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December 11, 2020
DAT-2020-045

Li Ma
Department of Ecology
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Subject: Submittal of Draft Supplemental Feasibility Study Report
Boeing Auburn Facility
Agreed Order No. 01HWTRNR-3345

Dear Mr. Ma:

Pursuant to Agreed Order (No. 01HWTRNR-3345), The Boeing Company (Boeing) herein submits the draft Supplemental Feasibility Study (SFS) report for the Boeing Auburn Fabrication Division Plant (Boeing Auburn Plant). This report was prepared in response to The Washington State Department of Ecology (Ecology) request for an SFS via an email sent on July 20, 2020. The SFS document was requested by Ecology to address its formal and informal comments on the draft FS report submitted to Ecology on October 30, 2019.

Since the submittal of the draft FS, Boeing has completed the following activities based on comments from Ecology:

- SFS field investigation activities for:
    - AOC A-13 (Building 17-06 [east side] Petroleum Hydrocarbon Contamination); and
    - AOC A-14 (Site-wide trichloroethene [TCE] and vinyl chloride [VC] Groundwater Contamination and TCE in limited soil areas at the Facility).

  Results of these investigation activities confirmed existing results provided in the draft FS report.
- Revisions to the numerical groundwater flow model and contaminant transport model.
- Updates to the Site-wide restoration time frame analysis for AOC A-14.
- Additional evaluation of alternatives for AOC A-14, including:
    - Evaluation of a combination dynamic groundwater recirculation and enhanced in situ bioremediation treatment option in focus areas. This alternative was shown to be infeasible; and therefore, was not included as an alternative in the SFS.
    - Evaluation of EISB in three focus areas as individual alternatives:
        - Algona Focus Area
        - Algona and 17-07 Property Boundary Focus Areas
        - Algona, 17-07 Property Boundary, and The Outlet Collection Focus Areas.

      These alternatives, along with the MNA alternative, were evaluated with the revised contaminant transport model and revised Site-wide restoration time frame. These alternatives were also evaluated specifically for the effect on the restoration time frames for northern Algona residential area as requested by Ecology.

A summary of the activities completed since submittal of the draft FS are presented as part of the SFS. The SFS is intended to be evaluated along with the assumptions and alternative analysis for other Site AOCs documented in the draft FS report. The following items are specifically included in the SFS:

- Presentation of the results of the SFS field investigation activities.
- A summary of revisions to the numerical groundwater flow model and contaminant transport model, and updates to the Site-wide restoration time frame analysis for AOC A-14.
- Presentation and evaluation of additional Ecology-requested remedial alternatives for AOC A-14 and recommendation of a selected alternative based on the disproportionate cost analysis.

The SFS evaluation of remedial alternatives for AOC A-14 was completed in accordance with the Model Toxics Control Act (MTCA) regulation (Chapter 173-340 of the Washington Administrative Code [WAC]) and Resource Conservation and Recovery Act (RCRA) regulations for Corrective Action (WAC 173-303-64610 through 173-303-64630). Boeing's submittal of the SFS pursuant to the AO does not waive any of Boeing's rights under the AO, MTCA, RCA 70.105D, or any other authority to disagree with, dispute, or challenge any Ecology decisions for the Boeing Auburn Facility or the agency's alleged underlying authority for such decisions. Boeing's submittal of the SFS is further not a waiver of, or change to, its previously articulated positions regarding those issues that Boeing and Ecology have been unable to agree on (such as appropriate groundwater cleanup levels and delineation of stormwater features and appropriate cleanup levels for these features).

Thank you for the opportunity to provide this SFS and the collaboration between Boeing and Ecology leading up to its preparation. We look forward to discussing the SFS with you and moving closer to implementation of the selected remedies at the Boeing Auburn Site.

Please contact me if you have any questions.

Sincerely,

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Draft Supplemental Feasibility Study Report
Boeing Auburn Facility
Auburn, Washington

December 11, 2020

Prepared for

The Boeing Company

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Draft Supplemental Feasibility Study
Boeing Auburn Facility
Auburn, Washington

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LIST OF ABBREVIATIONS AND ACRONYMS

µg/L	micrograms per liter
Agreed Order	Agreed Order No. 01HWTRNR-3345
AOC	area of concern
ARAR	applicable or relevant and appropriate requirement
ARI	Analytical Resources, Inc.
bgs	below ground surface
Boeing	The Boeing Company
Boeing Auburn Plant	Auburn Fabrication Division Plant
cDCE	cis-1,2-dichloroethene
CFR	Code of Federal Regulations
CMS	conceptual site model
CMT	continuous multi-channel tubing
COC	constituent of concern
CPOC	conditional point of compliance
CSM	conceptual site model
CVOC	chlorinated volatile organic compound
DCA	disproportionate cost analysis
DNAPL	dense non-aqueous phase liquid
DRO	diesel-range organics
Ecology	Washington State Department of Ecology
EDR	Engineering Design Report
EIM	Ecology Environmental Information Management (database)
EISB	enhanced *in situ* bioremediation
EPA	US Environmental Protection Agency
FS	feasibility study
FSWP	Feasibility Study Work Plan
ft	feet, foot
IHS	indicator hazardous substance
IRA	interim remedial action
LAI	Landau Associates, Inc.
LNAPL	light non-aqueous phase liquid
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MTCA	Model Toxics Control Act
NAPL	non-aqueous phase liquid
NTR	National Toxics Rule
NWTPH-Dx	northwest total petroleum hydrocarbon diesel-range extended
OMB	Office of Management and Budget

ORO	oil-range organics
pCUL	proposed cleanup level
PID	photoionization detector
POC	point of compliance
RCRA	Resource Conservation and Recovery Act
REL	remediation level
RI	remedial investigation
SFS	supplemental feasibility study
SIM	select ion monitoring
SWMU	solid waste management unit
SWQS	surface water quality standards
TCE	trichloroethene
TPH	total petroleum hydrocarbon
UIC	underground injection control
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
WAC	Washington Administrative Code
WDOH	Washington State Department of Health

1.0 INTRODUCTION

This document, prepared by Landau Associates, Inc. (LAI), presents the results of a supplemental feasibility study (SFS) conducted for cleanup of environmental releases associated with The Boeing Company's (Boeing's) Auburn Fabrication Division Plant (Boeing Auburn Plant) and associated properties (Boeing Auburn Facility). The Boeing Auburn Plant is located at 700 15th Street Southwest, Auburn, Washington (State Dangerous Waste Identification [ID] No. WAD041337130). The location and current extent of property that Boeing owns as part of the Boeing Auburn Plant is shown on Figure 1-1. The Boeing Auburn Site is currently undergoing Resource Conservation and Recovery Act (RCRA) corrective action as required by Agreed Order No. 01HWTRNR-3345 (Agreed Order).[1]

MTCA defines a "Facility" or "Site" as:

> "any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, landfill, storage container, motor vehicle, rolling stock, vessel, or aircraft; or any site or area where a hazardous substance, other than a consumer product in consumer use, has been deposited, stored, disposed of, or placed, or otherwise come to be located (WAC 173-340-200)."

However, in order to clarify discussion in this document, the following terms and definitions are used to describe and provide a distinction between the property currently owned by Boeing, property that is currently part of the RCRA Facility permit, and property that is part of the "Site" as a result of contaminant migration:

- The **Boeing Auburn Plant** or **Boeing Property** includes property currently owned and operated by Boeing that is used for manufacturing and other auxiliary purposes. Specifically, this does not include properties formerly owned by Boeing including Prologis (formerly AMB), Safeway distribution center, YMCA, JA, and PSE properties.
- The **Boeing Auburn Facility (Facility)** includes properties owned by parties to the Agreed Order. This includes property currently owned by Boeing and property owned by Prologis (Figure 1-2).
- The **Boeing Auburn Site (Site**) includes the Facility and all contiguous property affected by releases of hazardous substances that are confirmed or suspected to have originated at the Facility. The approximate extent of the current Site is shown on Figure 1-3. The Site boundary may change over time as additional data is gathered and/or areas are remediated.

The SFS was requested by the Washington State Department of Ecology (Ecology) in July 2020 (Ecology 2020d) pursuant to the Agreed Order. A draft feasibility study (FS) report was submitted in October 2019 [LAI 2019a]). The draft FS developed and evaluated remedial action alternatives and recommended remedial action alternatives to address releases from the Facility. Boeing conducted investigations to characterize releases from the Facility that have affected soil, groundwater, and

[1] The agreed order was originally dated May 15, 2020 (Ecology 2002), and first amended on April 7, 2006 (Ecology 2006), and second amended on November 1, 2018 (Ecology 2018).

downgradient stormwater features as documented in the Remedial Investigation (RI) report (LAI 2017d). The RI report documented investigation activities at solid waste management units (SWMUs) and areas of concern (AOCs) at the Facility and in downgradient areas of the Site. Data collected as part of the RI was sufficient to determine the nature and extent of contamination and provide recommendations for SWMUs and AOCs to be carried forward to the FS for evaluation of remedial alternatives. No individual SWMUs were carried forward to the FS;[2] however, five AOCs were carried forward to the FS:

- AOC A-01: Underground Storage Tanks (USTs) TAU-01 and TAU-02 northwest of Building 17-06;
- AOC A-09: Building 17-07 Acid Scrubber Drain Line Leak;
- AOC A-13: Building 17-06 (east side) Petroleum Hydrocarbon Contamination;
- AOC A-14: Site-wide trichloroethene (TCE) and vinyl chloride (VC) Groundwater Contamination, and TCE in limited soil areas at the Facility; and
- AOC A-15: Site-wide TCE and VC contamination in surface water and stormwater collection, treatment, and conveyance features.

Additional descriptions of these AOCs are provided in the draft FS report. The draft FS report described FS field investigation activities and evaluation of alternatives for each AOC developed as part of the Ecology-approved FS work plan (FSWP; LAI 2018b). Ecology requested an SFS to address a series of formal and informal comments on the draft FS (Ecology 2020a). This SFS specifically addresses Ecology comments provided on AOC A-13 and AOC A-14. The other AOCs remain unchanged; the reader should refer to the draft FS for the outcomes of the FS evaluation for those AOCs. The draft FS and this SFS were performed in accordance with the Model Toxics Control Act (MTCA) regulation (Chapter 173-340 of the Washington Administrative Code [WAC]) and RCRA regulations for Corrective Action (WAC 173-303-64610 through 173-303-64630).

1.1 Objectives

The objectives of this SFS are to address formal and informal Ecology-provided comments on the draft FS report. Ecology comments included discussions during project team meetings, along with a series of emails (Ecology 2019b, c, d, e, 2020a, b, c, d, e, f). The following items are included in the SFS:

- Presentation of the results of the SFS field investigation activities for AOC A-13 and AOC A-14 as requested by Ecology after submittal of the draft FS report.
- A summary of revisions to the draft FS report based on Ecology comments; these revisions include updates to the previous Ecology-reviewed numerical groundwater flow model and contaminant transport model, and updates to the Site-wide restoration time frame analysis for AOC A-14.
- Presentation and evaluation of additional Ecology-requested remedial alternatives for AOC A-14 and recommendation of a selected alternative based on the disproportionate cost analysis.

[2] Investigation of SWMU S-15a/16 is carried forward as part of AOC A-13.

The SFS alternatives for AOC A-14 were also evaluated specifically for the effect on the restoration time frames for the northern Algona residential area as requested by Ecology.

1.2 Background

A description of the Site background, previous Site investigation, previous interim actions, the nature and extent of contamination, and a conceptual site model (CSM) are provided in the FS report. A short summary of background information is provided in this report for context.

The Site lies within the Auburn Valley. The uppermost aquifer in the Auburn Valley consists of saturated portions of alluvial deposits from the White and Green Rivers and is made up of highly variable, but predominantly coarse, alluvial sands and gravels with occasional interbedded silt layers. The Osceola Mudflow serves as a regional aquitard between the uppermost aquifer and deeper aquifers. In general, groundwater flows from the south (White River) to the north (Green River). Locally, at the Site, groundwater flow has a pronounced westerly component driven by groundwater discharge zones associated with stormwater features, wetlands, and Mill Creek to the northwest of the Boeing property. For the purposes of investigation and discussion, groundwater within the upper aquifer is divided into three hydraulically interconnected zones, based on depth below ground surface (bgs; Geomatrix 2003):

- A shallow zone, from the water table[3] to 35 feet (ft) bgs
- An intermediate zone, from 35 to 75 ft bgs
- A deep zone, from 75 ft bgs to the contact with the Osceola Mudflow (typically between 80 and 100 ft bgs).

