Evaluation of Wyckoff Groundwater Level Data June 19 through September 16, 2013

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This memorandum summarizes the Wyckoff groundwater level results for the 90-day monitoring period of June 19 through September 16, 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 December 2013 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

Water Level Data Collection

The June 19, 2013 through September 16, 2013 time period represents the next 90-day monitoring period in succession from the previous groundwater level data evaluation memorandum (March 21, 2013 through June 18, 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, June 19, 2013 through September 16, 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 two of these eight well pairs (VG5U/VG5L and CW13/VG4L), the percent duration of the 90-day period is less than 10 percent.
- Four well pairs have a downward gradient percent duration of the 90-day monitoring period greater than 10 percent (MW14/CW05, MW18/02CDMW01, PO03/99CDMW02, and PO13/VG1L), and two well pairs have a percent duration greater than 20 percent (CW03/CW02 at 20.6% and CW08/P4L at 30.4%).

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	7.83	9.81	1.25	1.97	5.43	-1.59	77	3.51	11.3	12.5%
MW18/02CDMW01	7.68	9.24	1.20	1.57	5.24	-1.42	75	4.25	13.3	14.8%
PO03/99CDMW02A	7.97	9.76	1.22	1.79	5.69	-1.73	78	4.01	13.0	14.5%
CW03/CW02	8.15	9.07	1.11	0.92	3.64	-1.49	94	4.72	18.5	20.6%
VG-2U/VG-2L	8.28	8.78	1.06	0.50	1.73	0.11	none			
VG-3U/VG-3L	8.09	10.25	1.27	2.16	4.86	0.60	none			
VG-5U/VG-5L	8.63	10.80	1.25	2.17	4.62	-0.25	10	1.85	0.77	0.9%
PO13/VG-1L	7.48	9.31	1.24	1.83	5.34	-2.02	89	4.13	15.3	17.0%
CW13/VG-4L	9.11	11.03	1.21	1.92	4.93	-1.08	69	2.72	7.8	8.7%
CW08/P-4L	8.06	8.96	1.11	0.89	4.66	-3.27	117	5.62	27.4	30.4%

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

Treatment Plant Operations and Effects on Groundwater Flow

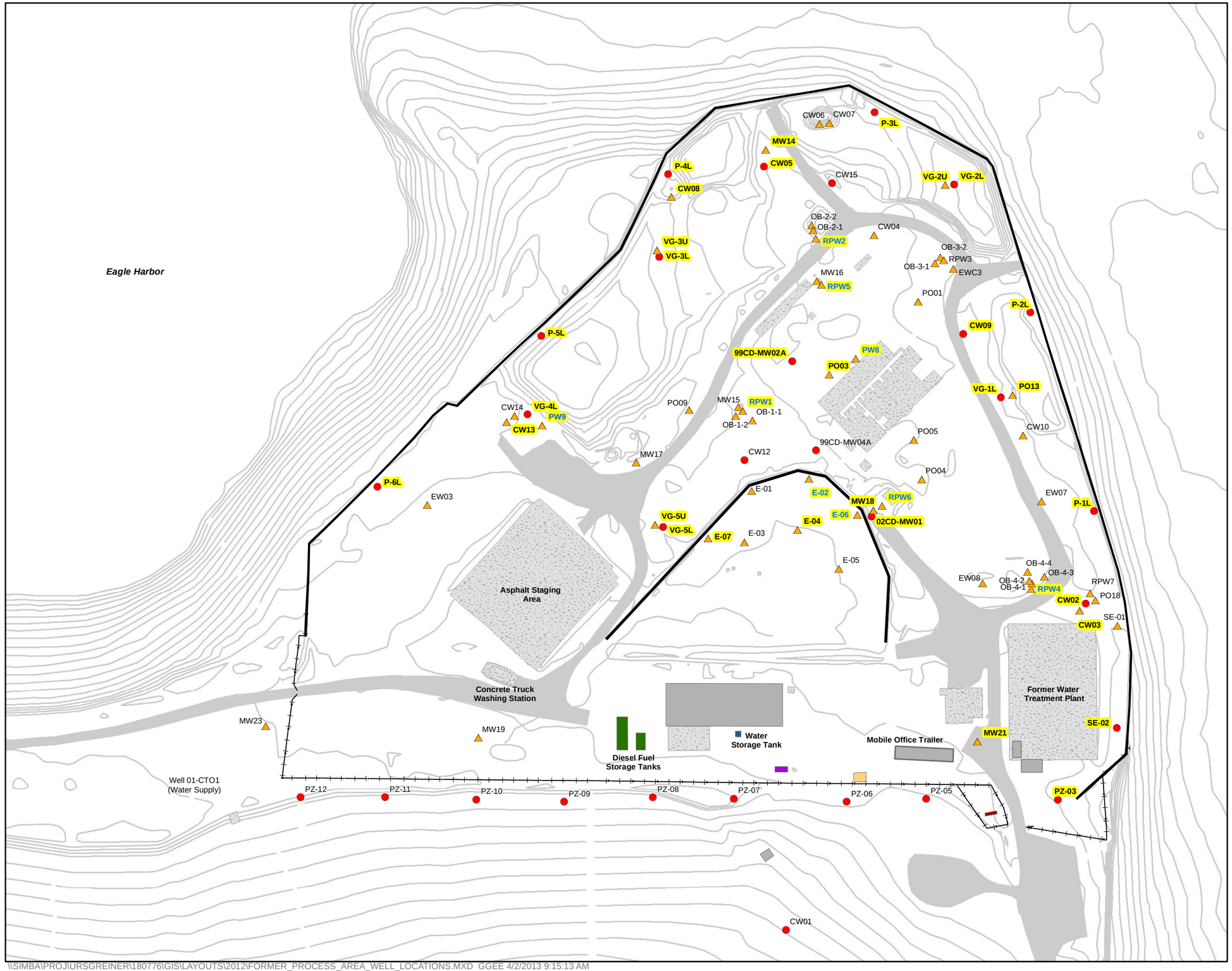
The treatment plant and all of the extraction well systems were shutdown for an extended period over the 90-day monitoring period due to low water levels and for summer maintenance. When normal pumping operations resumed on September 3, 2013, the extraction well systems were operated 24 hours per day 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 1,402,388 gallons during the 90-day monitoring period which equates to about 11 gpm over the entire period including all down time regardless of cause. [Note, when fully operating, the system can pump about 72 gpm.]

