



## MEMORANDUM

To: Jerome B. Cruz, Ph.D. and Ching Pi Wang  
Washington State Department of Ecology  
Toxics Cleanup Program, Northwest Regional Office  
3190 - 160th SE Bellevue, WA 98008

From: John Kane

A handwritten signature in blue ink that reads "John Kane".

Date: April 12, 2019

Re: Expansion of Bioremediation/Groundwater Recirculation System  
Bothell Service Center Simon & Sons (BSCSS)

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### **Background**

A portion of the proposed Bioremediation/Groundwater Recirculation system started operating on Thursday October 18, 2018. A confirmation email was sent to Jerome Cruz at Ecology on October 22, 2018 (email attached). The injection and extraction wells are all located in the distal portion of the BSCSS PCE plume. (These wells are shown in the attached Figure 1). The injections wells activity started on October 18, 2018 include 2-I, 4-I, 6-I, 8-I, 9-I, 11-I, 12-I, and 14-I. The extraction wells included 3-E, 7-E, 13-E, and 16-E. Both the injection and extraction wells are currently operating. The extraction wells provide the water used in the bioremediation injection. Groundwater is pumped into a poly tank next to the bioremediation/groundwater recirculation trailer on the BSCSS property. The groundwater is then pumped through an activated charcoal vessel into a second poly tank. This treated groundwater is then pumped into the holding tank inside the remediation trailer where the bioremediation product Carbstrate is added to the solution.

A meeting to discuss permanently turning off the heating portion of the Electrical Resistance Heating (ERH) system at BSCSS was held on Monday December 10, 2018 at the Washington State Department of Ecology (Ecology) Northwest Regional Office (NWRO) and attended by the City of Bothell, represented by Nduta Mbuthia, John Kane and Jeff Jensen of Kane Environmental, Inc., Ecology representatives Ching Pi Wang and Jerome Cruz, and Greg Sandberg and Robert D'Angou of Cascade Thermal Inc.

As discussed at the December 10, 2018 meeting, the heating portion of the ERH system had been turned off on November 20, 2018. Kane/Cascade made a recommendation to Ecology at that meeting to leave the ERH heating system off, but to continue the soil vapor extraction (SVE) portion of the system through the end of February 2019. This revised scope was approved by Ecology and the City of Bothell. The continued SVE portion of the ERH system was shut down at the end of February 2019.

Following the shutdown of the SVE portion of the ERH system in February 2019, a groundwater sampling task was completed in March 2019 as requested by Jerome Cruz and Ching Pi Wang of Ecology NWRO. Kane Environmental field personnel collected a total of 14 groundwater samples from existing groundwater monitoring wells within, and in proximity to, the ERH treatment area at the BSCSS site. Figure 2 shows the location of the 14 wells sampled outlined in green boxes and the analytical data results is provided in the attached Table 1. For comparison purposes, the most recent previous groundwater sampling round of the same wells from November/December 2018 were included in the table. This recent sampling in March 2019 serves as the baseline for post-ERH treatment for the wells within, and in proximity to, the ERH treatment area. During this sampling round, groundwater temperature in each well were measured. The groundwater well temperatures are provided in the attached Table 2.