Former releases from the Facility have resulted in two primary areas of impacted groundwater that extend more than 1 mile northwest of the Facility. The groundwater plumes at the Site are identified as the “Area 1 Plume” (originating from the northern portion of the Facility, former Area 1; originating from former Building 17-03 and former Building 17-05) and the “Western Plume” (originating from the west side of the Facility in or near Building 17-07). The plumes are comprised of the chlorinated volatile organic compounds (CVOCs) TCE and its breakdown products cis-1,2-dichloroethene (cDCE) and VC. TCE and VC are the indicator hazardous substances (IHSs)[4] in Site-wide groundwater because of their prevalence and relative toxicity; while cDCE is also present in Site groundwater, the concentrations do not exceed cDCE proposed cleanup levels (pCULs; see section 1.3.1). Some localized areas of TCE soil contamination are also present at the identified groundwater contamination release areas at the Facility. A-14 comprises the two groundwater plumes and the associated release areas, as well as low-level groundwater contamination upgradient or crossgradient of the release areas. It is also important to understand that portions of the upgradient and cross-gradient contamination, as

[3] The depth to the water table is variable across the Site, from less than 5 feet (ft) bgs to more than 20 ft bgs.

[4] Per WAC 173-340-200, indicator hazardous substances (IHSs) are defined as “the subset of hazardous substances present at a site selected under WAC 173-340-708 for monitoring and analysis during any phase of remedial action for the purpose of characterizing the site or establishing cleanup requirements for that site.”

well as downgradient areas along the eastern and northern edge of the Area 1 Plume, appear to be caused by other sources not associated with the Boeing Auburn Facility (LAI 2014, 2017d). The approximate extent of the two groundwater plumes along with the wells that are part of the current monitoring well network is shown on Figure 1-4. In addition to groundwater, the plumes effect the water quality of a few stormwater drainage and collection features northwest of the Facility (i.e., the Chicago Avenue ditch and the Auburn 400 stormwater basins). The stormwater and surface water features at the Site are shown on Figure 1-5.

1.2.1 Extent of Groundwater Contamination

The age/history of the original releases and the aquifer dynamics at the Site have resulted in large, mature, low concentration CVOC groundwater plumes. The current horizontal extent of the Area 1 Plume and Western Plume is due to dissolution of TCE at the release areas and advective migration of dissolved TCE and degradation products (cDCE and VC) downgradient with the bulk flow of groundwater. The resulting spatial distribution of the plumes is affected by aquifer heterogeneity, and contaminant transport processes such as sorption, dispersion, and contaminant degradation. Plume maps for the shallow, intermediate, and deep groundwater zones for TCE and VC are presented on Figures 1-6 through 1-11. Plume maps for the shallow, intermediate, and deep groundwater zones for total CVOCs (sum of all chlorinated VOCs: TCE, DCE,[5] and VC) are presented on Figures 1-12 through 1-14. Additionally, a geologic and total CVOC cross-section along the general centerline of the plume for both the Western and Area 1 Plumes (see alignment on Figure 1-15) are provided on Figure 1-16a and 1-16b, respectively.

CVOC concentrations in groundwater and where groundwater flows into stormwater features are below heath-based screening criteria for human health and the environment, so there are no unacceptable risks to potential human or ecological receptors at the Site. Site groundwater is not used for drinking water. There are no concentrations of CVOCs detected above Site-specific health risk-based criteria in stormwater features at the Site (the Chicago Avenue ditch or the Auburn 400 stormwater basins).[6] CVOCs in groundwater degrade to non-detect concentrations before reaching surface water features at the Site (Mill Creek).

CVOC concentration magnitude and distribution indicate late-stage plume dynamics (Kueper et al. 2014), as characterized by relatively low concentrations throughout the plumes, with the highest concentrations in the plumes located downgradient of the original release areas. This also indicates that the source material in the original release areas has been depleted. Additional discussion on the plume characteristics is provided in Section 1.2.2.

[5] Includes cDCE, tDCE, and 1,1-DCE.

[6] The Chicago Avenue ditch and the Auburn 400 basins are stormwater features and the concentrations of CVOCs detected in these stormwater features are well below risk levels protective of human health calculated by Washington Department of Health (WDOH; WDOH 2013, 2014). In addition, surface water cleanup levels are based on use as drinking water and human consumption of fish. Stormwater cannot be used as drinking water and no edible fish are present in stormwater features.

The highest TCE concentrations in the Western Plume are downgradient of the release area, north of Building 17-07, in the deep zone (AGW201-6; TCE concentration of 6.4 micrograms per liter [µg/L]), at the Facility boundary in the intermediate zone (AGW145; TCE concentration of 6.2 µg/L), and in commercial Algona (AGW167 and AGW169; TCE concentration of 5.1 and 5.0 µg/L, respectively). The highest concentrations of VC in the Western Plume are downgradient of the release area, west of Building 17-07, in the intermediate zone (AGW155; VC concentration of 4.8 µg/L), in commercial Algona in the intermediate zone (AGW251-3; VC concentration of 4.3 µg/L), and at the area of the Algona Enhanced Natural Attenuation Pilot Test in the shallow zone (AGW270; VC concentration of 4.1 µg/L). The highest concentration of TCE detected in the Area 1 Plume is downgradient of the former Building 17-03 release area and former Building 17-05 release areas in the shallow and intermediate zones (AGW125, TCE concentration of 5.5 µg/L; AGW126, TCE concentration of 6.7 µg/L). The next highest TCE concentrations in the Area 1 Plume are found downgradient near The Outlet Collection in the intermediate zone (AGW196) and deep zones (AGW195, AGW197 and AGW234). Concentrations in the distal end of the Area 1 Plume in all groundwater zones decrease to non-detect before groundwater enters Mill Creek downgradient (see Figure 1-16b). The highest VC concentrations in the Area 1 Plume are downgradient in the shallow zone (AGW232; VC concentration of 4.3 µg/L) and intermediate zone (AGW196; VC concentration of 2.5 µg/L).

1.2.2 Plume Characteristics

As indicated in Section 1.2.1, groundwater data indicate that the dense non-aqueous phase liquid (DNAPL) in the former release areas has been completely depleted (e.g., late-stage condition), but desorption and back diffusion are contributing to residual low concentrations throughout the impact portions of the aquifer (LAI 2017d; Kueper et al 2014). As the more permeable zones of the aquifer clean up (i.e., deplete the original DNAPL) through dissolution and flushing, the mass that has become adsorbed in the finer-grained, low-permeability portions of the aquifer, then slowly diffuses (as a result of an eventual concentration gradient reversal) back into the permeable portions creating a low concentration, but long-lived secondary “source” of downgradient contamination. This is a rate-limited desorption process commonly referred to as back diffusion or matrix back diffusion. Back diffusion is a process that will occur regardless of the remedial alternative selected and is a common source of contaminant rebound after groundwater treatment is performed.

The bulk of the remaining dissolved mass is located downgradient of the release areas. The highest CVOC concentrations are mid-plume, and the remaining dissolved mass in the release areas is present as the result of back diffusion processes from fine-grained soils interbedded with the coarse sands and gravels. CVOC degradation is a significant factor in attenuation of the plumes at the Site. The main degradation process occurring at the Site is microbially-mediated reductive dechlorination that occurs in anaerobic portions of the aquifer. Anaerobic aquifer conditions are present at the majority of the Site and reductive dechlorination is a well-documented process at the Site (LAD 2019, LAI 2019b). Conditions at the Site support that biological, chemical, and physical natural attenuation processes are occurring throughout the Site and indicate that monitored natural attenuation (MNA) is an appropriate Site remedy.

CVOC degradation is evident along horizontal flow paths extending from the release areas to the distal ends of the Western and Area 1 Plumes, as groundwater flows through areas with relatively elevated levels of organic carbon and associated anaerobic aquifer conditions. While degradation takes place to varying degrees throughout the heterogeneous aquifer, the most anaerobic aquifer conditions and the highest degradation rates take place in the shallow and intermediate zones. Groundwater moves upward as it approaches wetland areas at and near Mill Creek. Increased levels of CVOC degradation occur in the biologically active and organic carbon-rich zones in the shallow groundwater in these areas. Degradation significantly attenuates CVOC concentrations near wetland areas at and near Mill Creek resulting in non-toxic end-products in groundwater before entering surface water (as demonstrated by the absence of TCE in samples collected from the hyporheic zone beneath/adjacent to Mill Creek, and the absence of any CVOCs in samples collected in Mill Creek).

1.3 Proposed Cleanup Standards

Cleanup standards, comprised of pCULs and points of compliance (POCs) for each media of concern for the Site, were developed in the draft FS report with consideration of applicable state and federal laws and applicable, relevant, and appropriate requirements (ARARs). These cleanup standards, as summarized and modified below, are used in development and evaluation of cleanup alternatives that are presented in Sections 4.0 through 5.0 of this report. Final cleanup standards will be approved by Ecology through incorporation into the final cleanup action plan.

1.3.1 Proposed Cleanup Levels

As part of the draft FS, pCULs were developed for IHSs and other contaminants of concern (COCs) identified in soil, groundwater, and surface water. The pCULs for soil, groundwater, and surface water are presented in Tables 1-1 through 1-3. Minor modifications to the pCULs presented in the draft FS are described and included in this SFS.

Groundwater pCULs are based on protection of drinking water, developed in accordance with the MTCA regulation WAC 173-340-720. At Ecology's request, the surface water quality standards (SWQS) have also been evaluated for use as groundwater cleanup levels in addition to the drinking water standards. Boeing disagrees with Ecology's application of SWQS to groundwater. [7] While the regulations stipulate that groundwater cleanup levels must be protective of surface water beneficial uses, they do not require that groundwater cleanup levels be equal to SWQS throughout the Site.[8]

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[7] See additional discussion in Section 3.2.2 and legal justification in Appendix B of the draft FS report.

[8] WAC 173-340-720(1)(c) requires that "Ground water cleanup levels shall be established at concentrations that do not directly or indirectly cause violations of surface water, sediments, soil, or air cleanup standards established under this chapter or other applicable state and federal laws." It does not require that groundwater cleanup levels be equal to SWQS.

Ecology also should not apply cleanup levels equal to the SWQS criteria protective of drinking water and fish consumption to all stormwater conveyance, treatment, and control structures. The SWQS regulation specifically indicates that it is not intended for application to human-created waters managed primarily for the removal or containment of pollution (WAC 173-201A-260[3]). In addition, Site-specific health risk-based criteria were developed for stormwater conveyance, treatment, and control structures (e.g., Chicago Avenue ditch) because these structures are not expected to be used for drinking water at any point in the future, and individuals are not expected to consume aquatic organisms from these structures at any time in the future because the stormwater structures do not support adequate adult fish/shellfish habitat. Health risk-based screening levels for stormwater conveyance, treatment, and control structures were developed based on reasonable maximum exposure scenarios that included direct human contact, incidental ingestion, and inhalation. The reasonable maximum exposure scenarios were reviewed and approved by both Ecology and Washington State Department of Health (WDOH; LAI 2013, WDOH 2013, 2014). Legal and regulatory justification for why SWQS should not be applied to stormwater features is presented in the draft FS. [9] In addition, the Chicago Avenue ditch and the Auburn 400 basins are defined per Ecology guidance as stormwater features (Ecology 2017b).[10] Per drinking water supply regulations, "Every [drinking water] purveyor shall obtain drinking water from the highest quality source feasible… No intake or other connection shall be maintained between a public water system and a source of water not approved by the department" (WAC 246-290). Based on these regulations, a stormwater management system, such as the Chicago Avenue ditch and Auburn 400 basins would never be approved by the Washington State Department of Health as a source of drinking water. Therefore, regulating the water in the Chicago Avenue ditch as surface water protective of drinking water standards is overly conservative because it does not represent a viable human exposure pathway.

The draft FS presented SWQS for the State of Washington that were based on water quality criteria from WAC 173-201A as partially revised by the U.S. Environmental Protection Agency (EPA) through the National Toxics Rule (NTR) criteria established under 40 Code of Federal Regulations (CFR) 131.45 (criteria specific to the State of Washington) for some COCs. However, as of April 16, 2020, the EPA has withdrawn most of the human health criteria for Washington found in the NTR. Therefore, the applicable TCE SWQS has changed from the NTR value (0.3 µg/L) to the WAC 173-201A value (0.38 µg/L). Based on this regulatory revision, the applicable update to the pCULs is included in Tables 1-2 and 1-3.

[9] See additional discussion in Section 3.2.3 and legal justification in Appendix B of the draft FS report.

[10] Ecology Environmental Information Management (EIM) database documentation describes the stormwater features "ditch" and "stormwater pond" as follows:

- **Ditch**: A human made channel used for drainage, to drain water from low lying areas, alongside roadways or fields, or to channel water for plant irrigation. A ditch receives water infiltration sources and runoff (non-point) but would not receive water diverted from a larger waterbody.
- **Stormwater Pond**: A pond that stores, infiltrates, and/or treats stormwater runoff. Four types of ponds include retention, detention, treatment, and combination treatment/detention ponds.

1.3.2 Points of Compliance

This section discusses the process used to establish POCs as part of the development of proposed cleanup standards, and for use in the FS evaluation. Proposed POCs will be finalized in the cleanup action plan.

