**	**IWDA-1**
MTCA Requirements	**Existing Systems**	**MSW-1 With Expanded LFG Collection System**	**MSW-2 With Contingent Ground Water Treatment System**	**Existing Soil Cover With Restoration**	**Existing Soil Cover**	**Confirm Thickness of Existing Cover and Augment**	**Existing Soil Cover With Restoration**
Threshold Requirements							
Protects Human Health and the Environment	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complies with Cleanup Standards	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complies with Applicable State and Federal Laws	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provides for Compliance Monitoring	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Other Requirements							
Permanent to Maximum Extent Practicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Provides Reasonable Restoration Timeframe	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Considers Public Concerns	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional Requirements							
Requires Ground Water Cleanup Actions	No	No	Yes	No	No	No	No
Does Not Rely Primarily on Institutional Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Minimizes Present and Future Site Releases and Migration	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Does Not Rely Primarily on Dilution and/or Dispersion	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6.3.1-2 - Disproportionate Coast Analysis - Alternatives for MSW Landfill

Project No. 060255, MSW Landfill, Pasco Landfill, Pasco, WA

Alternative MSW-1: Existing landfill gas collection network; Existing engineered cover system and monitoring for potential Landfill Gas migration; Existing enclosed flare system with future replacement.
Contingent Alternative MSW-2: Alternative MSW-1 with expanded landfill gas collection system.
Contingent Alternative MSW-3: Alternative MSW-2 with contingent groundwater treatment system.

Evaluation Criteria	**Alternative MSW-1**	**Contingent Alternative MSW-2**	**Contingent Alternative MSW-3**	**Comments**
Protectiveness	3	3	3	Alternatives are equally protective based on meeting the remedial action objectives.
Permanence	3	3	3	Waste will remain in place. Landfill gas is permanently destroyed.
Effectiveness Over the Long Term	3	2	1	Effectiveness based on historical observations of the existing engineered systems, and complexity of contingency systems.
Management of Short-term Risks	3	2	1	Alternatives MSW-2 and MSW-3 require drilling and/or excavation, which may result in short-term risk.
Technical and Administrative Implementability	3	2	1	Implementability based on performance of existing systems, and complexity of contingency systems.
Consideration of Public Concerns	3	3	3	Concerns addressed based on previous public comment.
Total Benefit Score	18	15	12	
Capital Costs (millions)	$0.03	$0.17	$0.67	
O&M Costs (millions)	$1.45	$1.56	$2.92	
Total Costs (millions)	$1.48	$1.73	$3.59	
Total NPV Costs (millions)	$1.36	$1.61	$3.33	
Benefit-to-Cost Ratio (Benefit Score/NPV Costs)	**12.2**	**8.7**	**3.3**	

Note:

Alternatives are ranked with 1 being the least favorable rating and 3 being the most favorable rating.

Table 6.3.2-1 - Disproportionate Cost Analysis - Alternatives for Burn Trenches

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco, WA

Alternative BT-A: Existing BT with inspection, maintenance, and reporting.

Contingent AlternativeBT-B: Alternative BT-A and assess BT soil cover thickness.

Contingent Alternative BT-C: Alternative BT-B and implement soil cover restoration.

Evaluation Criteria	**Alternative BT-A**	**Contingent Alternative BT-B**	**Contingent Alternative BT-C**	**Comments**
Protectiveness	1	2	3	Alternatives are protective based on historical observations of the existing engineered systems.
Permanence	3	3	3	Municipal solid waste will remain in place.
Effectiveness Over the Long Term	3	3	3	Alternatives are effective based on historical observations of the existing engineered systems.
Management of Short-term Risks	3	2	1	Alternatives BT-2 and BT-3 require excavation and construction, which may result in short-term risk.
Technical and Administrative Implementability	3	3	3	All alternatives are implementable.
Consideration of Public Concerns	3	3	3	Concerns addressed based on previous public comment.
Total Benefit Score	16	16	16	
Capital Costs (millions)	$0.00	$0.02	$0.11	
O&M Costs (millions)	$0.02	$0.03	$0.04	
Total Costs (millions)	$0.02	$0.05	$0.15	
Total NPV Costs (millions)	$ 0.01	$0.05	$0.14	
Benefit-to-Cost Ratio (Benefit Score/NPV Costs)	**1143**	**314**	**113**	

Note:

Alternatives are ranked with 1 being the least favorable rating and 3 being the most favorable rating.

Table 6.3.2-2 - Disproportionate Cost Analysis - Alternatives for Burn Trenches

Project No. 060255, Burn Trenches, Pasco Landfill, Pasco, WA

Alternative BT-A: Existing BT with inspection, maintenance, and reporting.
Contingent AlternativeBT-B: Alternative BT-A and assess BT soil cover thickness.
Contingent Alternative BT-C: Alternative BT-B and implement soil cover restoration.

Evaluation Criteria	**Alternative BT-A**	**Contingent Alternative BT-B**	**Contingent Alternative BT-C**	**Comments**
Protectiveness	1	2	3	Alternatives are protective based on historical observations of the existing engineered systems.
Permanence	3	3	3	Municipal solid waste will remain in place.
Effectiveness Over the Long Term	3	3	3	Alternatives are effective based on historical observations of the existing engineered systems.
Management of Short-term Risks	3	2	1	Alternatives BT-2 and BT-3 require excavation and construction, which may result in short-term risk.
Technical and Administrative Implementability	3	3	3	All alternatives are implementable.
Consideration of Public Concerns	3	3	3	Concerns addressed based on previous public comment.
Total Benefit Score	16	16	16	
Capital Costs (millions)	$0.00	$0.02	$0.11	
O&M Costs (millions)	$0.02	$0.03	$0.04	
Total Costs (millions)	$0.02	$0.05	$0.15	
Total NPV Costs (millions)	$ 0.01	$0.05	$0.14	
Benefit-to-Cost Ratio (Benefit Score/NPV Costs)	**1143**	**314**	**113**	

Note:

Alternatives are ranked with 1 being the least favorable rating and 3 being the most favorable rating.

Table 6.3.3-1
MTCA Requirements – Zone A

	Alternatives						
	A-1	A-2	A-6	A-7	A-8	A-9	
Alternative	Monitoring and maintenance of existing RCRA cap/cover system, existing SVE treatment for Zone A source area, ground water performance monitoring, and ICs	All A-1 elements, in addition to enhanced SVE system and a general ground water treatment contingent remedy	Removal of cap/cover systems, excavation of waste and impacted and layback soils to top of Touchet Beds, on-site disposal of soils/bulked drums in lined AOC cell, off-site disposal of overpacked drum waste, backfill of excavation area and RCRA cap placement, thermal treatment of Touchet Beds, SVE treatment during construction, ground water performance monitoring, and ICs	All A-6 elements, except excavation and on-site disposal of Touchet Bed soils in lined AOC cell (instead of thermal treatment of Touchet Beds), and SVE treatment during construction	Implementation of A-2 for Years 1-10 and A-7 for Years 11-30	Removal of cap/cover systems, excavation of waste and impacted and layback soils to top of Upper Pasco Gravels, off-site disposal of all excavated materials (overpacked drum waste, bulked drums and impacted soils with some pre-treatment, geomembrane), backfill and RCRA cap placement in excavation area, SVE treatment during construction, ground water performance monitoring, and ICs	Comments
Threshold Requirements							
Protects human health and the environment	Yes	Yes	Yes	Yes	Yes	Yes	All remedial alternatives in Zone A meet the threshold requirements.
Complies with cleanup standards	Yes	Yes	Yes	Yes	Yes	Yes	
Complies with applicable state and federal laws	Yes	Yes	Yes	Yes	Yes	Yes	
Provides for compliance monitoring	Yes	Yes	Yes	Yes	Yes	Yes	
Other Requirements							
Permanent to maximum extent practicable	See Table 6.3.3-2 and Tables 6.3.3-3a through 6.3.3-3e.						This criterion is evaluated under the MTCA Disproportionate Cost Analysis.
Provides reasonable restoration timeframe	Yes	Yes	Yes	Yes	Yes	Yes	Alternatives A-6 through A-9 provide overall shorter restoration timeframes through waste removal and/or destruction (through thermal treatment), compared to Alternatives A-1 and A-2, whose timeframes are dependent on SVE operation and long-term cap and ground water monitoring.
Considers public concerns	Yes	Yes	Yes	Yes	Yes	Yes	Public concerns will be addressed following the public comment period for the CAP.
Additional Requirements							
Requires permanent ground water cleanup actions	No	No	No	No	No	No	All alternatives require performance sampling of ground water quality and confirmation of continued attainment of cleanup levels at the designated POC.
Does not rely primarily on institutional controls	Yes	Yes	Yes	Yes	Yes	Yes	Although all alternatives rely on ICs to ensure that the integrity of the cap and cover system is maintained, ICs are not the primary remedial action.
Minimizes present and future site releases and migration	Yes	Yes	Yes	Yes	Yes	Yes	All alternatives minimize present and future releases and migration of hazardous substances.
Does not rely primarily on dilution and/or dispersion	Yes	Yes	Yes	Yes	Yes	Yes	None of the alternatives rely primarily on dilution and/or dispersion.

Notes:
AOC = area of contamination
CAP = Cleanup Action Plan
IC = institutional control
MTCA = Model Toxic Control Act
POC = point of compliance
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

Table 6.3.3-2
MTCA Disproportionate Cost Analysis Summary – Zone A

Alternative MTCA Evaluation Criteria	A-1	A-2	A-6	A-7	A-8	A-9
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs	**All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs[a]**	**All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction[a]**	**Implementation of A-2 for Years 1-10 and A-7 for Years 11-30[a]**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs**
Protectiveness (WAC 173-340-360(3)(f)(i))	3	3	3	3	4	5
Permanence (WAC 173-340-360(3)(f)(ii))	3	4	3	4	4	4
Effectiveness Over the Long Term (WAC 173-340-360(3)(f)(iv))	1	2	3	5	4	6
Management of Short-term Risks (WAC 173-340-360(3)(f)(v))	6	5	3	2	4	1
Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi))	5	4	2	3	3	3
Consideration of Public Concerns[b] (WAC 173-340-360(3)(f)(vii))	4	4	4	4	4	4
Overall Environmental Benefit Score (Sum)	22	22	18	21	23	23
Total Costs ($, Millions)	$16.1	$18.3	$62.1	$60.3	$49.9	$128.1
Benefit-to-Cost Ratio (Benefit Ranking per $Million)	**1.34**	**1.17**	**0.28**	**0.34**	**0.45**	**0.18**
Benefit-to-Cost Ratio (Benefit Ranking per $100,000)	**13.4**	**11.7**	**2.8**	**3.4**	**4.5**	**1.8**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.

2. Average rankings for the various evaluation criteria are shown as integers.

3. Ranking assumes contingent actions are implemented.

a. Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

b. All alternatives have some public concerns and are ranked equally in the FFS. Public concerns will be addressed following the public comment period for the CAP.

AOC = area of contamination
CAP = Cleanup Action Plan
FFS = focused feasibility study
IC = institutional control
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction
WAC = Washington Administrative Code

Table 6.3.3-3a
MTCA Evaluation Sub-criteria for Protectiveness (WAC 173-340-360(3)(f)(i)) - Zone A

Alternative MTCA Evaluation Sub-criteria for Protectiveness	A-1	A-2	A-6	A-7	A-8	A-9
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs	**All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs [a]**	**All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction [a]**	**Implementation of A-2 for Years 1-10 and A-7 for Years 11-30 [a]**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs**
Degree to which existing risks are reduced	1	2	3	4	5	6
	Alternative A-9 received the highest score because of removal of Zone A with off-site disposal, although some wastes would remain in the Upper Pasco Gravels following removal. Alternatives A-6, A-7, and A-8 ranked lower than Alternative A-9 because the AOC keeps a substantial mass of Zone A wastes on site. Alternative A-6 ranked slightly lower than Alternatives A-7 and A-8 because thermal treatment of the Touchet Beds would require 6 to 8 months during which time Touchet Bed wastes would still be in place and could migrate to ground water (especially increased mobility of COCs resulting from the higher subsurface temperatures associated with thermal treatment). Alternatives A-1 and A-2 significantly reduce risks with the existing cover system and SVE operation and are already very protective of ground water as demonstrated by dissipation of the downgradient plume in recent years, but ranked the lowest because wastes remain in place and could migrate to ground water over a longer time frame. Alternative A-2 ranked slightly higher than A-1 because it includes an enhanced SVE system and a contingent ground water action.					
Time required to reduce risks at facility and attain CULs	1	2	4	5	3	6
	Although ground water dCULs have been met outside of the Zone A cap, Alternatives A-6 through A-9 ranked incrementally high because additional potential future risks are reduced through treatment/destruction and/or removal of the Zone A source area, rather than containment/treatment. Alternative A-8 ranked lower than Alternatives A-6 and A-7 because operation of the enhanced SVE system would be implemented for at least 10 years before any potential excavation and on-site disposal of the Touchet Beds in the AOC would be considered.					
On-site risks resulting from implementation	6	5	2	1	3	4
	Alternatives A-1 and A-2 received the highest rankings (lowest on-site risks) because there is no direct contact and exposure to wastes and contamination for humans and ecological receptors. All excavation-based alternatives (Alternatives A-6 through A-9) have higher on-site risks during implementation due to excavation, transport, stockpiling, and disposal of Zone A wastes and, consequently, have lower rankings than Alternatives A-1 and A-2. Of the removal alternatives, Alternative A-9 ranked higher than Alternatives A-6, A-7, and A-8 because of slightly less on-site risks, due to off-site disposal rather than on-site AOC disposal. Alternative A-7 ranked lowest because of the added removal and on-site disposal of impacted soils in the Touchet Beds, compared to in situ treatment of that soil layer in Alternative A-6. Alternative A-8 ranked higher than Alternatives A-6 and A-7 because there is less mass of COCs to be removed (if the contingent excavation action is implemented) following 10 years of SVE operation.					
Off-site risks resulting from implementation	6	6	3	3	4	1
	No significant off-site risks apply to the SVE-based alternatives because all cleanup action components are conducted on-site with only a relatively small amount of low-risk condensate disposed off site; therefore, Alternatives A-1 and A-2 ranked the highest for this sub-criterion. Alternatives A-6, A-7, and A-8 with on-site AOC disposal pose low off-site risks due to the small number of drums and recovered bulked liquids/solvent assumed to go off site for disposal. Alternative A-8 ranked slightly higher than Alternatives A-6 and A-7 because excavation and on-site disposal of the Touchet Beds in the AOC would only occur if enhanced SVE system and contingent air sparge/ozone treatment are not sufficiently protective. The greatest off-site risks are in Alternative A-9 (therefore, ranking the lowest), which consists of off-site disposal of all drummed waste and impacted soils in Zone A.					
Improvement of overall environmental quality	1	2	3	4	4	6
	All Zone A alternatives provide an improvement of the overall environmental quality by reducing long-term direct risks and exposure to varying degrees. Because the difference between alternatives is related to the time over which improvement in overall environmental quality occurs, the alternatives have the same rankings as for the time required to reduce risks.					
Average Ranking for Protectiveness	**3**	**3**	**3**	**3**	**4**	**5**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.
2. Average ranking shown as an integer.

a. Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

AOC = area of contamination
COC = chemical of concern
CUL = cleanup level
dCUL = draft cleanup level
IC = institutional control
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

Table 6.3.3-3b
MTCA Evaluation Sub-criteria for Permanence (WAC 173-340-360(3)(f)(ii)) - Zone A

<table>
<tr><th rowspan="2">Alternative
MTCA Evaluation Sub-criteria for Permanence</th><th>A-1</th><th>A-2</th><th>A-6</th><th>A-7</th><th>A-8</th><th>A-9</th></tr>
<tr><th>Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs</th><th>All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy</th><th>Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs [a]</th><th>All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction [a]</th><th>Implementation of A-2 for Years 1-10 and A-7 for Years 11-30 [a]</th><th>Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs</th></tr>
<tr><td rowspan="2">Destruction of hazardous substances</td><td>5</td><td>6</td><td>3</td><td>2</td><td>4</td><td>2</td></tr>
<tr><td colspan="6">Due to the destruction efficiency of the SVE system, Alternatives A-1 and A-2 ranked higher than removal and disposal alternatives (Alternatives A-6 through A-9). Alternative A-8 ranked higher than the other removal and disposal alternatives because the enhanced SVE system has to be proven not sufficiently protective in order to trigger the implementation of contingent excavation action. Alternative A-2 ranked slightly higher than Alternative A-1 due to an enhanced SVE system and a potential contingent ground water action. Alternative A-6 includes thermal treatment of COCs in the Touchet Beds and, consequently, ranked higher than Alternatives A-7 and A-9. Alternatives A-7 and A-9 ranked the lowest because they rely only on either on-site or off-site disposal with relatively little destruction of hazardous substances.</td></tr>
<tr><td rowspan="2">Reduction or elimination of releases</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td colspan="6">All alternatives include reduction or elimination of releases of COCs through different engineered controls. However, Alternatives A-6 through A-9 ranked incrementally high because removal of drummed waste and impacted soils reduces releases of COCs. Alternative A-9 ranked the highest because it consists of full removal to the top of the Upper Pasco Gravels and off-site disposal; thus, releases are completely eliminated. Under Alternatives A-6 and A-7, most of the waste is re-disposed on site in an AOC, which could cause releases in the future and, consequently, these alternatives ranked lower than Alternative A-9. Alternatives A-1 and A-2 have effectively reduced and removed a large VOC mass from impacted soils, but releases from remaining residual contamination in the Touchet Beds soils are only addressed through long-term SVE system operation and containment. Alternative A-8 ranked higher than Alternative A-2 because the implementation of contingent excavation action (to completely eliminate releases from the Touchet Beds) could be implemented at year 11. It also ranked higher than Alternatives A-6 and A-7 because of destruction and removal of COCs during 10 years of SVE operation results in less mass of contaminants disposed of in the AOC.</td></tr>
<tr><td rowspan="2">Reduction or elimination of sources of releases</td><td>1</td><td>2</td><td>4</td><td>5</td><td>3</td><td>6</td></tr>
<tr><td colspan="6">Alternative A-9 ranked the highest for this sub-criterion because it includes full removal of drummed waste and impacted soils to the top of the Upper Pasco Gravels; thus, the sources of releases are completely eliminated. Alternative A-7 ranked slightly lower than Alternative A-9 because, although drummed waste and impacted soils to the top of the Upper Pasco Gravels are fully removed and disposed on site, the AOC could still be a future source of release. Alternative A-6 leaves the Touchet Beds in place but includes thermal treatment for these soil layers. Thermal treatment will destroy some, but not all Touchet Beds COCs and, consequently, Alternative A-6 ranked lower than Alternatives A-7 and A-9. Alternatives A-1 and
A-2 have only a treatment cleanup component, reducing but not eliminating sources of releases; therefore, they ranked the lowest for this sub-criterion. Alternative A-8 ranked slightly higher than Alternative A-2 because the implementation of contingent excavation action (to completely eliminate sources of releases in the Touchet Beds) could be implemented at year 11.</td></tr>
<tr><td rowspan="2">Irreversibility of waste treatment process</td><td>5</td><td>6</td><td>3</td><td>2</td><td>5</td><td>2</td></tr>
<tr><td colspan="6">COC destruction achieved through SVE treatment (Alternatives A-1 and A-2) or thermal treatment (Alternative A-6) is an irreversible process. Alternative A-8 ranked higher than the other removal and disposal alternatives because the enhanced SVE system is implemented the first 10 years (providing irreversible treatment process) and has to be proven not sufficiently protective in order to trigger the implementation of contingent excavation action. Alternative A-6 includes thermal treatment of the Touchet Bed soils, while Alternatives A-1 and A-2 will treat more than 90% of VOCs in the Zone A source area. Consequently, Alternatives A-1 and A-2 ranked higher than Alternative A-6. Alternatives A-7 and A-9 only account for irreversible treatment of a relatively small amount of liquids and waste/impacted soil through off-site stabilization and incineration.</td></tr>
<tr><td rowspan="2">Characteristics and quantity of treatment residuals generated</td><td>3</td><td>2</td><td>1</td><td>5</td><td>3</td><td>6</td></tr>
<tr><td colspan="6">Alternative A-9 has the least amount of treatment and associated treatment residuals; only a small percentage of wastes removed from Zone A and the Touchet Beds are assumed to require incineration and stabilization as components of off-site disposal. Alternative A-7 has the same treatment residuals, with the added passive collection/treatment of gasses generated in the on-site AOC. Alternatives A-1 and A-2 both generate non-hazardous condensate as part of SVE operations; however, Alternative A-2 may result in greater condensate volumes due to enhancement of the SVE system. Alternative A-8 may generate less condensate than Alternative A-2 because the enhanced SVE system is operated for the first 10 years only. Under Alternative A-6, COCs are volatilized in the Touchet Beds and the waste stream will be treated using activated carbon; therefore, potentially hazardous activated carbon, in addition to gas collection/treatment from the on-site AOC, will be generated as part of implementing this alternative. Therefore, Alternative A-6 ranked the lowest for this sub-criterion.</td></tr>
<tr><td>Average Ranking for Permanence</td><td>3</td><td>4</td><td>3</td><td>4</td><td>4</td><td>4</td></tr>
</table>

Notes:
1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.
2. Average ranking shown as an integer.
3. Under MTCA (WAC 173-340-360(3)(f)(ii)), permanence is defined as reduction in toxicity, mobility, or volume.

[a] Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

AOC = area of contamination
COC = chemical of concern
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction
VOC = volatile organic compound
WAC = Washington Administrative Code

Table 6.3.3-3c
MTCA Evaluation Sub-criteria for Effectiveness Over The Long Term (WAC 173-340-360(3)(f)(iv)) - Zone A

Alternative	A-1	A-2	A-6	A-7	A-8	A-9
MTCA Evaluation Sub-criteria for Effectiveness Over the Long Term	**Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs**	**All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs [a]**	**All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction [a]**	**Implementation of A-2 for Years 1-10 and A-7 for Years 11-30 [a]**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs**
Degree of certainty that the alternative will be successful	2	3	1	5	5	6
	All alternatives are anticipated to have a high degree of certainty of success because ground water downgradient of the Zone A cap is currently in compliance with dCULs. Alternatives A-7, A-8, and A-9 have the two highest rankings for this sub-criterion because the full removal of drummed waste and impacted soils to the top of the Upper Pasco Gravels with either on-site or off-site disposal will ensure long-term effectiveness in minimizing risks and exposure for human health and the environment. Although SVE treatment in Alternatives A-1 and A-2 has already been proven highly effective and protective of ground water, these alternatives ranked slightly lower than Alternatives A-7, A-8, and A-9. Alternative A-2 includes an enhanced SVE system and a contingent ground water action and, therefore, ranked slightly higher than Alternative A-1 for this sub-criterion. Alternative A-8 ranked higher than Alternative A-2 because if the enhanced SVE system is proven not sufficiently protective, the contingent excavation action would be implemented, ensuring long-term effectiveness. Thermal treatment in Alternative A-6 may have the potential for a high degree of certainty of success, but will require pilot-scale testing prior to full-scale implementation in the Touchet Beds. Uncertainty in the successful thermal treatment of the Touchet Beds results in Alternative A-6 being ranked the lowest for this sub-criterion.					
Reliability of the alternative during the time period hazardous substances will be on-site at concentrations that exceed CULs	1	2	4	5	4	6
	Alternative A-9 provides the greatest reliability over the long-term because of the removal and off-site disposal of drummed waste and impacted soils to the top of the Upper Pasco Gravels. Alternative A-7 removes the same amount of waste as Alternative A-9, but with on-site disposal in an AOC, and therefore, it is slightly less reliable over the long-term. Alternative A-6, which includes partial removal of Zone A, with the additional thermal treatment of the Touchet Beds (instead of removal) ranked slightly lower than Alternative A-7. Although the SVE system has demonstrated its ability to control exceedances of dCULs in ground water, the need for reliability over the operational time frame for the SVE-based alternatives results in them being ranked lower than the excavation-based alternatives. Alternative A-2 ranked slightly higher than Alternative A-1 due to the enhanced SVE operation, which provides more reliability over the SVE operational time frame. Alternative A-8 ranked slightly higher than Alternative A-2 because if the enhanced SVE system is proven not sufficiently protective, the contingent excavation action would be implemented, providing similar reliabilities as Alternatives A-6 and A-7 with on-site disposal in an AOC.					
Magnitude of residual risk	1	2	4	5	3	6
	Excavation-based alternatives (Alternatives A-6, A-7, A-8, and A-9) ranked incrementally the highest as minimal residual risks are expected after removal and either on-site or off-site disposal. However, because Alternative A-9 accounts for off-site disposal of all drummed waste and impacted soils, it ranked the highest for this sub-criterion. Although SVE treatment in Alternatives A-1 and A-2 have proven highly effective and protective of downgradient ground water, these alternatives have higher residual risks due to the amount of waste remaining in Zone A, and therefore, they ranked lower. Alternative A-8 ranked slightly lower than Alternative A-9 (but still higher than Alternative A-2), because residual risks would be minimized with the implementation of the contingent excavation action only at year 11 (instead of year 1).					
Effectiveness of controls required to manage treatment residues or remaining wastes	1	2	3	5	4	6
	Alternative A-9 has the highest ranking for this sub-criterion because it has the least amount of wastes remaining on site. Alternative A-7 ranks incrementally lower due to wastes being transferred on site to an AOC rather than removed and disposed off site. Alternative A-6 is similar to Alternative A-7, but leaves residual contamination in the Touchet Beds following treatment. Alternatives A-1 and A-2 leave the most wastes in Zone A and, consequently, rank lowest with Alternative A-2 slightly higher than Alternative A-1 due to the contingent ground water remedy, which could be implemented to manage contamination from residual wastes. Alternative A-8 ranked slightly lower than Alternative A-7 because wastes remain in Zone A for the first 10 years (while the enhanced SVE system is operating), but residual contamination in the Touchet Beds would be removed with the contingent excavation action at year 11, if it is implemented.					
Average Ranking for Effectiveness Over the Long-term	**1**	**2**	**3**	**5**	**4**	**6**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.
2. Average ranking shown as an integer.

a. Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

AOC = area of contamination
dCUL = draft cleanup level
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

Table 6.3.3-3d

MTCA Evaluation Sub-criteria for Management of Short-term Risks (WAC 173-340-360(3)(f)(v)) - Zone A

Alternative MTCA Evaluation Sub-criteria for Management of Short-term Risks	A-1	A-2	A-6	A-7	A-8	A-9
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs	**All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs [a]**	**All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction [a]**	**Implementation of A-2 for Years 1-10 and A-7 for Years 11-30 [a]**	**Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs**
Risk to human health and the environment associated with the alternative during construction and implementation	6	5	3	2	4	1
	SVE-based Alternatives A-1 and A-2 have less short-term risks to human health and the environment during construction and implementation, because SVE operation is a proven safe and reliable treatment technology that has been applied at the Site for over 15 years and these alternatives do not include invasive actions inside Zone A. Alternative A-1 ranked higher than A-2 because the potential contingent action in the latter (ozone treatment) would require proper on-site handling of chemical amendments by workers. Alternatives A-6, A-7, and A-9 have the highest potential for short-term risks to human health and the environment during removal of drummed waste/impacted soils and on-site or off-site disposal as these are high-risk activities, due to unknown conditions during construction, unknown condition of drums, physical hazards and safety considerations for workers, worker exposure during extensive segregation and handling of waste/soil and drum overpacking, potential uncontrolled releases, and facilitation of COC mobilization to the atmosphere, soils, and ground water. Alternative A-8 ranked slightly lower than Alternative A-2 but higher than Alternatives A-6, A-7, and A-9 because safe SVE operation would occur for the first 10 years but, if the contingent excavation action is implemented, Alternative A-8 would be subject to a similar high potential for short-term risks as for Alternative A-7. In addition, removal activities in Alternatives A-6 through A-9 pose potential risks to the community during excavation and on-site and off-site disposal. Alternatives A-7 and A-9 have additional risks due to greater excavation depth to the bottom of the Touchet Beds. Alternative A-9 ranked the lowest of all alternatives, because it includes the most off-site truck transportation of wastes through the community and long-haul distances to Subtitle C or D Landfills.					
Effectiveness of measures that will be taken to manage such risks	6	5	3	2	4	1
	Alternatives A-1 and A-2 ranked highest for this sub-criterion as they do not include invasive actions inside Zone A and are based on the reliable and proven safe operation of the SVE system. Consequently, no specific measures are anticipated to manage short-term risks. Alternative A-1 ranked higher than Alternative A-2 because the potential contingent action in the latter (ozone treatment) would require some on-site management of chemical amendments. Alternative A-8 ranked similarly to Alternative A-2 because no invasive action would occur in the first 10 years and only if the enhanced SVE system is proven not be effective, then the contingent excavation action would be implemented. The measures that need to be taken during partial or full removal operations under Alternatives A-6 through A-9 are highly uncertain at this time, due to unknown conditions during construction and state of drums; physical hazards to workers; exposure during extensive segregation and handling of waste/soil and drum overpacking; and potential uncontrolled releases. Although these risks could be managed with proper planning, comprehensive adaptive management and H&S programs would need to be in place to control high-risk activities, mitigate technical difficulties, and manage unsafe conditions and exposure risks to workers and the community during construction. The scope and effectiveness of these measures are unknown at this time. The large amount of truck traffic associated with off-site disposal in Alternative A-9 would be a risk to other drivers and the environment that cannot be prevented or managed once a truck is off site. Consequently, Alternative A-9 had the lowest ranking for this sub-criterion.					
Average Ranking for Management of Short-term Risks	**6**	**5**	**3**	**2**	**4**	**1**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.
2. Average ranking shown as an integer.

a. Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

AOC = area of contamination

COC = chemical of concern

H&S = health and safety

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

SVE = soil vapor extraction

Table 6.3.3-3e
MTCA Evaluation Sub-criteria for Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi)) - Zone A

Alternative MTCA Evaluation Sub-criteria for Technical and Administrative Implementability	A-1	A-2	A-6	A-7	A-8	A-9
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Existing SVE Treatment for Zone A Source Area, Ground Water Performance Monitoring, and ICs	All A-1 Elements, In Addition To Enhanced SVE System and A General Ground Water Treatment Contingent Remedy	Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Touchet Beds, On-site Disposal of Soils/Bulked Drums in Lined AOC Cell, Off-site Disposal of Overpacked Drum Waste, Backfill of Excavation Area and RCRA Cap Placement, Thermal Treatment of Touchet Beds, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs [a]	All A-6 Elements, Except Excavation and On-site Disposal of Touchet Bed Soils in Lined AOC Cell (Instead of Thermal Treatment of Touchet Beds), and SVE Treatment During Construction [a]	Implementation of A-2 for Years 1-10 and A-7 for Years 11-30 [a]	Removal of Cap/Cover Systems, Excavation of Waste and Impacted and Layback Soils to Top of Upper Pasco Gravels, Off-site Disposal of All Excavated Materials (Overpacked Drum Waste, Bulked Drums and Impacted Soils with Some Pre-treatment, Geomembrane), Backfill and RCRA Cap Placement in Excavation Area, SVE Treatment During Construction, Ground Water Performance Monitoring, and ICs
Technically possible	6	5	1	2	4	3
	Alternative A-1 ranked the highest because it is the most readily implementable remedial alternative from the technical point of view because it has been successfully implemented since 2002 with the upgraded SVE system and the Zone A cap. Alternative A-2 ranked slightly lower than Alternative A-1 for technical possibility because it includes a contingent ground water action that may require treatability testing prior to full-scale implementation. Alternatives A-7, A-8, and A-9 require a comprehensive technical construction project plan due to the invasive nature and difficulty of the excavation activities . Therefore, these two alternatives ranked lower than Alternative A-2. Alternative A-7 ranked slightly lower than Alternative A-9 because it has the additional construction of the AOC cell for on-site disposal. Alternative A-8 ranked slightly lower than Alternative A-2 as the first 10 years of SVE operation would be readily implementable and if the contingent excavation action occurs, similar technical construction difficulties would apply as for Alternatives A-7 and A-9. Although Alternative A-6 is technically possible, it has some uncertainty in implementability and effectiveness of thermal treatment given site-specific factors that would not be resolved until treatability testing is performed; thus, it ranked the lowest for this sub-criterion.					
Availability of necessary off-site facilities, services, and materials	6	5	3	3	4	1
	Alternatives A-1 and A-2 ranked the highest for this sub-criterion because these alternatives use existing facilities, services, and materials known to be available. Alternative A-8 ranked slightly lower than Alternative A-2 as the technical implementability is equivalent for the first 10 years, but if the contingent excavation action occurs, similar facilities, services, and materials would be needed as for the other removal alternatives. Alternatives A-6 through A-9 are directly impacted by the availability of permitted disposal facilities and are limited geographically. Because these excavation-based alternatives include high-risk construction activities, unique highly skilled and appropriately trained personnel to perform the excavation may be more limited (i.e., Level A trained personnel and companies that will assume risk associated with Level A work); among the excavation-based alternatives, Alternative A-9 ranked the lowest because it requires the greatest amount of services and materials and coordination with off-site facilities related to full removal and off-site disposal of drummed waste and impacted soils down to the top of the Upper Pasco Gravels.					
Administrative/regulatory requirements	6	5	1	2	3	4
	Alternatives A-1 and A-2 are the most readily implementable remedial alternatives from the administrative and regulatory points of view because they are essentially in place and, therefore, they ranked the highest for this sub-criterion. Alternative A-2 ranked slightly lower than Alternative A-1 because the contingent ground water remedy would require regulatory approval before implementing. Alternatives A-6 and A-7 have the lowest rankings because they require administrative and regulatory approval for the implementation and construction of the on-site AOC and it is not certain that the necessary approvals would be granted. In addition, Site access for an on-site AOC would need to be approved by the property owner, which may not be granted. Alternative A-6 would also need regulatory approval for implementation of thermal treatment of the Touchet Beds and consequently, it ranked lower than Alternative A-7. Alternative A-8 ranked lower than Alternative A-2 because the SVE operation is already in place and would continue for at least another 10 years; however, if the contingent excavation action is implemented, Alternative A-8 would require the appropriate administrative and regulatory approvals for the implementation and construction of the on-site AOC. Regulatory requirements for off-site disposal under Alternative A-9 are complicated because excavated drummed waste and impacted soils need to go out of state and because of land ban requirements that may apply.					
Scheduling, size, complexity, access	6	5	1	1	2	3
	Alternatives A-6 through A-9 have a high level of scheduling, sizing, and complexity challenges associated with partial or full removal of drummed waste and impacted soils, compared to the continued operation of the SVE system in Alternatives A-1 and A-2. In addition, Alternatives A-6, A-7, and A-8 (if the contingent excavation action is implemented) require approval of the on-site AOC by the property owner. Therefore, these two excavation-based alternatives ranked the lowest. Alternative A-7 ranked slightly higher than Alternative A-6 because it does not have the higher complexity associated with the Touchet Beds thermal treatment in Alternative A-6. Alternative A-1 is the most readily implementable remedial alternative in terms of ease of scheduling and relative complexity and, therefore, ranked highest for this sub-criterion. Alternative A-2 ranked slightly lower than Alternative A-1 due to the added complexity of the contingent ground water action in this alternative.					
Monitoring requirements	1	2	5	5	3	6
	It is anticipated that all alternatives would require long-term ground water compliance monitoring for an assumed total period of 30 years with various levels of sampling frequency and analytes sampled, depending on the remedial alternative. Similarly, all alternatives would require cap inspection, monitoring, and maintenance in perpetuity. In addition, Alternatives A-6 and A-7 will require inspection, monitoring, and maintenance of the new Zone A cap and the AOC. Performance monitoring of the SVE system will continue with routine inspections, maintenance, upgrades, and equipment replacement assumed to occur over 30 years for Alternatives A-1 and A-2, and 10 years for Alternatives A-6 through A-9. Overall, Alternative A-9 has the least amount of monitoring because it has a single Zone A cap and, therefore, ranks the highest. Alternatives 6 and 7 are ranked lower than A-8 due to the added monitoring of the AOC. Alternative A-6 is slightly lower than A-7 due monitoring of the thermal treatment of the Touchet Beds. Alternatives A-1 and A-2 rank lowest due to the longer term monitoring of the SVE system. Alternative A-8 ranked slightly higher than Alternative A-2 because performance monitoring of the SVE system would continue for 20 years and afterwards, the added monitoring of the AOC, if the contingent excavation action is implemented.					
Average Ranking for Technical and Administrative Implementability	**5**	**4**	**2**	**3**	**3**	**3**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 6 being the most favorable ranking.
2. Average ranking shown as an integer.

a. Ability to obtain regulatory approval for an on-site AOC is highly uncertain; in addition, Site access for an on-site AOC construction would be arranged with the property owner.

AOC = area of contamination
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act
SVE = soil vapor extraction

Table 6.3.4-1
MTCA Requirements – Alternatives in Zone B

Alternative	B-1	B-2	B-3	B-4	B-5	Comments
	Cap operation/ monitoring/ maintenance, ground water performance monitoring, ICs	**All B-1 elements, plus Monitored Natural Attenuation**	**All B-1 elements, plus amend vadose zone to stimulate bioremediation**	**All B-1 elements, plus amend vadose zone to stimulate absorption / stabilization**	**Cap removal, excavation, off-site waste disposal, membrane placement, back fill and cap, and all B-1 elements**	
Threshold Requirements						
Protects Human Health and the Environment	Yes	Yes	Yes	Yes	Yes	
Complies with Cleanup Standards	Yes	Yes	Yes	Yes	Yes	
Complies with Applicable State and Federal Laws	Yes	Yes	Yes	Yes	Yes	
Provides for Compliance Monitoring	Yes	Yes	Yes	Yes	Yes	
Other Requirements						
Permanent to Maximum Extent Practicable	See Table 6.3.4-2	See Table 6.3.4-2	See Table 6.3.4-2	See Table 6.3.4-2	See Table 6.3.4-2	This criterion is evaluated under the MTCA Disproportionate Cost Analysis.
Provides Reasonable Restoration Timeframe	Yes	Yes	Yes	Yes	Yes	
Considers Public Concerns	Yes	Yes	Yes	Yes	Yes	Public concerns will be addressed following the public comment period for the Cleanup Action Plan.
Additional Requirements						
Requires Ground Water Cleanup Actions	No	No	No	No	No	Alternatives require performance sampling of ground water quality and confirmation of continued attainment of cleanup levels at the designated point of compliance.
Does Not Rely Primarily on Institutional Controls	Yes	Yes	Yes	Yes	Yes	Although all alternatives rely on ICs to ensure that the integrity of the cap and cover system is maintained, institutional controls are not the primary remedial action.
Minimizes Present and Future Site Releases and Migration	Yes	Yes	Yes	Yes	Yes	All of the alternatives minimize present and future releases and migration of hazardous substances.
Does Not Rely Primarily on Dilution and/or Dispersion	Yes	Yes	Yes	Yes	Yes	None of the alternatives rely primarily on dilution and/or dispersion.

ICs = Institutional Controls

Table 6.3.4-2
MTCA Disproportionate Cost Analysis – Alternatives in Zone B

		B-1	**B-2**	**B-3**	**B-4**	**B-5**	**Comments**
		Cap operation/ monitoring/ maintenance, ground water performance monitoring, ICs	**All B-1 elements, plus Monitored Natural Attenuation**	**All B-1 elements, plus amend vadose zone to stimulate bioremediation**	**All B-1 elements, plus amend vadose zone to stimulate sorption / stabilization**	**Cap removal, excavation, off-site waste disposal, membrane placement, back fill and cap, and all B-1 elements**	
Protectiveness	Score	**5**	**4**	**3**	**3**	**5**	Alternatives B-1, B-3 and B-5 are most protective of the environment - risks are reduced and overall environmental quality is improved. Alternatives B-3 and B-4 risk undermining the cap system.
Permanence	Score	**4**	**4**	**4**	**3**	**5**	Alternatives B-1 and B-4 reduce mobility of contaminants, B-2, B-3, B-5 reduce mobility, volume and toxicity through in situ treatment and /or off-site disposal.
Effectiveness Over the Long Term	Score	**5**	**4**	**4**	**4**	**5**	Alternatives B-1 and B-5 are the most effective because they do not compromise the long-term cap system. Alternatives B-2, B-3, and B-4 involve increasing undermining of cap system.
Management of Short-Term Risks	Score	**5**	**4**	**3**	**3**	**2**	Alternative B-5 requires excavation, long-distance transport, and off-site disposal. Alternatives B-2, B-3, and B-4 undermine cap system and generate hazardous waste.
Technical and Administrative Implementability	Score	**5**	**4**	**4**	**4**	**3**	Alternative B-1 is easily implementable as continued cap. Alternatives B-2, B-3, B-4 and B-5 have increasing levels of technical and administrative difficulty.
Consideration of Public Concerns	Score	**3**	**3**	**3**	**3**	**3**	Public concerns will be addressed following the Cleanup Action Plan public comment period. Mid rank score of 3 assumed until then.
Overall Benefit Score		**27**	**23**	**21**	**20**	**23**	
Total Costs (NPV $millions)		**$2.17**	**$2.76**	**$3.17**	**$3.06**	**$24.30**	
Benefit-to-Cost Ratio (Overall Benefit Score/Total Costs)		**12.4**	**8.3**	**6.6**	**6.5**	**0.9**	

Notes:

1. Alternatives are ranked with 1 being the least favorable rating and 5 being the most favorable rating.
2. ICs = Institutional Controls

Table 6.3.5-1
MTCA Requirements – Zones C/D

	Alternatives			
	CD-1	**CD-2**	**CD-3**	
Alternative	**Monitoring and maintenance of existing RCRA cap/cover system, ground water performance monitoring, and ICs**	**All CD-1 elements, in addition to contingent remedy (in situ chemical amendment of impacted soil)**	**Removal of cap/cover systems, excavation and off-site disposal of waste/soil, geomembrane and RCRA cap placement, backfill, ground water performance monitoring, and ICs**	**Comments**
Threshold Requirements				
Protects human health and the environment	Yes	Yes	Yes	All remedial alternatives in Zones C/D meet the threshold requirements.
Complies with cleanup standards	Yes	Yes	Yes	
Complies with applicable state and federal laws	Yes	Yes	Yes	
Provides for compliance monitoring	Yes	Yes	Yes	
Other Requirements				
Permanent to maximum extent practicable	See Table 6.3.5-2 and Tables 6.3.5-3a through 6.3.5-3e.			This criterion is evaluated under the MTCA Disproportionate Cost Analysis.
Provides reasonable restoration timeframe	Yes	Yes	Yes	Alternative CD-3 provides a shorter restoration time frame, compared to Alternatives CD-1 and CD-2, because final source elimination (waste removal) is part of its scope; therefore, it requires less long-term monitoring.
Considers public concerns	Yes	Yes	Yes	Public concerns will be addressed following the public comment period for the CAP.
Additional Requirements				
Requires permanent ground water cleanup actions	No	No	No	All alternatives require performance sampling of ground water quality and confirmation of continued attainment of cleanup levels at the designated point of compliance.
Does not rely primarily on institutional controls	Yes	Yes	Yes	Although all alternatives rely on ICs to ensure that the integrity of the cap and cover system is maintained, ICs are not the primary remedial action.
Minimizes present and future site releases and migration	Yes	Yes	Yes	All alternatives minimize present and future releases and migration of hazardous substances.
Does not rely primarily on dilution and/or dispersion	Yes	Yes	Yes	None of the alternatives rely primarily on dilution and/or dispersion.

Notes:
CAP = Cleanup Action Plan
IC = institutional control
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act

Table 6.3.5-2
MTCA Disproportionate Cost Analysis Summary – Zones C/D

Alternative / MTCA Evaluation Criteria	CD-1	CD-2	CD-3
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Protectiveness (WAC 173-340-360(3)(f)(i))	2	2	2
Permanence (WAC 173-340-360(3)(f)(ii))	1	2	2
Effectiveness Over the Long Term (WAC 173-340-360(3)(f)(iv))	1	2	3
Management of Short-term Risks (WAC 173-340-360(3)(f)(v))	3	2	1
Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi))	3	2	2
Consideration of Public Concerns [a] (WAC 173-340-360(3)(f)(vii))	2	2	2
Overall Environmental Benefit Score (Sum)	12	12	12
Total Costs ($, Millions)	$0.7	$1.6	$7.2
Benefit-to-Cost Ratio (Benefit Score per $ Million)	**16.9**	**7.7**	**1.7**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average rankings for the various evaluation criteria are shown as integers.
3. Ranking assumes contingent actions are implemented.

a. All alternatives have some public concerns and are ranked equally in the FFS. Public concerns will be addressed following the public comment period for the CAP.

CAP = Cleanup Action Plan

FFS = focused feasibility study

IC = Institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

WAC = Washington Administrative Code

Table 6.3.5-3a
MTCA Evaluation Sub-criteria for Protectiveness (WAC 173-340-360(3)(f)(i)) - Zones C/D

Alternative / **MTCA Evaluation Sub-criteria for Protectiveness**	**CD-1**	**CD-2**	**CD-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Degree existing risks are reduced	1	2	3
	Alternatives achieve similar levels of reduction of existing risks because caps prevent direct contact and exposure to buried wastes and ground water dCULs have been met outside of the Zones C/D cap. Alternative CD-3 received the highest ranking because of removal of Zones C/D with off-site disposal. Alternatives CD-1 and CD-2 ranked lowest because wastes remain in place and could migrate to ground water over a longer time frame; however, Alternative CD-2 ranked slightly higher than Alternative CD-1 because it includes a contingent remedy.		
Time required to reduce risks at facility and attain CULs	1	2	3
	Although ground water dCULs are already achieved outside of the Zones C/D cap, Alternatives CD-2 and CD-3 ranked incrementally high because potential future risks are reduced through treatment/destruction and/or removal of the Zones C/D source area, rather than containment/treatment.		
On-site risks resulting from implementation	3	2	1
	Lowest risk with existing Zones C/D conditions (Alternative CD-1) because there is no direct contact and exposure to waste and contamination for humans and ecological receptors. Alternative CD-3 has greater on-site risks during implementation due to excavation, transport, and stockpiling of Zone E wastes, prior to off-site disposal.		
Off-site risks resulting from implementation	3	2	1
	No significant off-site risks apply to Alternatives CD-1 and CD-2 because all cleanup action components are conducted on-site; therefore, these alternatives ranked the highest for this sub-criterion. The greatest off-site risks are in Alternative CD-3 (therefore, ranking the lowest), which consist of off-site disposal of all waste and impacted soils in Zones C/D.		
Improvement of overall environmental quality	1	2	3
	All Zones C/D alternatives provide an improvement of the overall environmental quality by reducing long-term direct risks and exposure to varying degrees. Because the difference between alternatives is related to the time over which improvement in overall environmental quality occurs, the alternatives have the same rankings as for the time required to reduce the risks sub-criteria above.		
Average Ranking for Protectiveness	**2**	**2**	**2**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

CUL = cleanup level

dCUL = draft cleanup level

IC = institutional control

MTCA = Model Toxic Control Act

Table 6.3.5-3b
MTCA Evaluation Sub-criteria for Permanence (WAC 173-340-360(3)(f)(ii)) - Zones C/D

<table>
<tr><th rowspan="2">Alternative
MTCA Evaluation Sub-criteria for Permanence</th><th>CD-1</th><th>CD-2</th><th>CD-3</th></tr>
<tr><th>Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs</th><th>All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)</th><th>Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs</th></tr>
<tr><td rowspan="2">Destruction of hazardous substances</td><td>1</td><td>3</td><td>2</td></tr>
<tr><td colspan="3">Due to the treatment efficiency of in situ chemical amendment, Alternative CD-2 ranked the highest for this sub-criterion, compared to off-site disposal (Alternative CD-3).</td></tr>
<tr><td rowspan="2">Reduction or elimination of releases</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="3">Alternatives CD-1 and CD-2 include reduction or elimination of releases of COCs, through different engineered controls. However, Alternatives CD-3 ranked the highest because removal of waste effectively eliminates releases of contaminants.</td></tr>
<tr><td rowspan="2">Reduction or elimination of sources of releases</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="3">Alternative CD-3 ranked the highest because it eliminates the source of COCs, compared to Alternative CD-2, which only reduces the source of contaminants.</td></tr>
<tr><td rowspan="2">Irreversibility of waste treatment process</td><td>1</td><td>3</td><td>1</td></tr>
<tr><td colspan="3">COC destruction in Alternative CD-2, achieved through in situ chemical amendment, is more irreversible than containment or off-site disposal. Therefore, this alternative ranked the highest for this sub-criterion.</td></tr>
<tr><td rowspan="2">Characteristics and quantity of treatment residuals generated</td><td>3</td><td>1</td><td>3</td></tr>
<tr><td colspan="3">Alternatives CD-1 and CD-3 ranked the highest for this criterion because they have no treatment and associated treatment residuals. Alternative CD-2 ranked the lowest since in situ chemical amendment is the major component of this alternative; although treatability studies may be required for Alternative CD-2 to evaluate the optimum stabilization conditions of waste, small amounts of treatment residuals are anticipated.</td></tr>
<tr><td>Average Ranking for Permanence</td><td>1</td><td>2</td><td>2</td></tr>
</table>

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.
3. Under MTCA (WAC 173-340-360(3)(f)(ii)), permanence is defined as reduction in toxicity, mobility, or volume.

