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September 4, 2020

Aoki Estate
c/o Clark Davis
7191 Wagner Way NW Suite 202
Gig Harbor, WA 98335
(cdavis@cjd-law.com)

Re: Further Action at the following Site:

- **Site Name:** Aoki Property
- **Site Address:** 1310-1312, 1314 and 1316 East Pike Street, Seattle, WA
- **Facility/Site No.:** 6153541
- **Cleanup Site ID:** 2994
- **VCP Project No.:** NW1743

Dear Clark Davis:

The Washington State Department of Ecology (Ecology) received your request for an opinion on your independent cleanup of the **Aoki Property** facility (Site). This letter provides our opinion. We are providing this opinion under the authority of the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

Issue Presented and Opinion

Is further remedial action necessary to clean up contamination at the Site?

YES. Ecology has determined that further remedial action is necessary to clean up contamination at the Site.

This opinion is based on an analysis of whether the remedial action meets the substantive requirements of MTCA, Chapter 70.105D RCW, and its implementing regulations, Chapter 173-340 WAC (collectively "substantive requirements of MTCA"). The analysis is provided below.

Description of the Site

This opinion applies only to the Site described below. The Site is defined by the nature and extent of contamination associated with the following releases:

- Tetrachloroethylene (PCE) and related degradation products trichloroethylene (TCE), cis- and trans-1,2-dichloroethene (cis-1,2-DCE; trans-1,2-DCE) released to soil, groundwater and air

The Site originated from PCE releases associated with former dry cleaning operations located in two tenant spaces at 1314 East Pike Street which occupies two King County tax parcels (Property). PCE in soil, groundwater and soil vapor detected on adjoining properties to the west at 1310-1312 East Pike Street (McDonnell parcel) and the east at 1316 East Pike Street (Madrona parcel) is attributable to the release(s) on the Property as well. These three addresses (comprising four tax parcels) are where the Site has come to be located. The Site may also have come to be located in the East Pike Street Right-of-Way.

Enclosure A includes a detailed description of the Property and the Site, as currently known to Ecology.

Please note a parcel of real property can be affected by multiple sites. At this time, we have no information that the Property associated with this Site is affected by other sites.

Basis for the Opinion

This opinion is based on the information contained in the documents listed in **Enclosure B**. An opinion was requested on the *Addendum to Amended Remedial Investigation/Feasibility Study* dated May 1, 2020.

In addition to the reports listed in **Enclosure B**, Ecology previously issued written opinions for this Site in letters dated March 30, 2009, March 8, 2010, April 20, 2010, April 25, 2012, June 25, 2012, July 24, 2013, September 8, 2016, August 20, 2018 and January 20, 2020.

A number of the documents listed in **Enclosure B** and previous opinion letters are accessible in electronic format from the Site web page[1]. The complete records are kept in the Central Files of the Northwest Regional Office of Ecology (NWRO) for review by appointment only. Visit our Public Records Request page[2] to submit a public records request or get more information about the process. If you require assistance with this process, you may contact the Public Records Officer at publicrecordsofficer@ecy.wa.gov or (360) 407-6040.

This opinion is void if any of the information contained in those documents is materially false or misleading.

Analysis of the Cleanup

Ecology has concluded that **further remedial action** is necessary to clean up contamination at the Site. That conclusion is based on the following analysis:

[1] https://apps.ecology.wa.gov/gsp/Sitepage.aspx?csid=2994
[2] https://ecology.wa.gov/publicrecords

1. Characterization of the Site.

This Site has been investigated since 2005 and several interim remedial activities have been conducted. However, Ecology has determined the characterization of the Site is not yet sufficient to establish cleanup standards and select a cleanup action. The Site is described above and in **Enclosure A.**

Ecology does not concur that the Site characterization in the Remedial Investigation is complete for these reasons:

- The PCE source was not completely identified, located or delineated by Site characterization activities conducted to date and thus addressed by interim remedial actions conducted to date.

- The lateral and vertical extent of contamination in soil has not been delineated. All Ecology opinion letters with a Site Description included as an enclosure issued between 2012 and 2019 stated "The vertical and lateral extent of PCE contamination in soil has not been delineated." This is a critical issue to resolve before the Site can move forward with final cleanup plans.

- Report figures in the documents received by Ecology that show dashed lines indicating 'estimated extent' do not represent delineation of contamination since it is unknown at this time.

- Wedges of PCE-contaminated soil likely remain in place beyond the limits of the 2008 remedial excavation. These areas were not characterized.

