# Evaluation of Wyckoff Groundwater Level Data September 17 through December 15, 2013

**PREPARED FOR:** Howard Orlean/EPA Region 10

**PREPARED BY:** Nicole Badon/CH2M HILL
Rob Healy/CH2M HILL

**COPIES** Chung Yee/ Washington Dept. of Ecology
Helen Bottcher/EPA Region 10
Stan Warner/CH2M HILL
Keith Allers/CH2M HILL
Richard Brooks/ Suquamish Tribe
Perry Barrett/ City of Bainbridge Island
Ken Scheffler/CH2M HILL
Carolyn Kossik/CH2M HILL

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This memorandum summarizes the Wyckoff groundwater level results for the 90-day monitoring period of September 17 through December 15, 2013.

## Summary/Recommendations

- Hydraulic containment was maintained in all 10 well pairs over the 90-day monitoring period: MW14/CW05, MW18/02CDMW01, PO03/99CDMW02A, CW03/CW02, VG-2U/VG-2L, VG-3U/VG-3L, VG-5U/VG-5L, PO13/VG-1L, CW13/VG4L, and CW08/P-4L.
- The groundwater elevation data from the transducers in the 10 well pairs should be downloaded again in March 2014 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

## Water Level Data Collection

The September 17, 2013 through December 15, 2013 time period represents the next 90-day monitoring period in succession from the previous groundwater level data evaluation memorandum (June 19, 2013 through September 16, 2013). The locations of the wells are shown in Figure 1 and wells with transducers are listed in Table 1. Model 705 KPSI™ Level and Pressure Transducers are installed in 22 upper aquifer wells and 18 lower aquifer wells and were last calibrated in August 2013.

All data are available in e-format upon request.

**Table 1 – Wells with Transducers, September 17, 2013 through December 15, 2013**

| Upper Aquifer | | Lower Aquifer | |
|---|---|---|---|
| CW03 | PO13 | 02CDMW01 | PZ03 |
| CW08 | RPW-1 | 99CDMW02A | SE02 |
| CW13 | RPW-2 | CW02 | VG-1L |
| E-02[1] | RPW-4 | CW05 | VG-2L |
| E-04[1] | RPW-5 | CW09 | VG-3L |
| E-06[1] | RPW-6 | P-1L | VG-4L |
| E-07[1] | PW-8 | P-2L | VG-5L |
| MW14 | PW-9 | P-3L | |
| MW18 | VG-2U | P-4L | |
| MW21 | VG-3U | P-5L | |
| PO03 | VG-5U | P-6L | |

[1] The E-0x series of wells are located within the Pilot Test sheet pile wall.

## Hydraulic Containment / Isolation Evaluation

The hydraulic containment/isolation performance at the Wyckoff site is evaluated based on water level data from 10 upper and lower aquifer well pairs: MW14/CW05, MW18/02CDMW01, PO03/99CDMW02A, CW03/CW02, VG-2U/VG-2L, VG-3U/VG-3L, VG-5U/VG-5L, PO13/VG-1L, CW13/VG-4L, and CW08/P-4L (See Figure 1 for these locations). The hydraulic containment at each well pair is evaluated by first calculating the average groundwater elevations of the upper and lower aquifers using the water elevation data recorded every 15 minutes during the 90-day monitoring period. Then the average groundwater elevations of the upper and lower aquifers at each well pair are compared relative to each other. If the average lower aquifer groundwater elevation is greater than that of the upper aquifer, an overall net upward gradient of groundwater is indicated and hydraulic containment is demonstrated. If a well pair meets the definition of hydraulic containment, the ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for that well pair is greater than 1. A secondary evaluation of hydraulic containment/isolation performance is conducted through examination of the short term periods when downward hydraulic gradients occur within well pairs. In addition, groundwater elevations for each well pair are compared at each 15 minute recording, and the summary statistics are evaluated. The maximum, average, and minimum change in groundwater elevation for each well pair is calculated, along with percent duration of the 90-day monitoring period when net downward gradients occur. Hydrographs for each well pair have been prepared and are presented in Figures 2a through 2j.

The hydraulic evaluation data for the well pairs are summarized together in Table 2. This table presents the average groundwater elevations for each well pair, the ratio of the average upper to lower aquifer groundwater elevation, and summary statistics on the short-term change (compared at each 15-minute recording) in groundwater elevations between the upper and lower aquifers.

- Ratios are greater than 1 in all 10 well pairs, indicating hydraulic containment is maintained at all well pair locations.

- Short term vertical gradient data (short-term change per 15-minute recording) indicate that an upward gradient is sustained at all times during the 90-day monitoring period at two of the monitoring well pairs (VG-2U/VG-2L, and VG-3U/VG-3L).
- A series of short duration downward gradient periods, averaging less than six hours each, occur in the other eight monitoring well pairs. In six of these eight well pairs (MW14/CW05, MW18/02CDMW01, PW03/99CDMW02, CW03/CW02, VG-5U/VG-5L, and CW13/VG-4L ), the percent duration of the 90-day period is less than 5 percent.
- One well pair has a downward gradient percent duration of the 90-day monitoring period greater than 10 percent (PO13/VG-1L at 11%) and one well pair has a percent duration greater than 20 percent (CW08/P-4L at 26.1%).