COC = chemical of concern
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act
WAC = Washington Administrative Code

Table 6.3.5-3c
MTCA Evaluation Sub-criteria for Effectiveness Over The Long Term (WAC 173-340-360(3)(f)(iv)) - Zones C/D

Alternative **MTCA Evaluation Sub-criteria for Effectiveness Over the Long Term**	**CD-1**	**CD-2**	**CD-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Degree of certainty that the alternative will be successful	1	2	3
	All alternatives are anticipated to have a high degree of certainty of success (i.e., meeting ground water dCULs downgradient of the Zone E cap). Alternative CD-3 ranked the highest because the removal of wastes will ensure long-term effectiveness in minimizing risks and exposure to human health and the environment. All alternatives, however, have long-term cap O&M and ground water monitoring obligations.		
Reliability of the alternative during the time period hazardous substances will be on site at concentrations that exceed CULs	1	2	3
	Alternative CD-3 provides the greatest reliability over the long-term because of waste removal and off-site disposal; however, long-term cap O&M and ground water monitoring obligations remain. The contingent action in Alternative CD-2 increases reliability over the long term, compared to Alternative CD-1.		
Magnitude of residual risk	1	2	3
	Alternative CD-3 ranked the highest as minimal risks that are expected after removal and off-site disposal of wastes. Alternatives CD-1 and CD-2 have greater residual risks due to the amount on untreated/treated waste remaining and, therefore, residual contamination, and would need to be addressed over the long term.		
Effectiveness of controls required to manage treatment residues or remaining wastes	1	2	3
	The highest ranking is for Alternative CD-3, which has the least amount of wastes remaining on site. Although Alternatives CD-1 and CD-2 leave all wastes in Zones C/D, Alternative CD-2 ranked slightly higher than Alternative CD-1 due to the contingent remedy, which could be implemented to manage contamination from residual wastes.		
Average Ranking for Effectiveness Over the Long-term	**1**	**2**	**3**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

CUL = cleanup level
dCUL = draft cleanup level
IC = institutional control
MTCA = Model Toxic Control Act
O&M = operation and maintenance
RCRA = Resource Conservation and Recovery Act

Table 6.3.5-3d
MTCA Evaluation Sub-criteria for Management of Short-term Risks (WAC 173-340-360(3)(f)(v)) - Zones C/D

Alternative / MTCA Evaluation Sub-criteria for Management of Short-term Risks	CD-1	CD-2	CD-3
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Risk to human health and the environment associated with the alternative during construction and implementation	3	2	1
	There are negligible short-term risks associated with Alternative CD-1 because it is non-invasive during construction and implementation; therefore, it ranked the highest for this sub-criterion. Alternative CD-2 has slightly higher short-term risks due to performing the chemical amendment on site. Alternative CD-3 has the highest short-term risks and exposure of workers to waste and impacted soil during implementation due to excavation, waste management, and overall construction.		
Effectiveness of measures that will be taken to manage such risks	3	2	1
	Alternative CD-1 ranked the highest for this sub-criterion as it does not include invasive actions in Zones C/D, and therefore no specific mitigation measures are anticipated to manage short-term risks. Alternative CD-1 ranked higher than Alternative CD-2 because of the potential contingent action in the latter (in situ chemical amendment) would require some on-site management. Mitigation measures to manage risks associated with removal operations in Alternative CD-3 are uncertain at this time, but short-term risks could be managed with proper planning, comprehensive adaptive management, and H&S programs. Increased truck traffic associated with off-site disposal in Alternative CD-3 provides additional risk to other drivers and the community that can not be prevented/managed once trucks are off-site.		
Average Ranking for Management of Short-term Risks	**3**	**2**	**1**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

H&S = health and safety

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

Table 6.3.5-3e

MTCA Evaluation Sub-criteria for Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi)) - Zones C/D

Alternative **MTCA Evaluation Sub-criteria for Technical and Administrative Implementability**	**CD-1**	**CD-2**	**CD-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Technically possible	3	1	2
	All alternatives are technically possible and pose various degrees of technical challenges based on the combinations of engineered controls used. Alternative CD-1 ranked the highest because it is the most readily implementable remedial alternative from the technical points of view because it has been successfully implemented since 2002 with the Zones C/D cap. Alternative CD-3 requires a comprehensive technical construction project plan due to the invasive nature and difficulty of the excavation activities; thus, this alternative ranked lower than Alternative CD-1.There is some uncertainty in the ability to implement in situ chemical amendment, given site specific factors that would not be resolved until treatability testing is performed and/or the EDR phase (to evaluate the optimum operating conditions), prior to full-scale implementation and, therefore, Alternative CD-2 ranked the lowest for this sub-criterion.		
Availability of necessary off-site facilities, services and materials	3	2	1
	Alternative CD-1 ranked the highest for this sub-criterion because this alternative uses existing facilities, services, and materials, known to be available. Alternative CD-3 is directly impacted by the availability of permitted disposal facilities and are limited geographically. Also, highly skilled personnel will be required to properly conduct in situ chemical amendment in Alternative CD-2 (thus, it ranked slightly lower than Alternative CD-1). Appropriately trained personnel to perform removal action in Alternative CD-3 may be limited and Alternative CD-3 requires the greatest amount of services and materials and coordination with off-site facilities, related to excavation and off-site disposal.		
Administrative/regulatory requirements	3	2	1
	Administrative and regulatory requirements are easily met for Alternative CD-1 because it is the most readily implementable alternative as it is essentially in place; thus, it ranked the highest for this sub-criterion. Alternative CD-2 ranked slightly lower than Alternative CD-1 because the contingent remedy would require regulatory approval before implementing. Administrative and regulatory requirements for transport and off-site disposal in Alternative CD-3 are complicated due to land ban requirements and because excavated impacted soils need to go out of state (DOT requirements); thus, it ranked the lowest for this sub-criterion.		
Scheduling, size, complexity, access	3	2	1
	Alternative CD-3 has a high degree of scheduling, sizing, complexity, challenges, and difficulty associated with excavation and off-site disposal; therefore, it ranked the lowest for this sub-criterion. Minimal technical difficulties are expected for Alternative CD-2, but it is still easily implementable. Alternative CD-1 is the most readily implementable remedial alternative in terms of ease of scheduling and complexity and, therefore, it ranked the highest for this sub-criterion.		

Table 6.3.5-3e

MTCA Evaluation Sub-criteria for Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi)) - Zones C/D

Alternative	**CD-1**	**CD-2**	**CD-3**
MTCA Evaluation Sub-criteria for Technical and Administrative Implementability	**Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs**	**All CD-1 Elements, in Eddition to Contingent Remedy (In Situ Chemical Amendment of Impacted Soil)**	**Removal of Cap/Cover Systems, Excavation and Off-Site Disposal of Waste/Soil, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Monitoring requirements	1	2	3
	It is anticipated that all alternatives will require long-term ground water compliance monitoring and cap inspection, monitoring, and maintenance in perpetuity. Overall, Alternative CD-3 has the least amount of monitoring and, therefore, it ranked the highest.		
Average Ranking for Technical and Administrative Implementability	**3**	**2**	**2**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

DOT = Department of Transportation

EDR = Engineering Design Report

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

Table 6.3.6-1
MTCA Requirements – Zone E

Alternative	Alternatives			Comments
	E-1	E-2	E-3	
	Monitoring and maintenance of existing RCRA cap/cover system, ground water performance monitoring, and ICs	All E-1 elements, in addition to contingent remedy (ex situ stabilization of waste)	Removal of cap/cover systems, excavation and off-site disposal of waste/soil with pre-treatment, geomembrane and RCRA cap placement, backfill, ground water performance monitoring, and ICs	
Threshold Requirements				
Protects human health and the environment	Yes	Yes	Yes	All remedial alternatives in Zone E meet the threshold requirements.
Complies with cleanup standards	Yes	Yes	Yes	
Complies with applicable state and federal laws	Yes	Yes	Yes	
Provides for compliance monitoring	Yes	Yes	Yes	
Other Requirements				
Permanent to maximum extent practicable	See Table 6.3.6-2 and Tables 6.3.6-3a through 6.3.6-3e.			This criterion is evaluated under the MTCA Disproportionate Cost Analysis.
Provides reasonable restoration timeframe	Yes	Yes	Yes	Alternative E-3 provides a shorter restoration time frame, compared to Alternatives E-1 and E-2, because final source elimination (waste removal) is part of its scope; therefore, it requires less long-term monitoring.
Considers public concerns	Yes	Yes	Yes	Public concerns will be addressed following the public comment period for the CAP.
Additional Requirements				
Requires permanent ground water cleanup actions	No	No	No	All alternatives require performance sampling of ground water quality and confirmation of continued attainment of cleanup levels at the designated point of compliance.
Does not rely primarily on institutional controls	Yes	Yes	Yes	Although all alternatives rely on ICs to ensure that the integrity of the cap and cover system is maintained, ICs are not the primary remedial action.
Minimizes present and future site releases and migration	Yes	Yes	Yes	All alternatives minimize present and future releases and migration of hazardous substances.
Does not rely primarily on dilution and/or dispersion	Yes	Yes	Yes	None of the alternatives rely primarily on dilution and/or dispersion.

Notes:
CAP = Cleanup Action Plan
IC = institutional control
MTCA = Model Toxics Control Act
RCRA = Resource Conservation and Recovery Act

Table 6.3.6-2
MTCA Disproportionate Cost Analysis Summary – Zone E

Alternative / MTCA Evaluation Criteria	E-1	E-2	E-3
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)**	**Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Protectiveness (WAC 173-340-360(3)(f)(i))	2	2	2
Permanence (WAC 173-340-360(3)(f)(ii))	1	2	2
Effectiveness Over the Long Term (WAC 173-340-360(3)(f)(iv))	1	2	3
Management of Short-term Risks (WAC 173-340-360(3)(f)(v))	3	2	1
Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi))	3	2	2
Consideration of Public Concerns [a] (WAC 173-340-360(3)(f)(vii))	2	2	2
Overall Environmental Benefit Score (Sum)	12	12	12
Total Costs ($, Millions)	$0.8	$2.2	$20.1
Benefit-to-Cost Ratio (Benefit Score per $ Million)	**14.2**	**5.4**	**0.6**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average rankings for the various evaluation criteria are shown as integers.
3. Ranking assumes contingent actions are implemented.

a. All alternatives have some public concerns and are ranked equally in the FFS. Public concerns will be addressed following the public comment period for the CAP.

CAP = Cleanup Action Plan
FFS = focused feasibility study
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act
WAC = Washington Administrative Code

Table 6.3.6-3a
MTCA Evaluation Sub-criteria for Protectiveness (WAC 173-340-360(3)(f)(i)) - Zone E

Alternative **MTCA Evaluation Sub-criteria for Protectiveness**	**E-1**	**E-2**	**E-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)**	**Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Degree existing risks are reduced	1	2	3
	Alternatives achieve similar levels of reduction of existing risks because caps prevent direct contact and exposure to buried wastes and ground water dCULs have been met outside of the Zone E cap. Alternative E-3 received the highest ranking because of removal of Zone E with off-site disposal. Alternatives E-1 and E-2 ranked lowest because wastes remain in place and could migrate to ground water over a longer time frame; however, Alternative E-2 ranked slightly higher than Alternative E-1 because it includes a contingent remedy.		
Time required to reduce risks at facility and attain CULs	1	2	3
	Although ground water dCULs are already achieved outside of the Zone E cap, Alternatives E-2 and E-3 ranked incrementally high because potential future risks are reduced through treatment/destruction and/or removal of the Zone E source area, rather than containment/treatment.		
On-site risks resulting from implementation	3	2	1
	Lowest risk with existing Zone E conditions (Alternative E-1) because there is no direct contact and exposure to waste and contamination for humans and ecological receptors. Alternative E-3 has greater on-site risks during implementation due to excavation, transport, and stockpiling of Zone E wastes, prior to off-site disposal.		
Off-site risks resulting from implementation	3	2	1
	No significant off-site risks apply to Alternatives E-1 and E-2 because all cleanup action components are conducted on-site; therefore, these alternatives ranked the highest for this sub-criterion. The greatest off-site risks are in Alternative E-3 (therefore, ranking the lowest), which consist of off-site disposal of all waste and impacted soils in Zone E.		
Improvement of overall environmental quality	1	2	3
	All Zone E alternatives provide an improvement of the overall environmental quality by reducing long-term direct risks and exposure to varying degrees. Because the difference between alternatives is related to the time over which improvement in overall environmental quality occurs, the alternatives have the same rankings as for the time required to reduce risks sub-criteria above.		
Average Ranking for Protectiveness	**2**	**2**	**2**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

CUL = cleanup level
dCUL = draft cleanup level
IC = institutional control
MTCA = Model Toxic Control Act
RCRA = Resource Conservation and Recovery Act

Table 6.3.6-3b

MTCA Evaluation Sub-criteria for Permanence (WAC 173-340-360(3)(f)(ii)) - Zone E

<table>
<tr><th rowspan="2">Alternative
MTCA Evaluation Sub-criteria for Permanence</th><th>E-1</th><th>E-2</th><th>E-3</th></tr>
<tr><th>Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs</th><th>All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)</th><th>Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs</th></tr>
<tr><td rowspan="2">Destruction of hazardous substances</td><td>1</td><td>3</td><td>2</td></tr>
<tr><td colspan="3">Due to the treatment efficiency of ex situ stabilization, Alternative E-2 ranked the highest for this sub-criterion, compared to off-site disposal (Alternative E-3).</td></tr>
<tr><td rowspan="2">Reduction or elimination of releases</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="3">Alternatives E-1 and E-2 include reduction or elimination of releases of COCs, through different engineered controls. However, Alternatives E-3 ranked the highest because removal of waste effectively eliminates releases of contaminants.</td></tr>
<tr><td rowspan="2">Reduction or elimination of sources of releases</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td colspan="3">Alternative E-3 ranked the highest because it eliminates the source of COCs, compared to Alternative E-2 which only reduces the source of contaminants.</td></tr>
<tr><td rowspan="2">Irreversibility of waste treatment process</td><td>1</td><td>3</td><td>1</td></tr>
<tr><td colspan="3">COC stabilization in Alternative E-2, achieved through ex situ treatment, is more irreversable than containment or off-site disposal. Therefore, this alternative ranked the highest for this sub-criterion.</td></tr>
<tr><td rowspan="2">Characteristics and quantity of treatment residuals generated</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td colspan="3">Alternative E-1 ranked the highest for this criterion because it has no treatment and associated treatment residuals. Alternative E-3 ranked slightly lower than Alternative E-1 because it has a small percentage (20%) of wastes removed from Zone E that are assumed to require stabilization as a component of off-site disposal. Alternative E-2 ranked the lowest because stabilization is the major component of this alternative; although treatibility studies may be required for Alternative E-2 to evaluate the optimum stabilization conditions of waste, small amounts of treatment residuals are anticipated.</td></tr>
<tr><td>Average Ranking for Permanence</td><td>1</td><td>2</td><td>2</td></tr>
</table>

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.
3. Under MTCA (WAC 173-340-360(3)(f)(ii)), permanence is defined as reduction in toxicity, mobility, or volume.

COC = chemical of concern

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

WAC = Washington Administrative Code

Table 6.3.6-3c
MTCA Evaluation Sub-criteria for Effectiveness Over The Long Term (WAC 173-340-360(3)(f)(iv)) - Zone E

Alternative **MTCA Evaluation Sub-criteria for Effectiveness Over the Long Term**	**E-1**	**E-2**	**E-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)**	**Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Degree of certainty that the alternative will be successful	1	2	3
	All alternatives are anticipated to have a high degree of certainty of success (i.e., meeting ground water dCULs downgradient of the Zone E cap). Alternative E-3 ranked the highest because the removal of wastes will ensure long-term effectiveness in minimizing risks and exposure to human health and the environment. All alternatives, however, have long-term cap O&M and ground water monitoring obligations.		
Reliability of the alternative during the time period hazardous substances will be on site at concentrations that exceed CULs	1	2	3
	Alternative E-3 provides the greatest reliability over the long-term because of waste removal and off-site disposal; however, long-term cap O&M and ground water monitoring obligations remain. The contingent action in Alternative E-2 increases reliability over the long term, compared to Alternative E-1.		
Magnitude of residual risk	1	2	3
	Alternative E-3 ranked the highest as minimal risks are expected after removal and off-site disposal of wastes. Alternatives E-1 and E-2 have greater residual risks due to the amount on untreated/treated waste remaining and, therefore, residual contamination) and would need to be addressed over the long-term.		
Effectiveness of controls required to manage treatment residues or remaining wastes	1	2	3
	The highest ranking is for Alternative E-3, which has the least amount of wastes remaining on site. Although Alternatives E-1 and E-2 leave all wastes in Zone E, Alternative E-2 ranked slightly higher than Alternative E-1 due to the contingent remedy, which could be implemented to manage contamination from residual wastes.		
Average Ranking for Effectiveness Over the Long-term	**1**	**2**	**3**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

CUL = cleanup level
dCUL = draft cleanup level
IC = institutional control
MTCA = Model Toxics Control Act
O&M = operation and maintenance
RCRA = Resource Conservation and Recovery Act

Table 6.3.6-3d
MTCA Evaluation Sub-criteria for Management of Short-term Risks (WAC 173-340-360(3)(f)(v)) - Zone E

Alternative / **MTCA Evaluation Sub-criteria for Management of Short-term Risks**	**E-1**	**E-2**	**E-3**
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)**	**Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Risk to human health and the environment associated with the alternative during construction and implementation	3	2	1
	There are negligible short-term risks associated with Alternative E-1 because it is non-invasive during construction and implementation; therefore, it ranked the highest for this sub-criterion. Alternative E-2 has slightly higher short-term risks due to performing stabilization on site. Alternative E-3 has the highest short-term risks and exposure of workers to waste and impacted soil during implementation, due to excavation, waste management, and overall construction.		
Effectiveness of measures that will be taken to manage such risks	3	2	1
	Alternative E-1 ranked the highest for this sub-criterion as it does not include invasive actions in Zone E, and therefore no specific mitigation measures are anticipated to manage short-term risks. Alternative E-1 ranked higher than Alternative E-2 because of the potential contingent action in the latter (ex situ stabilization) would require some on-site management. Mitigation measures to manage risks associated with removal operations in Alternative E-3 are uncertain at this time, but short-term risks could be managed with proper planning, comprehensive adaptive management and H&S programs. Increased truck traffic associated with off-site disposal in Alternative E-3 provides additional risk to other drivers and the community that cannot be prevented/managed once trucks are off site.		
Average Ranking for Management of Short-term Risks	**3**	**2**	**1**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

H&S = health and safety

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

WAC = Washington Administrative Code

Table 6.3.6-3e
MTCA Evaluation Sub-criteria for Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi)) - Zone E

<table>
<tr><th rowspan="2">Alternative
MTCA Evaluation Sub-criteria for Technical and Administrative Implementability</th><th>E-1</th><th>E-2</th><th>E-3</th></tr>
<tr><th>Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs</th><th>All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)</th><th>Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs</th></tr>
<tr><td rowspan="2">Technically possible</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td colspan="3">All alternatives are technically possible and pose various degrees of technical challenges based on the combinations of engineered controls used. Alternative E-1 ranked the highest because it is the most readily implementable remedial alternative from the technical points of view, as it has been successfully implemented since 2002 with the Zone E cap. Alternative E-3 requires a comprehensive technical construction project plan due to the invasive nature and difficulty of the excavation activities; thus, this alternative ranked lower than Alternative E-1. There is some uncertainty in the ability to implement ex situ stabilization, given site specific factors that would not be resolved until treatability testing is performed and/or the EDR phase (to evaluate the optimum operating conditions), prior to full-scale implementation and therefore, Alternative E-2 ranked the lowest for this sub-criterion.</td></tr>
<tr><td rowspan="2">Availability of necessary off-site facilities, services and materials</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Alternative E-1 ranked the highest for this sub-criterion because this alternative uses existing facilities, services, and materials, known to be available. Alternative E-3 is directly impacted by the availability of permitted disposal facilities and are limited geographically. Also, highly skilled personnel will be required to properly conduct ex situ stabilization in Alternative E-2 (thus, it ranked slightly lower than Alternative E-1). Appropriately trained personnel to perform removal action in Alternative E-3 may be limited and Alternative E-3 requires the greatest amount of services and materials and coordination with off-site facilities, related to excavation and off-site disposal.</td></tr>
<tr><td rowspan="2">Administrative/regulatory requirements</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="3">Administrative and regulatory requirements are easily met for Alternative E-1 because it is the most readily implementable alternative as it is essentially in place; thus, it ranked the highest for this sub-criterion. Alternative E-2 ranked slightly lower than Alternative E-1 because the contingent remedy would require regulatory approval before implementing. Administrative and regulatory requirements for transport and off-site disposal in Alternative E-3 are complicated due to land ban requirements and because excavated impacted soils need to go out of state (DOT requirements); thus, it ranked the lowest for this sub-criterion.</td></tr>
</table>

Table 6.3.6-3e

MTCA Evaluation Sub-criteria for Technical and Administrative Implementability (WAC 173-340-360(3)(f)(vi)) - Zone E

Alternative / MTCA Evaluation Sub-criteria for Technical and Administrative Implementability	E-1	E-2	E-3
	Monitoring and Maintenance of Existing RCRA Cap/Cover System, Ground Water Performance Monitoring, and ICs	**All E-1 Elements, in Addition to Contingent Remedy (Ex Situ Stabilization of Waste)**	**Removal of Cap/Cover Systems, Excavation and Off-site Disposal of Waste/Soil with Pre-treatment, Geomembrane and RCRA Cap Placement, Backfill, Ground Water Performance Monitoring, and ICs**
Scheduling, size, complexity, access	3	2	1
	Alternative E-3 has a high degree of scheduling, sizing, complexity, challenges, and difficulty associated with excavation and off-site disposal; therefore, it ranked the lowest for this sub-criterion. Minimal technical difficulties are expected for Alternative E-2, but it is still easily implementable. Alternative E-1 is the most readily implementable remedial alternative in terms of ease of scheduling and complexity and, therefore, it ranked the highest for this sub-criterion.		
Monitoring requirements	1	2	3
	It is anticipated that all alternatives will require long-term ground water compliance monitoring and cap inspection, monitoring and maintenance in perpetuity. Overall, Alternative E-3 has the least amount of monitoring and, therefore, it ranked the highest.		
Average Ranking for Technical and Administrative Implementability	**3**	**2**	**2**

Notes:

1. Alternatives are order-ranked with 1 being the least favorable ranking and 3 being the most favorable ranking.
2. Average ranking is shown as an integer.

DOT = Department of Transportation

EDR = Engineering Design Report

IC = institutional control

MTCA = Model Toxic Control Act

RCRA = Resource Conservation and Recovery Act

Table 6.3.7-1
MTCA Requirements – On-property Ground Water (Central Area)

Alternative	Alternative ONP-1 Focused SVE treatment (contingent remedy), to be implemented to capture low-level VOCs in soil gas in the Central Area, to address potential future impacted ground water on the PSL property	Comments
Threshold Requirements		
Protects human health and the environment	Yes	Alternative ONP-1 meets the threshold requirements.
Complies with cleanup standards	Yes	
Complies with applicable state and federal laws	Yes	
Provides for compliance monitoring	Yes	
Other Requirements		
Permanent to maximum extent practicable	Yes	Alternative ONP-1 is a solution that is permanent to the maximum extent practicable.
Provides reasonable restoration timeframe	Yes	Alternative ONP-1 has an overall shorter restoration time frame with the contingent action. Focused SVE treatment provides immediate protection to ground water and permanently destroys COCs in recovered SVE gasses; therefore, more mass elimination and less long-term ground water monitoring will likely occur.
Considers public concerns	Yes	Public concerns will be addressed following the public comment period for the CAP.
Additional Requirements		
Requires permanent ground water cleanup actions	No	Alternative ONP-1 requires performance sampling of ground water quality and confirmation of continued attainment of cleanup levels at the designated point of compliance.
Does not rely primarily on institutional controls	Yes	ICs are not the primary remedial actions of Alternative ONP-1.
Minimizes present and future site releases and migration	Yes	Alternative ONP-1 minimizes present and future releases and migration of hazardous substances.
Does not rely primarily on dilution and/or dispersion	Yes	Alternative ONP-1 does not rely primarily on dilution and/or dispersion.

Notes:
CAP = Cleanup Action Plan
COC = chemical of concern
IC = institutional control
MTCA = Model Toxics Control Act
PSL = Pasco Sanitary Landfill
SVE = soil vapor extraction

Table 7-1
Summary of Preferred Alternatives

Zone	Preferred Remedial Alternative	Description	Total Cost[1] ($ million)
MSW Landfill	MSW-1	Alternative MSW-1 consists of leaving the MSW Landfill in place with existing GCCS and enclosed flare system, existing RCRA cover system, monitoring for potential landfill gas migration, ground water performance monitoring, and ICs.	$1.4
Balefill and Inert Waste Areas	BA-1	Alternative BA-1 consists of leaving the Balefill Area and Inert Waste Disposal Areas in place and rehabilitating the existing soil cover to a minimum thickness of 30 inches.	$0.5
Burn Trenches	BT-A	Alternative BT-A consists of leaving the Burn Trenches in place, with inspection, maintenance, and reporting, with ICs.	$0.01
Zone A	A-2	Alternative A-1 consists of monitoring and maintenance of the existing RCRA cap/cover system, existing SVE treatment for Zone A source area, ground water performance monitoring, and ICs, in addition to an enhanced SVE system and a "general ground water contingent treatment remedy" (e.g., air sparging system/ozone to treat ground water impacts prior to leaving the Site).	$18.3
Zone B	B-1	Alternative B-1 consists of monitoring and maintenance of the existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$2.2
Zones C/D	CD-1	Alternative CD-1 consists of monitoring and maintenance of the existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$0.7
Zone E	E-1	Alternative E-1 consists of monitoring and maintenance of the existing RCRA cap/cover system, ground water performance monitoring, and ICs.	$0.8
On-property Ground Water	ONP-1	Alternative ONP-1 consists of ground water performance monitoring, which is the primary action under this remedy. Focused SVE treatment is a contingent remedy included for cost purposes and may be implemented to capture low-level VOCs in the area between the south end of the MSW Landfill and Zones C/D and E if indicated by ground water monitoring.	$1.5

Notes:

1. Total costs are presented on a net present value basis.

GCCS = gas collection and control system

IC = institutional control

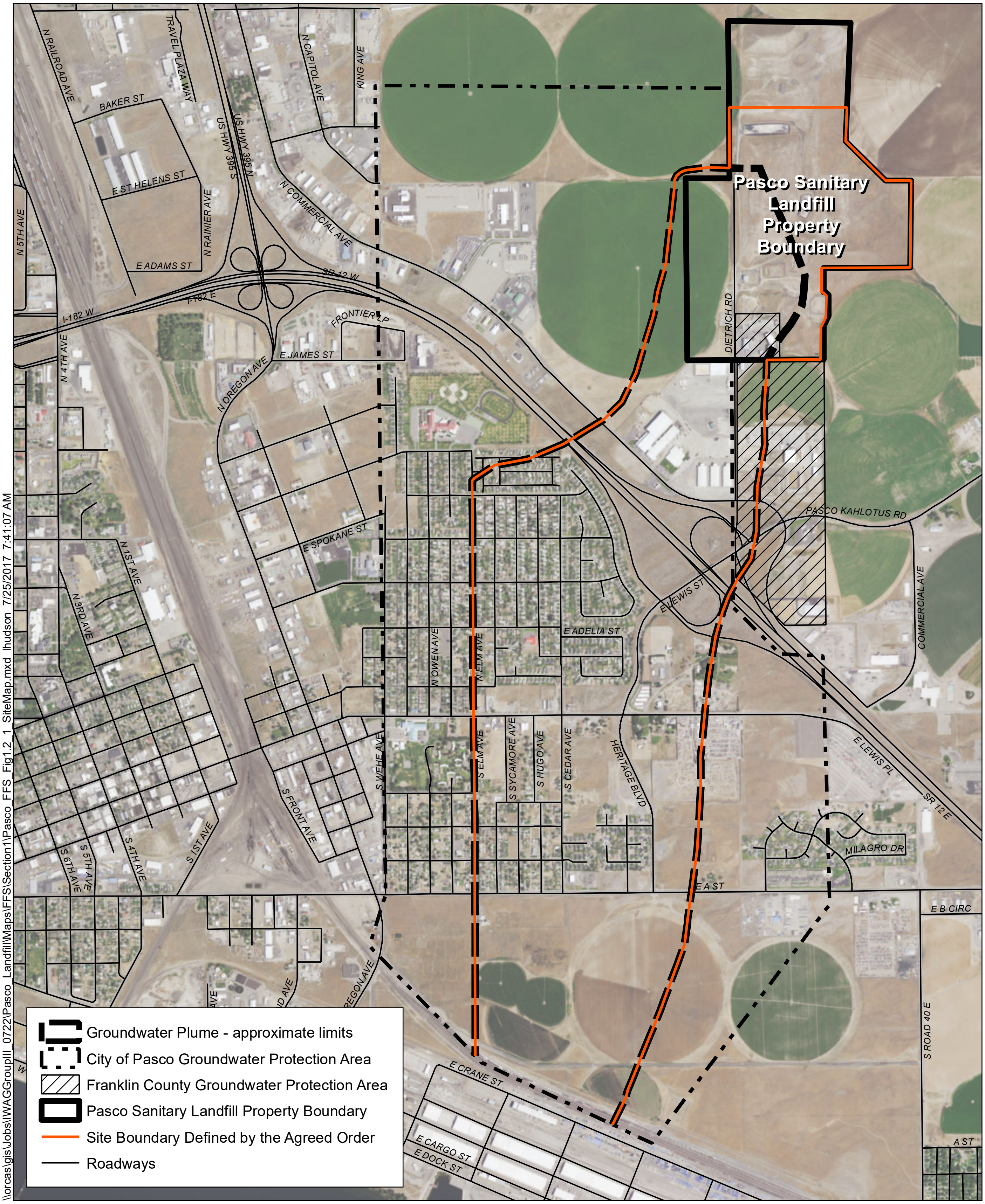
MSW = municipal solid waster

RCRA = Resource Conservation and Recovery Act

SVE = soil vapor extraction

VOC = volatile organic compound

FIGURES



\orcas\gis\Jobs\IWAGGroupII_0722\Pasco Landfill\Maps\FFS\Section1\Pasco FFS Fig1.2 1 SiteMap.mxd lhudson 7/25/2017 7:41:07 AM

NOTE:
Site encompasses both the landfill property as well as the off-site groundwater plume area.

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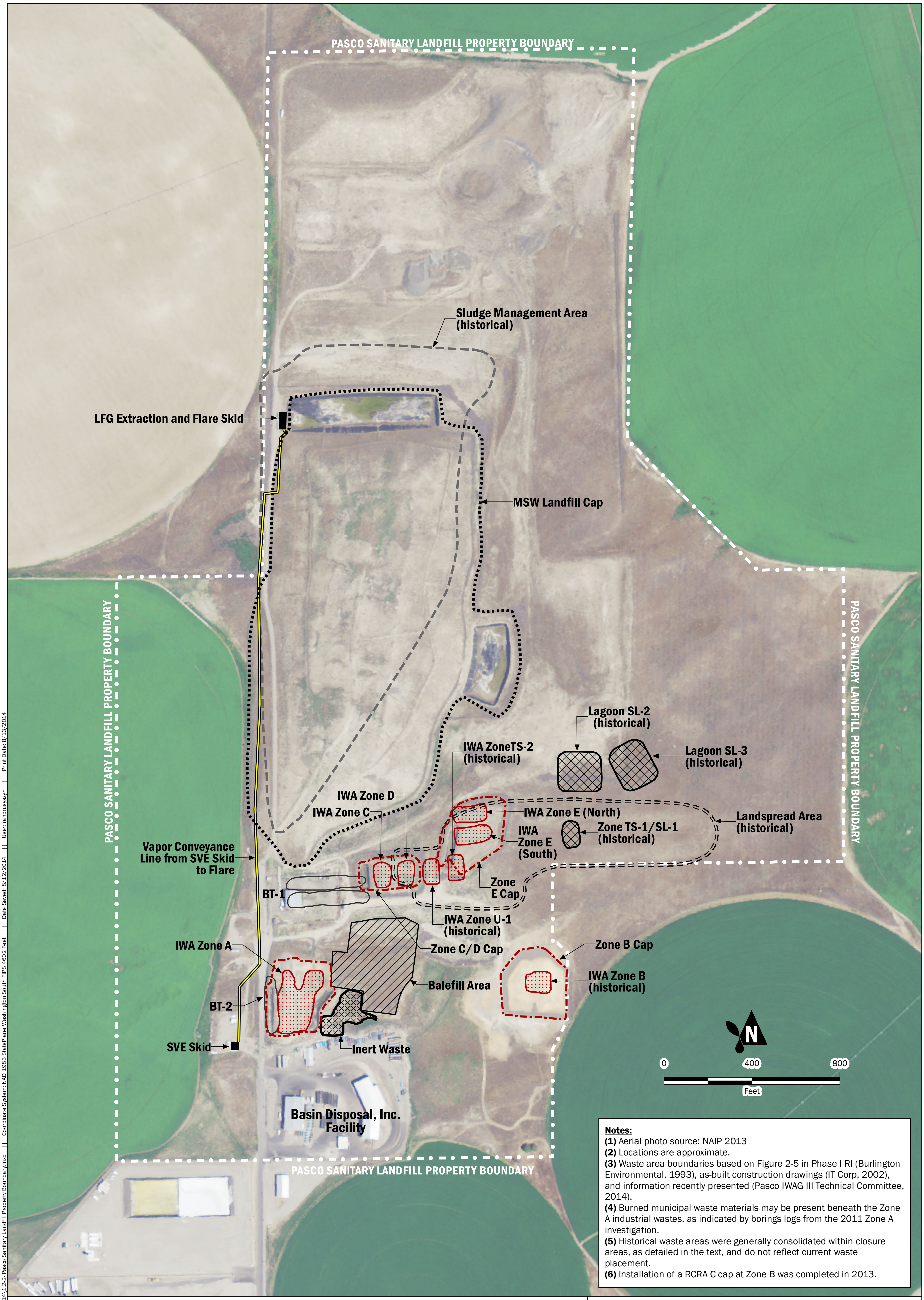
Feet
0 1,000 2,000

Figure 1.2-1
Site Map
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:

(1) Aerial photo source: NAIP 2013

(2) Locations are approximate.

(3) Waste area boundaries based on Figure 2-5 in Phase I RI (Burlington Environmental, 1993), as-built construction drawings (IT Corp, 2002), and information recently presented (Pasco IWAG III Technical Committee, 2014).

(4) Burned municipal waste materials may be present beneath the Zone A industrial wastes, as indicated by borings logs from the 2011 Zone A investigation.

(5) Historical waste areas were generally consolidated within closure areas, as detailed in the text, and do not reflect current waste placement.

(6) Installation of a RCRA C cap at Zone B was completed in 2013.

Industrial Waste Areas
IWA Caps
Sludge Lagoons
Sludge Management Area
MSW Landfill Cap
Landspread Area
Balefill Area
Burn Trenches
Inert Waste Disposal Area

Pasco Sanitary Landfill Property Boundary and Location of Waste Disposal Areas

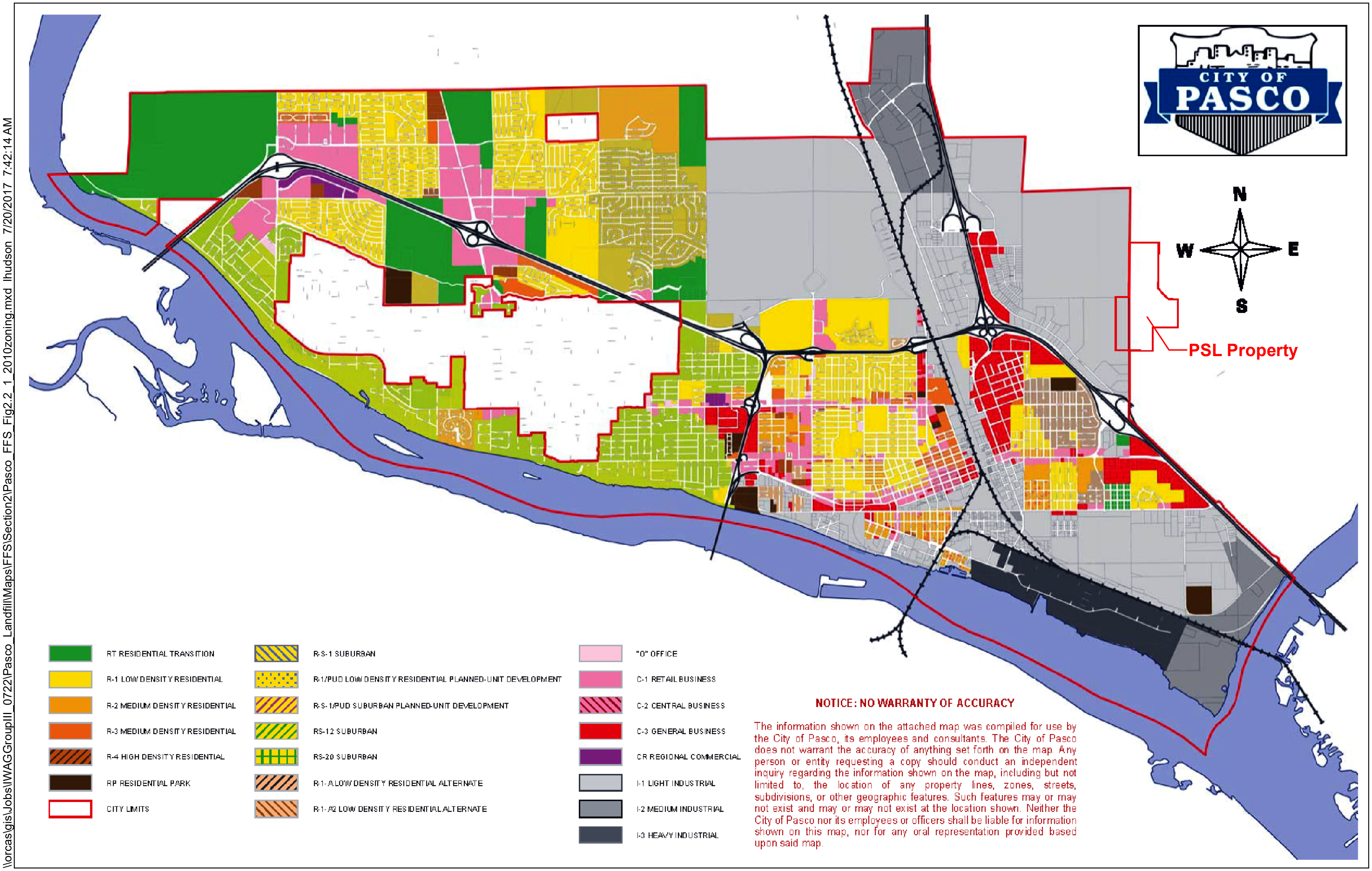
MSW Disposal Area O&M Manual
Pasco Landfill Site
Pasco, Washington

Aspect CONSULTING

AUG-2014	BY: PSB / RAA	FIGURE NO.
PROJECT NO. 060255	REVISED BY: - - -	1.2-2

GIS Path: T:\projects_8\Pasco_Landfill\Delivered\2014\1.2-2- Pasco Sanitary Landfill Property Boundary.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 8/12/2014 || User: randrusyszyn || Print Date: 8/13/2014

\\orcas\gis\Jobs\WAGGroupIII_0722\Pasco_Landfill\Maps\FFS\Section2\Pasco_FFS_Fig2.2_1_2010zoning.mxd lhudson 7/20/2017 7:42:14 AM



NOTICE: NO WARRANTY OF ACCURACY

The information shown on the attached map was compiled for use by the City of Pasco, its employees and consultants. The City of Pasco does not warrant the accuracy of anything set forth on the map. Any person or entity requesting a copy should conduct an independent inquiry regarding the information shown on the map, including but not limited to, the location of any property lines, zones, streets, subdivisions, or other geographic features. Such features may or may not exist and may or may not exist at the location shown. Neither the City of Pasco nor its employees or officers shall be liable for information shown on this map, nor for any oral representation provided based upon said map.

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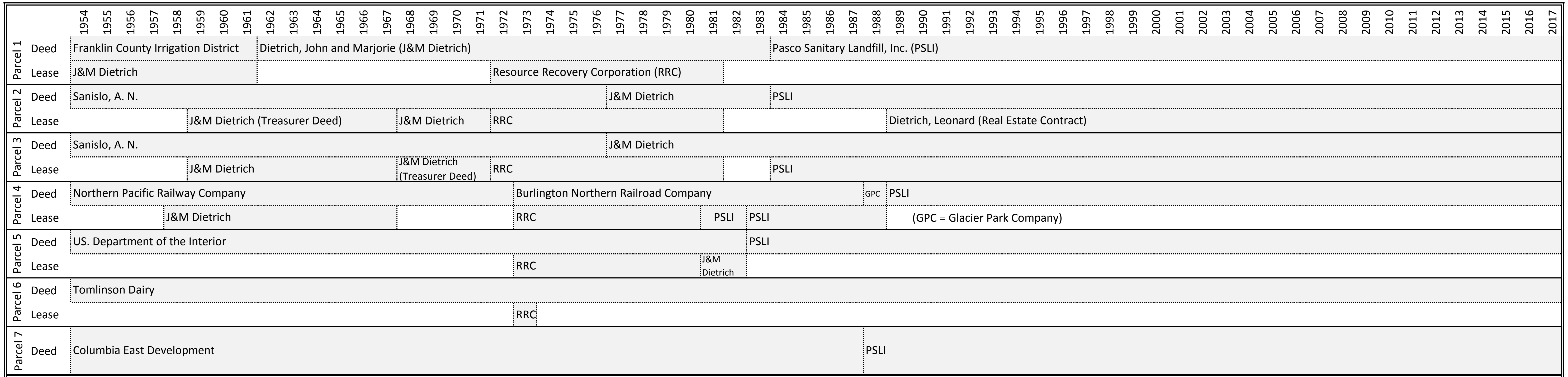
Figure 2.2-1
City of Pasco Zoning 2010
Pasco Sanitary Landfill NPL Site
Pasco, WA

Figure 2.3-1 - Property Ownership Timeline

Pasco Sanitary Landfill NPL Site



Excerpt from Phase I Remedial Investigation:
"The lease and ownership history of all the parcels of the [facility] is presented in Table 3-5. Figure 3-13 indicates the geographic location of the parcels referenced in Table 3-5. The information presented in Table 3-5 and Figure 3-13 was gathered from a search of all available Burlington Environmental, Chempro, PSL and RRC files. One of the documents encountered was a title search of all the parcels comprising the [facility] conducted in 1991 by McCluskey, Sells, Ryan, Olbertz & Haberty, Attorneys at Law. However, the information included in the title search appears to have some discrepancies in the parcel descriptions and owners. Therefore, the lease and ownership history was developed using original documents where available, and supplemented as needed with information from the title search. Due to discrepancies in the title search and lack of sufficient original documents, the accurate ownership history of the parcels in the west half of the northwest quarter of Section 22 could not be fully resolved."

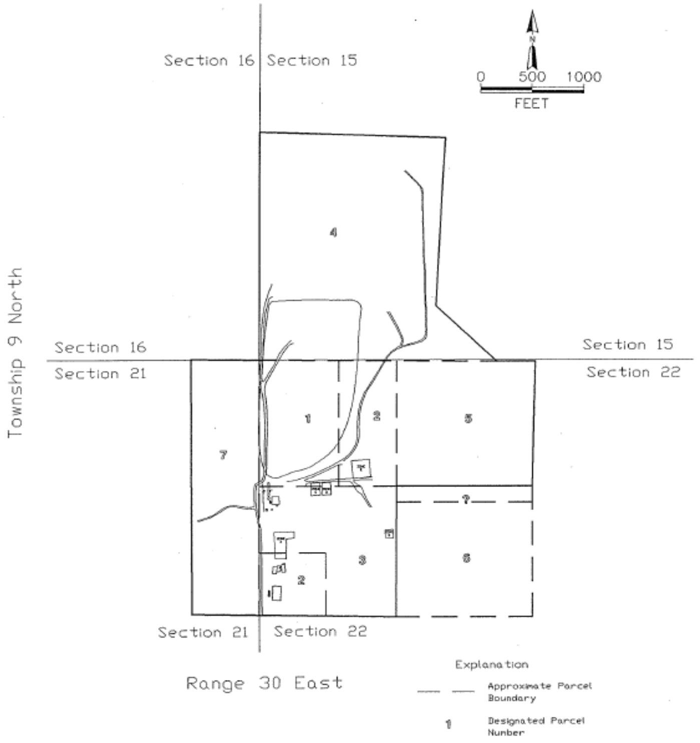
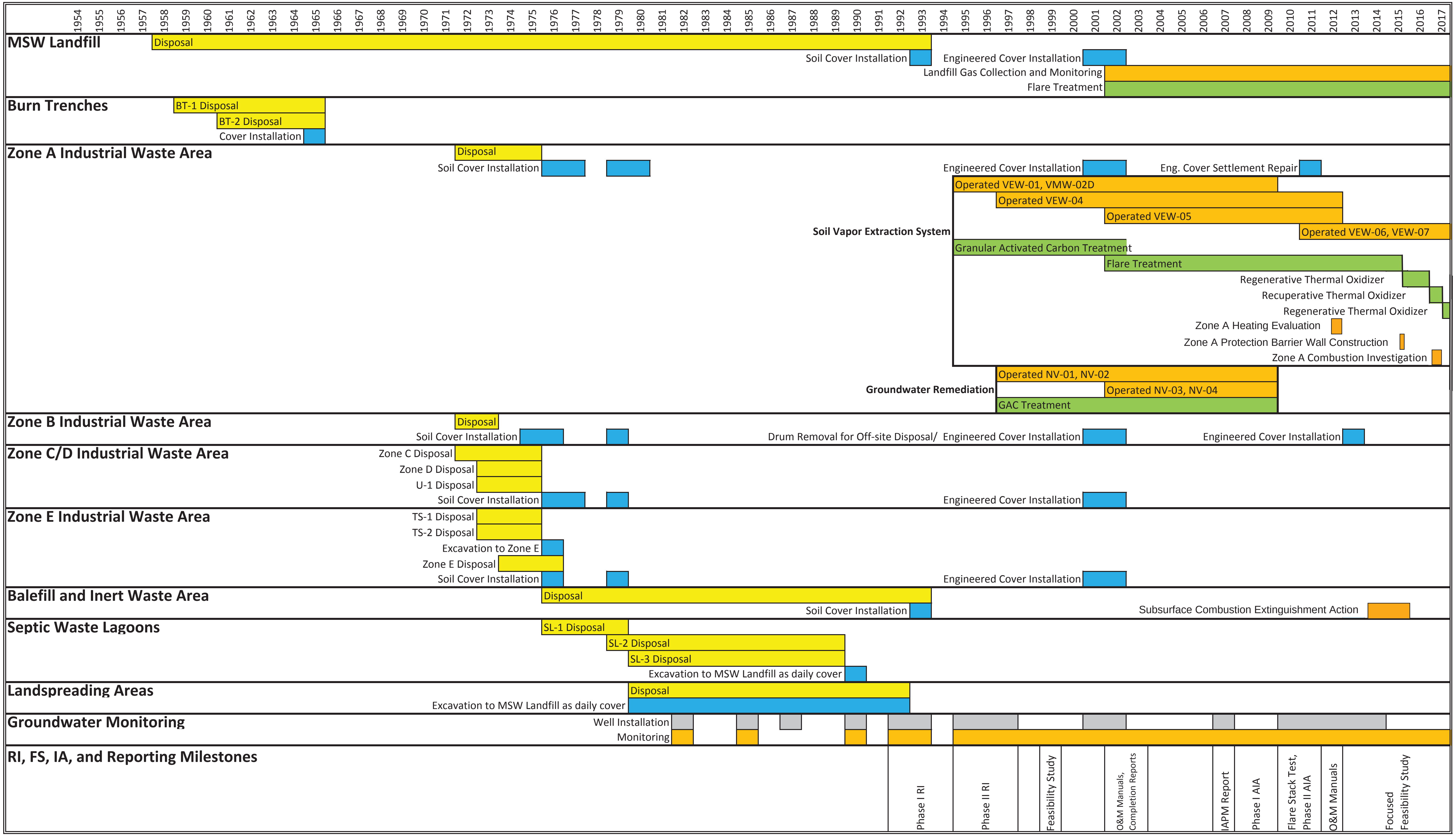


Figure 3-13 from Phase I Remedial Investigation

Figure 2.3-2
Timeline of Operations, Closure, Cover, Remediation, and Monitoring



Based on
Aspect Consulting, LLC
7/26/2017
P:\Pasco Landfill\FFS Report_Revised\RevisedFiguresTables\ActivitySummary_20170726

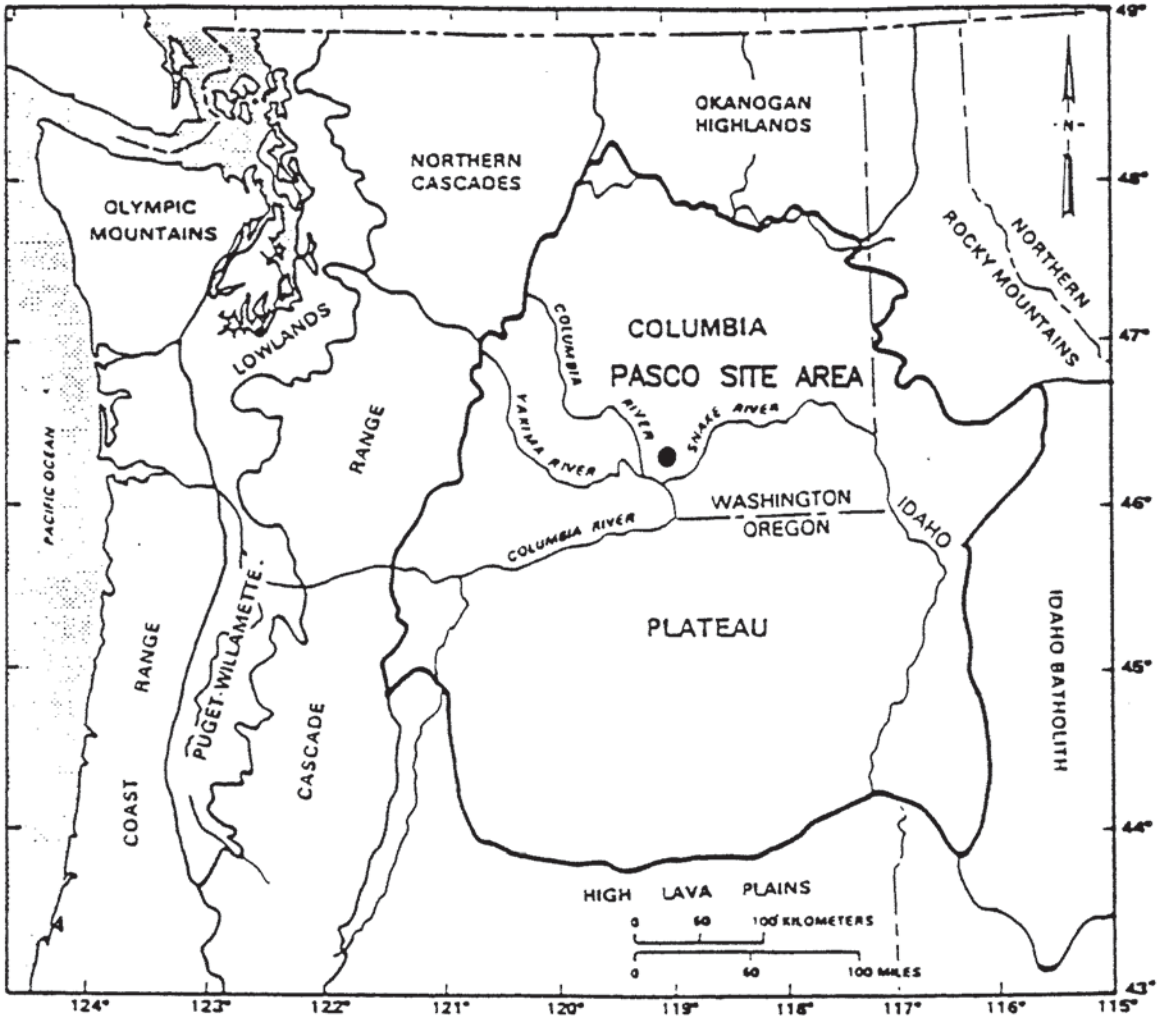
Pasco Sanitary Landfill Property Boundary

2-foot Contour

NOTE:
1. Topography survey conducted in 2013
by U.S. Geological Survey.