### **Bioremediation/Groundwater Recirculation System Expansion**

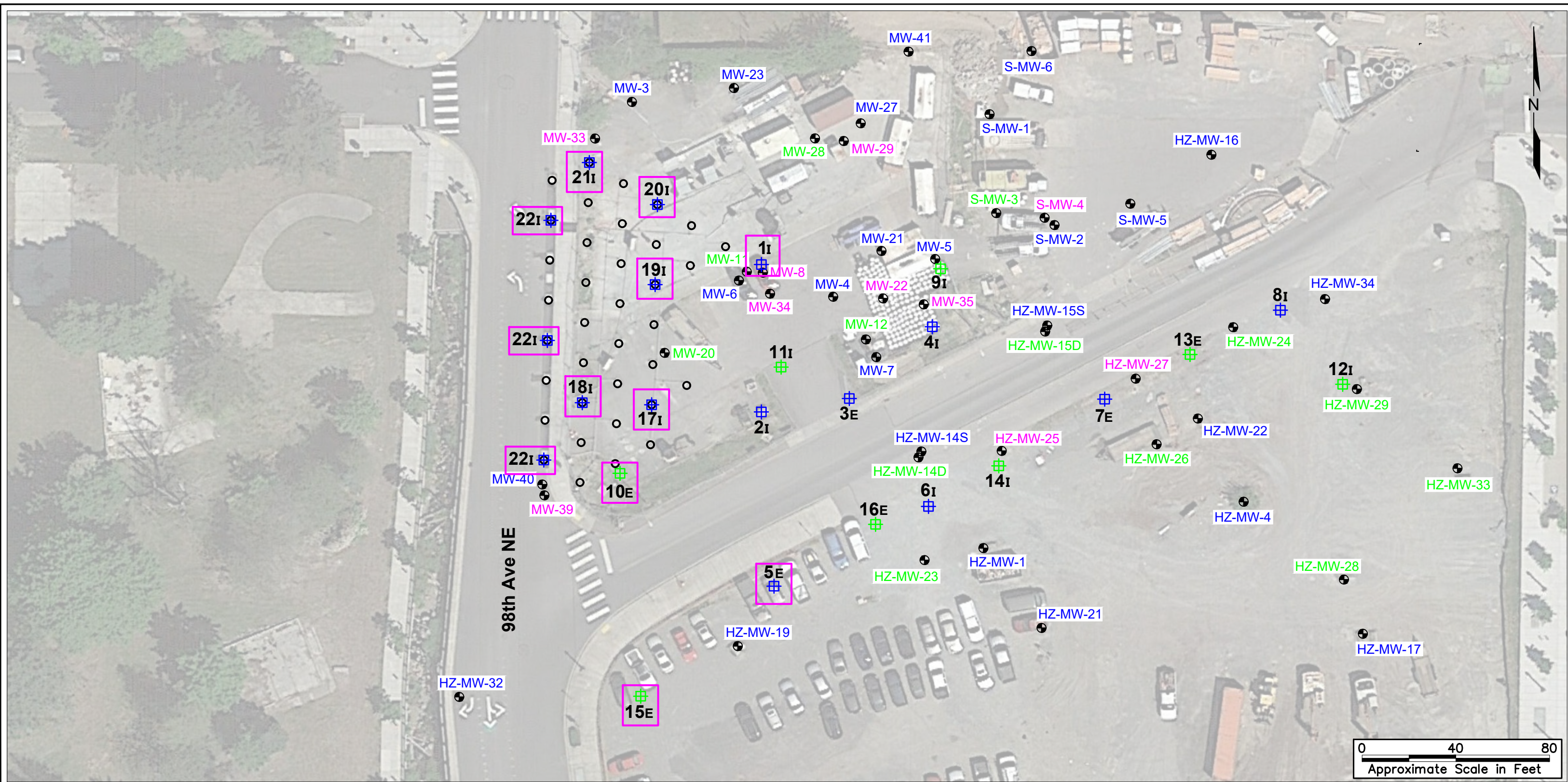
John Kane of Kane Environmental contacted Dr. Rob D'Angou of Cascade Thermal and Mr. Eric Bueltel, P.E. Technical Director of ETEC Advanced Bioremediation Solutions regarding the current groundwater temperatures for their opinion regarding expansion of bioremediation/groundwater recirculation at the BSCSS site that would also include existing ERH wells. Dr. D'Angou stated that temperatures at approximately 35°C accelerates dissolution/desorption and enhances biotic degradation. Dr. D'Angou further stated that the optimal temperature is approximately 35°C for anaerobic reductive dechlorination (dehalorespiration) temperatures above ambient groundwater (13.3°C to 15.9°C). Groundwater temperatures from 10 wells farthest away from the ERH system, located on the former Hertz site, ranged between 13.3°C to 15.9°C in early December 2018.

Mr. Eric Bueltel stated that near the ERH area, the Oxidation Reduction Potential (ORP) has decreased to -70 mV at groundwater monitoring well MW-11 and -52 mV at well MW-6 in the presence of increasing Total Organic Carbon (TOC), indicating possible reductive bioactivity already occurring in the surrounding area. MW-6 and MW-11 are located immediately downgradient from the ERH treatment area in the central portion of the BSCSS site and both had groundwater temperatures above 40°C. Regarding the use of the ERH wells for injection, Mr. Bueltel also stated that while ideal temperatures are approximately 35°C, adding cooler water from the groundwater recirculation process into the ERH wells in areas where the groundwater is currently above 40°C, the cooler water will reduce temperatures in the immediate









areas around the higher temperature ERH wells used for injection. As the cooler water travels away from the ERH injection wells, there will be a growing environment for the bacteria to thrive in. It should be noted that only three wells, MW-6, MW-11, and MW-20 had temperatures above 40°C, while the remaining twelve wells within, and in proximity to, the ERH treatment area had groundwater temperatures below 35°C.