- Soil samples collected in angled borings are not representative of the lateral and vertical extent of contamination. These samples can give some indication of the contamination in one sampling location but not the presence or concentration above or below it. This information is still needed.

- The reported wellhead measuring point elevation of monitoring well MW-17 (348.93 feet above mean sea level) installed in 2018 appears to be anomalous as it is approximately 2 feet lower than the elevation of the land surface. Ecology requests that MW-17 be resurveyed by a Washington state-licensed land surveyor. Permission to also include monitoring well MW-10 in the surveying should be obtained.

- Ecology has not concurred that the extent of PCE and other VOC contamination has been delineated in groundwater. The first monitoring wells installed on the Site (MW-1 through MW-5) in 2007 all contained PCE at concentrations exceeding the Method A cleanup level. This contamination was not bounded laterally or vertically. As a result, the location and depth of PCE contaminant plume(s) in groundwater were not established prior to the introduction of chemical oxidant solutions injected into Site monitoring wells beginning in 2009. It is not possible to determine the status of the

cleanup of groundwater at this time without further groundwater monitoring and potentially additional monitoring wells to determine the lateral and vertical extent of PCE and its degradation products.

- There is a potential for vapor intrusion from the Site into buildings on the adjoining McDonnell and Madrona parcels. Indoor air sampling in these buildings is needed immediately.

2. Establishment of cleanup standards.

Ecology has determined your characterization of the Site is not yet sufficient to establish cleanup standards and select a cleanup action.

3. Selection of cleanup action.

Ecology has determined the cleanup actions you selected for the Site do not meet the substantive requirements of MTCA.

The selected cleanup actions are considered interim actions that included excavation and SVE presented in a *Cleanup Action Plan* dated November 20, 2008. Selected interim cleanup actions also included chemical injections into two injection wells, SVE wells and monitoring wells.

An opinion letter from Ecology dated April 20, 2010 stated "*While this is appropriate technology and may result in site cleanup, it is Ecology's opinion that it will be difficult to empirically demonstrate that all the contaminated soil beneath the adjacent buildings and the E Pike Street right-of-way can be fully remediated by the SVE and in-situ chemical oxidation (ISCO) systems*." The statement acknowledges that the Site presents challenging conditions for the cleanup but at this time Ecology anticipates that further remediation may be necessary to resolve contamination in these and other areas of the Site.

4. Cleanup.

Ecology has determined the cleanup you performed does not meet any cleanup standards at the Site.

<u>Soil</u>
The former building on the Property was demolished in October 2007. In November 2008, a remedial excavation was conducted measuring approximately 30 feet by 45 feet with a maximum depth of 20 feet bgs in the center. Due to the proximity of adjacent buildings, further excavation of the Property was not feasible. The sidewalls sloped from 0 to 20 feet bgs. Approximately 1,376 tons of PCE-contaminated soil were excavated and removed from the Property. Except for two soil confirmation samples in the north side wall of the excavation, all bottom and sidewall soil confirmation samples contained PCE at concentrations exceeding the Method A cleanup level of 0.05 mg/kg up to a maximum of 25 mg/kg.

In March 2009, following the excavation, six horizontal and two vertical soil vapor extraction (SVE) wells were installed in the excavation and above the contaminated soil left in place. Following SVE well placement, the excavated area was backfilled with pea gravel and then capped with asphalt pavement for the Property's current use as a parking lot. Three of the horizontal wells were installed at a depth of 4 feet bgs, two at 15 bgs and one in the center/bottom of the former excavation at 20 feet bgs. One vertical SVE well (VSVE-1) was located in the southwest corner of the Property. A second vertical SVE well (VSVE-2) is located in the southeast corner of the Property (screened in excavation backfill from 2 to 12 feet bgs) but is not accessible from the ground surface.

The initial SVE configuration described above was put into operation in March 2009 and operated for approximately 1.5 years and removed a total of 13.6 pounds of PCE before becoming asymptotic. The placement of the horizontal SVE wells in permeable pea gravel excavation backfill, the gravel sub-base of the asphalt, the permeability of the bituminous asphalt, and a new storm water line installed on the Property all may have contributed to leakage into the shallow SVE system.