\\orcas\gis\Jobs\WAGGroupIII_0722\Pasco_Landfill\Maps\2017_03\AQ_PascoLandfill_Fig2_4_1_1_SiteTopography.mxd lhudson 3/17/2017 10:12:32 AM

Figure 2.4.1-1
Site Topography
Pasco Sanitary Landfill NPL Site
Pasco, WA



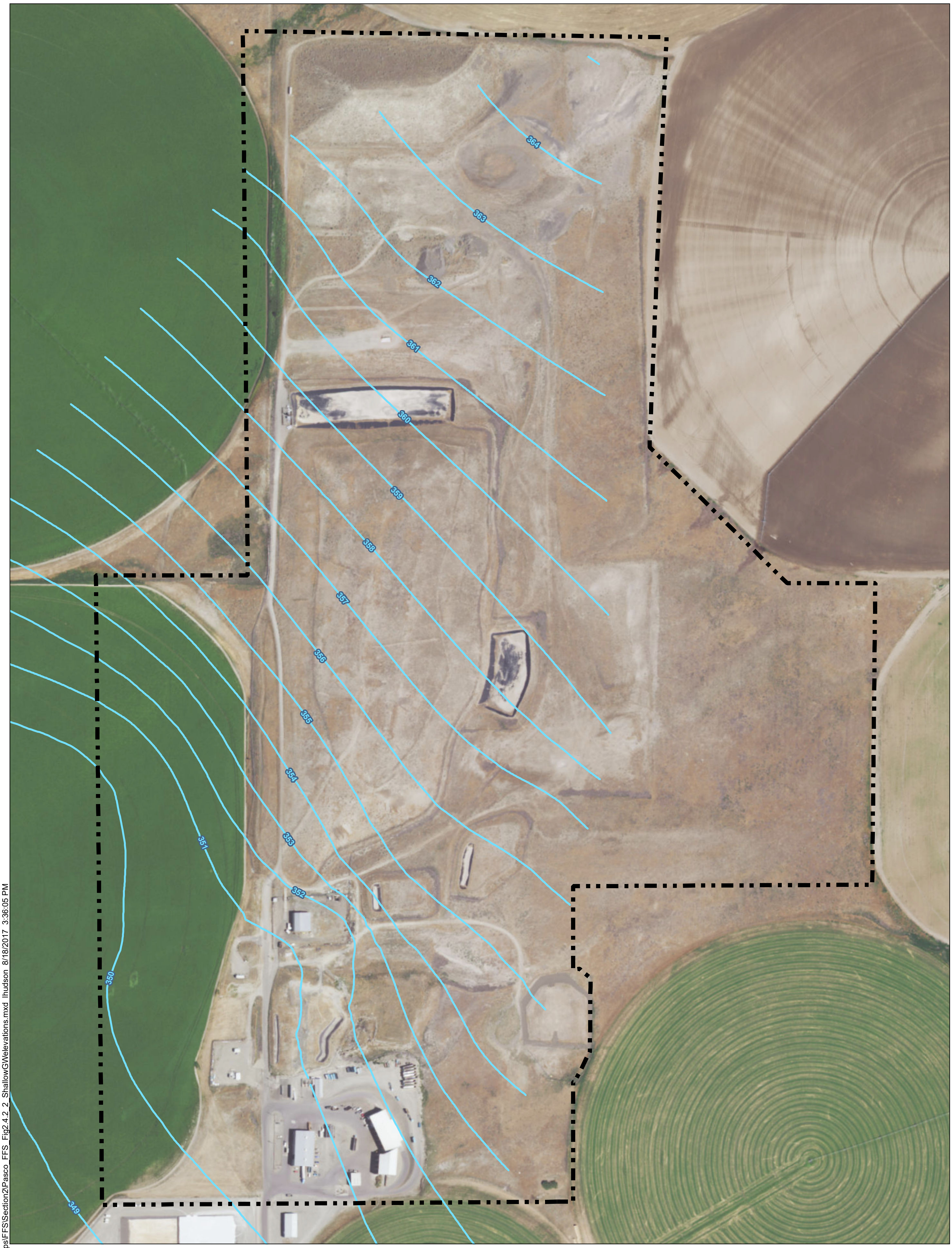
Index map of geologic provinces. (Modified from Myers and others, 1979)

PHILIP
ENVIRONMENTAL

TITLE:
The Columbia
Plateau
Pasco Landfill Phase II RI

DWN: bw
DES.: plh2ri07
CHKD:
APPD:
DATE: 11/13/96
REV.: 3
PROJECT NO.: 624419

Figure 2.4.2-1



⬚ Pasco Sanitary Landfill Property Boundary
— 1-foot Contour

NOTE:
1. Shallow groundwater elevations based on October sampling in 2016 Annual Report: Groundwater Monitoring and Interim Action Performance Monitoring (PBS, 2017).

Feet
0 250 500

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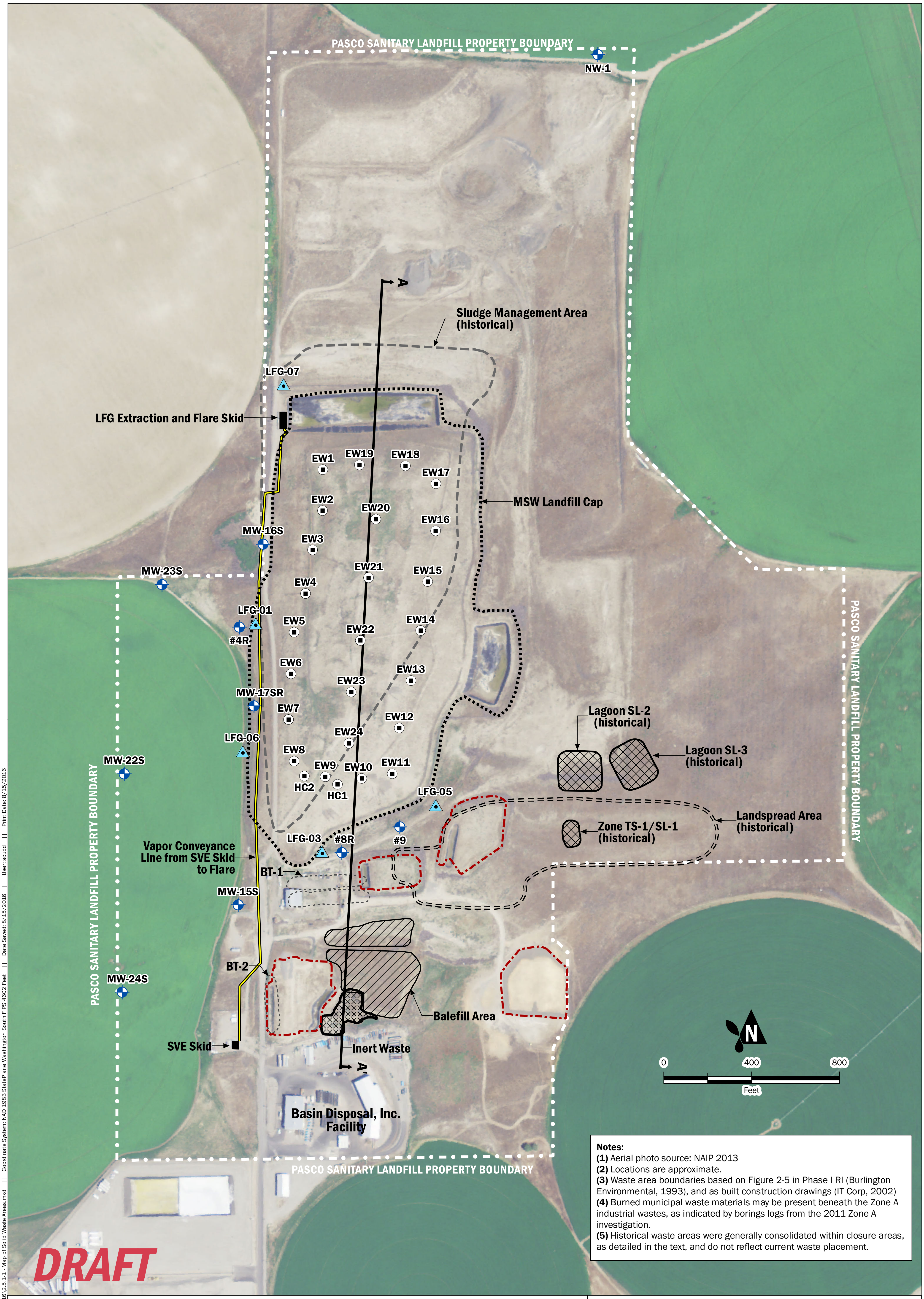
Figure 2.4.2-2
Shallow Ground Water Elevations
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:
(1) Aerial photo source: NAIP 2013
(2) Locations are approximate.
(3) Waste area boundaries based on Figure 2-5 in Phase I RI (Burlington Environmental, 1993), and as-built construction drawings (IT Corp, 2002)
(4) Burned municipal waste materials may be present beneath the Zone A industrial wastes, as indicated by borings logs from the 2011 Zone A investigation.
(5) Historical waste areas were generally consolidated within closure areas, as detailed in the text, and do not reflect current waste placement.

- ▣ Landfill Gas Extraction Wells
- ⊕ Existing Groundwater Monitoring Wells
- ▲ Existing LFG Monitoring Probes
- ▭ IWA Caps
- ▨ Sludge Lagoons
- ▭ Sludge Management Area
- ▭ MSW Landfill Cap
- ▭ Landspread Area
- ▨ Balefill Areas
- ▭ Burn Trenches
- ▨ Inert Waste Disposal Area

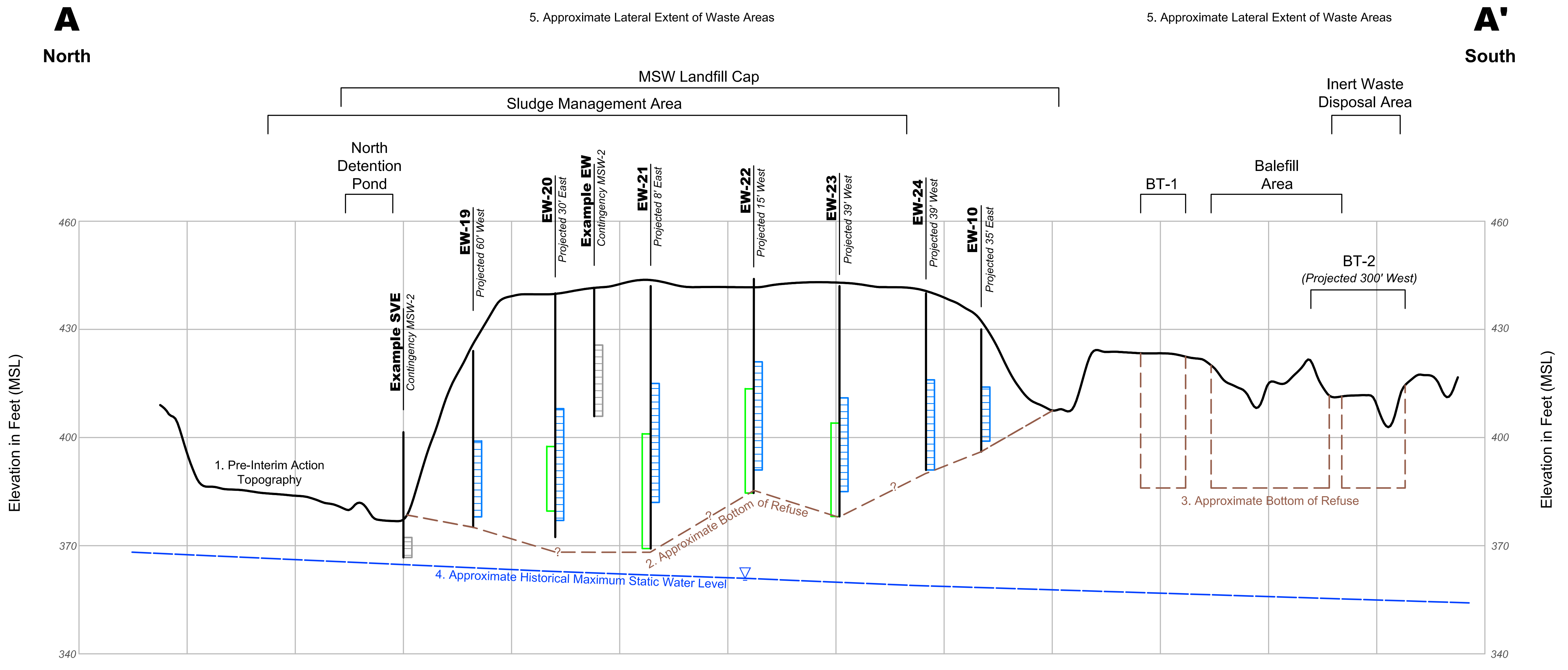
Municipal Solid Waste Areas

Pasco Landfill Site
Pasco, Washington

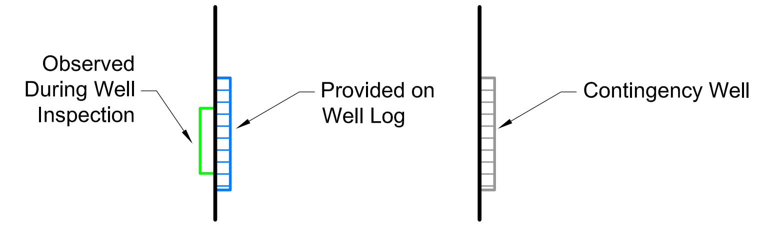
Aspect CONSULTING

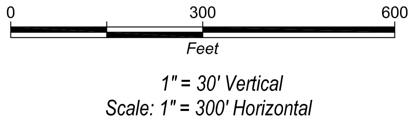
AUG-2016	BY: PSB / RAA	FIGURE NO.	
PROJECT NO. 060255	REVISED BY: SCC	**2.5.1-1**	

GIS Path: T:\projects_8\Pasco_Landfill\Delivered\2016\2.5.1-1 - Map of Solid Waste Areas.mxd || Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet || Date Saved: 8/15/2016 || User: scudd || Print Date: 8/15/2016



Well Perforation Interval:





1" = 30' Vertical
Scale: 1" = 300' Horizontal

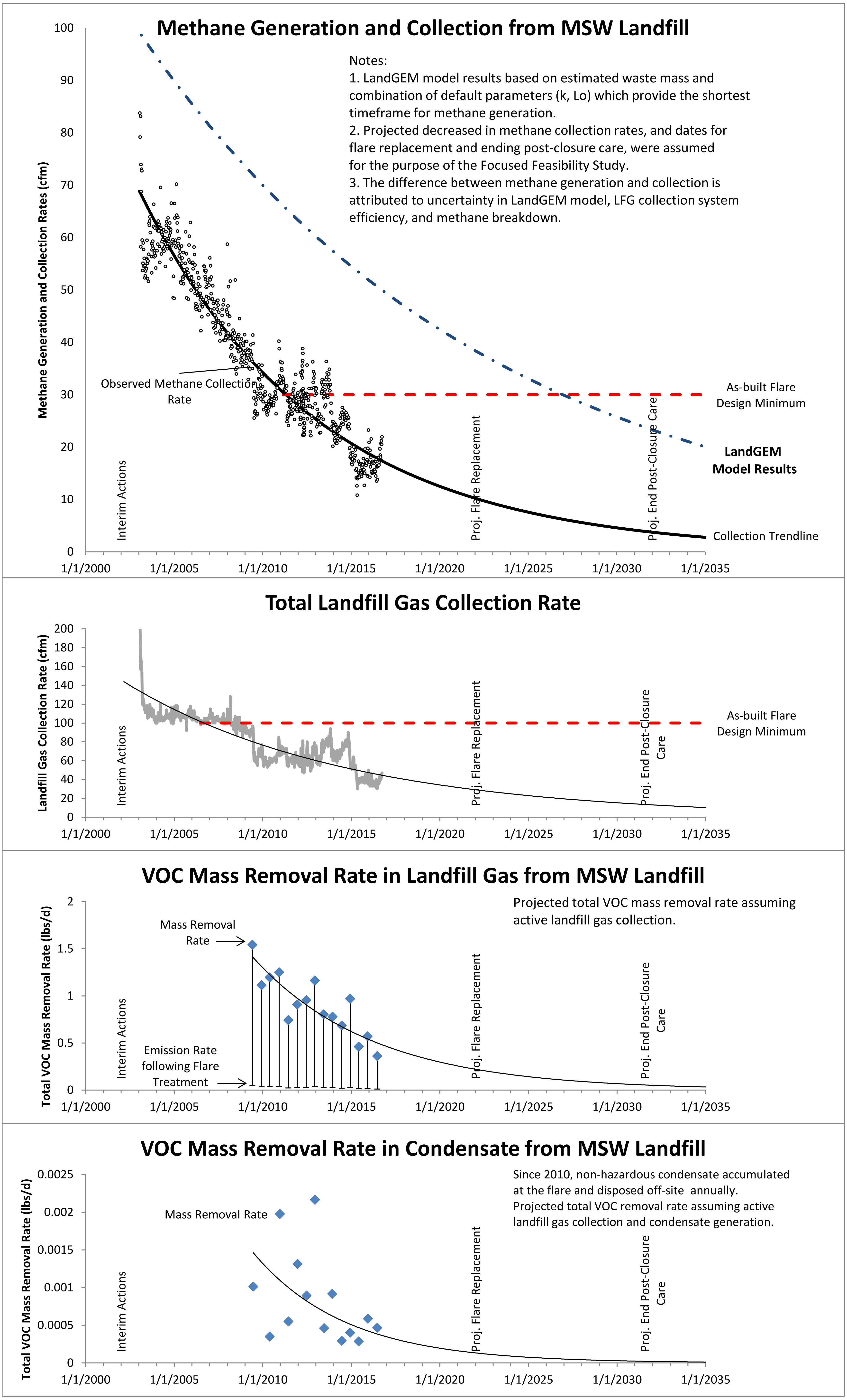
Notes:

1. Pre-Interim Action Topography - based on photogrammetric methods using aerial photo from March 11, 2000 (IT Corp., 2002).
2. Approximate Bottom of Refuse estimated from drillers logs and well inspections in 2014.
3. Approximate Bottom of Refuse estimated from sub-Zone A investigation (EPI, 2012) and minimum topographic elevations in the vicinity.
4. Approximate Groundwater Level - estimated from historical maximum water levels observed during 2nd Quarter 2011.
5. Approximate lateral extent for waste areas consistent with boundaries illustrated in Figure 2.5.1-1.

Cross Section A-A' of Municipal Solid Waste Areas

Pasco Landfill Site
Pasco, Washington

Aspect CONSULTING	Aug-2016 PROJECT NO. 060255	BY: PSB/SCC REV BY: SCC	FIGURE NO. 2.5.1-2



Notes:
1. LandGEM model results based on estimated waste mass and combination of default parameters (k, Lo) which provide the shortest timeframe for methane generation.
2. Projected decreased in methane collection rates, and dates for flare replacement and ending post-closure care, were assumed for the purpose of the Focused Feasibility Study.
3. The difference between methane generation and collection is attributed to uncertainty in LandGEM model, LFG collection system efficiency, and methane breakdown.

Projected total VOC mass removal rate assuming active landfill gas collection.

Since 2010, non-hazardous condensate accumulated at the flare and disposed off-site annually.
Projected total VOC removal rate assuming active landfill gas collection and condensate generation.

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7/26/2017
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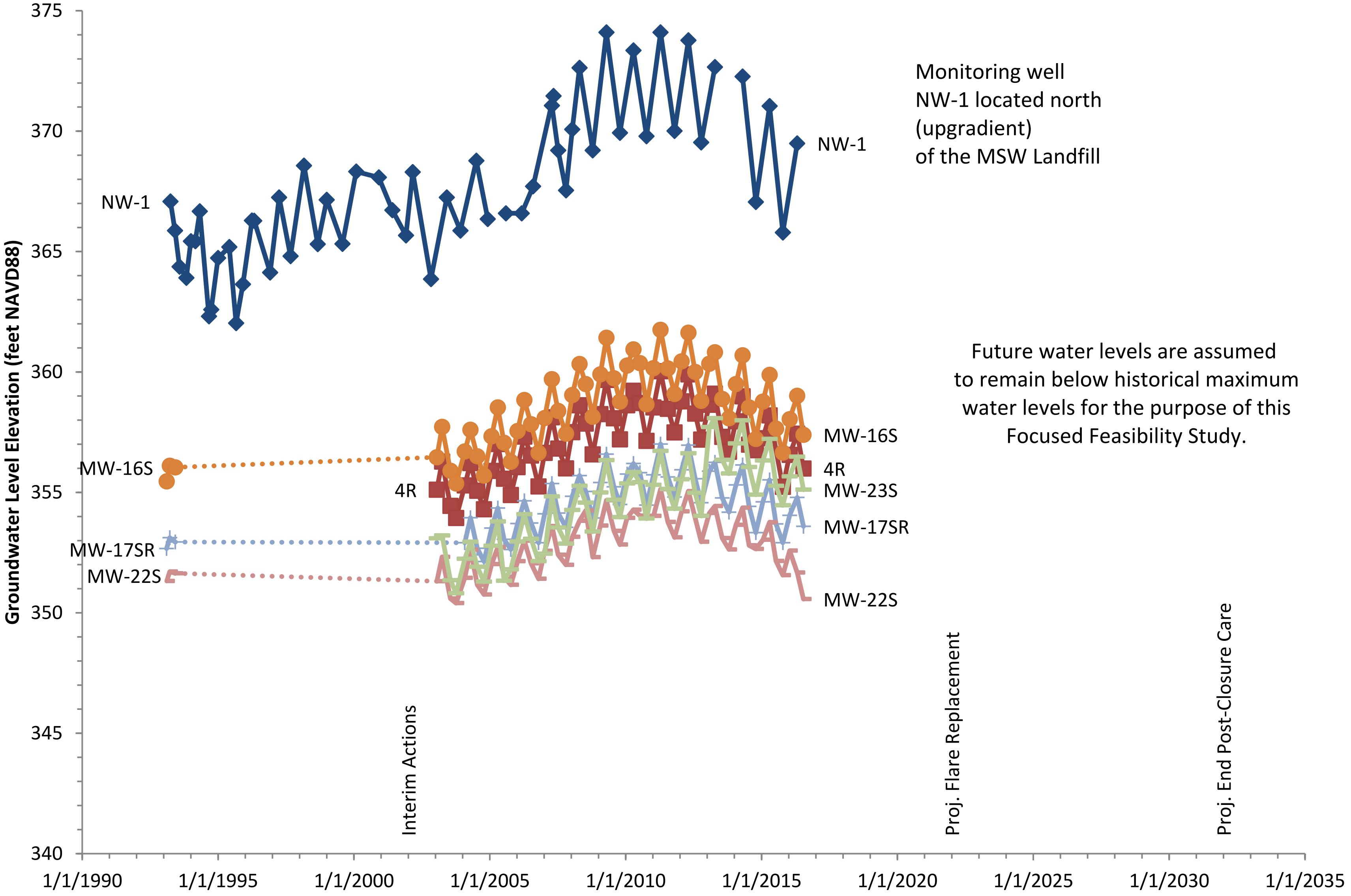
Figure 2.5.1-3
Decreasing Landfill Gas Generation and Collection Rates from the MSW Landfill
Pasco Sanitary Landfill NPL Site

DRAFT



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7/26/2017
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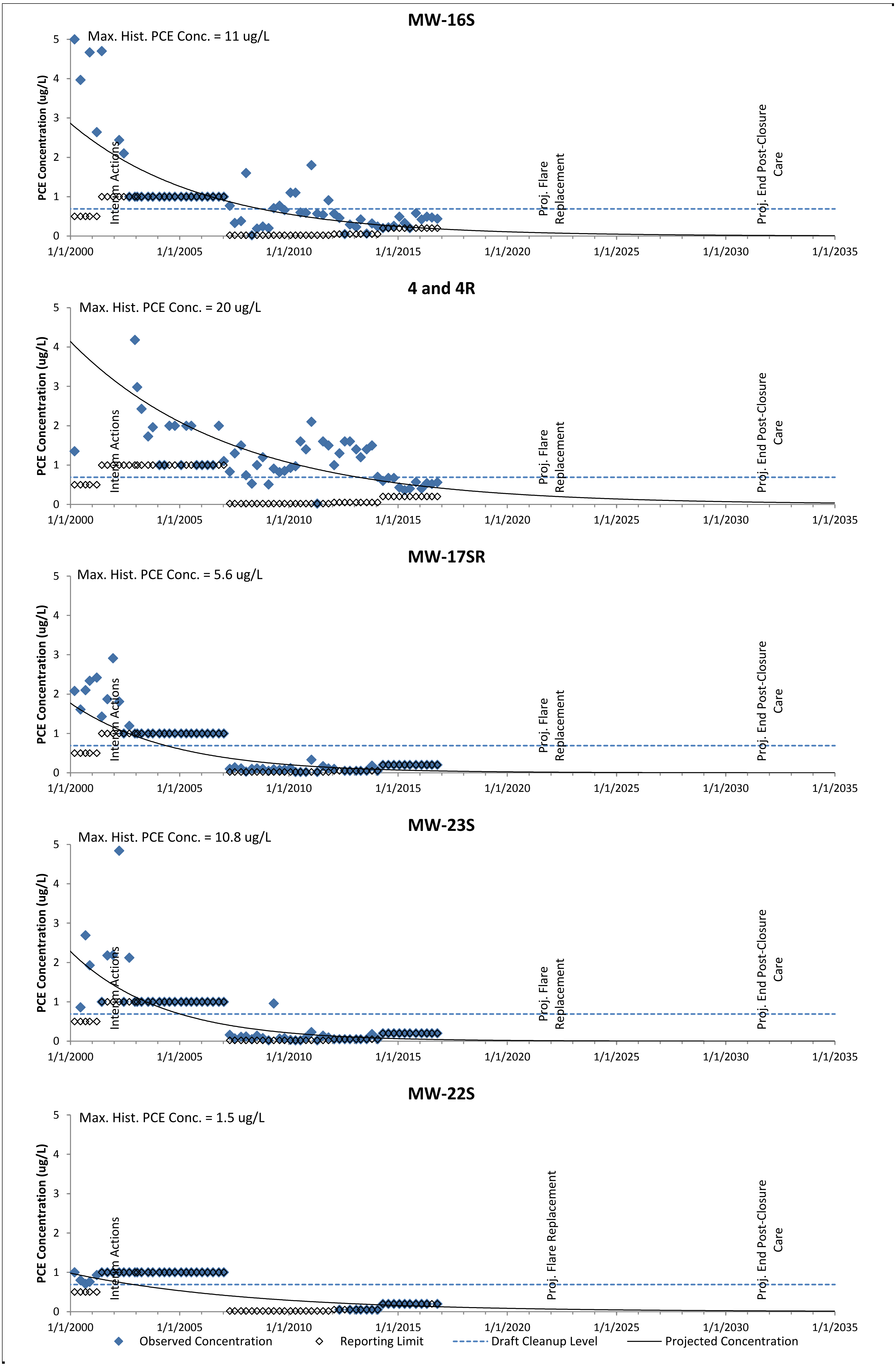
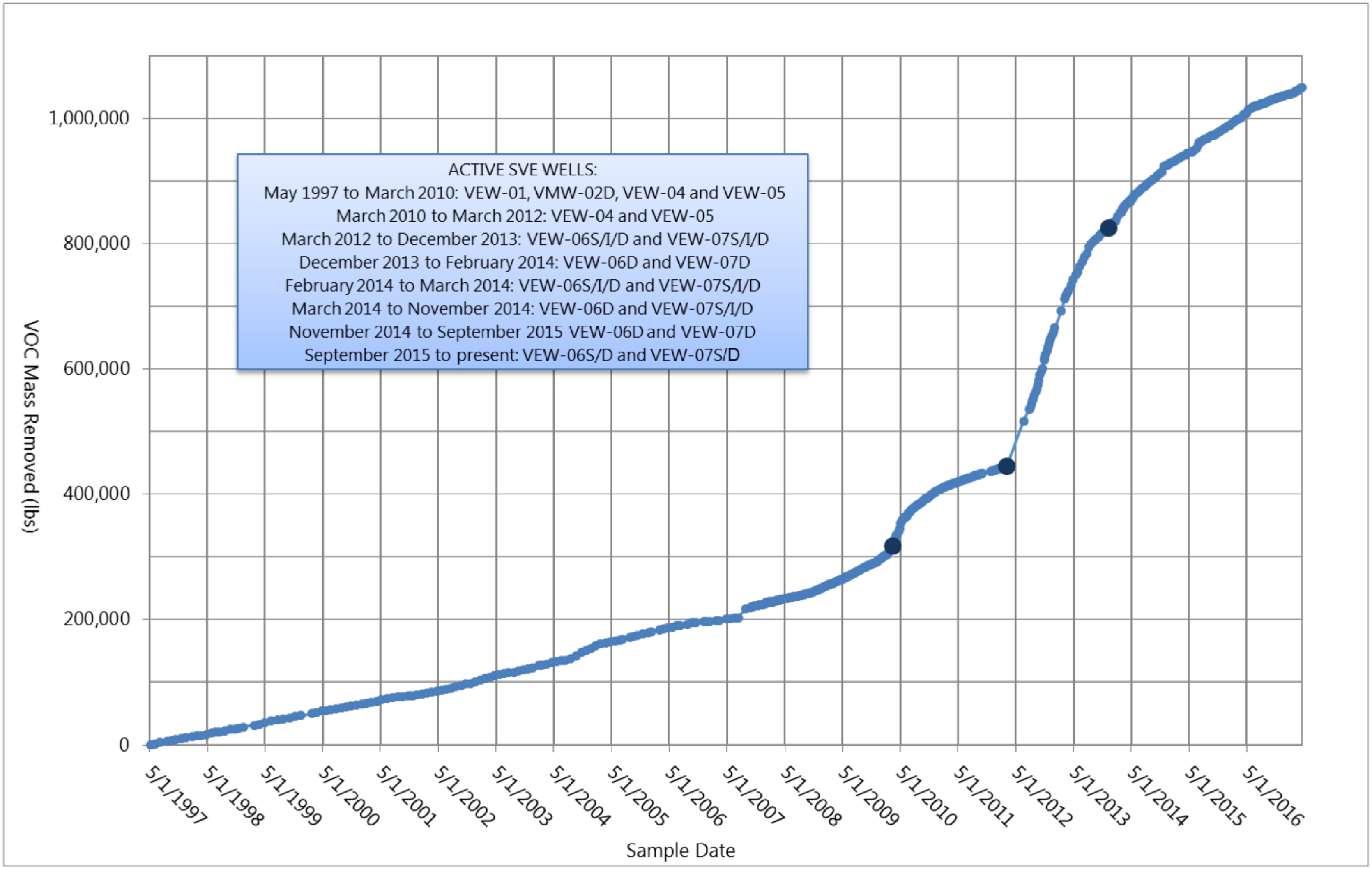
Figure 2.5.1-4
Changes in Ground Water Levels at MSW Landfill Monitoring Wells
Pasco Sanitary Landfill NPL Site



Projected concentrations based on trendline through all observed concentrations, including non-detects at reporting limit.

Aspect Consulting, LLC
7/26/2017
P:\Pasco Landfill\Analysis\PascoGW7.xlsx

Figure 2.5.1-5
Decreasing PCE Concentrations to Below Cleanup Levels in MSW Landfill Wells
Pasco Sanitary Landfill NPL Site



ACTIVE SVE WELLS:
May 1997 to March 2010: VEW-01, VMW-02D, VEW-04 and VEW-05
March 2010 to March 2012: VEW-04 and VEW-05
March 2012 to December 2013: VEW-06S/I/D and VEW-07S/I/D
December 2013 to February 2014: VEW-06D and VEW-07D
February 2014 to March 2014: VEW-06S/I/D and VEW-07S/I/D
March 2014 to November 2014: VEW-06D and VEW-07S/I/D
November 2014 to September 2015 VEW-06D and VEW-07D
September 2015 to present: VEW-06S/D and VEW-07S/D

Note: Figure modified from Monthly Status Report No. 85 – April 2017 (PBS, April 2017).

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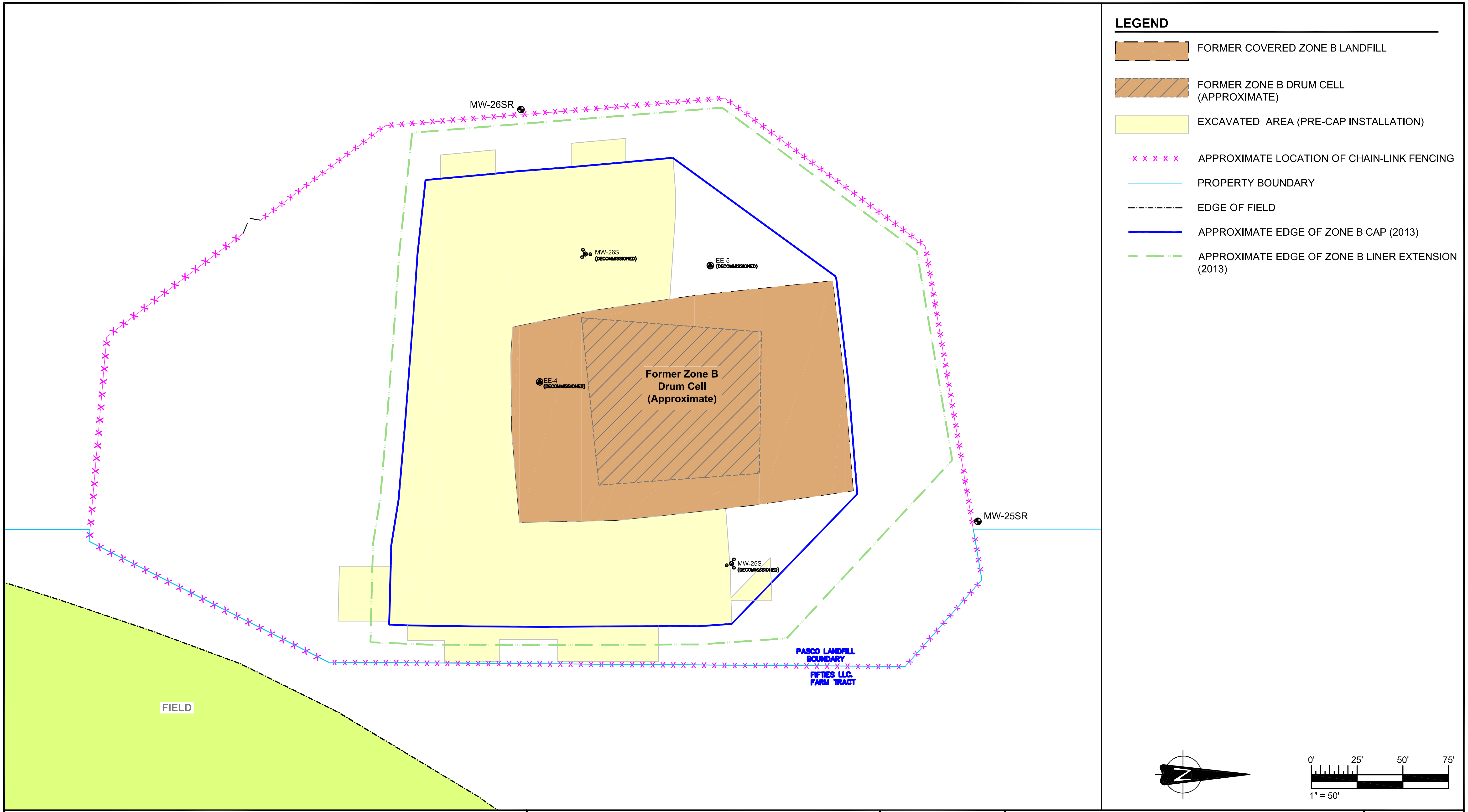
Figure 2.5.3-1
Cumulative VOC Mass Removed Since May 1997 by Zone A SVE System
Pasco Landfill NPL Site
Pasco, WA



BASE TOPOGRAPHIC MAP PROVIDED BY DSE & ASSOCIATES,
SCIO, OREGON, NOVEMBER 21, 2011

DRAFT

DRAWN BY: SD CHECKED BY: TW

BAYER CROPSCIENCE

Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

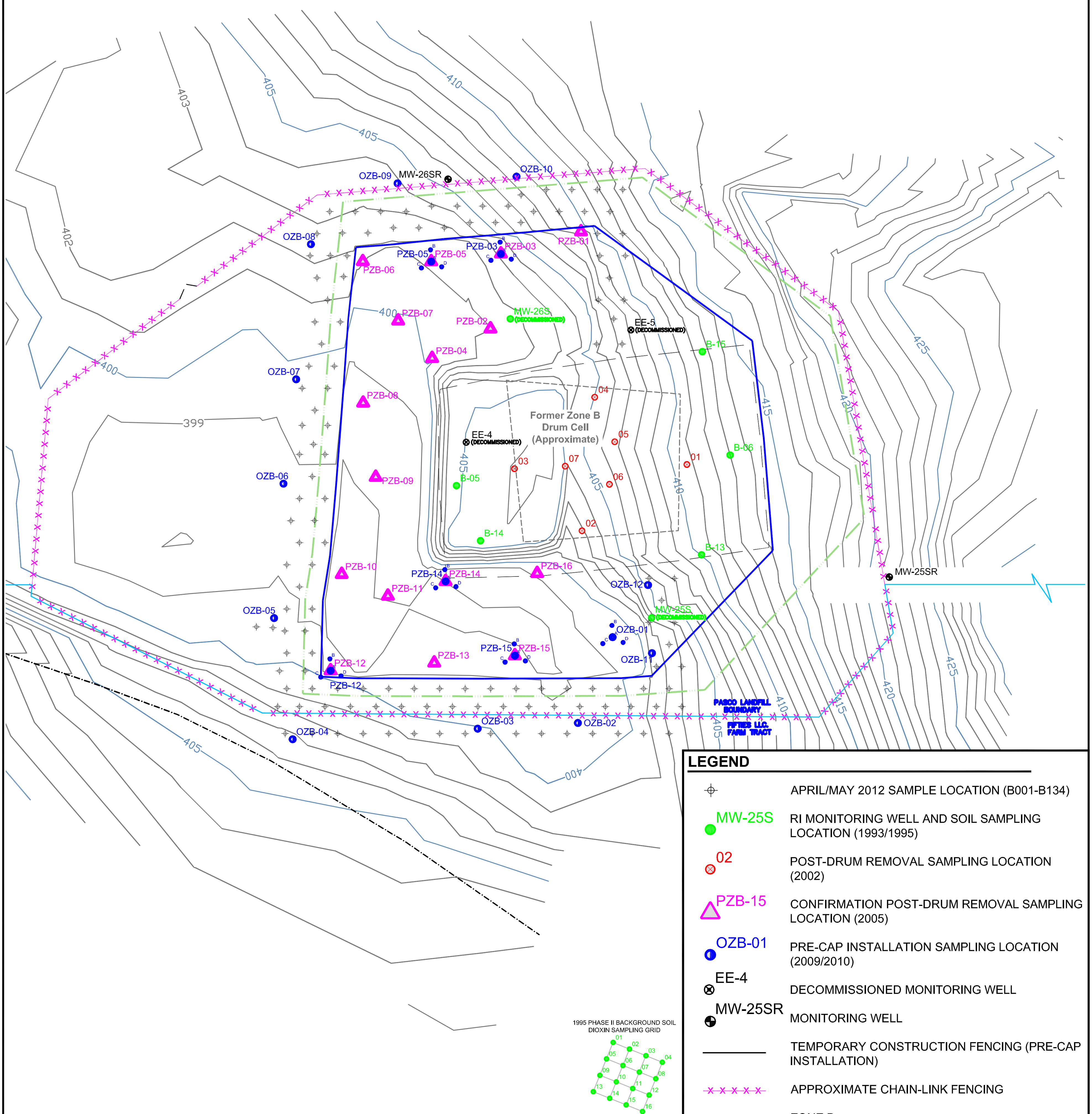
amec foster wheeler

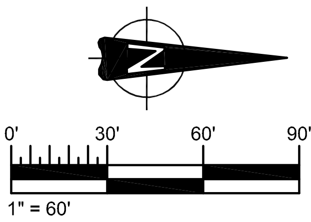
FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

ZONE B SITE PLAN

DATE	AUGUST 2017
SCALE	1" = 50'
PROJECT NO.	4-61M-107051
FIGURE	2.5.4-1a

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 1a – Zone B Site Plan.dwg – – – Aug. 01, 2017 8:44am – stephane.descombes





LEGEND

⌖	APRIL/MAY 2012 SAMPLE LOCATION (B001-B134)
● MW-25S	RI MONITORING WELL AND SOIL SAMPLING LOCATION (1993/1995)
⊗ 02	POST-DRUM REMOVAL SAMPLING LOCATION (2002)
△ PZB-15	CONFIRMATION POST-DRUM REMOVAL SAMPLING LOCATION (2005)
◐ OZB-01	PRE-CAP INSTALLATION SAMPLING LOCATION (2009/2010)
⊗ EE-4	DECOMMISSIONED MONITORING WELL
◕ MW-25SR	MONITORING WELL
———	TEMPORARY CONSTRUCTION FENCING (PRE-CAP INSTALLATION)
-x-x-x-x-	APPROXIMATE CHAIN-LINK FENCING
— — —	ZONE B
- - - - - -	APPROXIMATE FORMER ZONE B DRUM CELL (INTERIM ACTION COMPLETION REPORT URS, 2002)
———	PROPERTY BOUNDARY
-·-·-·-	EDGE OF FIELD
———	APPROXIMATE EDGE OF CAP
—··—··—	APPROXIMATE EDGE OF LINER EXTENSION

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Portland, OR 97224

amec foster wheeler

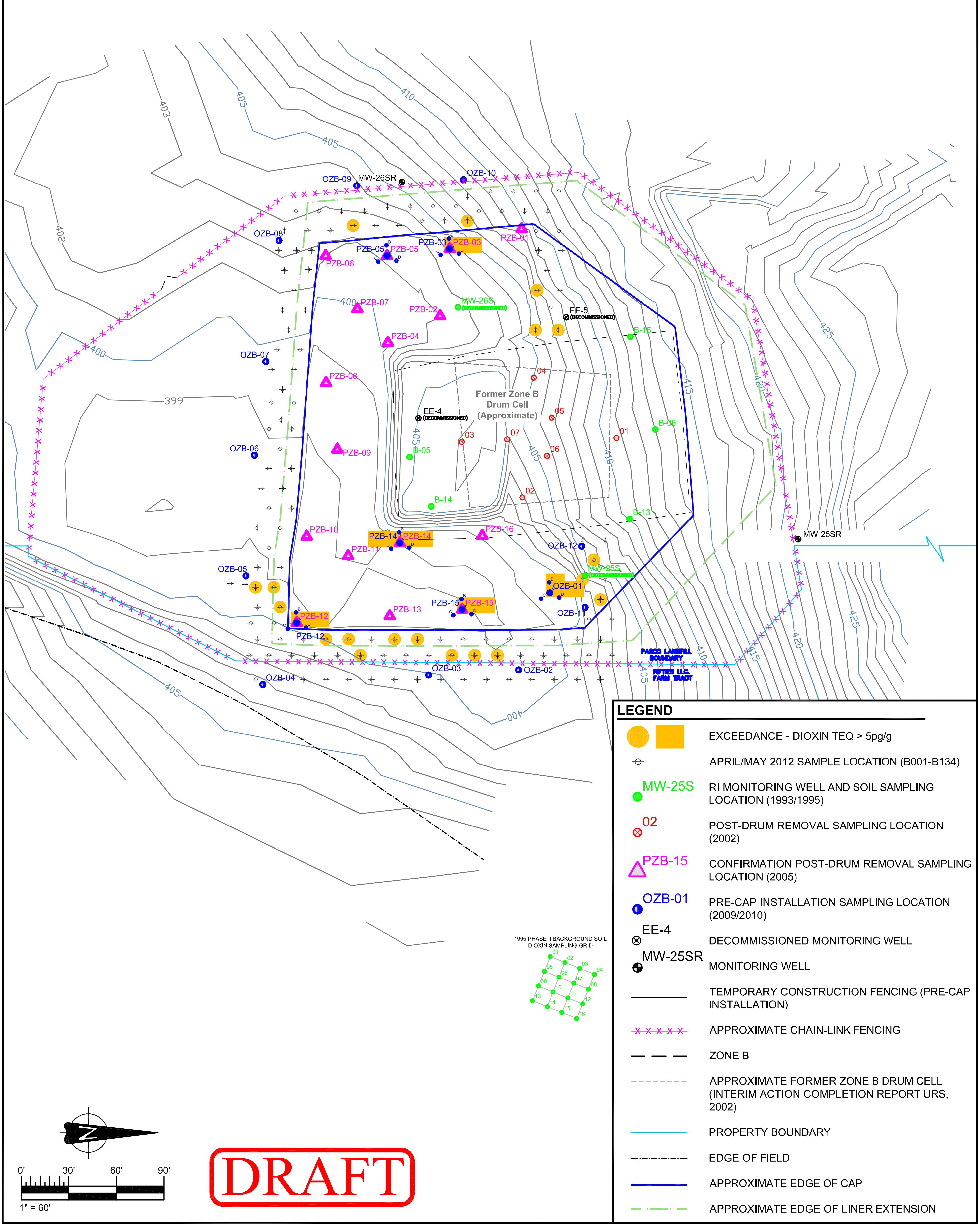
FOCUS FEASIBILITY STUDY
PASCO LANDFILL

HISTORICAL SOIL SAMPLE LOCATIONS
ZONE B

DATE AUGUST 2017
SCALE 1" = 60'
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-1b

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 1b-4 – Soil Sample Locations and Cleanup Level Exceedances – Zone B.dwg – 1b – Aug. 01, 2017 9:03am – stephane.descombes



LEGEND

● ■	EXCEEDANCE - DIOXIN TEQ > 5pg/g
⌖	APRIL/MAY 2012 SAMPLE LOCATION (B001-B134)
● MW-25S	RI MONITORING WELL AND SOIL SAMPLING LOCATION (1993/1995)
⊗ 02	POST-DRUM REMOVAL SAMPLING LOCATION (2002)
△ PZB-15	CONFIRMATION POST-DRUM REMOVAL SAMPLING LOCATION (2005)
◐ OZB-01	PRE-CAP INSTALLATION SAMPLING LOCATION (2009/2010)
⊗ EE-4	DECOMMISSIONED MONITORING WELL
◕ MW-25SR	MONITORING WELL
———	TEMPORARY CONSTRUCTION FENCING (PRE-CAP INSTALLATION)
-x-x-x-x-	APPROXIMATE CHAIN-LINK FENCING
— — —	ZONE B
- - - - - -	APPROXIMATE FORMER ZONE B DRUM CELL (INTERIM ACTION COMPLETION REPORT URS, 2002)
———	PROPERTY BOUNDARY
-·-·-·-·-	EDGE OF FIELD
———	APPROXIMATE EDGE OF CAP
— · — · —	APPROXIMATE EDGE OF LINER EXTENSION

