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August 18, 2016

Ms. Debbie Taege
The Boeing Company
EHS Remediation Group
PO Box 3707 Mail Code 9U4-26
Seattle, WA 98124-2207

Re: Ecology Contingent Approval and Modifications to the Draft Boeing Everett Uplands and Powder Mill Gulch Feasibility Study (FS) Report, dated November 13, 2015

Dear Ms. Taege:

Thank you for submitting the Draft Boeing Everett Uplands and Powder Mill Gulch Feasibility Study Report (FS Report), dated November 13, 2015. The Department of Ecology (Ecology) received the FS Report on November 17, 2015 and received missing sections 9 and 10 of the Report on December 10, 2015 (at Ecology's request). The Boeing Company (Boeing) was required to submit this FS Report per the provisions of the Agreed Order, DE 96HS-N274 (AO), and the schedule contained in the Ecology-approved Uplands FS Work Plan.

Subsequently, Ecology also received Esperance Sand Aquifer upgradient groundwater data on May 23rd and June 3rd, and indoor air sample results on June 10, 2016. These data submittals were required by Ecology as Additional Work under the AO in order to help Ecology resolve data gaps in the FS Report.

Ecology appreciates Boeing's efforts to prepare this large FS Report. We also appreciate the company's installation and sampling of an additional upgradient groundwater well, and the sampling of indoor air in five additional Boeing Everett buildings. Ecology shares Boeing's goal of finalizing remedy selection for the Uplands and Powder Mill Gulch (PMG) area and moving on to implementation as soon as possible.

Ecology carefully reviewed and considered all of Boeing's preferred remedies for each of the Upland and PMG solid waste management units (SWMUs). For many Boeing Everett facility SWMUs, Ecology's preferred remedial alternative is the same as Boeing's. In some instances, Ecology added requirements so that the alternative would be fully compliant with the Model Toxics Control Act (MTCA) regulations, but the basic remedial technology is the same. For two

SWMUs (Powder Mill Gulch and SWMU 171), Ecology's preferred alternative is significantly different than what Boeing proposed, and this is due to our determination that a different remedial technology is appropriate for those SWMUs per the MTCA regulations.

Based on our review of the FS Report, and consistent with the MTCA regulations, Ecology concludes that it is not necessary to revise the document. Subject to Ecology's final determination after public notice and comment, Ecology believes that the FS Report contains sufficient information for Ecology to select preferred remedial alternatives for each of the identified SWMUs at the Boeing Everett plant. We do not believe a revision would alter our decision.

The FS Report's primary purpose is to evaluate a number of candidate alternatives for potential implementation as the final remedy at the Boeing Everett site. To move forward and complete the FS it is not necessary for Boeing and Ecology to arrive at consensus on the entire content of the FS Report. In this letter, then, Ecology has not listed every statement in the FS Report that we do not approve, or provided revised statements which we can approve. Instead we have only identified those statements in Boeing's FS Report which we disagree with and where the disagreement, from our perspective, is the most consequential in terms of Ecology's selection of site-wide final remedies. These statements are described and discussed in Attachments A, B, and C.

To reiterate, Ecology does not request nor is Boeing required to submit another revised FS Report. The approved Public Review FS Report shall consist of the November 13, 2015 FS Report as modified by Attachments A, B, and C of this letter. This contingent approval process is, in our view, the fastest and most cost-efficient way to complete the FS and move towards ultimate remedy implementation in the Uplands and PMG areas.

If Boeing has disagreements with Ecology decisions in portions of this cover letter or Attachments A, B, or C, the company may request a meeting. The meeting request should include clear and brief descriptions of all points of disagreement or questions (see AO Section VII.4). If Boeing does not choose to request a meeting or agrees to accept Ecology's contingent approval letter (including the requirements set forth in Attachments A, B, and C), Ecology will consider that dispute resolution under the AO was not invoked and we will begin preparations for a formal RI/FS public comment period.

After Ecology considers public comments on the RI and FS reports and our preliminary preferred remedial alternatives, Boeing will be asked to develop and submit a Draft Cleanup Action Plan (DCAP). The DCAP should be prepared as required under the provisions of AO DE 96HS-N274, and provide a general description of Ecology's proposed cleanup action (in accordance with WAC 173-340-380).

If you have any questions regarding this letter, or need clarifications or wish to schedule a follow-up meeting, contact me at (425) 649-7264.

Sincerely,

Dean Yasuda

Dean Yasuda, P.E.
Environmental Engineer
Hazardous Waste & Toxics Reduction Program

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Attachment A: Summary of Ecology Preliminary Determination for Selected Remedies for the Boeing Everett Solid Waste Management Units

Caveat: the public has not been formally asked to comment on the RI Report, the FS, or a CAP yet. What follows, therefore, is a preliminary determination by Ecology prior to receiving comments during the FS formal comment period. Ecology may revise these determinations after the FS formal comment period.

Ecology made the preliminary determination that the remedial actions proposed to the public in a draft Cleanup Action Plan should include the following:

General Requirements:

1. Ecology is not approving use of passive diffusion bag (PDB) samplers at this time. Ecology responded to the use of PDBs (in lieu of low flow sampling with dedicated bladder pumps) several years ago. At that time Ecology requested a statistically based side-by-side PDB vs bladder pump sampling work plan for implementation. During those work plan discussions, Boeing decided not to pursue PDB use and agreed to continue with groundwater sampling with dedicated bladder pumps. If Boeing wishes to again consider the use of PDB sampler in lieu of dedicated bladder pumps, the same side by side sampling work plan must still be submitted and approved by Ecology. Ecology would be willing to entertain discussions for such a proposal only after the cleanup action plan is finalized in order to prevent delays approving the FS and cleanup action plan.

2. Minimum requirements for cleanup actions include the threshold requirement to "provide for compliance monitoring" and is usually addressed in a Compliance Monitoring Plan (see WAC 173-340-410 and -720(9)). The Compliance Monitoring Plan is typically prepared and submitted in the later stages of the Design process, and is often included in the final Engineering Design Report. Boeing made assumptions regarding groundwater sampling frequencies for various SWMUs in the FS report in order to better estimate alternative costs. But Ecology is not approving any of the proposed groundwater sampling frequencies at this time. During cleanup action plan development, groundwater sampling frequencies for the preferred alternative can be conceptually discussed so that the document can contain a general description of likely monitoring requirements. Selection of specific monitoring goals, and determining how those goals should be measured, however, should await the remedial Design phase.

3. Where Ecology's preferred remedial alternative relies on containment of contamination rather than removal or in-situ treatment, Boeing is required to identify and implement contingency remedial actions if:

    a) contaminated groundwater from this SWMU is detected in the Esperance Sand Aquifer;

b) new data or information suggests that the FS Vadose Zone Model (Appendix B) is less conservative than currently assumed, and the potential for contaminating the Esperance Sand Aquifer exists; or,
c) contaminants are known to be migrating away from their current location (containment failure) at rates that make containment by itself ineffective.

Boeing is required to evaluate at least the following contingent remedial action options: removal of existing subsurface contamination above cleanup levels, in-situ treatment of subsurface contamination above cleanup levels, other actions to meet cleanup standards and prevent further migration of contamination vertically or laterally. Further contingent remedial action evaluation is required during the development of the draft cleanup action plan (dCAP) and engineering design report (EDR).

Containment remedial actions that are implemented at outdoor SWMUs require low permeability or sealed concrete cover and sealed joints to prevent water infiltration. They also require quarterly inspections for concrete and joint seal integrity, routine maintenance, and, if necessary, repair. Quarterly inspection reports shall be submitted to Ecology within 30 calendar days of the end of each quarter. They shall contain: conditions observed during the inspection, (any) recommended actions, and a description of any restoration, improvement and other corrective action work needed or taken to maintain a low permeability (7E-12 cm^2 per Appendix B) cover.

4. The dCAP and EDR will need to state that if Ecology determines that the selected remedial action cannot attain cleanup levels at the standard point of compliance in any contaminated media within a reasonable timeframe, Boeing shall provide Ecology with a contingency remedial action plan. The purpose of the contingency action proposed in that plan will be to meet cleanup standards within a reasonable timeframe. Boeing shall implement the contingency remedial action plan after approval by Ecology.

5. Financial assurance is required for all near and long terms costs for cleanup actions conducted under RCRA and MTCA, including: maintenance of institutional controls and environmental covenants; ongoing operation and maintenance (O&M) work; and, long term monitoring and repair costs until cleanup standards are met.

6. Within 30 calendar days of receipt of Ecology's letter, Boeing shall submit revised Tables 5-1 through 5-11 that include individual chemical hazard quotients and individual excess carcinogenic risks. In addition, the tables shall include the sum of hazard quotients (hazard index) and summed excess carcinogenic risk for each chemical, pathway, and media.

7. The Ecology Water Quality Program has finalized its revisions to Chapter 173-201A WAC regulations on August 1, 2016, in response to EPA's revised 40 CFR Part 131 NTR water quality criteria. This regulatory revision was a several year process and updates surface water quality standards to include human health criteria. These regulatory revisions will reduce TCE surface water and groundwater cleanup levels as applicable ARARs. The revisions also increase other surface water and groundwater cleanup levels. Ecology

included these revised ARARs into the determination of appropriate cleanup levels for the Site.

8. For those soil cleanup actions under WAC 173-340-740(6)(f), Ecology recognizes that cleanup actions requiring containment of hazardous substances rather than removal will not meet soil cleanup levels at the standard soil point of compliance. However, Ecology expects the requirements of WAC 173-340-740(6)(f)(i) through (vi) are met.

SWMU Specific Requirements:

Exposure Pathway Model (EPM) A:

Based on the low concentrations of contaminants and low volumes of perched groundwater at these SWMUs, Ecology believes the likelihood of contaminated perched groundwater migrating to the Esperance Sand Aquifer is unlikely under WAC 173-340-720(2)(c). Therefore, based on current information, Ecology is not requiring Boeing meet soil cleanup levels protective of the more stringent potable groundwater cleanup levels based on water quality ARARs.

SWMU 090, Building 40-51 Former UST EV-11 (outdoor unit):
Ecology's preferred remedy is the same as Boeing's preferred remedy: Alternative 1 – Maintain Containment. Ecology understands that the contaminated perched groundwater is limited to fill soils near the southwest corner of the building. As part of the preferred action, Boeing is required to conduct routine indoor air and sub-slab vapor sampling in the southwest side of this building. Institutional controls will be required to provide and implement an adequate health and safety plan for workers exposed to contaminated subsurface soils and perched groundwater.[1]

SWMU 112, Building 40-11, Oil Water Separator (outdoor unit):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment and Institutional Controls. Based on measurements of the most recent soil gas contaminant concentrations at this SWMU, routine soil gas and potentially indoor air sampling at the nearby building will be required.[1]

SWMU 151 Building 40-51, Southern Air Scrubber Sump (outdoor unit):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment and Institutional Controls.[1]

EPM B:

SWMU 086, 089, 094, Building 40-56 Former Silkscreen USTs (outdoors):
Ecology's preferred remedy is the same as Boeing's:[2] Alternative 2 Soil Vapor Extraction, Groundwater Extraction, Institutional Controls and Monitoring. Ecology notes that an additional cleanup requirement for this SWMU (per WAC 173-340-747(2)(b)) is that the *soil concentration shall not result in the accumulation of nonaqueous phase liquid on or in ground water*. In addition, as part of the preferred alternative the groundwater extraction/containment system will be optimized for more effective containment and removal of the contaminated groundwater.

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[1] Shallow (1.25 foot depth) TCE soil gas concentrations have been measured above Ecology's sub-slab vapor screening levels. Ecology will therefore require that Boeing apply the EPA Region 9 (2014) short-term TCE action level of 8 µg/m3 as a maximum allowable TCE exposure concentration for a female construction ("trenching") worker that may be the first trimester of pregnancy.

[2] Alternative 1(site monitoring and site cover) cannot be the most permanent remedy because it does not meet threshold requirement for achieving groundwater cleanup levels. Furthermore, it will not provide for a reasonable timeframe and over-relies on dilution (see WAC 173-340-360(2)(a), (b) and (e)). Installation of new low permeability (or significant modification of the current) surface cover and its effectiveness is uncertain since it is not clear if rainwater is infiltrating through the current cover directly above the SWMU or if rainwater (or leaking water lines) is infiltrating at a distance from the SWMU and flowing under the SWMU.

Based on the effectiveness of soil and groundwater treatment, routine indoor air and sub-slab vapor (SSV) sampling may also be required on the south side of this building (near SWMUs 086, 089, and 094). The need for further routine indoor air and soil gas (SG) sampling, once groundwater and soil cleanup levels are met, will be dependent on meeting Method C air cleanup levels in indoor air and Ecology's soil gas and sub-slab screening levels, protective of those indoor air levels (both levels are now available in the CLARC database).[3] Ecology's preferred alternative also requires deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer (as indicated by the vadose zone model, Appendix B of the FS report).

The FS report indicates that this alternative can be implemented without significantly interfering with current building operations.[4] That is an important consideration. However, if alternative 2 is not successful in meeting soil and groundwater cleanup levels in a reasonable timeframe, Boeing will be required to prepare a contingent remedy work plan for Ecology's review and approval. This contingent remedy work plan will evaluate other technologies, including near-term excavation and dewatering (alternative 3), and propose a preferred action for implementation.

Furthermore, Boeing's proposed risk-based soil cleanup levels protective of potable groundwater, must be revised for three compounds. The levels for ethylbenzene, toluene and xylene in the Esperance Sand Aquifer do not properly consider State and Federal Water Quality (National Toxics Rule 40CFR131 and the 2015 updated National Recommend Water Quality Criteria – Human Health[5] criteria under Section 304(a) of the Clean Water Act) and Federal Groundwater MCL ARARs. These ARAR concentrations must be used in determining MTCA Method B groundwater cleanup levels.

Revised ethylbenzene, toluene and total xylene soil, perched groundwater and Esperance Sand Aquifer cleanup levels are calculated as such:

Compound	Soil Cleanup Level Protective of Esperance Sand Aquifer	Perched Groundwater Cleanup Level, Non-potable (inhalation + dermal)[6]	Esperance Sand Aquifer Cleanup Level used as basis for soil cleanup level
	(mg/kg)	(µg/L)	(µg/L)
Ethylbenzene	0.60	4300	68[7]
Toluene	0.41	15,100	57[8]

[3] Due to the shallow perched groundwater in the area and shallow vadose zone soil contamination, use of Ecology's groundwater VI screening levels (also in CLARC) is not appropriate.

[4] Refer to Page 8-12, which states, *Alternative 2 is the next most implementable because construction and operation of an SVE system is comparatively straightforward, without significant disruptions to on-site activities.*

[5] Under WAC 173-201A-600(1) and -602, Powder Mill Creek is protected for the following designated uses: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

[6] Same as FS report

[7] Based on CWA304, Federal National Recommended Water Quality Criteria for Human Health updated in 2015

[8] Based on CWA304, Federal National Recommended Water Quality Criteria for Human Health updated in 2015

Total Xylenes	14.6	485	1600[9]
Benzene	0.002	122	0.44[10]
TCE	0.0025	9	0.38[11]
Vinyl chloride	0.00014	350	0.02[12]
1,1 DCE	0.046	799	7.0[13]
cis-1,2 DCE	0.078	3020	16[14]
Trans-1,2 DCE	0.520	30,200	100[15]
PCE	remove[16]	remove	4.9[17]

Lastly, in order for Ecology to agree that the contaminated perched groundwater[18] does not need to meet Method B (potable) cleanup levels, the requirements of WAC 173-340-720(2)(c) must be met. Under WAC 173-340-720(2)(c):

(c) The department determines it is unlikely that hazardous substances will be transported from the contaminated ground water to ground water that is a current or potential future source of drinking water, as defined in (a) and (b) of this subsection, at concentrations which exceed ground water quality criteria published in chapter 173-200 WAC.

This requirement is intended to protect and prevent contamination of potable drinking water sources, such as the Esperance Sand Aquifer. It is not intended to act as a permit to discharge contamination from an upper non-potable aquifer to a deeper potable aquifer (similar to an underground injection well or NPDES permit) up to a groundwater cleanup level. This is especially important since the Esperance Sand Aquifer does not have detectable silkscreen (mainly xylene, ethylbenzene, and toluene) contaminant concentrations. The FS report, Appendix B Vadose zone modeling results show that silkscreen contaminants will reach the Esperance Sand Aquifer if water infiltration is allowed to occur at this SWMU. Therefore, in

[9] Method B groundwater cleanup calculation

[10] Adopted Regulation Chapter 173-201A WAC

[11] Adopted Regulation Chapter 173-201A WAC

[12] Adopted Regulation Chapter 173-201A WAC

[13] EPA MCL

[14] Method B groundwater cleanup calculation

[15] EPA MCL

[16] Upon review of the most recent perched groundwater chemical data from groundwater monitoring wells, PCE was not a detected contaminant. In addition, Ecology bases its decision on its understanding that it is not aware of detected PCE in the soils. This decision assumes PCE is not found in perched groundwater or soils through finalization of the CAP.