In October 2010, due to diminishing returns associated with the original SVE well configuration in excavation backfill, newly drilled angled monitoring wells (MW-11 through MW-14) that encountered PCE above cleanup levels in soil and groundwater beneath adjacent Property buildings were converted to SVE wells. Originally planned as monitoring wells, the four wells were drilled at a 30-degree angle extending beneath adjacent buildings with MW-11 and MW-12 under the McDonnell parcel and MW-13 and MW-14 under the Madrona parcel.

In 2010, the original and vertical SVE wells were permanently disconnected and the four angled SVE wells under the adjacent buildings were put into operation for SVE. From October 2010 to shutdown of the system in July 2019, a total of 6.52 pounds of PCE were recovered from the subsurface. A graph of the SVE removal shows that after October 2010 when the angled wells replaced the horizontal SVE wells, the removal rate was nearly flat and never achieved the more robust withdrawals of PCE that would be expected following SVE startup in a different area.

The SVE system put into operation from 2009 to 2019 removed a total of approximately 20 pounds of PCE from the subsurface but because of the original lack of delineation of the extent of contamination, it is not possible to evaluate the effectiveness of the system. Complete delineation would have indicated the extent of contamination which would guide the installation of confirmatory soil sampling following remediation.

Ecology agrees that some PCE has been successfully removed from the subsurface but considers it unlikely that the source, residual, and pooled PCE have been removed by the SVE system based on the total amount of PCE removed and the 2010 reconfiguration of the system. Without complete delineation of the original contamination, it is impossible to confirm that the Site has been cleaned up.

Groundwater

Multiple chemical injections into wells on the Property have been conducted as described in the Site Description. Although PCE and other VOC concentrations decreased following the injections, rebound has occurred eventually but the extent of rebound is unknown because more injections were conducted as soon as increased PCE concentrations were detected. As a result, the current location of the PCE plume in groundwater is uncertain because the delineation is incomplete. Also, the injections may have changed the distribution of the PCE contamination.

There is no standard or requirement in MTCA for the number of consecutive quarters of groundwater monitoring data below cleanup levels needed for Ecology's consideration of a No Further Action determination. For chlorinated solvent sites where recalcitrant contaminants persist (as has been demonstrated at this Site), a longer period of compliance monitoring is needed.

In addition, at sites where injections are conducted, especially where monitoring wells are doubling as both the monitoring and injection points such as at this Site, a longer period of monitoring is needed to confirm the effectiveness of the remedy. It is difficult to distinguish clear results when the monitoring well network is part of the injection well network. At this Site, the observed rebound of PCE concentrations in groundwater compounds the need for additional long-term groundwater monitoring without any further injections. As stated in Ecology's 09/08/16 opinion letter, "*…groundwater samples collected in injection wells such as IW-1 and IW-2 are not necessarily representative of groundwater quality in the water-bearing zone that the injection well is screened in.*"

Air

Composite samples of SVE system influent air are not representative of soil gas concentrations on the Site. Discreet soil gas sampling locations are needed to assess the potential for vapor intrusion into future buildings on the Property and into existing buildings on adjacent properties.

Comparing current PCE concentrations to groundwater screening levels for vapor intrusion is not appropriate because of the probable soil contamination exceeding cleanup levels above the water table underneath the buildings. Also groundwater injections have reduced concentrations but may rebound so current concentrations are not representative.

Restoration Time Frame

Due to the potential for source material remaining in the subsurface and the current concentrations in groundwater that are expected to rebound following injections, Ecology anticipates that the cleanup will take considerably longer using the proposed alternative of monitored natural attenuation. It is difficult for Ecology to see a path to an NFA determination for this Site without a much more aggressive remedial effort based on a thorough Site characterization.

The cleanup has progressed for a number of years and has removed a portion of the PCE contamination in soil. Groundwater is likely still impacted by PCE source material that has not been addressed. The multiple injection events may have reduced the dissolved PCE

concentrations but not addressed the PCE source which will continue to contaminate the groundwater.

Because this Site extends to adjacent properties, and the need to have a comprehensive investigation and remedial plan, Ecology recently explored the possibility of this Site being cleaned up under an Agreed Order. However, Ecology currently does not have the capacity to manage an agreed order at this time due to lack of resources and a state-wide hiring freeze. An agreed order may remain an option for the future.

Ecology encourages consideration of a cooperative cleanup with adjacent land owners who have long had an interest in a complete cleanup and the ability to redevelop their properties unencumbered.

Ecology is willing to meet with you and the adjacent property owners to discuss a path forward to complete the cleanup of this Site.