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

Date	Wells Shut Down	Reason
May 9 – August 30, 2013	PW-1, PW-6, PW-9	Shutdown for low water level and summer maintenance
May 17 – August 30, 2013	EW-2	Shutdown for low water level and summer maintenance
June 21 – August 30, 2013	PW-2, PW-4, PW-5, PW-8, EW-6	Shutdown for summer maintenance
August 30 – September 3, 2013	PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, PW-9, EW-2, EW-6	Shutdown for operations test
September 6 – September 9, 2013	PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, PW-9, EW-2, EW-6	Weekend shutdown
September 11 – September 17, 2013	PW-9	Shutdown due to low water level
September 13 – September 16, 2013	PW-2, PW-4, PW-5, PW-6, PW-8, EW-2, EW-6	Weekend shutdown
September 13 – September 17, 2013	PW-1	Shutdown due to low water level

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 during the period of extended shutdown of all extraction well systems, and during periods of no rainfall. As shown on Figure 3, the maximum negative gradient occurred for 7 of the 8 well pairs on August 19 and 20, 2013. The maximum negative gradient at CW13/VG4L occurred on July 22, 2013. During the extended shutdown, upper aquifer water levels showed a steady increase over the monitoring period while lower aquifer water levels showed daily fluctuations that paralleled the rise and fall of the tide in Puget Sound. The maximum negative gradients observed during this monitoring period appear to correlate with maximum low tides and corresponding maximum low lower aquifer water levels.

Although numerous short-duration negative gradient events occurred for 8 of the 10 well pairs over this 90-day monitoring period, previous monitoring period extraction volumes were high enough and precipitation amounts were low enough to allow for extended extraction well system shutdowns, while maintaining hydraulic containment at all well pairs across the site.



LEGEND

- Lower Aquifer Well
- Upper Aquifer Well
- Fence
- Wall
- Roads
- Buildings
- Concrete Slab

Well labels:

highlighted - well is monitored with transducer
blue text - production well

FIGURE 1

Former Process Area Well Locations

WYCKOFF/EAGLE HARBOR SUPERFUND SITE

\\SIMBA\PROJ\URSGREINER\180776\GIS\LAYOUTS\2012\FORMER_PROCESS_AREA_WELL_LOCATIONS.MXD GGEE 4/2/2013 9:15:13 AM

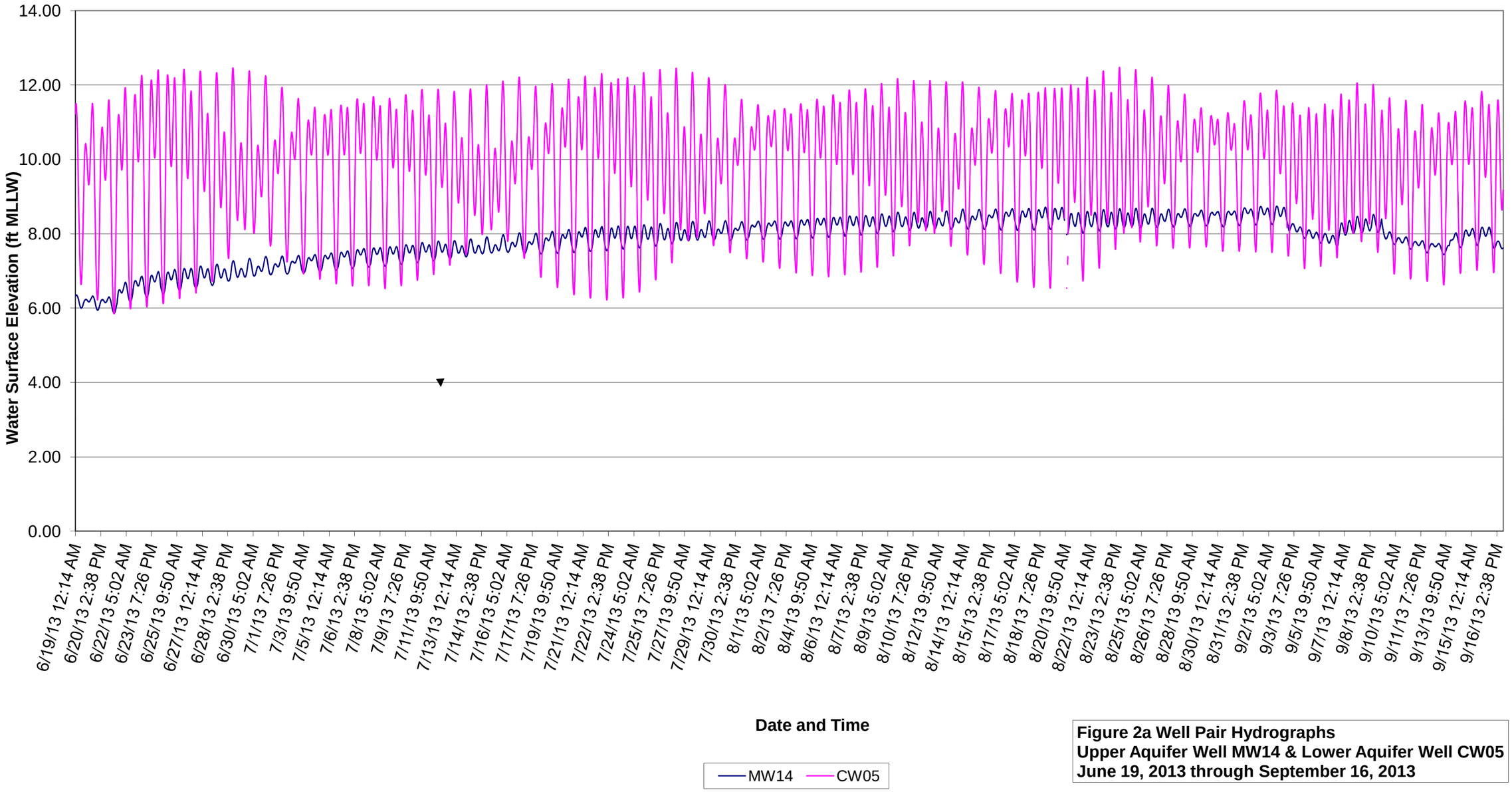


Figure 2a Well Pair Hydrographs
Upper Aquifer Well MW14 & Lower Aquifer Well CW05
June 19, 2013 through September 16, 2013