[17] Adopted Regulation Chapter 173-201A WAC

[18] In addition, based on the observation of year around perched groundwater at this SWMU, Ecology assumes that rainwater infiltration into the contaminated soils is occurring now. Installation of new impervious (or significant modification of the current) surface cover will be expensive, more disruptive of any nearby operations, and its effectiveness uncertain since it is not clear if rainwater is infiltrating through the current cover directly above the SWMU or if rainwater (or leaking water lines) is infiltrating at a distance from the SWMU and flowing under the SWMU. The Vadose Zone Modeling report states that contamination will reach the Esperance Sand aquifer from the SWMU if water is allowed to infiltrate into the contaminated vadose zone soils. Ecology comments on the vadose zone modeling report indicated that contaminated perched groundwater was not accounted for in the modeling results and the most uncertainty in the modeling results lies in the accuracy in the amount of time before vadose zone contamination from either perched groundwater or subsurface soils reaches the Esperance Sand Aquifer.

order for Ecology to allow non-potable cleanup levels for this contaminated perched aquifer, one of two options must occur at the site: (a) during and after operation of the SVE system, an low permeability (7E-12 cm^2 or lower) concrete cover must prohibit recharge of rainwater into the perched aquifer at this SWMU (and the result must be elimination of measurable perched groundwater below this SWMU), or (b) after the operation of the SVE system, additional groundwater extraction wells are required to minimize to the maximum extent possible, the amount of contaminated perched groundwater at this SWMU.

EPM C:

SWMU 166, Building 45-53, Former UST EV110-1 (outdoors):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment. This assumes that groundwater cleanup levels are met at the time the CAP is finalized.

EPM D:

SWMU 055 and 168, Building 40-24, Utility Trenches and Sumps (indoors and outdoors):
Ecology's preferred remedy is the same as Boeing's:[19] Alternative 4- Near Term Excavation, Dewatering and Periodic Removal of Perched Groundwater present in backfill within the 40-24 building trenches. Ecology notes that an additional cleanup requirement at this SWMU is that the *soil concentration shall not result in the accumulation of nonaqueous phase liquid on or in ground water* (WAC 173-340-747(2)(b)). Ecology's preferred alternative requires deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer.

Similar to EPM B, in order for Ecology to agree that the contaminated perched groundwater does not need to meet Method B (potable) cleanup levels, the requirements of WAC 173-340-720(2)(c) must be met. Under WAC 173-340-720(2)(c):

(c) The department determines it is unlikely that hazardous substances will be transported from the contaminated ground water to ground water that is a current or potential future source of drinking water, as defined in (a) and (b) of this subsection, at concentrations which exceed ground water quality criteria published in chapter 173-200 WAC.

This requirement is intended to protect and prevent contamination of potable drinking water sources, such as the Esperance Sand Aquifer. It is not intended to act as a permit to discharge contamination from an upper non-potable aquifer to a deeper potable aquifer (similar to an underground injection well or NPDES permit) up to a groundwater cleanup level. This is especially important since the Esperance Sand Aquifer does not currently have detectable skydrol hydraulic fluid contaminant concentrations. The FS report, Appendix B Vadose zone modeling results show that skydrol hydraulic fluid contaminants will reach the Esperance Sand Aquifer if water infiltration is allowed to occur at this SWMU. Therefore, in order for Ecology

[19] Alternative 1(site monitoring) cannot be the most permanent remedy because it does not meet the threshold requirement for achieving groundwater cleanup levels. Furthermore, it over-relies on dilution and will not provide for a reasonable restoration timeframe (per WAC 173-340-360(2)(a), (b) and (e)).

to allow non-potable cleanup levels for this contaminated perched aquifer, the following is required: (a) after removal of the outdoor vault E contaminated soils and perched groundwater within vault E, the outdoor component of this SWMU must be repaired in a manner that prevents measurable rainwater (rainfall runoff) from entering the fill surrounding the area at the 40-24 building vault E and the utility tunnel. One option is the combination of backfilling the Vault E excavation with impermeable fill material and covering the area with low permeability concrete; and (b) "continuous" removal of measurable perched groundwater from within the remaining 40-24 building utility trench;

Contaminated perched groundwater was discovered in boring ESB1290[20] and in the North Sump. Ecology's preferred alternative therefore requires "continuous" removal of perched groundwater from within the 40-24 building utility trench. Boeing should also use all reasonable methods to attempt to install additional groundwater extraction wells near ESB1290 and the North Sump, assuming these northerly areas of the utility trench in this area currently contains contaminated perched groundwater. Reducing the amount of perched groundwater[21] beneath the contaminated soils within the 40-24 building will reduce the migration force driving contamination through the unsaturated soils to the Esperance Sand Aquifer.

Lastly, Ecology notes that EPA has not listed tributyl phosphate (TBP) in their Integrated Risk Information System (IRIS) database, which is the preferred source for toxicity data. This is due to inadequate toxicity data, needed to support a rigorous IRIS review. Our second preferred source for toxicity data is the Provisional Peer-Reviewed Toxicity Value (PPRTV) assessment. Boeing cited a 2010 TBP assessment document (EPA 2010) in the FS report, Appendix C. This PPRTV assessment found some evidence that bladder tumors were produced through regenerative cell proliferation in response to epithelial damage at high doses; this mechanism of cancer formation would not operate at lower doses that do not cause organ damage. EPA concluded that the mode of action for bladder cancer has not been sufficiently characterized.

TBP may also cause hepatocellular adenomas (liver cancer), but no mode of action has been elucidated for that type of cancer either. Based on these uncertainties, EPA chose to use the linear low-dose extrapolation, which assumes that there is no threshold for carcinogenesis, to derive an oral slope factor of 0.009 per mg/kg-day. This slope factor is reported in EPA's regional screening level database, which Boeing used to obtain some of the chemical parameters for the leaching model. As a result, Boeing should use the lower of the TBP calculated cleanup levels for cancer[22] and non-cancer effects.

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[20] In 1998, 60 ppm of tributyl phosphate and 14 ppm of dibutyl phenyl phosphate were detected in perched groundwater samples from ESB1290.

[21] In addition, based on the observation of year around perched groundwater at this SWMU, Ecology assumes that rainwater infiltration into the contaminated soils is occurring now.

[22] Ecology notes that the FS report indicates the TBP non-potable groundwater cleanup level based on non-carcinogenicity is less than the cleanup level based on carcinogenicity. The FS report also uses the BHT non-potable groundwater cleanup level based on carcinogenicity (Ecology preference), even though the FS text indicates it would use the cleanup level based on non-carcinogenicity.

Ecology's calculated soil and perched groundwater cleanup levels (protective of the Esperance Sand Aquifer cleanup levels) are shown in the table below:

Compound	Soil Cleanup Level protective of Esperance Sand Aquifer (based on carcinogenicity)	Perched Groundwater Cleanup Level (dermal pathway)	Esperance Sand Aquifer Cleanup Level (based on carcinogenicity)
	(mg/kg)	(µg/L)	(µg/L)
Tributyl Phosphate (TBP)[23]	0.51	4300 Unchanged from FS report	9.7
BHT	7.4	12,000 Unchanged from FS report	24

EPM E:

Based on the absence of perched groundwater at these SWMUs, Ecology believes the likelihood of contaminated vadose zone soils migrating to the Esperance Sand Aquifer is unlikely under WAC 173-340-720(2)(c). Therefore, based on current information, Ecology is not requiring Boeing meet soil cleanup levels protective of the more stringent potable groundwater cleanup levels based on water quality ARARs.

SWMU097, Building 40-11, Former Vapor Degreaser (indoors):
Ecology's preferred remedy is the same as Boeing's:[1] Alternative 3[24] - Near Term Excavation of all contaminated soils to meet SWMU cleanup levels at a standard point of compliance.

SWMU171, Building 40-31, Former Bluestreak Vapor Degreaser (indoors):
Ecology's preferred remedy is Alternative 2 –Soil Vapor and Extraction.[1] Ecology prefers alternative 2 over alternative 1-- maintaining containment (Boeing's preferred remedy) -- because of the following reasons:

a) very high TCE concentrations have been measured in vadose zone soil (up to 11,000 µg/kg) and in SSV (up to 48,000 µg/m^3). Recent one-time (May 2016) indoor air measurements of TCE and VC were above MTCA Method B unrestricted air cleanup levels but below Method C industrial cleanup levels. Despite these findings, unacceptable TCE vapor intrusion into the building is a distinct possibility in the future given the high TCE soil and SSV concentrations;

b) the effectiveness (ranked *good* in Table 8-7a) of the SVE system in attaining soil cleanup levels at the standard point of compliance, and

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[23] Used as a surrogate for other Skydrol hydraulic fluid ingredients: Dibutyl Phenyl Phosphate (DBPP), Butyl Diphenyl Phosphate (BCPP), and Triphenyl Phosphate (TPP)

[24] *The FS Report, Table 8-8a describes only three alternatives. Alternative 3 is near term excavation remedial alternative. However the FS Report, page 9-8 discusses Alternative 4 as Boeing's preference. Ecology assumes Table 8-8a is correct and the text on page 9-8 is incorrect.*

c) alternative 2 (SVE) will minimally disrupt building operations (as stated in the FS report, Table 8-7a and page 8-26).

Boeing may implement Alternative 1 (maintenance of containment) in the short term while awaiting an acceptable window of opportunity (minimal interference with carpet storage and cutting operations) for the construction of the SVE system. During this time interval and following construction and operation of the SVE system, routine SSV and indoor air monitoring will be required. The duration of this monitoring program will be dependent on SVE's ability to quickly reduce soil gas concentrations to acceptable levels.

Ecology's preferred alternative also requires deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer (as indicated by the vadose zone model, Appendix B of the FS report).

SWMU098, Building 40-53, Former Mock Up Degreaser (indoors):
Ecology's preferred remedy is the same as Boeing's:[1] Alternative 1 – Maintain Containment. Ecology's preferred remedy requires routine SSV and indoor air monitoring due to elevated TCE sub-slab vapor concentrations and shallow TCE vadose zone soil contamination. Ecology notes that recent one-time (May 2016) indoor air concentrations of TCE and VC were below MTCA Method C industrial cleanup levels. However, unacceptable TCE vapor intrusion into the building in the future is a distinct possibility given the high TCE SSV concentrations.

Ecology's preferred alternative also requires deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer.

SWMU 170, Building 40-02, Former Large Vapor Degreaser (indoors):
Ecology's preferred remedy is the same as Boeing's:[1] Alternative 1 – Maintain Containment. Ecology's preferred remedy also requires the same types of gas and air monitoring, as well as deep groundwater monitoring, described in the SWMU098 discussion above.

SWMU169, Building 40-02, Former Small Vapor Degreaser (indoors):
Ecology's preferred remedy is the same as Boeing's:[1] Alternative 1 – Maintain Containment. Ecology's preferred remedy also requires the same types of gas and air monitoring, as well as deep groundwater monitoring, described in the SWMU098 discussion above.

Paint Crib, Building 40-02 (indoors):
Ecology's preferred remedy is the same as Boeing's:[1] Alternative 1 – Maintain Containment. Ecology's preferred remedy also requires the same types of gas and air monitoring described in the SWMU098 discussion above.

SWMU054, Building 40-51, Former Wastewater AST (outdoors):
Ecology's preferred remedy: Alternative 1 – Maintain Containment in the short term, together with Alternative 2- Future Excavation.[1] Boeing's preferred remedy is alternative 1. But Ecology

prefers that this alternative be coupled with alternative 2's future excavation, with excavation scheduled for a time when site maintenance or redevelopment minimizes disruption to building operations. Our preferred alternative also requires routine SSV and indoor air monitoring due to elevated TCE sub-slab vapor concentrations and shallow TCE vadose zone soil contamination. Though recent sampling of indoor air (May 2016) indicated that building 40-51 TCE and VC indoor air were below MTCA Method C industrial cleanup levels, unacceptable TCE vapor intrusion into the building in the future is a distinct possibility given the high TCE shallow (1.25 foot depth) SG concentrations and shallow TCE soil contamination.

Other elements of Ecology's preferred alternative include:

a) maintaining a low permeability concrete surface as part of the remedial action and as assumed in the vadose zone modeling results (FS report, appendix B);
b) deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer; and,
c) submitting annual status update reports to indicate: (1) results of routine inspections to document the condition of the low permeable concrete surface cover (based on the vadose zone modeling results to have an intrinsic permeability of 7.0EE-12 cm^2) above and adjacent to elevated TCE surface soil contamination; (2) any repairs and concrete joint sealing conducted to maintain a low permeability concrete surface cover, and at a minimum, seal surface cover cracks, expansion joints and other breaches in the concrete surface that can act as conduits for surface water to contact the contaminated subsurface soils; (3) all other maintenance work conducted on the low permeability concrete surface cover; (4) other necessary near-term repair or maintenance work required and the timeline for performing that work; and, (5) an updated schedule for planned future excavation of part or all of the subsurface contamination above SWMU-specific cleanup levels.

Boeing estimated this future excavation work could be conducted within 15 to 20 years (Table 8-13a).

Building 40-32, Footing Excavation (indoors):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment[1]
Ecology's preferred remedy requires the same types of gas and air monitoring, as well as deep groundwater monitoring, described in the SWMU098 discussion above.

EPM F:

SWMU068, South Complex, Former South Fire Pit (outdoors):
Ecology's preferred remedy is the same as Boeing's: Alternative 4 – Near Term Excavation to meet cleanup levels at a standard point of compliance.

EPM G:

SWMU065, Building 40-51, Former Paint Stripping Tankline (metals only):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment.

Building 40-11, UST EV48-1(outdoors):
Ecology's preferred remedy is Alternative 1 – Maintain Containment in the short term with Alternative 2-Future Excavation. Boeing's preferred remedy is future excavation (only).

Ecology's preferred alternative also includes:

a) components to remove all known free product (NAPL) to the maximum extent practicable. This is needed to comply with WAC 173-340-747(2)(b);
b) deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer; and,
c) annual status update reports documenting: (1) the results of routine inspections to assess the condition of the concrete surface cover (assumed in the vadose zone modeling results with intrinsic permeability of 7.0EE-12 cm^2) above and adjacent to elevated surface soil contamination; (2) any repairs and concrete joint sealing conducted to maintain a low permeability concrete surface cover, and, at a minimum, to seal surface cover cracks, expansion joints and other breaches in the concrete surface that can act as conduits for surface water to contact the contaminated subsurface soils; and, (3) all other maintenance work on the low permeability concrete surface cover. The reports shall also: (a) propose other necessary near-term repair or maintenance work required and include a timeline for that work, and (b) include an updated schedule for planned future excavation of part or all of the subsurface contamination above SWMU-specific cleanup levels. Ecology expects such excavation to occur at a time when the USTs have reached the end of their service life[25] and the timing minimizes disruption to operations.

Boeing estimated this future excavation work could be conducted within 15 to 20 years (Table 8-17a).

SWMU165, Building 45-52, Former Fuel Farm USTs (outdoors):
Ecology's preferred remedy is Alternative 1 – Limited Excavation and Maintain Containment in the short term with Alternative 2 -- Future Excavation. Boeing's preferred remedy was alternative 1 (only).

Ecology's preferred alternative also requires actions to remove all known free product and the installation of deep well(s), as described in b) of the Building 40-11, UST EV48-1, discussion above. It additionally requires annual status update reports, as described in c) of the Building 40-11, UST EV48-1, discussion. With respect to the schedule for planned future excavation,

[25] page 9-11 of the FS report

Ecology expects this work to be conducted at a time that minimizes disruption to operations and is consistent with the current substation upgrade schedule (as indicated in the FS report).

Boeing estimated this work could be conducted within 5-10 years (Table 8-18a).

SWMU083, Flightline, Former UST EV-15 (outdoors):
Ecology's preferred remedy is the same as Boeing's: Alternative 1 – Maintain Containment. However, our preferred alternative also requires deep well(s) located as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer,.

EPM H:

SWMU093, Building 45-01, Former Solvent USTs (MEK) (outdoors):
Ecology's preferred remedy is Alternative 1 – Maintain Containment in the short term with Alternative 2 - Future Excavation. Boeing's preferred remedy is alternative 1 (only).

Ecology's preferred alternative requires:

a) maintenance of a low permeability concrete surface as part of the remedial action and as assumed in the vadose zone modeling results (FS report, appendix B);
b) deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer; and,
c) annual status update reports, as described in c) of the Building 40-11, UST EV48-1, discussion. With respect to the schedule for planned future excavation, Ecology expects this work to be conducted at a time when upgrade or removal of fuel lines or other site maintenance and redevelopment occurs so as to minimize disruption to building operations (as stated in the FS report).

Boeing estimated this future excavation work could be conducted within 15 to 20 years (Table 8-20a).

SWMU067 and 071, Building 40-56, Former Recycling Unit and USTs (indoors):
Ecology's preferred remedy is Alternative 1 – Maintain Containment in the short term with Alternative 2- Future Excavation. Boeing's preferred remedy is alternative 1 (only).
Our preferred alternative requires:

a) routine SSV and indoor air monitoring. Elevated sub-slab vapor concentrations have been detected as well as shallow vadose zone VOC soil contamination. Although May 2016 indoor air VOC concentrations were below MTCA Method C industrial air cleanup levels, unacceptable vapor intrusion into the building is a distinct future possibility given the shallow soil contamination below the building floor and immediately outside;

b) deep well(s) as close as possible to the downgradient edge of the SWMU in order to verify that contamination from this SWMU is not leaching into the Esperance Sand Aquifer; and,

c) annual status update reports as described in (c) of the EV-48-1 SWMU.

The reports shall also: (1) propose other necessary near-term repair or maintenance work required and include a timeline for that work, and (2) include an updated schedule for planned future excavation of part or all of the subsurface contamination above SWMU-specific cleanup levels at a time when future maintenance or redevelopment minimizes disruption to building operations.