Limitations of the Opinion

1. Opinion does not settle liability with the state.

Liable persons are strictly liable, jointly and severally, for all remedial action costs and for all natural resource damages resulting from the release or releases of hazardous substances at the Site. This opinion **does not**:

- Resolve or alter a person's liability to the state.
- Protect liable persons from contribution claims by third parties.

To settle liability with the state and obtain protection from contribution claims, a person must enter into a consent decree with Ecology under RCW 70.105D.040(4).

2. Opinion does not constitute a determination of substantial equivalence.

To recover remedial action costs from other liable persons under MTCA, one must demonstrate that the action is the substantial equivalent of an Ecology-conducted or Ecology-supervised action. This opinion does not determine whether the action you performed is substantially equivalent. Courts make that determination. *See* RCW 70.105D.080 and WAC 173-340-545.

3. State is immune from liability.

The state, Ecology, and its officers and employees are immune from all liability, and no cause of action of any nature may arise from any act or omission in providing this opinion. *See* RCW 70.105D.030(1)(i).

Contact Information

Thank you for choosing to clean up the Site under the Voluntary Cleanup Program (VCP). After you have addressed our concerns, you may request another review of your cleanup. Please do not hesitate to request additional services as your cleanup progresses. We look forward to working with you.

For more information about the VCP and the cleanup process, please visit our web site: www.ecy.wa.gov/programs/tcp/vcp/vcpmain.htm. If you have any questions about this opinion, please contact me at (425) 649-7064 or heather.vick@ecy.wa.gov.

Sincerely,

Heather Vick, LHg
Toxics Cleanup Program, NWRO

Enclosures (2): A – Description of the Site
B – Basis for the Opinion: List of Documents

cc: Bradford Augustine, Madrona Real Estate Services, LLC, (brada@madronarealestate.com)
Lauren Carroll, Pacific Crest Environmental, LLC, (lcarroll@pceenv.com)

Enclosure A

Description of the Site

Site Description

This section provides Ecology's interpretation and understanding of Site conditions and forms the basis for the opinions expressed in the body of the letter.

Site: The Site is associated with tetrachloroethylene (PCE) and related degradation products trichloroethylene (TCE), cis- and trans-1,2-dichloroethene (cis-1,2-DCE; trans-1,2-DCE) released to soil, groundwater and air at 1314 East Pike Street in Seattle, Washington (Property).

The Site is also located on two adjoining tax parcels located at 1310-1312 East Pike Street to the west and 1316 East Pike Street to the east. Details regarding the tax parcels are provided in the table below. Individual parcels are referred to in this opinion letter using the Property references below.

Parcel No.	Acres	E. Pike St. No.	Current Land Use	Property Reference
6003000175	0.10	1310-1312	1 store and a 3-BR apartment	McDonnell parcel
6003000160	0.08	1314	Parking lot	Property
6003000200	0.04	1314	Parking lot	Property
6003000300	0.14	1316	3 stores and four 2- to 3-BR apartments	Madrona parcel

Property and Area Description: The Property is located in the Capital Hill neighborhood which is just east of the Seattle downtown business district. This area contains a high-density mixture of retail, commercial and mixed/multi-family residential land uses. The Property is bordered to the south by East Pike Street. The Property is bordered to the east by the Madrona parcel, a one-story residence and hair salon (14th Avenue Hair) and 14th Avenue. The Property is bordered to the west by the McDonnell parcel, Solis Apartments with retail space on the first floor, five stories/45 apartments and one story of underground parking and 13th Avenue. The Property is bordered to the north by Reo Flats, an 8-story apartment building with retail space on the first floor and two floors of underground parking.

Property History and Current Use: From 1920 to at least 1944, the Property was used primarily for residential purposes. In 1949, a commercial building was constructed and divided into two tenant spaces (east and west tenant spaces with street numbers 1314 and 1314½ East Pike Street respectively). Known historical uses of the 1949 Property building until its demolition in 2007 are summarized in the table below:

West Tenant Space (1314½ East Pike)	East Tenant Space (1314 East Pike)
1949 Building constructed/divided	1949 Building constructed/divided
1949 to 1978: Various commercial uses including an optometrist, water heater sales and a fish cleaning shop	1950 - 1955 East Pike Cleaners (clothes pressing)
	1955 Dry cleaning equipment added
	1969 Dry cleaning equipment removed
	1969 – 1971 Wood carvers studio
	1971 – 1973 Ceramic artist studio