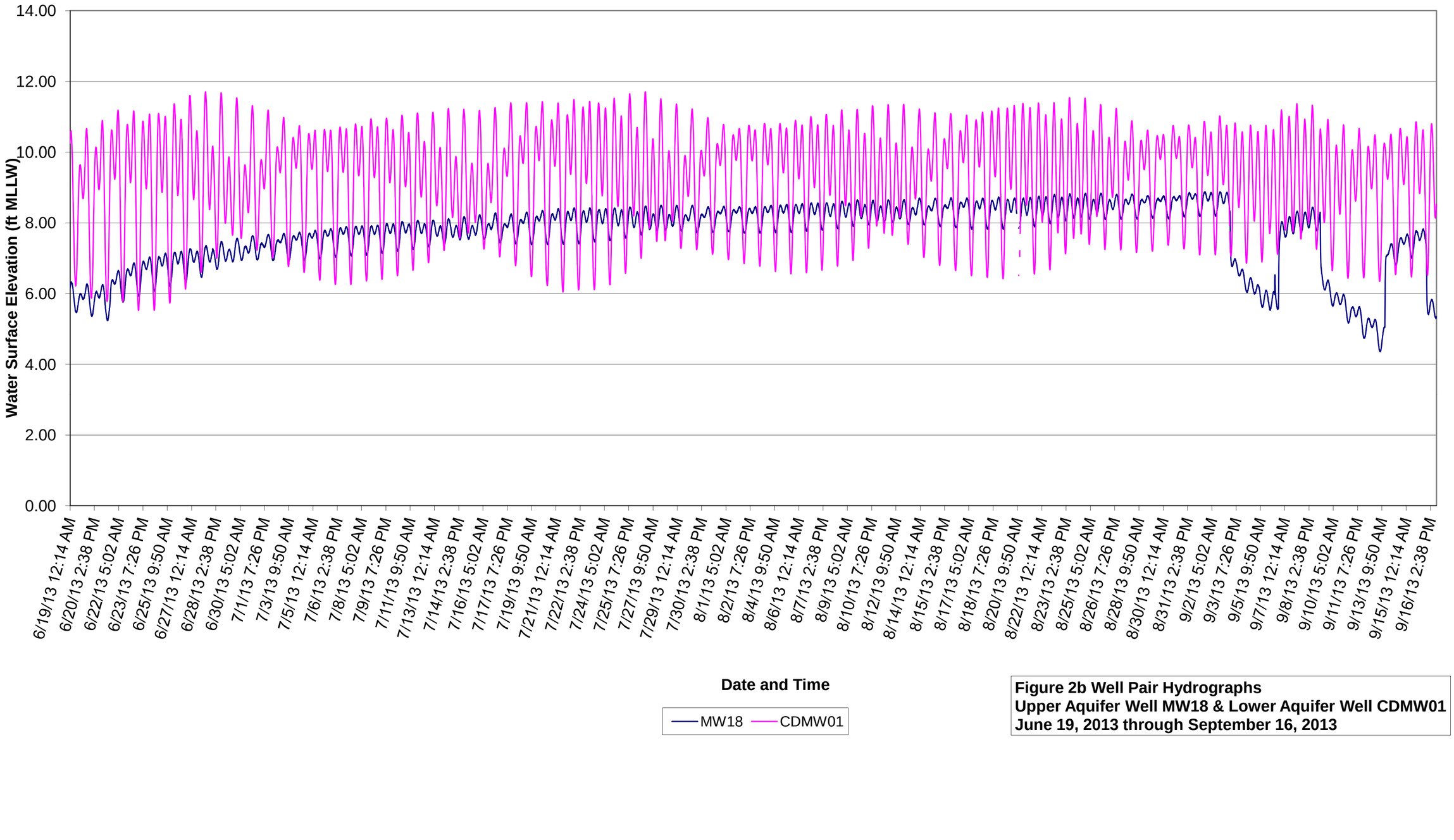


Figure 2b Well Pair Hydrographs
Upper Aquifer Well MW18 & Lower Aquifer Well CDMW01
June 19, 2013 through September 16, 2013