Mr. Bueltel further stated that the Carbstrate remediation product does not lose its effectiveness if it is added into an environment with a temperature greater than 35°C. The injected Carbstrate product will persist until the groundwater has sufficiently cooled enough for the bacteria to thrive. When the temperature in the area cools to 35°C or less, the Carbstrate will already be efficiently distributed through the ERH area for the bacteria to utilize.

Based on the current groundwater temperatures from wells within, and in proximity to, the ERH treatment area, Kane Environmental recommends injecting Carbstrate bioremediation product into the ERH wells as shown in the attached figure. Kane Environmental also recommends adding the additional injection well 1-I, , and extraction wells 5-E, 10-E, and 15-E to the bioremediation/groundwater recirculation system shown in Figure 1.



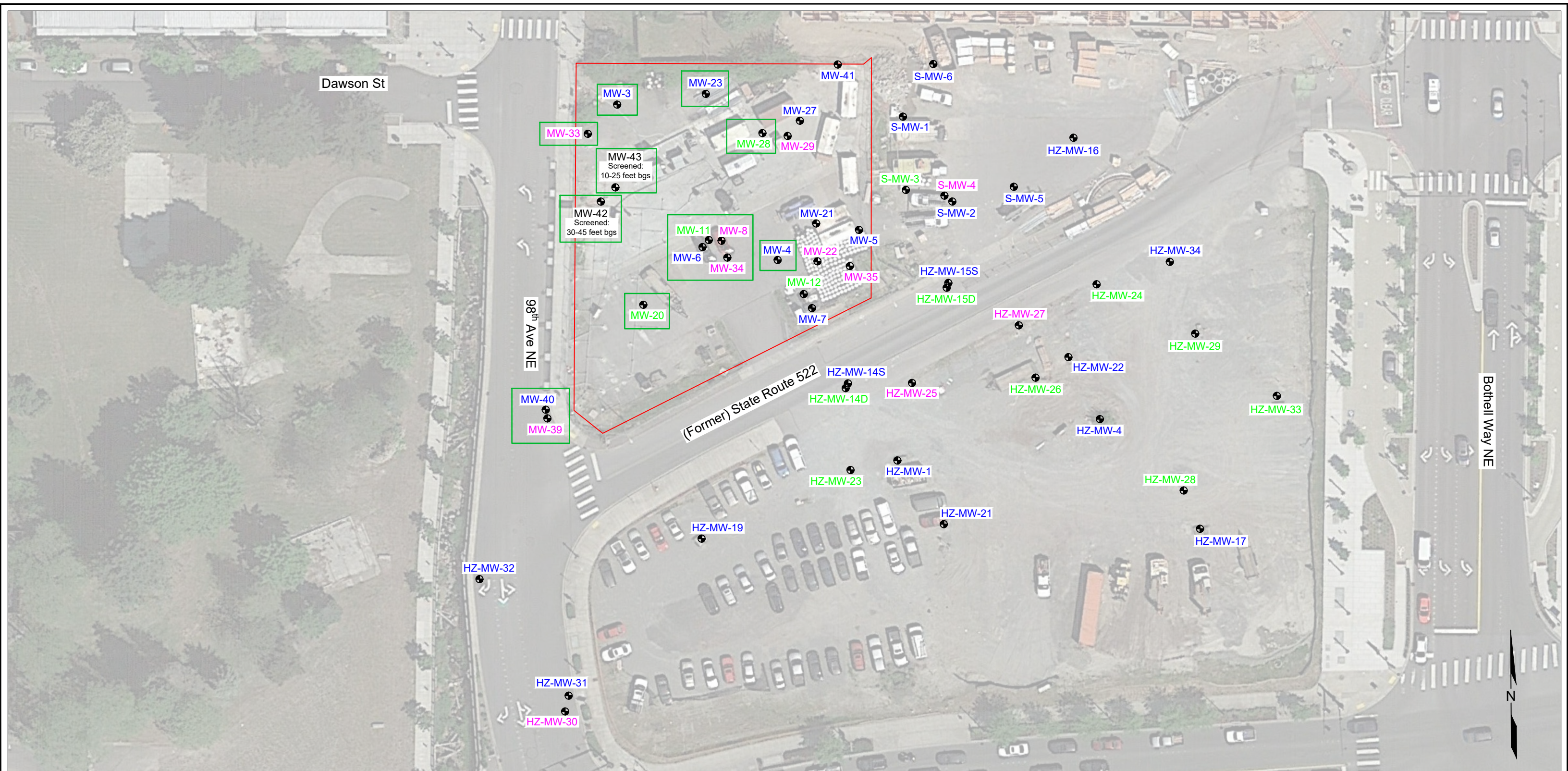
**LEGEND**

- |                                                                                        |                                                                  |                                                                                     |                                                                                             |                                                                                       |                                                    |
|----------------------------------------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------|
|  MW-1 | Location of shallow monitoring well (screened 5-25 ft bgs)       |  | Approximate location of ERH electrode                                                       |  | Inactive well to be included in remediation system |
|  MW-2 | Location of intermediate monitoring well (screened 25-35 ft bgs) |  | Approximate location of shallow injection/extraction well (screened 5-25 ft bgs)            | <b>E</b>                                                                              | Extraction well                                    |
|  MW-3 | Location of deep monitoring well (screened 35-55 ft bgs)         |  | Approximate location of intermediate/deep injection/extraction well (screened 25-55 ft bgs) | <b>I</b>                                                                              | Injection well                                     |
|                                                                                        |                                                                  |  | Approximate location of proposed ERH injection well (screened 5-25 ft bgs)                  |                                                                                       |                                                    |



**Bothell Service Center Simon & Son**  
 18107 Bothell Way NE  
 Bothell, Washington

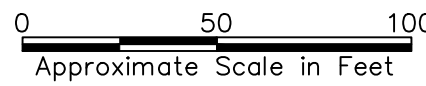
**Figure 1**  
 Site Plan



Aerial Photo Source: Google Earth Pro  
 Aerial Photo Date: May, 2018

**LEGEND**

- BSCA Property Boundary
- MW-1 Monitoring Well, Shallow (5-25ft)
- MW-2 Monitoring Well, Intermediate (25-35 ft)
- MW-3 Monitoring Well, Deep (35-55 ft)
- MW-4 New Monitoring Well, Screened as Noted
- Wells sampled in February-March, 2019



