Evaluation of Wyckoff Groundwater Level Data December 21, 2012 through March 20, 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 December 21, 2012 through March 20, 2013.

Summary/Recommendations

- Hydraulic containment was maintained in 9 of the 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, and CW08/P-4L.
- Hydraulic containment was not maintained in well pair CW13/VG4L over the 90-day monitoring period.
- The groundwater elevation data from the transducers in the 10 well pairs should be downloaded again in June 2013 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

Water Level Data Collection

The December 21, 2012 through March 20, 2013 time period represents the next 90-day monitoring period in succession from the previous groundwater level data evaluation memorandum (September 22 through December 20, 2012). The locations of the wells are shown in Figure 1 and wells with transducers are listed in Table 1. Model 705 KPSI^{TM} Level and Pressure Transducers are installed in 22 upper aquifer wells and 18 lower aquifer wells and were recently calibrated in January 2013, during this monitoring period. Several of the transducers showed minor out-of-calibration values. The required

corrections ranged from 2 to 4 inches. The transducers were recalibrated on January 31, 2013, after discussions with the vendor.

All data are available in e-format upon request.

Table 1 – Wells with Transducers, December 21, 2012 through March 20, 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 9 of the 10 well pairs, indicating hydraulic containment is maintained at these well pair locations.
- The ratio is less than 1 in well pair CW13/VG4L, indicating that hydraulic containment was not maintained.
- 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 occur in the other eight monitoring well pairs. In three of these eight well pairs (MW18/02CDMW01, PO03/99CDMW02A, and CW03/CW02), the percent duration of the 90-day period is less than 10 percent.
- Five well pairs have a percent duration of the 90-day monitoring period greater than 10 percent (MW14/CW05, VG5U/VG5L, PO13/VG1L, CW13/VG-4L, and CW08/P4L). Two of these five wells have a percent duration exceeding 30 percent (CW13/VG4L at 33.0% and CW08/P4L at 45.1%).

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	7.46	9.62	1.29	2.16	5.52	-2.68	53	4.88	10.8	12.0%
MW18/02CDMW01	4.89	9.50	1.94	4.61	8.71	-0.70	5	3.75	0.8	0.9%
PO03/99CDMW02A	6.08	9.79	1.61	3.71	7.16	-1.72	20	4.66	3.9	4.3%
CW03/CW02	6.57	9.07	1.38	2.50	4.73	-1.52	20	6.75	3.1	3.4%
VG-2U/VG-2L	7.05	8.73	1.24	1.68	2.48	0.21	none			
VG-3U/VG-3L	5.97	10.53	1.76	4.56	6.70	0.55	none			
VG-5U/VG-5L	9.63	11.42	1.19	1.79	5.01	-2.73	46	10.50	10.86	12.1%
PO13/VG-1L	7.22	9.41	1.30	2.19	6.09	-3.28	56	14.75	11.6	12.9%
CW13/VG-4L	11.82	11.67	0.99	-0.15	3.30	-6.14	99	22.25	29.7	33.0%
CW08/P-4L	9.05	9.18	1.01	0.12	4.10	-5.29	130	19.50	40.6	45.1%

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

Treatment Plant Operations and Effects on Groundwater Flow

The treatment plant and the majority of the extraction well systems were operated 24 hours per day and 7 days per week during the 90-day monitoring period. During the monitoring period, select wells were shut down for an extended period due to low water levels or for freeze protection. 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 6,811,856 gallons during the 90-day monitoring period which equates to about 53 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
December 30, 2012 – January 2, 2013	PW-8	Shutdown for maintenance
January 10 – January 15, 2013	PW-1, PW-2, PW-4, PW-5, PW-6, PW-8, PW-9	Shutdown for severe freeze protection
January 10 – January 18, 2013	EW-2, EW-6	Shutdown for severe freeze protection
February 7 – February 22, 2013	PW-1, PW-9	Shutdown due to low water level
February 8 – February 22, 2013	PW-6	Shutdown due to low water level
February 8, 2013 --	EW-2	Shutdown due to low water level
February 23 – February 25, 2013	PW-8	Tripped off due to high pressure
February 25, 2013 --	PW-1, PW-6, PW-9	Shutdown due to low water level