Boeing estimated this work could be conducted within 15 to 20 years (Table 8-21a).

In addition, the dCAP's soil and indoor air cleanup levels for benzene, toluene, ethylbenzene, and xylene shall be identical to the cleanup levels for SWMUs 086, 089, and 094 since they share the same contaminants of concern, identical depths, media, vertical migration pathway, and the same general location with respect to the building.[26]

EPM I:

Esperance Sand Aquifer; EGW061:
Ecology's preferred remedy is no further action subsequent to two additional rounds of sampling (August 2016 and October 2016) and analysis of total and dissolved arsenic and lead from EGW217, EGW061, EGW067, and EGW079. This is contingent on monitoring results continuing to indicate that metals concentrations near EGW061 are stable, through finalization of the CAP, thus providing another line of scientific evidence of natural arsenic groundwater regional background. Boeing's preferred remedy is alternative 1 – institutional controls and monitoring.

EPM J:

SWMU100, South Complex Former Gun Club (outdoors):
Ecology's preferred remedy is the same as Boeing's: Alternative 2 – Comprehensive Excavation to meet cleanup levels at a standard point of compliance.

EPM K:

Powder Mill Gulch (PMG) Trichloroethylene (TCE) Groundwater Contamination in Esperance Sand Aquifer: Ecology's preferred remedy is Alternative 4 - Enhanced In-Situ Bioremediation in the Source Area and Downgradient locations to meet groundwater and surface water cleanup levels at their respective standard points of compliance (SPOCs).[1] Alternative 1 is Boeing's

[26] There is currently no perched groundwater under SWMUs 067 and 071. However, the potential exists for outdoor area (SWMU 86, 89, 94) contaminated perched groundwater to migrate a short distance under the 40-56 building to SWMUs 067 and 071.

preferred remedy. However, alternative #1 does not meet the threshold and other requirements for attaining groundwater cleanup standards in source and downgradient areas within a reasonable timeframe [please see WAC 173-340-360(2)(a)(ii) and (2)(b)(ii)].

Cost estimates in the FS report for alternatives 1 through 4 are based on meeting groundwater remediation levels (RELs), not groundwater cleanup levels, at the SPOC. Achieving groundwater and surface water **cleanup levels** at their respective standard points of compliances in a reasonable timeframe is an important and required remedial action objective for the site. In order to accomplish this cleanup objective within a reasonable timeframe, injections cannot be limited to just those target areas where TCE levels are 500 µg/L or greater (a threshold established for the groundwater interim action only), as proposed by Boeing. Our preferred alternative therefore anticipates additional injections.[27]

Ecology's preferred alternative (Alternative 4) requires the following in the cleanup action plan:

a. injections and monitoring designed and operated such that groundwater recovery wells are kept running at all times to minimize the flux of TCE contaminated groundwater entering the creek (objective of the ongoing MTCA interim action);
b. locations of EISB injections to be determined in the EDR. These locations may differ (more or fewer locations) than what was proposed in the FS preliminary design. The objective of the preferred alternative is to attain cleanup levels for groundwater and surface water at respective SPOCs, not to meet less stringent Powder Mill Gulch (PMG) interim action TCE contaminated groundwater treatment objectives. The cleanup action must therefore be designed to provide adequate groundwater treatment and minimize the groundwater restoration timeframe;
c. at least two to three EISB injection phases. More injection may be required at new or repeat locations in order to facilitate attainment of groundwater cleanup levels at the SPOC;
d. establishment of a "decision-point" regarding the need for additional EISB injections. If Boeing believes that additional EISB injections are not needed and that monitored natural attenuation (MNA) will achieve groundwater and surface water cleanup levels in a reasonable timeframe, AND that the MNA action meets all necessary cleanup requirements under MTCA, Boeing may propose to terminate EISB injection in favor of an MNA approach. If Ecology agrees, we may still require operation of the groundwater extraction wells in order to minimize TCE contaminated groundwater flux to the creek;
e. controls to ensure that the extraction of groundwater contaminated with chlorinated volatile organic compounds (CVOCs) is not only prohibited for drinking water purposes but prohibited for any use, unless specifically approved by Ecology;
f. continued efforts to inform the public about site contamination and prevent access to creek surface water and nearby creek bank TCE contaminated groundwater seeps throughout the cleanup process. This includes additional signage near Powder Mill

[27] Described on page 6-42 of the FS report.

Creek access points, warning the public to stay away from the creek (creek bank groundwater seeps and within water);

g. restrictive covenants and institutional controls on all downgradient (including non-Boeing) properties in accordance with WAC 173-340-440. Newly constructed buildings near and above the TCE groundwater plume must be designed to mitigate potentially unacceptable vapor intrusion impacts;
h. routine soil gas sampling from (soil gas) wells ESG001, ESG002, ESG003, and ESG004 (Bertch Capital Partners and Panattoni properties located over the TCE contaminated groundwater). The purpose of this sampling is to determine whether soil gas TCE levels pose a potential and future vapor intrusion threat during the period that TCE concentrations in the Esperance Sand groundwater exceed cleanup levels;
i. optimization of the interim action groundwater pump and treat system to reduce TCE contaminated groundwater flux to the creek to the maximum extent practicable; and,
j. financial assurance for all near and long terms costs for cleanup actions required under RCRA and MTCA, including maintenance of institutional control and environmental covenants; ongoing O&M work, long term repair costs until cleanup levels are met and shown be maintained at those levels.

Furthermore, groundwater and surface water cleanup levels proposed by Boeing for the Esperance Sand Aquifer must be revised since all of the groundwater eventually discharges to Powder Mill Creek. Given, the use of standard points of compliance, groundwater and surface water cleanup standards must be established that consider: State and Federal Water Quality ARARs (Chapter 173-201A WAC, National Toxics Rule 40CFR131 and the 2015 updated National Recommend Water Quality Criteria – Human Health[28] criteria under Section 304(a) of the Clean Water Act); Federal Groundwater MCLs; and, as appropriate, MTCA Method B groundwater cleanup levels.

Groundwater and surface water CVOC cleanup levels should be revised as follows:

	Media	Cleanup Level (µg/L)	ARAR Source
Trichloroethylene (TCE)	Groundwater Surface Water	0.38 0.38	Chapter 173-201A Chapter 173-201A
cis-1,2-Dichloroethylene (cis-1,2 DCE)	Groundwater Surface Water	16 [MTCA B] 590	na EPA Eco

[28] WAC 173-340-730(1) states that the classification and the highest beneficial use of a surface water body, determined in accordance with chapter 173-201A WAC, shall be used to establish the reasonable maximum exposure for that water body. Surface water cleanup levels shall use this presumed exposure scenario. Under WAC 173-201A-600(1) and -602, Powder Mill Creek is protected for the following designated uses: Salmonid spawning, rearing, and migration; primary contact recreation; domestic, industrial, and agricultural water supply; stock watering; wildlife habitat; harvesting; commerce and navigation; boating; and aesthetic values.

trans-1,2-Dichloroethylene (trans-1,2 DCE)	Groundwater Surface Water	100 100	MCL CWA304[29]
1,1-dichloroethylene (1,1 DCE)	Groundwater Surface Water	7 7	MCL MCL
Vinyl chloride	Groundwater Surface Water	0.02 0.02	Chapter 173-201A Chapter 173-201A

[29] Federal National Recommended Water Quality Criteria for Human Health updated in 2015

Attachment B: Description of, and rational for, Ecology's preferred remedial alternatives -- where the primary remedial technology differs from Boeing's preferred alternative

For many Boeing Everett facility SWMUs, Ecology's preferred remedial alternative is the same as Boeing's. In some instances, Ecology added requirements so that the alternative would be fully compliant with the MTCA regulations, but the basic remedial technology is the same. This Attachment (B) does not discuss these SWMUs. Ecology's rationale for additional requirements is summarized in Attachment A.

For a few SWMUs, Ecology's preferred alternative is significantly different than what Boeing proposed, and this is due to Ecology's determination that a different remedial technology (for example, enhanced bioremediation versus groundwater pump and treat) is appropriate. This Attachment B only focuses on the two facility SWMUs where Ecology's preferred remedial alternative is significantly different from, and includes more aggressive treatment than, Boeing's preferred alternative.

B.1. EPM E: SWMU171, Building 40-31, Former Bluestreak Vapor Degreaser

B.1.1 Threshold Requirements: requirements that all alternatives must comply with if selected; described in WAC 173-340-360(2)(a).

B.1.1.1 Protect Human Health and the Environment (WAC 173-340-360(2)(a)(i)):
Conclusions: All four of Boeing's alternatives should adequately protect human health and the environment as long as: (a) institutional controls are effective over time; (b) shallow TCE soil contamination does not result in unacceptable indoor air vapor intrusion (above cleanup levels), and (c) TCE soil contamination does not eventually migrate to the Esperance Sand Aquifer.

B.1.1.2 Comply with cleanup standards (WAC 173-340-700 through 173-340-760):

Conclusions: Boeing estimated a restoration timeframe of 30 years for **Alternative 1**. The alternative would not require the removal of TCE-contaminated soil above cleanup levels (0.025 µg/kg, per Table 5-5 of the FS report) at the Standard Point of Compliance. Instead, TCE-contaminated soils (estimated to be as high as 11,000 µg/kg in shallow soils) would be left in place under the concrete floor.

Under WAC 173-340-740(6)(f), Ecology recognizes that cleanup actions requiring containment of hazardous substances rather than removal will not meet soil cleanup levels at the standard soil point of compliance. In these cases, the cleanup action may still be determined to comply with cleanup standards, provided the cleanup action is:

(i) permanent to the maximum extent practicable per WAC 173-340-360;
(ii) protective of human health;
(iii) protective of terrestrial ecological receptors under WAC 173-340-7490 through 173-340-7494;

(iv) inclusive of WAC 173-340-440 institutional control requirements that prohibit or limit activities that could interfere with the long-term integrity of the containment system;
(v) inclusive of monitoring requirements under WAC 173-340-410 and periodic reviews under WAC 173-340-430 to ensure the long-term integrity of the containment system; and,
(vi) inclusive of identifying the types, levels and amount of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the draft cleanup action plan.

Remedial alternative #1 is compliant with (iii) and (vi) and can be made compliant with (iv) with a few additional requirements. However, alternative #1 is not compliant with (i) (refer to Section B.1.2.3 below). Nor does it meet (ii) and (v), since routine indoor air and sub-slab vapor sampling, at a minimum, is required due to the shallow TCE soil contamination.

Alternatives #2 through #4 are expected to either remove TCE contamination from the subsurface soils OR remove TCE-contaminated soil itself in order to meet proposed soil cleanup levels at the standard point of compliance within a reasonable timeframe.

B.1.1.3 Comply with applicable state and federal laws (see WAC 173-340-710)

Conclusions: All four Boeing remedial alternatives could be designed to comply with ARARs.

B.1.1.4 Provide for compliance monitoring (see WAC 173-340-410 and 173-340-720 through 173-340-760):

Conclusions: All four Boeing alternatives could be designed to meet Ecology requirements for compliance monitoring.

B.1.2 Other Requirements: When selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall also meet the following requirements:

B.1.2.1 Provide for a Reasonable Restoration Timeframe, WAC 173-340-360(2)(b)(ii) and (4)
To determine whether a cleanup action provides for a reasonable restoration time frame, the following factors must be considered:

(i) potential risks posed by the site to human health and the environment;
(ii) practicability of achieving a shorter restoration time frame;
(iii) current uses of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;

(iv) potential future use of the site, surrounding areas, and associated resources that are, or may be, affected by releases from the site;
(v) availability of alternative water supplies;
(vi) likely effectiveness and reliability of institutional controls;
(vii) ability to control and monitor migration of hazardous substances from the site;
(viii) toxicity of the hazardous substances at the site; and
(ix) natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

Conclusions: Boeing's estimated restoration timeframe for alternative #1 is 30 years. The FS report did not provide a discussion of how this restoration timeframe was calculated. However, Ecology believes it is very likely that subsurface TCE soil contamination will remain below the concrete floor for longer than 30 years given that the compound is not expected to degrade under current subsurface conditions.

In-situ treatment (SVE) is capable of reducing volatile soil contamination concentrations, however, and is thus capable of practicably achieving a much shorter restoration timeframe (restoration via SVE under alternative #2 was estimated to take approximately 5 years). The high **toxicity** of trichloroethylene (TCE) as the primary contaminant in subsurface soils and sub-slab vapor further emphasizes the importance of a shorter restoration timeframe for this SWMU. **In our view Alternative #1** therefore fails to meet criterion (ii); i.e., it is practicable to achieve a shorter restoration timeframe.

Alternatives #2 through #4 have estimated restoration timeframes of 5 years (SVE-alternative #2), 15-20 years (future excavation - alternative #3) and 2 years (near term excavation - alternative #4). We believe that they each meet the reasonable restoration timeframe criteria of WAC 173-340-360(2)(b)(ii) and (4).

B.1.2.2 Consider public concerns, WAC 173-340-360(2)(b)(iii):

Conclusions: Compliance with this requirement is generally best measured after the draft Cleanup Action Plan (CAP) has been provided to the public for comment. Given that this contaminated area is within the boundary of the Boeing Everett Plant, it is difficult to predict the (non-Boeing) public sentiment regarding the type of cleanup action that would be preferred. However, Ecology considers it likely that the employees working in the building above this TCE contaminated soil and the downgradient public would prefer a faster and more permanent remedial alternative.

B.1.2.3 Use permanent solutions to the maximum extent practicable, WAC 173-340-360(2)(b)(i) and (4) Evaluative Criteria:

As noted above, the MTCA disproportionate cost analysis (DCA) applies to those alternatives that meet **minimum requirements for cleanup actions** (WAC 173-340-360(2). If these minimum requirements are not met, the corresponding "alternative" is not evaluated under the DCA and cannot be selected as the site's cleanup action. We

believe this is the case for alternative 1; it does not meet WAC 173-340-360(2) minimum requirements. Nevertheless, in our responses below to Boeing's analysis of the DCA criteria we also included comments on alternative 1.

WAC 173-340-360(3) provides the regulations for 'determining whether a cleanup action uses permanent solutions to the maximum extent practicable.' Besides using permanent solutions to the maximum extent practicable, the preferred cleanup action **must**:

- Protect human health and the environment
- Comply with cleanup standards.
- Comply with ARARs
- Provide for compliance monitoring
- Provide for a reasonable restoration timeframe
- Consider public concerns
- Not primarily rely on ICs where it is technically possible to implement a more permanent cleanup action

To decide whether a cleanup action uses permanent solutions to the maximum extent practicable, a DCA is performed. This analysis requires ranking the alternatives from most to least permanent. If the incremental costs of an alternative over that of a less permanent, lower cost alternative exceed the incremental benefits, the added costs are "disproportionate." The preferred alternative, then, is the most permanent action whose costs are not disproportionate to cheaper, less permanent actions.

Boeing used the WAC 173-340-360(3)(f) criteria to evaluate *permanence to the maximum extent practicable* for the four remedial alternatives for EPM E Bluestreak Degreaser. A score of from 1 to 10 was assigned to each alternative, per criterion. Each criterion was assigned a weighting factor where the sum of the weighting factors for each criterion equaled 1.0. The sum of the criterion score multiplied by its associated weighting factor were then totaled up as the weighted score for each of the four remedial alternatives. MTCA does not say this is how the DCA should be performed; however, it is a reasonable methodology as long as it is applied consistent with the objectives of WAC 173-340-360. These objectives are essentially to determine which alternatives are the most permanent, how much each alternative is likely to cost, and - through use of the DCA criteria – what benefits are associated with each alternative.

In accordance with WAC 173-340-360(3)(e)(ii)(C), the comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. Ecology has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, we select the less costly alternative provided the requirements of WAC 173-340-360(2) are met.

Below is Ecology's response to Boeing's evaluation of the four remedial alternatives with respect to the "permanent to the maximum extent practicable" criterion. We evaluated and weighted the DCA criteria somewhat differently than Boeing. This resulted in a conclusion that alternative #2 is the cleanup option permanent to the maximum extent practicable.

Protectiveness (360(3)(f)(i)):
This criterion is intended to compare each remedial alternative's *time required to reduce risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.*

Boeing believes that alternatives #1 through #4 are equally protective (a score of 8 was assigned to each). However, Ecology believes alternative #1 is less protective than alternatives #2 through #4.

Sub-slab vapor (SSV) TCE concentrations as high as 35,000 $\mu g/m^3$ have been detected (2013), and these concentrations are 500 times higher than the Method C SSV screening level (and 2800 times higher than the Method B SSV screening level). To ensure that vapor intrusion is not unacceptably impacting indoor air quality, routine indoor air and sub-slab vapor monitoring would be required. However, routine (yet infrequent) indoor monitoring could miss transient indoor air TCE concentration spikes, and once monitoring indicates that indoor levels are too high, exposures have already occurred and will continue to occur until the levels drop.