1.3.2.1 Soil Point of Compliance

The standard POC where soil cleanup levels protective of direct human contact must be met is throughout a site from the ground surface to 15 ft bgs, in accordance with WAC 173-340-740(6)(d). The standard POC where soil cleanup levels protective of groundwater must be met is throughout a site, in accordance with WAC 173-340-740(6)(b). For the Site, where certain IHSs in groundwater are the result of leaching from soil, the proposed soil POC for COCs required to be protective of groundwater (shown in Table 1-1) would be throughout the Site. For all other COCs, or when groundwater is sufficiently cleaned up and the soil cleanup levels revert to protection of direct contact, the soil POC throughout the Site would be from the ground surface to 15 ft bgs.

MTCA also recognizes that when cleanup actions involve containment of hazardous substances, the soil cleanup levels would typically not be met at the POCs specified above. MTCA establishes conditions that must be met for the cleanup action to comply with the cleanup standards (WAC 173-340-740[6][f]). Some of the alternatives discussed in Section 4.0 include containment remedies; therefore, cleanup actions would comply with WAC 173-340-740[6][f] for these remedies.

1.3.2.2 Groundwater Point of Compliance

For the purposes of evaluating cleanup alternatives in this SFS, a standard POC was used for groundwater. Additionally, conditional points of compliance (CPOCs) were considered because achieving the pCUL based on protection of drinking water and specifically achieving the SWQS in groundwater, as required by Ecology and discussed above, cannot be achieved in a reasonable restoration time frame.

The standard POC for groundwater is throughout groundwater at the Site, in accordance with WAC 173-340-720(8). A CPOC is an alternative point or points (typically downgradient of the contaminant source) where compliance with the cleanup standards must be demonstrated. A CPOC may be used for a site (in accordance with WAC 173-340-720[8][c,d]) if it can be demonstrated that it is not practicable to meet the cleanup levels throughout the site in a reasonable restoration time frame, and that all practicable methods of treatment are to be used in the site cleanup. Boeing may pursue use of a CPOC downgradient of the release areas and possibly within the transition zone near Mill Creek. If Ecology requires the use of SWQS as the cleanup level for groundwater, Boeing is unaware of any other method (other than a CPOC at the transition zone or an area-wide CPOC) to meet MTCA's requirement that cleanup levels be achieved in a reasonable restoration time frame. There are two possible options for an off property (off-Facility) CPOC under MTCA (WAC 173-340-720[8][d][ii, iii]).[11] Alternately, Boeing may pursue one or more on-Facility CPOCs; MTCA specifically allows multiple points of compliance to address multiple sources and types of contamination (WAC 173-340-720[8][d][iii]).[12] The final determination for a CPOC can be made during the development of the cleanup action plan.

1.3.3 Remediation Levels

Remediation levels (RELs), or other qualitative or quantitative methods of identification of hazardous substances, are used to determine when the cleanup actions would be modified or changed based on the progress of the cleanup (WAC 173-340-355). The use of RELs for cleanup of TCE and VC in groundwater is appropriate at the Site.[13] Use of RELs would allow the remedy to progress and use appropriate, efficient, and effective technologies based on current conditions and performance of various cleanup action components. Because it is difficult to determine the exact timing of when a remedy would be sufficiently complete in a given area, and because the RELs are expected to be similar for each alternative, RELs are not included in costs and comparative evaluations in Section 5.0. RELs are appropriate for use for AOC-14 given the size of the plume, length of restoration time frame, and alternatives evaluated. A detailed description of RELs will be presented in the cleanup action plan.

[11] Additional discussion on off property (off-Facility) CPOC options are provided in Sections 3.3.2.1 and 3.3.2.2 of the draft FS report.
[12] Additional discussion of on-Facility CPOCs are provided in Section 3.3.2.3 of the draft FS report.
[13] The use of RELs was recommended by Ecology in a letter dated June 28, 2019 (Ecology 2019a).

2.0 SUPPLEMENTAL FEASIBILITY STUDY INVESTIGATION

Boeing completed SFS soil and groundwater investigation activities as requested by Ecology (Ecology 2019b) following submittal of the draft FS report (LAI 2019a). Ecology requested SFS investigation activities at AOC A-13 and AOC A-14 including:

- Collection of additional soil and groundwater data east of the petroleum hydrocarbon contamination in Building 17-06 to confirm the extent of contamination at AOC A-13; and
- Installation of a permanent continuous multi-channel tubing (CMT) groundwater monitoring well to monitor concentrations of TCE and degradation products at Former Building 17-03 (a potential release area for AOC A-14).

Boeing submitted a SFS work plan (LAI 2020b) outlining the details of the additional investigation activities. The proposed work was approved by Ecology on March 31, 2020 (Ecology 2020a). Boeing submitted the required CMT well variance request to Ecology on April 20, 2020 (LAI 2020a) and Ecology approved the variance on April 21, 2020 (Ecology 2020c). Field activities followed the methodology described in the SFS work plan.

2.1 Area of Concern A-13: Building 17-06

AOC A-13 (A-13) was designated to address petroleum hydrocarbon (hydraulic oil) contamination in soil and groundwater on the east side of Building 17-06. Investigations indicate that the source or sources of the hydraulic oil contamination are related to historical releases from an individual spar mill in Building 17-06. FS investigations focused on the area surrounding well AGW128, which has small amounts of seasonally present light non-aqueous phase liquid (LNAPL) hydraulic oil. After the draft FS was submitted, Ecology requested collection of additional soil and groundwater data east of the petroleum hydrocarbon contamination in Building 17-06 to confirm the extent of contamination at AOC A-13.

SFS investigation activities at AOC A-13 consisted of drilling and soil sampling at one boring (ASB0294); drilling, soil sampling, and groundwater sampling at one newly installed conventional groundwater monitoring well (AGW284); and groundwater sampling at one existing groundwater monitoring well (AGW042) for petroleum hydrocarbons east of Building 17-06. Drilling activities were completed on June 12, 2020 using a limited access sonic rig. The soil boring and the monitoring well were drilled to a depth of 25 ft bgs with soil samples collected during drilling. Well development was completed on June 15, 2020 and groundwater samples were collected from AGW284 and AGW042 on July 2, 2020. The new well and boring location were surveyed on June 26, 2020. The monitoring well and boring locations are shown on Figure 2-1. Boring and well details are provided in Table 2-1. Boring logs are provided in Appendix A.

Soil and groundwater samples were analyzed for diesel-range organics (DRO) and oil-range organics (ORO) by Method Northwest Diesel-Range Total Petroleum Hydrocarbon extended (NWTPH-Dx) at Analytical Resources, Inc. (ARI) located in Tukwila, Washington. Groundwater samples collected from the permanent groundwater wells were also analyzed for VOCs by EPA Method 8260D select ion monitoring (SIM). Laboratory data packages are provided in Appendix B.

2.1.1 Soil Results

Soil samples were collected from three depth intervals at both ASB0294 and AGW284. At each location, one sample was collected from above the water table (10 to 15 ft bgs interval), and two samples were collected from below the water table (15 to 20 ft bgs and 20 to 25 ft bgs intervals). Soil from each interval was field screened using visual and olfactory methods and by performing a sheen test. Field screening did not indicate the presence of contamination at either the boring or the well location. Sample results for soil collected from all three intervals at AGW283 and two of the three intervals at ASB0294 were below laboratory reporting limits. DRO and ORO were detected in the 16 ft bgs sample collected at ASB0294, with a DRO concentration of 20.7 milligrams per kilogram (mg/kg) and an ORO concentration of 174 mg/kg. The combined detected concentrations of DRO and ORO were below the total petroleum hydrocarbon (TPH) soil pCUL (71,000 mg/kg). Soil data are shown on Figure 2-2. Soil sample results are presented in Table 2-2.

2.1.2 Groundwater Results

Groundwater samples were collected from existing monitoring well AGW042 and new monitoring well AGW284. DRO and ORO were not detected above laboratory reporting limits in samples collected from either AGW042 or AGW284. TCE was detected at concentrations just above the laboratory reporting limit but below groundwater pCUL in the samples collected from AGW042[14] and AGW284. Boring and well locations with groundwater petroleum hydrocarbon data are shown on Figure 2-3. Groundwater analytical results are presented in Table 2-3.

2.1.3 Conclusions

Soil and groundwater results from the SFS investigation indicate that petroleum hydrocarbon contamination related to AOC A-13 does not extend east of Building 17-06. Petroleum hydrocarbons were not identified in groundwater sampling results, and soil sampling results had only one low-level (below the TPH pCUL) detection at 16 ft bgs at ASB0294. No soil petroleum contamination has been identified above the TPH (total DRO/ORO) pCUL in soil samples from current or previous AOC A-13 soil or well borings. No groundwater petroleum contamination has been identified above the TPH pCUL in groundwater samples from current or previously sampled AOC A-13 groundwater monitoring wells. TCE detections in groundwater are consistent with concentrations detected Site-wide and are addressed as part of AOC A-14. These sampling results continue to support the draft FS conclusion that current conditions at AOC A-13 do not warrant cleanup action at this time.

[14] TCE in the duplicate sample collected from AGW042 was detected at a concentration of 0.217 µg/L. The concentration of TCE in the parent sample collected from AGW042 was below the laboratory reporting limit.

2.2 Area of Concern A-14: Former Building 17-03

AOC A-14 was designated to address Site-wide CVOC contamination in groundwater, specifically TCE and VC. AOC A-14 comprises the two groundwater plumes and associated release areas (Area 1 Plume release areas at former Building 17-03 and 17-05, and Western Plume release areas at or near Building 17-07). During FS investigations, soil TCE contamination was added for evaluation of cleanup alternatives of soil above pCULs protective of groundwater (VC is not detected in soil at the Site). The extent of soil TCE contamination is limited to a small area at the Facility at former Building 17-03. VC is not detected in soil at any of the soil sampling locations. TCE concentrations are present above pCULs protective of groundwater (via leaching from soil) in the release area associated with the former Building 17-03 vapor degreaser. However, concentrations are well below pCULs protective of direct contact for industrial workers. Because of the limited extent of soil contamination exceeding pCULs at AOC A-14, evaluation of remedial alternatives for soil is not necessary.

FS investigation results indicated that there was likely a historical TCE release associated with a degreasing system or associated piping in former Building 17-03 (LAI 2017a, b, 2019b). After the draft FS was submitted, Ecology requested installation of a new permanent multi-level CMT groundwater monitoring well at the Former Building 17-03 Area 1 release area to monitor concentrations of TCE and degradation products in the shallow, intermediate, and deep groundwater zones.

As part of the SFS investigation, a CMT monitoring well (AGW283) was installed at Former Building 17-03 between June 9 and 11, 2020 with a rotosonic drill rig. The investigation included drilling to a depth of 110 ft bgs, collecting soil samples from the vadose zone, and installing the seven-channel CMT well in all three groundwater zones. The screened interval for each channel was completed as follows: 1 (18.5 to 21 ft bgs), 2 (29 to 30 ft bgs), 3 (39 to 40 ft bgs), 4 (52 to 53 ft bgs), 5 (65 to 66 ft bgs), 6 (87 to 88 ft bgs), 7 (99.8 to 100 ft bgs). Well development was completed on June 17, 2020 and groundwater samples were collected from each of the seven channels on July 2, 2020. The new well location was surveyed on June 26, 2020. The monitoring well location is shown on Figure 2-4. Well details are provided in Table 2-4. Boring logs are provided in Appendix A.

Soil and groundwater samples were analyzed for VOCs by EPA Method 8260D and 8260D SIM at ARI in Tukwila, Washington. Laboratory data packages are provided in Appendix B.

2.2.1 Soil Results

Soil samples were collected from the vadose zone at AGW283 at two depths. Soil was field screened by performing a headspace analysis using a ppbRAE photoionization detector (PID). Soil samples were collected at the depths with the highest PID readings: 14 and 16 ft bgs. TCE was detected above laboratory reporting limits in both soil samples collected from AGW283. TCE concentrations were 0.00628 mg/kg at 14 ft bgs and 0.0560 mg/kg at 16 ft bgs. The 14 ft bgs sample result is below soil pCULs for TCE for protection of groundwater (0.025 mg/kg). The 16 ft bgs sample result is slightly above the soil pCUL for TCE for protection of groundwater, but below the Method C direct contact value (1,800 mg/kg). Soil data for VOC constituents of concern are presented on Figure 2-6. Complete soil results are provided in Table 2-5.

2.2.2 Groundwater Results

Groundwater samples were collected from each of the seven channels at AGW283. TCE was the only VOC constituent detected above reporting limits in groundwater. TCE concentrations were detected at channel 1 (screened 18 to 21 ft bgs) at 3.92 µg/L and channel 2 (screened 29 to 30 ft bgs) at 0.588 µg/L. Both detected TCE concentrations are below the pCUL protective of drinking water (and slightly above the SWQS of 0.38 µg/L). Samples from all other screened intervals did not have detections of TCE. Chloroform was analyzed in samples from each CMT channel to determine whether water used during drilling activities had dissipated. Chloroform was not detected above laboratory reporting limits at any channel. Boring and well locations with groundwater data for detected constituents of concern are presented on Figure 2-7. A cross section of the area is shown on Figure 2-5. Groundwater analytical results are provided in Table 2-6.