	1973 – 1979 Unknown occupant
1979 – 1982 Unknown	1979 – 2006 Coin-Op Laundry
1983 – Coin-Op Laundry in east tenant space expanded to include dry cleaning in west tenant space	
1996 - Dry cleaning operation ended; dry cleaning equipment removed	
1996 – 2004 Computer store	
2004 – 2007 Vacant	
2007 – Building demolished	2007 – Building demolished

Both tenant spaces were occupied intermittently by separate dry cleaner businesses until 1996. Between 1950 and 1955, the east tenant space was reportedly occupied by East Pike Cleaners, a clothes pressing shop. Dry cleaning equipment was installed at the cleaners in 1955 which was operated until 1968; the dry cleaning equipment was removed by 1969. Other businesses in the building included a wood carver and a Coin-Op Laundry. Dry cleaning was conducted in the west tenant space from 1983 to 1996 associated with the Coin-Op Laundry. The building was demolished in 2007, and the Property paved over with asphalt. The current use of the Property is a parking lot.

Sources of Contamination: The source of the contamination on the Property is assumed to be leaks and spills of dry cleaning fluids that occurred over the years in both the east and west tenant spaces; used dry cleaning fluid may have also been disposed of outside the building. Fluids from the dry cleaning operation carried into the sanitary sewer system may have also leaked into the surrounding soils. The actual location(s) of the PCE source has not been identified.

Physiographic Setting: The Site is located within the Puget Sound Lowland physiographic province, a north-south trending structural and topographic depression, which is bordered on its west side by the Olympic Mountains, and to the east by the Cascade Mountain foothills. The Site is located on the southwest side of Capitol Hill, a neighborhood and also a sub-physiographic division of metropolitan Seattle. The topography of the Property slopes to the southwest; ground elevations on the Property range from approximately 346 to 351 feet above mean sea level.

Surface/Storm Water System: The closest surface water body to the Site is Elliot Bay in Puget Sound which is approximately 1 mile to the southwest. Storm water runoff on and in the vicinity of the Property disperses via sheet flow to catch basins connected to the City of Seattle storm water system.

Water Supply: The City of Seattle provides potable water to the Site area using the Cedar and Tolt River watersheds as the source.

Ecological Setting: The Site and the surrounding vicinity provide limited terrestrial ecological habitat because the area has been mostly developed with buildings and areas paved with concrete and asphalt.

Geology: Geologic conditions at the Site have been interpreted to consist of Vashon glacial till overlying from 25 to at least 60 feet of Vashon Advance outwash deposits. Indurated silts interpreted as Vashon-age lacustrine deposits were encountered below the Advance outwash in deep borings drilled at the south edge of the Site.

Groundwater: Groundwater first occurs on the Site under water table conditions in the Advance outwash aquifer about 25 to 30 feet bgs under water table conditions. Groundwater elevation data collected on the Site has indicated a flow direction to the north in the uppermost water-bearing zone. A north-south oriented, localized trough in the water table surface on the Aoki parcel has been interpreted from groundwater elevation data.

The Site is located on the southwest side of Capital Hill and the topography of the Site and vicinity indicates that groundwater most likely flows to the southwest. Although flow in isolated, perched water-bearing zones in and above the Vashon till can sometimes have localized flow patterns, unconfined groundwater in the Advance outwash aquifer would be more likely to follow the regional topographic trend and flow to the southwest.

An intermediate water-bearing zone which is thought to be semi-confined occurs between depths of approximately 40 and 80 feet bgs. The direction of groundwater flow in the intermediate zone reportedly fluctuates between north and south.

A deep water-bearing zone occurs at depths greater than approximately 80 feet bgs. The flow direction in the deep water-bearing zone is unknown as only one monitoring point, injection well IW-2, has been completed in that horizon.

Release and Extent of Contamination – Soil and Groundwater:

Soil and groundwater on the Site have been characterized in the following activities:

2005. Seven soil borings (B-1 through B-7) were advanced to a maximum depth of 12 feet bgs. A soil sample was collected from each boring at depths of 9 to 12 feet bgs except for B-4, where soil samples were collected at 8 and 12 feet bgs. The eight samples were selected for analysis without field screening with a photoionic detector. The samples were analyzed for PCE only, using EPA Method 8260. Five of the borings contained PCE at concentrations exceeding the Method A cleanup level. A soil sample collected 8 feet beneath a floor drain of the former Aoki parcel laundromat contained 2.2 mg/kg of PCE.