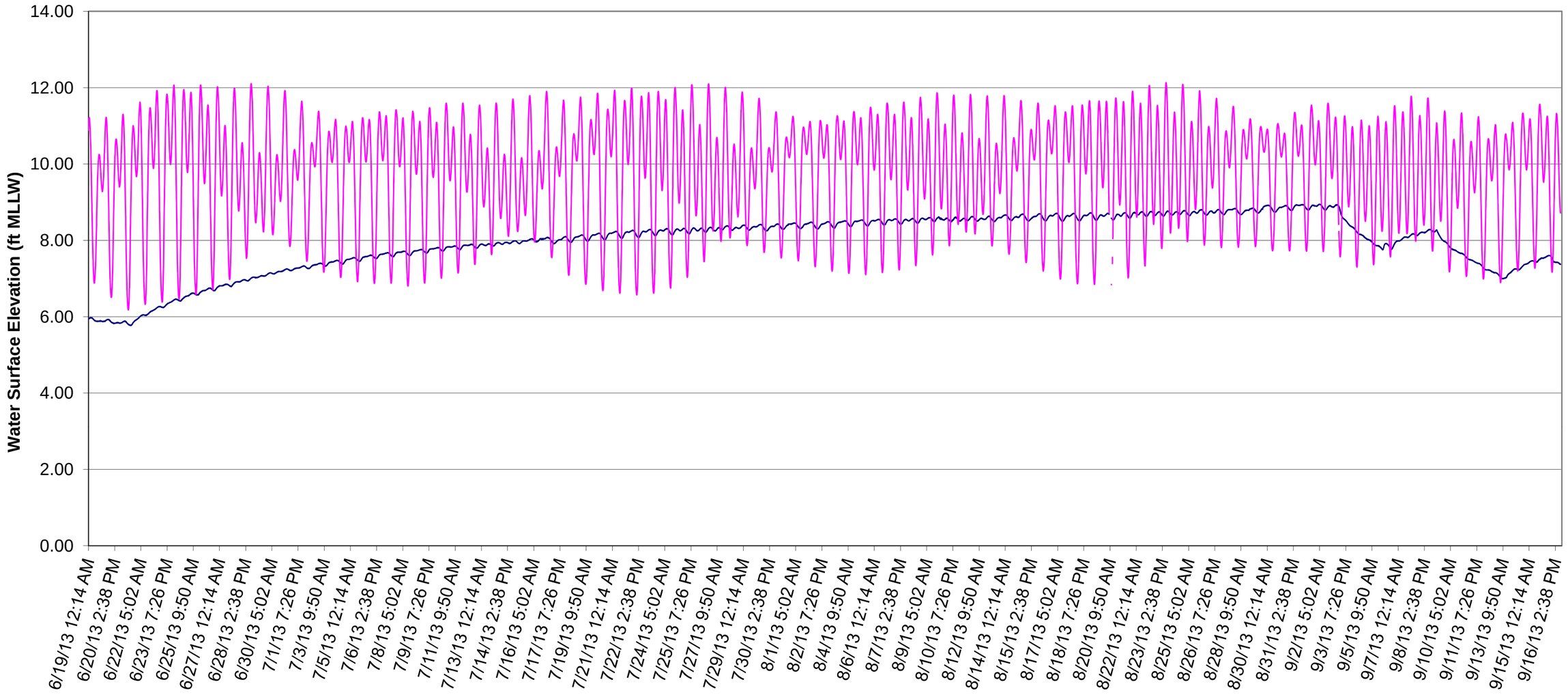


Figure 2c Well Pair Hydrographs
Upper Aquifer Well PO03 & Lower Aquifer Well CDMW02
June 19, 2013 through September 16, 2013

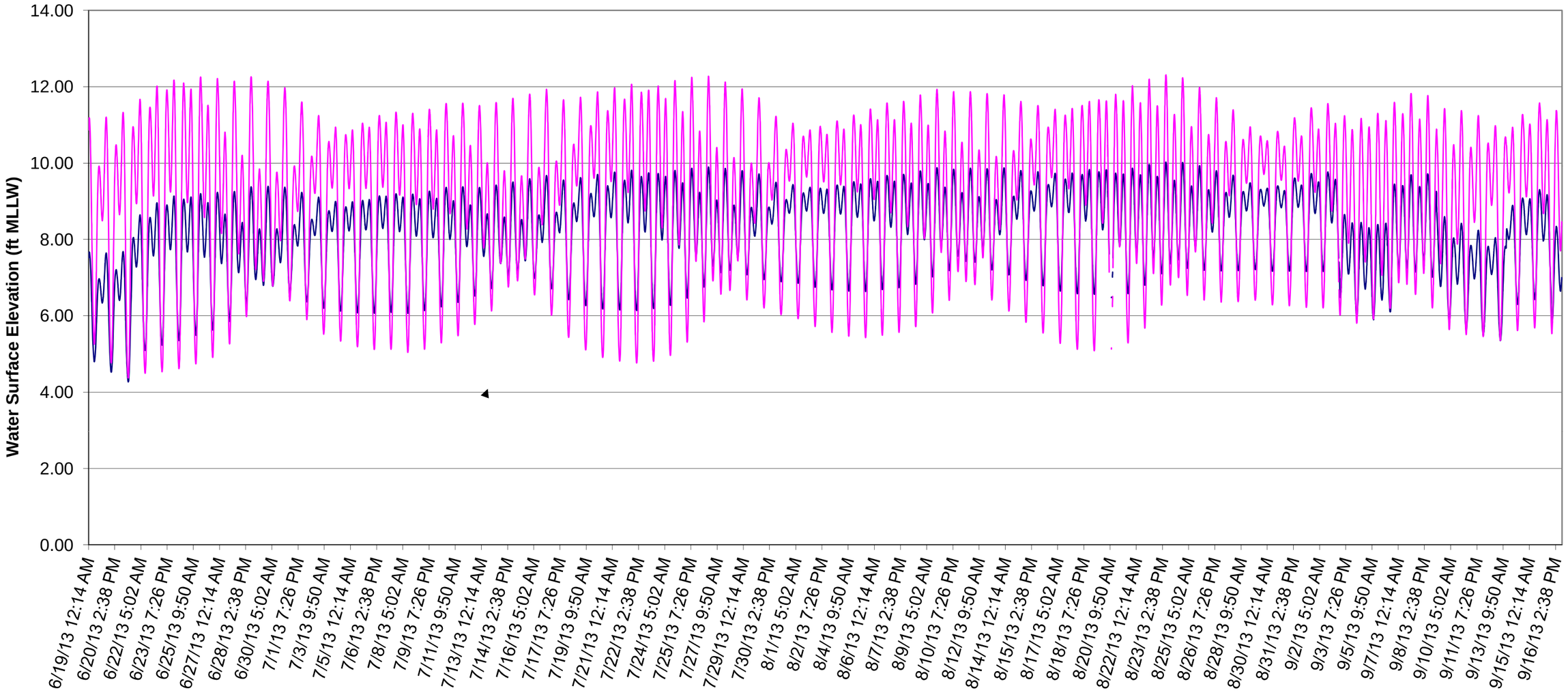


Figure 2d Well Pair Hydrographs
Upper Aquifer Well CW03 & Lower Aquifer Well CW02
June 19, 2013 through September 16, 2013