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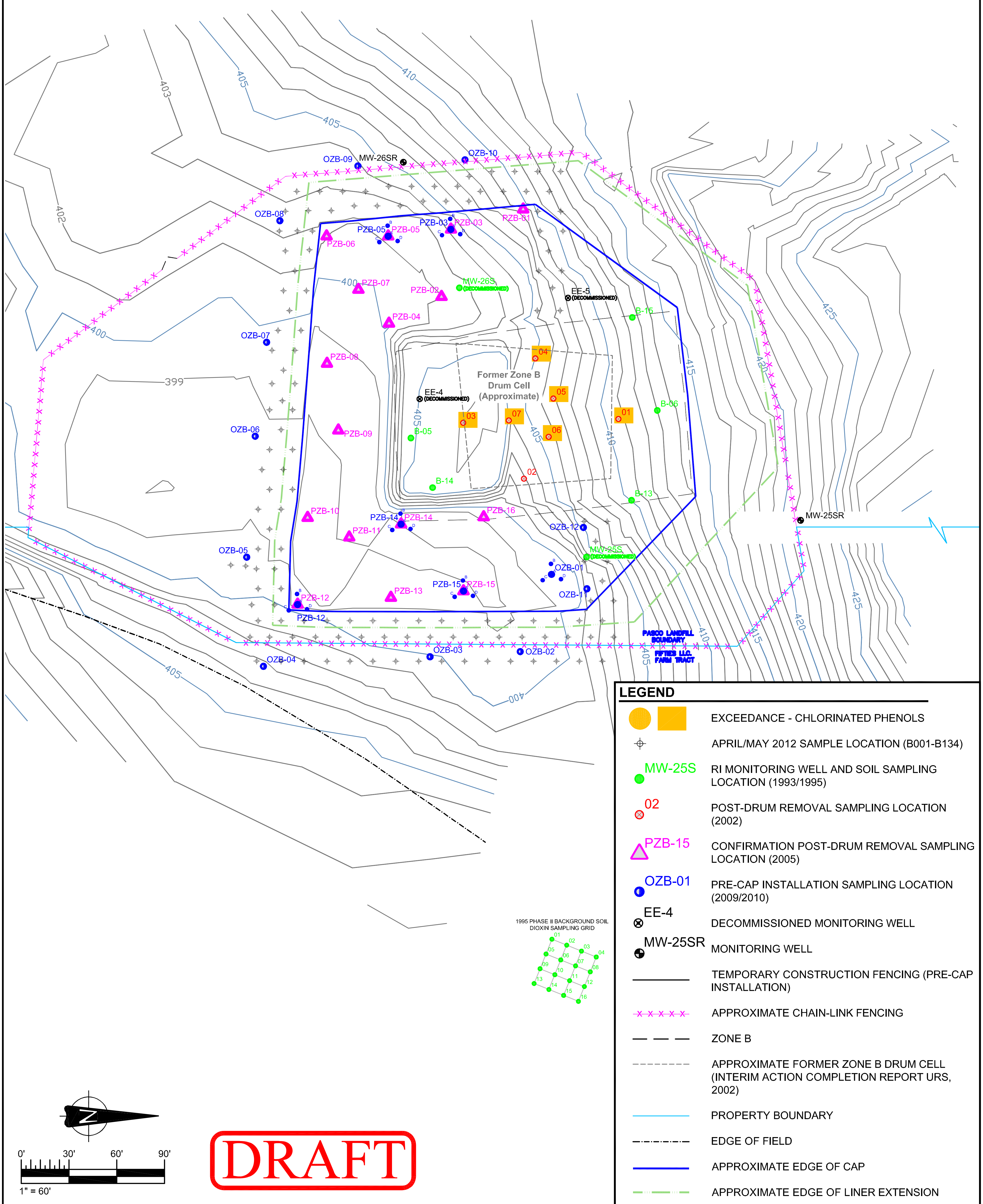
FOCUS FEASIBILITY STUDY
PASCO LANDFILL

DRAFT CLEANUP LEVEL EXCEEDANCES,
DIOXIN TEQ,
ZONE B HISTORICAL SOIL SAMPLES

DATE AUGUST 2017
SCALE 1" = 60'
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-2

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 1b-4 – Soil Sample Locations and Cleanup Level Exceedances – Zone B.dwg – 2 – Aug. 01, 2017 9:12am – stephane.descombes



LEGEND

● ■	EXCEEDANCE - CHLORINATED PHENOLS
⊕	APRIL/MAY 2012 SAMPLE LOCATION (B001-B134)
MW-25S ●	RI MONITORING WELL AND SOIL SAMPLING LOCATION (1993/1995)
02 ⊗	POST-DRUM REMOVAL SAMPLING LOCATION (2002)
PZB-15 △	CONFIRMATION POST-DRUM REMOVAL SAMPLING LOCATION (2005)
OZB-01 ◐	PRE-CAP INSTALLATION SAMPLING LOCATION (2009/2010)
EE-4 ⊗	DECOMMISSIONED MONITORING WELL
MW-25SR ◕	MONITORING WELL
———	TEMPORARY CONSTRUCTION FENCING (PRE-CAP INSTALLATION)
-x-x-x-x-	APPROXIMATE CHAIN-LINK FENCING
— — —	ZONE B
- - - - -	APPROXIMATE FORMER ZONE B DRUM CELL (INTERIM ACTION COMPLETION REPORT URS, 2002)
———	PROPERTY BOUNDARY
-·-·-·-	EDGE OF FIELD
———	APPROXIMATE EDGE OF CAP
—·—·—	APPROXIMATE EDGE OF LINER EXTENSION

DRAFT

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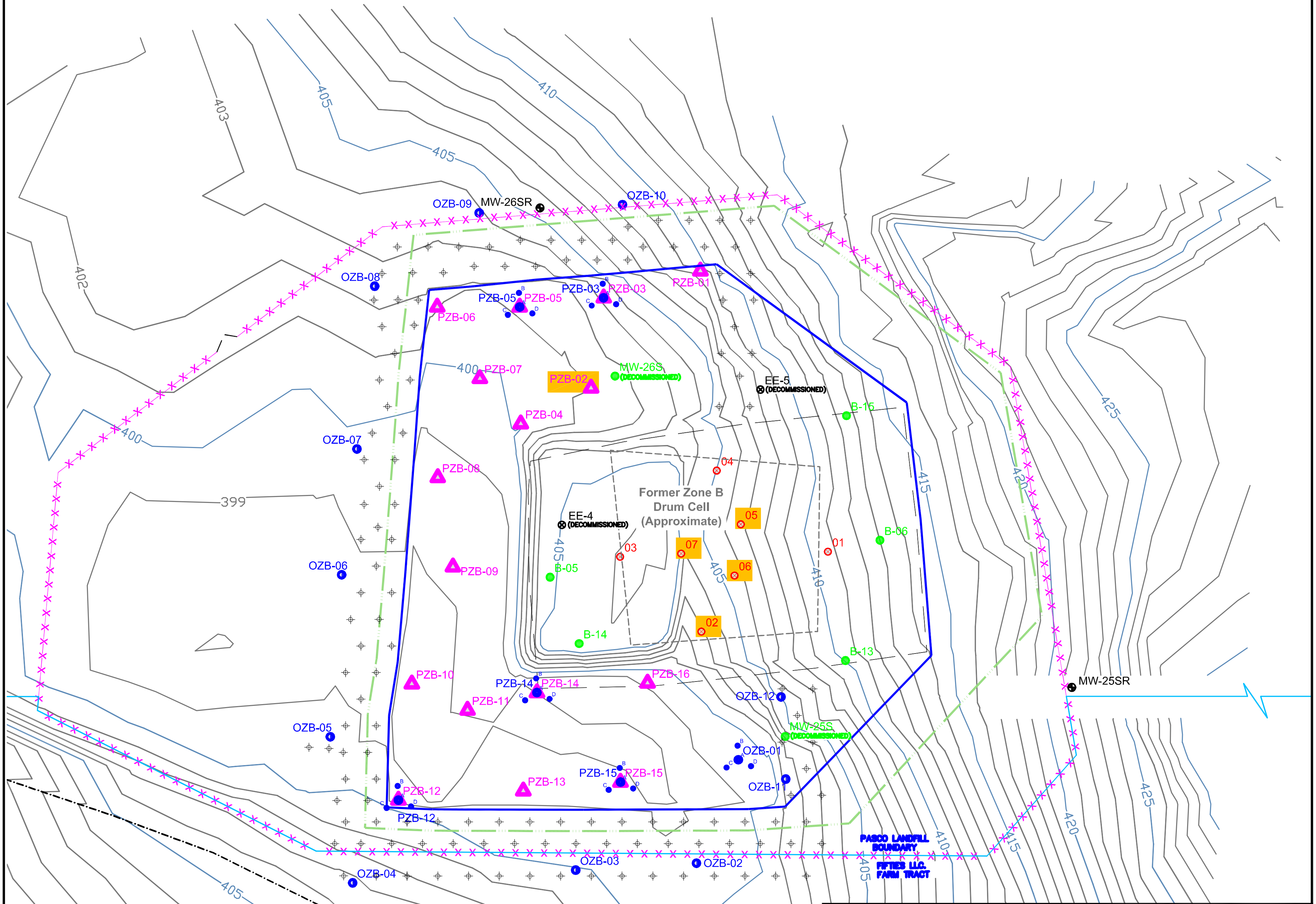
FOCUS FEASIBILITY STUDY
PASCO LANDFILL

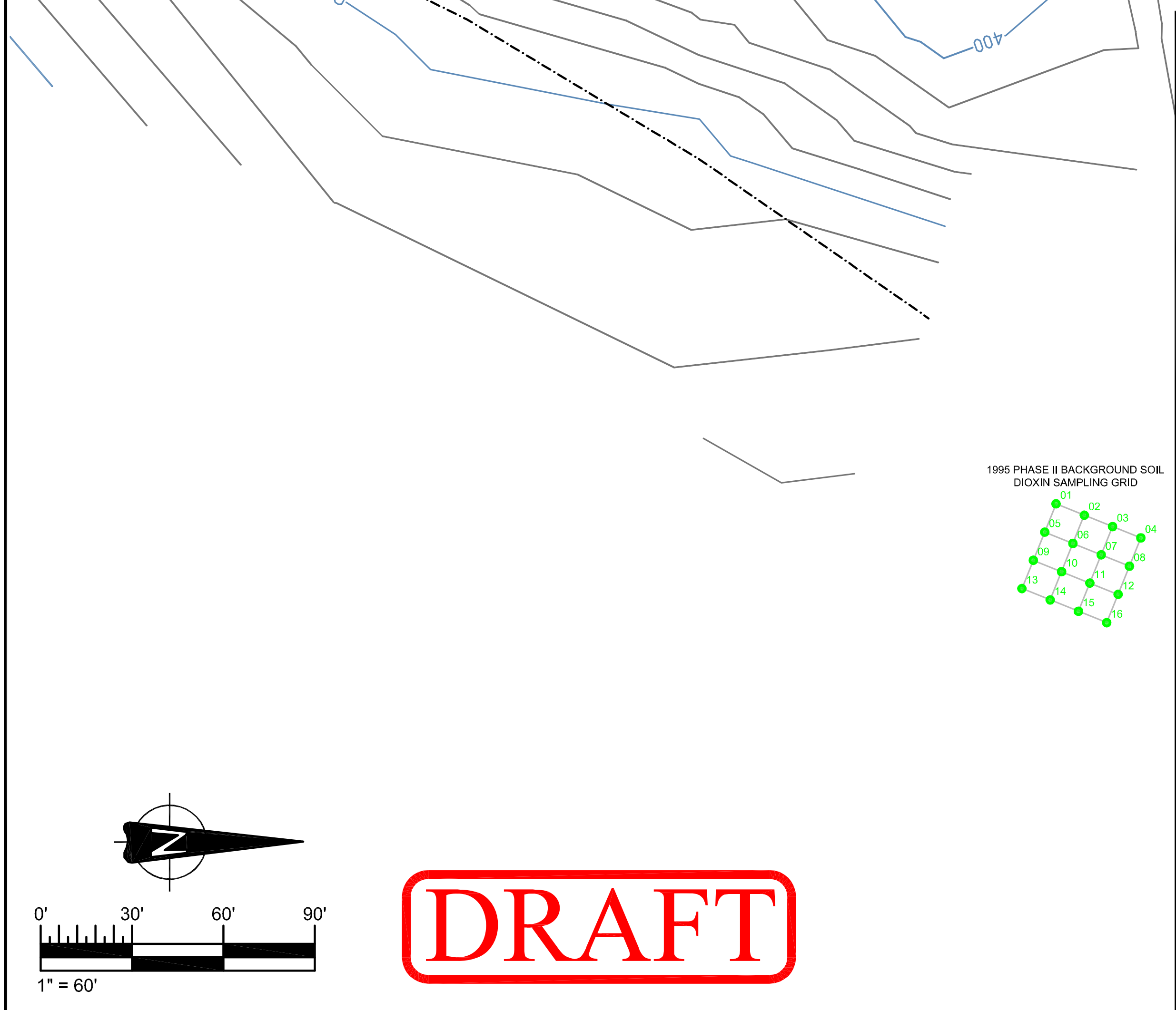
DRAFT CLEANUP LEVEL EXCEEDANCES,
CHLORINATED PHENOLS,
ZONE B HISTORICAL SOIL SAMPLES

DATE AUGUST 2017
SCALE 1" = 60'
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-3

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 1b-4 - Soil Sample Locations and Cleanup Level Exceedances - Zone B.dwg - 3 - Aug. 01, 2017 9:15am - stephane.descombes





DRAFT

LEGEND

● ■	EXCEEDANCE - HERBICIDES (2,4-D) > 27.2 µg/kg
⌖	APRIL/MAY 2012 SAMPLE LOCATION (B001-B134)
● MW-25S	RI MONITORING WELL AND SOIL SAMPLING LOCATION (1993/1995)
⊗ 02	POST-DRUM REMOVAL SAMPLING LOCATION (2002)
△ PZB-15	CONFIRMATION POST-DRUM REMOVAL SAMPLING LOCATION (2005)
◐ OZB-01	PRE-CAP INSTALLATION SAMPLING LOCATION (2009/2010)
⊗ EE-4	DECOMMISSIONED MONITORING WELL
◐ MW-25SR	MONITORING WELL
———	TEMPORARY CONSTRUCTION FENCING (PRE-CAP INSTALLATION)
-x-x-x-x-	APPROXIMATE CHAIN-LINK FENCING
— — —	ZONE B
- - - - -	APPROXIMATE FORMER ZONE B DRUM CELL (INTERIM ACTION COMPLETION REPORT URS, 2002)
———	PROPERTY BOUNDARY
-·-·-·-	EDGE OF FIELD
———	APPROXIMATE EDGE OF CAP
—··—··—	APPROXIMATE EDGE OF LINER EXTENSION

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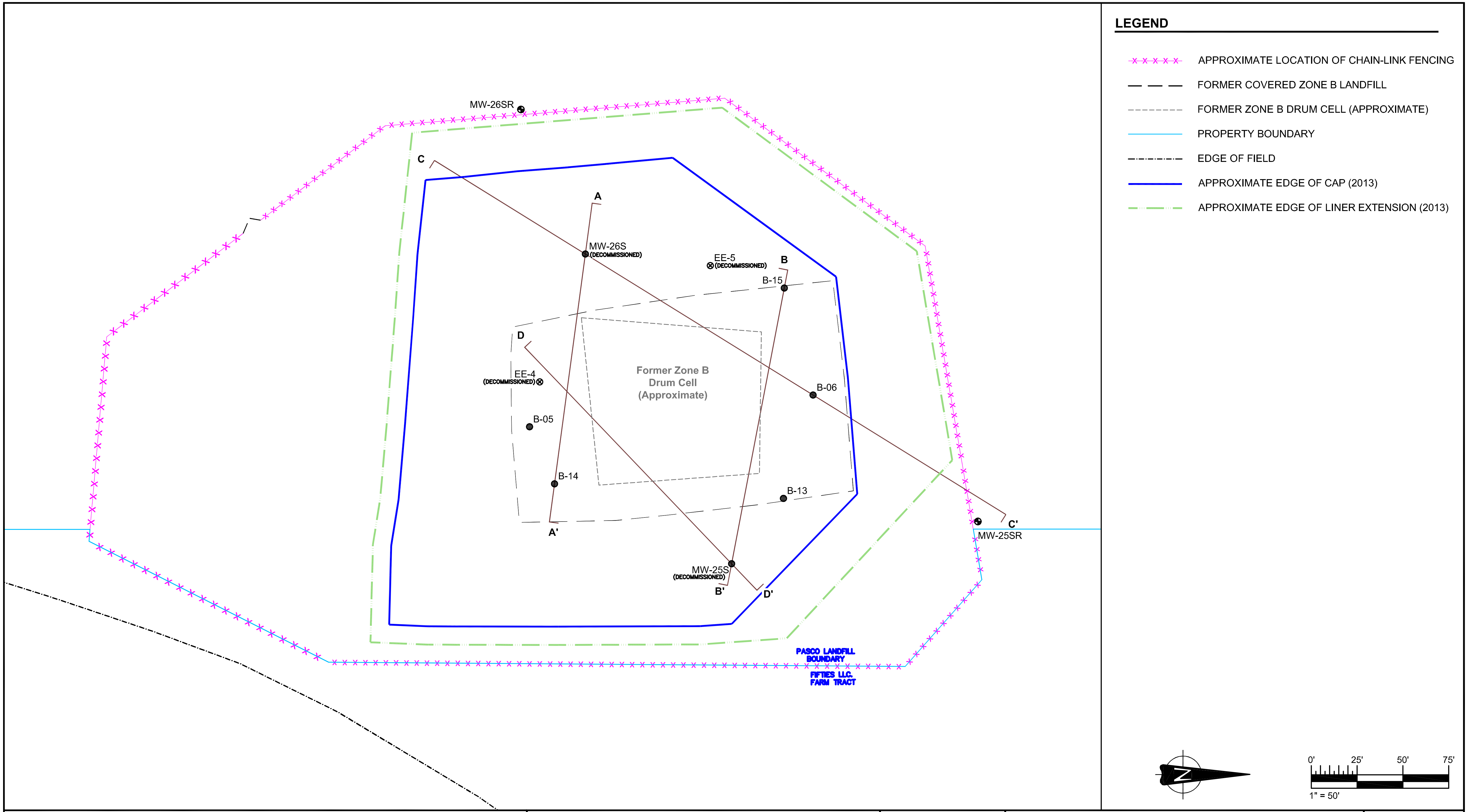
FOCUS FEASIBILITY STUDY
PASCO LANDFILL

DRAFT CLEANUP LEVEL EXCEEDANCES,
HERBICIDES (2,4-D),
ZONE B HISTORICAL SOIL SAMPLES

DATE	AUGUST 2017
SCALE	1" = 60'
PROJECT NO.	4-61M-107051
FIGURE	2.5.4-4

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 1b-4 – Soil Sample Locations and Cleanup Level Exceedances – Zone B.dwg – 4 – Aug. 01, 2017 9:18am – stephane.descombes



BASE TOPOGRAPHIC MAP PROVIDED BY DSE & ASSOCIATES,
SCIO, OREGON, NOVEMBER 21, 2011

DRAFT

DRAWN BY: SD CHECKED BY: TW

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foster
wheeler

FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CROSS SECTION LOCATIONS
PLAN VIEW

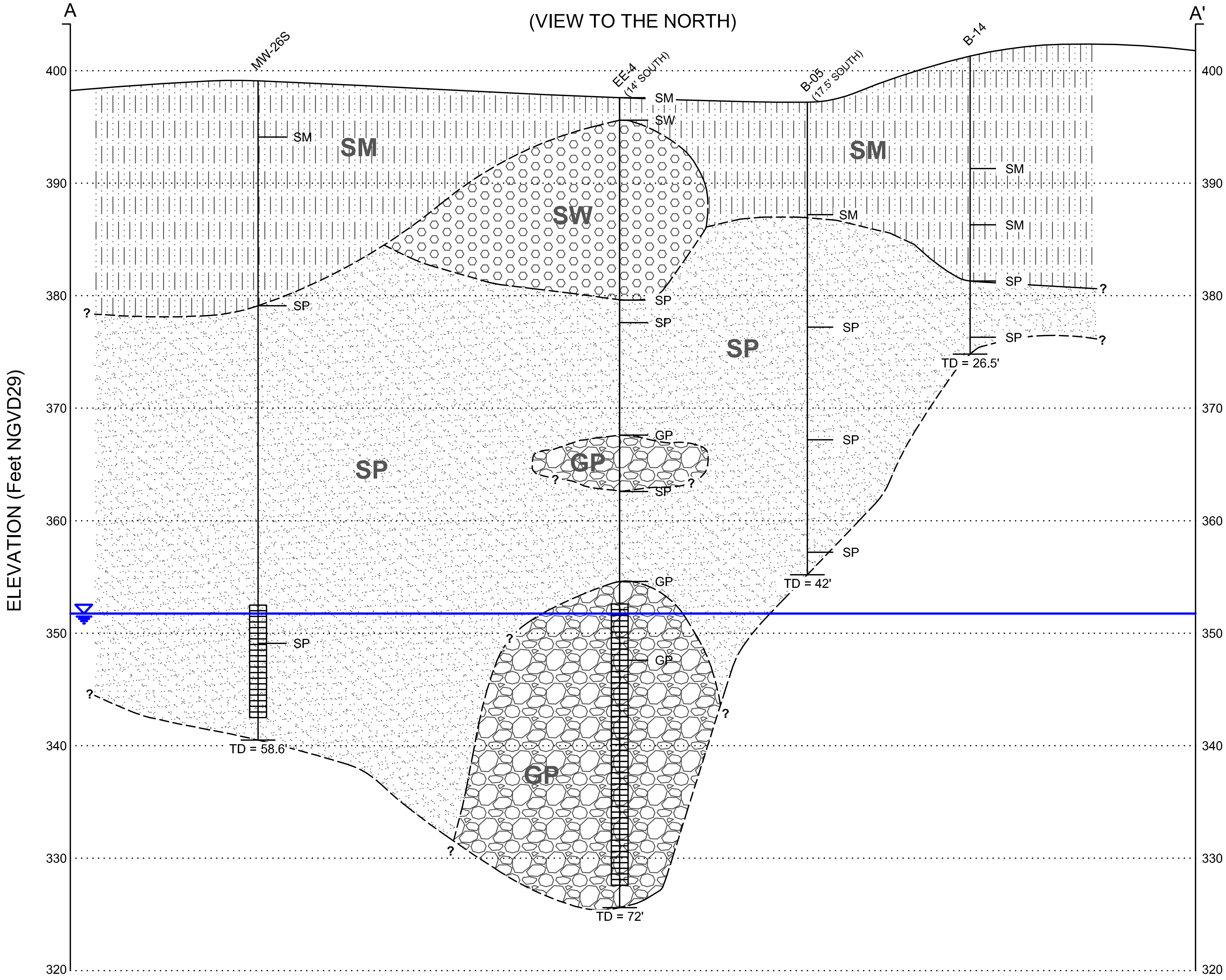
DATE
AUGUST 2017

SCALE
1" = 50'

PROJECT NO.
4-61M-107051

FIGURE
2.5.4-5

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 5 – Cross-Section – Plan View.dwg – – – Aug. 01, 2017 9:22am – stephane.descombes



LEGEND

Subsurface conditions based on historical well logs and soil borings from Remedial Investigation Phases I and II

▨	GP - Coarse gravel with occasional cobbles and varying amounts of silt
▨	SM - Silty-sand, sand-silt mixtures
▨	SP - Poorly-graded sand, gravelly sand, little or no fines
▨	SW - Fine to coarse sand
▽	Groundwater Elevation
B-05 TD = 48.3'	Soil Boring and Indentifier (TD=Total Boring Depth Below Ground Surface)
MW-25S TD = 107.5'	Monitoring Well and Identifier (TD=Total Well Depth Below Ground Surface)
- - -	Inferred Lithologic Contact

Notes:

- Groundwater elevation in MW-25s and MW-26s is from Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report, EPI, December 15, 2011, Depth to Water (feet).

0' 10' 20' 30'
1" = 10'
VERTICAL SCALE: 1" = 10'

0' 20' 40' 60'
1" = 20'
HORIZONTAL SCALE: 1" = 20'

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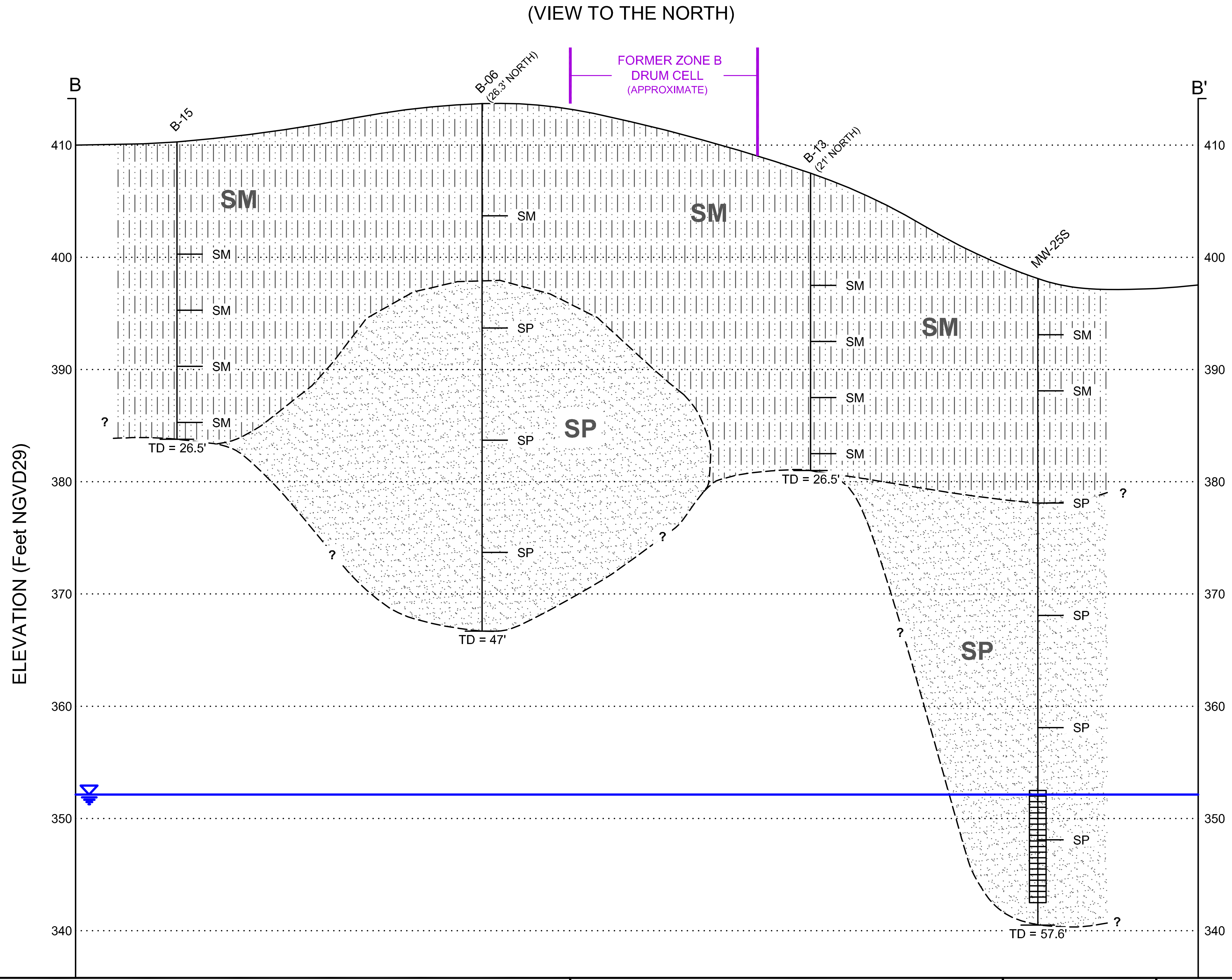
FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CROSS SECTION A - A'
PRIOR TO ZONE B CAP INSTALLATION

DATE AUGUST 2017
SCALE AS NOTED
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-6

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 6 – Cross-Section – A-A'.dwg – – – Aug. 01, 2017 9:41am – stephane.descombes



LEGEND

Subsurface conditions based on historical well logs and soil borings from Remedial Investigation Phases I and II

▨ GP - Coarse gravel with occasional cobbles and varying amounts of silt

▨ SM - Silty-sand, sand-silt mixtures

▨ SP - Poorly-graded sand, gravelly sand, little or no fines

▨ SW - Fine to coarse sand

▽ Groundwater Elevation

B-05 TD = 48.3' Soil Boring and Indentifier (TD=Total Boring Depth Below Ground Surface)

MW-25S TD = 107.5' Monitoring Well and Identifier (TD=Total Well Depth Below Ground Surface)

– – – Inferred Lithologic Contact

Notes:

- Groundwater elevation in MW-25s and MW-26s is from Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report, EPI, December 15, 2011, Depth to Water (feet).

0' 10' 20' 30'
1" = 10'
VERTICAL SCALE: 1" = 10'

0' 20' 40' 60'
1" = 20'
HORIZONTAL SCALE: 1" = 20'

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FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

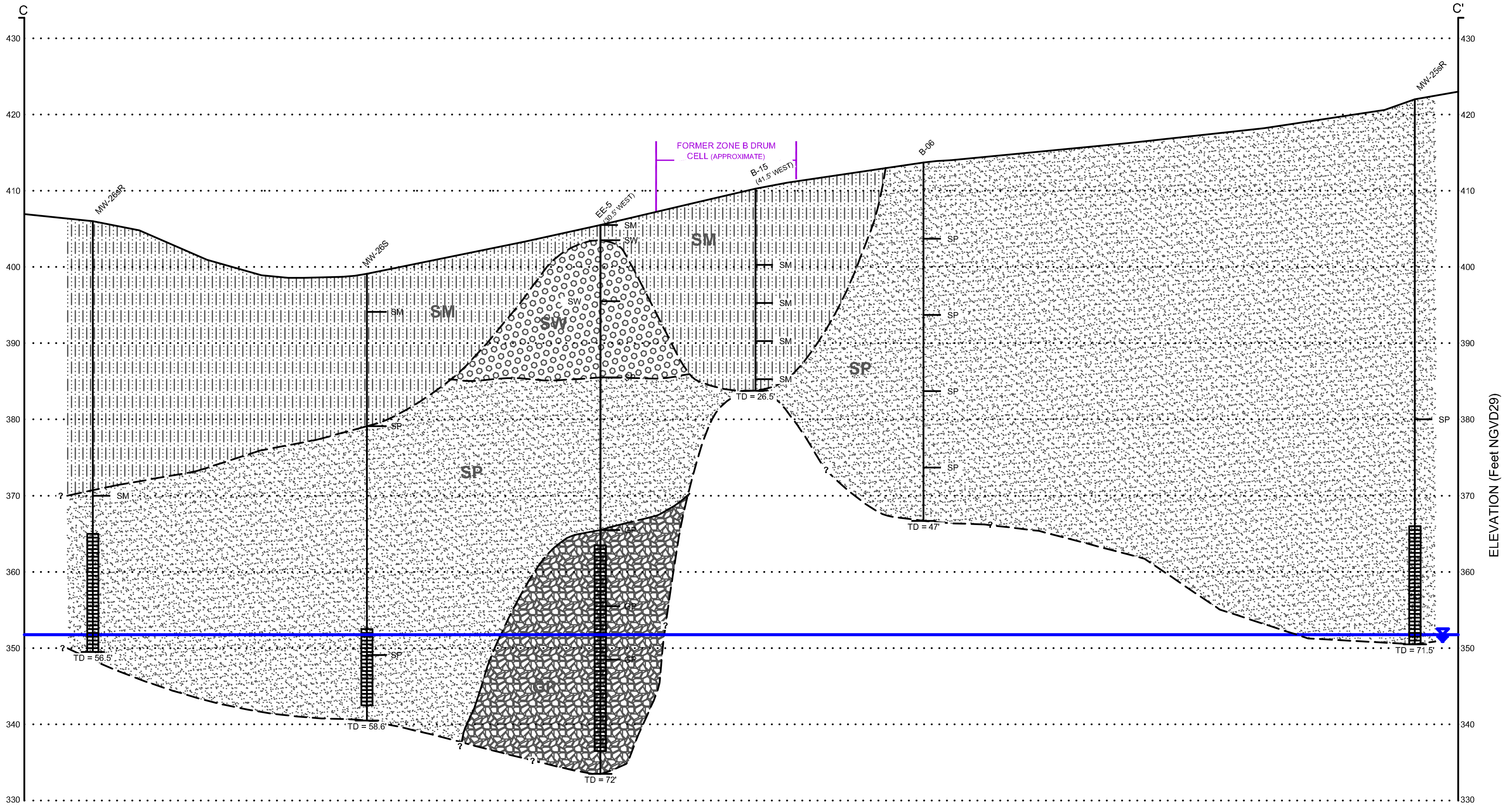
CROSS SECTION B - B'
PRIOR TO ZONE B CAP INSTALLATION

DATE AUGUST 2017
SCALE AS NOTED
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-7

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 7 – Cross-Section – B-B'.dwg – – – Aug. 01, 2017 9:48am – stephane.descombes

(VIEW TO THE WEST)



LEGEND

Subsurface conditions based on historical well logs and soil borings from Remedial Investigation Phases I and II

- GP - Coarse gravel with occasional cobbles and varying amounts of silt
- SM - Silty-sand, sand-silt mixtures
- SP - Poorly-graded sand, gravelly sand, little or no fines
- SW - Fine to coarse sand
- ▼ Groundwater Elevation
- B-05 TD = 48.3' Soil Boring and Indentifier (TD=Total Boring Depth Below Ground Surface)
- MW-25S TD = 107.5' Monitoring Well and Identifier (TD=Total Well Depth Below Ground Surface)
- Inferred Lithologic Contact

Notes:

- Groundwater elevation in MW-25s and MW-26s is from Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report, EPI, December 15, 2011, Depth to Water (feet).

0' 20' 40' 60'
1" = 20'
VERTICAL SCALE: 1" = 20'

0' 40' 80' 120'
1" = 40'
HORIZONTAL SCALE: 1" = 40'

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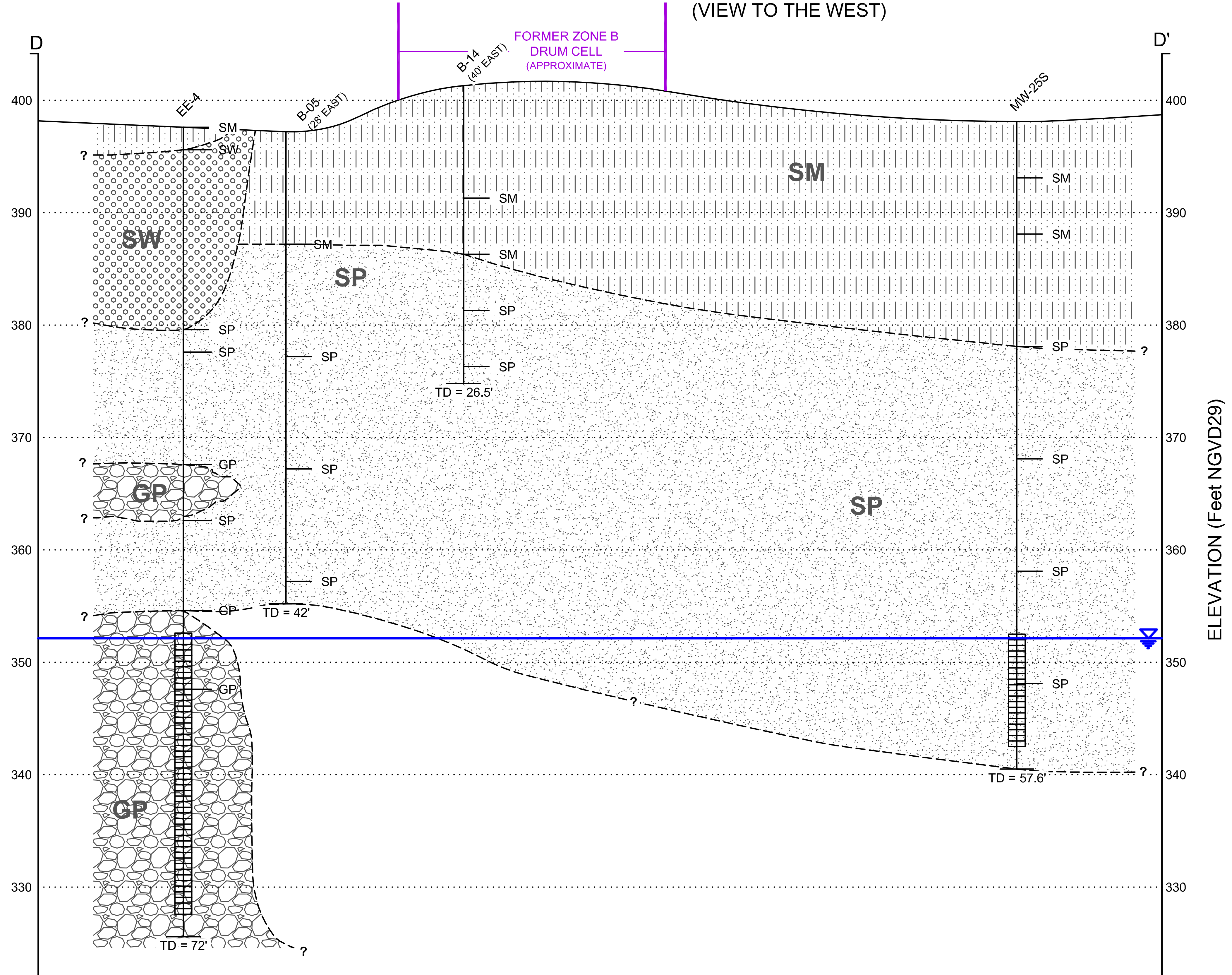
FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CROSS SECTION C - C'
PRIOR TO ZONE B CAP INSTALLATION

DATE	AUGUST 2017
SCALE	AS NOTED
PROJECT NO.	4-61M-107051
FIGURE	2.5.4-8

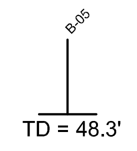
K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 8 - Cross-Section - C-C'.dwg - - - Aug. 01, 2017 9:57am - stephane.descombes



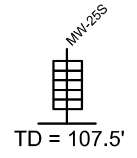
LEGEND

Subsurface conditions based on historical well logs and soil borings from Remedial Investigation Phases I and II

- ▨ GP - Coarse gravel with occasional cobbles and varying amounts of silt
- ▨ SM - Silty-sand, sand-silt mixtures
- ▨ SP - Poorly-graded sand, gravelly sand, little or no fines
- ▨ SW - Fine to coarse sand
- ▽ Groundwater Elevation



Soil Boring and Indentifier
(TD=Total Boring Depth
Below Ground Surface)

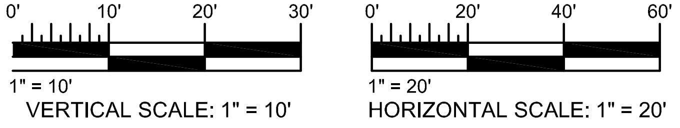


Monitoring Well and Identifier
(TD=Total Well Depth
Below Ground Surface)

Inferred Lithologic Contact

Notes:

- Groundwater elevation in MW-25s and MW-26s is from Third Quarter 2011 Ground Water Monitoring and Interim Action Performance Monitoring Report, EPI, December 15, 2011, Depth to Water (feet).



VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 20'

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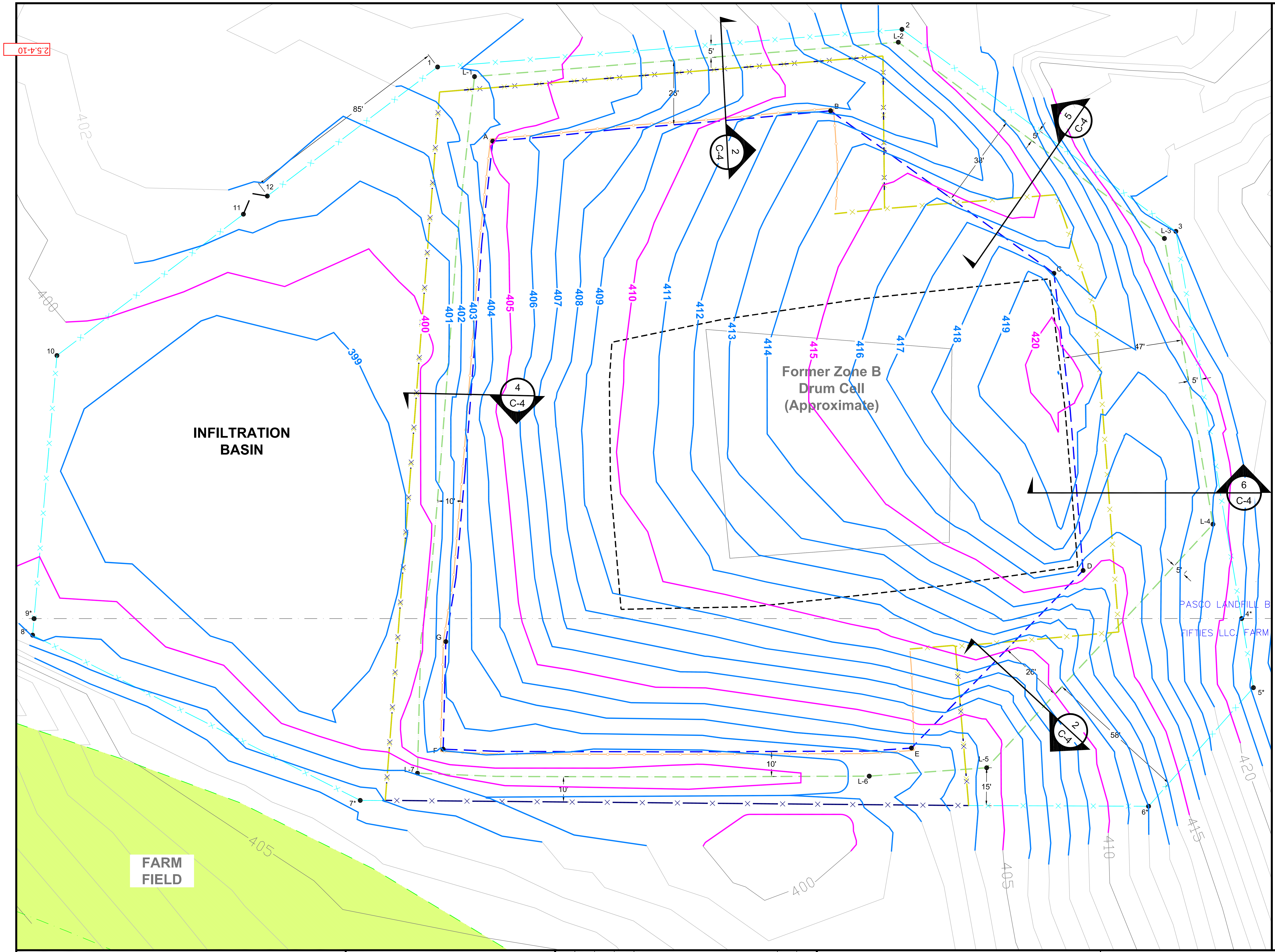
FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CROSS SECTION D - D'
PRIOR TO ZONE B CAP INSTALLATION

DATE	AUGUST 2017
SCALE	AS NOTED
PROJECT NO.	4-61M-107051
FIGURE	2.5.4-9

DRAWN BY: SD CHECKED BY: TW

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 9 - Cross-Section - D-D'.dwg - - - Aug. 01, 2017 10:02am - stephane.descombes



LEGEND

AS-BUILT CONTOUR (MAJOR)
AS-BUILT CONTOUR (MINOR)
EXISTING CONTOUR (MAJOR)
EXISTING CONTOUR (MINOR)
EXTENT OF TEMPORARY 12 MIL PLASTIC COVER PLACED IN 2002
TEMPORARY CONSTRUCTION FENCE
EXISTING CHAIN-LINK FENCING
ADDITIONAL CHAIN-LINK FENCING
CHAIN-LINK FENCE TO REMOVE
PROPERTY BOUNDARY
EDGE OF CAP
EDGE OF LINER EXTENSION

INFILTRATION AREA = 13,293 FT^2

CAP FOOTPRINT = 55,256 FT^2

LINER FOOTPRINT = 77,210 FT^2

CAP CORNER POSITIONS		
CORNER ID	EASTING	NORTHING
A	2007096.095	337633.736
B	2007083.972	337768.6163
C	2007148.855	337857.7879
D	2007267.504	337869.4125
E	2007338.387	337800.8899
F	2007338.848	337613.9354
G	2007295.909	337615.015
WASHINGTON STATE PLANE SOUTH US FEET; NAD 83		

FENCE CORNER POSITIONS		
CORNER ID	EASTING	NORTHING
1	2007066.481	337611.7179
2	2007051.451	337797.1016
3	2007132.105	337906.4597
4*	2007286.692	337932.7127
5*	2007314.294	337937.4002
6*	2007361.641	337895.5366
7*	2007359.298	337580.837
8*	2007293.32	337450.0546
9*	2007286.718	337450.628
10	2007181.681	337459.7506
11	2007125.248	337534.1942
12	2007118.007	337543.7461
* - DENOTES CORNER WITHIN FIFITIES LLC. PROPERTY		
WASHINGTON STATE PLANE SOUTH US FEET; NAD 83		

EDGE OF LINER CORNER POSITIONS		
CORNER ID	EASTING	NORTHING
L-1	2007070.303	337626.4464
L-2	2007056.586	337795.6401
L-3	2007134.931	337901.8681
L-4	2007249.04	337921.2469
L-5	2007346.269	337830.9116
L-6	2007349.615	337784.0416
L-7	2007348.441	337603.6911
WASHINGTON STATE PLANE SOUTH US FEET; NAD 83		

0' 10' 20' 30'
1" = 20'

NOTE: THESE DRAWINGS ARE THE PROPERTY OF AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. AND ARE NOT TO BE REPRODUCED IN ANY MANNER WITHOUT THE EXPRESS WRITTEN CONSENT OF AMEC ENVIRONMENT AND INFRASTRUCTURE, INC. AND ITS CLIENT.

