Comment Summary

The Washington State Department of Ecology received comments from two individuals and two organizations during the comment period (August 30, 2018 through September 28, 2018) for the proposed contingent groundwater remedy technical memorandum for the cleanup site located at 220 S. Dawson Street, Seattle, Washington. Thank you for sending your comments.

Table 1: List of Commenters

	First Name	Last Name	Submitted By
1	Velma	Veloria	Individual
2	Jimmy	Blais	Merlino Properties
3	James	Rasmussen	Duwamish River Cleanup Coalition
4	Daniel	Schwendeman	Individual

Comments and Responses

Based on Ecology's evaluation of the comments, no changes were made to the document. The comments are presented below in their original format, along with Ecology's responses.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000
711 for Washington Relay Service • Persons with a speech disability can call (877) 833-6341

October 29, 2018

Jimmy Blais
Merlino Properties
5050 1st Ave. S., Suite 102
Seattle, WA 98134

Mr. Jimmy Blais,

Thank you for having your environmental consultant, Landau, comment on the proposed new cleanup methods for General Electric Aviation (GE), located at 200 S. Dawson Street, Seattle, WA. We were copied on that September 21st comment letter to GE. Because you submitted the comments during the formal comment period (August 30, 2018 - September 28, 2018), we are responding to your comments directly in this letter.

We are currently requiring GE to clean up the trichloroethylene (TCE) contaminated groundwater on the 220 S. Dawson Street property and the groundwater contamination that has migrated west of this property. The cleanup is being conducted under the terms of a consent decree finalized in 2014.

Responses to comments:

We agree with GE that the injection of EHC (PeroxyChem) into the groundwater will be more effective than the in-situ bioremediation proposed by Landau. GE's proposed cleanup technology has been shown to be effective at other sites and as a result produce less vinyl chloride. We are confident that this method will reduce the TCE and other chlorinated volatile organic compounds to our required cleanup levels.

While we understand your concern about vapor intrusion in general, we do not believe that vapor intrusion is happening in your Liberty Ridge building (5033 and 5050 1st Avenue South), so indoor air sampling is not warranted for the following reasons:

- We monitor the wells under the Liberty Ridge building. From the data collected, we are confident that we know the magnitude and extent of the TCE groundwater plume under the building[1].

- We evaluate the potential for vapor intrusion into the building by monitoring the groundwater wells closest to the surface (MW-3S and EPI MW-4S under the Liberty Ridge building).

- TCE in those shallow groundwater monitoring wells are consistently below site groundwater cleanup levels (6.6 µg/L TCE).

- We based the site shallow groundwater cleanup levels on an empirical study designed that evaluated shallow groundwater volatile contaminant concentrations that do not result in unacceptable vapor intrusion into buildings[2].

- There are no cracks or openings in the floor that could lead to vapor intrusion. In 2005, we conducted a Liberty Ridge building walk and saw no floor openings to the soils beneath your building. However, if you have made any building modifications that created such large cracks or openings, please let me know where they are located.

Please call me at (425) 649-7264 if you have any questions regarding this letter.

Sincerely,

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

cc: Thea Levkovitz

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[1] Additionally, we oversaw and completed the remedial investigation (RI) and feasibility study (FS) for the contamination on the 220 S. Dawson Street property and the contamination that migrated west and under the Liberty Ridge building. We updated Liberty Ridge during FS (and selection of final remedy) and development of the final cleanup action plan. Liberty Ridge commented on the cleanup action plan, but did not object to the groundwater characterization under their building.

[2] Ecology approved the same concentrations used as the PSC Georgetown groundwater inhalation pathway interim measure action levels (IPIMALs) for the shallow GW CUL. These IPIMALs were the result of an empirical study correlating groundwater VOC data with indoor air VOC data, that then attempted to develop a mathematical relationship between the two (an "attenuation factor"). Ecology believes these are applicable to the GE site because the two cleanup sites lie above the same aquifer, have similar vadose zone characteristics, and share the same COCs (chlorinated volatile contaminants such as PCE, TCE, 1,1,1-TCA, and decomposition products of each). Based on Ecology's current understanding, Ecology does not believe there are significant geological differences in the vadose zones at the PSC-G and GE sites

LANDAU ASSOCIATES

September 21, 2018

GE Global Operations--EHS
1 River Road, Bldg. 5-7W
Schenectady, NY 12345

Attn: Thomas D. Antonoff, Senior Project Manager, Environmental Remediation

Transmitted via email to: *Tom.Antonoff@ge.com*

Re: Response to Review of Landau Associates Technical Memorandum
Former General Electric Aircraft Site
Seattle, Washington
Project No. 1752001.010.011

Dear Mr. Antonoff:

We submit this response letter on behalf of Mr. Jimmy Blais of Merlino Properties. Thank you for your response to the concerns we raised regarding the planned use of EHC® for bioremediation and potential indoor air impacts to the Liberty Ridge building.

We understand from your response that you remain confident that injection of EHC, as described in the contingent remedy proposal, will be effective at reducing TCE concentrations in the source zone. As detailed in our memorandum, we hold a different technical opinion as to the efficacy of EHC versus liquid donor substrates. We reiterate our concerns that EHC will not be effectively emplaced in the thin silt zone, but that EHC hydrofractures will break out of the silt during injection and result in EHC distributed in random tendrils above and below the silt. We do not expect EHC injection to significantly reduce the ongoing flux of TCE due to back diffusion from the silt in the source area. We understand that bioremediation with liquid electron donor substrates, as originally described in the feasibility study, would be applied as a follow up treatment in the event that EHC is not adequately effective.

To restate our concerns about potential indoor air impacts to the Liberty Ridge building, we are most concerned with the limited shallow groundwater data beneath the building that was used as the basis for the Johnson-Ettinger modeling of potential indoor air impacts. It is our position that groundwater data from the three shallow wells located in and immediately adjacent to the building (EPI-MW-2S, -3S, and -4S) are inadequate to assess potential indoor impacts for a building that is approximately 180 feet x 350 feet (63,000 square feet). It is unlikely that these three monitored points adequately represent maximum TCE concentrations that may exist in preferential flow paths within the shallow water-bearing zone beneath the building.