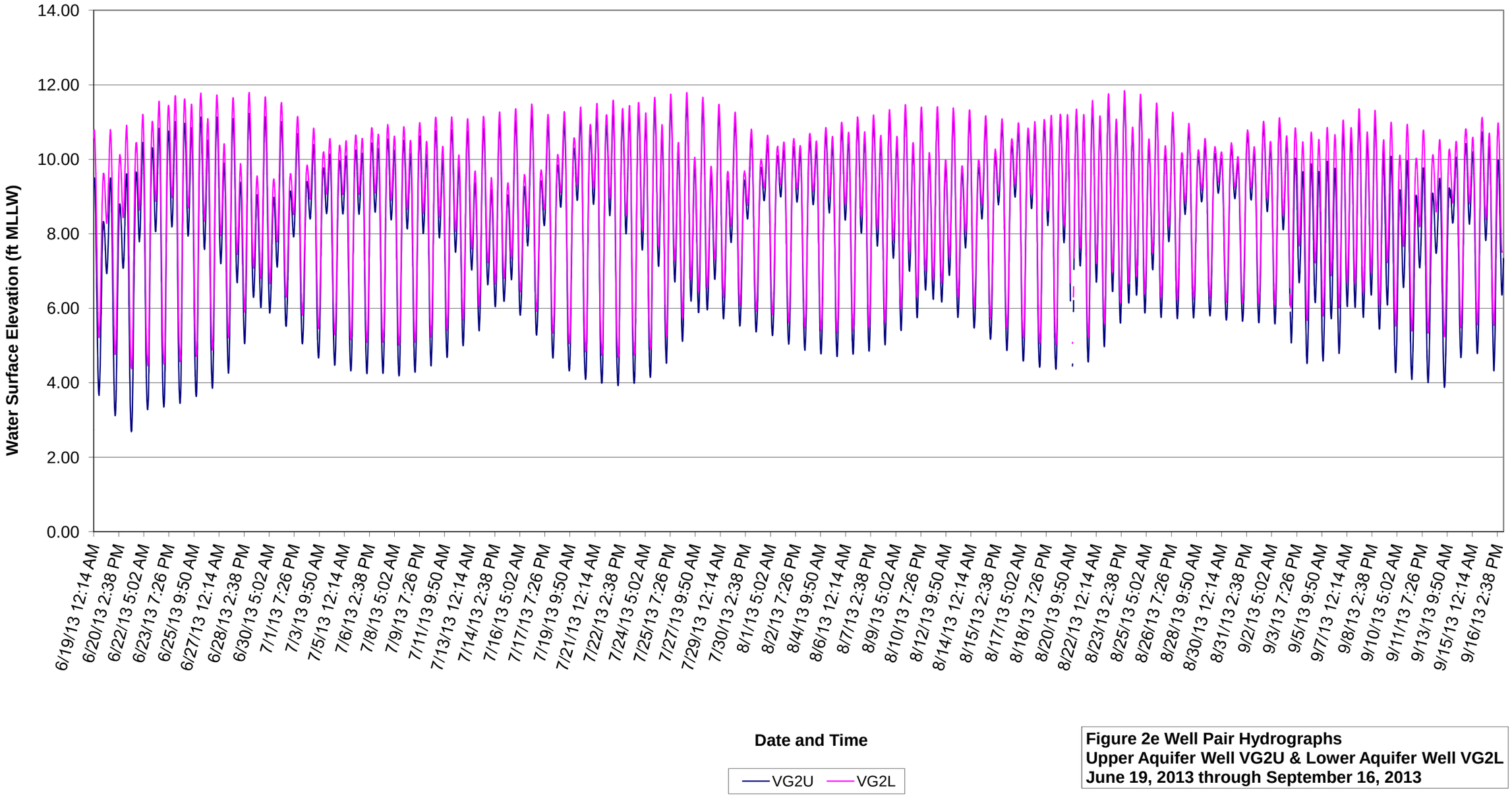


Figure 2e Well Pair Hydrographs
Upper Aquifer Well VG2U & Lower Aquifer Well VG2L
June 19, 2013 through September 16, 2013

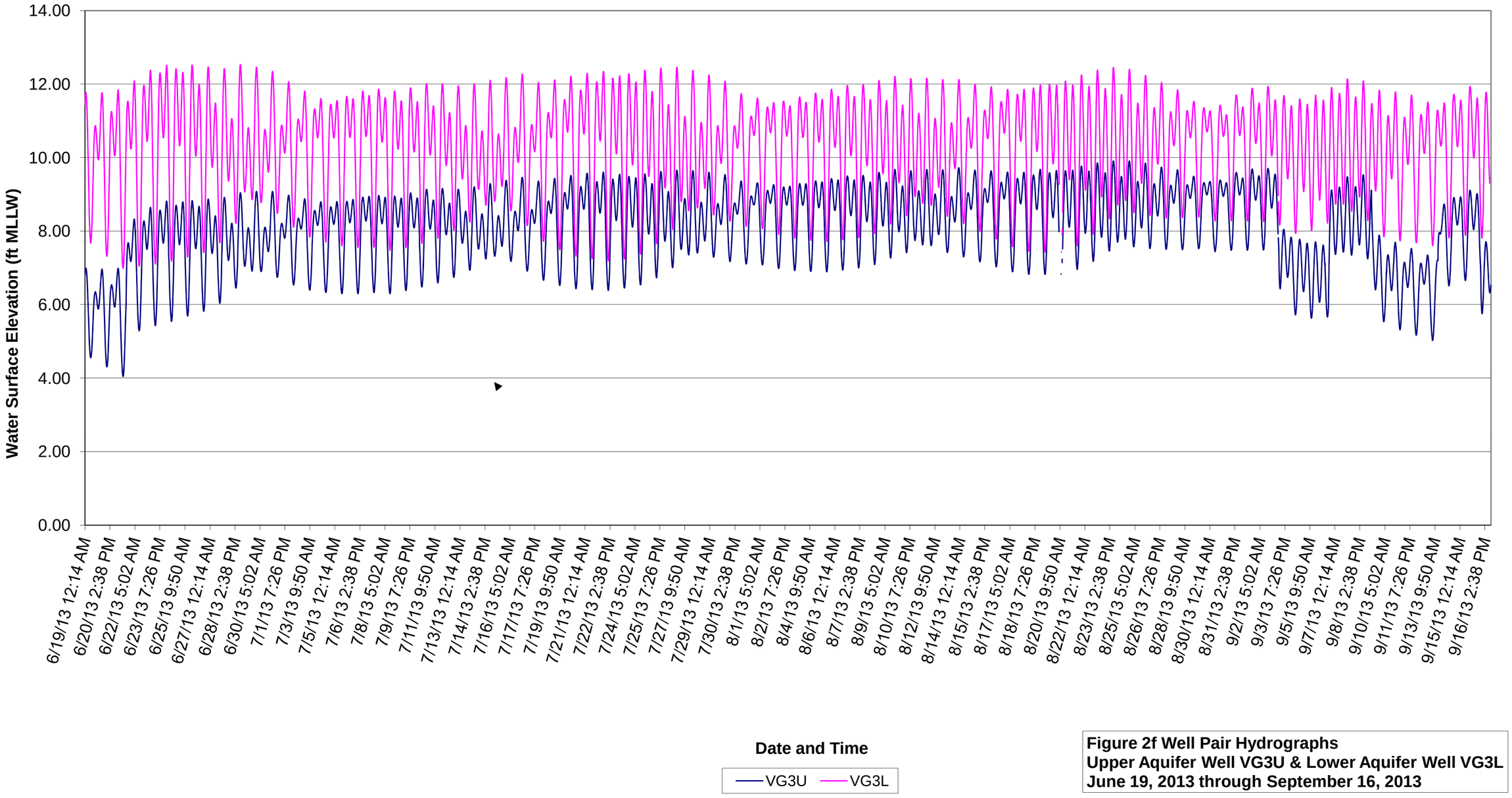


Figure 2f Well Pair Hydrographs
Upper Aquifer Well VG3U & Lower Aquifer Well VG3L
June 19, 2013 through September 16, 2013