**Bothell Service Center Simon & Son**  
 18107 Bothell Way NE  
 Bothell, Washington

**Figure 2**  
 Groundwater Monitoring  
 Well Locations

**Table 1  
Bothell Service Center Simon Son  
ERH Area Groundwater Analytical Results**

Well	Well Type and Water Bearing Zone	Screened Depth, (ft bgs)	Date Sampled	Depth to Water (ft below TOC)	Sampled By	PCE (µg/L)	TCE (µg/L)	1,1-DCE (µg/L)	(cis) 1,2-DCE (µg/L)	(trans) 1,2-DCE (µg/L)	Vinyl Chloride (µg/L)	pH (units)	Conductivity (µS)	Dissolved Oxygen (mg/L)	Oxidation Reduction Potential (mV)	Dissolved Iron (ug/L)	Sulfate (mg/L)	Chloride (mg/L)	Ammonia as N (mg/L)	Methane (mg/L)	Ethane (mg/L)	Ethene (mg/L)	Total Organic Carbon (mg/L)	
MW-3	Shallow	5 to 20	12/5/18	7.93	Kane	<1.00	<0.50	<1.0	<1.00	<1.0	<0.20	5.90	62.5	38.7	6.94	<100	3.18	2.79	<0.100	<0.00863	<0.0162	<0.0151	2.7	
			2/12/19	7.79	Kane	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	<0.20	6.03	57.5	8.2	141.5	<100	4.16	3	<0.10	<0.00863	<0.0162	<0.0151	2.36
MW-4	Shallow	10 to 25	11/30/18	7.67	Kane	<b>4,370</b>	<b>373</b>	<50	<b>1,720</b>	<50	<10	6.35	347.4	0.12	50	<b>604</b>	18.8	16	<0.100	0.721	<0.162	<0.151	3.1	
			2/22/19	7.23	Kane	<b>4,080</b>	<b>343</b>	<1.0	<b>1,790</b>	<b>10.7</b>	<b>9.72</b>	6.49	311.5	0.22	19.9	<100	16.2	16.5	<0.10	4.12	<0.0162	<0.0151	1.94	
MW-6	Shallow	10 to 25	12/21/18	8.79	Kane	<b>2,670</b>	<b>1,000</b>	<1.0	<b>2,560</b>	<1.0	<b>25.5</b>	5.96	378	0.23	-65.4	<b>5,260</b>	8.68	11.2	0.413	0.0808	<0.162	<0.151	14.3	
			2/22/19	7.79	Kane	<b>1,820</b>	<b>568</b>	<1.0	<b>1,040</b>	<b>14.2</b>	<b>14</b>	6.16	295.1	0.15	-52	<b>5,800</b>	13	7.69	<0.10	0.706	<0.0162	<0.0151	13.2	
MW-8	Deep	45 to 50	12/20/18	10.05	Kane	<b>14.5</b>	<b>4.37</b>	<1.0	<b>9.38</b>	<1.0	<0.20	6.13	197.6	0.28	30	<100	4.13	6.53	<0.100	<0.00863	<0.0162	<0.0151	1.66	
			2/22/19	8.75	Kane	<b>4.98</b>	<b>2.9</b>	<1.0	<b>7.33</b>	<1.0	<0.20	6.28	183.2	0.24	65	<100	4.95	7.14	<0.10	0.0173	<0.0162	<0.0151	1.82	
MW-11	Intermediate	25 to 33	12/20/18	8.56	Kane	<b>41</b>	<b>11.5</b>	<1.0	<b>4.92</b>	<1.0	<0.20	5.72	287	0.16	14.3	<b>611</b>	37.4	13.5	<0.100	0.109	<0.162	<0.151	8.99	
			2/21/19	7.9	Kane	<b>16.9</b>	<b>14.6</b>	<1.0	<b>9.58</b>	<1.0	<0.20	5.96	316.3	0.16	-70	<b>1,240</b>	10.3	14.4	<0.10	0.87	<0.0162	<0.0151	23.7	
MW-20	Intermediate	25 to 30	12/20/18	7.5	Kane	<b>32</b>	<b>879</b>	<1.0	<b>552</b>	<1.0	<b>2.23</b>	5.72	264	0.05	-4.4	<b>3,140</b>	2.56	8.88	1.54	0.0446	<0.0162	<0.0151	95.4	