We request an evaluation of potential indoor impacts to the Liberty Ridge building to confirm the results of the Johnson-Ettinger modeling. We recommend placement of 10 Radiello® passive sorbent samplers (approximate 80-foot sampling grid) at agreed upon locations within the building, as a low-cost and non-intrusive method of investigation. After being deployed for approximately 2 weeks, the Radiello samplers would be recovered and submitted for laboratory analysis of TCE by gas chromatography/mass spectrometry (GC/MS). Deployment and recovery of the samplers is described in the Radiello product manual (https://www.environmental-expert.com/downloads/radiello-manual-pdf-1766-kb-30140). In the event of TCE detections in indoor air above the site cleanup level of 0.22 micrograms per cubic meter ($\mu g/m^3$), follow-up evaluations of indoor air and/or soil vapor would be required. In the event that TCE indoor impacts above the cleanup level and TCE in soil vapor are confirmed, mitigation measures would be required.

LANDAU ASSOCIATES, INC.

Clint Jacob, PE, LG
Principal

CLJ/ljl
[P:\1752\001\R\RESPONSE TO GE MEMO REVIEW_092118.DOCX]

cc: Jimmy Blais, Merlino Properties
Jason Palmer, AECOM
Dean Yasuda, Washington State Department of Ecology

Thomas D. Antonoff
Senior Project Manager

GE
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VIA EMAIL

Mr. Jimmy Blais
Merlino Properties
5050 1st Ave., Suite 102
Seattle, WA 98134

Re: Review of Landau Associates Technical Memorandum
Former General Electric Aircraft Site
Seattle, Washington
Project No. 1752001.010.011 Date

Dear Mr. Blais,

Thank you for sharing the Technical Memorandum by Landau Associates dated July 31, 2018. GE appreciates the opportunity to review these comments in advance of the public comment period.

We agree with Mr. Jacob that enhanced in-situ bioremediation (EISB) is the most appropriate remedial technology for treating the trichloroethylene (TCE) at the South Dawson Street site. The main point of difference highlighted in the Liberty Ridge memo is the amendment and delivery method used. Over the past decade GE has applied tens/hundreds of thousands of pounds of EHC® at multiple sites in various geologic media to treat TCE sources. In our experience EHC® promotes reductive dechlorination of TCE as the primary degradation pathway and reduction of TCE via the ZVI as the secondary pathway. The secondary pathway is advantageous because it does not produce daughter products, including vinyl chloride (VC). In our experience the material is long lasting in the subsurface consistent with the manufacturers claim of a 5-year lifetime. The organic material will ferment to volatile fatty acids (VFAs) and provide some downgradient treatment due to advective flow.

The primary advantage of EHC® in the South Dawson Street context is that it is injected as a slurry, can penetrate into the low permeability lenses where the TCE likely resides, and will largely stay where it is injected. This is in contrast with soluble electron donors such as lactate and emulsified vegetable oil (EVO) recommended in the CAP, which will flow preferentially into the high permeability soils, largely bypass the low permeability zones, and be rapidly washed away by the high groundwater flow in these areas. This is more true with lactate than with EVO, but based on the results observed in the ISCO pilot study even EVO may be rapidly flushed through the system before it can sorb to the soil.

The distribution of EHC® in the subsurface can be effectively mapped using a magnetic susceptibility meter, which measures the iron in the amendment. Although not stated in the technical memorandum, the injection depths can be staggered among injection points to provide more complete vertical coverage of the injection zone. We believe this approach should be sufficient to treat the relatively low concentrations of TCE in the soil and groundwater.

It should be noted that the remedy as described in the technical memorandum is focused on the source area in the alleyway on the McKinstry property. Treating this area is the objective of the phase 1 program outlined in the CAP. Following the phase 1 program, we will take what we learn and apply it to the downgradient soil and groundwater where TCE is found at greater depths. We will revisit the Liberty Ridge comments at that time and make any necessary adjustments to the remedial program. Liberty Ridge will also have access to the phase 1 data, just as you were able to review the ISCO pilot study completion report, and have additional opportunity to comment at that time.

In regards to vapor intrusion (VI), shallow groundwater concentrations are the primary factor that could contribute to indoor air impacts. The highest groundwater TCE concentrations referenced in your comment letter, adjacent to or below the Liberty Ridge building (at wells WP-27, WP-28, WP-29, and WP-34), were found in the intermediate depth groundwater samples and were collected in the years 1999 and 2000 (see Figures 2-17 and 2-22 from the ENSR/AECOM Focused Feasibility Study). TCE concentrations in shallow groundwater samples from the same wells and the same time period were significantly lower, and lower than concentrations used for indoor air calculations at the former GE building where the VI mitigation system (VIMs) was required.

Groundwater concentrations in both shallow and intermediate/deep monitoring wells have continued to decrease over the 18 years since these samples were collected, across both the on- and off-property areas, as shown in the quarterly groundwater monitoring reports that have been provided to you. With the exception of monitoring well MW-1 located at the eastern end of the McKinstry alleyway, all shallow monitoring wells upgradient and beneath the Liberty Ridge building have been below the TCE cleanup standard since 2015. Incidentally, the site-specific TCE cleanup standard for shallow groundwater is based on the protection of indoor air. Therefore, the predictive indoor air modeling via EPA's Johnson and Ettinger model demonstrates that VI was not and is not a risk at the Liberty Ridge building. We believe this assessment is still conservative and applicable, but we are willing to discuss this issue further with you if you still have concerns.

Again, thank you for sharing this memorandum with us prior to the scheduled public comment period. We are very interested in moving forward with our remedial action before the warm weather ends, and this opportunity to review your concerns will help us achieve that goal. Please contact me at your convenience if you would like to discuss the project in further detail.