2.2.3 Conclusions

TCE was the only constituent of concern detected in soil and groundwater samples collected from AGW283. TCE breakdown products cDCE and VC were not detected. Results are generally consistent with those of the previous investigations completed in the former Building 17-03 area. As expected, groundwater concentrations are lower in samples collected from the monitoring well than from previous groundwater grab samples from adjacent borings.

TCE was identified in soil at a concentration slightly above the pCUL for protection of groundwater (via leaching from soil) in the 16 ft bgs sample collected from the CMT monitoring well location (AGW283). The only other soil sampling location where TCE concentrations have been identified above the pCUL in the Building 17-03 area was at FS boring location ASB0290 (drilled December 2018 approximately 110 ft north of AGW283) in samples collected from depths of 12 ft and 16 ft bgs (TCE concentrations of 0.0445 µg/L and 0.0653 µg/L, respectively). Because of the limited extent of soil contamination exceeding pCULs protective of drinking water and concentration below direct contact pCULs at former Building 17-03, evaluation of remedial alternatives for soil is not necessary.

Results for TCE in groundwater for samples collected from monitoring well AGW283 are lower than the grab sample results from adjacent boring (ASB0277; sampled August 2017). The highest TCE concentration in groundwater samples collected from ASB0277 was 11 µg/L (at 40 ft bgs). The highest concentration of TCE (3.92 µg/L) detected in groundwater samples from AGW283 were in the sample from the water table (screened 18 to 21 ft bgs). Groundwater samples collected from soil borings tend to have higher contaminant concentrations than samples from properly developed monitoring wells because drilling activities disturb the soil column resulting in both desorption of TCE and in suspension of fine particles (turbidity) with sorbed TCE. Additionally, the last groundwater sampling events for groundwater in this area were approximately two and three years ago, since which time some level of attenuation has likely occurred. TCE concentrations at the newly installed monitoring well do not exceed groundwater pCULs protective of drinking water.

The results of the SFS investigation at former Building 17-03 do not change the overall findings or the alternatives evaluated for remediation of AOC A-14 in the draft FS. Although soil concentrations were identified above the TCE pCUL for protection of groundwater (via leaching from soil), groundwater concentrations are expected to meet the pCUL as described in Section 5.2.4. Once pCULs are met, empirical evidence is provided that the concentrations remaining in soil do not result in unacceptable concentrations in groundwater and, therefore, soil pCULs will be adjusted to the Method C direct-contact value. Groundwater TCE concentrations identified in the new CMT monitoring well are below the drinking water standards, relatively consistent with TCE concentrations at other nearby groundwater monitoring wells and are indicative of matrix desorption and back diffusion processes.

3.0 REVISIONS TO GROUNDWATER MODELING AND RESTORATION TIME FRAME ANALYSES

Based on review of the draft FS, Ecology requested revisions to the numerical groundwater flow and transport model (flow and transport models) and to the evaluation of individual well restoration time frames (Ecology 2019c). The modeling and restoration time frame analysis was used in the draft FS AOC A-14 evaluation of alternatives and disproportionate cost analysis (DCA). This section summarizes modifications to the flow and transport model. Details of the flow and transport model modifications and calibration are provided in Appendix C. This section also summarizes modifications to Site-wide AOC A-14 restoration time frame analyses. Details of the individual well restoration time frame calculations are provided in Appendix D.

3.1 Numerical Groundwater Flow and Transport Model

Ecology provided formal and informal comments and requested modifications to the regional and local numerical groundwater flow and transport models used to support the draft FS to refine the simulation of TCE transport in groundwater at the Site. Ecology comments included discussions during project team meetings, along with a series of emails and a formal meeting to review initial Ecology comments (Ecology 2019c, d, LAI 2020c). Ecology requested changes to the simulation of dissolved TCE in groundwater downgradient of the Boeing Auburn Facility that would better-enable matching the TCE simulated in the calibration period of the transport model relative to observed TCE in some specific areas of the Site. Boeing made adjustments to the hydraulic conductivity field to address these requested changes and refine the simulated TCE concentrations to better match observed TCE concentrations. Ecology also requested reductions of the degradation rates in the wetland area of the transport model. Boeing completed these updates and also added an additional degradation rate field to better match known degradation rate conditions. These modifications had larger impacts to the model calibration that required recalibration of additional model parameters, including drain conductance values and the release area concentration assumptions. Due to the complexity and interrelation of these modifications and the effect on model results, an iterative process was performed to complete the modifications and recalibrate the model. A summary of the modifications made to the flow and transport models is presented below. Details of the flow and transport models are provided in Appendix C.

3.1.1 Numerical Groundwater Flow Model

Revisions to the regional groundwater flow model included updates to the hydraulic conductivity field and recalibration of conductance values for surface drainage features. From the initial flow model PEST calibration (LAI 2016), the modeled hydraulic conductivity field included relatively isolated areas of relatively high and low hydraulic conductivity along the boundary of the City of Algona and City of Auburn to the northwest of the Facility and to the north of The Outlet Collection, and south of the Auburn Environmental Park (Figure 3-1). An iterative calibration was performed between the regional flow model and local transport model through manual modification of flow model parameters.

Modification of the hydraulic conductivity of the flow model resulted in the need to recalibrate conductance[15] values for select drainage features (including Auburn 400 Stormwater Basins, segments of Mill Creek, and the Auburn Environmental Park). The modifications to the conductance values were needed to maintain overall calibration objectives and to simulate groundwater flow patterns that more closely match the path of the TCE plumes. Ecology provided approval of the revisions to the regional flow model on May 6, 2020 (Ecology 2020b).

3.1.2 Groundwater Contaminant Transport Model

Revisions to the local groundwater contaminant transport model included degradation rate modifications and recalibration of release area concentrations. Degradation rate modifications included decreasing degradation rates in the area along the western margins of the model (termed the 'wetland area' in the Draft FS) and increasing degradation rates in other areas relative to regional values. These increased degradation rate areas were identified based on elevated potential for reductive dechlorination according to the Site-wide natural attenuation assessment (LAI 2019b) and transport model recalibration. Areas of modified degradation rates are shown on Figure 3-2.

Subsequent recalibration of the release area concentrations was completed in order to account for changes to the degradation rates and flow paths. Adjustments to the estimated concentrations of the release areas were required in order to compensate for the complex effects of the various modifications made to the flow and transport models. Locations of release areas and the general conceptual model of release area concentration changes over time were kept consistent to those described in the draft FS. The modifications to the release area concentrations resulted in an improved calibration of simulated TCE contamination in groundwater beneath the Site from the period of assumed initial releases (i.e., 1960s and 1970s) to present day (2018 for the purposes of the FS). The transport model revisions were approved by Ecology on June 15, 2020 (Ecology 2020e).

3.1.3 Predictive Model

Once the recalibration of the transport model was completed, additional modifications were made to the predictive simulated TCE transport from present day into the future. Updates to the predictive simulation consisted of improved interpolation of observed 2018 TCE concentrations, which included minor modifications to the interpolated release area concentrations (based on the ending concentrations in the updated calibration period). The updated predictive model was used to predict future TCE concentrations and the effects of the various alternatives evaluated in the SFS. The predictive modeling of the SFS alternatives was used in conjunction with Site restoration time frames (See Section 3.2) to evaluate differences in overall restoration time frames for each alternative. In addition to the comparison of alternatives Site-wide, an additional analysis specifically for the northern Algona residential area (Algona residential area; Figure 3-3) was performed due to the

[15] Conductance quantifies the relative permeability of the bed material of the drainage feature (i.e., the hydraulic connectivity of the drainage feature with the adjacent groundwater).

potential public concerns noted by Ecology in this area. To address these potential concerns, model simulations and analyses were completed specifically for the shallow zone in the Algona residential area. Each SFS alternative was evaluated for the effects of TCE concentration reductions in the Algona residential area.

3.2 Restoration Time Frames

Ecology requested revisions to the restoration time frame analysis for Site-wide VOC groundwater contamination (AOC A-14). Ecology's formal and informal comments included discussions during project team meetings, along with a series of emails (Ecology 2019c, d, 2020d, f, LAI 2020d, e). In the draft FS report, restoration time frames for AOC A-14 were estimated based on individual well point attenuation rates (calculated from observed concentration well trends from 2011 to 2018) and 2018 concentrations for TCE, VC, and total CVOCs. At Ecology's direction, the approach for assessing restoration time frames was modified for the SFS and resulted in a less conservative restoration time frame estimate. Ecology-requested revisions to the restoration time frames in the SFS included:

- Revising which wells were included in the restoration time frame evaluation. After discussions with Ecology, Boeing decided to use a Mann-Kendall statistical trend analysis to determine wells to be included in the evaluation.
- Only including TCE and VC restoration time frames (not including total CVOCs).

Details of the methodology for calculating individual well restoration time frames are provided in Appendix D.

3.2.1 Point Attenuation Rates

Point attenuation rates were calculated from the linear regression of the individual wells' concentration data over time. Attenuation rates are used to understand how quickly natural attenuation is occurring and to estimate how long it will take to reach cleanup goals using an MNA remedy (Adamson 2014). Before calculating point attenuation rates, the GSI Mann-Kendall Toolkit (GSI Environmental 2012) was used to statistically analyze the concentration trends for Site monitoring wells using 8 years of data[16] (January 2011 through December 2018). The commonly used Mann-Kendall analysis[17] uses statistical methods to evaluate trends[18] as either decreasing, increasing, stable, or no trend. Point attenuation rates were then calculated for all wells with decreasing concentration trends based on the Mann-Kendall analysis. Point attenuation rates could not be calculated for wells where the Mann-Kendall analysis indicated increasing or stable trends or no trend due to data variability. Therefore, Ecology directed Boeing to only use wells that the Mann-Kendall analysis identified as having decreasing concentration trends for the restoration time frame analysis.

[16] Eight years of data was used to evaluate more recent data (rather than the entire data set) as a more reliable indicator of current conditions, but with enough data to provide sufficient statistical analysis.
[17] The Mann-Kendall analysis was also used as part of the MAROS analysis completed in the RI report (LAI 2017d).
[18] Trends could only be evaluated for wells that have at least four concentration results above laboratory reporting limits.

3.2.2 Restoration Time frame Results

Point attenuation rates were used along with TCE and VC concentrations from 2018 for each well to determine the time frame to meet pCULs protective of drinking water or to meet SWQS in groundwater at each Site monitoring well (restoration time frames). For each well, either the TCE or VC restoration time frame (whichever was longer) was used to determine the predicted restoration time frame for that well. Individual well restoration time frames ranged from wells already meeting the pCUL (0 years) to 32 years to meet pCULs protective of drinking water, and 0 to 359 years to meet SWQS in groundwater. Estimated restoration time frames for individual wells are shown on Figure 3-4 and 3-5 for pCULs protective of drinking water and SWQS in groundwater, respectively.

Evaluation of individual well data provides an estimate of how long cleanup will take at each location. The wells requiring the longest time frame for cleanup drive the overall Site restoration time frame (the Site is not considered cleaned up until the cleanup standards are met throughout the Site using a standard point of compliance under MTCA). Because conditions or concentration trends at an individual well can change over time as discussed in Appendix D, estimating restoration time frames carries inherent uncertainty and it is more useful to use order-of-magnitude estimates of restoration time frames for the purposes of cost evaluation required as part of the FS process. The estimate to meet pCULs protective of drinking water with Site-wide MNA as the remedy (Alternative D1) is approximately 30 years. The estimate to meet SWQS in groundwater, with Site-wide MNA as the remedy, is approximately 100 years. The 100-year value was used for FS evaluation purposes because predicted restoration time frames for most wells were within the 0- to 100-year range. Only one well had a much longer than estimated restoration time frame of 300 years to meet SWQS in groundwater, and the next longest predicted restoration time frame was 102 years to meet SWQS in groundwater. Because MNA is a key component for completion of all the remedial alternatives, these estimated restoration time frames were used as the baseline for comparison against all the other SFS remedial alternatives as described in Section 4.0 and 5.2.4. It is important to keep in mind that wells statistically shown to be stable, have no trend, or have an increasing trend were not considered in the restoration time frame analysis at Ecology's direction and the actual site-wide restoration time frame may take longer than the estimated values used for the purpose of the FS evaluation. It should be noted that Boeing may use statistical methods to evaluate compliance with final CULs.[19]

[19] Model Toxics Contract Act (MTCA) states that "less than 10% of the sample concentrations shall exceed the groundwater cleanup level during a representative sampling period" (Washington Administrative Code [WAC] 173-340-720[9][e][2]). Therefore, the 90th percentile demonstrates compliance with the cleanup standards.