			3/14/19	7.55	Kane	<0.841	<b>136</b>	<10	<b>163</b>	<b>84.3</b>	<2.0	6	219.3	0.2	68.3	<b>1,460</b>	0.348	7.8	1.07	0.0463	<0.0162	<0.0151	45.3	
MW-23	Shallow	6 to 16	12/5/18	8.70	Kane	<b>1.05</b>	<0.50	<1.0	<1.00	<1.0	<0.20	5.65	112	1.24	49.8	<b>124</b>	10.3	2.16	<0.100	0.0854	<0.0162	<0.0151	2.4	
			2/12/19	8.18	Kane	<b>2.11</b>	<0.50	<1.0	<1.0	<1.0	<0.20	5.34	75.1	5.16	128.7	<100	6.02	1.46	<0.10	<0.00863	<0.0162	<0.0151	1.17	
MW-28	Intermediate	25 to 35	12/12/18	10.01	Kane	<1.00	<0.50	<1.0	<1.00	<1.0	<0.20	5.70	130	1.78	48.7	<100	11.8	8.06	<0.100	<0.00863	<0.0162	<0.0151	0.69	
			2/19/19	9.07	Kane	<1.0	<0.50	<1.0	<1.0	<1.0	<0.20	5.73	108.6	2.56	202.9	<100	8.78	5.65	<0.10	<0.00863	<0.0162	<0.0151	0.618	
MW-33	Deep	40 to 50	12/5/18	10.4	Kane	<1.00	<0.50	<1.0	<1.00	<1.0	<0.20	6.13	174	0.07	43.5	<100	10.6	6.74	<0.100	<0.00863	<0.0162	<0.0151	3.01	
			2/19/19	9.17	Kane	<1.0	<0.50	<1.0	<1.0	<1.0	<0.20	6.35	164.3	0.18	204.8	<100	11.5	6.45	<0.10	<0.00863	<0.0162	<0.0151	1.44	
MW-34	Deep	40 to 50	12/11/18	8.5	Kane	<1.00	<0.50	<1.0	<1.00	<1.0	<0.20	5.92	285	0.09	44.3	<b>561</b>	13.5	39	<0.100	0.0103	<0.0162	<0.0151	1.2	
			2/21/19	7.59	Kane	<b>1.29</b>	<0.50	<1.0	<b>1.52</b>	<1.0	<0.20	5.95	255.8	0.22	91.9	<b>367</b>	14.6	32.7	<0.10	0.0274	<0.0162	<0.0151	10.49	
MW-39	Deep	40 to 50	12/17/18	6.33	Kane	<b>2.32</b>	<b>2.62</b>	<1.0	<b>6.81</b>	<1.0	<0.20	6.39	225.4	0.15	-3.5	<b>4,580</b>	2.13	3.45	0.563	0.364	<0.0162	<0.0151	3.36	
			3/13/19	6.32	Kane	<1.0	<0.50	<1.0	<b>1.99</b>	<1.0	<0.20	6.4	205.6	0.09	-44.3	<b>4,380</b>	<0.30	3.76	0.445	0.552	<0.0162	<0.0151	4.15	
MW-40	Shallow	15 to 25	12/17/18	6.28	Kane	<b>212</b>	<b>46</b>	<1.0	<b>56.7</b>	<1.0	<0.20	6.43	69.2	2.39	52.6	<100	1.55	0.586	<0.100	<0.00863	<0.0162	<0.0151	1.11	
			3/13/19	6.29	Kane	<b>213</b>	<b>146</b>	<b>1.49</b>	<b>746</b>	<b>1.3</b>	<0.20	6.08	63.3	1.33	82.2	<100	0.819	2.08	<0.10	0.00959	<0.0162	<0.0151	2.03	
MW-42	Deep	30 to 45	1/3/19	10.21	Kane	<1.0	<0.50	<1.0	<1.0	<1.0	<0.2													
			3/18/19	8.79	Kane	<1.0	<0.50	<1.0	<1.0	<1.0	<0.20	6.63	155.4	0.06	76.4	<b>821</b>	1.99	3.57	0.266	0.177	<0.0162	<0.0151	1.9	
MW-43	Shallow	10 to 25	1/2/19	10.4	Kane	<b>225</b>	<b>32</b>	<b>5.95</b>	<b>7.16</b>	<b>3.24</b>	<0.2													
			3/18/19	8.42	Kane	<b>2</b>	<0.50	<1.0	<b>1.2</b>	<1.0	<0.20	6.61	183.6	0.1	-4.6	<b>286</b>	14.4	3.34	<0.10	0.0336	<0.0162	<0.0151	8.25	
MTCA Method A Cleanup Level <sup>1</sup>						5.0	5.0				0.2													
MTCA Method B Cleanup Level <sup>2</sup>								400	16	160							11,200							