Sincerely,

Thomas D. Antonoff
Senior Project Manager, Environmental Remediation

Technical Memorandum

TO: Jimmy Blais, Merlino Properties

FROM: Clint Jacob, PE

DATE: July 31, 2018

RE: **Review of Environmental Documents**
Former General Electric Aircraft Site
Seattle, Washington
Project No. 1752001.010.011

Introduction

As per your request, Landau Associates, Inc. (LAI) is providing review comments in this technical memorandum for the following documents related to the former General Electric (GE) Aircraft site located at 220 South Dawson Street in Seattle, Washington (site). Groundwater contaminated with trichloroethene (TCE) at the GE site extends beneath the adjacent Liberty Ridge property (5033 and 5050 1st Avenue South) managed by Merlino Properties. As an affected party, Merlino Properties is a stakeholder in the cleanup performed by GE and overseen by the Washington State Department of Ecology (Ecology). The purpose of this document review is to provide a professional opinion as to the efficacy of proposed remedial actions at the site and potential risks or impacts to the Liberty Ridge property. Reviewed documents are:

- Agreed Order between GE and Ecology (2008)
- Focused Feasibility Study (FS) –Version 3 (2008)
- Draft Cleanup Action Plan (DCAP; 2012)
- Liberty Ridge Access and Settlement Agreement (2014)
- Final Draft Consent Decree (2014)
- Persulfate *In-Situ* Chemical Oxidation Bench Test Report (2015)
- GE Recommendations for Oxidant at Dawson Street (2015)
- Phase I Engineering Design Report (2016)
- *In-Situ* Chemical Oxidation (ISCO) Pilot Study Completion Report (2017)
- Addendum to ISCO Completion Report (2018)
- Ecology Response and Contingent Approval Letter for the Engineering Design Report (EDR) Phase 1 (2018)
- Draft Contingent Remedy Evaluation Memorandum (2018)
- Ecology Response and Comment Letter for the Draft Contingent Groundwater Treatment Remedy Technical Memorandum (2018)
- Ecology Contingent Approval of the Groundwater Recovery System Modification (RW-3) Work Plan (2018).

Our opinion, presented below, addresses the following:

1) The site conceptual model, that is, site conditions and contaminant distribution at the site
2) Considerations for selection of a TCE mass removal technology for the site
3) The optimal approach for application of *in-situ* bioremediation at the site
4) Potential risks or impacts to the Liberty Ridge property.

Site Conceptual Model

After reviewing the above-listed documents, three important site constraints were not well understood or adequately considered in the site conceptual model at the time of the FS:

1) TCE contamination is the result of an old release. For releases older than about 10 years, it is understood that most of the remaining contaminant mass is in lower permeability units (e.g., silts, silty sands; ITRC 2011). In the first few years after a solvent release, the highest concentrations will be in the most permeable units (sands) with diffusion into the adjacent silts. Several years after the release ends, mass will be mostly flushed out of the high groundwater flow zones but will continue to slowly bleed back out of the silt resulting in lower but persistent solvent concentrations in groundwater. This is known as back diffusion and provides a slow and long-lasting source of contamination in groundwater. Tom Sale of Colorado State University has demonstrated this effect with a dye (representing contaminated groundwater) flushed through a sand tank containing clay lenses; the initial flush of dye is followed by a period of clean water flush during which the back diffusion effect is clearly observed.[1]
2) Low permeability silt and silty sand are present in the source area/release area (FS Figure 2-2, ENSR/AECOM 2008). TCE mass in these units outside the areas where soil excavations were completed provides a long-term source of back diffusion. This was identified after the FS in the recent Contingent Remedy Evaluation memorandum (AECOM 2018) as a cause of ISCO treatment failure.
3) Preferential flow paths (i.e., buried stream channels within the aquifer) result from depositional environment (riverine deposition) of site aquifer soils. Most of the groundwater flow and flux of contaminants are through these flow paths (i.e., groundwater and contaminants are primarily transported offsite along flow paths of the cleanest sand not in the silt or silty sand). Flow in buried preferential flow paths at the site is apparent in the C-C' cross section presented in the FS (see FS Figure 2-22, ENSR/AECOM 2008). In this cross section, there are high TCE concentrations in the source, mid-plume, and near the end of the plume which are separated by areas of much lower concentrations. This is does not represent discrete and separate portions of the plume in the aquifer. Instead, this likely reflects the movements of the highest contaminant concentrations along a sinuous preferential flow path (i.e., buried, meandering stream channels), which is intersected at multiple locations by the cross section. This means that the effects of treatment within the source or the plume will be observed at some downgradient wells much sooner than others; in fact, treatment effects

[1] Sale, T. 2014. "Colorado State Matrix Diffusion Video." GSI Environmental. https://www.gsi-net.com/en/publications/useful-groundwater-resources/colorado-state-matrix-diffusion-video.html.

may be observed at distant wells and not closer wells. This effect was observed during the ISCO pilot test, when persulfate concentrations were observed very quickly at some downgradient wells and not at all at closer monitoring wells (AECOM 2017). Injected treatment fluids will move most readily into these preferential flow paths where intersected by injection wells. This movement of injection fluid in preferential flow paths was identified in the recent Contingent Remedy Evaluation memorandum (AECOM 2018) as a cause of ISCO treatment failure.