4.0 DEVELOPMENT OF ADDITIONAL CLEANUP ACTION ALTERNATIVES – AOC A-14

The draft FS report evaluated five cleanup action alternatives for cleanup of TCE and VC in Site-wide groundwater and TCE in Facility soil. Ecology concluded that the MNA alternative (Alternative D1) selected as the recommended remedy in the draft FS report should be evaluated against three additional alternatives in this SFS (Ecology 2020d). The additional alternatives evaluated for the SFS are to differentiate the effects of enhanced *in situ* bioremediation (EISB) on different focus areas within the plumes. The focus areas were selected to provide additional downgradient treatment to plume areas with higher CVOC concentrations, areas that have longer projected restoration time frames, or areas that warrant special attention due to consideration of public concerns. The three areas include:

- **Algona Focus Area:** This is an area of Algona along Milwaukee Avenue where treatment could target groundwater upgradient of the Chicago Avenue ditch and northeastern residential neighborhood. Treatment in this area would be an expansion of the Algona Enhanced *In Situ* Bioremediation pilot test treatment area. Concentrations of CVOCs in groundwater in this area are relatively low; however, this area is included as a focus area because of potential public concerns or perceptions due to its location underlying a residential area at the Site. There are also no complete exposure pathways in this area, except for potential incidental direct contact exposure at a stormwater ditch (Chicago Avenue ditch). Concentrations of COCs detected in water in the ditch are below health-based screening criteria for children or workers (WDOH 2013, 2014). Additionally, because of the nature of the water (urban stormwater runoff) and steeply sloped banks of the ditch, it is unlikely for the public to be regularly accessing/contacting the water.
- **17-07 Property Boundary Focus Area:** This is an area along the Boeing property boundary where treatment could target an area with one of the highest TCE concentrations (AGW145) at the Site. The concentration at this well (TCE concentration of 6.2 ug/L in 2018) represents a small portion of the plume and there are no complete exposure pathways in this focus area.
- **The Outlet Collection Focus Area:** The Outlet Collection mall parking lot on the southern, northern, and western sides of the main mall building where treatment could target an area with some of the highest CVOC concentrations and longer restoration time frames at the Site. While this area has a relatively large area with higher CVOC concentration, there are no complete exposure pathways in this focus area. Due to the depth, extent, and location of this area (a large portion of which is located underneath the expansive Outlet Collection mall building), groundwater treatment covering the entire area is technically infeasible.

The conceptual layout for EISB at the focus areas is shown on Figure 4-1. The focus areas were evaluated in combinations as requested by Ecology, and resulted in three new remedial alternatives that were evaluated for the SFS:

- **Alternative D6:** EISB at Algona Focus Area and MNA;
- **Alternative D7:** EISB at Algona and 17-07 property boundary focus areas and MNA; and

- **Alternative D8:** EISB at Algona, 17-07 property boundary, and The Outlet Collection Focus Areas and MNA.

A summary of each remedial alternative is provided in Table 4-1.

MNA is included as a component of each alternative evaluated for AOC A-14 because targeted cleanup alone will not meet cleanup criteria throughout the groundwater plumes (See Section 2.2 of the draft FS report). MNA is considered an active remedy under the MTCA regulation (WAC 173-340-200) at sites meeting the necessary requirements (WAC 173-340-370[7]), and results in a permanent remedy. Additionally, natural attenuation of VOCs is already occurring throughout the Site under natural conditions that are highly conducive to reductive dechlorination of TCE and breakdown products (LAI 2019b). MNA is an appropriate remedy (either independently or in conjunction with other remediation technologies) at the Site, and the remedial alternatives for the Site meet or would meet the requirements for the appropriate use of an MNA remedy set forth in WAC 173-340-370(7):

- "Source control (including removal and/or treatment of hazardous substances) has been conducted to the maximum extent practicable."
- "Leaving contaminants on-site during the restoration time frame does not pose an unacceptable threat to human health or the environment."
- "There is evidence that natural biodegradation or chemical degradation is occurring and will continue to occur at a reasonable rate at the site."
- "Appropriate monitoring requirements are conducted to ensure that the natural attenuation process is taking place and that human health and the environment are protected."

Source control has been completed at the Site as part of the interim remedial action (IRA) that occurred in former Building 17-05 in 2004/2005. A description of the IRA is provided in Section 2.4 of the draft FS. Compliance with the other requirements for MNA is also discussed in the draft FS.

The following sections summarize and evaluate previously evaluated Alternative D1 and new Alternatives D6, D7, and D8.

4.1 Alternative D1: MNA

Alternative D1 includes containment of COCs in soil and MNA for cleanup of Site-wide groundwater. Release areas are already contained under pavement or building slabs. Monitoring and confirmation of ongoing containment of the soil would be completed by periodic inspections and maintenance, as necessary. Institutional controls will be put in place to maintain asphalt/concrete and buildings overlying contaminated soil. Restrictive covenants will be put in place to prohibit activities that could interfere with the institutional controls. Soil cleanup is not necessary because concentrations are below direct contact cleanup levels and will be empirically demonstrated to be protective of groundwater once pCULs are met in groundwater.[20] Routine sampling and analysis for MNA

[20] For additional discussion, see section 3.2.1 of the draft FS report.

parameters and CVOCs would be conducted at wells with TCE and VC concentrations above pCULs and at a series of boundary wells. The data would be evaluated to monitor the progress and effectiveness of the naturally occurring reductive dechlorination and other attenuation processes at the Site. Natural attenuation has already been evaluated and is demonstrated to be occurring at a rapid rate at the Site (LAI 2019b; Appendix D). Additionally, current risks to human health and the environment are below Site-specific health-based risk thresholds (See Section 2.3 of draft FS report). Based on predictive modeling and statistical evaluation of restoration time frames at Site monitoring wells, MNA is estimated to require approximately 30 years to reach pCULs protective of drinking water and 100 years to reach the SWQS in groundwater Site-wide. Evaluation of restoration time frames is presented in Appendix D. Wells proposed for ongoing monitoring (based on exceedance of pCULs or concentrations greater than SWQS) and possible proposed boundary wells are presented on Figures 4-2a (pCULs) and 4-2b (SWQS).

4.2 Alternative D6: Enhanced *In Situ* Bioremediation at Algona Focus Area and MNA

Alternative D6 includes EISB at the Algona focus area and Site-Wide MNA. A description of the effectiveness of the EISB pilot test for the Algona focus area is provided in Appendix E.

Algona EISB

The EISB conceptual remedy design for the Algona neighborhood would extend the existing pilot test injection row (LAI 2017c, 2018) to the north to create an approximately 980-ft-long injection row with a total of 29 single injection wells installed on 35-ft centers to target the shallow groundwater zone. Five of the injection wells were already installed during the pilot test; an additional 24 wells would be installed for full-scale implementation. A conceptual layout of the injection row and possible monitoring wells is shown on Figure 4-3.

For the purposes of this SFS, it is assumed the electron donor injection solution for the Algona neighborhood would consist of 5 percent LactOil by volume and yeast extract as a source of micronutrients for enhanced reductive dechlorination. Based on the number of proposed wells targeting only the shallow zone, each injection event would take approximately 6 weeks to complete. The injections would employ the concurrent extraction/injection method at adjacent wells in the same manner as used for the pilot test injection (to spread the injection solution between the injection points to promote a more continuous zone of treatment in the crossgradient direction between injection wells). This alternative assumes injections would need to be performed approximately every 4 years for 20 years based on the increased bioremediation parameters and lack of CVOC rebound at 4.5 years after injection, observed during pilot test injection results as described in Appendix E[21] (maximum of five events included for FS cost estimate design).

[21] Injection timing is not based on meeting CULs; only decreasing overall concentrations and achieving favorable bioremediation parameters. Injection performance metrics will be developed as part of the Engineering Design Report (EDR).

Concentrations of CVOCs in the Algona focus area are relatively low. EISB implementation in the Algona focus area would treat the contamination upgradient of the Chicago Avenue ditch and Algona residential area extending approximately 400-ft downgradient of the injection row, which may be considered important to the local residents and the City of Algona. Degradation rates would be increased within this treatment area (assumed to increase up to two times based on the pilot test injection; See Appendix E), and therefore, would reduce the restoration time frame in the treatment area. However, this treatment area would only extend to or slightly beyond the Chicago Avenue ditch, and would not result in direct treatment of groundwater in the residential Algona neighborhood. Because of the water table elevation is so close to the ground surface, EISB treatment could not be implemented within the residential Algona neighborhood (injection fluid would likely surface into residential crawl spaces, basements, and yards). Therefore, direct injection in the residential Algona neighborhood is technically infeasible.

Treatment would result in decreased CVOC concentrations in groundwater upgradient of the Chicago Avenue Ditch and decreased flux into the Algona residential area. Numerical model results show that TCE shallow zone restoration time frames in the Algona residential area could be reduced by approximately 56 percent (Appendix C). However, back diffusion from the aquifer soil matrix, which is not accounted for by the groundwater model, will continue to be a prominent factor affecting CVOC concentrations downgradient of the injection areas (i.e., in residential Algona), and VC is the driving constituent for restoration time frames in the Algona residential area based on individual well data as discussed in Alternative D1.

It is assumed that the EISB injections would maintain effectiveness for approximately 30 years (20 years of active treatment followed by 10 years of sustained treatment due to endogenous decay and enhanced contaminant desorption and back diffusion). No additional monitoring wells are proposed to be added to the extensive existing well network for the downgradient plumes as part of EISB implementation. Quarterly groundwater monitoring will be performed for the year after each injection (to monitor the effectiveness of the injection activities) and will transition to semiannual monitoring after the first two injection events (6 years of semiannual monitoring). Annual monitoring would continue for the remaining 9 years of active treatment, and biannual monitoring would occur for 10 years of sustained treatment after active treatment ends.

Monitored Natural Attenuation

Upon completion of the EISB remedial action, MNA would be implemented for cleanup of Site-wide groundwater remaining above pCULs. Routine sampling and analysis for MNA parameters and CVOCs would be conducted at wells with TCE and VC concentrations above pCULs and at a series of boundary wells, as discussed in Alternative D1.

Restoration Time Frame

The predictive transport modeling described in Appendix C indicates that EISB in the Algona focus area (expanding and re-injection at the former Pilot Test area at Milwaukee Avenue in Algona) would not decrease the overall Site-wide restoration time frame for AOC A-14. The resulting MNA implementation time frame would remain unchanged at approximately 30 years to meet pCULs protective of drinking water and 100 years to meet SWQS in groundwater, because restoration time frames in the Algona area are not the driver of the overall restoration time frame for the site. Even when the Algona focus area is treated, various other areas throughout the plumes drive the long restoration time frames due to the diffuse nature of the plumes (See Section 2.2 of the draft FS report). Evaluation of restoration time frames is presented in Appendix D. Wells proposed for ongoing monitoring are assumed not to change from Alternative D1 for the purposes of cost estimation and are presented on Figure 4-2a (pCULs) and Figure 4-2b (SWQS).

4.3 Alternative D7: Enhanced *In Situ* Bioremediation at Algona and 17-07 Property Boundary Focus Areas and MNA

Alternative D7 includes EISB at the Algona focus area, EISB at the Building 17-07 property boundary focus area, and Site-Wide MNA.

Algona EISB

The implementation of EISB in the Algona focus area under this alternative would be the same as described in Alternative D6.

17-07 Property Boundary EISB

The EISB conceptual remedy design for the 17-07 property boundary focus area consists of a 1,120-ft-long injection row with 33 injection well clusters (three-well clusters) installed on 35-ft centers to target the shallow, intermediate, and deep groundwater zones. A conceptual layout of the injection row and possible monitoring wells is shown on Figure 4-4. It should be noted that other locations for this injection row may be more appropriate and would be evaluated during planning for this injection if Alternative D7 was the remedy selected.

For the purposes of this SFS, it is assumed the injection solution for the property boundary injection row would consist of 5 percent LactOil by volume and yeast extract as a source of micronutrients for enhanced reductive dechlorination. Each injection event would take approximately 18 weeks to complete. The injections would employ the concurrent extraction/injection method at adjacent wells used in the Algona pilot test. This alternative assumes injections would be performed approximately every 4 years for 20 years based on the increased bioremediation parameters and lack of CVOC rebound at 4.5 years after injection observed during pilot test injection results as described in Appendix E[22] (maximum of five events included for FS cost estimate design).

EISB implementation in the 17-07 property boundary focus areas would serve only to treat elevated CVOC concentrations in groundwater in the vicinity of monitoring well AGW145 and reduce flux of contaminants in groundwater from this area. Based on additional groundwater modeling results, it appears that groundwater from the 17-07 property boundary focus area moves to the northwest, cross-gradient of the northern Algona residential area. EISB at the 17-07 property boundary would not provide any additional protectiveness to the Algona neighborhood that would not already be provided by the Algona focus area injections (Alternative D6). The 17-07 property boundary treatment area would be expected to extend approximately 400 ft downgradient of the injection row and provide treatment in the area of AGW145. However, back diffusion driven concentrations remaining in the plumes will continue to affect concentrations downgradient of the injection area. While flux of CVOCs into downgradient areas may be decreased, back diffusion will continue to be the driving factor for the untreated areas downgradient of the treatment areas (as is the case for groundwater throughout the majority of the Site).