In addition, the 8-foot deep soil sample from B-7 was analyzed for total petroleum hydrocarbons as diesel, heavy oil and kerosene using Ecology's Method WTPH-D extended. The location of soil boring B-7 is not shown on any report figure but it contained 420 mg/kg of kerosene.

In 2007, the 2005 soil borings (B-1 through B-6) were renamed SB-1 through SB-6 in reports prepared by Pacific Crest Environmental.

2006. One soil boring was advanced off-Property on the southwest side of the Aoki parcel building to 35 feet bgs and converted to monitoring well MW-1. A passive (Gore-sorber) soil vapor survey was conducted in the south central portion of the Site that indicated PCE and TCE in the subsurface. Nine shallow soil borings (SP-1 through SP-9) were advanced to depths of 4 to 6 feet bgs. An additional five soil borings were advanced to depths of 36.5 to 55 feet bgs and converted to monitoring wells MW-2 through MW-6.

2007. The existing building on the Property was demolished to facilitate Site investigation and cleanup activities.

2008. Three soil borings (S-1 through S-3) were advanced to depths between 80 and 100 feet bgs underlying the former building footprint. Two soil borings were advanced in the northern part of the Property to depths of up to 80 feet bgs and completed as monitoring wells MW-7 and MW-8.

2009. Two soil borings were advanced to depths of 72 and 110 feet bgs and completed as injection wells IW-1 and IW-2 in the former building footprint and within the former excavation area. The two wells were installed to facilitate in-situ chemical oxidation injections in the intermediate and deep zones however no conductor casing was installed to prevent vertical migration of DNAPL into the deeper horizons. One boring was advanced off-Property to the southeast and completed as monitoring well MW-9 screened in the intermediate water-bearing zone from 66.5 to 76.5 feet bgs.

2010. Four soil borings (B01 through B04) were advanced with one boring (B02) completed as monitoring well MW-10. Six soil borings (four angled at approximately 30º; two vertical) were advanced and completed as monitoring wells MW-11 through MW-16.

2012. Slug testing was conducted in monitoring wells MW-5, IW-1 and IW-2, and a well yield test was conducted in MW-5.

2018. Monitoring well MW-17 was drilled to a depth of 35 feet bgs; the well is screened in the water table zone from 25 to 35 feet bgs.

Soil: The vertical and lateral extent of PCE contamination in soil has not been fully determined. However, PCE concentrations in soil have been found to decrease with depth and may stabilize in the range of 0.002 to 0.009 milligrams per kilogram (mg/kg) from 60 to 100 feet bgs (the deepest samples were obtained from approximately 100 feet bgs). Soil above an approximate depth of 60 feet bgs contains PCE concentrations ranging up to 25 mg/kg which is above the Method A cleanup level of 0.05 mg/kg.

Groundwater: PCE contamination in groundwater is most pronounced near the water table, and appears to increase with depth indicating PCE source material below the water table. Maximum

concentrations of PCE in the upper part of the aquifer have been as high as 8,300 micrograms per liter (μg/L), and the known extent of the plume is largely coincident with the area of soil contamination. A source of residual or pooled PCE in groundwater is most likely located in the southwest corner of the Property based on samples collected in monitoring wells MW-1, MW-2, MW-3 and MW-11 prior to the initiation of injections in 2009.

Interim Actions:

Cleanup activities that have taken place at the Site following building demolition in 2007 include:

- Soil excavation and disposal in 2008 following former building demolition; accessible area where contaminated soil was present and was excavated.

    - The excavation extended to a maximum depth of approximately 20 feet bgs in the center with sloped sides. The final excavation perimeter dimensions were approximately 45 feet by 30 feet.
    - Confirmation soil samples were collected at the final limits of the excavation. Except for the two north sidewall samples, all soil confirmation samples contained PCE at concentrations above the Method A cleanup level. The most highly-elevated concentrations were in the west side of the excavation.
    - Approximately 1,376 tons of soil containing HVOCs were disposed of off-Site.

