

Appendix E

Detailed Discussion on Synoptic Groundwater Gauging Events (September 2014 through June 2015)

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The sections below present summaries of the behavior of the groundwater flow regime during the recent monitoring events (September 2014 through June 2015).

1.0 Synoptic Groundwater Gauging Event – September 2014

On September 8, 2014, fluid-level measurements were collected from 671 monitoring wells and up to 30 surface water gauging stations (Table 4-1).

Shallow Hydrostratigraphic Zones (S1, S2, S3)

Groundwater elevation measurements in Zone S1 ranged from 77.41 feet above mean sea level (msl) (in IA-14) to 129.50 feet above msl (in IA-12). Higher hydraulic heads were consistently recorded in IA-10 (northwestern portion of the Site) while the lowest hydraulic heads were observed in IAs 11, 13, 14, and 15 (southeastern portion of the Site). The average depth to water in Zone S1 (i.e., the top of the water table) within the Site bounds was estimated at 10.40 feet below ground surface (bgs).

As shown on Figure 17, Zone S1 is characterized by two areas of steep horizontal gradient: the northeastern corner of IA-12 and in the southeastern portion of the Site (IA-14 and IA-15). The horizontal hydraulic gradient is similarly steep in the same two areas in Zone S2 (Figures 18 and 19). The spacing of the water-level contours suggests the water-bearing overburden and weathered bedrock is relatively permeable under the Site.

Under most of the Site, there is a steep downward vertical gradient from Zone S1 through Zone S2 and into Zone S3. The steep vertical gradients are likely attributed to the Site's topographic relief and lithology contrasts in bulk horizontal and vertical hydraulic conductivity between the overburden/weathered bedrock and the competent, highly fractured bedrock.

As reported in previous reports, multiple areas of high potentiometric head have been observed upstream of Nichols Park and IA-4 (Zone S1), and in an area east of former Building 115 in IA-3/IA-7 (Zone S3). In Zone S2, a localized change in horizontal gradient was identified in the northeast corner of IA-12 during the first four quarters of monitoring.¹

Groundwater elevation data collected in September 2014 (Figures 17 through 19) indicate

¹ The northeastward gradient observed within Zone S2 in IA-12 is inconsistent with the direction of groundwater flow established for Zones S1 and S3. The water levels in wells MW-271B and MW-61B may be anomalously low because they are screened in rock with fewer transmissive fractures and, therefore, their response to aquifer recharge events is negligible (i.e., in poor communication with the water-bearing fractures in the overlying Zone S1).

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localized areas of high potentiometric head in IA-4 and in an area north of the Nichols Park dam (Zone S1). The isolated area of horizontal gradient reversal in the northeastern corner of IA-12 was once again observed in Zone S2. In Zone S3, a zone of anomalously high potentiometric heads transecting the northeastern portion of the Site can be observed in IAs 12, 3, and 7. During this quarter, there is no evidence of localized areas of elevated potentiometric heads in IA-3/IA-7.

Deep Hydrostratigraphic Zones (D1, D2, D3, D4)

The groundwater elevation data collected across the deep bedrock aquifer ranged from 60.10 to 110.03 feet above msl in Zone D1, -155.59 to 103.95 feet above msl in Zone D2, and -231.65 to 103.06 feet above msl in Zone D3.² As shown on Figures 20 through 22, groundwater elevation measurements were higher in the northwestern portion of IA-10 and lower in the southern portion of the Site (IAs 14 and 15).

As previously reported, the steepening gradients observed in the eastern portion of the Site likely correlate with the contrast in geologic conditions in these areas, where the higher and lower transmissive rock meet resulting in higher groundwater elevations at the contact (i.e., creating northeast to southwest trending potentiometric feature).

2.0 Synoptic Groundwater Gauging Event – December 2014

On December 8, 2014, fluid-level measurements were collected from 591 monitoring wells and up to 31 surface water gauging stations (Table 4-2).

Shallow Hydrostratigraphic Zones (S1, S2, S3)

As shown on Figures 17 through 19, there is no significant variation in the groundwater horizontal gradient for Zones S1, S2, and S3. Groundwater elevation measurements in Zone S1 ranged from 77.88 feet above msl (in IA-14) to 129.74 feet above msl (in IA-12). Depth to water across the Site was on average 9.53 feet bgs.