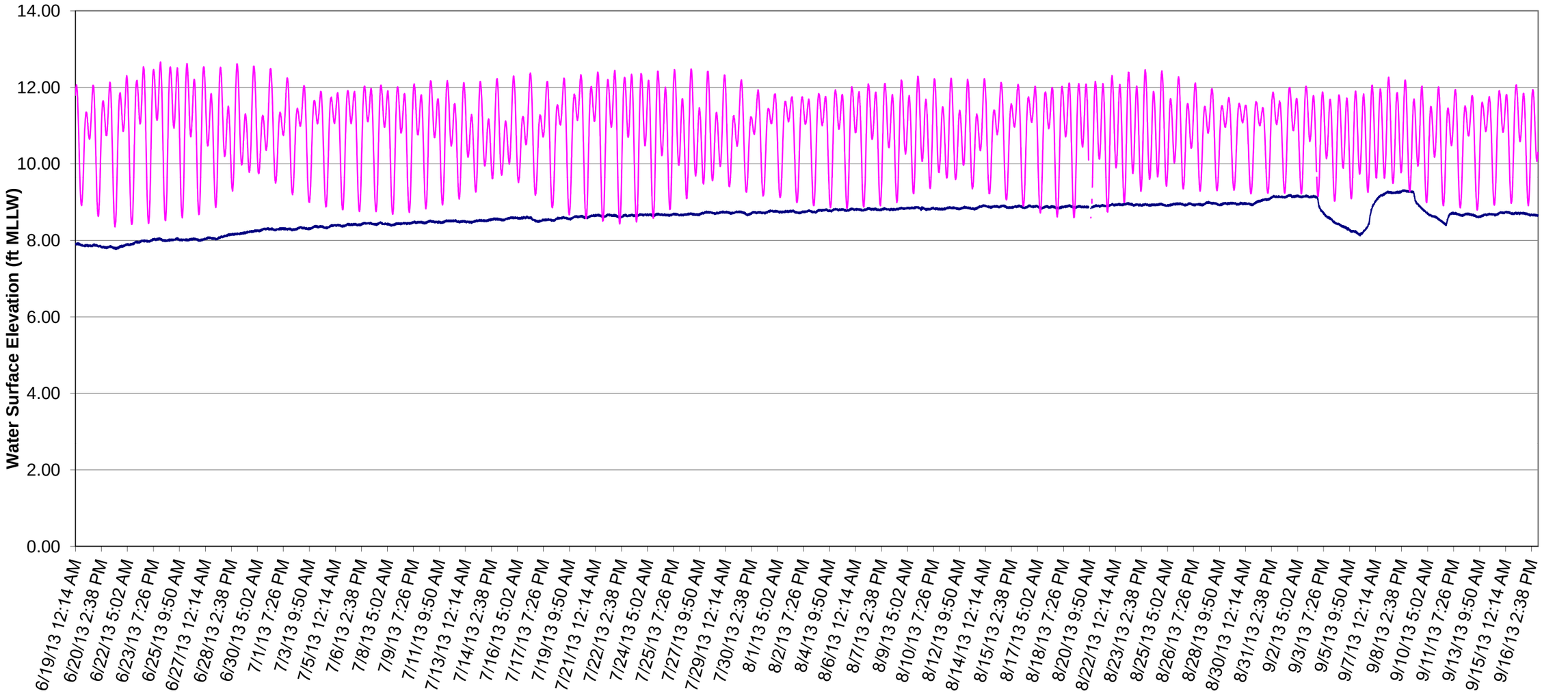


Figure 2g Well Pair Hydrographs
Upper Aquifer Well VG5U & Lower Aquifer Well VG5L
June 19, 2013 through September 16, 2013