- Following the 2008 excavation, installation of a soil vapor extraction (SVE) system was completed and put into operation in 2009. The original SVE system consisted of:

    - Two 20-foot long horizontal wells, oriented north-south, installed at depths of about 15 feet bgs east (HSVE-ED) and west (HSVE-WD) of the center of the backfilled excavation.
    - Two 50-foot long horizontal wells, oriented north-south, installed at depths of approximately 4 feet bgs east (HSVE-ES) and west HSVE-WS) of the edges of the backfilled excavation.
    - One 20-foot long horizontal well installed at a depth of about 4 feet bgs near the northernmost edge (HSVE-NS) of the excavation.
    - One 20-foot long horizontal well installed at a depth of about 20 feet bgs, oriented north south (HIW-1) near the bottom center of the excavation.
    - The horizontal SVE wells were constructed of 4-inch diameter Schedule 40 polyvinyl chloride 0.010-inch slotted well screen wrapped with geotextile filter fabric to prevent clogging from fines in the imported, compacted pea gravel backfill material.

- In 2008 and 2009, three vertical SVE wells were installed for the purpose of in-situ remediation including VSVE-1 for integration into the SVE system and IW-1 and IW-2 for the delivery of chemical oxidants to the Intermediate and Deep Zones.

- In 2008, VSVE-2 was installed into the open remedial excavation prior to placement of the pea gravel backfill. Located in the southeast corner of the Aoki parcel, VSVE-2 consists of a vertical 10-foot long section of 2–inch diameter PVC well screen that was integrated into the SVE system (similar to the horizontal SVE components piping). VSVE-2 is connected to 2–inch diameter carrier piping at approximately 2 feet bgs, connecting to the manifold in the SVE compound.

Wells	Screen Length (feet)	Depth (feet bgs[1])	Installed/ Start-Up	Taken Offline
Horizontal SVE Wells				
HSVE-ES	20	4	03/2009	04/2010
HSVE-WS	20	4	03/2009	10/2010
HSVE-ED	50	15	03/2009	04/2010
HSVE-WD	50	15	03/2009	10/2010
HSVE-NS	20	4	03/2009	10/2010
HIW-1	20	20	03/2009	04/2010
Vertical SVE Wells				
VSVE-1	30	35	03/2009	10/2010
VSVE-2	10	12	03/2009	10/2010
MW-4	10	39	03/2009	04/2010
MW-5	20	40	03/2009	10/2010
Angled SVE Wells				
MW-11	43	48	10/2010	07/2019
MW-12	43	48	10/2010	07/2019
MW-13	35	40	10/2010	07/2019
MW-14	35	50	10/2010	07/2019

1 Depth of angled wells is length of wellbore in feet.

- In April and October 2010, the SVE system was modified to remove the horizontal wells, VSVE- 1, MW-4 and MW-5. At that point, the SVE system only consisted of four angled SVE extraction wells (MW-11 through MW-14) beneath the adjoining buildings to the east and west of the Property. Originally planned as monitoring wells, angled SVE wells MW-11 and MW-12 were installed on the west side of the Property extending from the under the adjacent McDonnell property. Angled SVE wells MW-13 and MW-14 were installed on the east side of the Property extending under the adjacent Madrona property.

- In July and October 2009, in-situ chemical oxidation (ISCO) injections in groundwater were initiated using monitoring wells MW-1, MW-2, MW-4 and MW-5. Additional ISCO injections followed in 2013, 2014 and 2015. In 2017, in-situ chemical reduction (ISCR) injections were initiated followed by additional ISCR injections in 2018 and

2019. The eight chemical injection events are summarized in the following table and described in more detail below.

Injection Event	**ISCO 07/09**	**ISCO 10/09**	**ISCO 10/13**	**ISCO 07/14**	**ISCO 04/15**	**ISCR 01/17**	**ISCR 11/18**	**ISCR 04/19**
Injection wells								
IW-1	**X**	**X**					**X**	
IW-2	**X**	**X**						
Monitoring wells used for injections								
MW-1		**X**	**X**	**X**			**X**	**X**
MW-2		**X**					**X**	**X**
MW-3		**X**					**X**	
MW-4	**X**	**X**					**X**	**X**
MW-5	**X**	**X**	**X**	**X**	**X**		**X**	**X**
SVE wells used for injections								
HIW		**X**						
HSVE-WS		**X**						
VSVE-1			**X**	**X**	**X**			
MW-11[1]			**X**	**X**	**X**	**X**	**X**	**X**
MW-12[1]			**X**	**X**	**X**		**X**	**X**
MW-13[1]			**X**	**X**	**X**		**X**	**X**
MW-14[1]			**X**	**X**	**X**		**X**	**X**

(1) angled well

Injections of sodium permanganate were initiated in 2009 with the following ISCO events:

- IW-1, IW-2, MW-4 and MW-5 in July 2009
- IW-1, IW-2, HIW, HSVE-WS, MW-1, MW-2, MW-3, MW-4 and MW-5 in October 2009

In October 2013, July 2014 and April 2015, ISCO injections of potassium permanganate in groundwater were conducted as follows:

- MW-1, MW-5, MW-11 through MW-14 and VSVE-1 in October 2013 and July 2014
- MW-5, MW-11 through MW-14 and VSVE-1 in April 2015

In January 2017, an in-situ chemical reduction (ISCR) injection was conducted, when approximately 450 gallons of a 10% by weight (w/w) solution of zero-valent iron (ZVI) mixed with water were injected into monitoring well MW-11.