It is assumed that the EISB injections would maintain effectiveness for 30 years (20 years of active treatment followed by 10 years of sustained treatment due to endogenous decay and donor back diffusion). No additional monitoring wells are proposed to be added to the extensive existing well network for the downgradient plumes as part of EISB implementation. Quarterly groundwater monitoring will be performed for the year after each injection (to monitor the effectiveness of the injection activities) and transition to semiannual monitoring after the first 2 injection events (6 years of semiannual monitoring). Annual monitoring would continue for the remaining 9 years of active treatment and biannual monitoring for 10 years of sustained treatment after active treatment ends.

Monitored Natural Attenuation

Upon completion of the EISB remedial actions, MNA would be implemented for cleanup of Site-wide groundwater remaining above pCULs. Routine sampling and analysis for MNA parameters and CVOCs would be conducted at wells with TCE and VC concentrations above pCULs and at a series of boundary wells, as discussed in Alternative D1.

Restoration Time Frame

The predictive transport modeling described in Appendix C indicates that EISB in the Algona and 17-07 property boundary focus areas (re-injection at the former Pilot Test area at Milwaukee Avenue in Algona and the property boundary near Building 17-07) would decrease the restoration time frame for AOC A-14 by approximately 3 percent (by treating the higher CVOC concentrations in the AGW145 area). The resulting MNA implementation time frame would be reduced to approximately 29 years to

[22] Injection timing is not based on meeting CULs; only decreasing overall concentrations and achieving favorable bioremediation parameters. Injection performance metrics will be developed as part of the EDR.

meet pCULs protective of drinking water and 97 years to meet SWQS in groundwater. The change to the overall Site restoration time frame is minimal due to treatment effecting small areas of the plumes. Even when the 17-07 property boundary and Algona focus areas are treated, various other areas throughout the plumes still drive the long restoration time frames due to the diffuse nature of the plumes (See Section 2.2 of the draft FS report). Evaluation of restoration time frames is presented in Appendix D. Wells proposed for ongoing monitoring are assumed not to change from Alternative D1 for the purposes of cost estimation and are presented on Figure 4-2a (pCULs) and Figure 4-2b (SWQS).

4.4 Alternative D8: Enhanced *In Situ* Bioremediation at Algona, 17-07 Property Boundary, and The Outlet Collection Focus Areas and MNA

Alternative D8 includes EISB at the Algona focus area, EISB at the 17-07 property boundary focus area, EISB at The Outlet Collection focus area, and Site-Wide MNA.

Algona EISB

The implementation of EISB in the Algona focus area under this alternative would be the same as described in Alternative D6.

17-07 Property Boundary EISB

The implementation of EISB in the 17-07 property boundary focus area under this alternative would be the same as described in Alternative D7.

The Outlet Collection EISB

The EISB conceptual remedy design for The Outlet Collection mall consists of six injection rows on several sides of the mall building. Each injection row would target the shallow, intermediate, and deep groundwater zones. One approximately 385-ft-long injection row would be located on the west side of the mall and include 12 clusters of three wells (36 wells total) installed on 35-ft centers. Three approximately 98-ft-long injection rows would be located on the south side of the mall and include 29 clusters of three wells (87 wells total per row) installed on 35-ft centers. The three southern rows would be installed approximately 200 ft apart. Two more injection rows would be installed on the north side of the mall. The two northern rows would be approximately 700 ft long, include 21 clusters of three wells (63 wells total per row) installed on 35-ft centers, with the rows spaced approximately 200 ft apart. In all, The Outlet Collection injection area would have 423 injection wells. A conceptual layout of the injection rows and possible monitoring wells is shown on Figure 4-5.

For the purposes of this SFS, it is assumed the injection solution for The Outlet Collection injection rows would consist of 5 percent LactOil by volume and yeast extract as a source of micronutrients for enhanced reductive dechlorination. Each injection event would take approximately 74 weeks (about 1.5 years) to complete. The scale and duration of the injection events is likely not practical in this location because of impacts to parking and business operations at The Outlet Collection. The injections would employ the concurrent extraction/injection method at adjacent wells used in the Algona pilot test. This alternative assumes injection would be performed approximately every 2 to 4 years for 10 to 20 years of active treatment (five events included for FS cost estimate design). The treatment effectiveness time frame is more uncertain in this area than in the Western Plume because of moderately reducing conditions in this portion of the Area 1 Plume compared to highly reducing conditions in the Western Plume. Timing of injections would be based on the increased bioremediation parameters and lack of CVOC rebound. Based on previous injection experience and cost impacts of additional injections, no more than 5 injection events would be completed.

EISB implementation in The Outlet Collection focus areas would serve only to treat elevated CVOC concentrations in groundwater within the individual treatment areas at The Outlet Collection area and reduction of contaminant flux from these areas. The treatment area(s) would be expected to extend approximately 200- to 400-ft downgradient of the injection rows. Back diffusion driving concentrations remaining in the plumes will continue to affect concentrations downgradient of the injection. While flux of CVOCs into the downgradient areas may be decreased, back diffusion will continue to be the driving factor for the untreated areas downgradient of the treatment areas (as is the case for groundwater throughout the majority of the Site).

It is assumed that the EISB injections would maintain effectiveness for 20 to 30 years (10 to 20 years of active treatment followed by 10 years of sustained treatment due to endogenous decay and donor back diffusion). No additional monitoring wells are proposed to be added to the extensive existing well network for the downgradient plumes as part of EISB implementation. Quarterly groundwater monitoring would be performed for the first 4 years of active treatment and transition to semiannual monitoring for the remaining 6 years of active treatment. Annual or biannual monitoring would continue for the remaining 10 to 20 years of active or sustained treatment after active treatment ends.

Monitored Natural Attenuation

Upon completion of the EISB remedial actions, MNA would be implemented for cleanup of Site-wide groundwater remaining above pCULs. Routine sampling and analysis for MNA parameters and CVOCs would be conducted at wells with TCE and VC concentrations above pCULs and at a series of boundary wells, as discussed in Alternative D1.

Restoration Time Frame

The predictive transport modeling described in Appendix C indicates that EISB in the three focus areas (injection at the former Pilot Test area at Milwaukee Avenue in Algona, property boundary near Building 17-07, and around The Outlet Collection Mall) would decrease the restoration time frame for AOC A-14 by approximately 15 percent (by treating the higher CVOC concentrations in the AGW145 area and portions of The Outlet Collection focus area). The resulting MNA implementation time frame would be reduced to approximately 25 years to meet pCULs protective of drinking water and 85 years to meet SWQS in groundwater. The change to the overall Site restoration time frame under this alternative is still minimal because the treatment only effects a relatively small area of the plumes. Even when the 17-07 property boundary, Algona, and The Outlet Collection focus areas are treated, various other areas throughout the plumes still drive the relatively long restoration time frames due to the diffuse nature of the plumes (See Section 2.2 of the draft FS report). Evaluation of restoration time frames is presented in Appendix D. Wells proposed for ongoing monitoring are assumed not to change from Alternative D1 for the purposes of cost estimation and are presented on Figure 4-2a (pCULs) and Figure 4-2b (SWQS).

5.0 ANALYSIS OF ADDITIONAL CLEANUP ACTION ALTERNATIVES – AOC A-14

This section evaluates each of the SFS cleanup action alternatives developed for AOC A-14 in Section 4.0 against applicable MTCA requirements and evaluation criteria. A recommended alternative is then selected based on the evaluation and comparison of the alternatives. This section includes:

- A summary of MTCA threshold requirements and other requirements that cleanup action alternatives must meet.
- A summary of evaluation criteria to compare cleanup action alternatives.
- A determination of how cleanup action alternatives meet the criteria under WAC 173-340-360(2).
- A relative cost-benefit analysis and comparison of each cleanup action alternative to determine whether the cleanup action is permanent to the maximum extent practicable using the criteria under WAC 173-340-360(3).
- An evaluation to determine if the cleanup action provides for a reasonable restoration time frame using criteria under WAC 173-340-360(4).

5.1 Minimum Requirements for Cleanup Action

MTCA regulations require that cleanup action alternatives meet certain minimum requirements as provided in WAC 173-340-360(2). Cleanup alternatives must also be evaluated to determine whether a cleanup action uses permanent solutions to the maximum extent practicable as provided in WAC 173-340-360(3). Consistent with MTCA, the alternatives described in Section 4.0 were evaluated with respect to the threshold requirements, and the other requirements (using permanent solutions to the maximum extent practicable, restoration time frame, and consideration of public concerns). The following sections briefly summarize the MTCA threshold and other requirements that must be met by the alternatives under consideration. Section 5.2 describes how the remedial alternatives for AOC A-14 meet these requirements and are compared against each other using evaluation criteria.

5.1.1 Threshold Requirements

WAC 173-340-360(2) requires first that all alternatives evaluated meet the following four threshold requirements:

- “Protect human health and the environment.”
- “Comply with cleanup standards (see WAC 173-340-700 through WAC 173-340-760).”
- “Comply with applicable state and federal laws (see WAC 173-340-710).”
- “Provide for compliance monitoring (see WAC 173-340-410 and 173-340-720 through 173-340-760).”

5.1.2 Other Requirements

In addition to the threshold requirements described in Section 5.1.1, WAC 173-340-360(2)(b) requires that cleanup actions meet certain other requirements:

- "Use permanent solutions to the maximum extent practicable…;"
- "Provide for a reasonable restoration time frame…;" and
- "Consider public concerns (see WAC 173-340-600)."

5.1.2.1 Requirements for a Permanent Solution to the Maximum Extent Practicable

Steps to determine whether a cleanup action uses permanent solutions to the maximum extent practicable are provided in WAC 173-340-360(3). WAC 173-340-200 defines a permanent solution as one in which cleanup standards "can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal site of any residue from the treatment of hazardous substances." MTCA recognizes that permanent solutions may not be practicable to achieve for all sites and provides a procedure referred to as a disproportionate cost analysis (DCA; WAC 173-340-360[3][e]) to determine whether a cleanup action is permanent to the maximum extent practicable.

As part of the analysis of whether an alternative uses permanent solutions to the maximum extent practicable, the DCA is performed to determine whether the incremental increase in costs of a cleanup alternative over that of a lower cost alternative is justified by providing a corresponding incremental increase in human health and environmental benefits (WAC 173-340-360[3][e][i]). The relative benefits of a cleanup alternative are based on evaluation criteria provided in WAC 173-340-360(3)(f). These criteria are:

- ***Protectiveness.*** Overall protectiveness of human health and the environment, including the degree to which site risks are reduced, time required to reduce risk at the Facility and attain cleanup standards, risks during implementation, and improvement of overall environmental quality.
- ***Permanence.*** The degree of reduction in toxicity, mobility, and volume of hazardous substances, including the reduction or elimination of hazardous substance releases and sources of releases.
- ***Cost.*** The cost to implement the remedy including capital costs and operation and maintenance costs.
- ***Effectiveness over the long term.*** Long-term effectiveness, including the degree of certainty that the alternative would be successful, long-term reliability, the magnitude of residual risk, and the effectiveness of controls required to manage treatment residues and remaining waste. The following types of cleanup action components may be used as a guide, in descending order, when assessing the relative degree of long-term effectiveness: reuse or recycling; destruction or detoxification; immobilization or solidification; onsite or offsite disposal in an engineered, lined, and monitored facility; onsite isolation or containment with attendant engineering controls; and institutional controls and monitoring.

- ***Management of short-term risks.*** The risk to human health and the environment during construction and implementation, and the effectiveness of measures to manage the risk.
- ***Technical and administrative implementability.*** Implementability, including consideration of whether the alternative is technically possible; the availability of necessary offsite facilities, services, and materials; administrative and regulatory requirements; scheduling, size, and complexity of construction; monitoring requirements; access for construction, operations, and monitoring; and integration with existing facility operations.
- ***Consideration of public concerns.*** Whether the community has concerns and the extent to which those concerns are addressed.

If the incremental increase in costs is determined to be disproportionate to the benefits, the more expensive alternative is considered impracticable and the lower cost alternative is determined to be permanent to the maximum extent practicable (WAC 173-340-360[3][e][i]). This process provides a mechanism for balancing the permanence of the cleanup action with its costs, while ensuring that human health and the environment are adequately protected. If alternatives are equal in benefits, the less costly alternative is selected (WAC 173-340-360[3][e][ii][C]).

5.1.2.2 Requirements for a Reasonable Restoration Time Frame

WAC 173-340-360(4)(b) specifies that the following factors be considered when determining whether a cleanup action provides for a reasonable restoration time frame:

- Potential risks to human health and the environment;
- Practicability of achieving a shorter restoration time frame;
- Current and potential future use of the Site, surrounding areas, and associated resources that are, or may be, affected by releases from the Site;
- Availability of alternative water supplies;
- Likely effectiveness and reliability of institutional controls;
- Ability to control and monitor migration of hazardous substances from the Site;
- Toxicity of the hazardous substances at the Site; and
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the Site or under similar Site conditions.