During this 90-day monitoring period, there were two days where single-day precipitation amounts were greater than one inch (December 26, 2012 and January 9, 2013). The maximum downward flow potential observed in the majority of the well pairs occurred within a few days following these two events. The exception is well pair PO03/099CDMW02, where the maximum downward flow potential occurred on December 24, 2012, two days prior to the increased precipitation. All of the extraction wells were shut down for freeze protection for several days beginning on January 10, 2013, which contributed to the maximum downward flow potential observed in some of the well pairs during that time period. Water levels in the upper aquifer wells showed a moderate decline when extraction well pumping resumed several days after the January 9, 2013 rainfall event.

The gradient evaluation documented in the previous section indicates that operation of the extraction well system 24 hours per day and 7 days per week during the rainy season is capable of maintaining hydraulic containment in the majority of the monitoring well pairs during periods of increased rainfall; however, the increased precipitation coupled with subsequent shutdown due to freezing results in decreased displacement and a greater occurrence of negative gradients. The well pair with the greatest

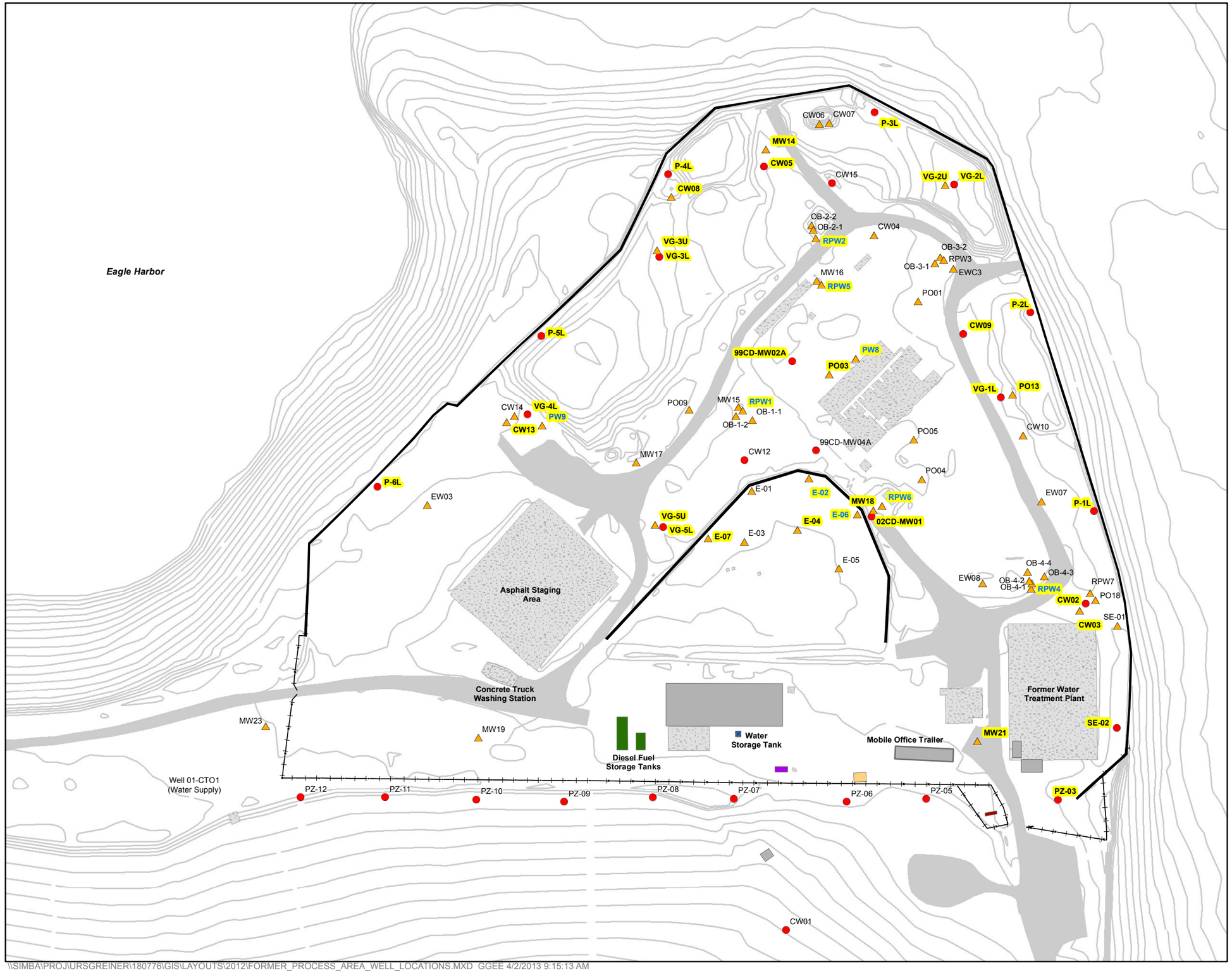
percentage of negative gradients during the 90-day monitoring period is CW08/P4L, which is located approximately 200 feet from the nearest extraction well. The well pair with the second highest percentage of negative gradients, and where loss of hydraulic containment over the monitoring period occurred, is CW13/VG4L, which is adjacent to production well PW-9. Because PW-9 has been shown to have little influence on surrounding wells (See September 2012 quarterly water level report), the increased rainfall and subsequent shutdown due to freezing had the greatest influence on hydraulic containment in the area surrounding this extraction well.