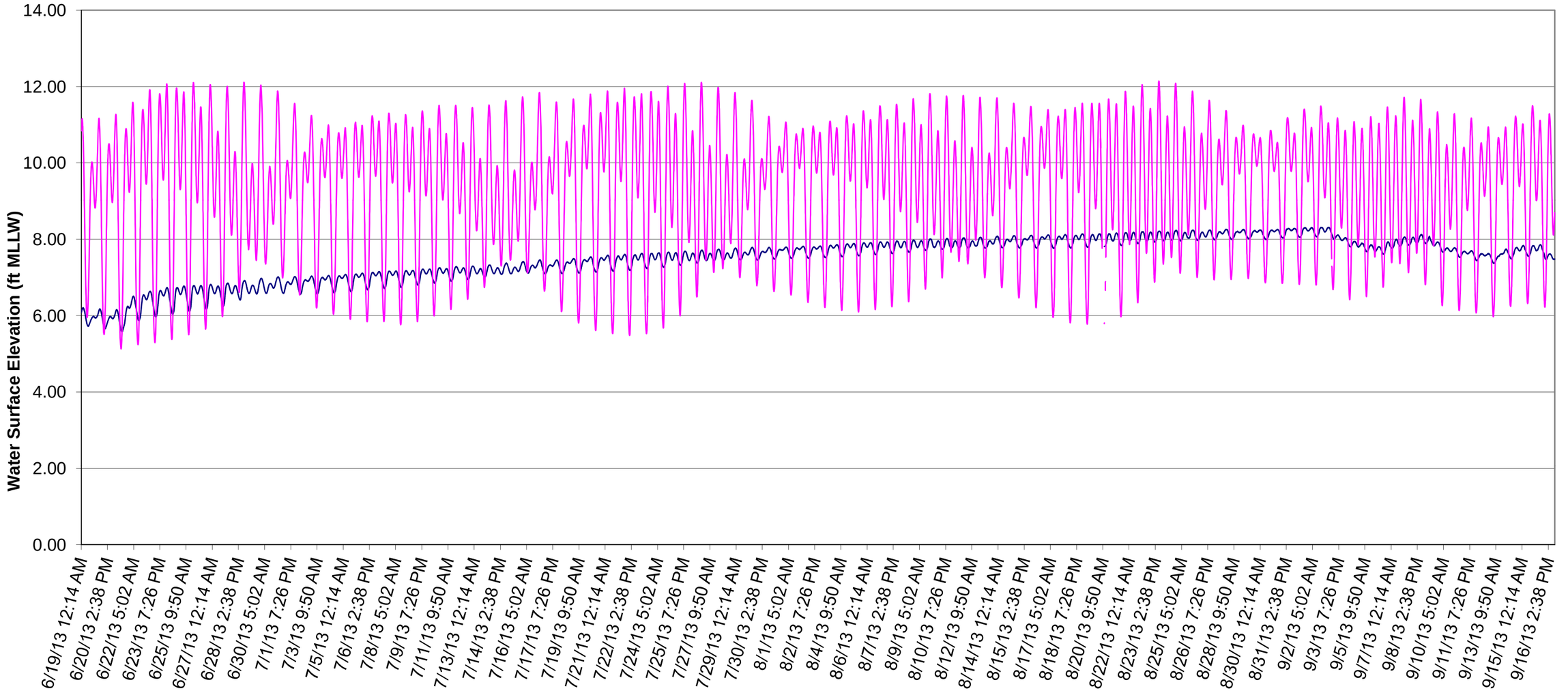


Figure 2h Well Pair Hydrographs
Upper Aquifer Well PO13 & Lower Aquifer Well VG1L
June 19, 2013 through September 16, 2013

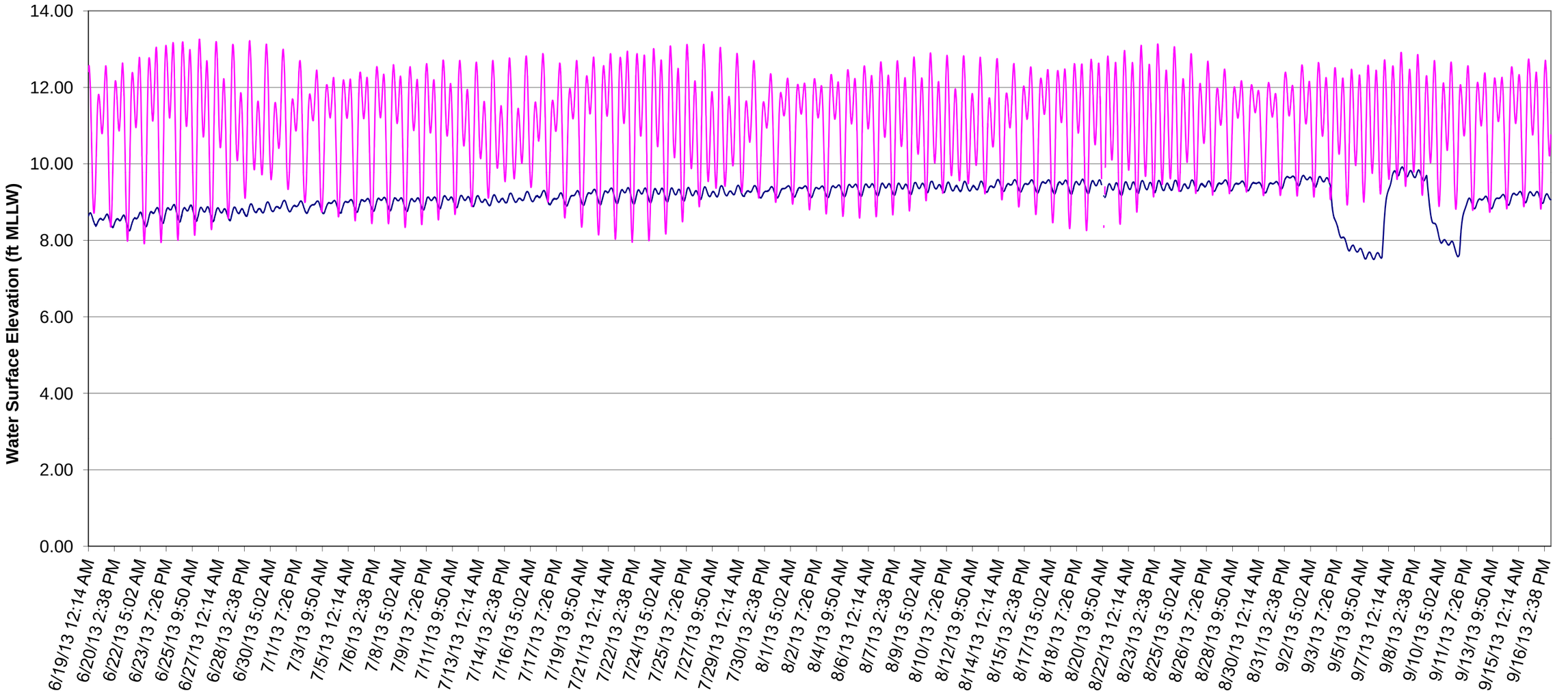


Figure 2i Well Pair Hydrographs
Upper Aquifer Well CW13 & Lower Aquifer Well VG4L
June 19, 2013 through September 16, 2013