If unacceptable levels of indoor air TCE were detected, and were due to vapor intrusion, Boeing would be required to propose contingent remedial/mitigative actions. However, exposures would continue until the actions had been successfully completed.
Permanence (360(3)(f)(ii)):

This criterion is used to compare the degree each remedial alternative *permanently reduces the toxicity, mobility or volume of hazardous substances, including the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of waste treatment process, and the characteristics and quantity of treatment residuals generated.*

The FS report states that remedial alternatives #2 through #4 are the most permanent actions (score of 7 to each). Remedial alternative #1 received a slightly lower score (6). Ecology agrees that remedial alternatives #2 through #4 (which all proposed to remove contamination from the subsurface) are more permanent than remedial alternative #1 (containment of contamination below the building floor), with its heavy reliance on institutional controls. However, we also believe that alternative #1 is significantly less permanent. A larger differential in scoring between alternatives #2 through #4 and alternative #1 was, in our opinion, therefore warranted.

Cost (360(3)(f)(iii)):
Boeing developed cost estimates for the four remedial alternatives in Appendix D, Table D-24.

Remedial alternative #1 cost estimate is $0.091 million;
Remedial alternative #2 cost estimate is $1.1 million;
Remedial alternative #3 cost estimate is $2.4 million; and
Remedial alternative #4 cost estimate is $2.7 million.

Alternative #1 is the least costly, followed – in increasing cost – by alternatives 2, 3, and 4. Ecology notes, however, that the cost estimate for alternative #1 is largely underestimated if

routine indoor air and sub-slab vapor sampling is required throughout the duration of the 30+ year restoration timeframe.[30]

Long-term effectiveness (360(3)(f)(iv))
This criterion is used to compare the long-term effectiveness of each remedial alternative *Long-term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed cleanup levels, the magnitude of residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. 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; on-site or off-site disposal in an engineered, lined and monitored facility; on-site isolation or containment with attendant engineering controls; and institutional controls and monitoring.*

Boeing believes remedial alternatives #3 and #4 have the highest long-term effectiveness (score of 7 assigned to both). This is followed by alternative #2 (score of 6), and lastly alternative #1 (score of 5). The FS report defines a score of 5-6 as "good."

Ecology generally agrees with this ranking. Excavation alternatives (#3 and #4) are considered more effective than in-situ treatment technologies (alternative #2) and much more effective than containment approaches (alternative #1).

Consideration of public concerns (360(3)(f)(vii))
Boeing believes remedial alternatives #1 and #3 should be ranked higher (a score of 8 each) than alternatives #2 and #4 (a score of 7 each). The public has not yet been provided any opportunity to give formal or informal input on Boeing's preferred remedial alternative (#1). And, as noted above in B.1.2.2, prior to the FS and CAP formal public comment periods Ecology can only anticipate public sentiment regarding the type of cleanup action they would prefer. However, we believe that employees working in the building above this TCE contaminated soil, as well as the downgradient (non-Boeing) public, would likely prefer a faster and more permanent remedial alternative (such as proposed by alternatives #2, 3, and 4).
Implementability (360(3)(f)(vi))

This criterion is used to compare the degree each remedial alternative is able to be *implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations and other current or potential remedial actions.*

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[30] Ecology anticipates that two indoor air and two sub-slab vapor sampling events would be needed per year (heating and non-heating season). Given the size of this SWMU, at least two indoor air, one ambient air, and two sub-slab vapor samples would be required for each sampling event. A contingency remedial action plan and implementation would be required if unacceptable vapor intrusion were confirmed.

Boeing rated remedial alternative #1 highest (a score of 9), followed by alternative #2 (score of 7), alternative #3 (score of 4), and alternative #4 (score of 3).

The FS Report states that Alternatives #3 and #4 would require significant disruptions to manufacturing operations and complicated planning and logistics to complete the work. Based on this information, Ecology agrees that excavation-based actions will disrupt manufacturing operations in that portion of the 40-31 building and, as a consequence, be more difficult to implement.

According to the FS report (Section 8, page 8-26): *Alternative 2 is the next most implementable because construction and operation of an SVE system is comparatively straightforward without significant disruptions to on-site activities*. The question, then, is whether this alternative is substantially more difficult to implement than alternative 1. The latter, of course, proposes to do less (in terms of remediation). But "Implementability" is not included in WAC 173-340-360(3)(e) to offset the benefits associated with more protective, permanent, and effective remedies that require *relatively more* to be implemented than those alternatives proposing to implement much less. Ecology therefore places less emphasis on this criteria when comparing a remedial alternative that proposes no aggressive treatment to one which will result in contaminant mass reduction – unless there are significant technical or administrative hurdles expected to be associated with implementing the latter.

Management of short-term risks (360(3)(f)(v)):
This criterion is used to compare the degree each remedial alternative presents *risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.*

Boeing rates remedial alternative #1 highest (score of 9), followed by alternative #2 (score of 7), alternative#4 (score of 6), and alternative #3 (score of 5).

As noted above for Implementability, the purpose of the "management of short-term risks" consideration is not to simply favor alternatives that propose to *do less* over those cleanup options proposing to *do more*. It is important, therefore, to fairly credit more aggressive alternatives when they can be designed to effectively manage those potential risks associated with their construction and implementation. Ecology believes the remedial alternatives evaluated by Boeing can all be designed so that the risk of danger to the public and site workers is minimal. Text in the FS report (page 8-25) appears to concur: *These risks can typically be managed effectively through careful design and implementation, however the risks are present.*

In our view, then, while alternative 1 seems to certainly pose the lowest potential short-term risk among the four alternatives, the construction and implementation of other three can be designed to effectively manage these risks.

B.1.3 Ecology Selection of Preferred Remedial Alternative: EPM E: SWMU171, Building 40-31, Former Bluestreak Vapor Degreaser

Ecology has determined that **alternative 1** does not meet threshold criteria and other minimum requirements for a cleanup action (WAC 173-340-360(2)(a) and (b)).[31] It is therefore excluded from the DCA and cannot be selected as the cleanup action. Our reasons are summarized below:

1. **Threshold Requirements-Comply with Cleanup Standards:** Alternative #1 proposes to leave contaminated soils in place under the concrete floor. This includes soils contaminated above applicable cleanup standards. Containment remedies are allowed under MTCA provided all conditions of WAC 173-340-740(6)(f)(i) through (vi) are met. Alternative #1, however, does not meet condition (i) because it is not permanent to the maximum extent practicable.

2. **Provide for a Reasonable Restoration Timeframe, WAC 173-340-360(2)(b)(ii) and (4):** Soil containment remedies are often associated with long, and sometimes indefinite, restoration timeframes. When they are selected, then, it is usually because: a) there is no feasible way to effectively treat the soil contamination, and b) the restoration timeframes associated with protecting nearby groundwater and indoor air quality *are* reasonable.

   Ecology believes it is very likely that the TCE subsurface soil contamination will remain below the concrete floor for longer than 30 years, given that TCE is not expected to degrade under current subsurface conditions.[32] Because in-situ treatment (such as alternative 2's SVE) is capable of reducing volatile TCE soil contamination concentrations, and thus can practicably achieve a much shorter restoration timeframe (approximately 5 years), Alternative #1 does not meet the WAC 173-340-360(4)(b)(ii) and (viii) criteria. Furthermore, the high **toxicity** of TCE, the primary contaminant in subsurface soils and sub-slab vapor, emphasizes the importance of minimizing the restoration timeframe for this SWMU.

Alternatives #2 through #4 meet threshold and other minimum requirements for a cleanup action. They are expected to comply with cleanup standards because they either intend to remove TCE contamination from the subsurface soils OR remove TCE-contaminated soil. They will accomplish this within a reasonable timeframe. **Alternatives #2 and #4** use more aggressive treatment (excavation or SVE) than Alternative #1 and have much shorter estimated restoration timeframes. Ecology therefore considers alternatives #2 (SVE) and #4 (near term excavation) to be associated with reasonable restoration timeframes, as defined by the criteria in WAC 173-340-360(2)(b)(ii) and (4). **Alternative #3** (future excavation) has an estimated restoration timeframe of 15-20 years. While this period may be as much as three times longer than the

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[31] In the FS report, Boeing argues that alternative 1 is its preferred alternative because other alternatives 2 through 4 are disproportionately costly and therefore alternative #1 is permanent to the maximum extent practicable. Ecology has dismissed alternative #1 because it does not meet all threshold and other minimum requirements for a cleanup action.

[32] Alternative #1 is not expected to utilize natural processes (such as biodegradation) to reduce concentrations of hazardous substances (TCE). Please see WAC 173-340-360(4)(b)(ix).

timeframes for alternatives 2 and 4, Ecology believes that, within the context of what can be done at this SWMU, it is also reasonable.

The MTCA regulations require the feasibility study to include at least one permanent cleanup action alternative, as defined in WAC 173-340-200, to serve as a baseline against which other alternatives shall be evaluated for the purpose of determining whether the selected cleanup action is permanent to the maximum extent practicable. Ecology chose remedial alternative #2 as the baseline alternative.

The MTCA regulations also require that remedial alternatives which **meet threshold and other minimum requirements** be ranked from most to least permanent. If the incremental costs of a more permanent alternative over a lower cost/less permanent alternative exceed the incremental benefits, the added costs are deemed "disproportionate." Per WAC 173-340-360(3)(ii)(C), the comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. Ecology has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action.

With this mind, we believe that alternatives #2 through #4 score higher in the DCA than alternative #1 (were it to be included in the DCA). This is because, in our view, the three alternatives appear to be more protective, more permanent, more effective over the long-term, and more likely to be welcomed by the public. Even if alternative #1 is less expensive, could be more easily implemented, and would have fewer potential short-term risks, we believe these advantages are out-weighed by the benefits of the other three alternatives. Remedial alternative #2 (SVE) is the least expensive option among alternatives #2 through #4, at an estimated cost of $1.1 million. It is therefore Ecology's preferred remedial alternative.[33]

While Ecology concludes that alternative #2 is our preferred remedial alternative for the EPM E SWMU 171 Former Blue streak Degreaser, we also believe that when it is proposed to the public in the dCAP it must contain additional elements. This is further discussed in Attachment A. So, besides the use of SVE to remove TCE contamination from subsurface soils, the Ecology preferred cleanup action shall also contain the following:

a. Post-SVE operation subsurface confirmation sampling.
b. Post-SVE operation indoor air and SSV sampling to confirm remaining CVOC soil contamination does not present an unacceptable vapor intrusion threat.
c. Contingency remedial action options if the SVE system fails to meet cleanup standards in a reasonable timeframe.
d. Restrictive covenants and institutional controls on areas where cleanup levels above unrestricted cleanup levels are not met (per WAC 173-340-440).

These additions are needed to ensure that threshold and other minimum requirements for cleanup actions are met.

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[33] Remedial alternatives #3 (future excavation) and #4 (near term excavation) would be slightly more permanent than alternative #2 mainly because excavation activities are likely to be more effective than in-situ SVE technologies. The cost estimates for remedial alternatives #3 and #4 are $2.4 million and $2.7 million, respectively.

B.2. EPM K: Powder Mill Gulch

B.2.1 Threshold Requirements: requirements that all alternatives must comply with if selected; described in WAC 173-340-360(2)(a).

B.2.1.1 Protect Human Health and the Environment (WAC 173-340-360(2)(a)(i):
Conclusions: All four of Boeing's alternatives should adequately protect human health and the environment as long as: a) institutional controls are effective; b) contaminated groundwater is not withdrawn for drinking water or other purposes, currently or in the future; and, (c) walkers on the trail within Powder Mill Gulch obey the signage and stay away from the creek and TCE contaminated groundwater seeps.

B.2.1.2 Comply with cleanup standards (see WAC 173-340-700 through 173-340-760):

Conclusions: **Alternative 1** [condition 1 – cleanup standards met and condition 2 – groundwater cleanup standards not met but groundwater remediation levels met prior to discharge into the creek] does not meet this threshold requirement. The alternative over-relies on the existing interim action groundwater extraction wells[34], by themselves, to achieve cleanup levels in the TCE groundwater source area.[35] Reliance on the current interim action pump and treat system, attempts at monitored natural attenuation, and institutional controls will not, in Ecology's view, achieve cleanup standards (within the source or throughout the TCE groundwater plume). The use of MNA without groundwater source remediation is not allowed under WAC 173-340-370(7)(a). Furthermore, selection of MNA as a cleanup action under the regulations requires that the attenuation be due at least in part to chemical degradation, and that this degradation consistently occur throughout the remediation interval at an appreciable rate. Nor do we believe that the aerobic aquifer conditions are favorable for chemically degrading the contamination. Instead, dilution is likely to be the main mechanism for attenuating contaminant concentrations, and attainment of cleanup levels is unlikely, let alone within a reasonable timeframe.

Under **Alternative 1** [condition 3-groundwater cleanup standards and remediation levels not met], Boeing states that the company may either: (a) optimize the interim action groundwater extraction system, (b) shut down the interim action groundwater extraction system and rely on MNA, or (c) implement contingent in situ groundwater treatment at

[34] Ecology reminds Boeing that the groundwater extraction wells are at least 1000 feet from the TCE groundwater source area and not expected to treat source area TCE contaminated groundwater AND not expected to have significant influence in mid-plume regions where many groundwater extraction wells are located at the edge of the plume near the creek. Again, the objective of the PMG interim action groundwater extraction wells was to provide hydraulic containment at Seaway Blvd (Boeing north property line) and intercept TCE contaminated groundwater before reaching the creek. The Phase 1 and Phase 2 PMG interim action was not intended to treat the source area and downgradient groundwater plume to meet cleanup levels in a reasonable timeframe. Instead, the main purpose of the IA was to quickly minimize the flow of TCE contaminated groundwater into Powder Mill Creek. This interim action was never intended to meet groundwater cleanup standards and this was the basis for Boeing agreeing to implement this required action.

[35] Benzene is also found in the groundwater source area.

strategic locations within the plume (in-situ enhanced bioremediation or in-situ chemical oxidation). Ecology does not believe that maintaining or optimizing operation of the interim action groundwater extraction wells will meet this threshold requirement by remediating the TCE groundwater source and downgradient areas to cleanup levels. Currently, the groundwater pumping wells are downgradient and 750 feet or more from the TCE groundwater source area. Moreover, cleanup levels are low, and groundwater pump and treat systems are not known for achieving such levels successfully. Secondly, MNA without groundwater source remediation is unlikely to be successful.[36] As noted above, WAC 173-340-370(7) assumes any cleanup action employing MNA is preceded by or coupled with effective source reduction. In addition, shutting off the interim action groundwater extraction wells before cleanup standards, intended to protect the creek, is also not an acceptable option to Ecology because this allows elevated concentrations of TCE contaminated groundwater to enter the creek. The groundwater pump and treat system (interim action) was required to prevent this.

As a final contingency (alternative 1, condition 3(c)), Boeing states in-situ (injections) bioremediation or chemical oxidation could be performed. However, this contingency action is discussed vaguely in the FS Report and Boeing does not discuss how this contingent in situ treatment would be conducted, how strategic injection locations would be identified under a final groundwater remedy. More importantly, the risk of employing in-situ treatment of the source area and downgradient groundwater contamination, only after waiting years for the groundwater pump and treat system to fail to meet cleanup standards, is that the mass of TCE in the source area and downgradient zones becomes more diffuse, resulting in a more difficult attempt to adequately treat groundwater to meet cleanup standards. This contingency will require more injection phases and more injection locations in an attempt to remove the same amount of TCE, had injections begun immediately, under alternatives #3 through #4. Ecology believes, this version of alternative #1 (pump and treat followed years later by in-situ treatment) will remove less contaminant mass than alternative #3 and #4. By alternative #1 treating less TCE contaminant mass, this results in high uncertainty that cleanup standards are attained. This is a consequence that Ecology does not want to accept.

The reasonable maximum exposure (RME) scenario for the Esperance Sand Aquifer contaminated aquifer is use as a current or future drinking water source.

It is not in the State's or local public's best interests to take a low probability wait-and-see approach under alternative #1 when more aggressive and successful treatment alternatives are available[37].

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[36] As stated in Table 6-11, *Unlikely that MNA on its own would be effective in cleaning up the groundwater in reasonable restoration time frame as demonstrated by already long-term presence of plume concentrations. Can be used as polishing step after completion of more aggressive cleanup action*, and on page 6-31 through 6-32, *However, based on the historical performance of a large number of pump and treat systems, it is generally demonstrated that pump and treat requires long restoration time frames to achieve parts per billion cleanup levels and, in many cases (especially near source zones), restoration may never be practically achieved using pump and treat technologies alone (USEPA 1996).*

[37] Ecology notes the in-situ enhanced bioremediation interim groundwater cleanup action in the TCE groundwater source area in reducing TCE groundwater concentrations.

In addition, we must also consider that:

- the regulations require that active source-reduction measures be taken to prevent/minimize releases to surface water via surface runoff and groundwater discharges in excess of cleanup levels. Dilution cannot be the sole method of demonstrating compliance with cleanup standards in this context. Please see WAC 173-340-370(7) and -370(6).; and,
- it is apparent from the most recent groundwater monitoring data that elevated TCE groundwater concentrations in certain source areas (EGW144, EGW127 and EGW158-1) are not decreasing and are highly unlikely to be affected by interim action groundwater extraction wells installed farther downgradient (mid-plume and toe of the plume).

Alternative 2 (source area-only enhanced bioremediation) meets the "compliance with cleanup standards" threshold criterion because additional and immediate source treatment is, in our view, the only dependable means of meeting groundwater cleanup standards at the source area. However, Ecology expects alternative 2 to have a significantly longer restoration time than alternative 4, since the former primarily relies on aquifer flushing to remediate all downgradient portions of the TCE groundwater plume (approximately 2500 feet in length).