SOURCE:
TOPOGRAPHIC SURVEY PERFORMED BY DSE & ASSOCIATES, 6/17/2013

REV	DATE	MONTH	YEAR	REVISION DESCRIPTION	ENG.	APPR.
A	06	02	2013	PROPOSED CAP DESIGN	PS	X
B	08	07	2013	AS-BUILT CAP DESIGN	PS	X

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Portland, OR 97224

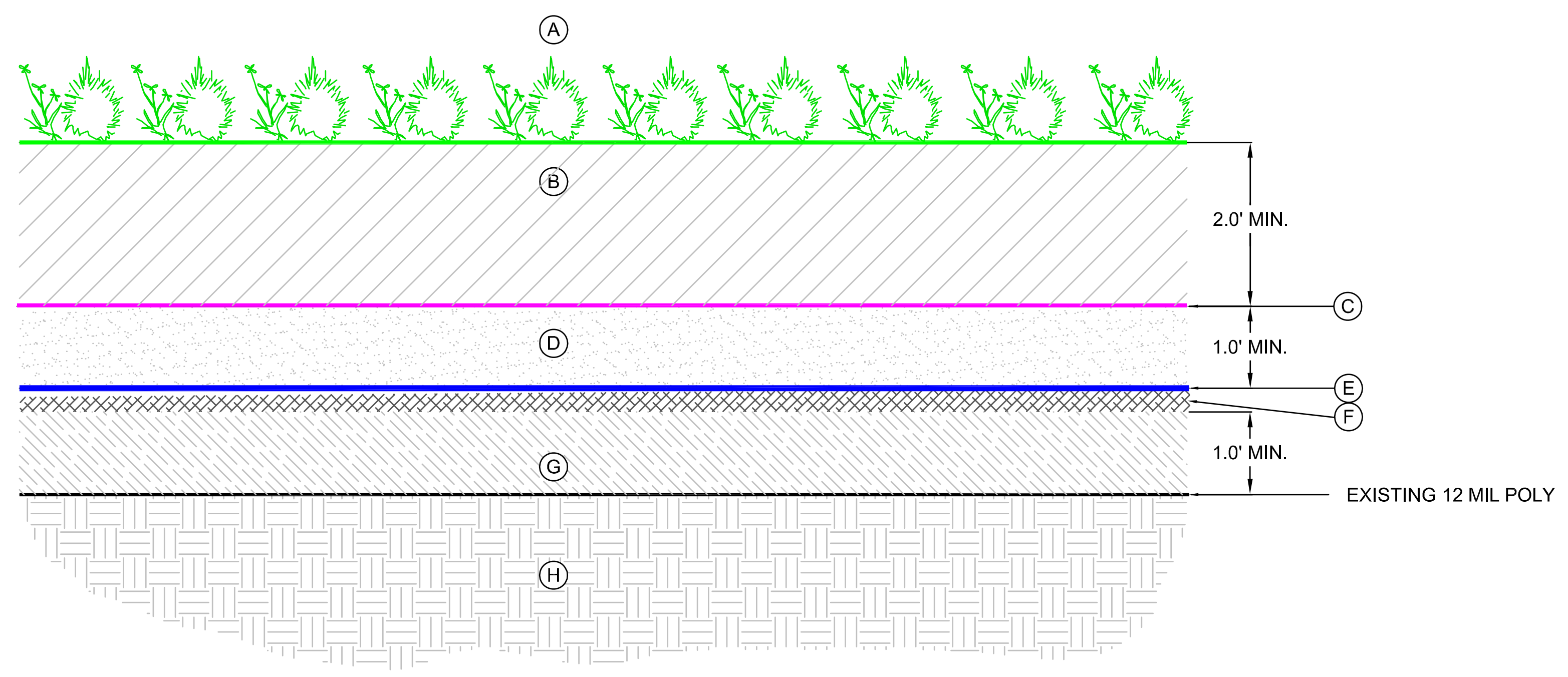
amec foster wheeler

FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

SITE GRADING PLAN AND CAP PLAN

DATE
AUGUST 2017
SCALE
1" = 20'
PROJECT NO.
4-61M-107051
FIGURE
2.5.4-10

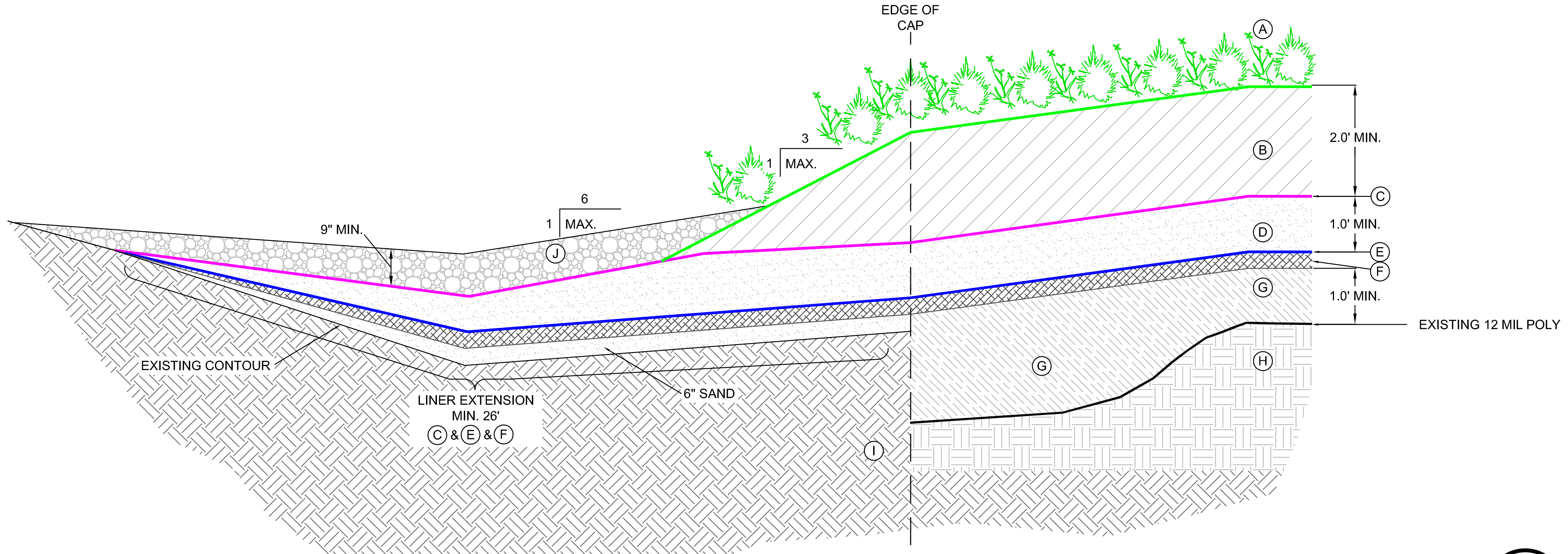
K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 10-13 - Grading Plan.dwg - 10 - Aug. 02, 2017 10:36am - stephane.descombes



TYPICAL CAP SECTION

NTS (MINIMUM CAP LAYER THICKNESSES)

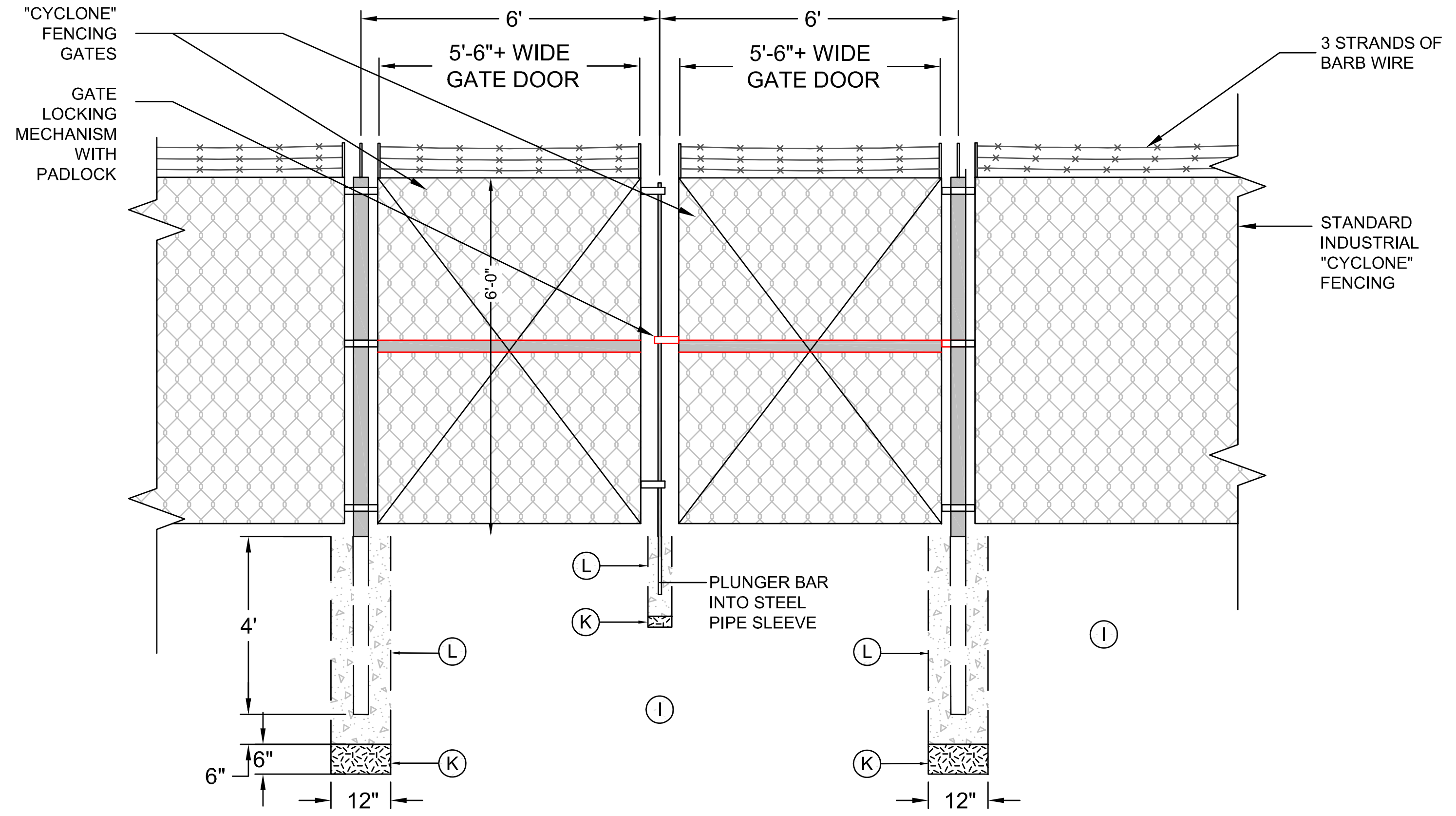
1 / C-4



CAP PERIMETER SECTIONS (TYPICAL)

NTS

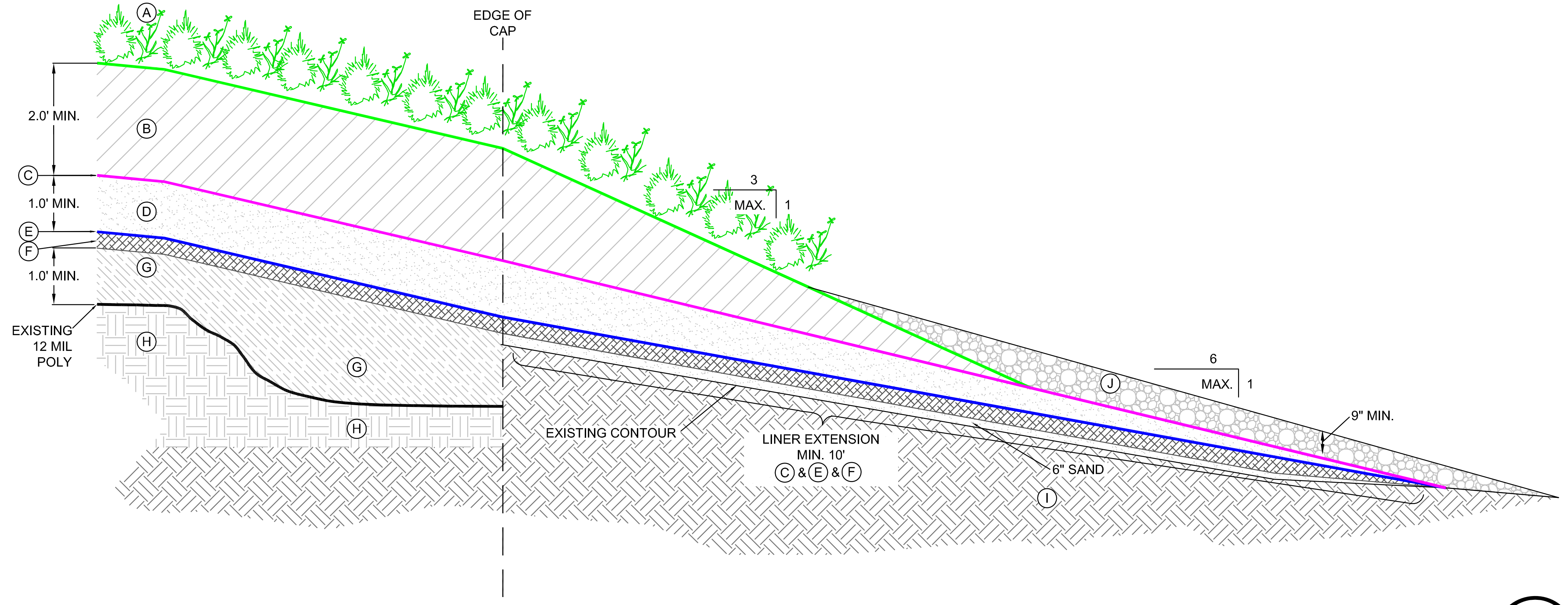
2 / C-4



TYPICAL DOUBLE GATE - SECTION VIEW

NTS

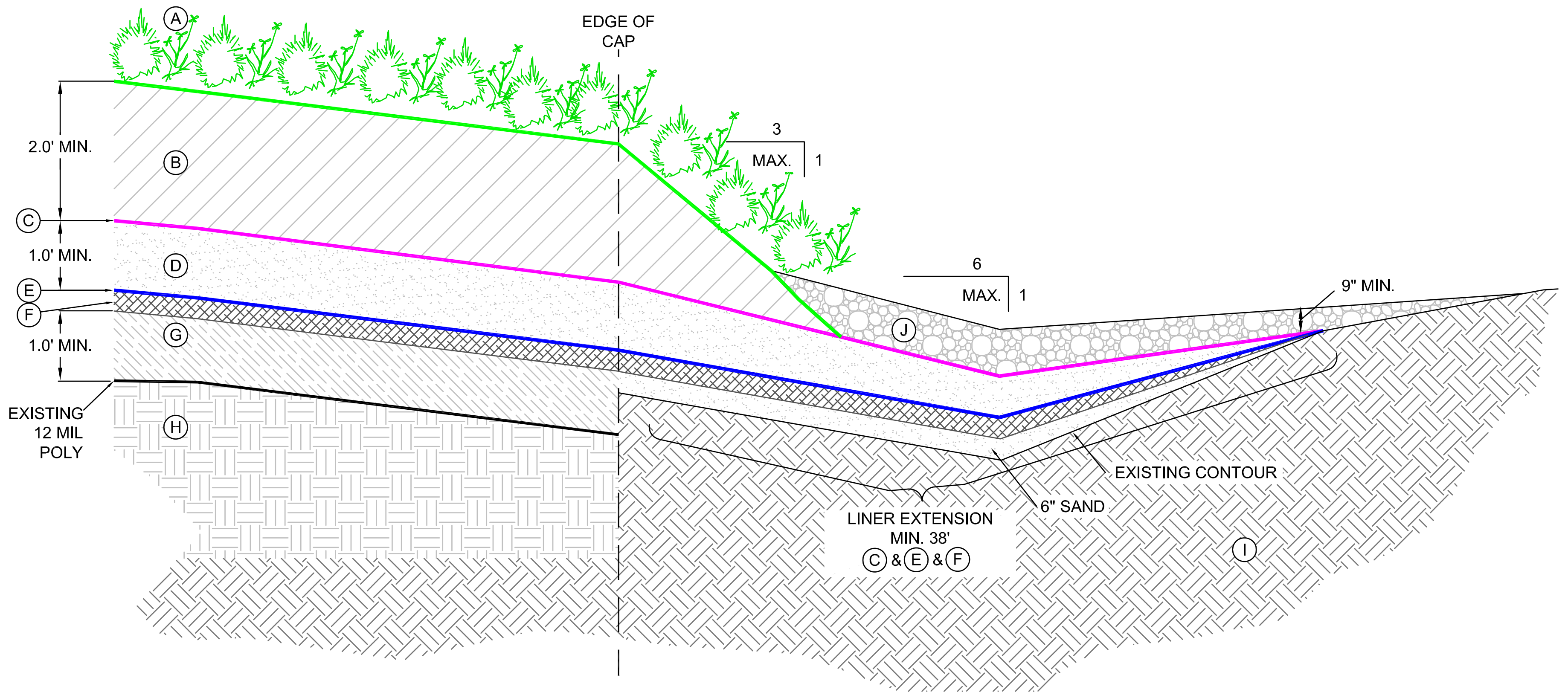
3 / C-4



EROSION PROTECTION DETAIL - SOUTH (TYPICAL)

NTS

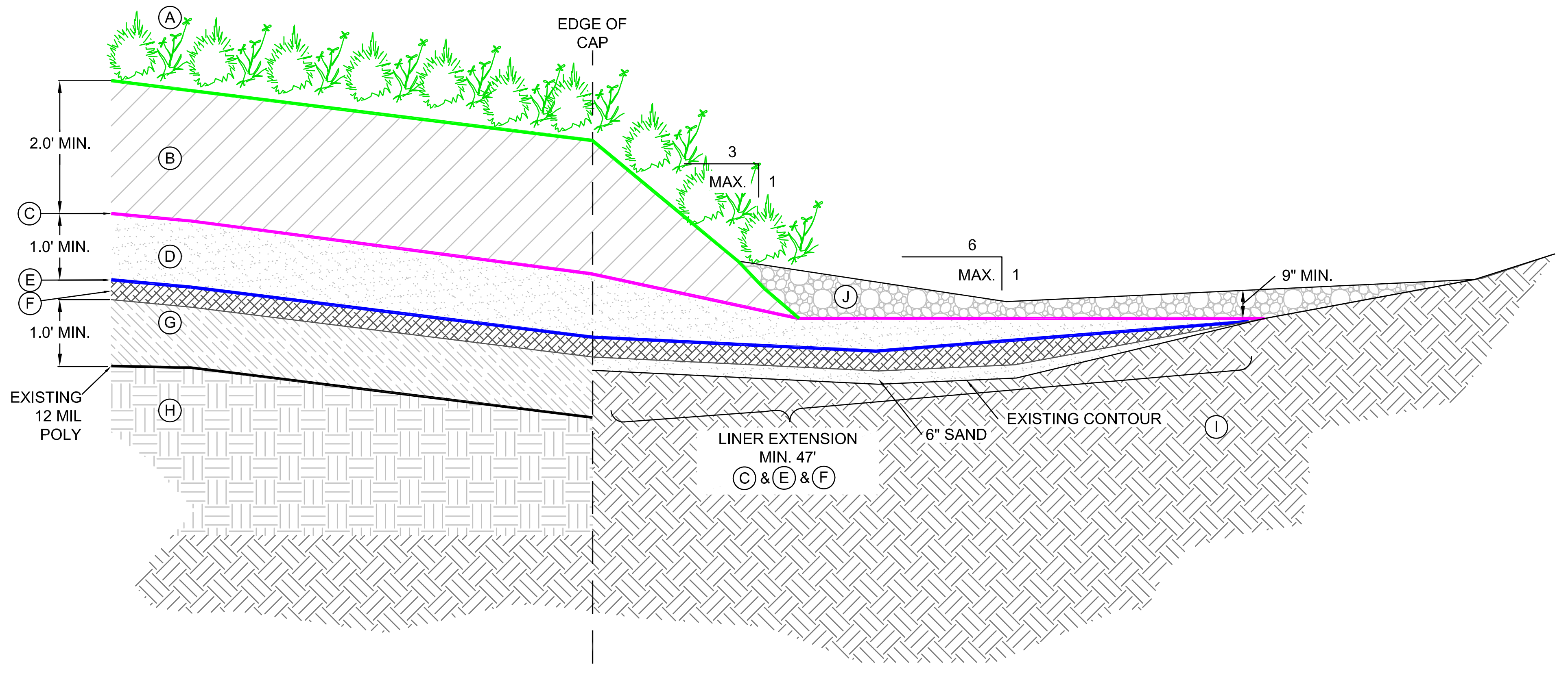
4 / C-4



EROSION PROTECTION DETAIL - NORTHWEST (TYPICAL)

NTS

5 / C-4



EROSION PROTECTION DETAIL - NORTH (TYPICAL)

NTS

6 / C-4

NOTES:

1. THE OUTER PERIMETER OF THE CAP SHALL HAVE SLOPES NO GREATER THAN 3:1. THE EROSION PROTECTION BASE SHALL NOT EXCEED A SLOPE OF 6:1.
2. A LAYER OF ORANGE POLY TEMPORARY CONSTRUCTION FENCING SHALL BE LAID DOWN DIRECTLY OVER THE TOP OF THE GEOTEXTILE TO ACT AS A VISUAL BARRIER FOR ANY FUTURE EXCAVATION WORK TO MITIGATE DAMAGE OF THE GEOMEMBRANE. THIS VISUAL BREAK MATERIAL SHALL COVER THE ENTIRE AREA OF THE GEOMEMBRANCE AND GCL. THE ORANGE POLY FENCING SHALL BE PLACED IN ROWS WITH NO LESS THAN 6" OF OVERLAPPING BETWEEN ROWS.
3. EDGE OF CAP - THE EXTENT OF THE COMPLIANT RCRA C COVER SYSTEM WHICH EXTENDS OVER THE ENTIRE AREA REQUIRING THE CAP BASED ON SITE SAMPLING WORK.

MATERIAL LIST:

A - NATIVE GRASS SPECIES (HYDROSEEDED AFTER CONSTRUCTION)
B - TOPSOIL LAYER
C - GEOTEXTILE LAYER WITH VISUAL BARRIER (TEMP CONSTRUCTION ORANGE POLY FENCE) OVERLYING GEOTEXTILE
D - SAND DRAINAGE MATERIAL
E - LAYFIELD EL6140 GEOMEMBRANE OR EQUIVALENT
F - LAYFIELD GCL OR EQUIVALENT BARRIER
G - NATIVE SOIL / GENERAL CLEAN FILL
H - EXISTING SOILS UNDER EXISTING POLY CAP
I - NATIVE SURROUNDING SOILS
J - 1" to 3" CLEAN CRUSHED ROCK EROSION PROTECTION BASE
K - 3/4" MINUS CRUSHED ROCK
L- CONCRETE

REV	DATE	MONTH	YEAR	REVISION DESCRIPTION	ENG.	APPR.
A	06	02	2013	PROPOSED CAP DESIGN	PS	X
B	08	07	2013	AS-BUILT CAP DESIGN	PS	X

BAYER CROPSCIENCE

Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

amec foster wheeler

FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CAP DETAILS

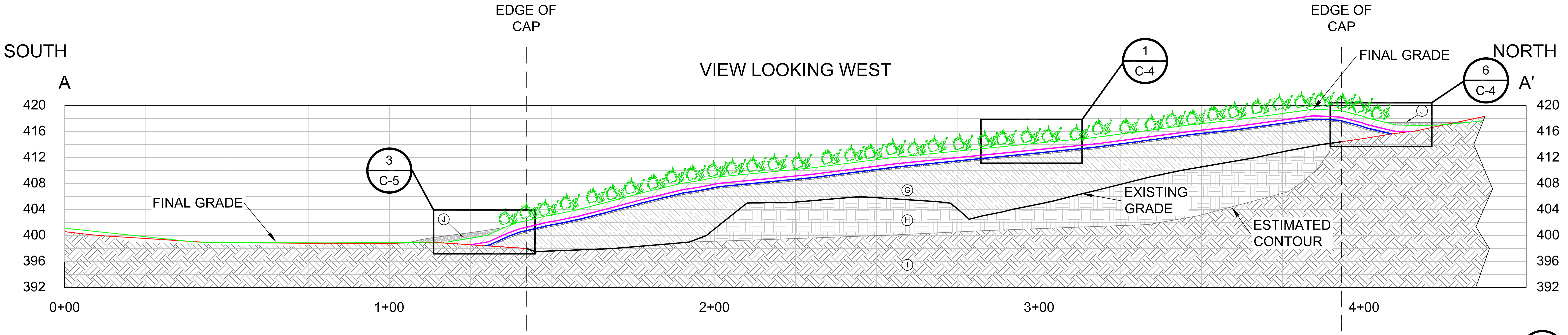
DATE AUGUST 2017
SCALE AS NOTED
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-11

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 10-13 – Grading Plan.dwg – 11 – Aug. 02, 2017 10:36am – stephane.descombes

2.5.4-12

MATERIAL LIST:

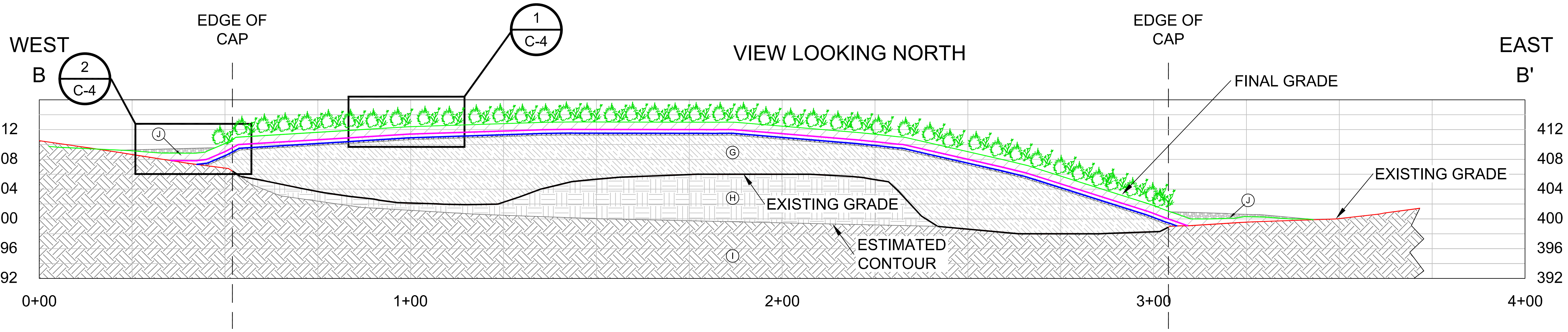
- A - NATIVE GRASS SPECIES (HYDROSEEDED AFTER CONSTRUCTION)
- B - TOPSOIL LAYER
- C - GEOTEXTILE LAYER WITH VISUAL BARRIER (TEMP CONSTRUCTION ORANGE POLY FENCE) OVERLYING GEOTEXTILE
- D - SAND DRAINAGE MATERIAL
- E - LAYFIELD EL6140 GEOMEMBRANE OR EQUIVALENT
- F - LAYFIELD GCL OR EQUIVALENT BARRIER
- G - NATIVE SOIL / GENERAL CLEAN FILL
- H - EXISTING SOILS UNDER EXISTING POLY CAP
- I - NATIVE SURROUNDING SOILS
- J - 1" TO 3" CRUSHED CLEAN ROCK



CROSS-SECTION A-A'

HORIZONTAL SCALE : 1"=20'
VERTICAL SCALE: 1" = 10'

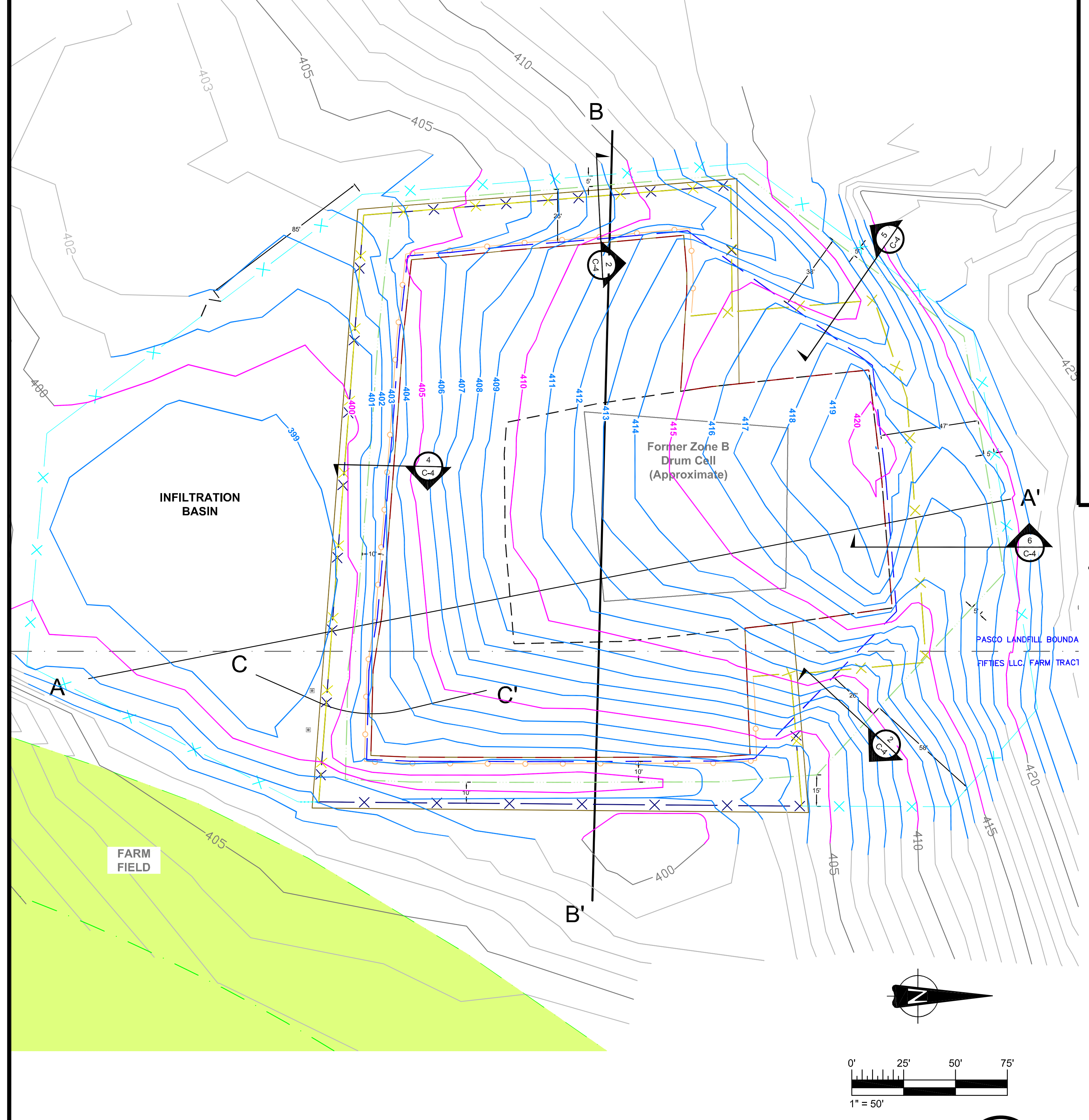
1
C-5



CROSS-SECTION B-B'

HORIZONTAL SCALE : 1"=20'
VERTICAL SCALE: 1" = 10'

2
C-5



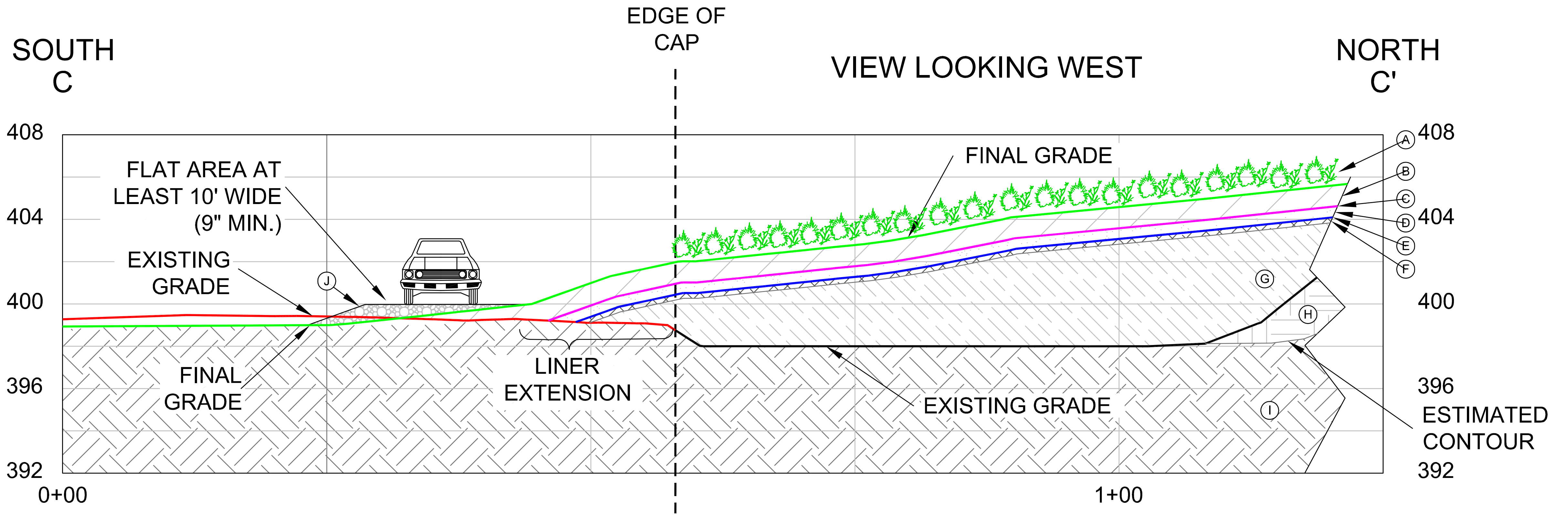
CROSS-SECTION LAYOUT

1"=50'

4
C-5

CROSS-SECTION LAYOUT LEGEND

—	AS-BUILT CONTOUR (MAJOR)
—	AS-BUILT CONTOUR (MINOR)
—	EXISTING CONTOUR (MAJOR)
—	EXISTING CONTOUR (MINOR)
- - - -	EXTENT OF TEMPORARY 12 MIL PLASTIC COVER PLACED IN 2002
—○—	TEMPORARY CONSTRUCTION FENCE
—×—	EXISTING CHAIN-LINK FENCING
—×—	ADDITIONAL CHAIN-LINK FENCING
—×—	CHAIN-LINK FENCE TO REMOVE
— - —	PROPERTY BOUNDARY
⬚	EDGE OF CAP



CROSS-SECTION C-C'

HORIZONTAL SCALE : 1"=10'
VERTICAL SCALE: 1" = 5'

3
C-5

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SOURCE:
TOPOGRAPHIC SURVEY PERFORMED BY DSE & ASSOCIATES, 6/17/2013

REV	DATE	MONTH	YEAR	REVISION DESCRIPTION	ENG.	APPR.
Ⓐ	06	02	2013	PROPOSED CAP DESIGN	PS	X
Ⓑ	08	07	2013	AS-BUILT CAP DESIGN	PS	X

BAYER CROPSCIENCE

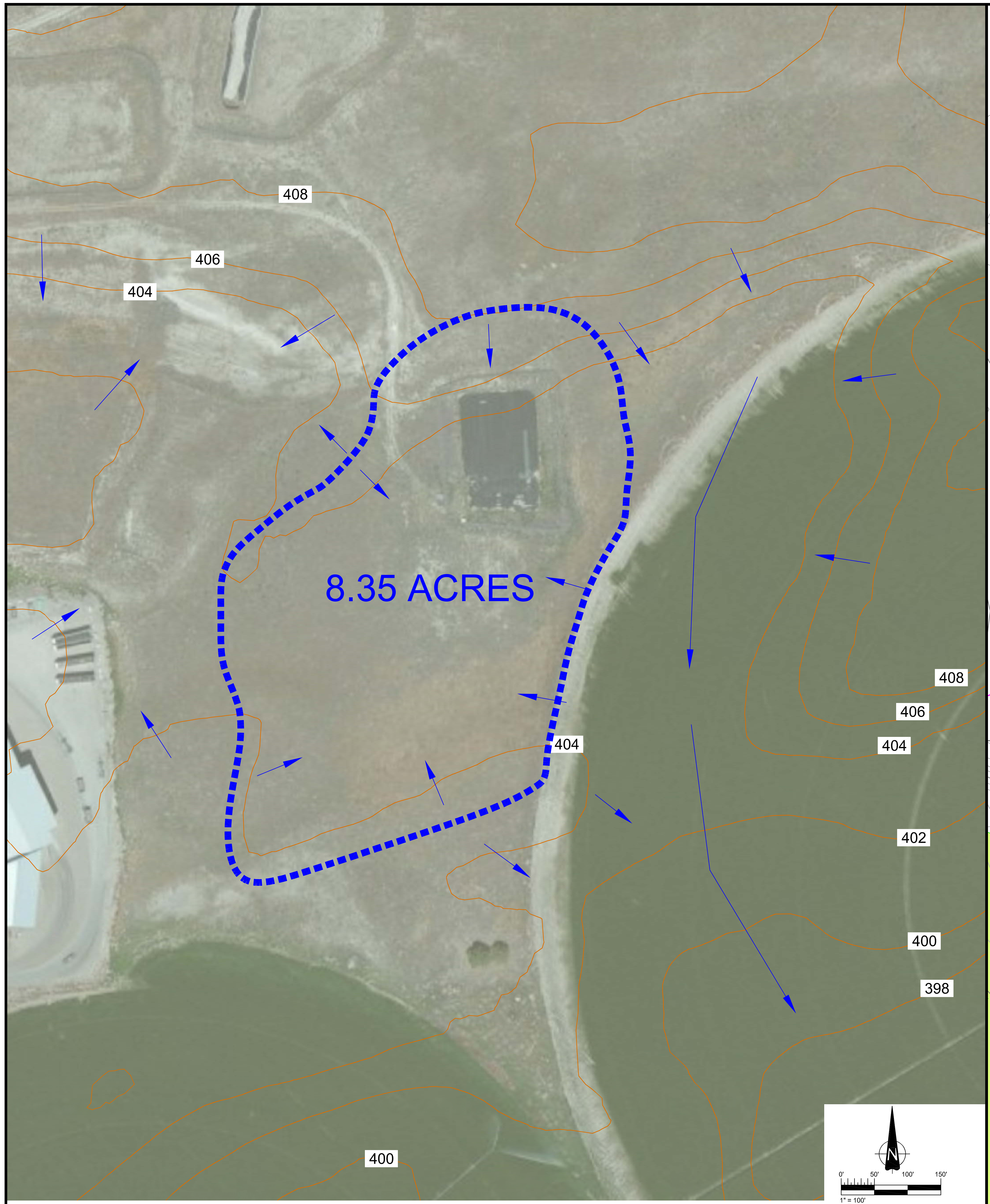
Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

CAP CROSS SECTIONS

DATE
AUGUST 2017
SCALE
AS NOTED
PROJECT NO.
4-61M-107051
FIGURE
2.5.4-12

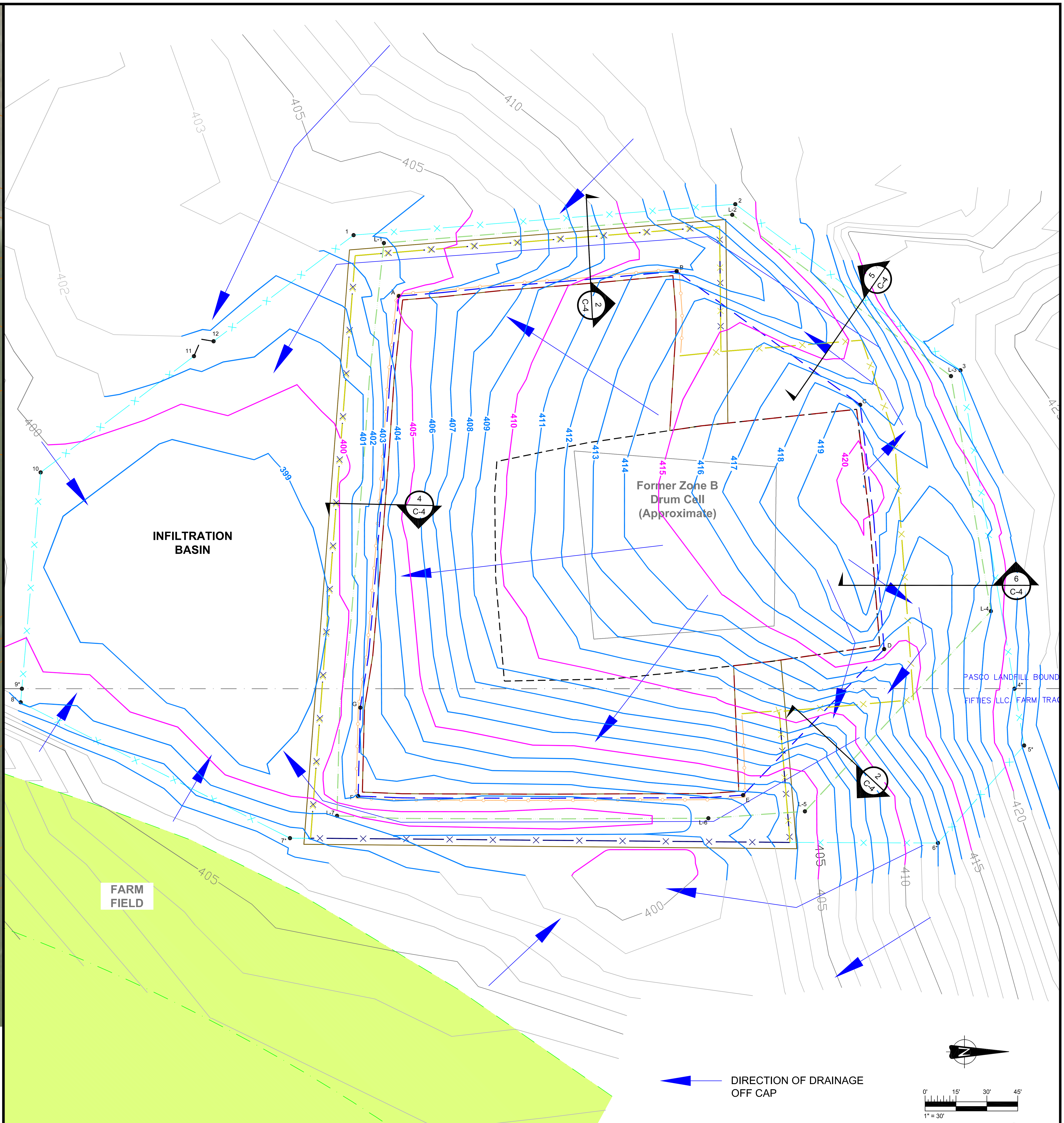
K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 10-13 - Grading Plan.dwg - 12 - Aug. 02, 2017 10:37am - stephane.descombes



ESTIMATED DRAINAGE AREA

1"=100'

1
C-6



CAP DRAINAGE PATTERN

1"=30'

2
C-6

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SOURCE:
TOPOGRAPHIC SURVEY PERFORMED BY DSE & ASSOCIATES, 6/17/2013

REV	DATE	MONTH	YEAR	REVISION DESCRIPTION	ENG.	APPR.
A	06	02	2013	PROPOSED CAP DESIGN	PS	X
B	08	07	2013	AS-BUILT CAP DESIGN	PS	X

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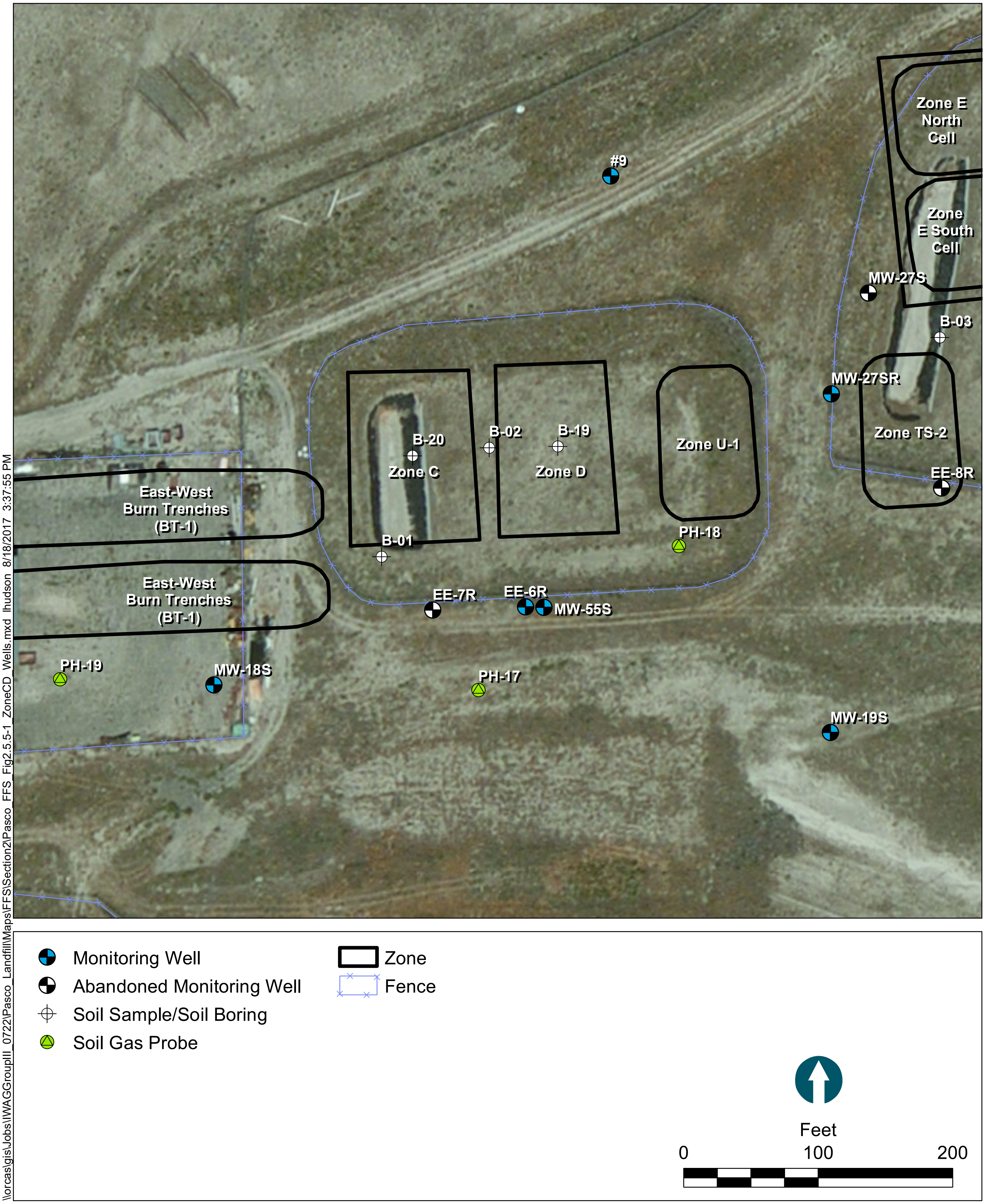
Amec Foster Wheeler
Environment & Infrastructure, Inc.
7376 S.W. Durham Road
Portland, OR 97224

FOCUSED FEASIBILITY STUDY
PASCO LANDFILL

ESTIMATED DRAINAGE BASIN AND CAP
DRAINAGE PATTERN

DATE AUGUST 2017
SCALE AS NOTED
PROJECT NO. 4-61M-107051
FIGURE 2.5.4-13

K:\10000\10700\10705\10705-1\dwg\FFS_2014_Revised_2017\Figure 10-13 – Grading Plan.dwg – 13 – Aug. 02, 2017 10:37am – stephane.descombes



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ANCHOR QEA

Figure 2.5.5-1
Zones C/D
Pasco Sanitary Landfill NPL Site
Pasco, WA

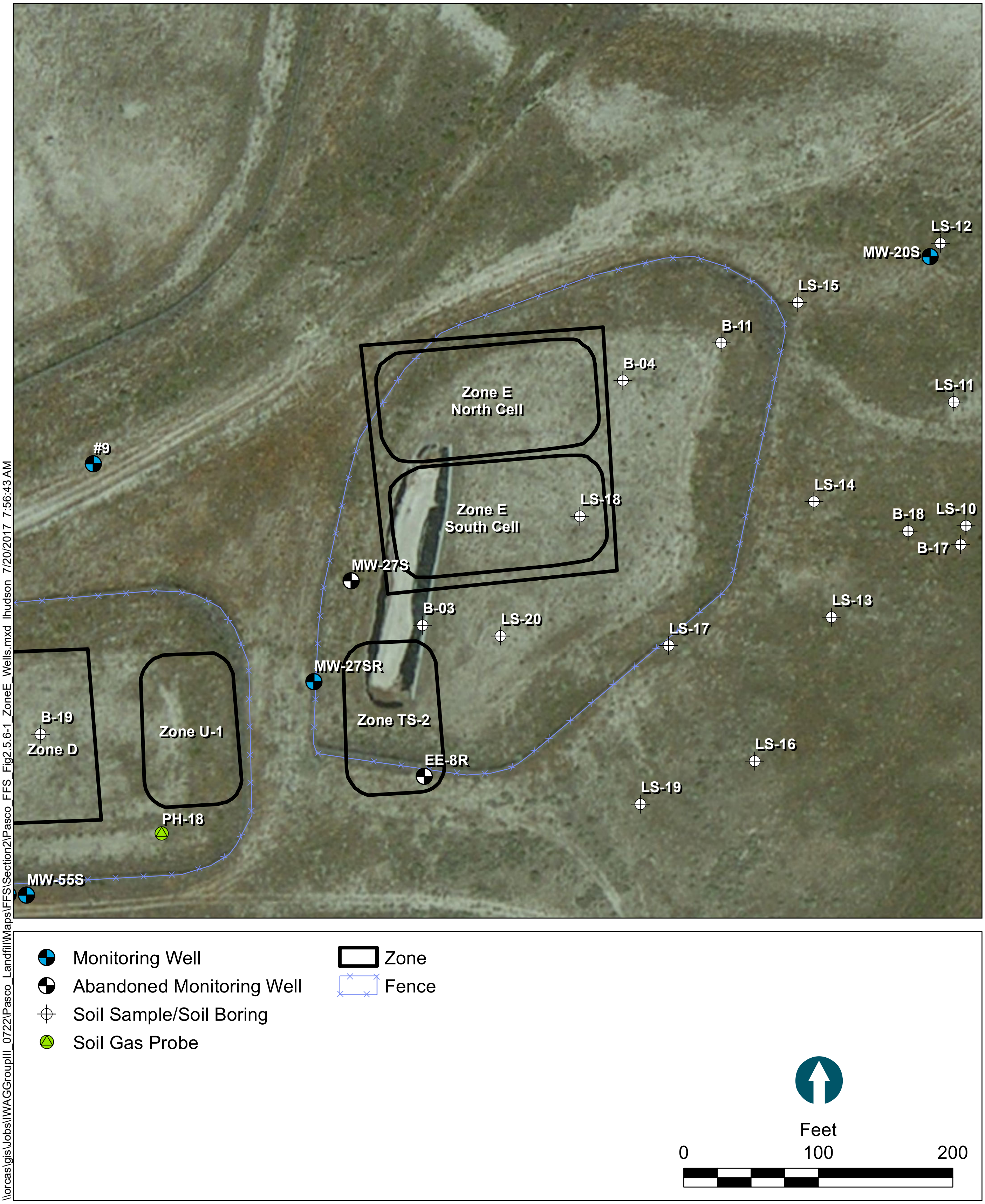

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Figure 2.5.6-1
Zone E
Pasco Sanitary Landfill NPL Site
Pasco, WA

\\orcas\gis\Jobs\IWAGGroupII_0722\Pasco_Landfill\Maps\FFS\Section2\Pasco_FFS_Fig2.5.7-1_OnPropertyGWwells.mxd lhudson 6/23/2017 12:11:06 PM

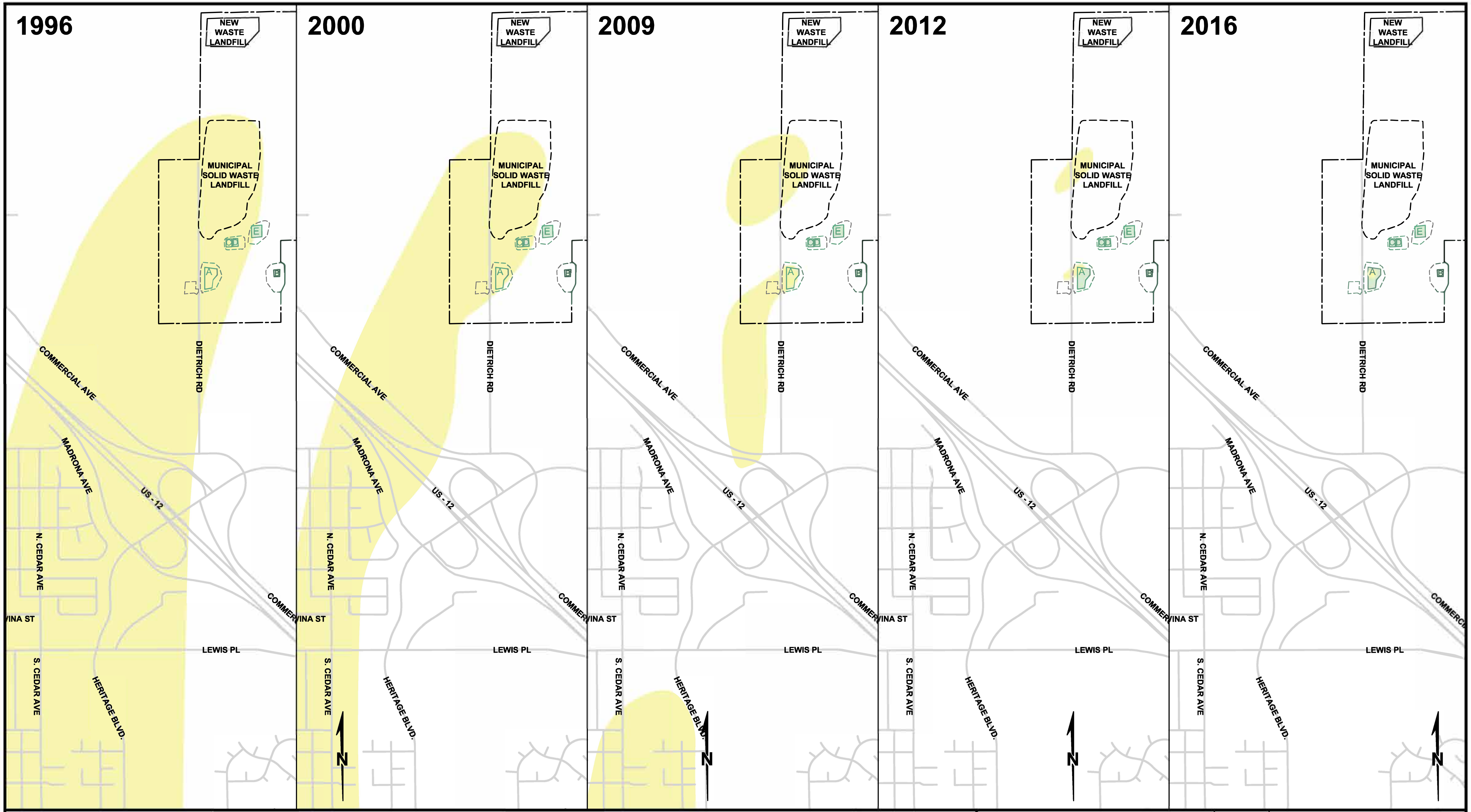
NOTE:
Figure 1.2-2 shows the individual waste areas located within the Pasco Sanitary Landfill property.