4) Given the above discussion of preferential flow paths, it is not clear whether potential indoor air impacts at the Liberty Ridge building downgradient of the GE site have been adequately evaluated or addressed. The DCAP indicates that modeling was used to predict indoor air concentrations in the building and determined that predicted indoor air concentrations were below interim action screening levels; this modeling was based on groundwater concentrations on the Liberty Ridge property. Given that the highest concentrations of TCE in groundwater move in discrete, preferential flow paths that may not have been fully characterized beneath the Liberty Ridge building, the groundwater concentrations used for indoor modeling may be lower than actual maximum concentrations occurring beneath the building. This would cause modeling results to be lower than actual indoor air concentrations. Furthermore, TCE concentrations in groundwater at locations adjacent to or beneath the Liberty Ridge building (e.g., MW-14, WP-27, WP-28, WP-29, and WP-34; see FS Figure 2-2, ENSR/AECOM 2008) are as high or higher than TCE concentrations in groundwater beneath the former GE building, where unacceptable indoor air concentrations require operation of a vapor intrusion mitigation (VIM) system. Groundwater sampling at multiple locations beneath the Liberty Ridge building to further identify preferential flow paths with high TCE concentrations may be infeasible; therefore, relatively less intrusive sampling of sub-slab soil vapor and/or indoor air would be the preferred approach to resolve this apparent data gap.

Mass Removal Technology Considerations

The best technologies for the site, given the constraints above, are those best suited to address slow back diffusion of contaminant mass from silt in the source and transport of contaminant mass downgradient in preferential flow paths. Of the treatment technologies considered in the FS, DCAP, and Contingent Remedy Evaluation memorandum (AECOM 2018), it is our opinion that appropriately designed anaerobic bioremediation is best suited to these site constraints. Bioremediation appropriately designed to address site constraints will:

- Enhance the naturally reduced aquifer condition and the reductive dechlorination already occurring at the site. Anaerobic bioremediation is better suited for the natural site conditions than ISCO, which attempts to create oxidizing conditions that are contrary to the naturally reduced aquifer conditions and naturally high organic carbon.
- An appropriate selection of electron donors will result in long-lasting treatment (likely 6 months to 1 year) between injection events. This is in contrast to the 5 days of longevity estimated for the injected persulfate. Long-lasting treatment is required to address the slow process of back diffusion. Less frequent injections will minimize disruption of site activities.
- An appropriate mix of liquid electron donors will maintain effective treatment in the source zone (not flush out of the most permeable preferential flow paths) and will also extend the

treatment zone downgradient to address high contaminant concentration areas of the plume. This results in the treatment of a larger area with fewer injection wells required. Based on the site average seepage velocity published in the FS (0.3–1.5 feet [ft] per day), the downgradient treatment zone could extend 100–200 ft from injection wells.

- Appropriately designed bioremediation will enhance the diffusion and biotreatment of the contaminant mass from silt. The electron donor should be injected above and below silt intervals that have sorbed TCE mass. This will result in low TCE conditions immediately adjacent to the silt, a steeper diffusion gradient, and more rapid diffusion. The electron donor will also diffuse into the silt, stimulating treatment at increasing distance into the silt with time. Although TCE was not detected in the middle depth of the source prior to the ISCO pilot test, TCE did exceed the site cleanup level in the middle zone during the ISCO pilot test (AECOM 2017). Donor injection over an interval above and below silt (e.g., 6–16 ft) would address the primary location of TCE as well as potential deeper migration to TCE due to injection.
- Anaerobic bioremediation has the substantial added benefit over other treatment technologies of sustained treatment following a period of active injections. Repeated injections of electron donor for active treatment are followed by an extended period of persistent moderate to low levels of electron donor that sustain biotreatment for long-term treatment of residual concentrations. Sustained treatment results from die off of microorganisms grown during the active treatment phase and their utilization as electron donor (a process known as endogenous decay) and back diffusion of electron donor from lower hydraulic conductivity units. Extended biotreatment following a period of active injection can last several years and provide a highly beneficial period of enhancement between active treatment and monitored natural attenuation (MNA) under natural conditions, which are eventually restored (Adamson and Newell 2009, Jacob et al. 2010, Adamson et al. 2011). This post-treatment benefit does not occur with other remediation technologies like pump and treat or ISCO, which are on or off, without sustained post-treatment effects.

Other treatment technologies considered in the FS, DCAP, and Contingent Remedy Evaluation memorandum (AECOM 2018) have various limitations, as follows:

- Groundwater extraction and treatment (GET). While GET can be effective for plume containment, it is not well suited for treatment of contaminant mass that is slowly released from silt by back diffusion. GET will pump large volumes of groundwater over a long period of time to maintain hydraulic control during the period of slow back diffusion.
- MNA. Very low concentrations of vinyl chloride detected at the site indicate that natural site conditions are inadequate to achieve complete reductive dechlorination of TCE through to non-toxic end products. Natural organic carbon is inadequate to achieve the highly reducing aquifer redox conditions required for complete reductive dechlorination.
- Air sparge (AS) and soil vapor extraction (SVE). AS provides oxygen and strips volatile contamination. Because TCE is not treated under aerobic conditions, stripping is the only potential benefit of AS. Furthermore, AS does not function well in heterogeneous aquifers such as the occurrence of the silt and silty sand units in the source zone. Bubbles from AS wells screened below the silt will not enter the silt or be effectively distributed above the silt,

where most of the TCE mass occurs. Attempted application of AS in the shallow zone above the silt would not address the mass in the underlying silt and would require a tight spacing of AS wells due to the thin saturated zone above the silt.

- *In-situ* Chemical Reduction (ISCR). ISCR can be an effective technology for TCE treatment. The use of EHC®, as described in the Contingent Remedy Evaluation memorandum (AECOM 2018), will stimulate both bioremediation and ISCR. However, in our opinion, the use of EHC is not well-suited to site constraints, as described below.

Optimal Approach for Anaerobic Bioremediation at the Site

An optimal approach for anaerobic bioremediation should utilize liquid donors, a combination of soluble and insoluble donors, relatively large injection volumes, and a vertical injection interval that delivers donor above and below silt units in the source.