Both **Alternatives 3 and 4**[38] (immediate source area and downgradient groundwater plume treatment with enhanced bioremediation or in-situ chemical oxidation) meet the "compliance with cleanup standards" threshold criteria. Both are also expected to result in relatively short restoration timeframes.

B.2.1.3 Comply with applicable state and federal laws (see WAC 173-340-710):

Conclusions: All four Boeing alternatives could be modified and then designed to comply with ARARs.

B.2.1.4 Provide for compliance monitoring (see WAC 173-340-410 and 173-340-720 through 173-340-760):

Conclusions: All four Boeing alternatives could be modified to meet Ecology requirements for compliance monitoring.

B.2.2 Other Requirements: When selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall also meet the following requirements:

B.2.2.1 Provide for a Reasonable Restoration Timeframe, WAC 173-340-360(2)(b)(ii) and (4)

[38] Page 6-41 states, Remediation of TCE focus areas would be implemented using EISB to achieve the following: Accelerate remediation of TCE focus areas and accelerate restoration of groundwater.

Conclusions: The FS report uses a standard point of compliance where groundwater and surface water cleanup levels must be met within a reasonable timeframe throughout the contamination. Therefore, Ecology expects the preferred alternative to achieve these levels. Since the source of TCE surface water contamination (in Powder Mill Creek) is solely due to TCE contaminated groundwater flowing into the creek, we also expect the preferred alternative to protect surface water quality. This means that groundwater cleanup levels must be as low as surface water cleanup levels.

The FS report estimates that it will take 55 years, 46 years, 32 years, and 32 years to attain groundwater cleanup levels employing remedial alternatives 1, 2, 3, and 4, respectively. These are long timeframes.

Ecology believes that **Alternative 1** does not meet the "reasonable restoration timeframe" threshold requirement for many of the same reasons it does not meet the threshold criterion for "complying with cleanup standards." We believe, in fact, that the only way to modify alternative 1 to meet this reasonable restoration timeframe requirement is to incorporate (immediate) source area and immediate downgradient groundwater treatment by enhanced bioremediation or in-situ oxidation. This essentially transforms alternative #1 into alternative #3 or #4.

Alternatives 2, 3, and 4 propose the addition of more aggressive groundwater treatment (enhanced bioremediation or in-situ chemical oxidation) to the interim action groundwater pump and treat system. The resulting restoration timeframes for these three remedial alternatives are 9 (alternative 2) and 23 years (alternatives 3 and 4) swifter than alternative 1's. There is value in hastening groundwater cleanup (reducing restoration timeframe). The Esperance Sand Aquifer is a potential drinking water source, and faster attainment of groundwater and surface water cleanup levels means that unrestricted access to the creek and creek banks can be realized sooner than later.[39] Furthermore, given the high toxicity and carcinogenicity of TCE, if it is technically practicable to achieve groundwater and surface water (creek) restoration timeframes shorter than what alternative 1 can achieve, this is what we should do [WAC 173-340-360(4)(b)(ii) and (viii)]. Enhanced biodegradation (alternative 4) and in-situ chemical oxidation (alternative 3) are well established technologies for in-situ treatment of TCE contaminated groundwater.

B.2.2.2 Consider public concerns (see WAC 173-340-360(2)(b)(iii):

Conclusions: Compliance with this requirement is generally best measured after the draft Cleanup Action Plan (CAP) has been provided to the public for comment. Ecology can only anticipate public sentiment during the formal FS public comment period, regarding the type of cleanup action that would be preferred, based on previous comments and discussions during the BBNC meeting on February 25, 2016. However, attendees at the

[39] Groundwater seeps with elevated TCE contamination are present on some of the creek banks. The TCE concentrations in these seeps are consistent with elevated groundwater TCE concentrations and higher than surface water TCE concentrations.

Boulevard Bluffs Neighborhood Coalition (BBNC) meeting were positively receptive to alternative #4, which has a significantly shorter groundwater restoration timeframe compared to the groundwater restoration timeframe for Boeing's preferred alternative #1.

Much of the site's groundwater and surface water TCE contamination is located off Boeing property, on City of Everett property (Lot #9) and on private property further north (toward Puget Sound). We are concerned that the public will view option #1 as essentially no action (beyond continued implementation of the interim action). And, we assume that the City of Everett, as owner of the Lot #9 property, prefers minimal groundwater and surface water restoration timeframes. This means performing more aggressive groundwater treatment (e.g., enhanced bioremediation and/or in-situ chemical oxidation) than what Boeing proposed in alternative #1. For these reasons Ecology considers it likely that alternatives #3 and #4, and perhaps alternative #2 as well, will be more acceptable to the public than alternative #1.

B.2.2.3 Use permanent solutions to the maximum extent practicable WAC 173-340-360(2)(b)(i) and (4) Evaluative Criteria:

As discussed above, the DCA is only applied to those cleanup alternatives capable of meeting the **minimum requirements for a cleanup action.** If these minimum requirements are not met, the "alternative" cannot be selected as the site's cleanup action. Even though alternative#1 does not meet the minimum requirements for a cleanup action, Ecology's responses below to Boeing's DCA also includes alternative #1.

As noted in B.1.2.3 above, to decide whether a cleanup action uses permanent solutions to the maximum extent practicable, a DCA is performed. Boeing used a DCA scoring and weighting methodology that is not established in regulation, but is reasonable as long as it is applied in a manner consistent with the objectives of WAC 173-340-360. The objectives of WAC 173-340-360 are to essentially determine which alternatives are the most permanent, how much each alternative is likely to cost, and - through use of the DCA criteria - what benefits are associated with each alternative.

Ecology evaluated and weighed the DCA criteria differently than Boeing, resulting in an overall conclusion that, among the four alternatives, alternative #4 is "permanent...to the maximum extent practicable."[40] Below we discuss the FS Report's DCA and explain how we arrived at our own conclusions per criterion.

Protectiveness (360(3)(f)(i)):
Boeing believes that remedial alternatives #3 and #4 (score of 8 assigned to both) are slightly more protective of human health and the environment than alternatives #1 and #2 (score of 7 assigned to both).

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[40] WAC 173-340-360(3)(e)(ii)(C) states that: *The comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. In particular, the department has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action. Where two or more alternatives are equal in benefits, the department shall select the less costly alternative provided the requirements of subsection (2) of this section are met.*

Based on Boeing's estimates for achieving groundwater cleanup levels at the standard point of compliance for each of the four remedial alternatives (times ranging from 32 years to 55 years), Ecology believes remedial alternatives #3 and #4 rank equally and are clearly more protective than remedial alternatives #1 (especially) and #2. Ecology would not score remedial alternatives #1 and #2 equally, as Boeing does in the FS report; we believe alternative #1 (Boeing's preferred alternative) is less protective. Risks to human health and the environment are finite and probable in the future, but the more aggressive treatment alternatives get to lower contaminant masses in the groundwater and surface water.

Permanence (360(3)(f)(ii)):
The FS report states that remedial alternatives #3 and #4 are the most permanent actions (score of 8 assigned to both). Boeing believes that alternative #2 is the next most permanent (score of 7 assigned), followed by alternative #1 (a score of 6).

We agree with Boeing's relative rankings. However, Ecology believes that remedial alternative #1 is significantly less permanent that alternative #2, given that it relies on ONLY the existing interim action groundwater pump and treat system – at least initially -- to achieve groundwater and surface water cleanup levels. Ecology also believes less total TCE contaminant mass will be removed from the groundwater plume if in-situ treatment is implemented after many years of groundwater pump and treatment (alternative #1) instead of immediately (alternatives #2 through #4).

Cost (360(3)(f)(iii)):
Boeing developed cost estimates for all four remedial alternatives in Appendix D, Table D-24. Costs for alternatives 1, 2, and 4 are roughly similar then, but alternative 3 is expected to be more expensive.

Remedial alternative #1 cost was $10.7 million;
Remedial alternative #2 cost was $12.5 million;
Remedial alternative #3 cost was $16.9 million; and
Remedial alternative #4 cost was $12.0 million.

FS cost estimates for alternatives 1 through 4 were not and should have been generated by assuming the goals for each alternative were attainment of **both** groundwater cleanup levels and surface water cleanup levels at their respective standard points of compliance. Instead, the FS Report provided estimated costs based on attaining groundwater remediation levels (RELs), not cleanup standards. The proposed groundwater RELs are higher than groundwater cleanup levels, and therefore attaining the former takes less time than attaining the latter. Boeing's estimated restoration timeframes for attaining BOTH groundwater and surface water cleanup levels are 55 years, 46 years, 32 years and 32 years for Alternatives 1, 2, 3, and 4, respectively. Boeing's estimated timeframes for attaining groundwater remediation levels is 38 years, 37 years, 22 years, and 22 years for Alternatives 1, 2, 3 and 4, respectively.

Based on the FS Report, Appendix D, annual O&M costs for both Alternatives 1 and 4 are estimated at approximately $300k per year. Since alternative #1 will take more time to reach cleanup standards than alternative #4, Ecology can expect that those extra annual O&M costs for alternative #1, results in a higher overall cleanup cost (to meet cleanup standards) than alternative #4. Another words, the O&M cost estimate (to attain cleanup standards) for alternative #1 was significantly underestimated compared to Alternatives #2, #3, and #4.

Furthermore, Boeing indicates its cost estimates are only accurate to within -30% to +50% uncertainty. This uncertainty alone results in the total costs for remedial alternatives #1 thru 4 being essentially equivalent.

Long-term effectiveness (360(3)(f)(iv))
Boeing believes remedial alternatives #3 and #4 have the highest long-term effectiveness (score of 8 assigned to both). This is followed by alternative #2 (score of 7), and alternative #1 (score of 6).

Ecology agrees that alternatives #3 and #4 will be more effective over the long-term than alternative #2. Alternatives #3 and #4 will both apply aggressive source and downgradient treatment technologies. From our perspective, alternative #1 over-relies on the existing interim action groundwater pump and treat system and natural attenuation, and is unlikely to meet cleanup standards even if in-situ treatment follows years of groundwater pump and treatment. The difference in effectiveness between alternatives #3 and #4, versus alternative #1, is therefore likely to be very significant.

Consideration of public concerns (360(3)(f)(vii))
As noted above, Ecology and Boeing can only anticipate public sentiment during the FS formal public comment period regarding the type of cleanup action that would be preferred based on previous comments and discussions. Boeing believes remedial alternatives #1 and #2 should be ranked highest (a score of 10 each). Remedial alternative #4 is rated next highest (scores of 9), followed by remedial alternative #3 (score of 8). The FS report states that public concerns with remedial alternatives #3 and #4 would be due to: (1) clearing and grading required on City of Everett (Lot #9) property for the installation of injection wells, and (2) limited/restricted access because of construction and injection activities.

It is difficult to know what the public will value most, aggressive and faster treatment or an action that does not temporarily restrict access to parts of Lot #9.[41] It may depend on who, among the local public, benefit most from unrestricted Lot #9 access. Ecology believes the public could accept temporary access restrictions during injections in order to attain a faster cleanup by 20 or more years.

At this point in the process, however, Ecology believes that alternatives #2 through #4 are likely to be the most acceptable to the public and City of Everett, since they are associated with relatively shorter restoration times (especially alternatives #3 and #4). Faster attainment of

[41] Injections are relatively fast activities and related access restrictions are expected to be of short duration only. Ecology agrees with Boeing, though, that some clearing of trees and shrubs on Lot #9 may be required.

groundwater and surface water cleanup levels means that unrestricted access to the creek and creek banks can occur sooner than later,[42] and as discussed in B.2.2.2 above, members of the public may view alternative #1 as essentially no action (beyond implementation of the interim action).

Implementability (360(3)(f)(vi))
Boeing rated remedial alternative #1 highest (a score of 9), followed by alternative #2 (score of 7), alternative #4 (score of 6), and alternative #3 (score of 5).

According to Section 8 of the FS report, all four remedial alternatives are both technically and administratively implementable. Enhanced bioremediation and in-situ chemical oxidation are well-established groundwater treatment technologies. Of course, it is easier to implement nothing than something, and generally tougher to implement more than less, so alternative #1 is more easily implementable than the other three remedial alternatives. As stated above, though, there should not be significant technical or administrative hurdles to implementing any of the alternatives.

Management of short-term risks (360(3)(f)(v))
Boeing rates remedial alternative #1 highest (score of 10), followed by alternative #2 (score of 9), alternative #4 (score of 7) and alternative #3 (score of 6). Alternative #1 proposes to implement fewer active measures and for this reason there is less potential risk to manage. For this reason Boeing ranked it highest. But Ecology believes that all four alternatives can be designed so that the risk of danger to the public and site workers is minimal.

B.2.3 Ecology Selection of Preferred Remedial Alternative: EPM K Powder Mill Gulch (PMG)

Ecology has determined that **alternative #1**, Boeing's preferred alternative, does not fully meet threshold criteria and fails "other" minimum requirements for a cleanup action (WAC 173-340-360(2)(a) and (b)). It should be excluded from the DCA and cannot be selected as the cleanup action. Even if alternative #1 is included Ecology's DCA analysis, it is clear to Ecology that alternative #4 (lowest cost of alternatives #2-#4) is the most permanent to the maximum extent practicable. Alternative#1 falls short in most of the DCA categories when compared to alternatives #2 - #4. The cost estimates for all four alternatives are approximately equal (within uncertainties in these types of high level estimates). Our reasons for this determination are summarized below:

> **Threshold Criteria-Comply With Cleanup Standards (WAC 173-340-360(2))**: **Alternative#1** will not, in our view, effectively remediate contaminated groundwater in the source area and all points downgradient, and will not attain cleanup levels plume-wide using the current interim action groundwater extraction and treatment. The

[42] Groundwater seeps with elevated TCE contamination are present on some of the creek banks. The TCE concentrations in these seeps is consistent with the elevated groundwater TCE concentration and higher than the surface water TCE concentrations.

groundwater extraction wells are primarily located near Powder Mill Creek (Creek) and the southern Boeing-Everett property boundary. They were placed at these locations in order to achieve interim action objectives. These IA objectives include hydraulically containing groundwater contamination within the limits of Boeing property AND minimizing, to the maximum extent possible, the flux of TCE-contaminated groundwater into the Creek. They do not include attaining groundwater and surface water cleanup standards site-wide. The objectives of the final site cleanup action are broader and more demanding. Even if the groundwater pump and treat system were further optimized, historically speaking, these types of groundwater treatment systems alone not very successful in achieving low groundwater and surface water cleanup standards (TCE). At many sites and especially near source zones, successful restoration has not been achieved using pump and treat technologies alone.

Monitored natural attenuation (MNA) is an optional contingency of alternative #1, if the groundwater pump and treat system does not attain cleanup levels. However, active source remediation is a requirement of MNA. Without active source remediation, MNA will fail to attain cleanup standards in groundwater and surface water.

As a final optional contingency under alterative #1, Boeing states in-situ (injections) bioremediation or chemical oxidation could be performed. It is true that alternative #1 could potentially include future implementation of in-situ groundwater treatment at strategic locations when groundwater cleanup standards are not met with the groundwater pump and treat system. However, this contingency action is discussed vaguely in the FS Report and Boeing does not describe specifically how this future action would be included as part of the site's final groundwater remedy. Ecology envisions such contingent in-situ treatment would only successful attain cleanup standards if implemented immediately in the locations and frequencies immediately as described in alternatives #3 and #4. The risk of employing in-situ treatment of the source area and downgradient groundwater contamination, only after waiting years for the groundwater pump and treat system to fail to meet cleanup standards, is that the mass of TCE in the source area and downgradient zones becomes more diffuse resulting in a more difficult attempt to adequately treat groundwater to meet cleanup standards. This contingency will require more injection phases and more injection locations to remove the same amount of TCE, had injections begun at the beginning, under alternatives #3 through #4. In fact, Ecology believes alternative #3 and #4 will remove more contaminant mass than alternative #1 (pump and treat followed by in-situ treatment). By alternative #1 treating less TCE contaminant mass, this results in high uncertainty that cleanup standards are attained. This is a consequence that Ecology does not want to accept.

Alternatives #2 through #4 fully comply with this threshold criteria because aggressive groundwater treatment in the source areas and source areas plus downgradient areas are performed immediately and this will destroy contaminant mass more quickly and thoroughly than alternative #1. These alternatives can immediately target the higher contamination zones within the TCE groundwater plume, that are currently accessible, thus maximizing the total mass of contamination removed from the aquifer. This results

in faster reductions in contaminant concentrations and lower endpoint contaminant concentrations.

Reasonable Restoration Timeframe [WAC 173-340-360(2)(b)]: **Alternative#1** does not meet this requirement. Boeing can practicably achieve a shorter and **reasonable restoration timeframe** by employing either enhanced in-situ bioremediation in the source and downgradient contaminated groundwater areas (alternative #4) OR in-situ chemical oxidation (alternative #3) in the contaminated source and downgradient groundwater areas. As mentioned previously, both of these groundwater cleanup technologies are well established and can be successful if implemented correctly. The FS report does not specify limitations to implementing either that cannot be reasonably overcome with good engineering design.

The Esperance Sand Aquifer is considered a potential drinking water source. Even though residents in the area are currently supplied drinking water from other sources, the MTCA regulations emphasize the preservation of future drinking water sources. In addition, TCE is highly **toxic** and the primary contaminant in the Esperance Sand Aquifer. Quickly reducing levels of this compound (while minimizing the production of vinyl chloride) should be a cleanup action priority.