Figure 2.5.7-1
Historic and Current On-property Monitoring Wells
Pasco Sanitary Landfill NPL Site
Pasco, WA

\\orcas\gis\Jobs\WAGroupII_0722\Pasco_Landfill\Maps\FFS\Section2\Pasco_FFS_Fig2.5.7-2_OffPropertyGWwells.mxd lhudson 8/18/2017 3:39:38 PM

ANCHOR QEA

Figure 2.5.7-2
Off-property Wells
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES

EXTENT OF EXCEEDANCES OF ONE OR MORE COMPOUND ABOVE DRAFT CLEANUP LEVELS IN ONE OR MORE QUARTER

0 375 750 1500

APPROXIMATE SCALE: 1" = 1500'

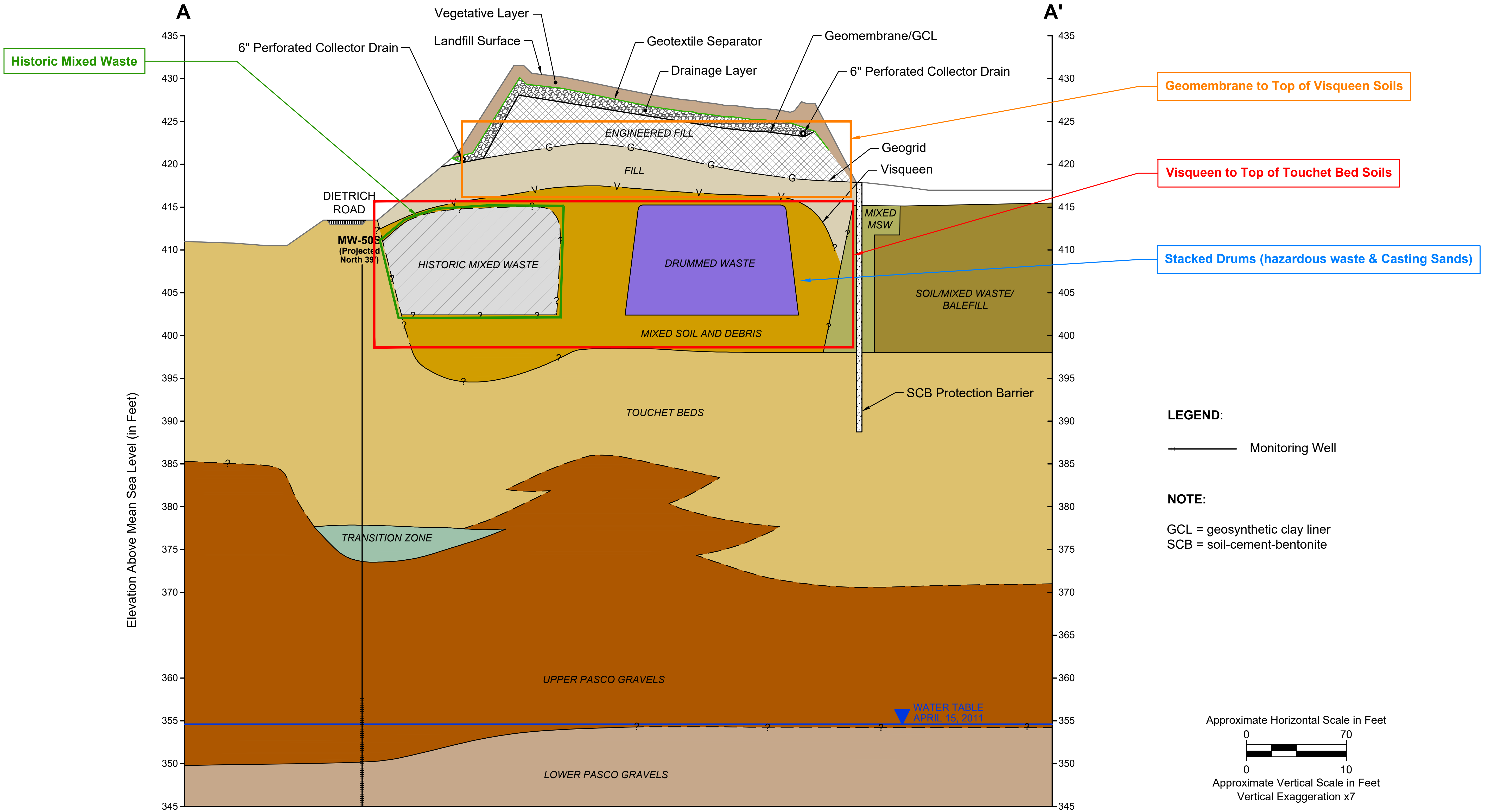
ENVIRONMENTAL PARTNERS INC

DETECTIONS ABOVE THE 2014 DRAFT CLEANUP LEVELS

PROJECT	03914.0		
PREPARED FOR	IWAG GROUP III PASCO LANDFILL		
LOCATION	1901 DIETRICH ROAD PASCO, WASHINGTON		
FIGURE	DRAWN BY	REVIEWED BY	DATE
2.5.7-3	VPB	ARM	8/24/17

Note: Increasing concentrations at MW-52S and MW-53S were observed starting November 2013, due to reduced SVE operation following the balefill combustion event.

Figure 2.5.7-4
TCE Trends Between Monitoring Wells at Zone A Source Area and Immediately Downgradient from Zone A
(Operation of Historic Wells and Operation of SVE Upgade Wells)
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTE:

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

Jul 20, 2017 9:40am hmerrick   K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-018.dwg Figure 2.6.2-1

ANCHOR QEA

Figure 2.6.2-1
Zone A Revised Conceptual Site Model
Pasco Sanitary Landfill NPL Site
Pasco, WA

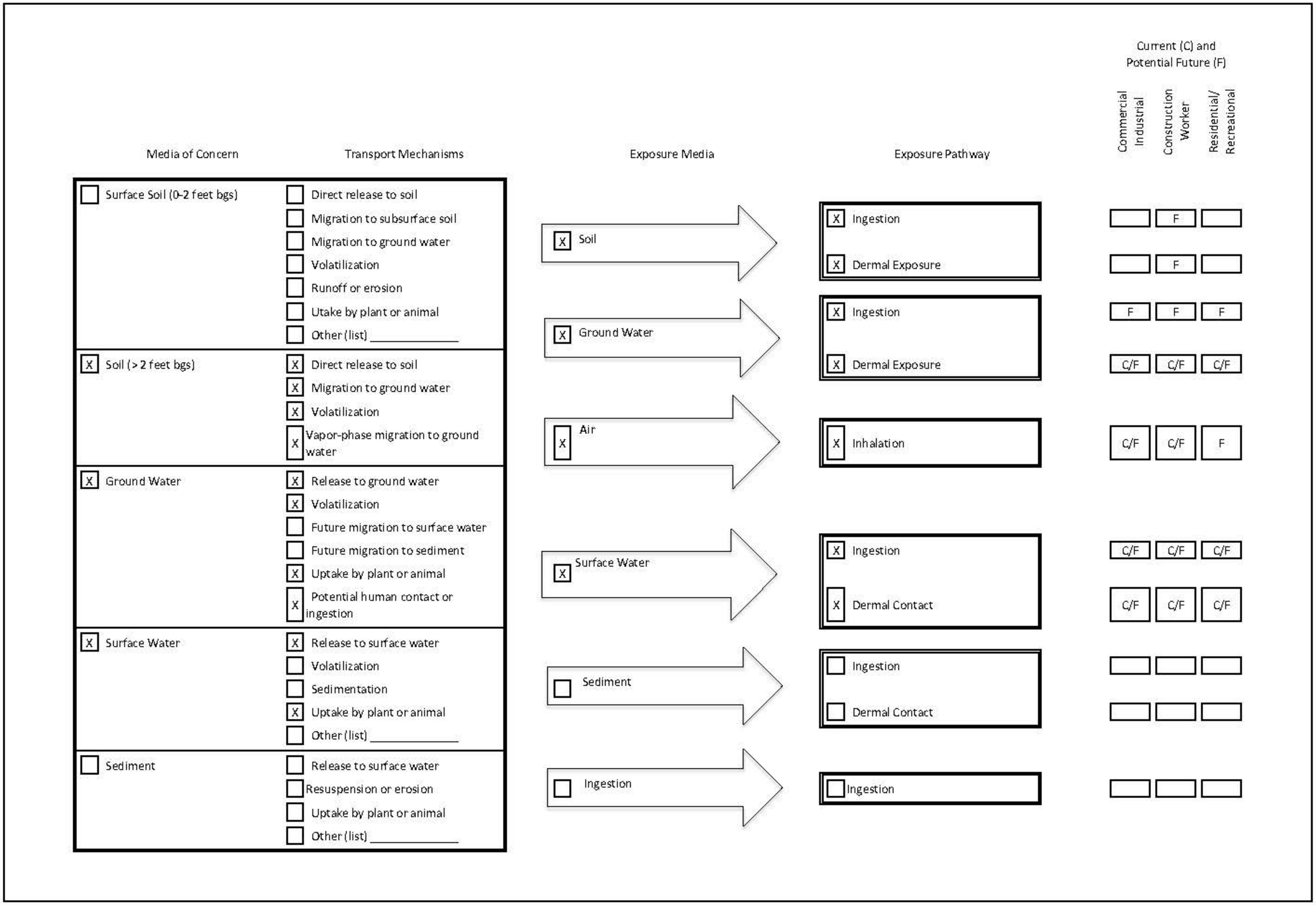
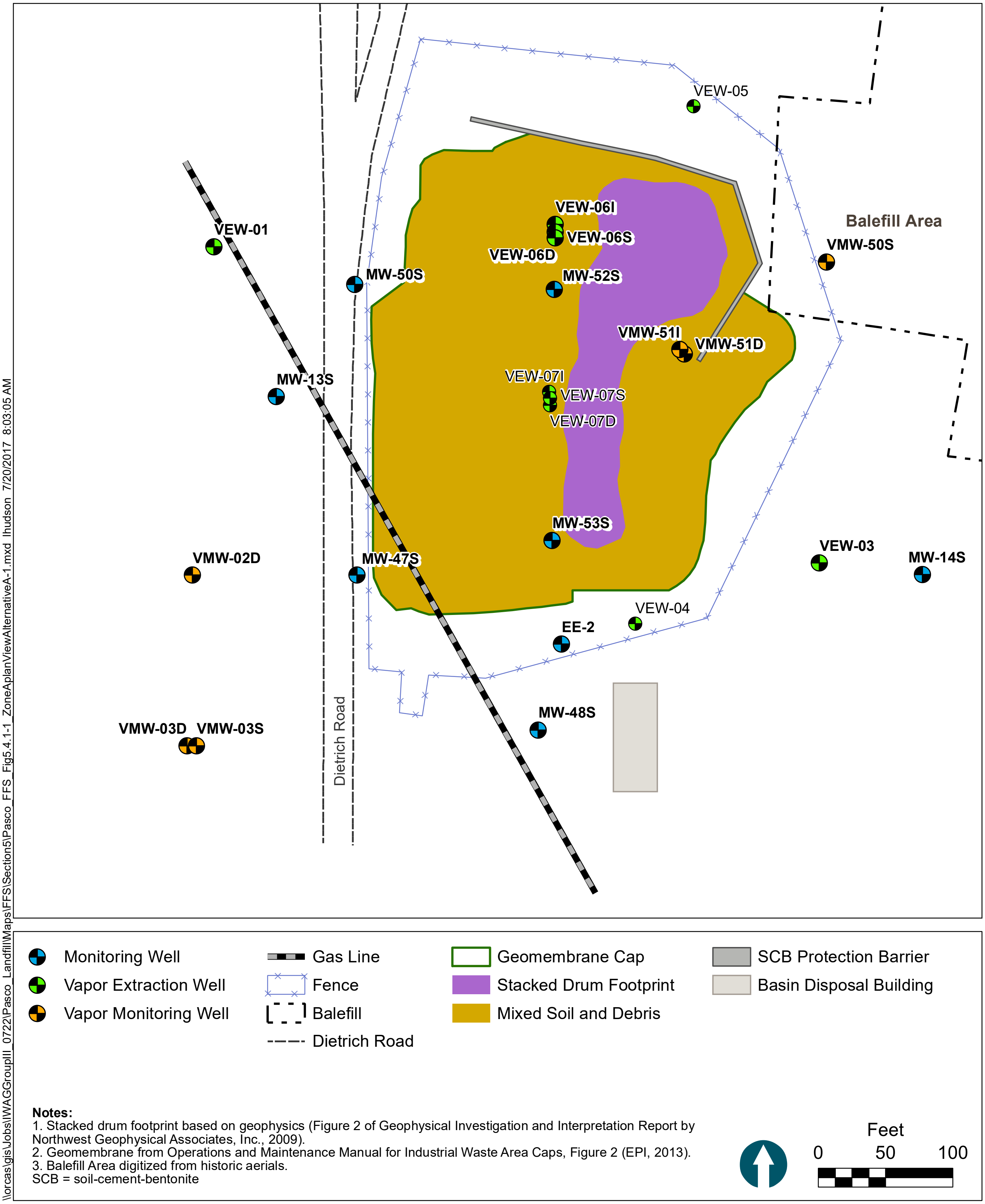


Figure 3-1
Site-wide Exposure Pathway
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
SCB = soil-cement-bentonite

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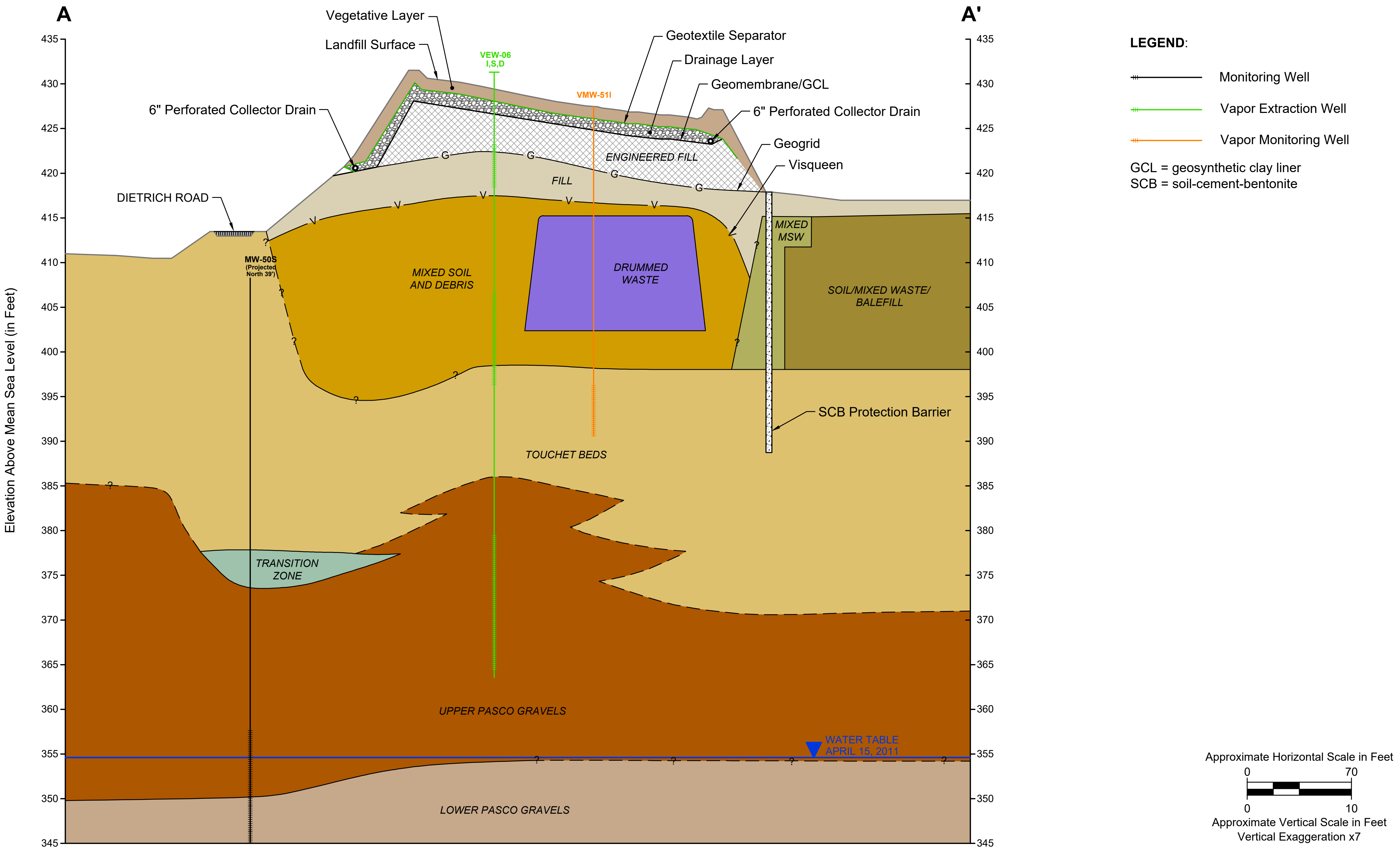
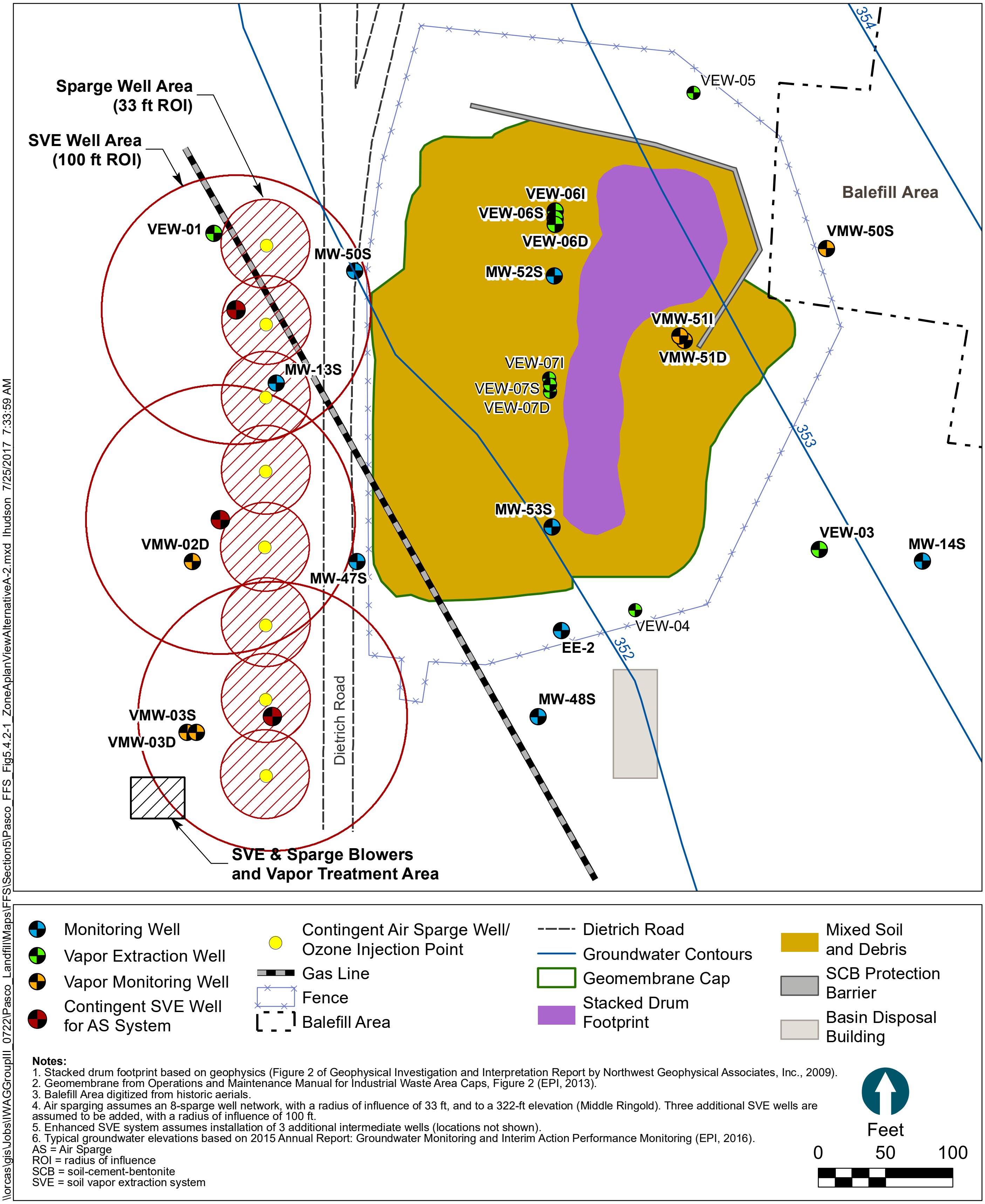
Figure 5.4.1-1
Zone A Plan View - Alternative A-1
Pasco Sanitary Landfill NPL Site
Pasco, WA



ANCHOR QEA

Figure 5.4.1-2
Zone A Cross Section A-A' - Alternative A-1
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
4. Air sparging assumes an 8-sparge well network, with a radius of influence of 33 ft, and to a 322-ft elevation (Middle Ringold). Three additional SVE wells are assumed to be added, with a radius of influence of 100 ft.
5. Enhanced SVE system assumes installation of 3 additional intermediate wells (locations not shown).
6. Typical groundwater elevations based on 2015 Annual Report: Groundwater Monitoring and Interim Action Performance Monitoring (EPI, 2016).

AS = Air Sparge
ROI = radius of influence
SCB = soil-cement-bentonite
SVE = soil vapor extraction system

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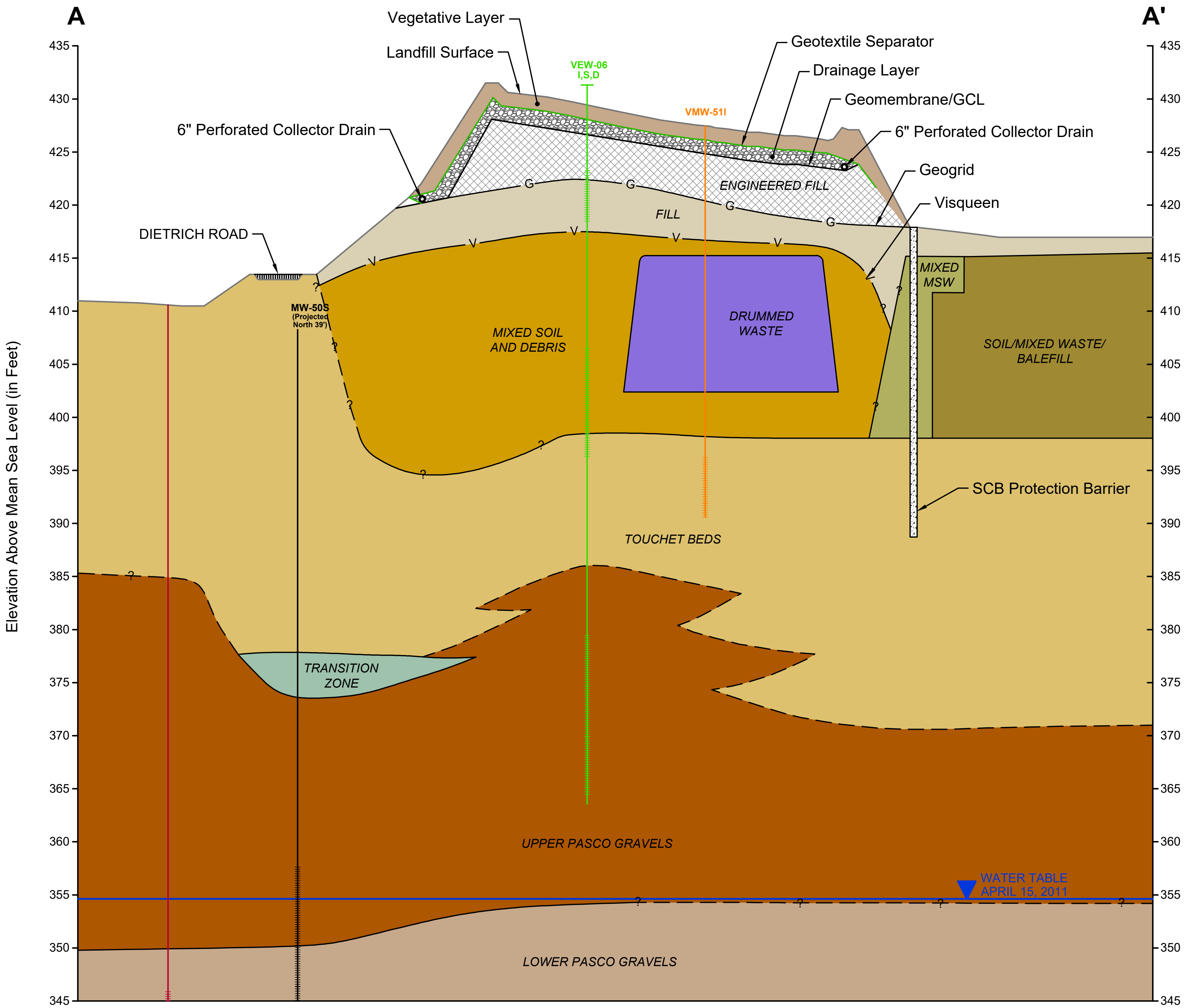
Figure 5.4.2-1
Zone A Plan View - Alternative A-2
Pasco Sanitary Landfill NPL Site
Pasco, WA



LEGEND:

- — New Vertical Sparge Well
- — Monitoring Well
- — Vapor Extraction Well
- — Vapor Monitoring Well

NOTES:

1. Air sparging assumes a 8-sparge well network with 2-foot-long screens and to an elevation of 322 feet (Middle Ringold). Four additional SVE wells are assumed to be added (approximately 33 feet apart) to an elevation of 361 feet (Upper Pasco Gravels).
2. Enhanced SVE system assumes installation of 3 additional intermediate wells.

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

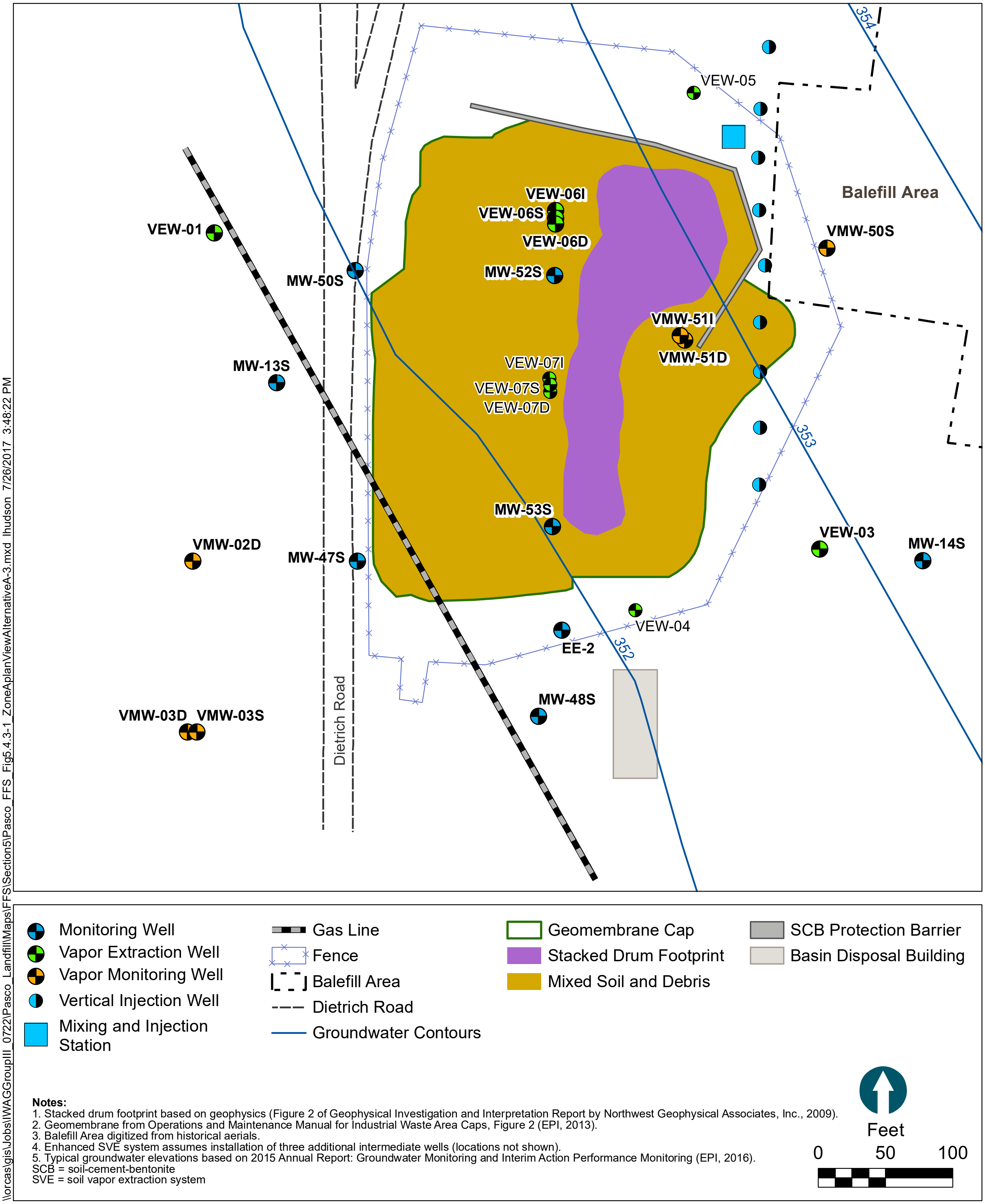
Approximate Horizontal Scale in Feet
0 70
0 10
Approximate Vertical Scale in Feet
Vertical Exaggeration x7

Jul 25, 2017 3:37pm tgriga K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-011.dwg Figure 5.4.2-2

ANCHOR QEA

Figure 5.4.2-2
Zone A Cross Section A-A' - Alternative A-2
Pasco Sanitary Landfill NPL Site
Pasco, WA

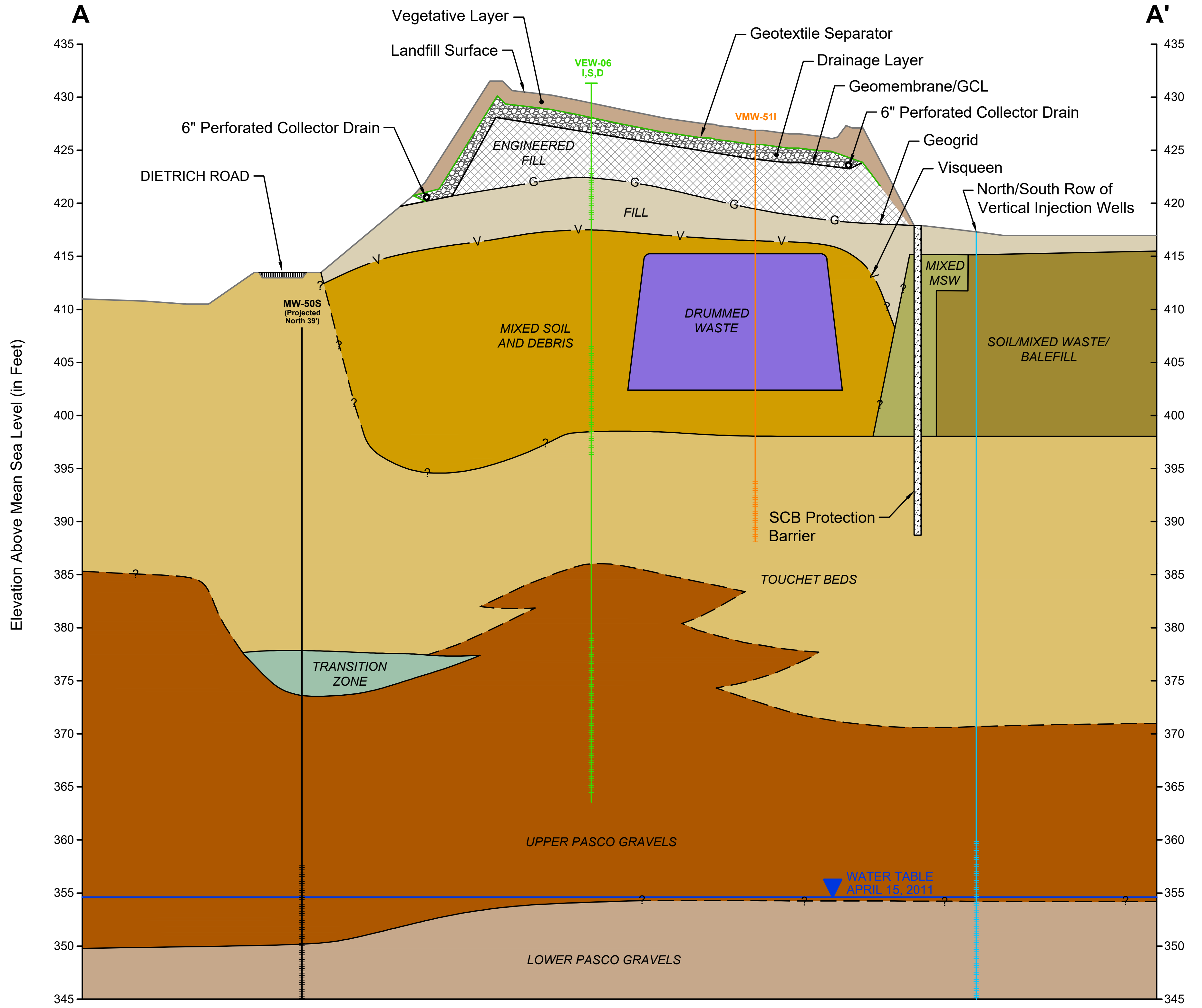
\\orcas\gis\Jobs\WAGGroupII_0722\Pasco_Landfill\Maps\FFS\Section5\Pasco_FFS_Fig5.4.3-1_ZoneAplanViewAlternativeA-3.mxd lhudson 7/26/2017 3:48:22 PM



Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historical aerials.
4. Enhanced SVE system assumes installation of three additional intermediate wells (locations not shown).
5. Typical groundwater elevations based on 2015 Annual Report: Groundwater Monitoring and Interim Action Performance Monitoring (EPI, 2016).
SCB = soil-cement-bentonite
SVE = soil vapor extraction system

ANCHOR QEA

Figure 5.4.3-1
Zone A Plan View - Alternative A-3
Pasco Sanitary Landfill NPL Site
Pasco, WA



LEGEND:

New Vertical Injection Well
Monitoring Well
Vapor Extraction Well
Vapor Monitoring Well

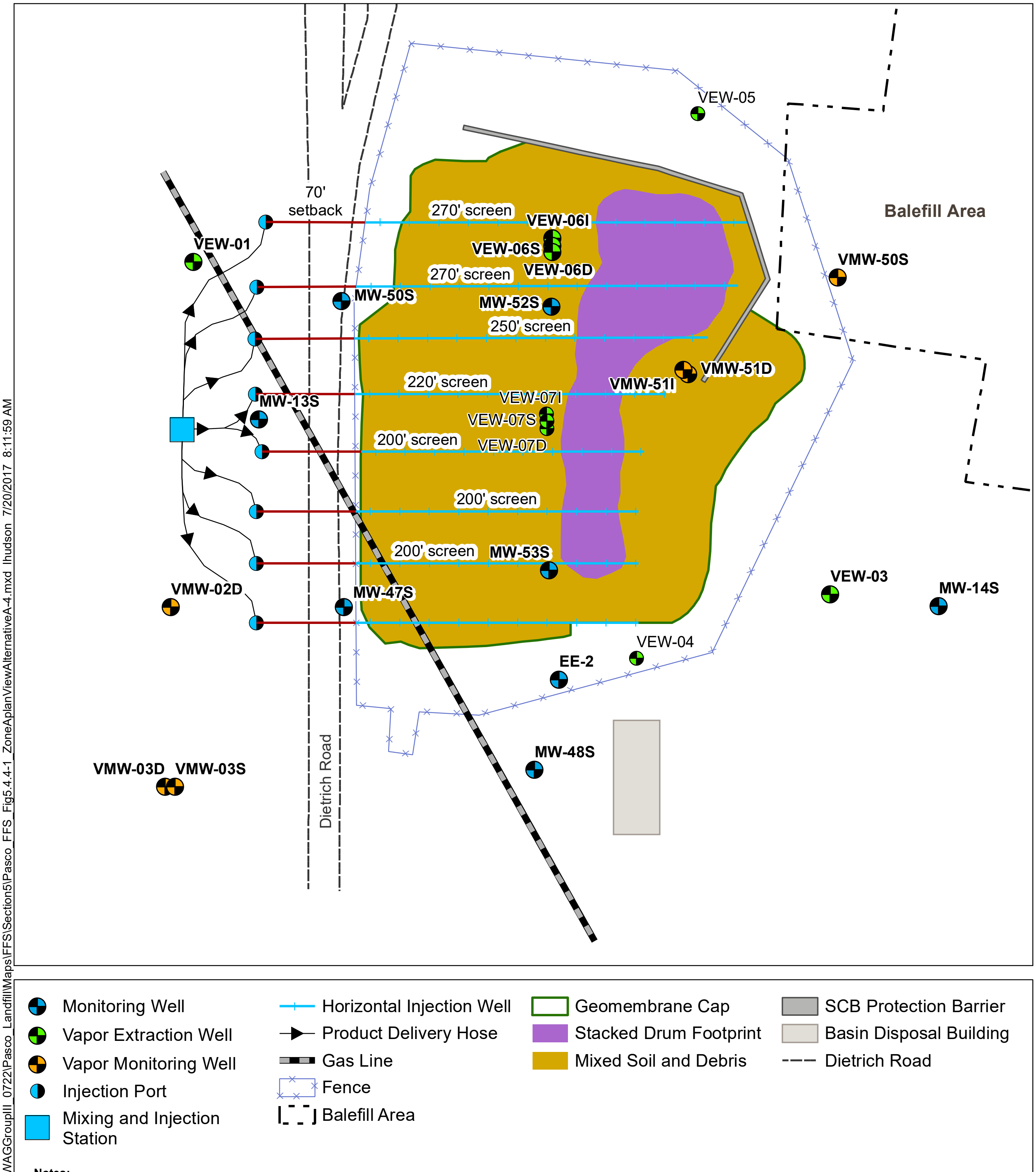
NOTE:

1. Enhanced SVE system assumes installation of 3 additional intermediate wells.

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

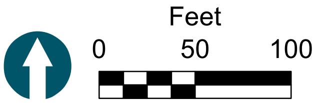
Approximate Horizontal Scale in Feet
0 70
0 10
Approximate Vertical Scale in Feet
Vertical Exaggeration x7

Figure 5.4.3-2
Zone A Cross Section A-A' - Alternative A-3
Pasco Sanitary Landfill NPL Site
Pasco, WA



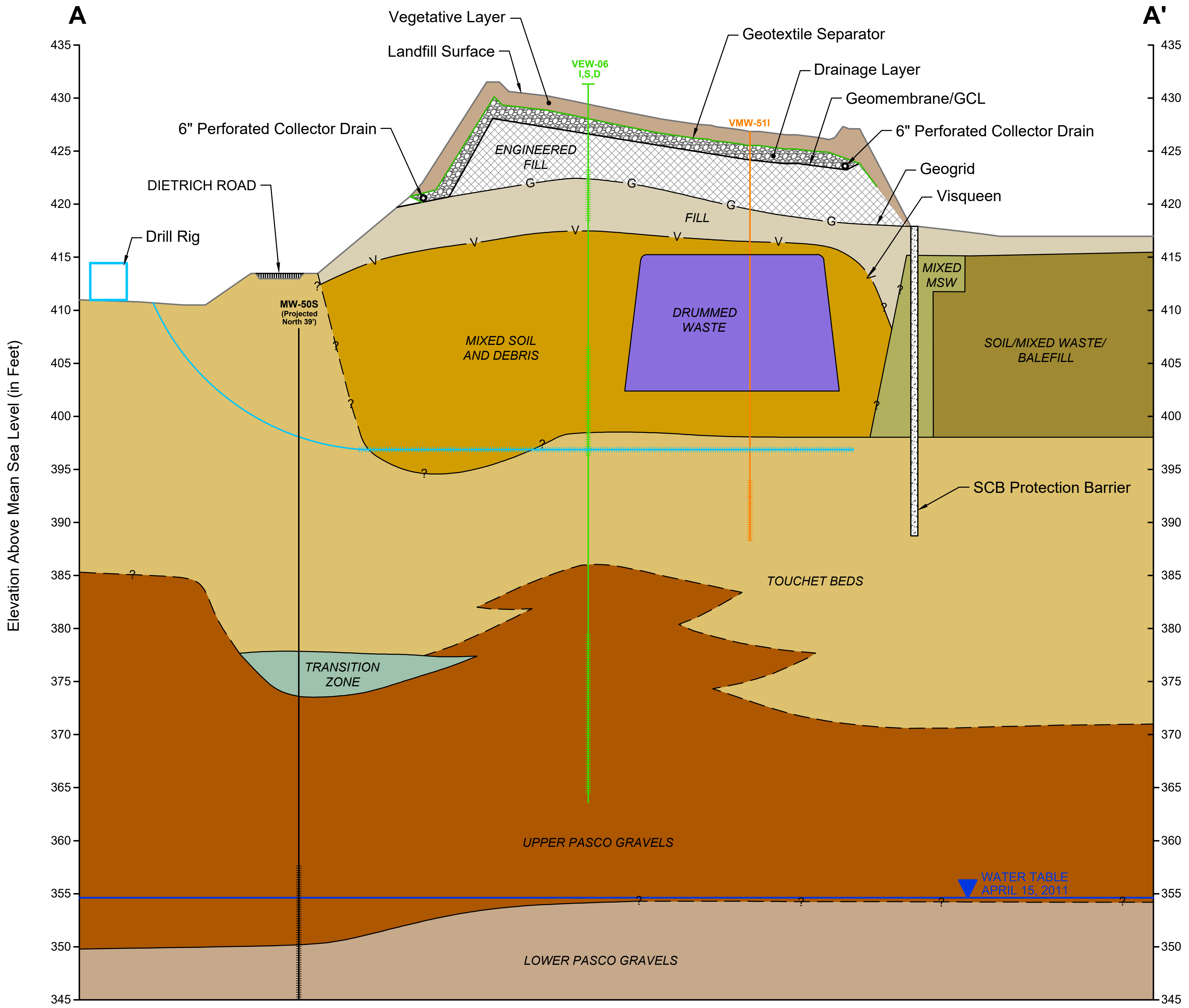
\\orcas\gis\Jobs\WAGGroupII_0722\Pasco_Landfill\Maps\FFS\Section5\Pasco_FFS_Fig5.4.4-1_ZoneAplanViewAlternativeA-4.mxd lhudson 7/20/2017 8:11:59 AM

Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
4. Enhanced SVE system assumes installation of 3 additional intermediate wells.
SCB = soil-cement-bentonite



ANCHOR QEA

Figure 5.4.4-1
Zone A Plan View - Alternative A-4
Pasco Sanitary Landfill NPL Site
Pasco, WA



LEGEND:

New Horizontal Injection Well

Monitoring Well

Vapor Extraction Well

Vapor Monitoring Well

NOTES:

1. Horizontal wells are assumed to be 270 feet long and at an elevation of 397 feet. Set back for drill rig is assumed to be 70 feet.
2. Enhanced SVE system assumes installation of 3 additional intermediate wells.

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

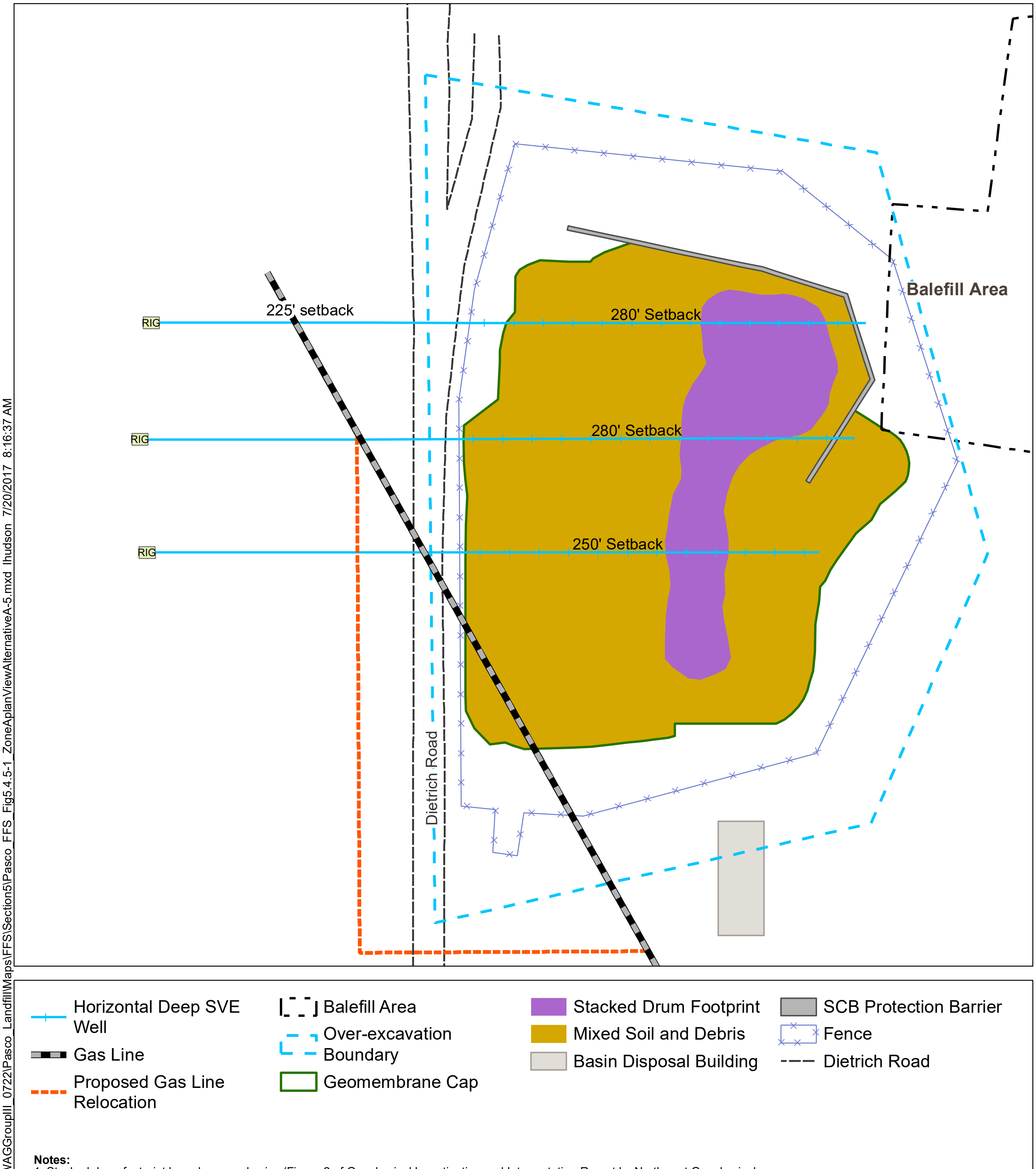
Approximate Horizontal Scale in Feet
0 70
0 10
Approximate Vertical Scale in Feet
Vertical Exaggeration x7

K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-011.dwg Figure 5.4.4-2

Jul 20, 2017 10:04am hmerrick

ANCHOR QEA

Figure 5.4.4-2
Zone A Cross Section A-A' - Alternative A-4
Pasco Sanitary Landfill NPL Site
Pasco, WA

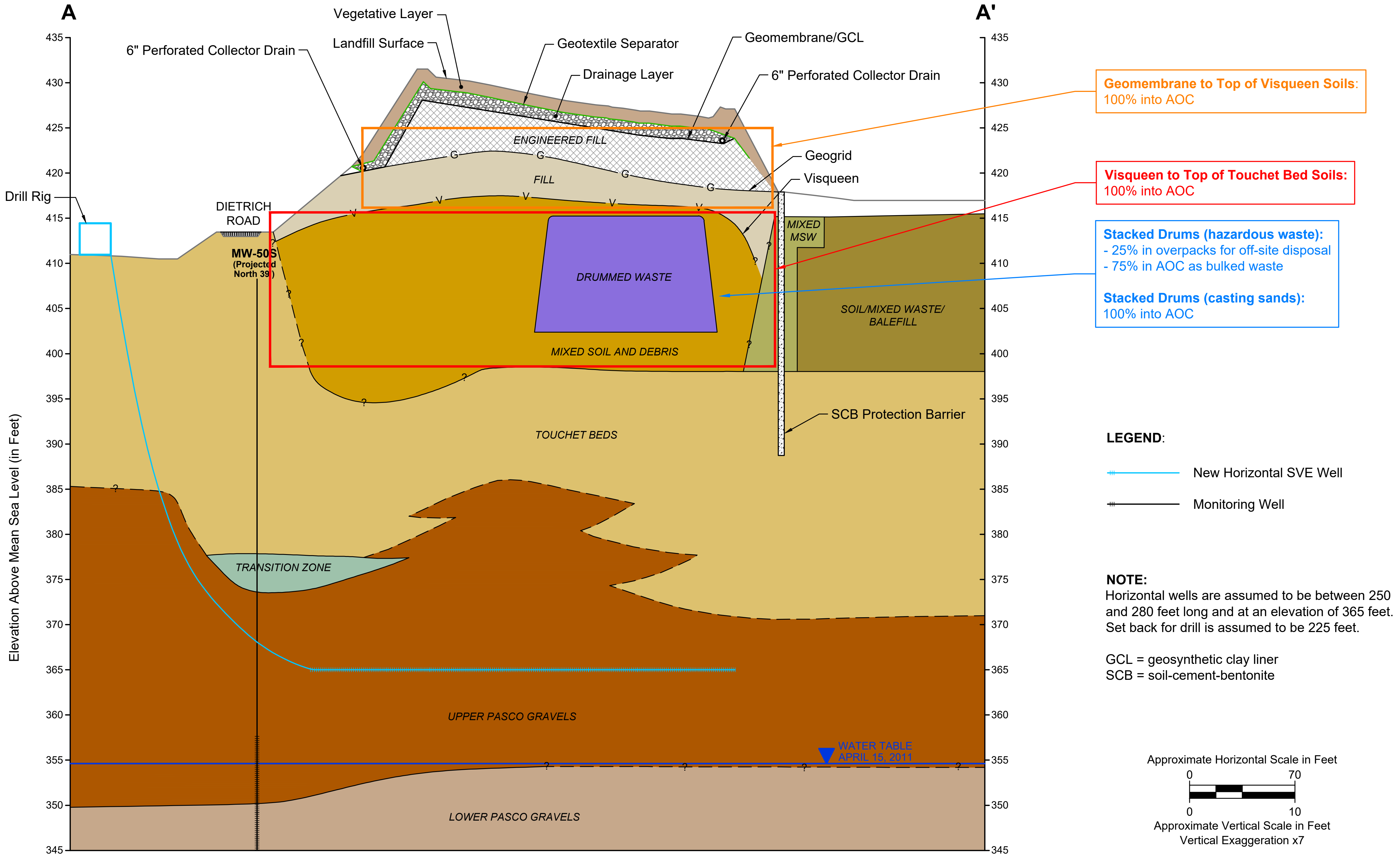


Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
4. Three new horizontal deep SVE wells to be installed prior to Zone A waste removal.
5. Approximate location of the Area of Contamination (AOC) cell shown in Figure 5.4.5-3.