Summary and Conclusion

Hydraulic containment and the effects of treatment plant operations on groundwater flow are evaluated using groundwater level data monitored via pressure transducers installed in 22 upper aquifer wells and 18 lower aquifer wells. Results of the evaluation indicate the following:

- Hydraulic containment was maintained in 9 of the 10 well pairs for the duration of the 90-day monitoring period with 24/7 pumping of the extraction wells, when water levels and temperatures allowed.
- Because of the limited influence of PW-9 on adjacent well pair CW13/VG4L, hydraulic containment was not maintained for this well pair during the monitoring period.

Because of the limited displacement estimated at PW-9 and CW-13, discussed in the September 2012 quarterly report, as well as a history of pump cycling at PW-9 and its limited influence on nearby observation wells, additional evaluation is recommended in this area. PW-9 and surrounding monitoring wells (CW13, CW14, and VG-4L) should be video logged to observe the state of the well screens. Following review of the video logs, further recommendations may include well redevelopment (if the well screen is fouled), or alternatively aquifer pump tests in PW-9, CW13 and CW14 to evaluate well yield and relative hydraulic conductivity. The later will determine if the limited well yields at PW-9 are due low hydraulic conductivity in the area.



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

N

0 50 100 Feet

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

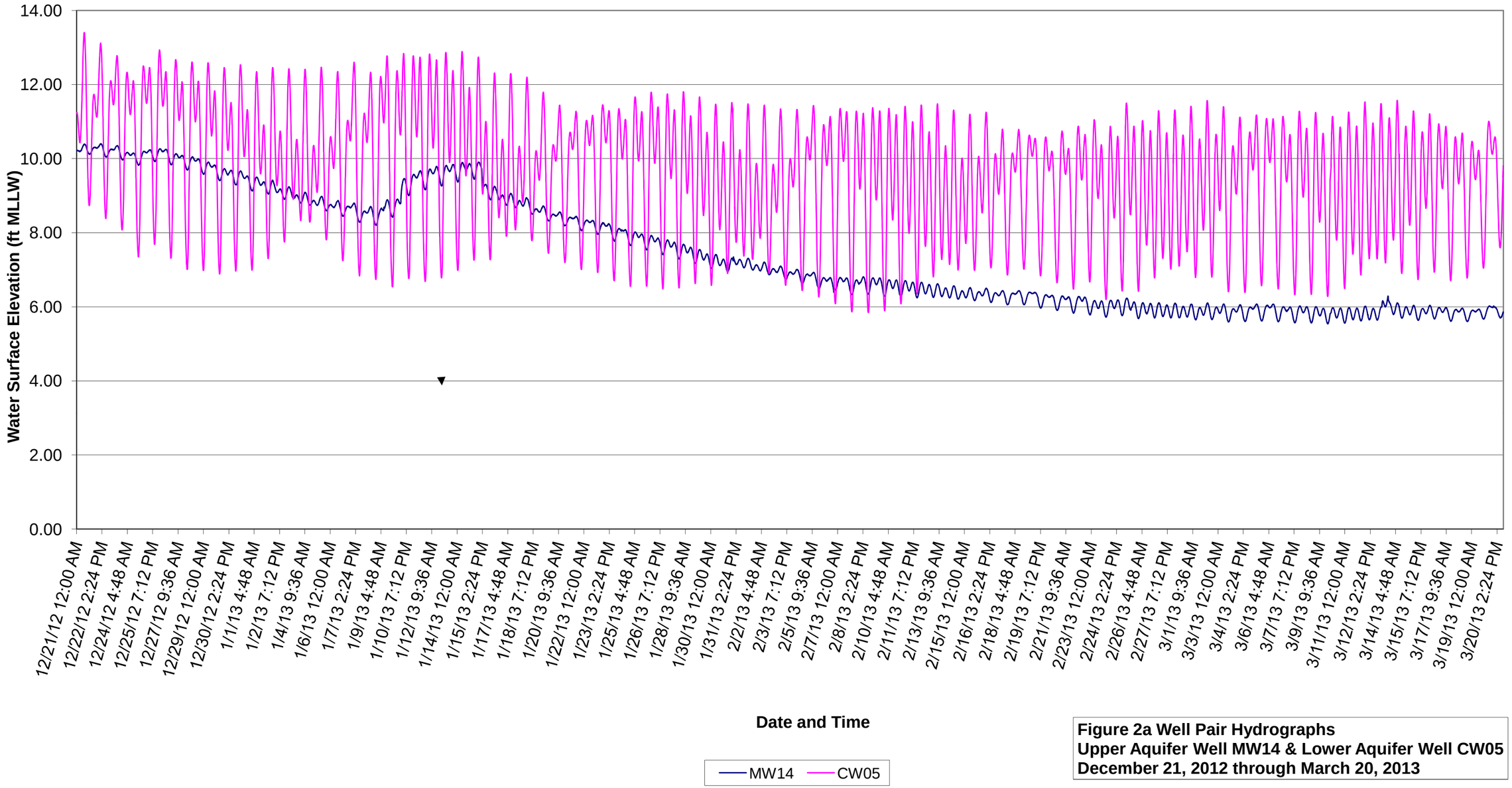


Figure 2a Well Pair Hydrographs
Upper Aquifer Well MW14 & Lower Aquifer Well CW05
December 21, 2012 through March 20, 2013