Alternatives #2 through #4 fully comply with this other requirement because they Boeing can practicably achieve a shorter and more reasonable restoration timeframe than alternative #1, by employing either enhanced in-situ bioremediation or in-situ chemical oxidation, both well-established technologies.

Institutional Controls [WAC 173-340-360(2)(e)(iii)]: **Alternative #1** has an over-reliance on institutional controls, when a more aggressive treatment alternative is available. Ecology is confident that institutional controls can be effective when applied at property owned and/or under the control of Boeing. We are less confident about their effectiveness/enforceability when employed elsewhere. Even though the City of Everett has placed several signs[43] in the area to stay on the walking trails and away from the creek and creek banks (TCE groundwater seeps) during the current creek and groundwater remediation, those institutional controls alone are not sufficient cleanup actions under MTCA, given the long restoration time required under alternative #1.

Alternatives #2 through #4 do not over-rely on institutional controls. In fact these alternatives have a reasonable balance of immediate and aggressive groundwater treatment and institutional controls during that treatment.

The MTCA regulations require the feasibility study to include at least one permanent cleanup action alternative to serve as a baseline against which other alternatives shall be evaluated for the purpose of determining whether the cleanup action selected is permanent to the maximum extent practicable. Remedial alternative #4 is the baseline remedial alternative.

[43] At Ecology's request, the City of Everett placed signs on Lot #9 property in 2009 to stay out of the creek during the interim TCE groundwater cleanup action.

The MTCA regulations also require that remedial alternatives which **meet threshold and other minimum requirements** be ranked from most to least permanent and evaluated by the DCA process. Per WAC 173-340-360(3)(ii)(C), the DCA's comparison of benefits and costs may be quantitative, but will often be qualitative and require the use of best professional judgment. Ecology has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action.

As stated in B.2.1 above, Ecology considers alternatives 2 through 4 to fully meet threshold and other minimum requirements. In our opinion alternatives 3 and 4 also score much higher than alternative #2 (and #1, if it were included) in the categories of protectiveness, permanence, long-term effectiveness, and public acceptability. Both of these alternatives (as well as alternative 2) can be readily implemented and designed to effectively manage potential short-term risks.

We believe that remedial alternative #4 (the baseline remedial alternative) and alternative #3 are essentially equally permanent. Both are more permanent than alternative #2. Since remedial alterative #4 is more permanent and less expensive than alternative #2, (and #1, were it included), alternative #2 can be eliminated under the DCA evaluation.[44] What remains for the DCA to determine, then, is which remedial alternative, #3 or #4, is permanent to the maximum extent practicable.

The estimated costs for alternatives #3 and #4 are $16.9 million and $12 million, respectively. When two alternatives are approximately equal in benefits, Ecology chooses the less costly of the two as our preferred alternative – provided, of course, that this alternative meets the WAC 173-340-360(2) minimum requirements for cleanup actions. Since alternative #4 is less expensive than alternative #3, alternative #4 is permanent to the maximum extent practicable and is Ecology's preferred cleanup action.

While Ecology concludes that alternative #4 is our preferred remedial alternative for the Powder Mill Gulch SWMU, we also believe that when it is proposed to the public in the dCAP it must contain additional elements. Those additional elements are discussed in Attachment A.

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[44] Ecology previously noted in Section B2.1 that the estimated cost of alternatives 1 -4 are underestimated due to additional O&M costs not accounted for the time between potentially attaining groundwater RELs to attaining groundwater cleanup levels at the SPOC. However, since alternatives 2-4 have similar (within reasonable uncertainties) restoration timeframes, this error is expected to have little effect in comparing the relative estimated costs of alternatives 2-4 only. However, correcting this error for alternative #1 estimated costs is expected to increase alternative #1 costs relative to alternatives #2 through #4 such that alternative #1 costs will be equal to or more expensive than alternatives #2 through #4.

Attachment C: Specific Comments and Revisions to the Draft Uplands FS Report under the Contingent Approval:

Section 2.0:

1. Page 2-4, Section 2.1.3 SWMU171 Current Conditions, Sub-Slab Vapor Conditions, Paragraph 2: The FS Report text states: *Upon review of the sub-slab vapor data that exceeded the industrial MTCA screening levels for TCE and because similar chemicals are used in the manufacturing processes, Boeing industrial hygienists were requested to assess indoor air to evaluate potential worker exposures. PCE, TCE, and their degradation products were not detected. Based on this assessment, the concentrations in sub-slab vapor are not a risk to workers via indoor air at this SWMU/AOC. No further investigation is necessary for this SWMU/AOC in compliance with the Washington State Airborne Contaminants Standard, Chapter 296-841 WAC.* This statement is incorrect and not approved by Ecology. The Washington State Worker Safety regulations cited do not supersede the MTCA regulatory authority (Chapter 173-340 WAC) to establish health risk based cleanup standards for indoor air as a result of vapor intrusion into buildings following a spill of volatile chemicals to the environment. The OSHA air standards are much higher than MTCA CULs, and at a cleanup site where indoor air is contaminated by vapor intrusion, the MTCA cleanup levels are the pertinent risk-based levels.

2. Page 2-35, Section 2.14.1 SWMU055 and 168 Summary Description, First Paragraph: Ecology adds that SWMU055 (two dangerous waste storage tanks) are RCRA regulated dangerous waste storage tanks covered under Boeing Everett's interim status Part A permit.

3. Page 2-49, Section 2.16.3 SWMU067 and 071 Current Conditions, Sub-Slab Vapor Conditions: The FS Report text states, *VOCs in subslab vapor are well below Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs), which are applicable to these SWMUs/AOCs because the same chemicals present in sub-slab vapor are in use within the shop (WAC 173-340-750[1][a]).* This statement is incorrect and not approved by Ecology. Boeing has since informed Ecology[45]that these VOCs are not used in the manufacturing process within the southern portion of the 40-56 building. In addition, The Washington State Worker Safety regulations cited do not supersede the MTCA regulatory authority (Chapter 173-340 WAC) to establish health risk based cleanup standards for indoor air as a result of vapor intrusion into buildings following a spill of volatile chemicals to the environment. The OSHA air standards are much higher than MTCA CULs, and at a cleanup site where indoor air is contaminated by vapor intrusion, the MTCA cleanup levels are the pertinent risk-based levels.

[45] March 1, 2016 telephone conference call.

4. Page 2-63, Section 2.19.3, PMG Esperance Sand Aquifer, Groundwater Conditions, Paragraph 2: The FS report text states, *Hydrologic and water quality data collected as a part of the Phase 1 IA indicate that the plume has been effectively hydraulically contained at Seaway Boulevard and plume migration minimized by the groundwater capture zone created through operation of the GET system (Landau 2014a and 2015b).* Ecology does not agree that the chemical groundwater data yet support this statement. The hydraulic data do indicate a majority of the contaminated groundwater is captured before migrating beyond Boeing Everett property.

5. Page 2-72, Section 2.21.4 SWMU098 Sub-slab Vapor Conditions, Second Paragraph: The FS report text states: *Upon review of the sub-slab vapor data that exceeded the industrial MTCA screening levels for TCE, and because similar chemicals are used in the manufacturing processes, Boeing industrial hygienists were requested to assess indoor air to evaluate potential worker exposures. PCE, TCE, and their degradation products were not detected. Based on this assessment, the concentrations in sub-slab vapor are not a risk to workers via indoor air at this SWMU/AOC. No further investigation is necessary for this AOC in compliance with the Washington State Airborne Contaminants Standard, Chapter 296-841 WAC.* This statement is incorrect and not approved by Ecology. TCE is not currently used in the manufacturing process within this building because the degreaser was removed. In addition, The Washington State Worker Safety regulations cited do not supersede the MTCA regulatory authority (Chapter 173-340 WAC) to establish health risk based cleanup standards for indoor air as a result of vapor intrusion into buildings following a spill of volatile chemicals to the environment. The OSHA air standards are much higher than MTCA CULs, and at a cleanup site where indoor air is contaminated by vapor intrusion, the MTCA cleanup levels are the pertinent risk-based levels.

6. Page 2-79. Section 2.24.2 Building 40-32 Sub-slab Vapor Conditions, Second Paragraph: The FS report text states: *Upon review of the sub-slab vapor data that exceeded the industrial MTCA screening levels for TCE, and because similar chemicals are used in the manufacturing processes, Boeing industrial hygienists were requested to assess indoor air to evaluate potential worker exposures. TCE and its degradation products were not detected. Based on this assessment, the concentrations in subslab vapor are not a risk to workers via indoor air at this SWMU/AOC. No further investigation is necessary for this AOC in compliance with the Washington State Airborne Contaminants Standard, Chapter 296-841 WAC.* This statement is incorrect and not approved by Ecology. TCE may be infrequently and in small amounts routinely used in this building (but not documented during actual sampling). The Washington State Worker Safety regulations cited do not supersede the MTCA regulatory authority (Chapter 173-340 WAC) to establish health risk based cleanup standards for indoor air as a result of vapor intrusion into buildings following a spill of volatile chemicals to the environment. The OSHA air standards are much higher than MTCA CULs, and at a cleanup site where indoor air is contaminated by vapor intrusion, the MTCA cleanup levels are the pertinent risk-based levels.

Section 3.0:

7. Page 3-1, Section 3.1 Sitewide Conceptual Site Model and Figure 3-1: Figure 3-1 does not show the presence of fill material over the entire site. Not only are fill soils present in excavations below grade that hold various underground waste or product holding tanks, but fill soils are also present in areas outside of many of these SWMUs. Page 3-3, Section 3.1.3 – Soil section states, *The fill at the Everett Plant is generally less than 15 feet thick, except in the areas of the filled upper reaches of PMG where fill thickness ranges to greater than 120 feet.*

8. Page 3-1, Section 3.1.1 History and Potential Sources, First Paragraph: The FS report should also state that contamination originating from Boeing Everett property has migrated to other non-Boeing properties (such as within Powder Mill Gulch). Boeing is responsible for cleanup of contamination originating on its property and migrating off-property.

9. Page 3-2, Section 3.1.2 Types of Hazardous Substances: The FS report should also state that PCBs and hydraulic fluid (Skydrol) are also hazardous Substances present in the environmental media and that Boeing is responsible for the cleanup of these contaminants.

10. Page 3-3, Section 3.1.3-Soils, Paragraph 2, Second Bullet: The FS report states: *The density and permeability of the glacial till impedes the downward migration of water and water-born contaminants, compared to a looser and more permeable material.* Ecology clarifies this statement by adding that the water (perched groundwater) will migrate slowly downward to the Esperance Sand Aquifer as a result of gravity flow and capillary pressure under unsaturated conditions. This is the recharge mechanism for the Aquifer.

11. Page 3-6, Section 3.2.1 Exposure Pathway Model A, Second Paragraph: Ecology adds the following statements: *The vapor intrusion pathway is a potential complete exposure pathway that will require routine sub-slab gas and indoor air sampling.*

12. Page 3-6, Section 3.2.1 Exposure Pathway Model A, Third Paragraph: Ecology revises this paragraph to include the need for institutional controls per WAC 173-340-440 in order to apply the exemption from terrestrial ecological risk evaluation under WAC 173-340-7491(1)(b).

13. Page 3-7, Section 3.2.2 Exposure Pathway Model B, Third Paragraph: Ecology adds the following statements, *The vapor intrusion pathway and contaminant migration pathway to the Esperance Sand Aquifer are both potential complete exposure pathways that will require routine sub-slab gas, indoor air and Esperance Sand Aquifer sampling. There is a potential for contaminated soil gas from the outdoor shallow contaminated soils to migrate under and into the south portion of the 40-56 building. The year around*

presence of perched groundwater in shallow soils just south and outside of the 40-56 building footprint, represents evidence that water infiltration is present even though the area is covered with either asphalt or concrete and there is a current potential for this contaminated perched groundwater to reach the Esperance Sand Aquifer. Or there are leaks from water lines that result in the recharging of the perched aquifer. These are mechanisms for recharging the perched groundwater.

14. Page 3-9, Section 3.2.4 Exposure Pathway Model D, Fourth Paragraph: Ecology adds the following statements in order correct the text: *The contaminant migration pathway to the Esperance Sand Aquifer is potential complete exposure pathways that will require routine Esperance Sand Aquifer sampling. The year around presence of perched groundwater in shallow soils outside and within the 40-24 building footprint, represents evidence that water infiltration is present even though the area is covered with either asphalt or concrete. Or there are leaks from water lines that result in the recharging of the perched aquifer.*

15. Page 3-9, Section 3.2.4 Exposure Pathway Model D, Fourth Paragraph: Ecology revises this paragraph to include the need for institutional controls per WAC 173-340-440 in order for the exemption from terrestrial ecological risk evaluation under WAC 173-340-7491(1)(b).

16. Page 3-10, Section 3.2.5, Exposure Pathway Model E, Third Paragraph: Ecology adds the following statements in order to correct the text: *The vapor intrusion pathway and contaminant migration pathway to the Esperance Sand Aquifer are both potential complete exposure pathways that will require routine sub-slab gas, indoor air and Esperance Sand Aquifer sampling. There is a potential for contaminated soil gas from beneath the indoor building floors to migrate into those buildings. The potential for contamination to migrate downward to the Esperance Sand Aquifer is directly affected by the long term effectiveness for preventing contamination infiltration through the vadose soils.*

17. Page 3-10, Section 3.2.5 Exposure Pathway Model E, Third Paragraph: Ecology revises this paragraph to include the need for institutional controls per WAC 173-340-440 in order for the exemption from terrestrial ecological risk evaluation under WAC 173-340-7491(1)(b).

18. Page 3-11, Section 3.2.6, Exposure Pathway Model F, Third Paragraph: Ecology adds the following statements to order to correct the text: *The vapor intrusion pathway and contaminant migration pathway to the Esperance Sand Aquifer are both potential complete exposure pathways that would require routine sub-slab gas, indoor air and Esperance Sand Aquifer groundwater sampling. However, the Ecology preferred remedial action is excavation of contaminated soils to meet soil cleanup levels at the standard point of compliance. Therefore, successful completion of this remedial action should result in residual soil and soil gas contamination that is protective of indoor air and the Esperance Sand Aquifer.*

19. Page 3-12, Exposure Pathway Model G, Third Paragraph: Ecology adds the following statements to order to correct the text: *The contaminant migration pathway to the Esperance Sand Aquifer is potential complete exposure pathways for some of these SWMUs and therefore will require routine Esperance Sand Aquifer sampling. The potential for contaminant migration to the Esperance Sand Aquifer will depend on the effectiveness of any outdoor surface cover (asphalt or concrete) in preventing water infiltration. The potential exists for unacceptable vapor intrusion into future buildings constructed over the shallow contaminated soils.* Ecology notes that Table 5-7 EPM G FS Cleanup Levels includes indoor air cleanup levels.

20. Page 3-14, Section 3.2.8 Exposure Pathway Model H, First Paragraph: Ecology adds the following statements: *The vapor intrusion pathway and contaminant migration pathway to the Esperance Sand Aquifer are both potential complete exposure pathways that will require routine sub-slab gas, indoor air and Esperance Sand Aquifer sampling. There is a potential for contaminated soil gas from below the building floor AND from the outdoor shallow contaminated soils to migrate under and into the south portion of the 4-56 building. Migration of nearby perched groundwater in shallow outdoor area soils toward the interior of the 40-56 building is possible.*

21. Page 3-16, Section 3.2.11, Exposure Pathway Model K, Second Paragraph: Ecology adds the following statements: *The potential exists for future unacceptable vapor intrusion into future buildings constructed over the shallow contaminated soils. Institutional Controls are required to prohibit the construction of buildings over and near the TCE groundwater without engineering measures to prevent unacceptable vapor intrusion into the building. In addition, routine soil gas and/or indoor air sampling is required for buildings near or above any portion of the TCE groundwater plume in order to verify the continued assumption that unacceptable vapor intrusion is not occurring in these buildings.*

22. Tables 3-1 through 3-3: Exposure pathway characteristics are modified to include Ecology added exposure pathways described in previous responses under Section 3.0.

Section 4.0:

23. Page 4-5, Exposure Duration and Frequency: The FS report text states: *However, because of the intermittent presence of perched groundwater across the sites, construction worker exposures to perched groundwater are not expected to occur throughout an entire year. Therefore, an exposure frequency of 3 months (60 days/year) was selected as a more appropriate, yet still conservative, facility-specific exposure frequency for construction worker exposures to perched groundwater.* Ecology does not agree with this statement, perched groundwater is found year around at the SWMUs where non-potable cleanup levels are developed.

Section 5.0:

24. Page 5-3 Section 5.1, Last Paragraph and three bulleted statements through Page 5-4 Paragraph 1 and six bulleted statements: These nine (9) bullets statements are not exact quoted statements from WAC 173-340-745(1)(a)(i). Boeing has edited these statements (and inserted a regulatory citation) in a manner that does not always reflect the full intent of the regulation. In addition, Boeing should have included equally important regulations WAC 173-340-745(1)(a)(iii)(A) – (E) regarding the qualification for an industrial site. Consequently, Ecology does not approve of this FS report text and instead Boeing should refer to the exact regulatory citation in the MTCA regulation.

25. Page 5-5, Section 5.1.1, Paragraph 1: SWMUs 067 and 071 in the 40-56 building have the same contaminants and contaminated media as SWMUs 086, 89, and 094. Furthermore, these five (5) SWMUs are located very close to each other and share commingled soil contamination. Therefore, Ecology will apply MTCA Method B soil cleanup levels for SWMUs 067 and 071 (similar to SWMUs 086, 089 and 094). All five SWMUs share the same potential soil to groundwater contaminant pathway.