In November 2018, ISCR injections were conducted of approximately 2,223 gallons of a 2.5% w/w solution of ZVI into monitoring wells MW-1 through MW-5, MW-11 through MW-14 and IW-1.

In April 2019, approximately 600 gallons of a 2.5% w/w solution of ZVI and water were injected into monitoring wells MW-1, MW-2, MW-4, MW-5 and MW-11 through MW-14.

The SVE system was shut down in July 2019 due to diminished and asymptotic VOC removal rates. The SVE system recovered an estimated total of 20.12 pounds of PCE during the approximate 10 years of operation.

Enclosure B

Basis for the Opinion:
List of Documents

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List of Documents

1. Pacific Crest Environmental, LLC, 2020. *Confirmation Soil Sampling and Analysis Plan, Aoki Site, 1314 East Pike Street, Seattle, Washington.* May 11.

2. Pacific Crest Environmental, LLC, 2020. *Addendum to Amended Remedial Investigation/Feasibility Study, Aoki Site, 1314 East Pike Street, Seattle, Washington.* May 1.

3. Pacific Crest Environmental, LLC, 2019. *Screening Level Calculations: Indoor Air and Groundwater, Aoki Site, 1314 East Pike Street, Seattle, Washington.* September 24.

4. Pacific Crest Environmental, LLC, 2019. *Amended Remedial Investigation and Feasibility Study Report, Aoki Site, 1314 East Pike Street, Seattle, Washington.* September 24.

5. Pacific Crest Environmental, LLC, 2017. *Proposed Approach to Addressing Ecology Review Comments, Remedial Investigation Data Gap and Feasibility Study Report, Aoki/Madrona Site, 1314 East Pike Street, Seattle, Washington.* March 8.

6. Pacific Crest Environmental, LLC, 2015. *Remedial Investigation Data Gap and Feasibility Study Report, Aoki/Madrona Site, 1314 East Pike Street, Seattle, Washington.* November 24.

7. Pacific Crest Environmental, LLC, 2014. *VCP No. NW1743, Cleanup Action Program Memorandum, Aoki/Madrona Site, 1314 East Pike Street, Seattle, Washington.* October 9.

8. Pacific Crest Environmental, LLC, 2013. *Aquifer Yield Test Report, Aoki Property, 1314 East Pike Street, Seattle, Washington.* April 22.

9. Pacific Crest Environmental, LLC, 2012. *Remedial Investigation and Interim Action Cleanup Progress Report, Aoki Site, 1314 East Pike Street, Seattle, Washington.* February 9.

10. SoundEarth Strategies, Inc., 2011. *Aoki Block Historical Summary Memorandum*. June 17.

11. Pacific Crest Environmental, LLC, 2010. *Sampling and Analysis Plan for Further Site Characterization, Aoki Property, 1314 East Pike Street, Seattle, Washington.* June 24.

12. Pacific Crest Environmental, LLC, 2010. *Cleanup Action Progress Report, Aoki Property, 1314 East Pike Street, Seattle, Washington.* January 28.

13. Pacific Crest Environmental, LLC, 2010. *Soil Vapor Extraction System and In-Situ Chemical Oxidation Operation and Maintenance Plan, Aoki Property, 1314 East Pike Street, Seattle, Washington.* January 28.

14. Pacific Crest Environmental, LLC, 2008. *Cleanup Action Plan, Aoki Property, 1314 East Pike Street, Seattle, Washington.* November 20.

15. Aspect Consulting, 2008. *East Pike Street Property Environmental Assessment*. May 22.

16. Pacific Crest Environmental, LLC, 2007. *Site Characterization Report, Aoki Property, 1314 East Pike Street, Seattle, Washington.* February 2.

17. Slotta Design and Construction, 2005. *Subsurface Investigation Report, Former Dry Cleaner, 1314 E. Pike Street, Seattle, WA 98122.* April 22.