- The Contingent Remedy Evaluation memorandum (AECOM 2018) calls for stimulation of bioremediation and complementary abiotic degradation (i.e., reductive elimination) through injection of EHC. There are number of problems with EHC that make it a less-than-ideal substrate choice for use at the site:
  - EHC consists of solid particles that must be injected as a slurry. The slurry is not injected into the aquifer in a uniform way, but is pushed out from the well in discrete channels that develop under injection pressure. This results in EHC placement in discrete lenses or channels (like tree roots) through a process known as hydrofracturing. The injection design in the Contingent Remedy Evaluation memorandum (AECOM 2018) targets three horizontal lenses over the vertical interval of 7–12 ft below ground surface (bgs). However, attempts to inject EHC within the thin silt layer in this interval will likely be ineffective, as most of the EHC will short circuit unpredictably into the sand above and below the silt. This is in contrast to much more uniform distribution that can be achieved above and below the silt with dissolved donors (e.g., lactate) and emulsified vegetable oil.
  - Following injection, EHC does not move with groundwater. The electron donor component of EHC ferments in place and only the soluble fermentation products (organic acids and hydrogen) move a shorter distance downgradient. This results in a much smaller downgradient treatment zone than can be achieved with appropriate mix of liquid electron donors. The use of EHC may form a treatment barrier that may treat groundwater as it moves through the barrier, as compared to an extended downgradient treatment zone that would result from the appropriate use of liquid donor substrates.
  - The electron donor component of EHC is a byproduct of grain milling and is a less-than-ideal donor source. The vendor (PeroxyChem) highlights an extended longevity for this donor, but it tends to too slowly releasing so that treatment effects occur only near the injection point without adequate downgradient treatment.
  - Zero-valent iron (ZVI) can be very effective for TCE mass destruction, but it requires direct contact with TCE contamination. ZVI is typically utilized in high concentration source zones with TCE concentrations greater than 1,000 micrograms per liter (µg/L),

conditions that do not appear to occur at the site. The large particle size of the ZVI present in EHC (50 to 600 microns) results in non-uniform distribution in discrete, hydrofractured lenses and channels, and is confined to a relatively short distance from the injection point. This incomplete distribution leaves a large percentage of the aquifer near the injection well untreated. If high concentration portions of the source are identified where ZVI could be appropriate, a colloidal ZVI (particle size 3-micron) would be a better choice. This can be injected with a liquid donor solution using injection wells and moves readily through sand for a more extensive distribution.

- As originally considered in the FS (ENSR/AECOM 2008), an optimal mix of electron donors would include soluble and insoluble donors. This results in a more extensive downgradient treatment zone and longer treatment longevity than the use of soluble or insoluble donors alone. This also results in fewer injection wells required to treat the source and downgradient plume, a longer period between injection events, and a shorter remediation time frame.
- The injection volumes commonly used for injection of electron donor substrates are often too small to achieve the desired radii of injection and overlap of emplaced substrate between injection points. This causes an incomplete treatment with stripes of treated aquifer immediately downgradient of injection wells and untreated stripes between. An appropriate injection volume in this aquifer to achieve overlap between injection wells on 15-ft centers, over a vertical interval of 10 ft, would be in the range of 2,500 gallons per well.
- The vertical injection interval should extend both above and below the target treatment zone. This "shotgun" approach is more likely to achieve complete treatment than attempting more surgical injection of donor to shorter intervals. Injection wells screened from 7 to 17 ft bgs in the source zone and 15 to 35 ft bgs in the mid-plume (see WP-34 and MW-14M on FS Figure 2-17, ENSR/AECOM 2008) would achieve this objective. While significant donor is not likely to be injected into the silt, this injection approach will surround the silt above and below with donor for effective treatment of back diffusion mass at the sand/silty sand contact.
- Three injections of electron donor over a 2- to 3-year period will likely be required to complete the active treatment phase. Continued persistent treatment effects will likely occur for 3–6 years following the final injection. This 5- to 9-year period of enhanced bioremediation is consistent with the back diffusion constraint described above and is likely to achieve site remedial objectives. A shorter treatment period is not likely to be effective.

Conclusions and Potential Risks

It is no surprise that ISCO, which attempts to create oxidizing conditions that are contrary to the site's naturally reduced aquifer conditions and naturally high organic carbon, was unsuccessful. Furthermore, the very short longevity of injected persulfate was grossly inadequate to address the slow and persistent back diffusion of TCE in the source area.

The use of EHC to stimulate biotic and abiotic destruction of TCE is likely to be less effective than the bioremediation approach using vegetable oil and lactate donors that was described in the FS (ENSR/AECOM 2008). As described above, a bioremediation design using an appropriate combination of liquid donor substrates is likely to result in a larger treatment area, greater treatment longevity, and lower cost than the EHC approach described in the Contingent Remedy Evaluation memorandum (AECOM 2018). An appropriate large-droplet vegetable emulsion may be utilized to retain more electron donor within the preferential flow paths in the source zone (i.e., avoid washout of donor from the most sandy zones). Bioremediation with liquid donor substrates can be effectively applied with other site remedial components (hydraulic control, vapor intrusion mitigation, and institutional controls).

The primary risk or impact to the Liberty Ridge property is that potential indoor air risks to the Liberty Ridge building may not have been adequately evaluated or addressed. Sampling of sub-slab soil vapor and/or indoor air would be the preferred approach to resolve this data gap.

A secondary risk or impact to the Liberty Ridge property is that the use the EHC instead of liquid electron donor substrates will result in less effective treatment. This may mean a greater disruption to the Liberty Ridge site because there would be more injection points required, more frequent injection events, and a longer treatment period. Less effective treatment and a longer treatment period may adversely impact the Liberty Ridge property value or potential redevelopment plans.

Limitations

This Technical Memorandum has been prepared for the exclusive application to the Liberty Ridge property adjacent to the former GE Aircraft site. The reuse of information, conclusions, and recommendations provided herein for extensions of the project or for any other project, without review and authorization by Landau Associates, shall be at the user's sole risk. Landau Associates warrants that within the limitations of scope, schedule, and budget, our services have been provided in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions as this project. We make no other warranty, either express or implied.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Clint L. Jacob, PE, LG
Principal

CLJ/SAW/ljl
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AECOM. 2017. ISCO Pilot Study Completion Report, GE South Dawson Street. October 27.