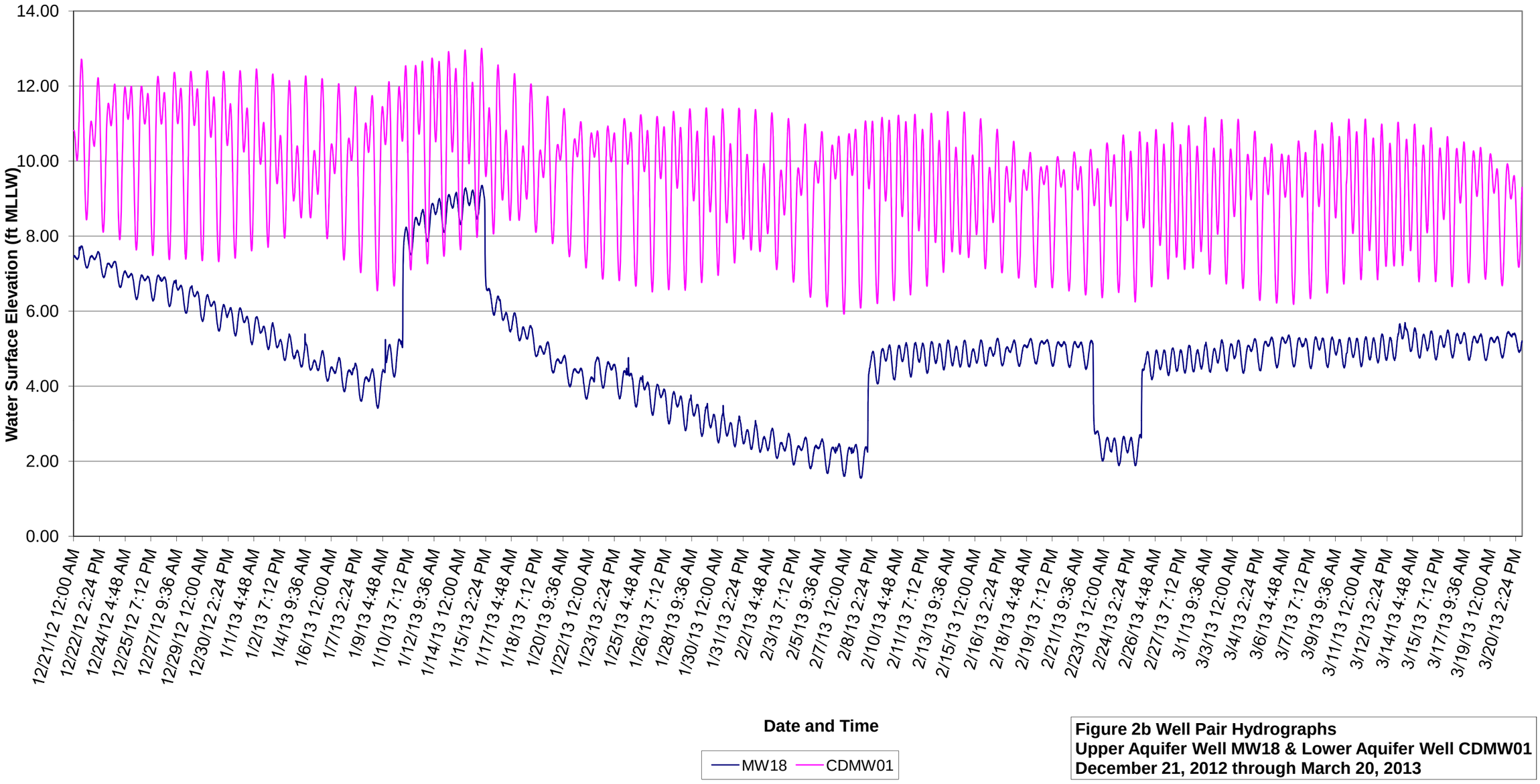


Figure 2b Well Pair Hydrographs
Upper Aquifer Well MW18 & Lower Aquifer Well CDMW01
December 21, 2012 through March 20, 2013

Figure 2c Well Pair Hydrographs
Upper Aquifer Well PO03 & Lower Aquifer Well CDMW02
December 21, 2012 through March 20, 2013