SCB = soil-cement-bentonite

\\orcas\gis\Jobs\WAGGroupII_0722\Pasco_Landfill\Maps\FFS\Section5\Pasco_FFS_Fig5.4.5-1_ZoneAplanViewAlternativeA-5.mxd lhudson 7/20/2017 8:16:37 AM

Figure 5.4.5-1
Zone A Plan View - Alternative A-5
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTE:
Horizontal wells are assumed to be between 250 and 280 feet long and at an elevation of 365 feet. Set back for drill is assumed to be 225 feet.

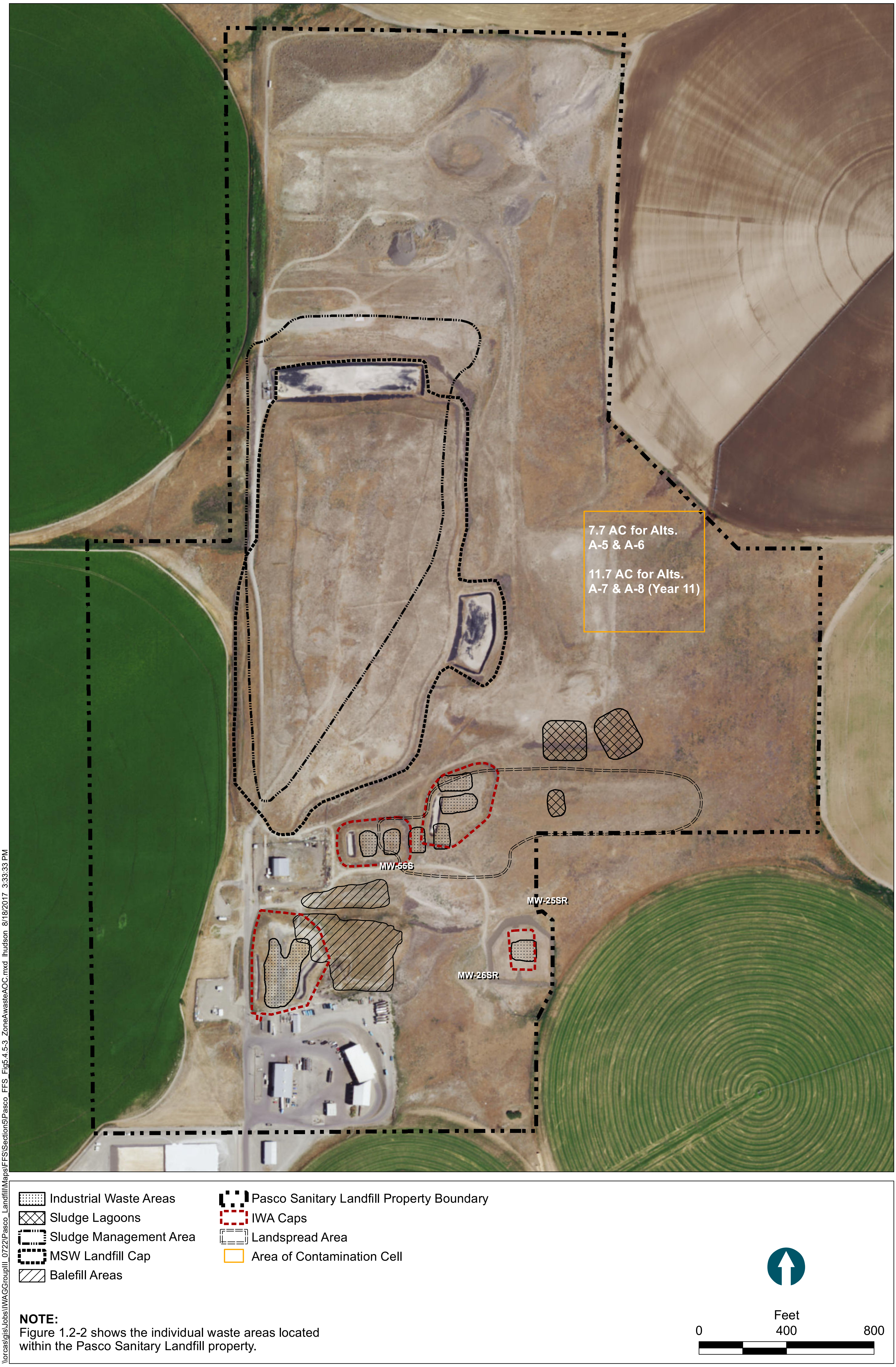
GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-018.dwg Figure 5.4.5-2

Jul 20, 2017 9:43am hmerrick

ANCHOR QEA

Figure 5.4.5-2
Zone A Cross Section A-A' - Alternative A-5
Pasco Sanitary Landfill NPL Site
Pasco, WA

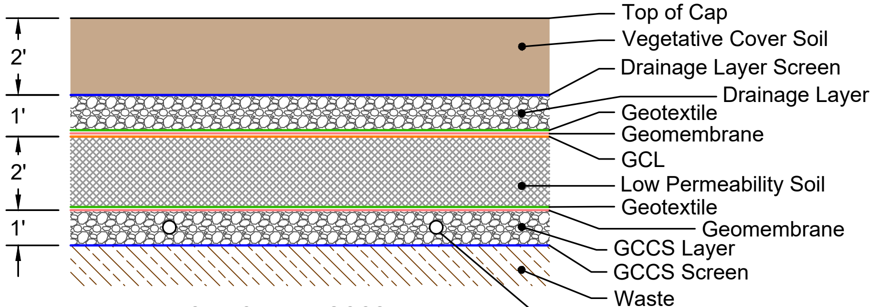


NOTE:
Figure 1.2-2 shows the individual waste areas located within the Pasco Sanitary Landfill property.

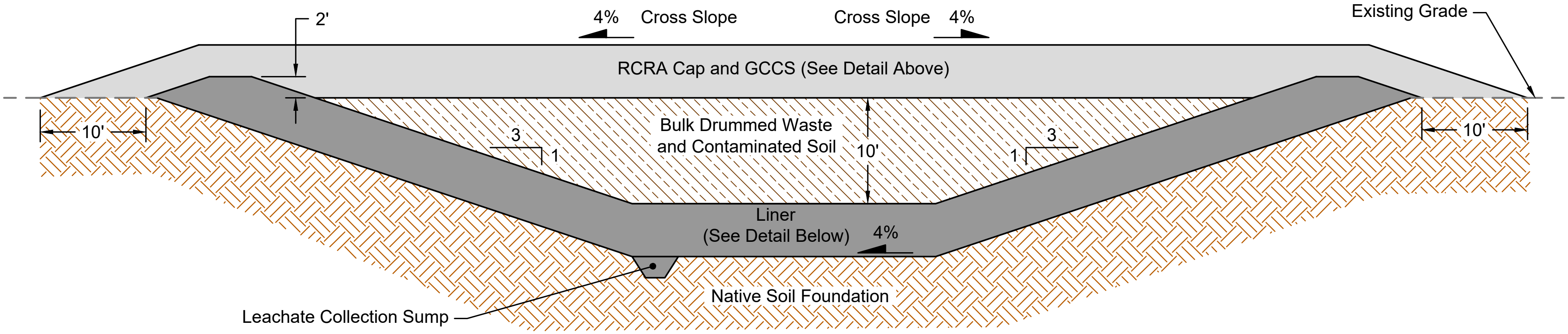
\\orcas\gis\Jobs\IWAGGroupIII_0722\Pasco_Landfill\Maps\FFS\Section5\Pasco_FFS_Fig5.4.5-3_ZoneAwasteAOC.mxd lhudson 8/18/2017 3:33:33 PM

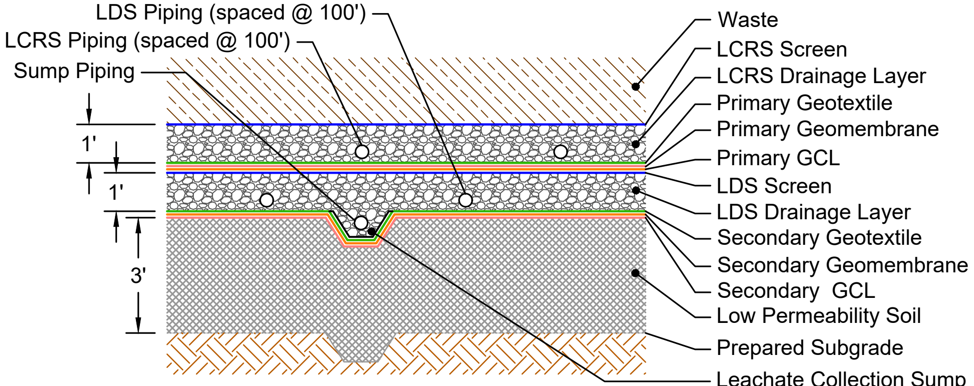
Figure 5.4.5-3
Approximate Location of Area of Contamination (AOC) for Zone A Wastes
Pasco Sanitary Landfill NPL Site
Pasco, WA

ANCHOR QEA



RCRA Cap and GCCS Detail





Liner Detail

NOTE: Typical cross section of an AOC cell, based on RCRA Subtitle C Minimum Technical Requirements (MTRs).

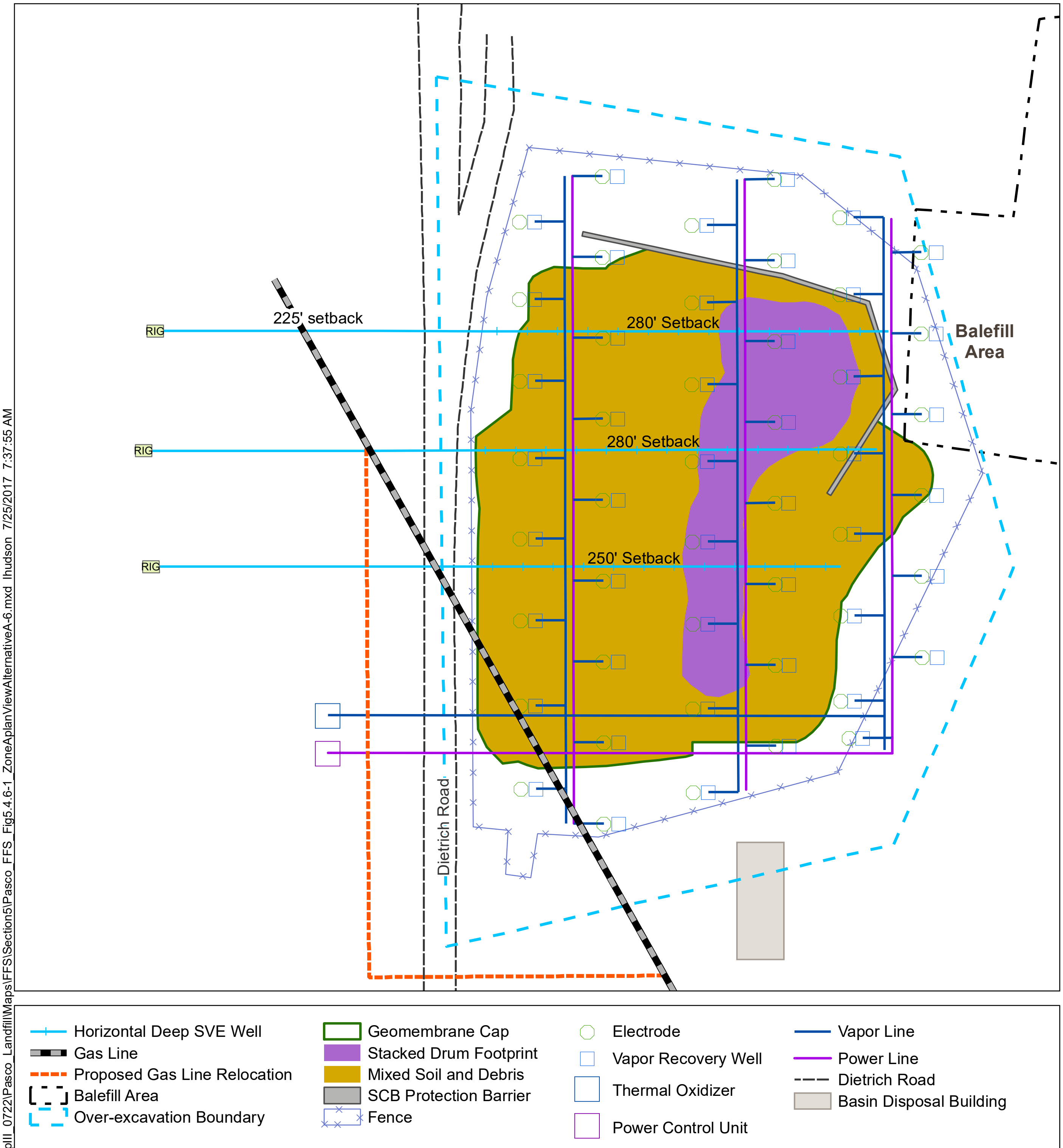
AOC = Area of Contamination
GCL = Geosynthetic Clay Liner
LDS = Leak Detection System
LCRS = Leachate Collection and Removal System
RCRA = Resource Conservation and Recovery Act
GCCS = Gas Collection and Control System

Not to Scale

Jul 20, 2017 9:44am hmerrick K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-014.dwg Figure 5.4.5-4

ANCHOR QEA

Figure 5.4.5-4
Typical Cross Section of AOC Cell
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
4. Three new horizontal deep SVE wells to be installed prior to Zone A waste removal.
5. Approximate location and typical cross section of the Area of Contamination (AOC) cell shown in Figures 5.4.5-3 and 5.4.5-4.
6. The Touchet Beds are assumed to be thermally-treated with approximately 380 25-ft-long electrodes (spaced 17 ft apart) and co-located vapor recovery wells.
SCB = soil-cement-bentonite

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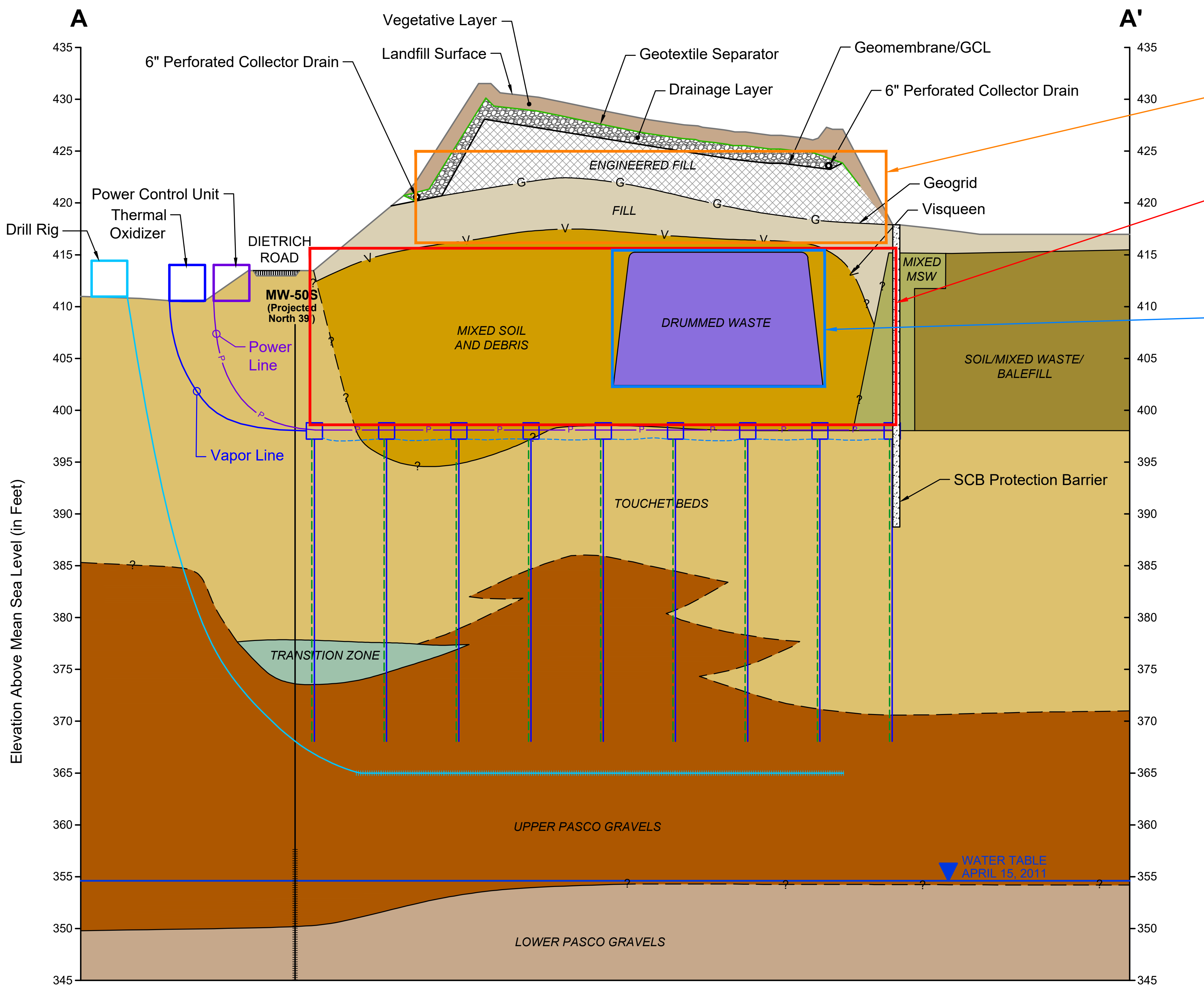
Figure 5.4.6-1
Zone A Plan View - Alternative A-6
Pasco Sanitary Landfill NPL Site
Pasco, WA



Geomembrane to Top of Visqueen Soils:
100% into AOC

Visqueen to Top of Touchet Beds Soils:
100% into AOC

Stacked Drums (hazardous waste):
- 25% in overpacks for off-site disposal
- 75% in AOC as bulked waste

Stacked Drums (casting sands):
100% into AOC

LEGEND:

―+―	New Horizontal SVE Well
―+―	Monitoring Well
- - - - - -	Electrode
☐――	Vapor Recovery Well
- - - - - -	Water Drip Line

NOTES:
1. Horizontal wells are assumed to be between 250 and 280 feet long and at an elevation of 365 feet. Set back for drill is assumed to be 225 feet.
2. The Touchet Beds are assumed to be thermally-treated with approximately 380 25-ft-long electrodes (spaced 17 ft apart) and co-located vapor recovery wells.

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

Approximate Horizontal Scale in Feet
0 70
0 10
Approximate Vertical Scale in Feet
Vertical Exaggeration x7

K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-015.dwg Figure 5.4.6-2

Jul 20, 2017 9:45am hmerrick

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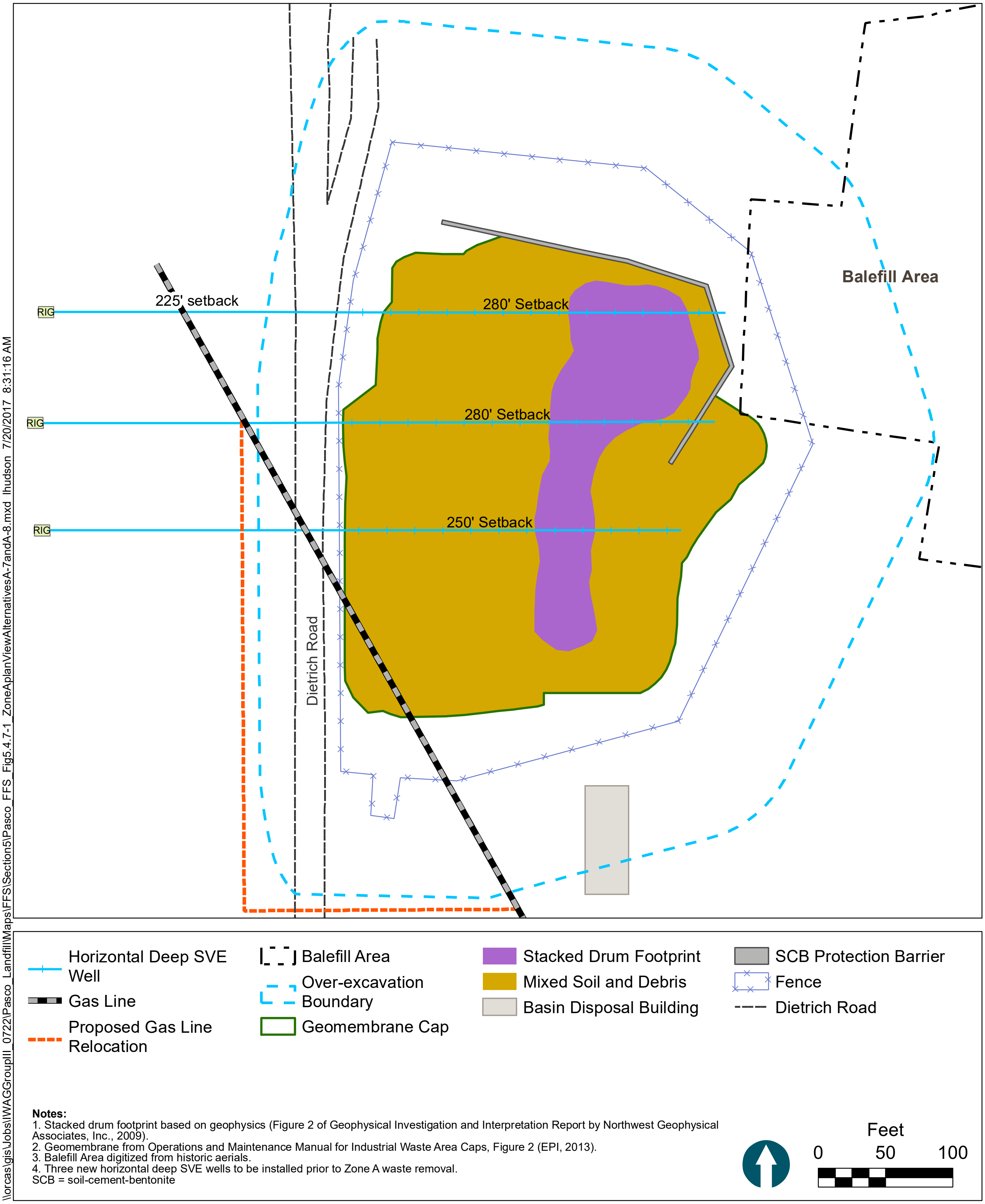
Figure 5.4.6-2
Zone A Cross Section A-A' - Alternative A-6
Pasco Sanitary Landfill NPL Site
Pasco, WA



Notes:
1. Stacked drum footprint based on geophysics (Figure 2 of Geophysical Investigation and Interpretation Report by Northwest Geophysical Associates, Inc., 2009).
2. Geomembrane from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 2 (EPI, 2013).
3. Balefill Area digitized from historic aerials.
4. Three new horizontal deep SVE wells to be installed prior to Zone A waste removal.
SCB = soil-cement-bentonite

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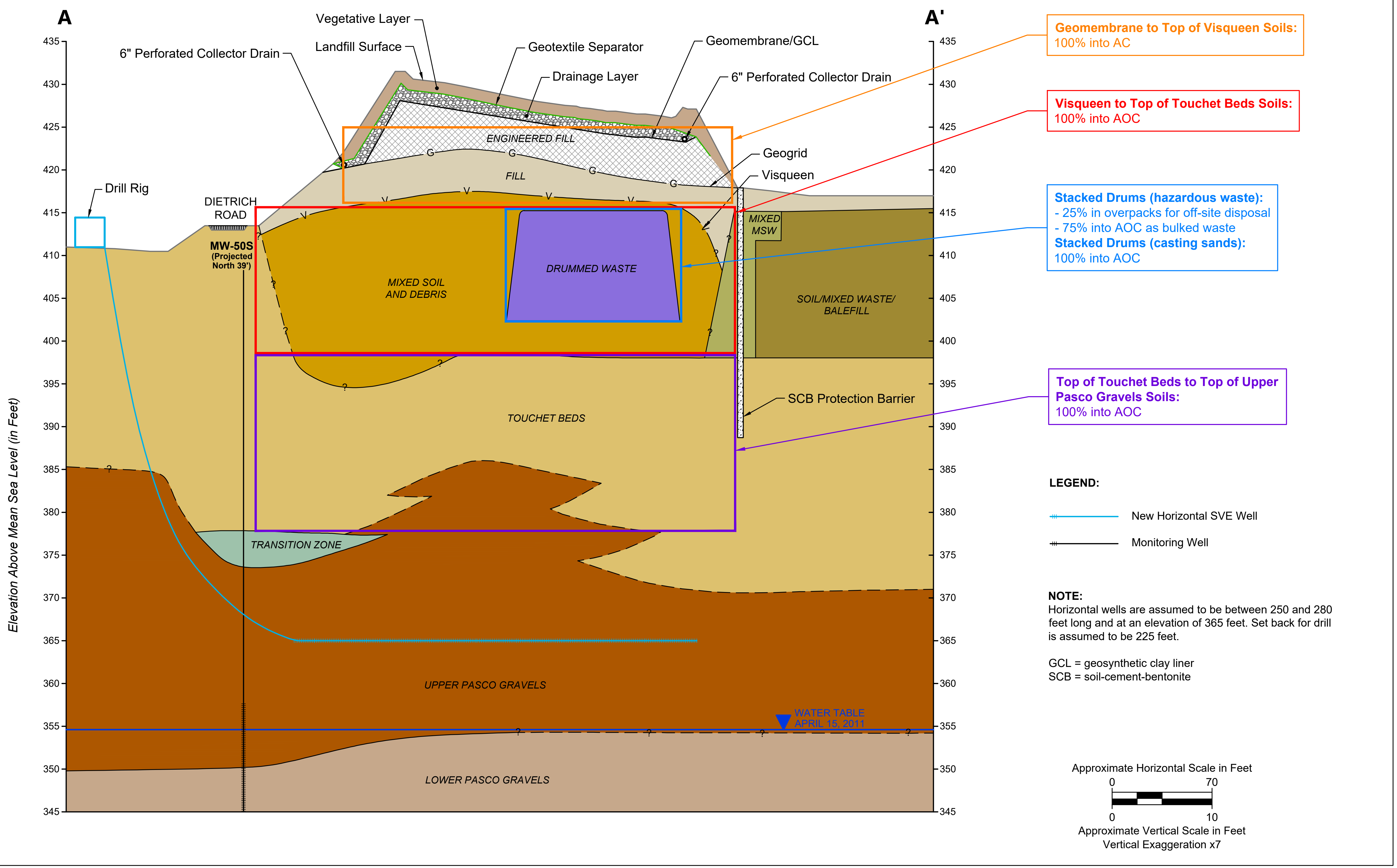
Figure 5.4.7-1
Zone A Plan View – Alternatives A-7, A-8 (Year 11), and A-9
Pasco Sanitary Landfill NPL Site
Pasco, WA



Geomembrane to Top of Visqueen Soils:
100% into AC

Visqueen to Top of Touchet Beds Soils:
100% into AOC

Stacked Drums (hazardous waste):
- 25% in overpacks for off-site disposal
- 75% into AOC as bulked waste

Stacked Drums (casting sands):
100% into AOC

Top of Touchet Beds to Top of Upper Pasco Gravels Soils:
100% into AOC

LEGEND:

New Horizontal SVE Well

Monitoring Well

NOTE:
Horizontal wells are assumed to be between 250 and 280 feet long and at an elevation of 365 feet. Set back for drill is assumed to be 225 feet.

GCL = geosynthetic clay liner
SCB = soil-cement-bentonite

Jul 20, 2017 9:56am hmerrick K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-016.dwg Figure 5.4.7-2

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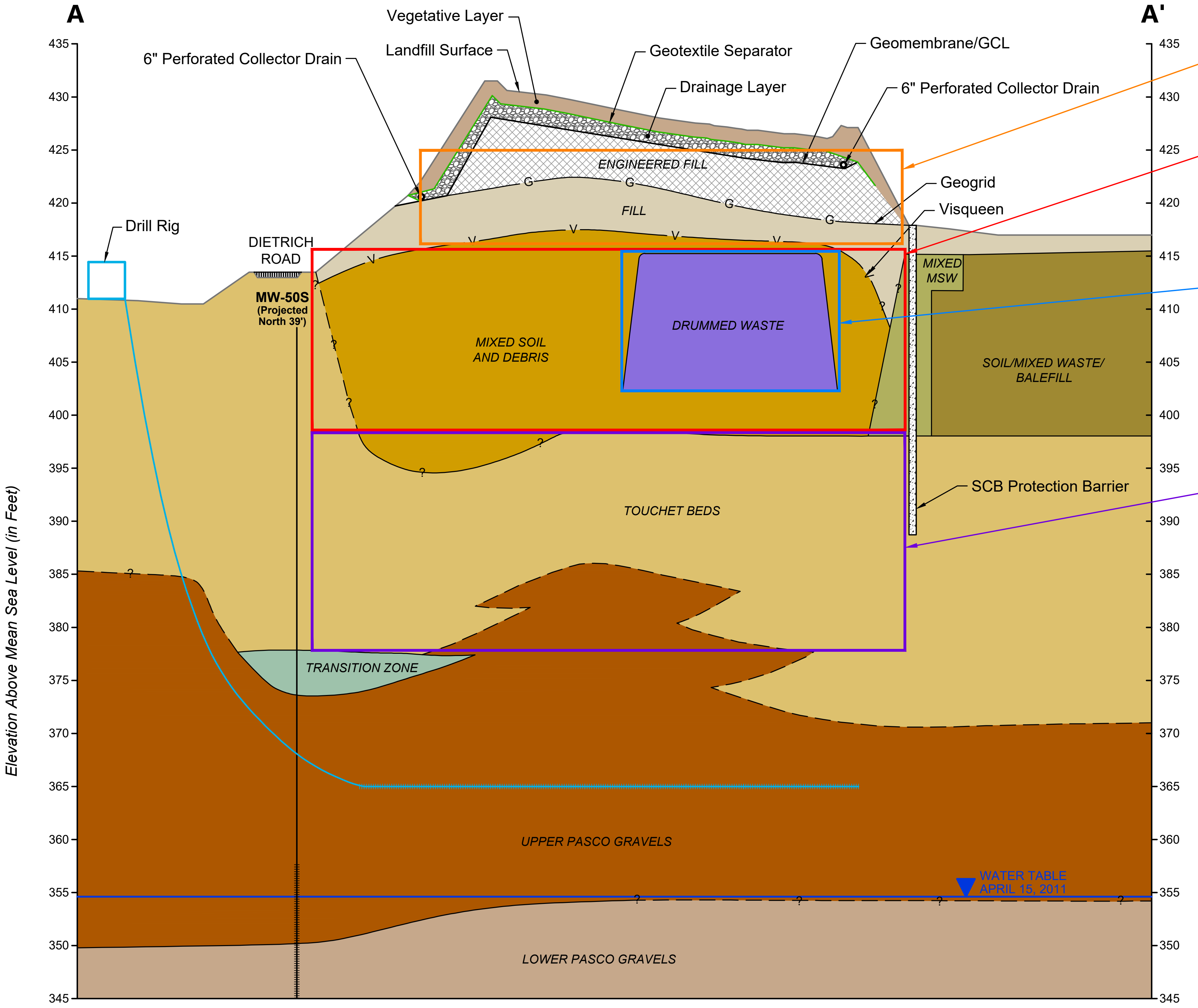
Figure 5.4.7-2
Zone A Cross Section A-A' – Alternative A-7 and A-8 (Year 11)
Pasco Sanitary Landfill NPL Site
Pasco, WA



Geomembrane to Top of Visqueen Soils:
100% for off-site disposal in direct Subtitle C Landfill

Visqueen to Top of Touchet Beds Soils:
100% for off-site disposal
- 50% direct subtitle C Landfill
- 50% RCRA stabilization

Stacked Drums (hazardous waste):
- 25% in overpacks of off-site disposal:
  - 80% direct subtitle C Landfill
  - 20% incineration
- 75% bulked off-site disposal
  - 50% direct subtitle C Landfill
  - 50% RCRA stabilization

Stacked Drums (casting sands):
100% subtitle D Landfill

Top of Touchet Beds to Top of Upper Pasco Gravels Soils:
100% for off-site disposal
- 50% direct subtitle C Landfill
- 40% RCRA stabilization
- 10% incineration

LEGEND:

New Horizontal SVE Well

Monitoring Well

NOTES:
1. Horizontal wells are assumed to be between 250 and 280 feet long and at an elevation of 365 feet. Set back for drill is assumed to be 225 feet.
2. RCRA stabilization refers to pre-treatment before disposal in a Subtitle C landfill.

Approximate Horizontal Scale in Feet
0 70

0 10
Approximate Vertical Scale in Feet
Vertical Exaggeration x7

K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-016.dwg Figure 5.4.9-1

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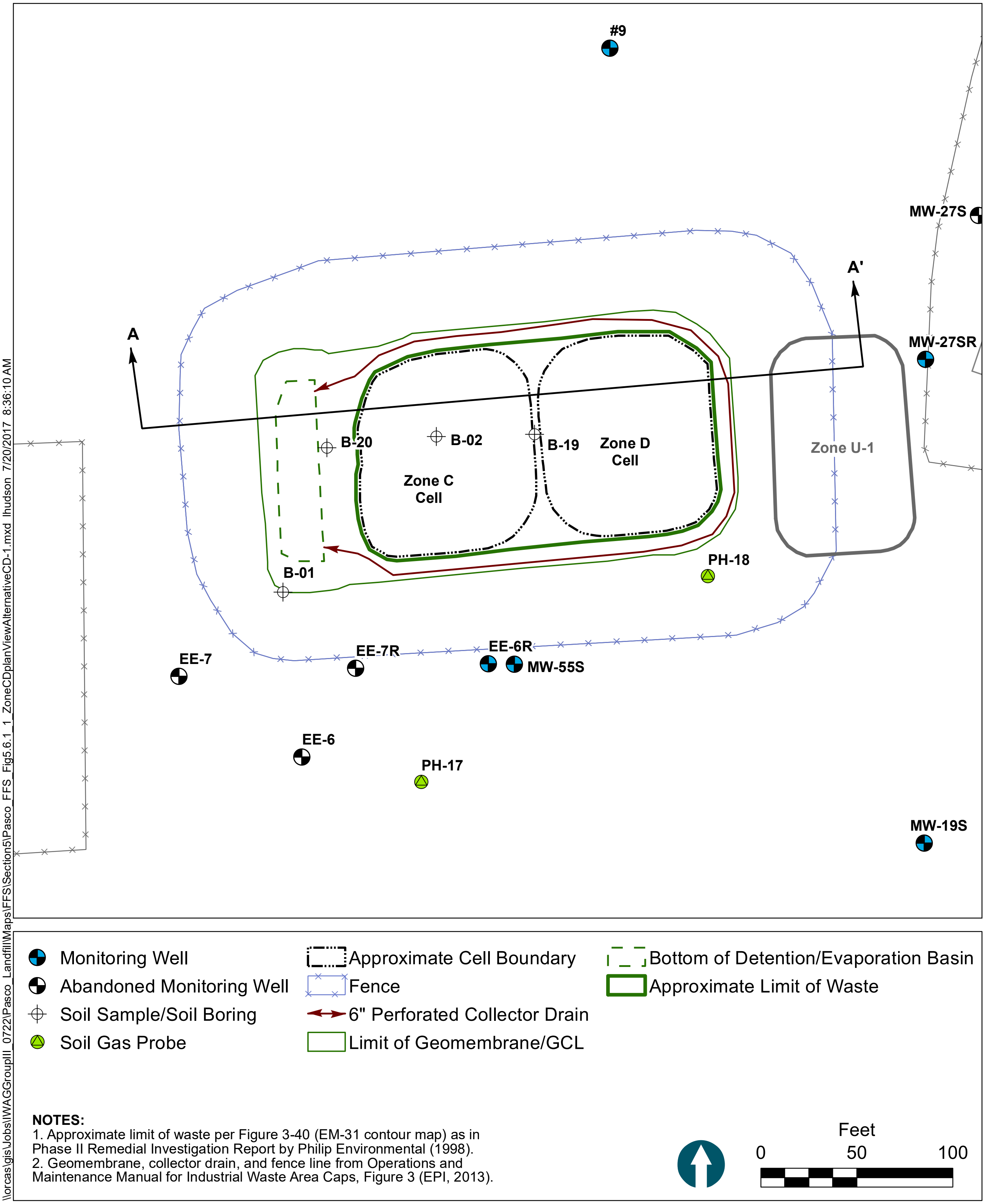
Figure 5.4.9-1
Zone A Cross Section A-A' – Alternative A-9
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:
1. Approximate limit of waste per Figure 3-40 (EM-31 contour map) as in Phase II Remedial Investigation Report by Philip Environmental (1998).
2. Geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).

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Figure 5.6.1-1
Zones C/D Plan View - Alternative CD-1
Pasco Sanitary Landfill NPL Site
Pasco, WA

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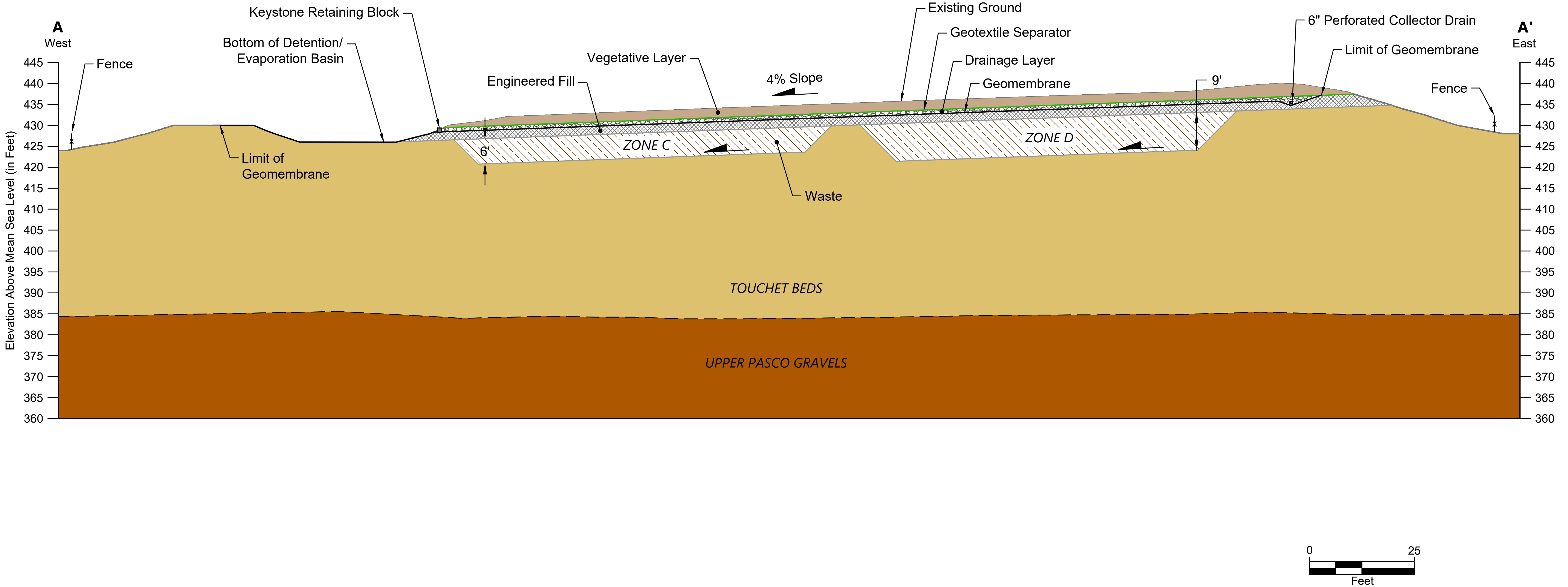
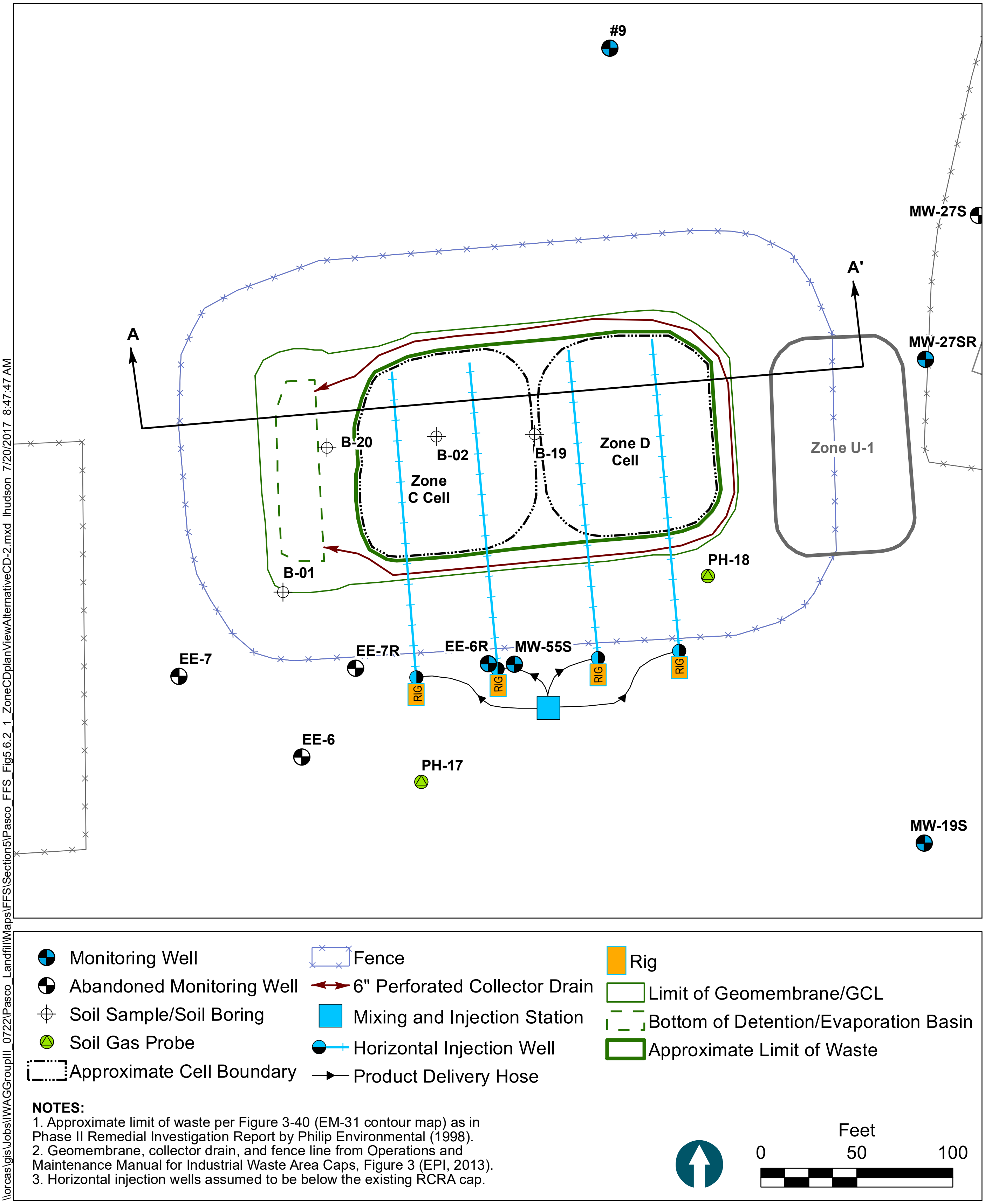
QEA



NOTE: RCRA cap cover system, geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2003).

Aug 21, 2017 10:04am hmerrick K:\Projects\0722-IWAG Group\Pasco Landfill\0722-RP-013.dwg 5.6.1-2

Figure 5.6.1-2
Zones C/D Cross Section A-A' – Alternative CD-1
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:

1. Approximate limit of waste per Figure 3-40 (EM-31 contour map) as in Phase II Remedial Investigation Report by Philip Environmental (1998).
2. Geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).
3. Horizontal injection wells assumed to be below the existing RCRA cap.

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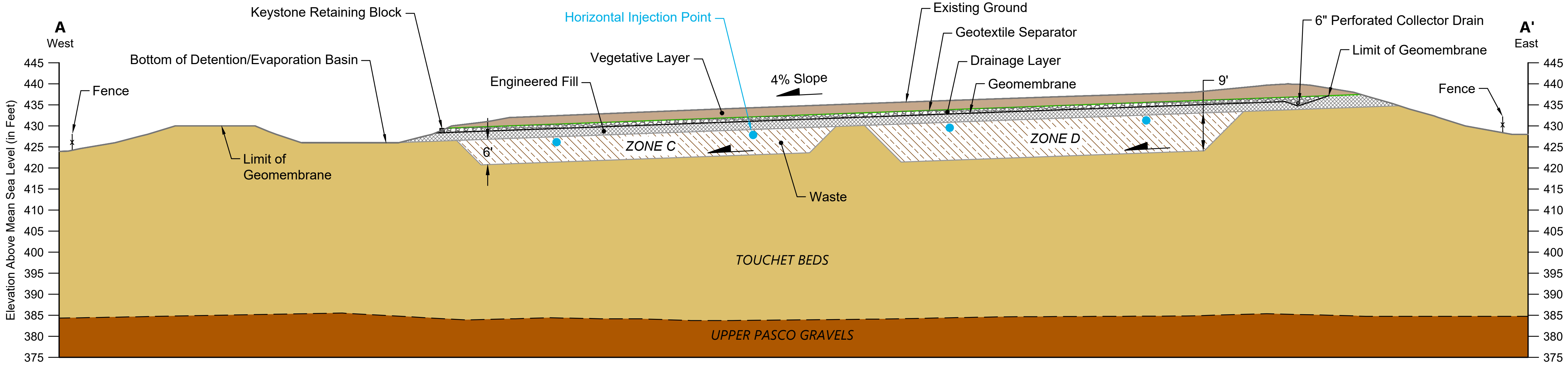
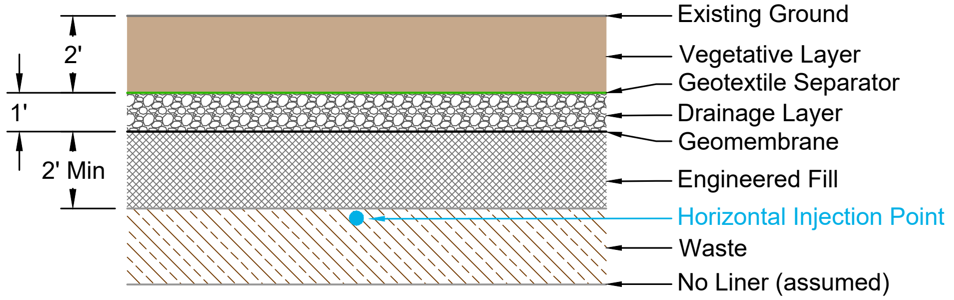
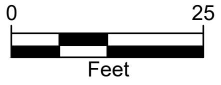
Figure 5.6.2-1
Zones C/D Plan View - Alternative CD-2
Pasco Sanitary Landfill NPL Site
Pasco, WA





1/1 RCRA Cap Cover System
SCALE: 1" = 5'



NOTES:

1. RCRA cap cover system, geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2003).
2. Horizontal injection point assumed to be immediately below the existing RCRA cap.