26. Page 5-6, Section 5.1.3, Last Paragraph: The FS text reads, *However, Boeing's evaluation of indoor air against the worker exposure requirements of Chapter 296-841 WAC, Airborne Contaminants, indicates no current risk to workers at the facility. Therefore, no cleanup action specific to sub-slab vapor is proposed in this FS.* Ecology disapproves of this text because these Washington State health and safety regulations Labor and Industries) do not supersede the MTCA indoor air cleanup regulations and cleanup action required as a result of exceedances of those MTCA indoor air cleanup regulations, as related to a release of volatile contaminants to the environment.

27. Page 5-8, Section 5.1.4, First Paragraph, Criterion 3: The leaching model shows that the soil contamination and perched groundwater contamination in many SWMUs has the potential to reach the Esperance Sand Aquifer if the water is allowed to infiltrate into the contaminated vadose zone soils. At this time, due to the existence of the perched groundwater in many contaminated areas, Ecology assumes that water infiltration is occurring to some finite extent.

28. Page 5-9, Section 5.1.6, Paragraph 2: Consistent with the derivation of terrestrial ecological soil cleanup levels for antimony and lead using Table 749-3, arsenic terrestrial ecological soil cleanup levels shall be based on the numeric criteria in Table 749-3 also. Given the Ecology preferred remedial action for the former gun club is excavation of contaminated soils, and given the main contaminants of concern are lead and PAHs will drive this cleanup, it is unlikely that arsenic soil contamination will remain at levels exceeding Table 749-3 numeric values (10 mg/kg).

29. Page 5-13, Point of Compliance, Fourth Paragraph: Ecology clarifies the surface water standard point of compliance as the point or points at which hazardous substances are released to surface waters of the state which includes (a) the stormwater outfall (PMG-26

sample location), (b) groundwater seeps that flow into the surface water, and (c) groundwater nearest to the surface water (without being diluted by surface water mixing). These points of compliance are consistent with WAC 173-340-730(6).

30. Page 5-14, Point of Compliance, Second Paragraph: The FS Report text states, *In accordance with the FSWP, this FS proposes conditional points depending on the cleanup action alternatives developed and evaluated in Section 6. The FS compares such alternatives to other alternatives that include a standard point of compliance.* Based on telephone conversations with Boeing's project manager, there are no SWMUs where a conditional point of compliance are proposed.

31. Page 5-14, Point of Compliance: The indoor air point of compliance was not included in this section. Therefore, Ecology will require Boeing to use the standard point of compliance for indoor air as defined in WAC 173-340-750(6). At this time there are no buildings near or directly above the PMG TCE groundwater plume. However, Ecology expects that institutional controls, notification of the owner/builder to prevent such construction until after engineering controls are in place to prevent unacceptable vapor intrusion into buildings.

Section 6.0:

In the explanation of alternatives 2, 3 and 4, Boeing states that the GET system is the primary cleanup technology. *Alternative 2/3/4 is similar to Alternative 1 and includes GET as the primary cleanup technology supplemented with institutional controls.....* Ecology disagrees with this statement as the GET system was installed to provide hydraulic containment and little expectation existed at that time or currently that it would effectively treat the source and downgradient TCE groundwater plume mass to reach cleanup levels.

32. Page 6-1, Section 6.3 Description of Cleanup Action Alternatives, Paragraph 2: In order for Ecology to accept a future excavation remedial alternative as the Ecology preferred alternative, there must be a timeline associated with the future excavation work. An Ecology final cleanup action must include an enforceable timeline schedule. In many instances where Boeing evaluated a 'future excavation' remedial option, a timeline estimate was provided for this work. Without an enforceable time schedule in a MTCA Order, future excavation remedial actions cannot be considered as final cleanup actions.

33. Page 6-2, Section 6.3 Description of Cleanup Action Alternatives, Paragraph 1: This paragraph attempts to interpret the institutional control requirements for the site. Ecology will look to the exact wording in WAC 173-340-440 for institutional control requirements for this site cleanup (on and off Boeing Everett property). Ecology will also require notification and Ecology approval prior to conducting any activities not in compliance with Ecology approved institutional controls and associated environmental covenants.

34. Page 6-2, Section 6.3.1 Exposure Pathway Model A SWMUs: The existence of perched groundwater indicates current rainwater infiltration. In addition, there is a potential for unacceptable indoor air vapor intrusion due to elevated soil gas contamination (refer to FS report page 6-4) and the close proximity of the contaminated soil gas to the all three buildings in this EPM A area.

35. Page 6-4, Section 6.3.1, EPM A Monitoring Components, Second Bullet: If groundwater cleanup levels are met, then Boeing will propose long term conformational monitoring for this SWMU 151. Routine soil gas and indoor air sampling is required as long as screening levels (soil gas, sub-slab vapor and/or groundwater) for indoor air are exceeded.

36. Page 6-7, Section 6.3.2 EPM B SWMUs, Paragraph 1: Ecology also includes the potential for contaminated perched groundwater and contamination in soils to migrate downward to the Esperance Sand aquifer. The existence of perched groundwater indicates current rainwater infiltration. In addition, there is a potential for unacceptable vapor intrusion due to elevated contamination in soil gas and the close proximity of the contaminated soil gas to the 40-56 building.

37. Page 6-8, Section 6.3.2, EPM B Alternative #1, Paragraph 1, Subparagraph #1 AND Paragraph #5: Alternative #1 – containment fails threshold requirements (WAC 173-340-360(2)(a)(ii)) as groundwater cleanup levels will not be met. Alternative #1 also fails to meet WAC 173-340-360(2)(e)(iii) for overreliance on institutional controls when it is technically possible to implement a more permanent remedy.

38. Page 6-9, Section 6.3.2, EPM B Alternative 2 – In Situ Treatment, Bullet #1: Ecology would expect optimization of the groundwater recovery system.

39. Page 6-13, Section 6.3.4, EPM D SWMUs, Paragraph 2, Subparagraph #1 AND Page 6-14, EPM D Alternative 1 – Maintain Containment: Alternative #1 – containment fails threshold requirements (WAC 173-340-360(2)(a)(ii)) as groundwater cleanup levels will not be met. Alternative #1 also fails to meet WAC 173-340-360(2)(e)(iii) for overreliance on institutional controls when it is technically possible to implement a more permanent remedy.

40. Page 6-18, Section 6.3.4 EPM D Alternative 4, Monitoring Components: Ecology will require downgradient monitoring of the Esperance Sand Aquifer for Skydrol contaminants since active remediation within the footprint of the 40-24 building is not going to occur.

41. Page 6-19, EPM E-F SWMUs, Paragraph 2: Ecology also includes the potential for contamination in soils to migrate downward to the Esperance Sand aquifer. In addition, there is a potential for unacceptable indoor air vapor intrusion due to elevated contamination in soil gas beneath the building floor.

42. Page 6-20, EPM E-F Alternative 1 – Maintain Containment: Ecology will require monitoring of the Esperance Sand Aquifer downgradient of SWMUs. Routine sub-slab vapor and indoor air sampling is required where soil gas and/or sub-slab vapor screening levels exceed those thresholds protective of indoor air cleanup levels.

43. Page 6-23, Section 6.3.6 EPM G-H Paragraph 2 AND Page 6-24, EPM G-H Alternative 1 – Maintain Containment: Ecology will require monitoring of the Esperance Sand Aquifer downgradient of SWMUs. Routine sub-slab vapor and indoor air sampling is required where soil gas and/or sub-slab vapor screening levels exceed those thresholds protective of indoor air cleanup levels.

44. Page 6-29, Section 6.3.9, Model K SWMU, Paragraph 1: Ecology includes dermal contact as a complete exposure pathway.

45. Page 6-29, Section 6.3.9, Model K SWMU, Paragraph 2, Bullet #1: Alternative #1 fails threshold and other requirements under WAC 173-340-360(2)(a) and (b). Refer to Ecology Appendix B discussion.

46. Page 6-30, Section 6.3.9, Model K SWMU, Alternative #1: Alternative #1 fails threshold and other requirements under WAC 173-340-360(2)(a) and (b). Refer to Ecology Appendix B discussion.

47. Page 6-31, Section 6.3.9, Model K SWMU, Alternative #1, Groundwater Extraction and Treatment, last paragraph: *Continued operation of the GET system will be protective of human and ecological receptors and will (and has already been observed to) accelerate remediation of the plume through direct removal of TCE mass from the groundwater and increased aquifer flushing.* Ecology disagrees and disapproves this statement that alternative #1 will restore groundwater with only the operation of the interim action groundwater recovery wells, to cleanup levels.

48. Page 6-37, Section 6.3.9 EPM K Alternative #2, Focused EISB Source Area Remediation: Any EISB injections would be targeted at contaminated groundwater source zones in order to meet the cleanup level at the standard point of compliance, not limited to areas where TCE concentrations exceed the arbitrary 500 µg/L as stated in the FS report text.

49. Page 6-38, Section 6.3.9 EPM K Alternative #2, Institutional Controls: Ecology expects institutional controls under WAC 173-340-440 to apply to all downgradient properties above the Esperance Sand Aquifer where contaminants are above cleanup levels.

50. Page 6-39, Section 6.3.9 EPM K Alternative #3, Focused ISCO Remediation: Any ISCO injections would be targeted at contaminated groundwater source zones in order to meet the cleanup level at the standard point of compliance, not limited to areas where TCE concentrations exceed the arbitrary 500 µg/L as stated in the FS report text.

51. Page 6-40, Section 6.3.9 EPM K Alternative #3, Paragraph 2: Injections and monitoring designed and operated such that the primary focus should be to keep the groundwater recovery wells running at all times to minimize the flux of TCE groundwater entering the creek (objective of the interim action);

52. Page 6-41, Section 6.3.9, EPM K Alternative #4, Paragraph#1, Bullet #2: Refer to paragraph #49.

53. Page 6-41, Section 6.3.9 EPM K Alternative #4, Focused EISB Remediation: Any EISB injections would be targeted at contaminated groundwater source zones in order to meet the cleanup level at the standard point of compliance, not limited to areas where TCE concentrations exceed the arbitrary 500 µg/L as stated in the FS report text.

54. Page 6-42, Section 6.3.9 EPM K Alternative #4, Paragraph 3: Injections and monitoring shall be designed and operated such that the primary focus should be to keep the groundwater recovery wells running at all times to minimize the flux of TCE groundwater entering the creek (objective of the interim action);

55. Page 6-42, Section 6.3.9, EPM K Alternative #4, Institutional Controls: Restrictive covenants and institutional controls shall apply to all downgradient including non-Boeing properties in accordance with WAC 173-340-440.

Section 7.0:

56. Page 7-1, Section 7.0 Analysis of Cleanup Action Alternatives, Paragraph 2: The FS text states: *This section documents that cleanup action alternatives selected for evaluation meet these threshold criteria. The analysis in this section satisfies AO Section VI(7)(B)(iii).* Ecology disagrees with this statement and it is not approved. Several of Boeing's cleanup action alternatives do not meet threshold or other requirements for a cleanup action under WAC 173-340-360(2) (a) and (b). Ecology has identified those cleanup action alternatives that fail threshold or other requirements in Appendix B and Appendix C of this letter.

57. Page 7-1, Section 7.0 Analysis of Cleanup Action Alternatives, Paragraph 6: In this paragraph Boeing expresses its opinion regarding only the negative aspects of selecting the most permanent cleanup action (such as traffic, possible coordination with production activities in the area, etc.). Ecology does not approve these statements. Boeing should have mentioned that the public may also see and prefer the benefits for a more permanent remedy with a much shorter restoration timeframe from a human health and environmental protection standpoint.

58. Page 7-3, Section 7.1.1 Exposure Path Models A-J, Comply with Cleanup Standards: This FS text is an attempt to summarize the cleanup action requirements for contaminated soils left in place and not remediated/removed to meet soil cleanup levels at the standard point of compliance. As stated previously, Boeing should either cite the MTCA

reference (Ecology preference) or restate verbatim the MTCA regulation and not attempt to summarize or restate/interpret the regulation in the FS report. Ecology does not approve any of the bulleted statements that are not exact statements found in the MTCA.

59. Page 7-4, Section 7.1.1 Exposure Path Models A-J, Provide for a Reasonable Restoration Time Frame, Paragraph 1: Many of the SWMUs also have contaminated (perched) groundwater above cleanup standards. The FS text is revised to read: *The maintain containment alternatives for soil contamination must meet all applicable MTCA requirements including WAC 173-340-740(6)(f), provide for a reasonable restoration time frame. ~~by establishing containment and institutional controls immediately following Ecology approval of the Institutional Controls Management Plan.~~*

60. Page 7-14, Section 7.1.8 Exposure Path Models A-J, Future Excavations: In order for Ecology to accept a future excavation remedial alternative as the Ecology preferred alternative, there must be a timeline associated with the future excavation work. An Ecology final cleanup action must include an enforceable timeline schedule. In many instances where Boeing evaluated a 'future excavation' remedial option, a timeline estimate was provided for this work. Without an enforceable time schedule in a MTCA Order, future excavation remedial actions cannot be considered as final cleanup actions.

61. Page 7-19, Section 7.2.2 Exposure Path Model K, Comply with Cleanup Standards: Ecology does not believe alternative 1 meets this threshold requirement and therefore this section is not approved. Refer to Appendix B and C for more detailed statements on this Ecology conclusion.

62. Page 7-20, Section 7.2.2 Exposure Path Model K, Provide for a Reasonable Timeframe: Ecology does not believe alternative 1 meets this requirement for a final cleanup action [WAC 173-340-360(2)(b)] and therefore this section is not approved. Refer to Appendix B and C for more detailed statements on this Ecology conclusion.

Section 8.0:

63. Page 8-1, Section 8.0, Paragraph 1: The text states: *The MTCA DCA is used to evaluate which of the alternatives that meets the threshold requirements is permanent to the maximum extent practicable.* This is an incorrect statement. Remedial alternatives that meet threshold requirements (WAC 173-340-360(2)(a)) and other requirements (WAC 173-340-360(2)(b)(ii) and (iii)) are then evaluated under the MTCA DCA to determine which remedial alternative(s) are permanent to the maximum extent practicable.

64. Page 8-2, Section 8.0, Last Paragraph: The text states, *Ecology has provided informal guidance (Myers 2010) during review of FS reports for other sites regarding the selection of these weighting factors, and the weighting factors used in this FS report are those recommended informally by Ecology.* Ecology did not approve or informally

recommend any weighting factors. Instead, Ecology recommended that Boeing justify the weighting factors they select to use.

65. Page 8-3, Section 8.1 Exposure Pathway Model A: Ecology adds that a potential pathway exists for some SWMUs for TCE vapor intrusion due to elevated TCE soil gas concentrations[46].

66. Page 8-7, Section 8.1 Exposure Pathway Model A, Management of Short Term Risks: Ecology clarifies the text by adding, *"Management of short-term risks" was not added to WAC-173-340-360(3)(e) as a criterion so that it could be used to offset the benefits associated with more protective, permanent, and effective remedies. Ecology believes the remedial alternatives evaluated by Boeing can be ranked about equally in terms of how effective they could be designed to manage short term risks. All could be designed so that the risk of danger to the public and site workers was minimal.*

67. Page 8-7, Section 8.1 Exposure Pathway Model A, Technical and Administrative Ecology clarifies the text by adding, Implementability: *'Implementability' is not included in WAC 173-340-360(3)(e) to offset the benefits associated with more protective, permanent, and effective remedies that require relatively more to be implemented than their less protective/permanent/effective alternatives. All four remedial alternatives are both technically and administratively implementable, however Alternative 4 (excavation) will be close to underground utilities and subsurface structures. Alternative 2 (injections for reductive dechlorination or biodegradation) were found implementable based on the successful results of previous FS pilot studies.*

In-situ bioremediation and chemical reductive dechlorination are well established groundwater treatment technologies. It is obviously easier to implement nothing than something, and generally more difficult to implement more than less, so according to

68. Page 8-8, Section 8.1 Exposure Pathway Model A, Consideration of Public Concerns: The FS text states it believes ALL of the EPM A alternatives are rated as excellent in regard to public concerns. Alternative 4 (excavation) was rated excellent in regard to public concerns, but slightly lower numerically than the other alternatives because it involves the highest degree of construction activity that could potentially impact site operations. The public has not provided any comment on the Boeing preferred remedial actions at these contaminated areas. Ecology considers it likely the employees working in the area and the downgradient public would prefer a faster and more permanent remedial alternative.

69. Page 8-9, Section 8.2 Exposure Pathway Model B: Ecology adds that a potential pathway exists for the contaminated perched groundwater to migrate to the lower Esperance Sand Aquifer[47] AND for volatile organic solvent vapor intrusion into the

[46] Exceeded the soil gas screening values for Method C based on sub-slab vapor attenuation. Soil gas samples depths were very shallow, less than 2 feet below the surface.
[47] This potential was evaluated in the FS report, Appendix B

building due to elevated volatile soil gas concentrations[48]. The existence of perched groundwater indicates current rainwater infiltration and the potential for vertical migration of contamination to the Esperance Sand Aquifer.