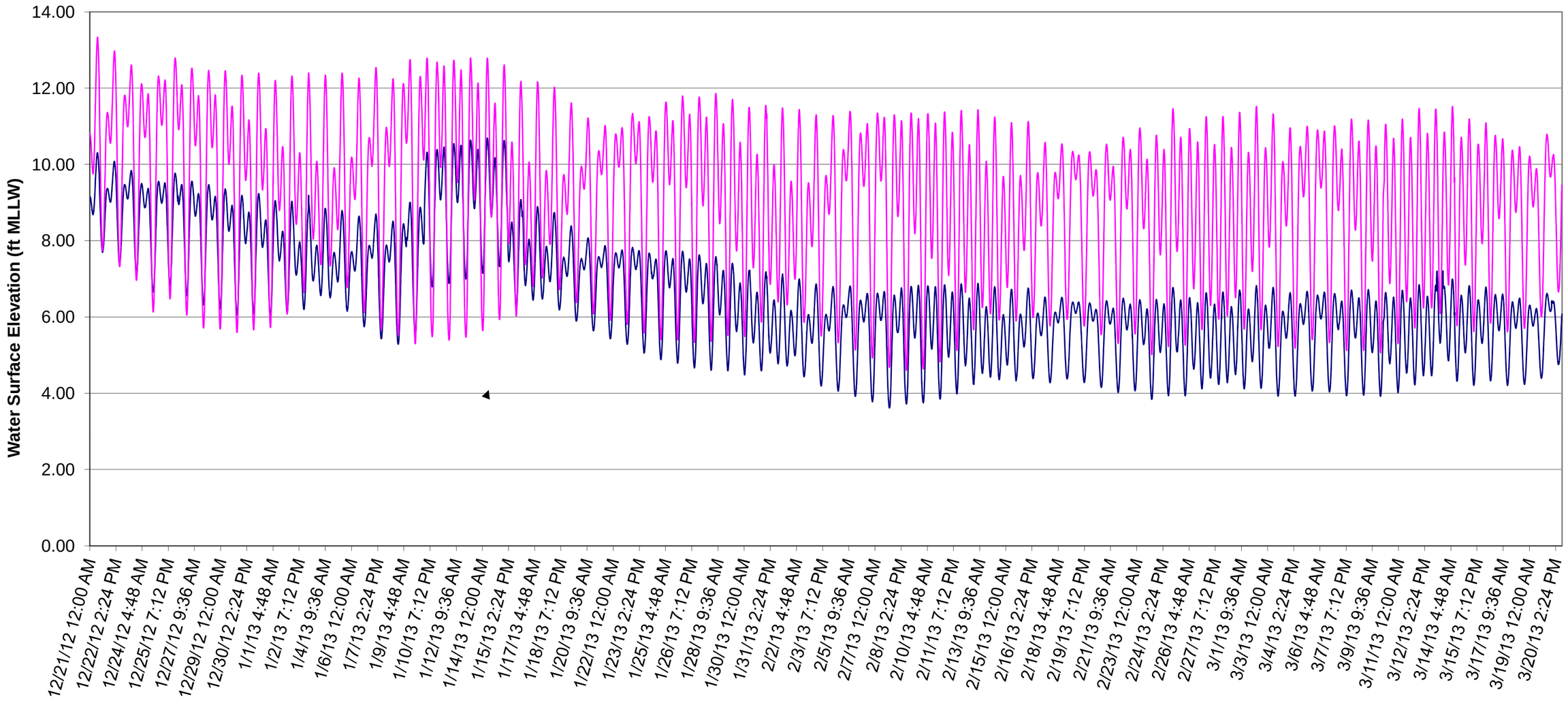


Figure 2d Well Pair Hydrographs
Upper Aquifer Well CW03 & Lower Aquifer Well CW02
December 21, 2012 through March 20, 2013