AECOM. 2016. Engineering Design Report, GE South Dawson Street. GE Global Research Center and AECOM. October 28.

Ecology. 2018. Letter: Contingent Approval of the Groundwater Recovery System Modification (RW-3) Work Plan, dated May 22, 2018 at the General Electric (GE) Aviation Division Site located at 220 South Dawson Street, Seattle, Washington (WAD009278706). From Dean Yasuda, Washington State Department of Ecology, to Tom Antonoff, General Electric. June 7.

Ecology. 2018. Letter: Ecology Response and Comment Letter for the Draft Contingent Groundwater Treatment Remedy Technical Memorandum, Dated April 10, 2018 for the Former General Electric (GE) Aviation Division Site located at 220 South Dawson Street, Seattle, Washington (WAD009278706). From Dean Yasuda, Washington State Department of Ecology, to Tom Antonoff, General Electric. May 22.

Ecology. 2018. Letter: Ecology Response and Contingent Approval Letter for the Engineering Design Report (EDR) Phase 1 for Persulfate In-Situ Chemical Oxidation (ISCO) Treatment of Groundwater at the General Electric (GE) Aviation Division Site Located at 220 South Dawson Street, Seattle, Washington (WAD009278706). From Dean Yasuda, Washington State Department of Ecology, to Tom Antonoff, General Electric. April 9.

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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000
711 for Washington Relay Service • Persons with a speech disability can call (877) 833-6341

October 29, 2018

James Rasmussen
Coordinator
Duwamish River Cleanup Coalition/TAG
210 South Hudson St. Suite #332
Seattle, WA 98134

Dear Mr. Rasmussen,

Thank you for sending your comments on the proposed contingent groundwater remedy at the 220 South Dawson Street cleanup site. General Electric Aviation (GE) is the potentially liable party (PLP) for this site. We oversee the cleanup activities and GE pays for the cleanup.

The Washington State Department of Ecology (Ecology) received your comments by email on September 27, 2018. Please see our responses below.

We evaluate all contaminated sites for Source Control Sufficiency through our Lower Duwamish Waterway (LDW) Source Strategy. (Chapter 6 of the LDW Source Control Strategy).

The GE Cleanup Site is no exception. We focus primarily on contaminants, like PCBs, that accumulate in LDW sediments. The main contaminants at the GE site do not accumulate in the LDW sediments.

The GE cleanup goes beyond the requirements of source control; it addresses a complete cleanup through the state Model Toxics Control Act (MTCA). The scope of the LDW Source Control Strategy and cleanups conducted by Environmental Protection Agency (EPA) may not be considered a complete MTCA cleanup for any particular site.

The Hazardous Waste and Toxics Reduction Program oversees the cleanup at the GE site. We follow MTCA cleanup (RCW 70.105D) requirements. The Toxics Cleanup Program oversees most of the LDW cleanups.

Current cleanup system prevents groundwater contaminated with trichloroethylene (TCE) and vinyl chloride (VC) from GE from reaching the Duwamish River.

Previously we required GE to maintain, operate and optimize a system that extracts contaminated groundwater and prevents it from reaching the Duwamish River. The extraction system is located on the west property boundary. We have reviewed data from 34 wells and we are confident that the system is working.

Cleanup is taking longer than expected.

We agree that it is taking longer than we expected to complete and reach agreement with the PLP on the major phases of the cleanup. It has also taken time to start the cleanup, to realize that the cleanup methods weren't working, and then to propose a new groundwater cleanup remedy.

We had considerable disagreement with GE Aviation on their feasibility study, cleanup action plan, consent decree, and engineering design plans for the groundwater cleanup remedy – all complex cleanup documents. It took longer than we expected to reach an agreement and complete these phases of the cleanup process.

Ecology will brief stakeholder groups.

In hindsight, we should have updated to the Duwamish River Cleanup Coalition (DRCC) and Georgetown Community Council (GTC) during the cleanup process. We will make a commitment to brief DRCC and GTC more frequently. We did update GTC on September 17, 2018 during the recent public comment period. At that time, we discussed the history of the site cleanup and the proposed groundwater treatment methods.

Please contact met at 425.649.7264 or email dyas461@ecy.wa.gov if you would like to schedule a briefing directly with DRCC or if you have any further questions regarding this letter.

Sincerely,

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

cc: Thea Levkovitz

DUWAMISH RIVER CLEANUP COALITION
Technical Advisory Group

Community Coalition for Environmental Justice

The Duwamish Tribe

Environmental Coalition of South Seattle

Georgetown Community Council

IM-A-PAL Foundation

People For Puget Sound program, Washington Environmental Council

Puget Soundkeeper Alliance

South Park Neighborhood Association

Washington Toxics Coalition

Waste Action Project

Working to ensure a Duwamish River Cleanup that is accepted by and benefits the community and protects fish, wildlife, and human health.

210 S. Hudson St., Suite 332
Seattle, WA 98134
206.954.0218
contact@duwamishcleanup.org
www.duwamishcleanup.org

9/27/18
Comment letter for;
Dean Yasuda
Site manager for the Dawson St Cleanup
Larry Altose
Communication manager for the Dawson St Cleanup
RE; New cleanup plans for
General Electric Aviation Div.
220 S Dawson St, Seattle, WA 98108

The Duwamish River Cleanup Coalition/Technical Advisory Group is the Community Advisory Group for EPA on the Duwamish River Superfund Site. We have responded to the Georgetown Community Council on concerns they have had about the new cleanup plans for the Dawson St. site.
The community has asked us to comment on the new cleanup plans. The largest concern about the new plans is how long this has taken to start a cleanup on the site and to realize that it wasn't working and then to revise a cleanup program. With all the actions that are planed in the Duwamish Valley EPA Superfund Cleanup, Early action cleanups over the last 17 years and efforts with many ground water plums that relate to source control for the pending remedial cleanup of the full river. Ecology is responsible for source control on the river as it relates to the upcoming full river cleanup. It just does not seem as if Ecology is really taking this roll seriously. From 2008 to 2014 (six years) to even develop a plan just seems like a long time. To finally start work in 2017 and almost immediately realize the plan was not working. That finally brings us to today. We would ask that the community be kept informed about the effectiveness of the new cleanup plans by having Mr. Yasuda come into the community with presentations about the cleanup and goals as well as how well the cleanup is adhering to the timeline that has been set.
Below is our memo to the Georgetown Community Council that was sent 9/7/18.