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Aug 21, 2017 10:05am hmerrick

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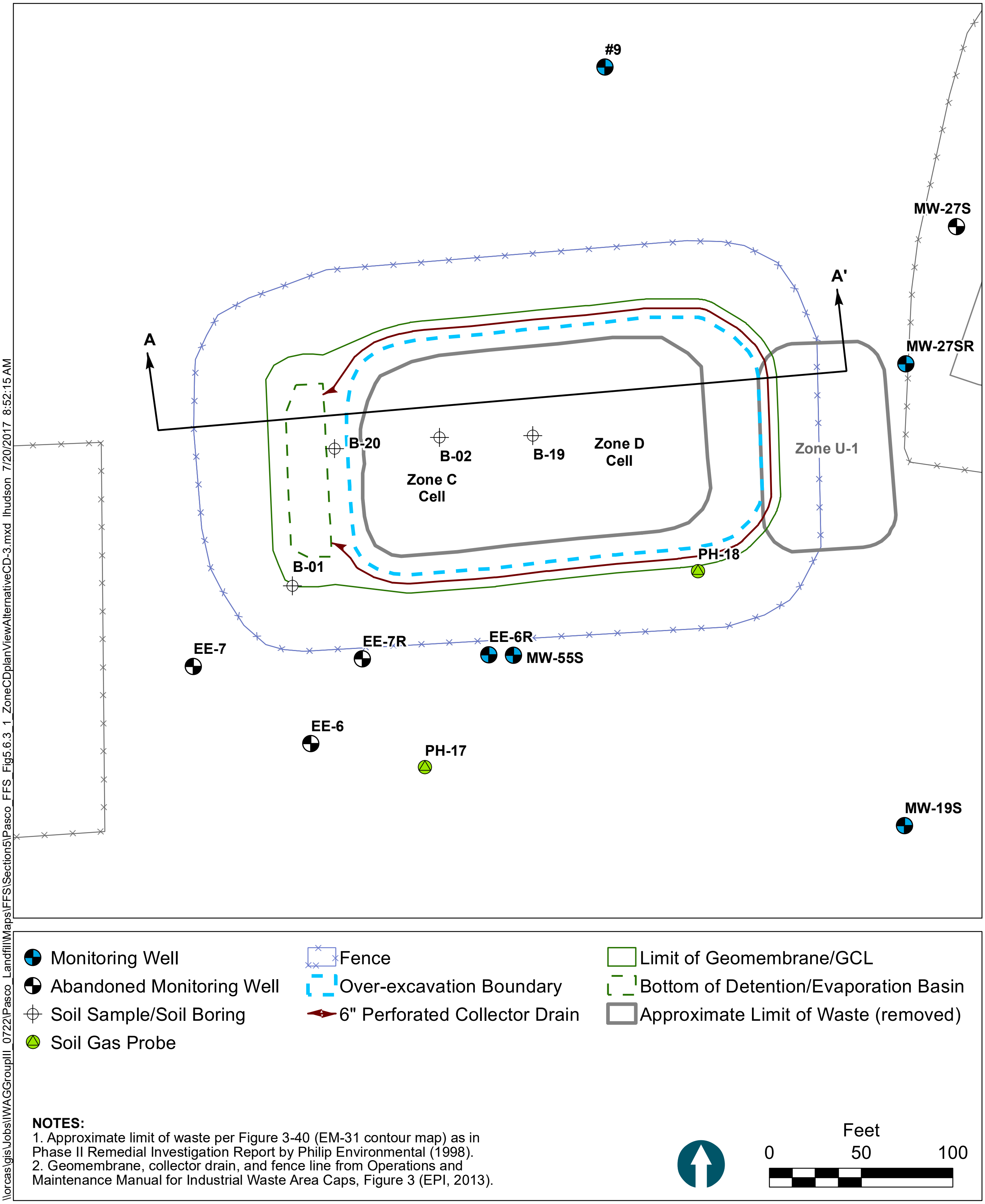
Figure 5.6.2-2

Zones C/D Cross Section A-A' – Alternative CD-2
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:
1. Approximate limit of waste per Figure 3-40 (EM-31 contour map) as in Phase II Remedial Investigation Report by Philip Environmental (1998).
2. Geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).

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Figure 5.6.3-1
Zones C/D Plan View - Alternative CD-3
Pasco Sanitary Landfill NPL Site
Pasco, WA

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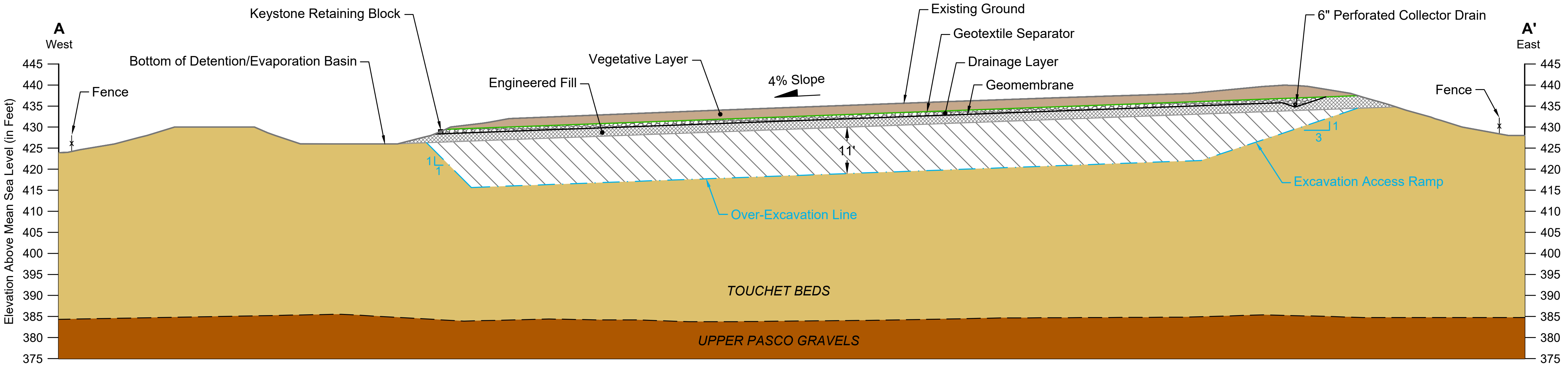

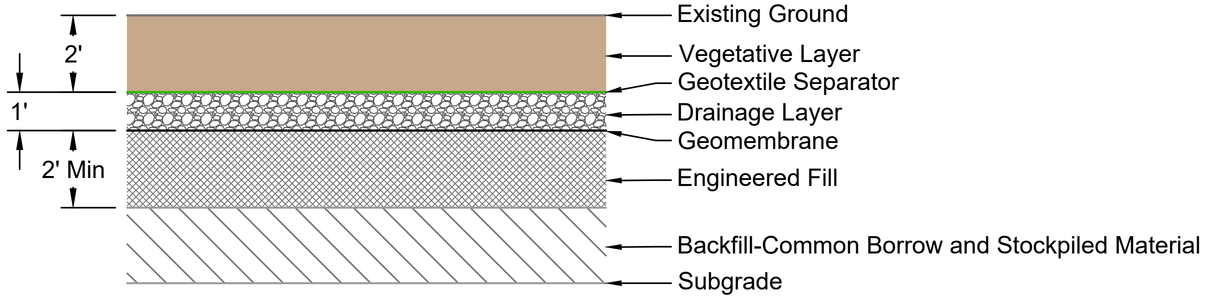

1/2 RCRA Cap Cover System
SCALE: 1" = 5'

0 25
Scale in Feet

NOTES:
1. RCRA cap cover system from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).
2. Over-excavation based on Figure 5.6.3-1 Plan View - Alternative CD-3.

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Aug 21, 2017 10:12am hmerrick

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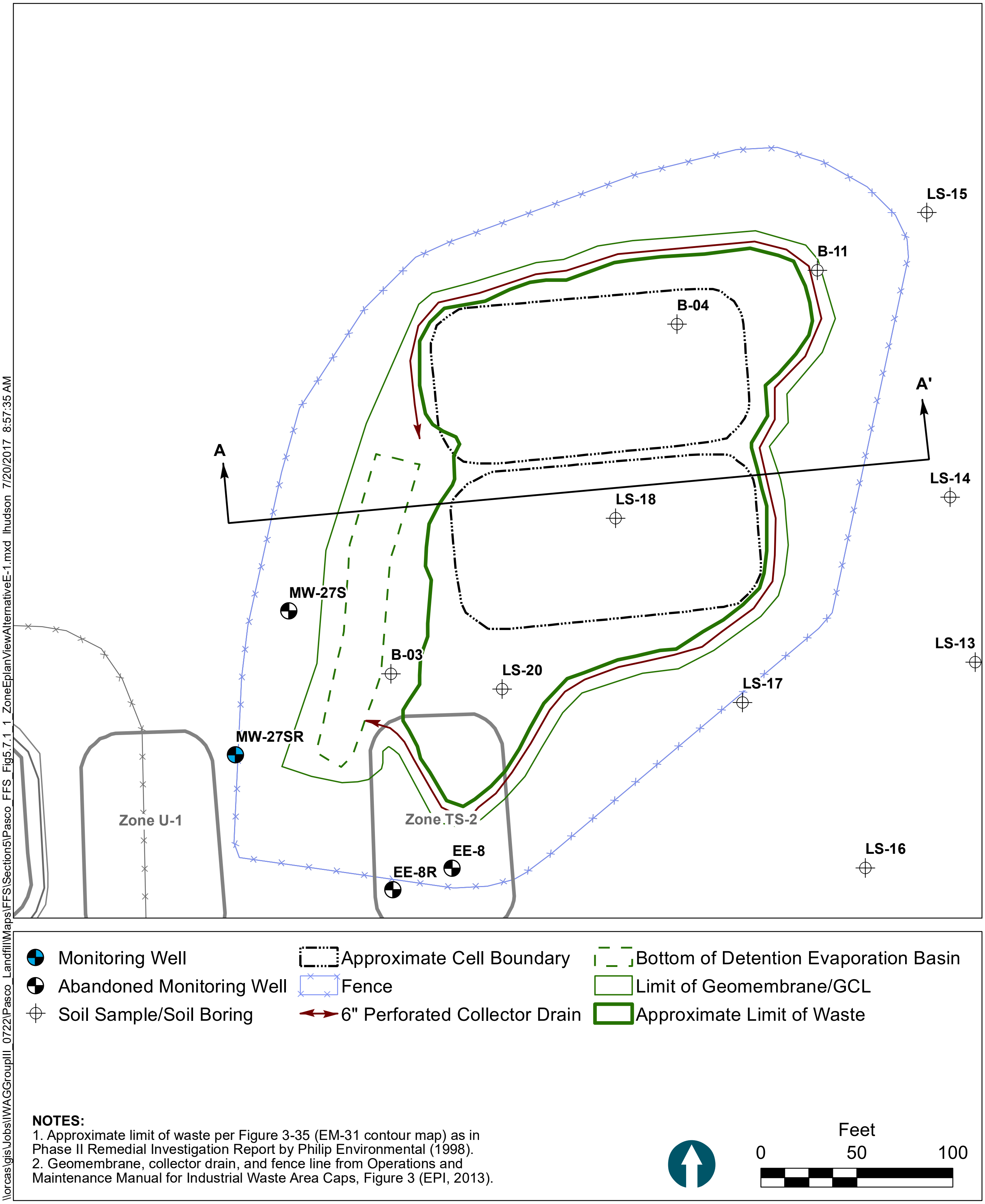
Figure 5.6.3-2
Zones C/D Cross Section A-A' - Alternative CD-3
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:

1. Approximate limit of waste per Figure 3-35 (EM-31 contour map) as in Phase II Remedial Investigation Report by Philip Environmental (1998).
2. Geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).

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Figure 5.7.1-1
Zone E Plan View - Alternative E-1
Pasco Sanitary Landfill NPL Site
Pasco, WA

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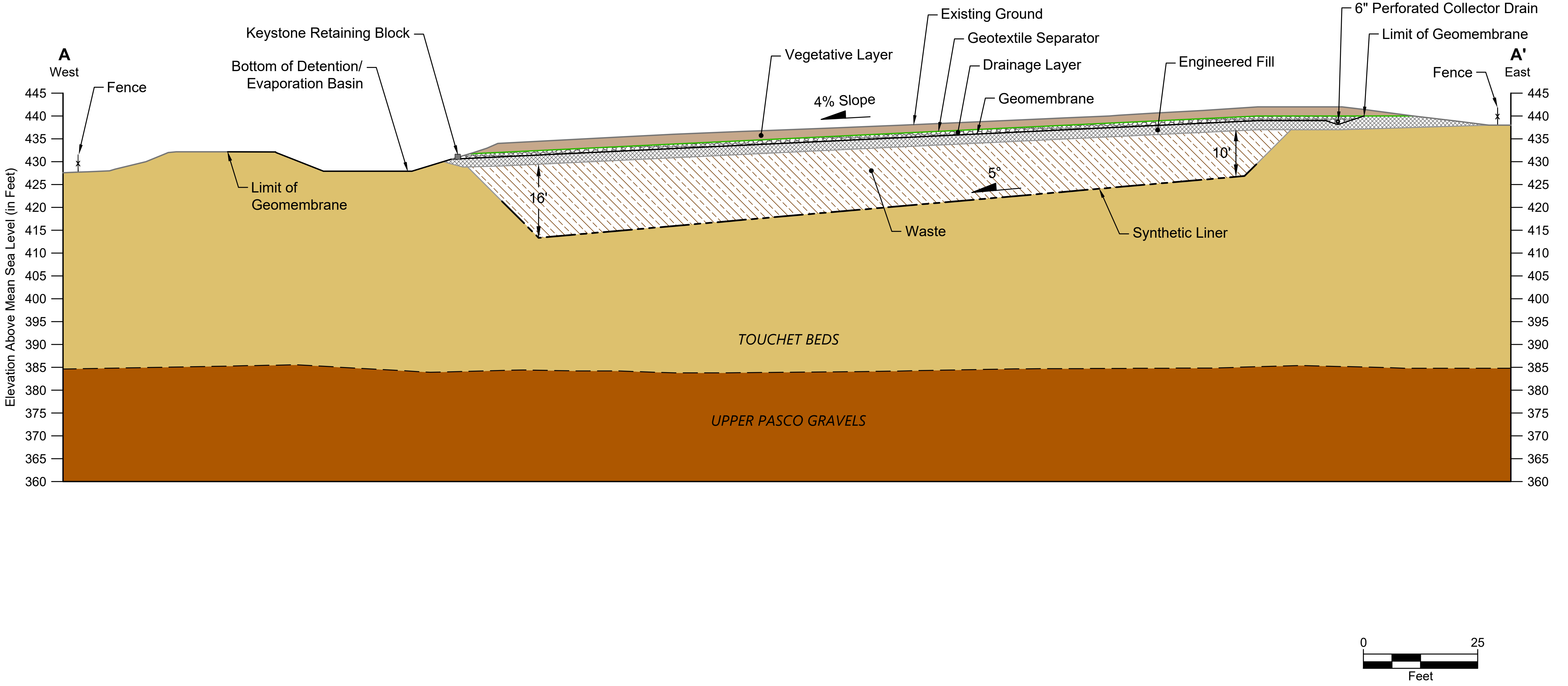

NOTE: RCRA cap cover system, geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2003).

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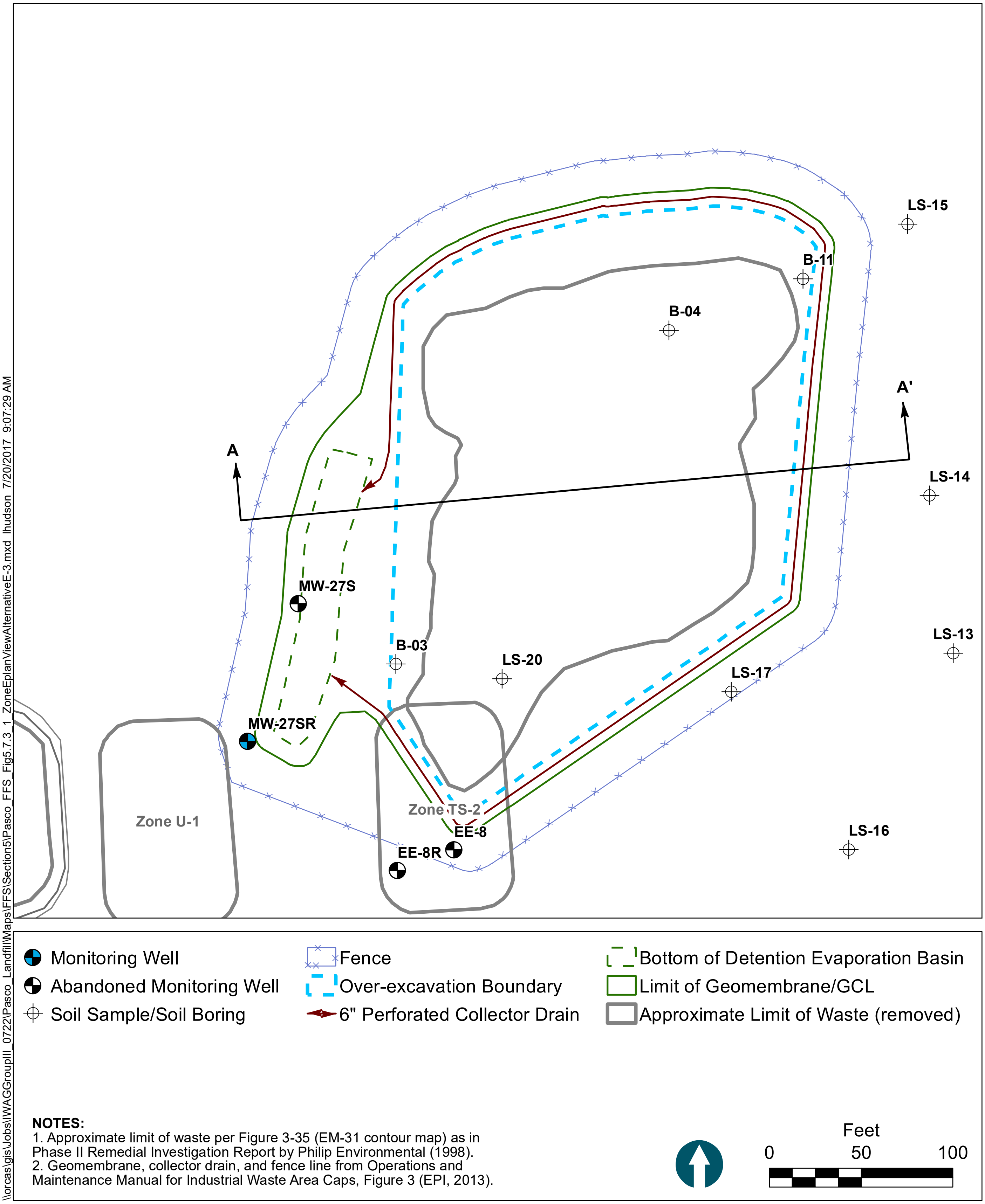
Figure 5.7.1-2
Zone E Cross Section A-A' – Alternative E-1
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:
1. Approximate limit of waste per Figure 3-35 (EM-31 contour map) as in Phase II Remedial Investigation Report by Philip Environmental (1998).
2. Geomembrane, collector drain, and fence line from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).

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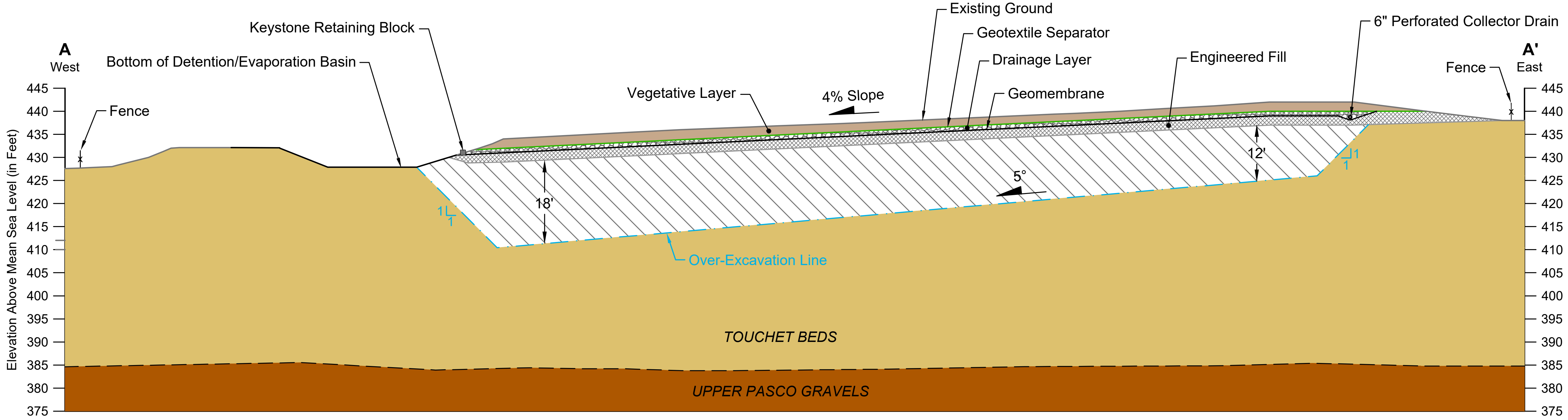
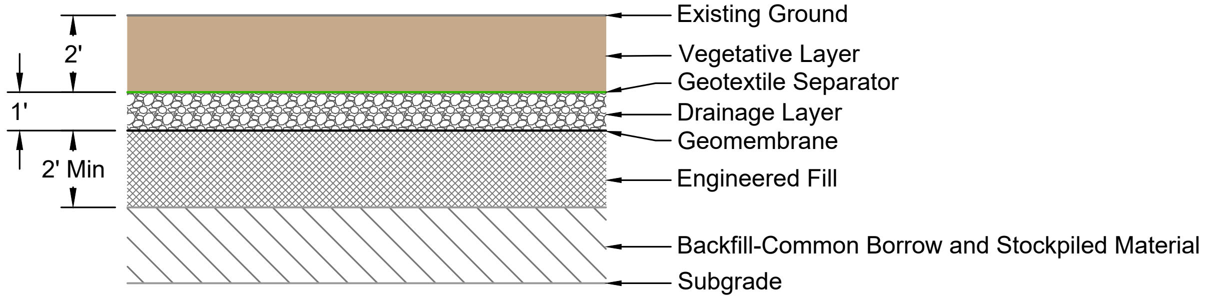
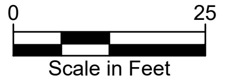
Figure 5.7.3-1
Zone E Plan View - Alternative E-3
Pasco Sanitary Landfill NPL Site
Pasco, WA





1/2 RCRA Cap Cover System
SCALE: 1" = 5'



NOTES:
1. RCRA cap cover system from Operations and Maintenance Manual for Industrial Waste Area Caps, Figure 3 (EPI, 2013).
2. Over-excavation based on Figure 5.7.3-1 Plan View - Alternative E-3.
3. Excavation access ramp with 3:1 slope on north end of excavation.

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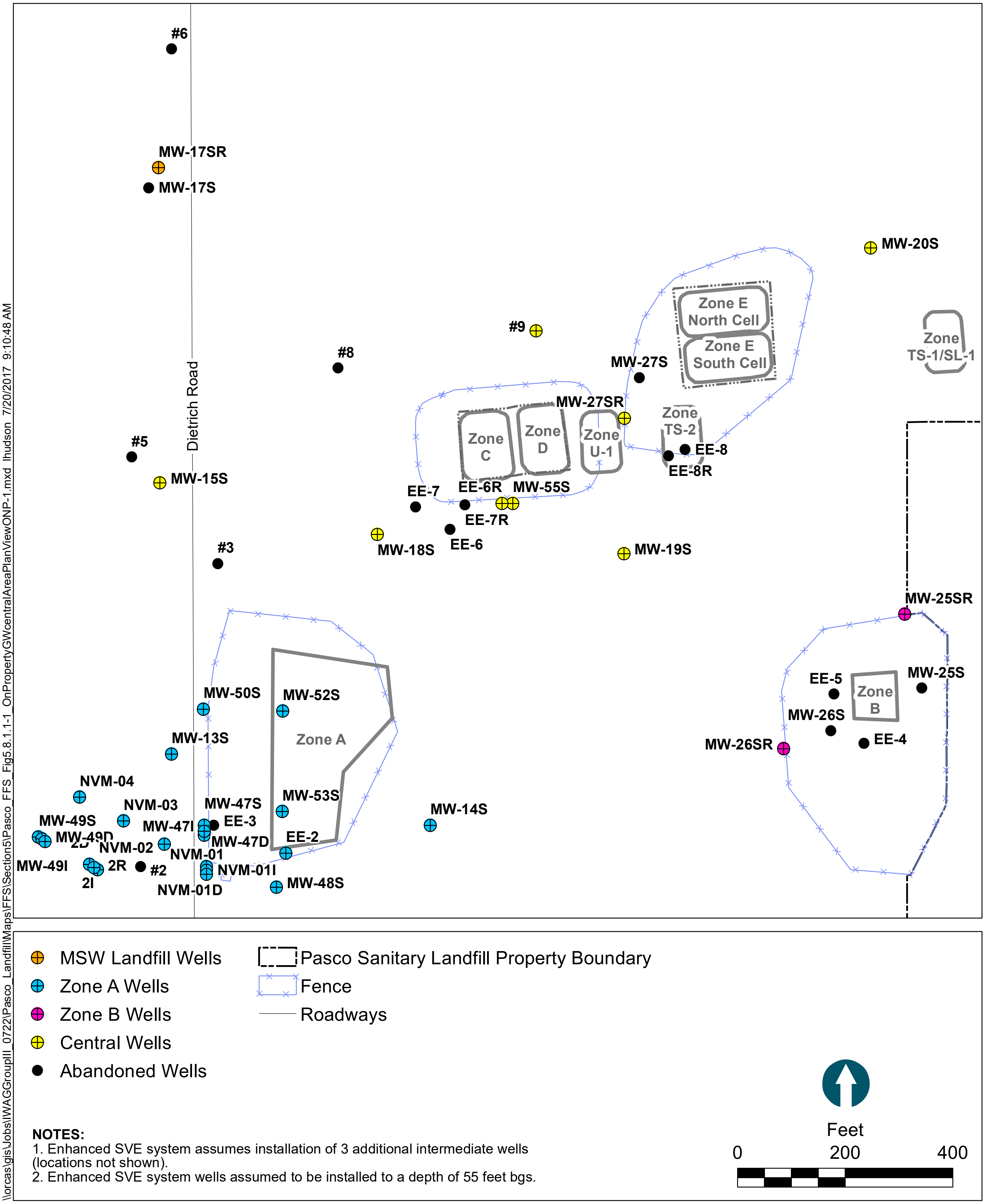
Figure 5.7.3-2
Zone E Cross Section A-A' - Alternative E-3
Pasco Sanitary Landfill NPL Site
Pasco, WA



NOTES:
1. Enhanced SVE system assumes installation of 3 additional intermediate wells (locations not shown).
2. Enhanced SVE system wells assumed to be installed to a depth of 55 feet bgs.

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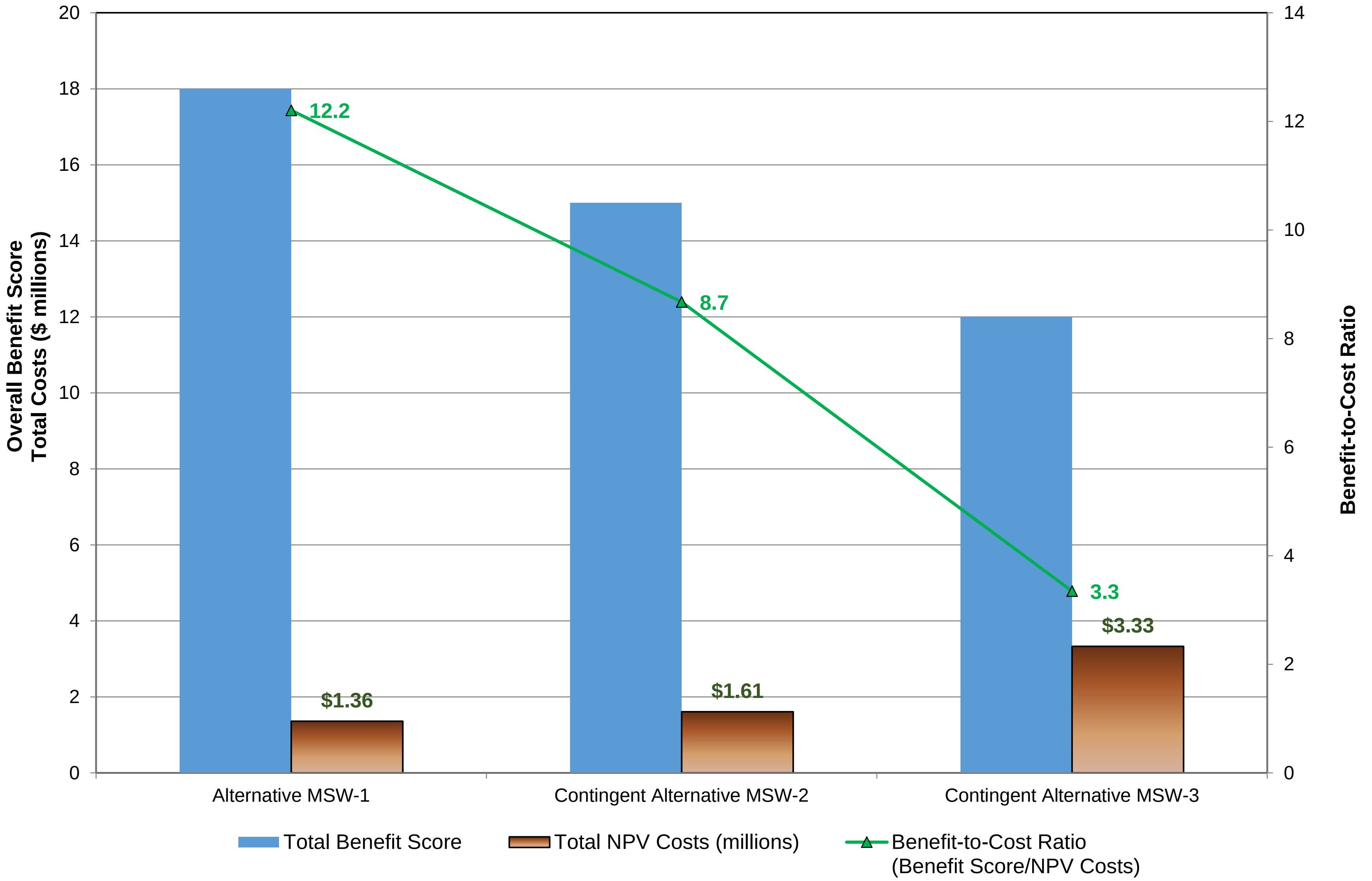
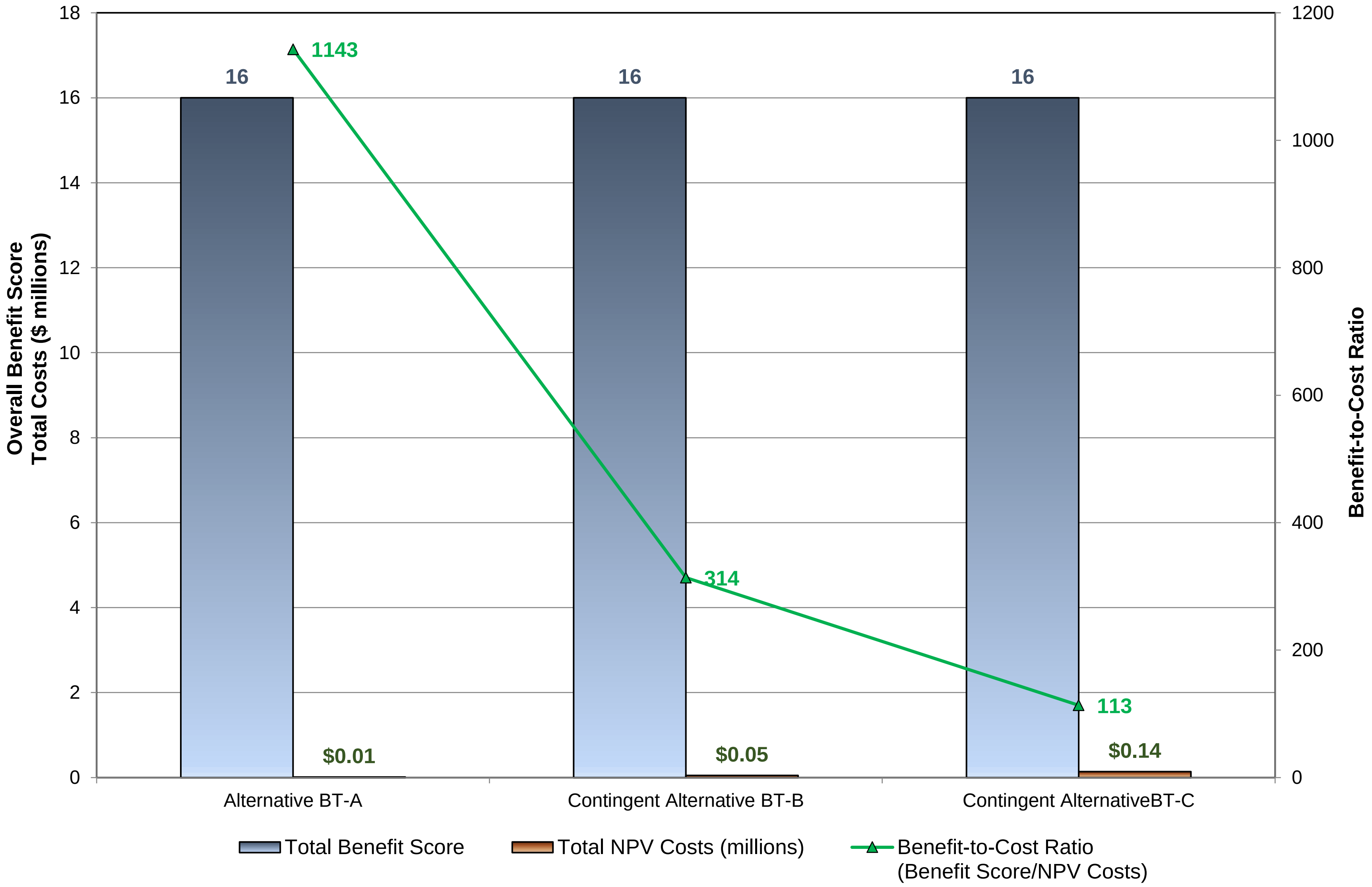
Figure 5.8.1.1-1
On-property Groundwater (Central Area) Plan View – Alternative ONP-1
Pasco Sanitary Landfill NPL Site
Pasco, WA



Aspect Consulting
8/1/2017

Figure 6.3.1-1
MSW Landfill Disproportionate Cost Analysis

Focused Feasibility Study
Pasco Landfill, Pasco, WA



Aspect Consulting
8/1/2017

Figure 6.3.2-1
Burn Trenches Disproportionate Cost Analysis

Focused Feasibility Study
Pasco Landfill, Pasco, WA

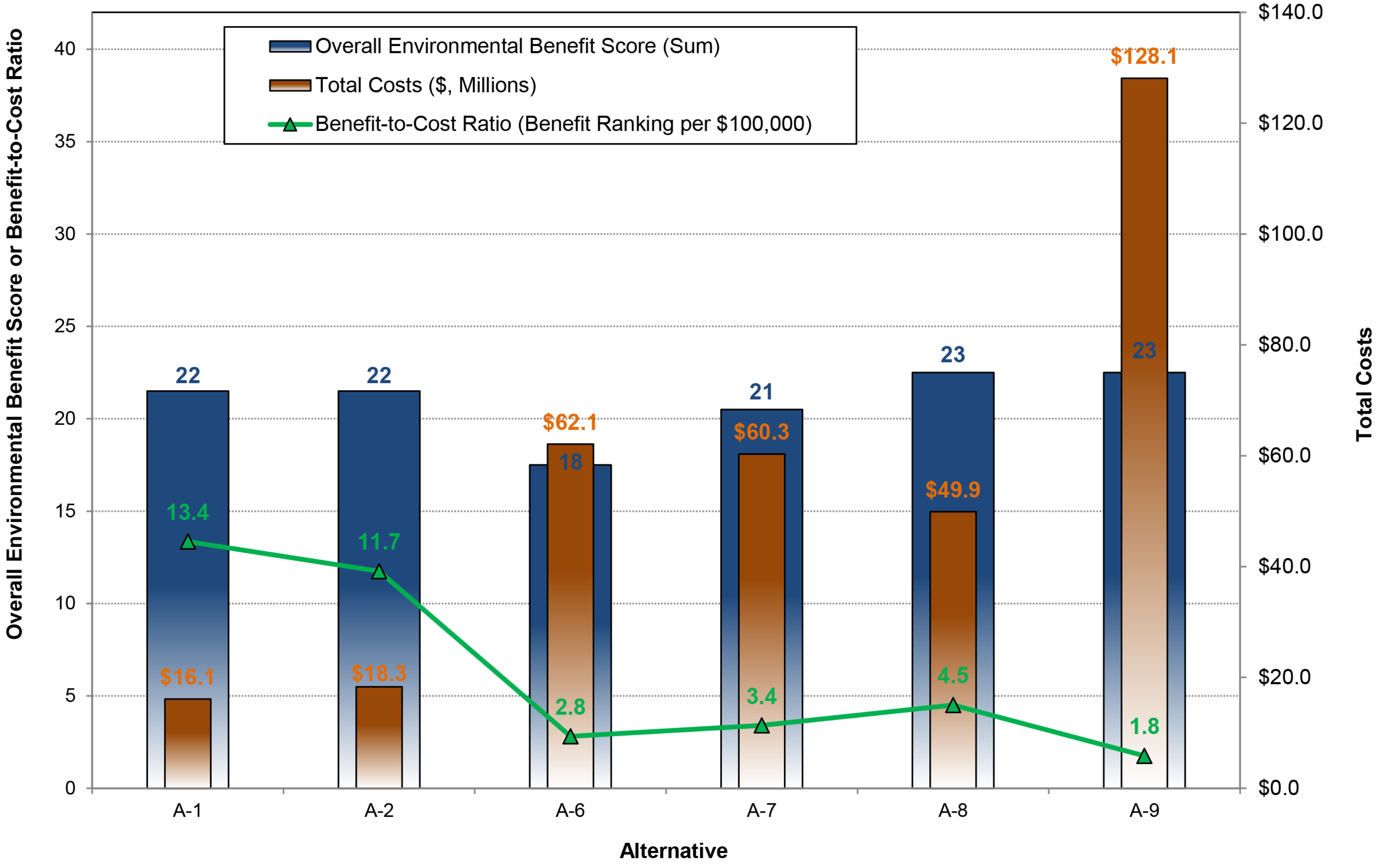


Figure 6.3.3-1

Zones A Relationship Between Benefits and Costs
Pasco Sanitary Landfill NPL Site
Pasco, WA

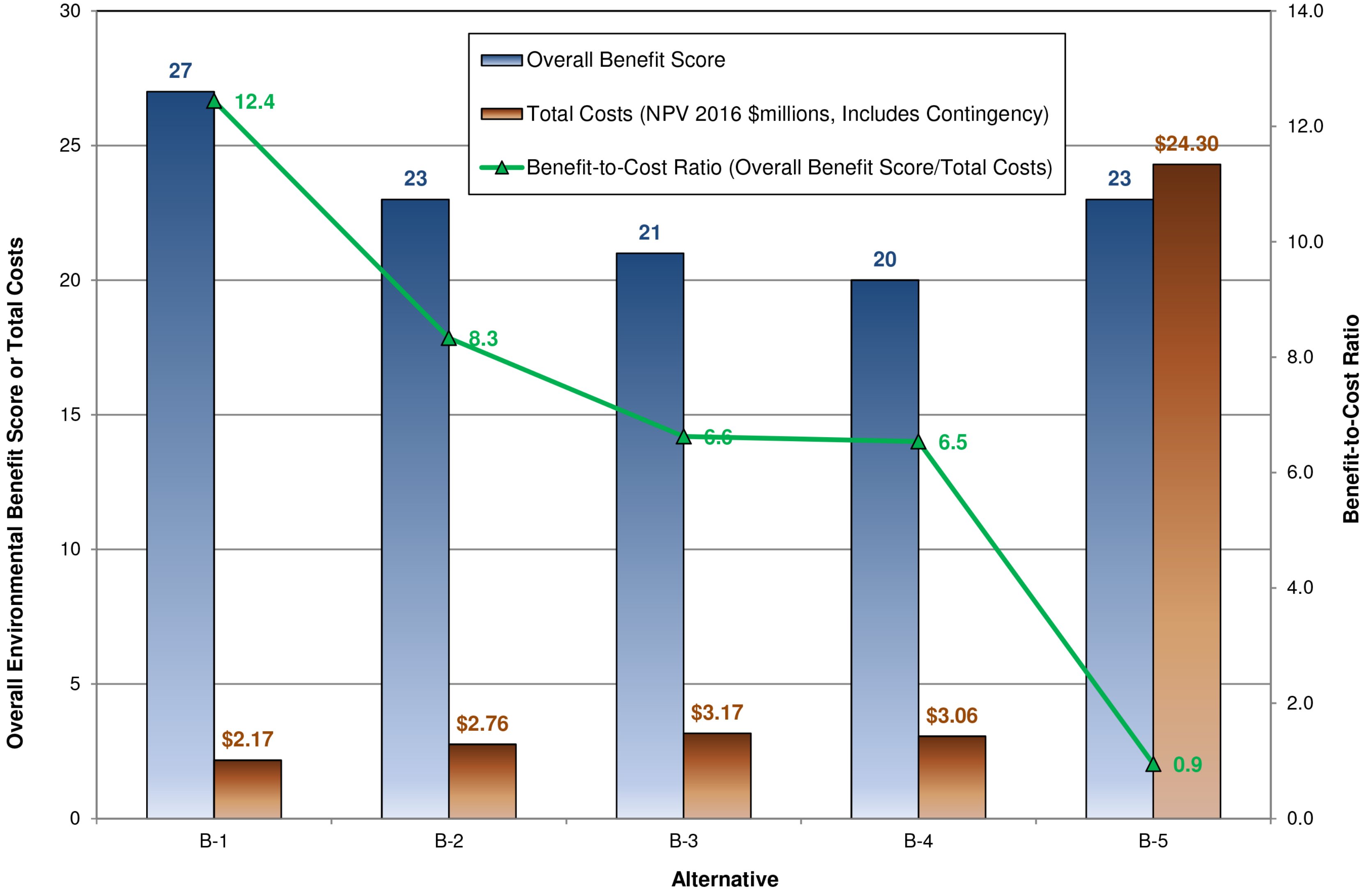


Figure 6.3.4-1
Zones B Disproportionate Cost Analysis
Pasco Sanitary Landfill NPL Site
Pasco, WA

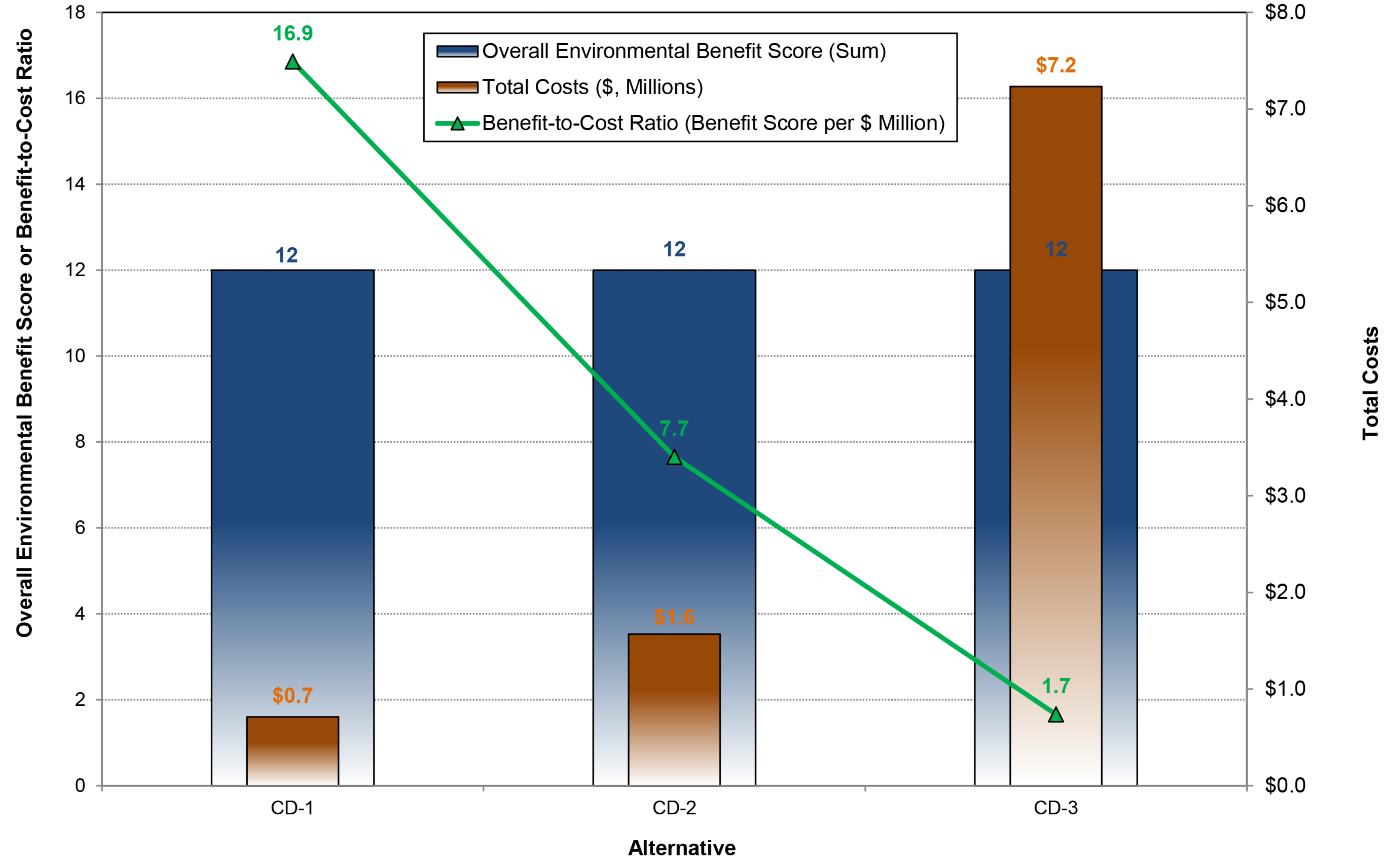


Figure 6.3.5-1
Zones C/D Relationship Between Benefits and Costs
Pasco Sanitary Landfill NPL Site
Pasco, WA

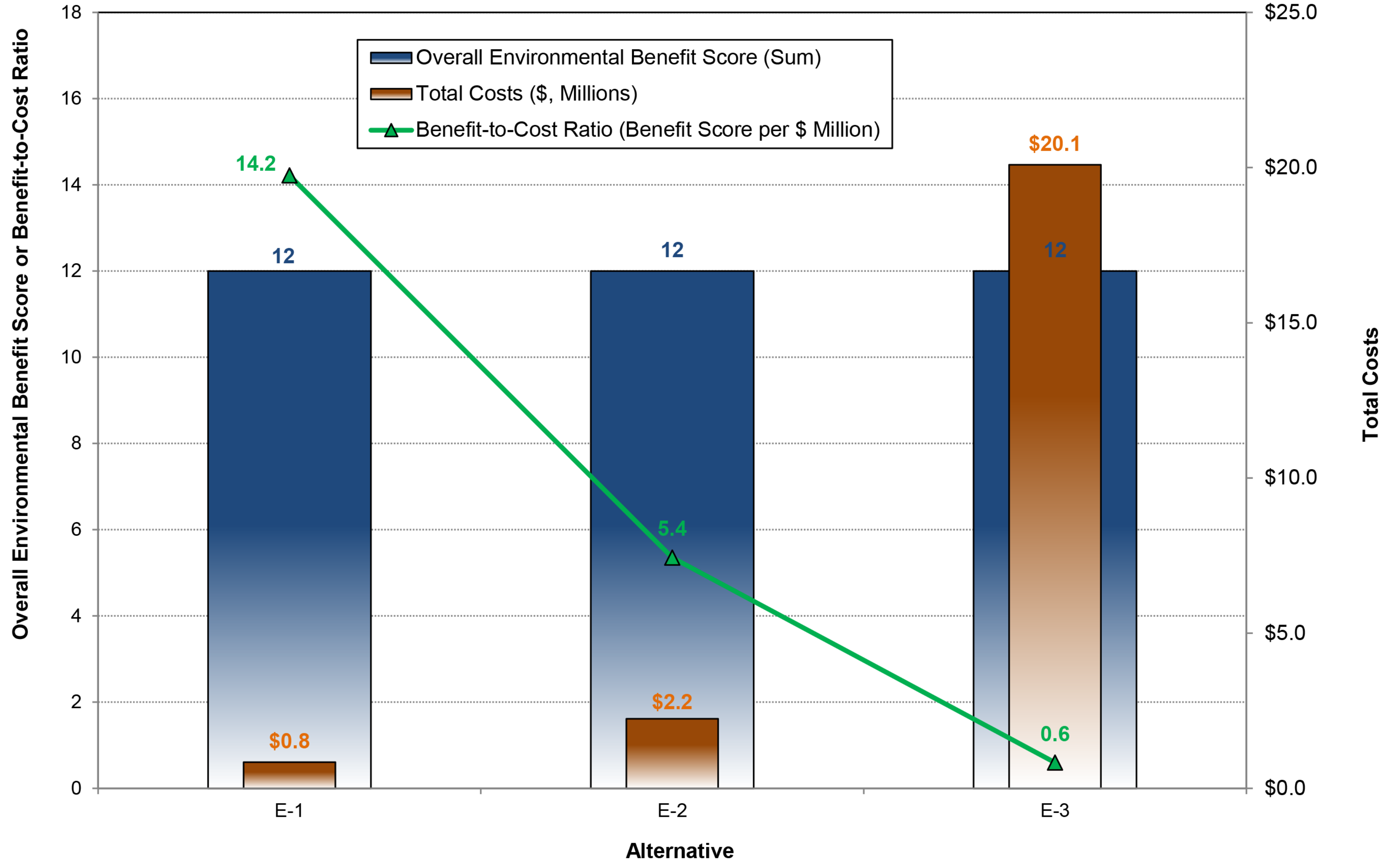


Figure 6.3.6-1
Zone E Relationship Between Benefits and Costs
Pasco Sanitary Landfill NPL Site
Pasco, WA