70. Page 8-9, Section 8.2 Exposure Pathway Model B, Paragraph 2, Sub-paragraph #1: Ecology has determined that alternative #1 (containment of contamination only) fails threshold requirements because this alternative will not achieve groundwater or soil cleanup standards. This alternative also has an overreliance on institutional controls when it is technically possible to implement a more permanent remedy. WAC 173-340-360(2)(e)(iii). Therefore, alternative #1 should not be included in the DCA evaluation of this subsection 8.2 (discussion of protectiveness, permanence, long term effectiveness, management of short term risks, technical and administrative implementability, and public concerns). Regardless, Boeing did not select alternative #1 as its preferred remedy and instead proposed alternative #2 (in-situ vapor extraction and groundwater extraction).

71. Page 8-12, Section 8.2 Exposure Pathway Model B, Technical and Administrative Implementability: Ecology clarifies the text by adding, *'Implementability' is not included in WAC 173-340-360(3)(e) to offset the benefits associated with more protective, permanent, and effective remedies that require relatively more to be implemented than their less protective/permanent/effective alternatives. All remedial alternatives are both technically and administratively implementable, however excavation alternatives will be close to underground utilities and subsurface structures. It is obviously easier to implement nothing than something, and generally more difficult to implement more than less.*

72. Page 8-12, Section 8.2 Exposure Pathway Model B, Consideration of Public Concerns: The public has not provided any comment on the Boeing preferred remedial actions at these contaminated areas. Ecology considers it likely the surrounding neighbors and the downgradient public would prefer the faster and most permanent remedial alternative.

73. Page 8-13, Section 8.2 Exposure Pathway Model B, Results of Disproportionate Cost Analysis (DCA): Ecology disagrees with this section and it is not approved. Ecology eliminates alternative #1 because it fails threshold criteria-compliance with cleanup standards. Therefore the DCA would need to evaluate alternatives #2 and #3, both of which pass MTCA threshold and other requirements for a cleanup action.

74. Page 8-17, Section 8.4 Exposure Pathway Model D: Ecology adds that a potential pathway exists for the contaminated perched groundwater to migrate to the lower Esperance Sand Aquifer. The existence of perched groundwater indicates current rainwater infiltration and the potential for vertical migration of contamination to the Esperance Sand Aquifer.

75. Page 8-17, Section 8.4 Exposure Pathway Model D, Paragraph 2, Sub-paragraph #1: Ecology has determined that alternative #1 (containment of contaminated groundwater

[48] Exceeds the soil gas screening values for Method C based on sub-slab vapor attenuations.

only) fails threshold requirements because this alternative will not achieve groundwater cleanup standards. This alternative also has an overreliance on institutional controls when it is technically possible to implement a more permanent remedy. WAC 173-340-360(2)(e)(iii). Therefore, alternative #1 should not be included in the DCA evaluation of this subsection 8.4 (discussion of protectiveness, permanence, long term effectiveness, management of short term risks, technical and administrative implementability, and public concerns). Regardless, Boeing did not select alternative #1 as its preferred remedy and instead proposed alternative #4 (near term excavation and groundwater dewatering).

76. Page 8-20, Section 8.4 Exposure Pathway Model D, Management of Short Term Risks: Refer to Ecology comment #66.

77. Page 8-21, Section 8.4 Exposure Pathway Model D, Technical and Administrative Implementability: Ecology clarifies the text by adding, *'Implementability' is not included in WAC 173-340-360(3)(e) to offset the benefits associated with more protective, permanent, and effective remedies that require relatively more to be implemented than their less protective/permanent/effective alternatives. All remedial alternatives are both technically and administratively implementable.*

78. Page 8-21, Section 8.4 Exposure Pathway Model D, Consideration of Public Concerns: Refer to Ecology Comment #72.

79. Page 8-21, Section 8.4 Exposure Pathway Model D, Results of Disproportionate Cost Analysis (DCA): Ecology eliminates alternative #1 because it fails threshold criteria-compliance with cleanup standards. Therefore the DCA would need to evaluate alternatives #2 and #3, both of which pass MTCA threshold and other requirements for a cleanup action.

80. Page 8-22, Section 8.5 Exposure Pathway Models E-F: Ecology adds that a potential pathway exists for the vadose zone soil contamination to migrate to the lower Esperance Sand Aquifer AND for volatile organic solvent vapor intrusion into the building(s) due to elevated volatile soil gas concentrations[49].

81. Page 8-22, Section 8.5 Exposure Pathway Models E-F, Paragraph 2, Fourth Sentence: The FS text states, *Where volatile constituent concentrations in sub-slab vapor exceed the industrial MTCA screening levels, the concentrations are not a current risk to industrial indoor air, either based on Boeing's industrial hygiene evaluation of the interior work spaces, or because the sub-slab vapor detections are outside of existing structures*. This statement is incorrect since industrial hygiene evaluations are not applicable to attaining indoor air cleanup levels under the MTCA regulations for spills of volatile chemicals that contaminate shallow soils and groundwater.

82. Page 8-25, Section 8.5 Exposure Pathway Models E-F, Management of Short Term Risks: Refer to Ecology comment #66.

[49] Exceeds soil gas screening values for Method C based on sub-slab vapor attenuations.

83. Page 8-25, Section 8.5 Exposure Pathway Models E-F, Technical and Administrative Implementability: Refer to Ecology Comment #77.

84. Page 8-26, Section 8.5 Exposure Pathway Models E-F, Consideration of Public Concerns: Refer to Ecology Comment #72

85. Page 8-27, Section 8.6 Exposure Pathway Models G-H: Ecology adds that a potential pathway exists for some SWMUs (067, 071, 093) in this group for the vadose zone soil contamination to migrate to the lower Esperance Sand Aquifer AND for volatile organic solvent vapor intrusion into the building(s) due to elevated volatile soil gas concentrations[50].

86. Page 8-30, Section 8.6 Exposure Pathway Models G-H, Management of Short Term Risks: Refer to Ecology comment #66.

87. Page 8-31, Section 8.6 Exposure Pathway Models G-H, Technical and Administrative Implementability: Refer to Ecology Comment #77.

88. Page 8-31, Section 8.6 Exposure Pathway Models G-H, Consideration of Public Concerns: Refer to Ecology Comment #72.

89. Page 8-36, Section 8.9 Exposure Pathway Model K, Third Paragraph: Ecology has determined that alternative #1 fails threshold requirements because this alternative will not achieve groundwater cleanup levels at the standard point of compliance. The means for alternative #1 to attain cleanup standards is to immediately apply aggressive groundwater treatment (such as in-situ chemical oxidation or in-situ enhanced bioremediation) in the source and downgradient areas (alternatives #3 and #4).

90. Page 8-36, Section 8.9 Exposure Pathway Model K, Paragraph 3, Third Sentence: The FS text reads, *As reflected by the scores for Alternatives 2, 3, and 4, there is uncertainty in the optimal configuration and application of bioremediation or ISCO in these alternatives, and hence uncertainty regarding the relative benefit of ISCO or bioremediation as a supplement to GET system operation.* Ecology disagrees with this text and this text is not approved in the FS report. Ecology acknowledges that there is uncertainty all of the four remedial alternatives evaluated but there is larger uncertainty with alternative #1 (relying mainly on the current interim action groundwater pump and treat system to remediate the Esperance Sand Aquifer to cleanup levels at the standard point of compliance (source area and throughout the TCE groundwater plume).

91. Page 8-36, Section 8.9 Exposure Pathway Model K, Paragraph 3, Fourth Sentence: The FS text reads: *There is also uncertainty regarding the potential for ISCO or bioremediation to create conditions that decrease the effectiveness of the GET system, such as biofouling of well screens or the treatment system or increased downgradient*

[50] Above the soil gas screening values for Method C based on sub-slab vapor attenuations.

migration of degradation products. Ecology believes this is a valid concern, however, this concern is present with all ISCO and bioremediation injection technologies ever implemented and there are engineering design features that can be implemented to reduce or mitigate this outcome. For example, designing the groundwater injection locations distant (upgradient and downgradient) from the groundwater extraction and monitoring wells. This recommendation is also stated in the FS report on page 8-38 (Alternative #4).

92. Page 8-45 Section 8.9 Exposure Pathway Model K, Disproportionate Cost Analysis: Ecology disagrees with Boeing's DCA analysis and it is not approved. Ecology has determined that alternative #1 fails threshold requirements and cannot not be included in the DCA evaluation. Refer to Appendix B, Section B.2.

Section 9.0:

93. Page 9-1, Section 9.0, First Paragraph, Third and Fourth Sentences: The text states: *This is because, with the exposures controlled, the substantial cost to perform active treatment is clearly disproportionate to the small additional benefit gained. For some SWMUs/AOCs, the DCA results indicate that containment should be selected, but an intrusive cleanup action is instead recommended in this FS.* As discussed in more detail in Appendices A and B, Ecology does not agree that active treatment for many of the upland SWMUs is disproportionately costly compared to Boeing preferred containment cleanup remedies. In many cases, the Boeing preferred containment remedy did not satisfy MTCA threshold and other requirements for a final cleanup action, thus the Boeing preferred containment remedy was not allowed to be evaluated in the DCA evaluation.

94. Page 9-2, Section 9.0, Second Paragraph (including 6 bulleted statements): Boeing describes interim cleanup actions conducted at many of the SWMUs. These are worthy cleanup actions, however, Ecology notes that many of these interim cleanup actions were not intended to and did not meet cleanup levels at the standard point of compliance.

95. Page 9-3, Section 9.0, Third Paragraph: Boeing discusses two excavation alternatives: near-term excavation and future excavation. A final cleanup under a MTCA administrative order must have a firm time schedule and therefore a 'future excavation' option without indicating the timeframe for when that excavation occurs is not an acceptable remedial action alternative. How can Ecology evaluate the 'reasonable restoration timeframe' requirement under WAC 173-340-360(4) for such an alternative?

96. Page 9-4, Section 9.0, Fourth Paragraph, Bullet #2: The text reads *....procedures to require that construction activities involving excavation or that could impact a remedy be reviewed by Boeing EHS personnel against the requirements and limitations of the institutional control plan.* Ecology must be notified prior to and approve of any activities that are forbidden by Ecology approved institutional controls or environmental covenants.

97. Page 9-6, Section 9.2: Ecology does not agree with Boeing's statement that remedial alternative #2 is disproportionately costly compared to alternative #1 (containment only). The MTCA regulations (WAC 173-340-360(2)(c)(II)(A)) require reasonable efforts to remove source contamination and NAPL at this SWMU. Alternative#1 will fail threshold criteria-compliance with cleanup levels for groundwater. Therefore, alternative #1 does not meet this requirement for a permanent groundwater remedy and cannot be selected as a cleanup action and cannot be evaluated in a disproportionate cost analysis (DCA). Remedial alternative #2 (SVE and groundwater extraction) offers reasonable efforts to remove source contamination and NAPL. Boeing agrees to implement remedial alternative #2 and Ecology agrees because alternative #1 is not allowed under MTCA as stated above.

98. Page 9-7, Section 9.4: Ecology does not agree with Boeing's statement that remedial alternative #4 (Near Term Excavation with Dewatering) is disproportionately costly compared to alternative #1 (containment only). The MTCA regulations (WAC 173-340-360(2)(c)(II)(A)) require reasonable efforts to remove source contamination and NAPL at this SWMU. Alternative #1 fails threshold criteria – compliance with cleanup standards for groundwater. Therefore alternative#1 cannot be selected as a cleanup action and cannot be evaluated in a disproportionate cost analysis (DCA). Remedial alternative #4 offers reasonable efforts to remove source contamination and NAPL. Boeing agrees to implement remedial alternative #4 and Ecology agrees because alternative #1 is not allowed under MTCA as stated above.

99. Page 9-8, Section 9.5: Ecology's preferred remedial alternative for SWMU #97 alternative #3 (near term excavation). Ecology believes this alternative is permanent to the maximum extent practicable. Ecology does not agree with Boeing's statement that remedial alternative #3 (SWMU#97) is disproportionately costly compared to alternative #1 (containment only). The MTCA regulations (WAC 173-340-360((2) and (4) require a reasonable restoration timeframe. Near term excavation is a dependable and well-established technology for further active TCE contaminated soil treatment. Ecology believes the additional cost to implement remedial alternative #3 over alternative #1 is not disproportionate. Therefore, remedial alternative #3 is the permanent to the maximum extent practicable remedy. In the end, Boeing agrees to implement near term excavation as the final cleanup action for SWMUs #97.

    Ecology's preferred remedial alternative for SWMU#171 is alternative #2, soil vapor extraction (SVE). Ecology disagrees with Boeing's section summary that results in the selection of alternative #1(containment only) for SWMU#171. Ecology's regulatory justification for preferring alternative #2 is discussed in Appendix B.1.

100. Page 9-9, Section 9.6: Ecology's preferred remedial alternative for SWMU #68 alternative 4 (near term excavation). Ecology believes this alternative is permanent to the maximum extent practicable. Ecology does not agree with Boeing's statement that remedial alternative #4 (SWMU#68) is disproportionately costly compared to alternative #1 (containment only). The MTCA regulations (WAC 173-340-360((2) and (4) require a

reasonable restoration timeframe. Near term excavation is a dependable and well-established technology for remediating contaminated soil. Ecology believes the additional cost to implement remedial alternative #4 over alternative #1 is not disproportionate. Therefore, remedial alternative #4 is the permanent to the maximum extent practicable remedy. In the end, Boeing agrees to implement near term excavation as the final cleanup action for SWMU#68. Therefore, Ecology doesn't believe it should spend additional time disagreeing with Boeing's justification statements.

101. Page 9-10, Section 9.7: Boeing discusses two excavation alternatives for the SWMU UST EV-48-1: near-term excavation and future excavation. A final cleanup under a MTCA administrative order must have a firm time schedule and therefore a 'future excavation' option without indicating the timeframe for when that excavation occurs is not an acceptable remedial action alternative.

102. Page 9-12, Section 9.9: Ecology believes remedial alternative#2 (comprehensive excavation) meets all threshold and other requirements for a final cleanup action and is permanent to the maximum extent practicable. Boeing agrees to implement comprehensive excavation to attain cleanup levels at the standard point of compliance.

103. Page 9-13, Section 9.10: Ecology believes remedial alternative #4 meets all threshold and other requirements for a final cleanup action and is permanent to the maximum extent practicable. Ecology disagrees with Boeing's section summary that results in the selection of alternative #1 for this the PMG TCE Groundwater Contamination SWMU. Ecology's regulatory justification for preferring alternative #4 is discussed in Appendix B.2.

FS Report, Appendix B: Vadose Zone Modeling Results

Generally, Ecology believes that the SESOIL modeling methodology and the assumptions applied to the SESOIL model are conservative. The model input parameters, including soil physical and chemical properties and contaminant concentrations, are generally representative of RI data, and reasonably conservative. We believe that the model results, particularly the predicted peak groundwater concentrations in the Esperance Sand Aquifer, can be used as one line of evidence to evaluate remedial alternatives for the soil contamination within various SWMUs/AOCs in the feasibility study.

Ecology also believes that SESOIL model, similar to other screening level analytical models, has its limitations and uncertainties. These limitations and uncertainties should be clearly stated and well understood by readers, and the modeling results should be interpreted and evaluated within these limitations and uncertainties. Specifically, the following limitations must be considered when SESOIL model is applied:

- SESOIL Model is applicable and useful to estimate the future maximum (peak) groundwater concentrations (for example, see Figures B-5, B-6, and B-7). However, the model cannot reliably to predict the times for soil contamination to reach the underlying

Esperance Sand Aquifer and for groundwater contamination to reach the maximum (peak) concentration and/or to attenuate to below the MCLs or cleanup levels. The considerable uncertainty with time prediction mainly results from: (1) vadose zone flow is assumed as gravity driven flow in most analytical vadose zone models. This inherited assumption will under-predict velocities of vertical groundwater flow and contaminant transport. In fact, vertical groundwater flow is generally driven by capillary pressure under unsaturated conditions within the vadose zone where capillary pressure driven flow transports much faster than the gravity driven flow; and (2) uncertainties associated with model input parameters for simulation of the vadose zone flow and transport, including infiltration rate, intrinsic permeability, total organic content, and adsorption coefficient or retardation factor. For some SWMUs/AOCs (such as Building 40-51), SESOIL model predicts contaminate will reach the peak concentrations in 40 to 50 years (see Figures B-5, B-6, and B-7). But for other SWMUs/AOCs (such as Building 40-56), the model predicts the peak concentrations will not be reached in several hundred years to over 1,000 years (see Figures B-14 and B-17). Uncertainty associated with these time predictions is significant and the timeframe is most likely over-estimated by the model.

- SESOIL Model cannot be used directly to simulate perched groundwater within the vadose zone, which is an important feature for several SWMUs/AOCs. Contaminated perched groundwater will not only behave as additional vadose zone source to the underlying Esperance Sand Aquifer, it could also migrate latterly to spread contamination within the vadose zone to a larger area than the original source area above. SESOIL model is not designed to simulate a perched groundwater within the vadose zone therefore the modeling results may have significant uncertainty if perched groundwater exists.

- SESOIL model results should be compared to the observed groundwater data within the Esperance Sand Aquifer for a "reality check". Building 40-32 modeling results predict TCE will not reach or migrate to the Esperance Sand Aquifer in approximately 300 years (see Figure B-37a), which seems to be a long time that cannot be supported by minimal site data. This type of modeling results should be evaluated against observed data at the site or contamination data from different SWMUs/AOCs with similar geologic and hydrogeologic settings. Uncertainty should be considered when remedial alternatives are evaluated and selected.