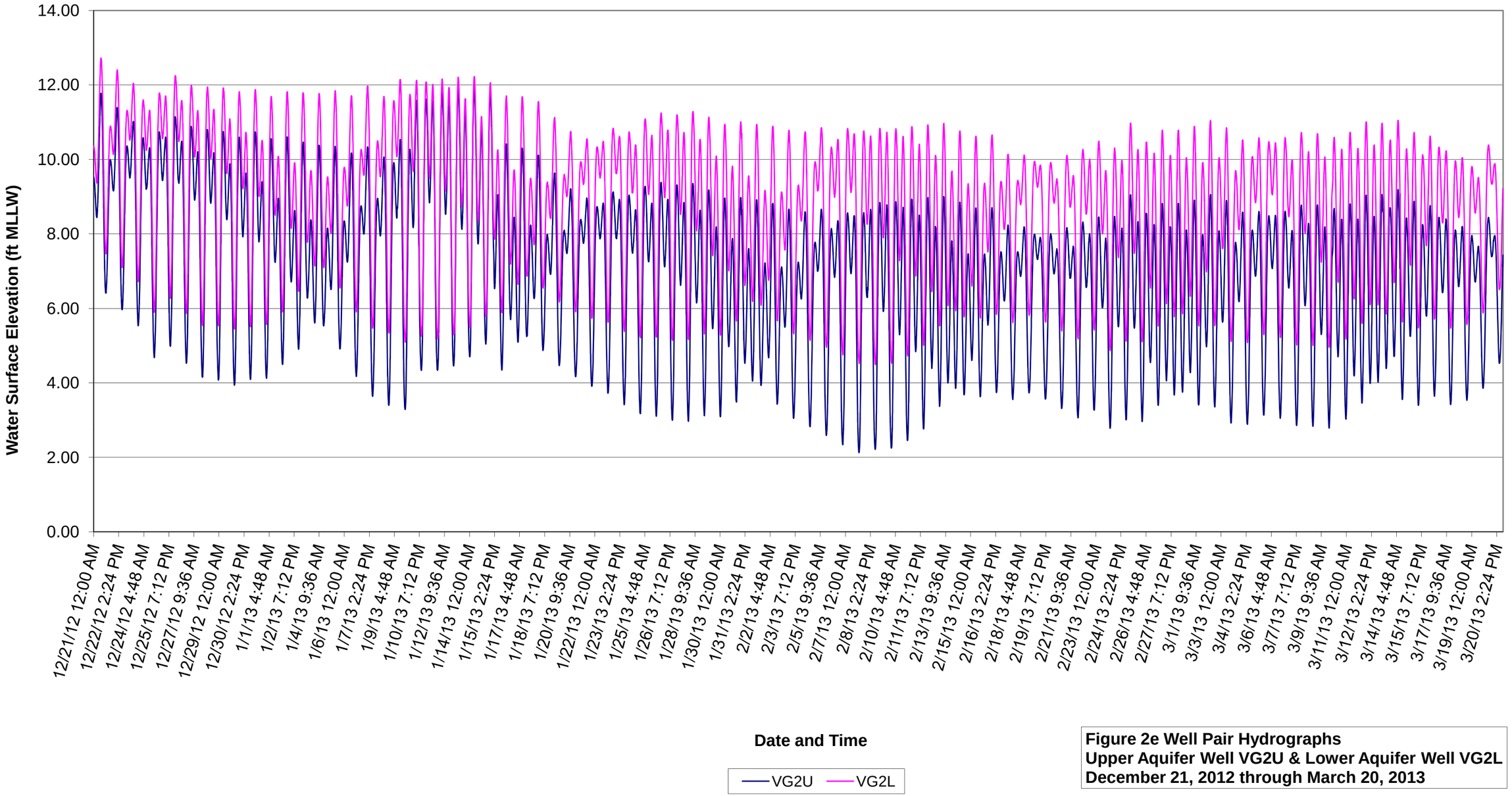


Figure 2e Well Pair Hydrographs
Upper Aquifer Well VG2U & Lower Aquifer Well VG2L
December 21, 2012 through March 20, 2013