² A small number of Site monitoring wells exhibit very low yield and are not fully recovered during when the comprehensive Site-wide groundwater gauging events are completed (resulting groundwater elevation measurements below mean sea level). As discussed in Section 4.1 of this report, the low-yield conditions at selected wells is likely the result of decreased fracture density/abundance and fracture inter-connectedness in the particular zone.

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Deep Hydrostratigraphic Zones (D1, D2, D3, D4)

During the December 2014 monitoring period, the groundwater elevation data collected across the deep bedrock aquifer ranged from 59.59 to 110.90 feet above msl in Zone D1, -149.28 to 116.55 feet above msl in Zone D2, and -229.69 to 102.03 feet above msl in Zone D3. As shown on Figures 20 through 22, there is very little variation in the contour spacing and horizontal gradient from September 2014 through June 2015.

3.0 Synoptic Groundwater Gauging Event – March 2015

On March 2, 2015, fluid-level measurements were collected from 621 monitoring wells (Table 4-3). The surface water gauging stations were not sampled during this quarter due to severe winter weather conditions that resulted in frozen streams and/or excessive snow accumulation.

Shallow Hydrostratigraphic Zones (S1, S2, S3)

As shown on Figures 17 through 19, the groundwater horizontal gradient for Zones S1, S2, and S3 remained consistent with previous quarters. Groundwater elevation measurements in Zone S1 ranged from 77.91 feet above msl (MW-277A in IA-14) to 129.10 feet above msl (MW-61 in IA-12). Depth to water across the Site was on average 10.68 feet bgs.

Deep Hydrostratigraphic Zones (D1, D2, D3, D4)

During this monitoring quarter, the groundwater elevation data collected across the deep bedrock aquifer ranged from 59.51 to 109.93 feet above msl in Zone D1, -140.52 to 103.61 feet above msl in Zone D2, and -223.70 to 107.84 feet above msl in Zone D3. Figures 20 through 22 provide a comparison of potentiometric groundwater contours for the recent monitoring quarters. As shown on these figures, the groundwater contours for Zones D1, D2, and D3 for each event are similar.

4.0 Synoptic Groundwater Gauging Event – June 2015

On June 1, 2015, fluid-level measurements were collected from 708 monitoring wells and up to 22 surface water gauging stations (Table 4-4). In addition to the 4-panel maps (comparing quarters September 2014 through June 2015), individual potentiometric surface maps were created for the June 2015 event. While Figures 20 through 22 provide an overall view of the Site's groundwater flow regime for multiple sample quarters, Figures 10 through 12 and 14 through 16 provide groundwater elevation data for June 2015.

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Shallow Hydrostratigraphic Zones (S1, S2, S3)

As shown on Figures 10 through 12 and Figures 17 through 19, the groundwater horizontal gradient showed variations over time in an area between IA-1 and IA-4 (between former Buildings 56 and 44) in Zones S1 through S3, and in an area bordering IA-4 and IA-2 (in the vicinity of former Buildings 36 and 57) in Zone S3. The higher groundwater elevations observed in these areas could be the result of short term water accumulation in an excavation pit (associated with the removal of a storm sewer catch basin) in the northern portion of the IA-1/IA-4 boundary and/or reported water leakage from other catch basins and water main leaks along the pipes in these areas. During this quarter, groundwater elevation measurements in Zone S1 ranged from 71.92 and 78.31 feet above msl (in IA-15 and IA-14, respectively) to 129.27 feet above msl (in IA-12). Depth to water across the Site was on average 9.39 feet bgs.

Deep Hydrostratigraphic Zones (D1, D2, D3, D4)

The groundwater elevation data collected across the deep bedrock aquifer ranged from 59.95 to 114.43 feet above msl in Zone D1, -139.26 to 106.11 feet above msl in Zone D2, and -220.99 to 104.00 feet above msl in Zone D3. With up to 148 depth-to-water readings collected from deep bedrock wells located on- and off-Site, the June 2015 synoptic gauging event provides the most comprehensive depiction of groundwater gradient conditions at the Site and surrounding areas to date. Evaluation of the June 2015 potentiometric maps for Zones D1, D2, and D3 (Figures 14 through 16 and Figures 20 through 22) shows that the groundwater gradient remained consistent with those of the previous quarters (from the northwest to the southeast). A discussion of the Site's groundwater flow regime over the last eight quarters of groundwater monitoring is provided under Section 4.1.6 of the Groundwater Progress Report.