5.1.2.3 Requirement for Consideration of Public Concerns

Consideration of public concerns is an inherent part of the cleanup process under MTCA (WAC 173-340-600). According to Ecology, a draft of this supplemental FS report along with the 2019 draft FS report will be issued for public comment, and the comments will be considered prior to finalizing this report. A public comment period will also occur for the draft cleanup action plan report, prior to the selection of the final cleanup action, as specified in WAC 173-340-380. Public concerns will be considered when finalizing cleanup alternatives and the final cleanup action plan, as applicable.

Further discussion of public concerns is incorporated into the disproportionate cost analysis section for AOC A-14 (Section 5.2.2 and 5.2.3) as required under WAC 173-340-360(3)(f)(vii).

5.2 Evaluation and Comparison of Alternatives—AOC A-14

This section evaluates and compares the adequacy of each SFS alternative for AOC A-14 relative to the criteria discussed in Section 5.1. The comparative analysis of the alternatives is organized by comparison to threshold requirements in Section 5.2.1 and other requirements in Sections 5.2.2, 5.2.3, and 5.2.4.

5.2.1 Threshold Requirements

For an alternative to achieve the threshold requirements, it must adequately protect human health and the environment, comply with cleanup standards, comply with state and federal laws, and provide for compliance monitoring. Threshold requirements are evaluated for SFS remedial alternatives (D1, D6, D7, and D8) in Table 5-1 and summarized below:

- Protection of human health and the environment: Each of the SFS remedial alternatives is protective of human health and the environment by reducing Site risks, addressing potential future exposure pathways, protecting human and ecological receptors, and improving overall environmental quality. There is no current risk above heath-based screening criteria to human health.
- Compliance with cleanup standards: Each of the SFS remedial alternatives complies with the cleanup standards. Applicable soil pCULs will meet the criteria in WAC 173-340-740(6)(f) through containment and institutional controls (per WAC 173-340-440) and will comply with groundwater standards once the MNA portion of the remedy is completed.
- Compliance with applicable state and federal laws: Each of the SFS remedial alternatives would comply with applicable state and federal laws (ARARs; summarized in the draft FS) or as otherwise applicable through proper development of cleanup levels (see Section 1.3).
- Provisions for compliance monitoring: All SFS alternatives include compliance monitoring (protection monitoring, performance monitoring, and confirmation monitoring) as required under WAC 173-340-410 and WAC 173-340-720 through -760.

As demonstrated, each of the cleanup action alternatives meets all of the MTCA threshold requirements. Each SFS alternative is a viable and appropriate cleanup alternative under MTCA.

5.2.2 Permanent Solutions to the Maximum Extent Practicable

One of the requirements for selecting a site cleanup action is to evaluate whether a cleanup alternative is permanent to the maximum extent practicable (WAC 173-340-360[2][b][i]). As described in Section 5.1.2.1, a DCA is performed to make this determination. Each of the remedial alternatives is evaluated using the DCA criteria identified in WAC 173-340-360(3)(f)(i-vii) and listed in Section 5.1.2.1. The results of the DCA are presented in Tables 5-2 and 5-3 and Figures 5-1 and 5-2. A summary of the costs is presented in Table 5-4. A breakdown of these costs is presented in Appendix F.

A brief summary of the justification for the DCA criteria rankings given for each alternative is provided below. The summary is intended to be used in conjunction with Table 5-2, which provides a more complete summary of the rankings and considerations for each criteria and alternative.

- ***Protectiveness.*** All SFS alternatives are ranked equally for protectiveness. There are no unacceptable risks to human health and the environment under current conditions, as described in the draft FS report. There are no concentrations of CVOCs detected above Site-specific health risk-based criteria in the Chicago Avenue ditch or the Auburn 400 stormwater basins,[23] so there is no alteration in protectiveness for implementation of EISB at any of the focus areas. All four alternatives rely on MNA to achieve the cleanup standards throughout the plumes; therefore, the time required to reduce the risk at the Site does not change significantly (only up to an estimated 15 percent decrease restoration time frame) no matter which alternative is selected (see Section 5.2.4). After completion of implementation of any of the alternatives, the improvement of overall environmental quality would be the same (the same cleanup standards would be met Site-wide no matter which alternative is implemented).
- ***Permanence.*** All SFS alternatives received high rankings for permanence because each alternative permanently treats groundwater and reduces the quantity and mobility of Site contamination through irreversible *in situ* biological destruction of contaminant mass. Alternatives D6, D7, and D8 were given increasingly slightly higher rankings than D1 because the focus area EISB injections include more rapid mass reduction in shallow, intermediate, and/or deep groundwater zones in the respective focus areas being treated.
- ***Effectiveness over the long term.*** All SFS alternatives are ranked equally for long-term effectiveness. The long-term groundwater treatment effectiveness for each remedy relies primarily on natural degradation processes to provide *in situ* destruction and detoxification to reach the groundwater pCULs. There are no unacceptable risks (no concentrations above Site-specific health-based risk thresholds) to human health and the environment throughout the duration of cleanup under any of the alternatives. Implementation of additional technologies therefore provides no additional effectiveness at reducing risk and no additional certainty that the alternatives would be successful at meeting pCULs since meeting pCULs is dependent on MNA and not the bioremediation injections. Concentrations are maintained by back diffusion throughout the Site; therefore, MNA will be the primary mechanism to meet pCULs. It is also unlikely that implementation of any currently available treatment technology can meet SWQS in groundwater Site-wide in a reasonable restoration time frame because of the very low limits (near laboratory detection limits), heterogeneity of the aquifer, the diffuse nature and extent of the CVOC plumes, and the potential to reach asymptotic concentration thresholds.[24] The values provided in Table 5-3 are assuming groundwater pCULs. If Ecology requires SWQS in groundwater, a lower value (3) for long-term effectiveness would be used instead of the current value due to the uncertainty of reaching SWQS for any available treatment alternative.
- ***Management of short-term risks.*** Alternative D1 received the highest benefit ranking for the management of short-term risk criteria because it includes no additional construction or

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[23] The Chicago Avenue ditch and the Auburn 400 basins are stormwater features and the concentrations of CVOCs detected in these stormwater features are well below risk levels protective of human health calculated by Washington Department of Health (WDOH; WDOH 2013, 2014). In addition, surface water cleanup levels are based on use as drinking water and human consumption of fish. Stormwater cannot be used as drinking water and no edible fish are present in stormwater features.

[24] See additional discussion in Section 3.2.2.3 of the draft FS.

operations and maintenance activities that could pose a risk to Site workers. Alternatives D6 through D8 received lower benefit rankings for short-term risks because of potential health and safety risks to Site workers (e.g., working around drill rigs, heavy equipment, pumps and pressurized lines), potential impacts to water in the Chicago Avenue ditch if injected donor substrate were to discharge to the ditch, Site infrastructure during implementation (e.g., impacts to stormwater or surface water features based on location of injection activities, possible impacts to stormwater drains or other utilities), and surrounding areas (more traffic use and distractions to residential, commercial users of these areas). Alternative D7 has a slightly lower score than D6 due to the extra risks involved with implementation at the 17-07 property boundary focus in addition to the Algona focus area. Alternative D8 has a much lower benefit ranking than D6 and D7 due to the significant increase in injection work that would be necessary and location of the injection infrastructure and work around The Outlet Collection mall (increased risk for damaging infrastructure, high vehicular and pedestrian traffic in busy mall parking areas with a large amount of infrastructure with traffic).

- ***Technical and administrative implementability.*** Alternative D1 received the highest benefit ranking for technical and administrative implementability criteria because it includes no additional construction or operations and maintenance,[25] and no permitting or other administrative challenges. Alternatives D6 through D8 received lower benefit rankings for technical and administrative implementability criteria. Alternatives D6 through D8 present access constraints because of the large number of required well installations and underground injection control (UIC) permits, and are difficult to implement technically because of the injections close to stormwater and/or surface water features that could cause water quality impacts in or potentially downgradient of those features if injected donor substrate were to discharge to them. Alternatives D7 and D8 have lower benefit rankings than Alternative D6 because of greater implementation challenges: The timeline to complete injection activities for these alternatives is greater (18 weeks per injection event at the 17-07 property boundary focus area, and more than 1.5 years per injection event at The Outlet Collection focus area); each alternative includes more and larger areas of injections where protection of utilities and infrastructure is required, as well as avoiding impacts to stormwater and/or surface water features; and each includes greater UIC permitting efforts.
- ***Consideration of public concerns.***[26] Alternatives D6 and D7 are ranked the highest for consideration of public concerns because they address potential public concerns or perceptions surrounding injection activities providing more rapid reduction of contaminant concentrations in the northern residential Algona area (even though CVOC concentrations currently present are below Site-specific risk-based health thresholds). Although Alternative D8 also includes injection activities in the Algona focus area, Alternative D8 has a lower ranking due to the negative impacts to property use and operations (each injection would last 1.5 years and cause closure of a large area of The Outlet Collection parking lot with equipment and injection solution left onsite) around The Outlet Collection. Alternatives D6 through D8 would also have potentially negative impacts to offsite property use and operations that

[25] The length of time groundwater monitoring would be required would be reduced slightly for Alternatives D7 and D8; but the long-term monitoring implementability is insignificant compared to EISB operations and maintenance.

[26] For consideration of public concerns, a high ranking means that it is assumed the public would not have as many concerns about this alternative. A low ranking means that it is assumed that public would have more concerns about this alternative.

would likely increase public concern.[27] The duration of treatment activities in public areas may create concerns related to lost revenue for commercial businesses, impact of additional traffic on roadways and noise, and concern about use of injection solution (can be perceived as chemicals, even though injection solution is non-toxic) in public areas around The Outlet Collection or businesses at the injection location upgradient of residential Algona. Alternative D1 is ranked lowest for consideration of public concern; the public may have heightened concerns about this alternative because of difficulty understanding that MNA is considered an active treatment, difficulty understanding the treatment mechanisms that occur as part of MNA, and an inaccurate perception that it is less protective. Potential public concerns about MNA treatment can be addressed with a well-executed public outreach plan. All the SFS alternatives are protective of human health and the environment. Public concerns related to all the alternatives will be considered and addressed in the same manner by responding to comments received during the required public comment period for the FS (and possibly the cleanup action plan), as part of the cleanup process under MTCA.

Based on these benefit rankings for each criteria and the assigned weighting factors,[28] the overall weighted benefit score for each alternative, from highest (best) to lowest (worst) is as follows:

- Alternative D1: 6.8
- Alternative D6: 6.3
- Alternative D7: 6.3
- Alternative D8: 5.5

Cost: The above benefit rankings do not consider cost. The final DCA criterion to be evaluated is the cost of each alternative (WAC 173-340-360[3][f][iii]).[29] As summarized below, Alternative D1 is the least expensive alternative and Alternative D8 is the most expensive. Cost breakdowns for the alternatives are provided in Table 5-4.

[27] Alternatives D6, D7, and D8 include injection activities on commercial properties in Algona (Primus Building and others) and in Auburn (at The Outlet Collection). The duration of each injection event at the commercial area in Algona would last approximately 6 weeks. Due to the amount of injection solution and size of the injection area needed at The Outlet Collection, each injection event would last approximately one and a half years. This length of injection activities would have a considerable impact on the business activities in both commercial Algona and at The Outlet Collection.

[28] Note that the use of weighting factors is not specifically included under MTCA; however, it has become a widely used and accepted practice by the regulated community and Ecology to assign weighting to the DCA criteria (Whatcom County Superior Court 2007, Ecology 2008). The weighting factors identified herein are typical for FS DCA evaluations performed under MTCA; protectiveness, permanence, and long-term effectiveness criteria are typically weighted more heavily "since they are core to protecting human health and the environment" (Ecology 2017a). Ecology guidance accepts and authorizes the use of alternative ranking and DCA criteria weighting. Boeing used the weights provided in Appendix H, Section H.1.4 (Ecology 2017a) in this FS DCA.

[29] Present value costs are required to be used for cost estimating per WAC 173-340-360(3)(f)(iii). EPA recommendations include a present value cost-estimating discount rate that is significantly out of date (October 1992). It is more appropriate and realistic to use applicable updated Office of Management and Budget (OMB)-published discount rates (i.e., OMB Circular A-94 Appendix C, revised November 2019) for the FS evaluation. The current real discount rate for a 30-year note is 0.4 percent (OMB Circular A-94 Appendix C, revised November 2019). Note that the real discount rate used in the draft FS was 1.5 percent based on the November 2018 OMB-published discount rates.