Background

GE produced and serviced aircraft parts during most of the years it occupied the building at 220 S. Dawson St. between 1949 and 1996. Other tenants have since occupied the building, using it for various warehousing operations.

During GE's occupancy, solvent spills and leaks contaminated underlying soil and groundwater. The main contaminants include solvents used to clean metal parts trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,1,1 - trichloroethane (1,1,1-TCA) as well as fuels and oils.

These contaminants are found in the indoor air, soil, and groundwater beneath the 220 South Dawson Street building. The contaminants have also migrated in the groundwater to the west near Colorado Avenue South. Some TCE in the soils and groundwater below the 220 South

Dawson Street building changed to a gas and moved upwards through the soil, into the building workspaces

Cleanup background

Ecology required GE to install a mitigation system to prevent people in the buildings from contaminated air from beneath the 220 S. Dawson St. building. (A process known as vapor intrusion). The system pulls contaminated vapors from under the building so that they do not enter and redirects them to a roof vent. Outdoors, the vapors quickly dissipate to acceptable levels. This was done under a legal agreement (Agreed Order or AO).
2008: We required GE to review possible cleanup methods and actions to clean up the site in a focused feasibility study (FFS). Ecology modified and approved the FFS report in late 2009. Done under a new AO.
2014: We required GE to implement Ecology's selected method to clean up contaminated soils, groundwater and indoor air that were above the necessary cleanup standards. Done under a legal Consent Decree.
2017: GE injected a cleanup chemical (aqueous persulfate chemical oxidant) into the contaminated groundwater below the 220 S. Dawson Street property. The results did not show that the actions adequately destroyed the TCE and other groundwater contaminants.
2018: GE tried a different cleanup method. They installed persulfate slow diffusion release bags into several groundwater wells on the same property. These actions also did not adequately destroy the TCE and other groundwater contaminants.

The criteria that the cleanup must meet is
Cleanup actions selected under MTCA must comply with several basic requirements. This includes meeting all the threshold (minimum) requirements for cleanup actions (WAC 173-340-360(2)(a)), as well as being evaluated against additional criteria as provided in WAC 173-340-360(2)(b). The threshold requirements listed in WAC 173-340-360(2)(a) are:
□ Protect human health and the environment
□ Comply with cleanup standards
□ Comply with applicable state and federal laws
□ Provide for compliance monitoring.
After confirming a remedial technology meets all the threshold requirements, it must also be evaluated against additional criteria listed in WAC 173-340-360(2)(b). Those additional criteria are:
□ Use permanent solutions to the maximum extent practicable
□ Provide a reasonable restoration time frame
□ Consider public concerns.

The new option that is being considered by Ecology is In-Situ Chemical Reduction which means CVOCs would be degraded in the reactive (abiotic and biotic) zone created from an amendment i njection into the shallow soil/groundwater at the site. This will effectively reduce groundwater CVOC concentrations below cleanup standards
and increase the protectiveness of the remedy for indoor air by lowering shallow saturated soil C VOC concentrations. The combination of biotic and abiotic treatment processes makes supplemental bacteria and nutrient injection less critical to overall technical effectiveness (as co mpared to EAB). CVOC degradation intermediates (e.g.,
vinyl chloride) may be temporarily present, but likely at lower concentrations than would occur using EAB. This remedy is protective of human health and the environment
and will comply with cleanup standards.

CVOCs in groundwater and saturated soil would be permanently removed from the subsurface vi a abiotic chemical reduction and anaerobic biodegradation. This remedy is a permanent solution to the maximum extent practical.
The expected restoration time frame for cleanup using this
technology options is expected to be 15 years based on remedy implementation at similar sites and the levels of CVOCs present at the site. This is a reasonable restoration timeframe.
ISCR would likely address all potential public concerns for the site. CVOCs exceeding cleanup standards would be immediately addressed with active treatment.
continued operation of the hydraulic control system will capture on-site CVOC impacted groundwater and limit the movement of CVOCs to off-site areas. Continued operation of the VIMs will protect on-site properties from the risk of CVOC impacts to indoor air.

This has been a very long process with fits and starts, but I believe the method being considered by Ecology now will get us down the road to finally fixing this problem.
If you have any concerns about this cleanup action please let me know because DRCC/TAG will be writing a comment letter to Ecology on this.

Sincerely,

James Rasmussen
Coordinator, Duwamish River Cleanup Coalition/Technical Advisory Group
james@duwamishcleanup.org

Yasuda, Dean (ECY)

From: Yasuda, Dean (ECY)
Sent: Tuesday, September 4, 2018 11:28 AM
To: [redacted]
Cc: Levkovitz, Thea (ECY)
Subject: Ecology Response - GE Aviation Comment Period Aug 30th - Sept 28-2018
Attachments: Figure.pdf

Hi Velma,

Thank you for your question about the cleanup at the former General Electric Aviation (GE) site at 220 S. Dawson St., Seattle, WA 98108. Since you sent your email question during the formal comment period, we will consider this a comment and enter it into the records. We will include any responses to your question in our summary of responses after the comment period closes.