Table 2
Summary of Groundwater Elevation Data by Well Pair

| | | | | Summary Statistics Short Term Comparison - Water Level Difference between the Upper and Lower Aquifer wells | | | Duration Analysis – Downward (neg.) Gradient | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Well Pair | Upper Aquifer Average Groundwater Elevation (ft MLLW) | Lower Aquifer Average Groundwater Elevation (ft MLLW) | Ratio (Avg Lower Aq WL / Avg Upper Aq WL)* | Average | Max | Min | Number Neg Grad Events | Average Duration Neg Grad (hours) | Total Duration Neg Grad (days) | Percent Duration of 90-day monitoring period |
| MW14/CW05 | 6.63 | 9.34 | 1.41 | 2.71 | 5.66 | -0.66 | 33 | 2 | 3 | 3.4% |
| MW18/02CDMW01 | 5.47 | 8.93 | 1.63 | 3.46 | 7.55 | -0.42 | 8 | 2 | 1 | 0.8% |
| PO03/99CDMW02A | 6.15 | 9.33 | 1.52 | 3.18 | 6.00 | -0.71 | 6 | 2 | 1 | 0.7% |
| CW03/CW02 | 6.64 | 8.65 | 1.30 | 2.01 | 4.21 | -0.90 | 20 | 4 | 3 | 3.3% |
| VG-2U/VG-2L | 7.15 | 8.37 | 1.17 | 1.23 | 1.86 | 0.38 | none | | | |
| VG-3U/VG-3L | 6.22 | 9.89 | 1.59 | 3.68 | 5.31 | 1.13 | none | | | |
| VG-5U/VG-5L | 8.25 | 10.56 | 1.28 | 2.31 | 4.45 | -0.51 | 6 | 3 | 1 | 0.8% |
| PO13/VG-1L | 6.66 | 8.91 | 1.34 | 10.56 | 5.52 | -1.49 | 73 | 3 | 10 | 11.0% |
| CW13/VG-4L | 8.59 | 10.97 | 1.28 | 2.38 | 5.40 | -0.77 | 28 | 2 | 3 | 3.0% |
| CW08/P-4L | 7.39 | 8.51 | 1.15 | 1.12 | 4.42 | -2.71 | 111 | 5 | 23 | 26.1% |

*** Ratio > 1 = Hydraulic Containment was Achieved**

## Treatment Plant Operations and Effects on Groundwater Flow

The treatment plant and all of the extraction well systems were shutdown numerous times over the 90-day monitoring period due to low water levels and for maintenance and freeze protection. When water levels allowed, the extraction well systems were operated 24 hours per day and 5 days per week through the end of the 90-day monitoring period. The dates during which the extraction wells were shut down for periods greater than 24 hours are listed in Table 3. These periods are graphically overlaid with the precipitation records and are shown in Figure 3. The total volume of water pumped was 3,794,930 gallons during the 90-day monitoring period which equates to about 29 gpm over the entire period including all down time regardless of cause. [Note, when fully operating, the system can pump about 72 gpm.]

During this 90-day monitoring period, hydraulic containment at the site was maintained in all 10 well pairs. The maximum negative gradients calculated for the 8 well pairs showing gradient reversals occurred in association with periods when the extraction wells were shut down (See Figure 3). An examination of the previous reporting period indicates that the maximum negative gradient well pair (MW14/CW05) that occurred on September 17, 2013, is associated with a shutdown event ending on the September 16$^{th}$. Although numerous short-duration negative gradient events occurred for 8 of the 10 well pairs over this 90-day monitoring period, extraction volumes were high enough and precipitation amounts were low enough that hydraulic containment was maintained at all well pairs across the site.

**Table 3 – Former Process Area (FPA) Extraction Well Pump Shutdown Periods Greater than 1 Day**

| Date | Wells Shut Down | Reason |
|---|---|---|
| September 18 – September 23, 2013 | PW-9 | Shutdown due to low water level |
| September 19 – September 23, 2013 | EW-6 | Shutdown due to low water level |
| September 20 –September 23, 2013 | PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, EW-2 | Shutdown for weekend |
| September 25 – September 30, 2013 | PW-9, EW-6 | Shutdown due to low water level |
| September 27 –September 30, 2013 | PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, EW-2 | Shutdown for weekend |
| October 4 – October 9, 2013 | PW-9 | Shutdown due to low water level |
| October 4 – October 11, 2013 | EW-2 | Shutdown due to low water level |
| October 11 – October 25, 2013 | EW-6 | Shutdown due to low water level and for maintenance |
| October 14 – November 8, 2013 | PW-1, PW-6, PW-9 | Shutdown due to low water level |
| October 25 – November 8, 2013 | EW-2 | Shutdown for maintenance |
| November 1 – November 4, 2013 | PW-2, PW-4, PW-5, PW-8, EW-6 | Shutdown for weekend |
| November 7 – November 8, 2013 | PW-2, PW-4, PW-5, PW-8 | Power outage |
| November 8 – November 11, 2013 | EW-2 | Shutdown due to loss of air pressure |
| November 8 – November 20, 2013 | EW-6 | Shutdown for maintenance |
| November 12 – November 19, 2013 | PW-1, PW-6, PW-9 | Shutdown due to low water level |
| November 22 – December 16, 2013 | PW-1, PW-6, PW-9, EW-2 | Shutdown due to low water level |
| December 2 – December 16, 2013 | PW-2, PW-4, PW-5, PW-8, EW-6 | Shutdown for freeze protection |