Alternative	Cost Summary	
	Remedy to Meet GW pCULs	Remedy to Meet SWQS in GW
Alternative D1	$2.30M present value ($2.46M undiscounted)	$9.61M present value ($11.7M undiscounted)
Alternative D6	$4.74M present value ($4.98M undiscounted)	$11.8M present value ($14.0M undiscounted)
Alternative D7	$11.2M present value ($12.1M undiscounted)	$18.1M present value ($20.9M undiscounted)
Alternative D8	$39.8M present value ($41.5M undiscounted)	$46.0M present value ($49.1M undiscounted)

Abbreviations and Acronyms:
GW = groundwater
M = million
pCULs = proposed cleanup levels
SWQS = surface water quality standards

5.2.3 Conclusion of Disproportionate Cost Analysis

To provide a direct quantitative metric for comparison of the costs and benefits of each alternative (WAC 173-340-360[3][e][ii][C]), a benefit-to-cost ratio was calculated for each. The overall benefit score for each alternative (as provided above) was divided by the overall cost (also provided above), then multiplied by the cost of the lowest cost alternative to normalize and scale the data to fit on the charts shown on Figures 5-1 and 5-2. This benefit-to-cost ratio provides a metric to evaluate whether the cost of each alternative is commensurate with its benefits. The most practicable permanent alternative is considered "permanent to the maximum extent practicable," so long as its benefits are not disproportionate to its costs as determined by comparison to other alternatives with higher benefit-to-cost ratios.

Using this methodology, the benefit-to-cost ratio for each of the alternatives for either meeting groundwater pCULs or SWQS in groundwater was calculated to be:

Alternative	Benefit-to-Cost Ratio	
	Remedy to Meet GW pCULs	Remedy to Meet SWQS in GW
Alternative D1	6.8	6.8
Alternative D6	3.1	5.1
Alternative D7	1.3	3.3
Alternative D8	0.3	1.1

Alternative D1 is the SFS alternative considered permanent to the maximum extent practicable per WAC 173-340-360(3)(e)(ii)(B). Alternative D1 consists of MNA for Site-wide groundwater and containment and institutional controls for Facility soil. The complete DCA analysis is presented in Table 5-3, and the rankings and associated rationale for the various rankings are presented in Table

5-2. The results of the relative cost and benefit analysis for each alternative, and the comparison between each, are provided in graphical format on Figures 5-1 and 5-2.

Based on the results of the DCA evaluation, **Alternative D1 is permanent to the maximum extent practicable.** Because Alternative D1 has both the highest benefit score and lowest cost, it logically also has the highest cost-to-benefit ratio over higher cost alternatives (as illustrated on Figures 5-1 and 5-2, which shows a peak in the benefit-to-cost ratio at Alternative D1). This indicates that more expensive alternatives are disproportionately costly to their benefits, and therefore, cannot be considered permanent to the maximum extent practicable. Alternative D1 also uses and takes advantage of active and naturally occurring contaminant degradation and treatment processes (that are also required in order to meet the cleanup standards under any of the alternatives), is permanent and protective of human health and the environment, and minimizes potential implementation risks to workers and public/commercial areas in the vicinity. There is no current risk above heath-based screening criteria to human health or the environment. MNA is a component of all of the SFS alternatives to meet cleanup levels.

5.2.4 Restoration Time Frame

This section evaluates whether each of the SFS remedial alternatives provides for a reasonable restoration time frame, as required under WAC 173-340-360(2)(b)(ii). The restoration time frame is defined in MTCA as "the period of time needed to achieve the required cleanup levels at the points of compliance established for the site" (WAC 173-340-200). Per WAC 173-340-360(4)(b), the selected alternative must meet the cleanup levels within a reasonable time frame based on the eight factors identified in Section 5.1.2.2 and WAC 173-340-360(4)(b)(i-ix).

Based on the restoration time frame evaluation conducted in the draft FS and as modified for this SFS below, if required to meet the SWQS in groundwater, none of the alternatives can achieve a reasonable restoration time frame at the standard point of compliance and there are no available remedial technologies that can achieve a reasonable restoration time frame.[30] However, the restoration time frame to meet the pCULs protective of drinking water at the standard point of compliance is considered reasonable for each alternative. A summary of the estimated restoration time frames for each remedial alternative and how each of the associated factors relates to "reasonableness" is summarized in Table 5-1.

5.2.4.1 Site-Wide

Estimated restoration time frames for Site-wide cleanup were determined based on evaluation of individual well point attenuation rates and corresponding restoration time frames from TCE and VC concentrations over time (data from 2011 through 2018). The specific methodology for the restoration time frame calculations is described in Appendix D. The reduction of overall restoration

[30] See discussion in Section 3.2.2.3 of the draft FS.

time frames for the different remediation alternatives was determined using the predictive numerical groundwater transport model as described in Appendix C. The estimated approximate restoration time frames for each alternative are as follows:

SFS Alternative	Contaminant Transport Model Site-Wide Alternatives Comparison (Percent [%] Reduction Compared to Alternative D1)	Estimated Restoration Time Frame	
		Years to Meet pCULs Protective of Drinking Water	Years to Meet SWQS in GW
Alternative D1	--	30	100
Alternative D6	0%	30	100
Alternative D7	3%	29	97
Alternative D8	15%	25	85

The calculations and the modeling demonstrate that Site-wide restoration time frames for AOC A-14 are estimated to be 25–30 years to meet pCULs protective of drinking water and 85–100 years to meet SWQS in groundwater, regardless of what remedial action alternative is selected.

The long restoration time frames to meet SWQS for all of the alternatives are a function of the extremely low SWQS values, the nature and extent of the contaminant distribution within the aquifer, and the size and heterogeneity of the aquifer.[31] Persistent low concentrations in groundwater are driven by rate-limited desorption and back diffusion processes from low permeability layers within the aquifer. This late-stage plume concept is well documented and known to sustain low contaminant concentrations for long periods of time (Kueper et al. 2014). When combined with very low cleanup levels, the resulting restoration time frames are extensive. Currently available remedial technologies provide little benefit with respect to back diffusion (Seyedabbasi et al. 2012, Kueper et al. 2014). This lack of effectiveness is related to the technical difficulty of accessing the sequestered mass in lower permeability portions of the aquifer. In aquifers dominated by back diffusion, the decline in concentration exhibits a tailing effect that results in slower and slower rates of reduction in concentration as concentrations become lower. This type of tailing effect magnifies the difficulty of achieving very low concentration cleanup levels in short periods of time. This type of tailing effect also explains why it is so much more difficult to achieve SWQS than drinking water standards in groundwater in a reasonable time frame, if ever. Though still considered technically difficult to achieve, the practicability and likelihood of achieving the pCULs protective of drinking water standards Site-wide is far greater than that of achieving SWQS in groundwater.

5.2.4.2 Northern Algona Residential Area

In addition to the restoration time frame analysis Site-wide, additional analysis was also completed specifically for the northern Algona residential area (Algona residential area) due to the potential public concerns Ecology noted in this area (see Figure 3-3). To address these potential concerns,

[31] See additional discussion in Section 2.2 of the draft FS.

model simulations and restoration time frame analyses were also completed specifically for the shallow zone in the Algona residential area.

Numerical modeling results indicate that TCE concentrations would fall below SWQS in the shallow zone in 18 years (Appendix C). Note, however, that based on individual well point attenuation data, VC is the driving constituent for restoration time frames in the Algona residential area (Appendix D). VC was not modeled independently with the numerical model. Based on individual well point attenuation data, SWQS for VC are indicated to be met in the Algona residential area in approximately 30 to 50 years (see Figure 3-4). Based on individual well data, drinking water standards are already met in the majority of the Algona residential area. Wells that have calculatable restoration time frames (3 wells in the Algona residential area with decreasing concentration trends) show 1 to 22 years to meet drinking water standards (see Figure 3-3).

Each SFS alternative was evaluated for the effects of TCE concentration reductions in the Algona residential area. Modeled results for the Algona residential area show the following comparison of different alternatives:

SFS Alternative	Contaminant Transport Model Algona Residential Area Shallow Zone Restoration Time Frames (Percent [%] Reduction Compared to Alternative D1)
Alternative D1	--
Alternative D6	56%
Alternative D7	56%
Alternative D8	56%

Numerical modeling results for TCE indicate that EISB in the Algona focus area (Alternative D6) reduces the restoration time frame to reach SWQS in shallow groundwater beneath the Algona residential area to 8 years (approximately 56 percent reduction compared to Alternative D1). As discussed above, this restoration time frame does not account for VC and back diffusion and, therefore, restoration time frames could be significantly longer. For example, if the 56 percent reduction were applied to the individual well restoration time frames for VC, the restoration time frame could be in the range of approximately 13 to 22 years for SWQS. Drinking water standards are already met in the majority of the Algona residential area. For the wells with calculatable individual well restoration time frames (i.e., those wells with decreasing trends) for drinking water standards, the 56 percent reduction could result in an approximate restoration time frame of 10 years for VC.

Alternatives D7 and D8 do not provide any anticipated additional benefit to the Algona residential area beyond that provided by Alternative D6 because the focused EISB treatment area upgradient of TCE contamination in the Algona residential area provides the greatest level of direct impact to cleanup in this area. Additionally, numerical modeling results show that upgradient TCE concentrations (e.g., currently elevated concentrations in the vicinity of the 17-07 property boundary) appear to move towards the northwest rather than moving towards the Algona residential area (See Appendix C). Therefore, it logically follows that the model results show no additional change to the shallow zone restoration time frames for the addition of the 17-07 property boundary EISB compared to EISB in the Algona focus area only. The addition of EISB for The Outlet Collection focus area for Alternative D8 does not impact the Algona residential area. The Outlet Collection is cross-gradient of the Algona residential area and EISB at The Outlet Collection has no impact on the Algona residential area.

6.0 SELECTED CLEANUP ACTION ALTERNATIVE – AOC A-14

As determined in this SFS and summarized below, Alternative D1 is permanent to the maximum extent practicable and is the preferred remedy for AOC A-14 at the Site. Alternative D8, including The Outlet Collection focus area EISB, is both technically infeasible and would be disproportionately costly to implement, as demonstrated in Section 5.0. Alternative D7, including the 17-07 property boundary focus area EISB, does not significantly impact the Site-wide restoration time frame or provide any additional impact or protectiveness to the Algona residential area and would be disproportionately costly to implement. Therefore, Alternative D6, including an injection area upgradient of the Algona residential area is the only reasonable EISB alternative. The focused EISB treatment area directly upgradient of the Algona residential area (Algona focus area EISB) provides the only direct impact to cleanup in this area. An EISB treatment would only be reasonably selected to address potential public concerns or perceptions identified by Ecology in the Algona residential area. However, Alternative D6 was also determined to be disproportionately costly to implement (i.e., not permanent to the maximum extent practicable) through the DCA analysis and does not decrease the Site-wide restoration time frame.

Alternative D1 (Site-wide MNA) was the selected cleanup action alternative for AOC A-14 as determined by the DCA analysis discussed in Section 5.2.3 that follows MTCA requirements. Selection of Alternative D1 is primarily based on the following:

- Alternative D1 achieves each of the threshold requirements as described in Section 5.2.1.
- The results of the DCA in Section 5.2.3 demonstrate that Alternative D1 uses permanent solutions to the maximum extent practicable. Alternative D1 received both the highest benefit score and received the highest benefit-to-cost score.
- Alternative D1 uses and takes advantage of active and naturally occurring contaminant degradation and treatment processes (that would be required to meet the cleanup standards under any of the alternatives).
- Alternative D1 is permanent and protective of human health and the environment; currently there are no unacceptable risks to human health and the environment. Potential future Site risks, if any, will be eliminated through the cleanup of groundwater and surface water.
- Alternative D1 provides the lowest potential implementation risks to workers and public/commercial areas in the vicinity of each of the alternatives.
- Contaminated soil is limited to a small area underneath pavement or buildings and does not exceed Method C direct contact cleanup levels. Surface water downgradient of the Site and contaminated groundwater are not being used as drinking water and therefore do not pose unacceptable risk from VOCs in groundwater (AOC A-14).

Although the evaluation of cleanup alternatives in Sections 4.0 and 5.0 included the standard POC, if Ecology requires cleanup of groundwater to the SWQS, a CPOC for AOC A-14 at either the Facility boundary as provided for under WAC 173-340-720(8)(c), or as an area-wide CPOC as allowable under WAC 173-340-720(8)(d)(iii) should be authorized by Ecology. It can be demonstrated that "it is not practicable to meet the cleanup level through the Site within a reasonable restoration time frame" (WAC 173-340-720[8][c]) if groundwater is required to meet SWQS. Achieving SWQS in groundwater Site-wide would increase the restoration time frames to approximately 85 to 100 years (compared to 25 to 30 years for drinking water standards), and cannot be accomplished in a reasonable time frame, if ever. In addition, RELs are appropriate for use for AOC-14 given the size of the plume, length of restoration time frame, and alternatives evaluated. Details of how RELs will be used will be presented in the cleanup action plan.

7.0 USE OF THIS REPORT

This report has been prepared for the exclusive use of The Boeing Company and applicable regulatory agencies for specific application to the Boeing Auburn project. No other party is entitled to rely on the information, conclusions, and recommendations included in this document without the express written consent of LAI. Further, the reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by LAI, shall be at the user's sole risk. LAI warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. LAI makes no other warranty, either express or implied.

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