Since 2002, Ecology has been overseeing the investigation and cleanup at this site under a cleanup agreed order (legal agreement). We have continued to review the data collected from 32 groundwater monitoring wells. Based on that data, we do not think that the trichloroethylene (TCE) groundwater contamination has traveled past Colorado Avenue South.

The current comment period is for a new groundwater cleanup method because the previous cleanup method was not working well. I have provided more detail below. Please feel free to call or email if you have any more questions.

- We required GE to maintain and operate a groundwater pump and discharge system along 2nd Avenue (just west of the 220 South Dawson Street property). This groundwater pumping system has been running for over a decade under two legal agreements (2002 and 2014).

- The contaminated groundwater is discharged to the sewer line under a King County discharge authorization. Although the current system significantly reduces the amount of trichloroethylene (TCE) contamination leaving the 220 S. Dawson Street property, there are no groundwater pumping systems capable of capturing all of the contaminated groundwater. We have required GE to improve this system to reduce and minimize the amount leaving the property as much as possible.

- If any TCE contaminated groundwater does get past the groundwater pumping system it eventually becomes diluted to below groundwater cleanup levels or is so low that there are no testing methods that can detect it, before it reaches the Duwamish River.

- The new proposed groundwater treatment method (under current public comment period) is intended to treat the TCE groundwater on the GE property and other properties west to below cleanup levels. This technology has been successful at other similar cleanup sites including other GE sites. We also reviewed technical literature which indicates that it is a viable treatment for TCE contaminated groundwater. However, each individual cleanup site has the potential to respond differently to each treatment technology. So we will continue to monitor the treatment regularly to determine if it is working.

- We have reviewed data for the last decade and the TCE contaminated groundwater above cleanup levels is not going beyond the most westerly groundwater monitoring wells.

Sincerely,

Dean Yasuda, P.E.
Environmental Engineer
Washington State Department of Ecology
Northwest Regional Office
425.649.7264

[redacted]

From: Velma Veloria
Sent: Thursday, August 30, 2018 5:26 PM
To: Yasuda, Dean (ECY)
Subject: Re: GE Aviation Comment Period Aug 30th - Sept 28-2018

Hi Dean,
In your literature, you mentioned that contaminants in the groundwater have moved approximately two blocks west off the property. Do you anticipate more movement away from the property and if so how much more? What can be done to curtail the movement of these contaminants?

The National Toxicology Program's 11th Report on Carcinogens categorizes trichloroethylene as "reasonably anticipated to be a human carcinogen", based on limited evidence of carcinogenicity from studies in humans and sufficient evidence of carcinogenicity from studies in experimental animals.

GE has already tried to clean these contaminants twice and has been unsuccessful. Has the new clean up method of injecting very small iron particles mixed with organic plant material into the contaminated groundwater been done elsewhere and what was the success rate?

Thanks,
Velma

On Thu, Aug 30, 2018 at 5:02 PM Yasuda, Dean (ECY) <DYAS461@ecy.wa.gov> wrote:

Hi Velma,

Thank you for your email.
Ecology would be interested in knowing what specific questions or concerns you have regarding the new proposed method to cleanup groundwater at the former General Electric Aviation (GE) site at 220 S. Dawson St., Seattle, WA 98108. You can submit your comments online during the comment period (August 30, 2018 - September 28, 2018) using the link below:

http://wt.ecology.commentinput.com/?id=UC4DH

Thank you

Sincerely,

Dean Yasuda, P.E.
Environmental Engineer
Washington State Department of Ecology
Northwest Regional Office

425.649.7264

-----Original Message-----
From: Velma Veloria [redacted]>
Sent: Thursday, August 30, 2018 3:21 PM
To: Yasuda, Dean (ECY) <DYAS461@ECY.WA.GOV>
Subject: Public Hearing

Hi Dean,
I would like to request a public hearing on the GE Aviation clean up.
Thanks,
Velma Veloria
[redacted]

Sent from my iPhone

Yasuda, Dean (ECY)

From: Yasuda, Dean (ECY)
Sent: Monday, October 29, 2018 1:01 PM
To: [redacted]
Cc: Levkovitz, Thea (ECY)
Subject: Ecology Response to Public Comment - Proposed Contingent Groundwater Remedy at Former GE Facility 220 South Dawson Street Seattle Washington

Importance: High

Mr. Daniel Schwendeman,

Thank you for submitting comments on the proposed new cleanup methods for General Electric Aviation (GE), located at 200 S, Dawson Street, Seattle, WA. We received your comments by email on August 31, 2018, during the formal comment period. We are responding to your comments directly in this email.

We are currently requiring GE to clean up the trichloroethylene (TCE) contaminated groundwater on the 220 S. Dawson Street property and the groundwater contamination that has migrated west of this property. The cleanup is being conducted under the terms of a consent decree finalized in 2014.

You stated that emulsified zero valent iron (eZVI) injections into chlorinated solvent contaminated groundwater at other cleanup sites has produced positive results.
We agree that eZVI injections will successfully treat and reduce TCE concentrations in groundwater at the site. To ensure that the method is working, we will collect and analyze groundwater samples after the injections.

Please call me at (425) 649-7264 if you have any questions regarding this response.

Sincerely,

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

Daniel Schwendeman

Regarding the technical memorandum: Nasa has indicated this solution has been producing positive [sic]
results in undergorund water cleanup since 2005. "EZVI was recognized as a 2005 NASA

Government Invention of the Year and 2005 NASA Commercial Invention of the Year. In 2006, the inventors won the Federal Laboratory Consortium's Award for Excellence in Technology Transfer. In 2007, EZVI was inducted into the Space Foundation's prestigious Space Technology Hall of Fame.

Since its development, numerous companies have licensed use of this technology from NASA. Several licenses are in the works, but currently six companies are using the NASA-developed EZVI groundwater remediation compound to clean up polluted areas all around the world, making it NASA's most-licensed technology to date."[www.nasa.gov/offices/oct/home/tech_life_ezvi.html]