**Notes:**

PCE – Tetrachloroethene  
TCE – Trichloroethene  
1,1-DCE - 1,1-Dichloroethene  
(cis) 1,2-DCE - (cis) 1,2-Dichloroethene  
Blank – Not analyzed or not available  
**Bold** – Analyte detected

**Bold / highlighted** – Analyte exceeds MTCA A/B cleanup level

< – Analyte not detected at listed reporting limit  
*Italicized* - Reporting limit exceeds MTCA A/B cleanup level  
ug/L – micrograms per liter

1 – Table 720-1, WAC 173-340-900

2 – WA Dept. of Ecology CLARC ground water data table

(<https://fortress.wa.gov/ecy/clarc/FocusSheets/Groundwater%20Methods%20B%20and%20A%20and%20ARARs.pdf>)

NA – Not Applicable

**Table 2**

**ERH Monitoring Wells - Groundwater Temperatures**

**March 2019 Sampling**

<b>Well</b>	<b>Average Temperature oC</b>
MW-3	11.9
MW-23	11.7
MW-28	13
MW-33	14.8
MW-34	27.7
MW-11	46.8
MW-6	40.7
MW-4	13.1
MW-8	29.5
MW-42	32.8
MW-43	33
MW-20	15.3*
MW-38	26.9
MW-40	30.7

\*Indicates Temperature was measured after the water passed through a cooling coil and the temperature is not representative of the actual groundwater.

**Groundwater Monitoring Well Temperatures**

**December 2018**

<b>Well</b>	<b>Average Temperature oC</b>
HZ-MW-31	14.3
HZ-MW-30	13.9
HZ-MW-28	14.2
HZ-MW-17	14.8
HZ-MW-33	14.1
HZ-MW-29	14.3
HZ-MW-34	15.9
HZ-MW-32	13.3
HZ-MW-19	14.5
HZ-MW-21	13.9