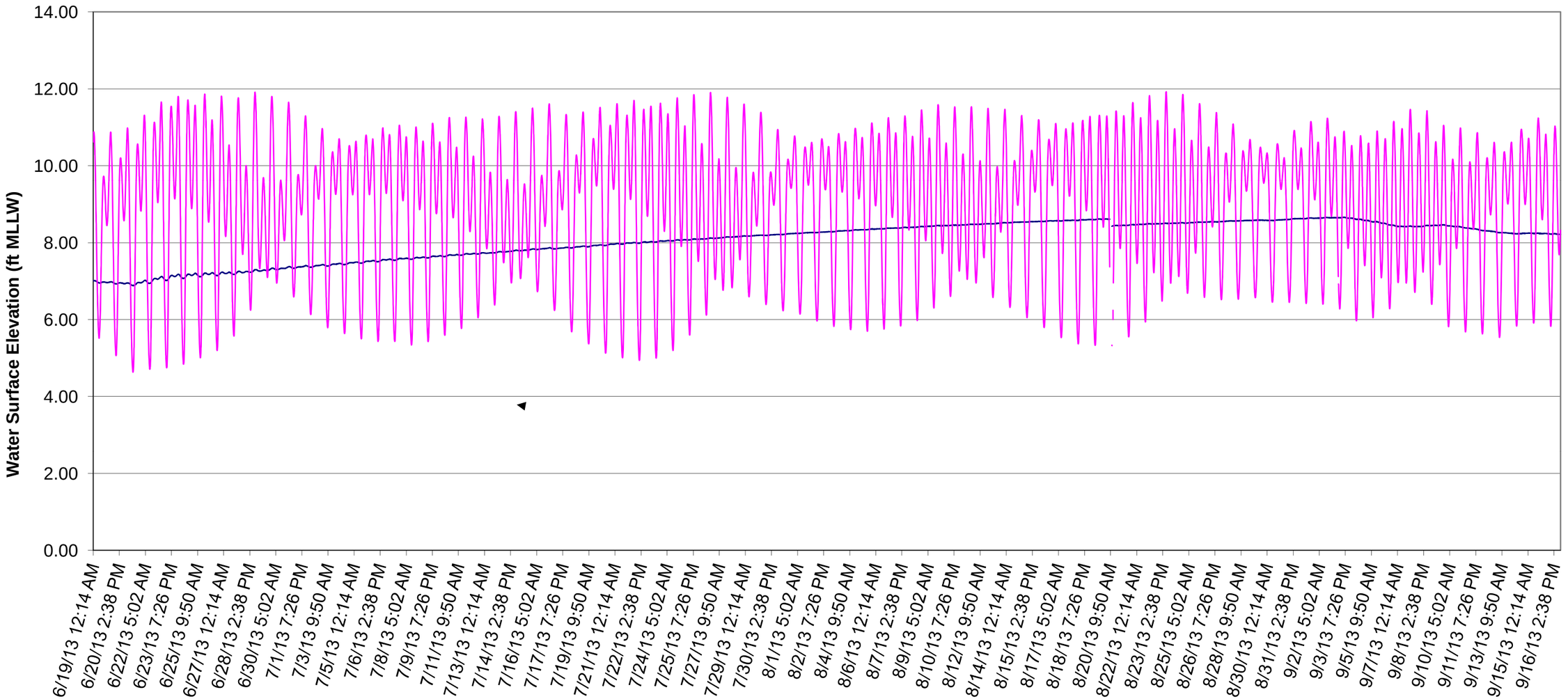


Figure 2j Well Pair Hydrographs
Upper Aquifer Well CW08 & Lower Aquifer Well P4L
June 19, 2013 through September 16, 2013

Maximum Downward Flow Potentials

MW14/CW05	8/19/2013
MW18/02CDMW01	8/19/2013
PO03/99CDMW02	8/19/2013, 8/20/2013
CW03/CW02	8/19/2013
VG2U/VG2L	none
VG3U/VG3L	none
VG5U/VG5L	8/19/2013, 8/20/2013
PO13/VG1L	8/19/2013, 8/20/2013
CW13/VG4L	7/22/2013
CW08/P4L	8/19/2013

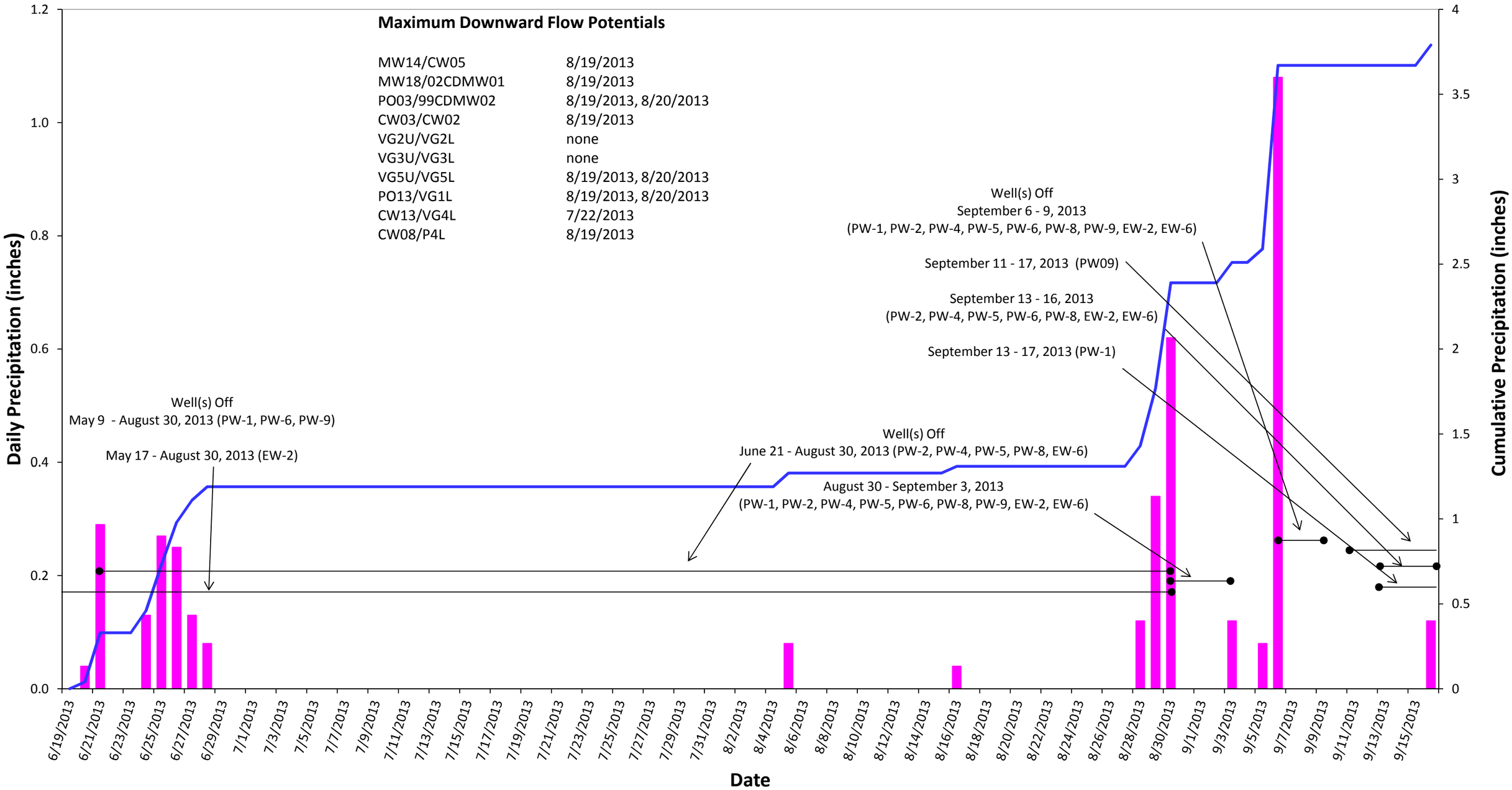


Figure 3 Wyckoff Site Precipitation, Well Field Shutdown, and Max Downward Flow Potential Summary June 19, 2013 through September 16, 2013