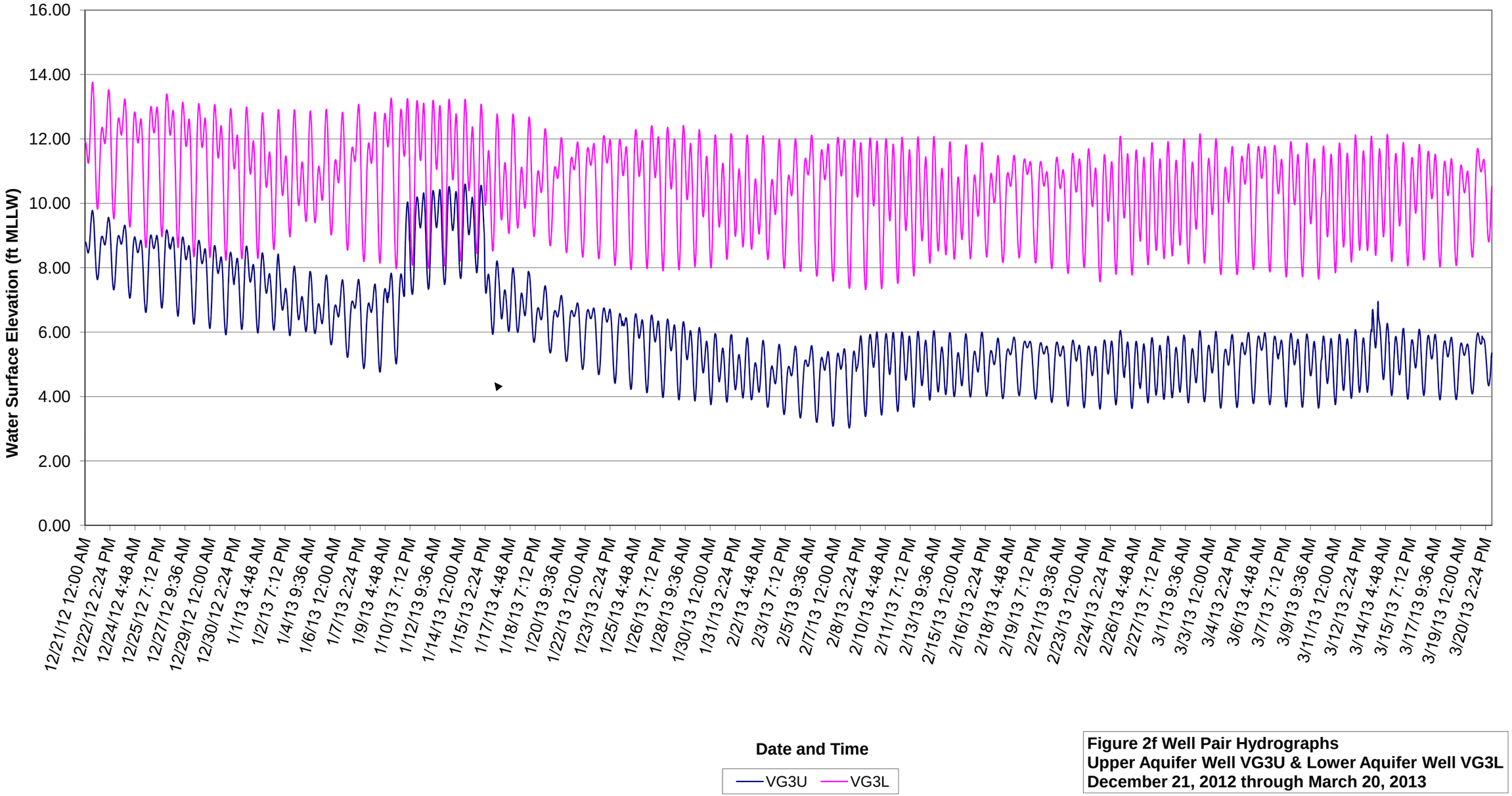


Figure 2f Well Pair Hydrographs
Upper Aquifer Well VG3U & Lower Aquifer Well VG3L
December 21, 2012 through March 20, 2013

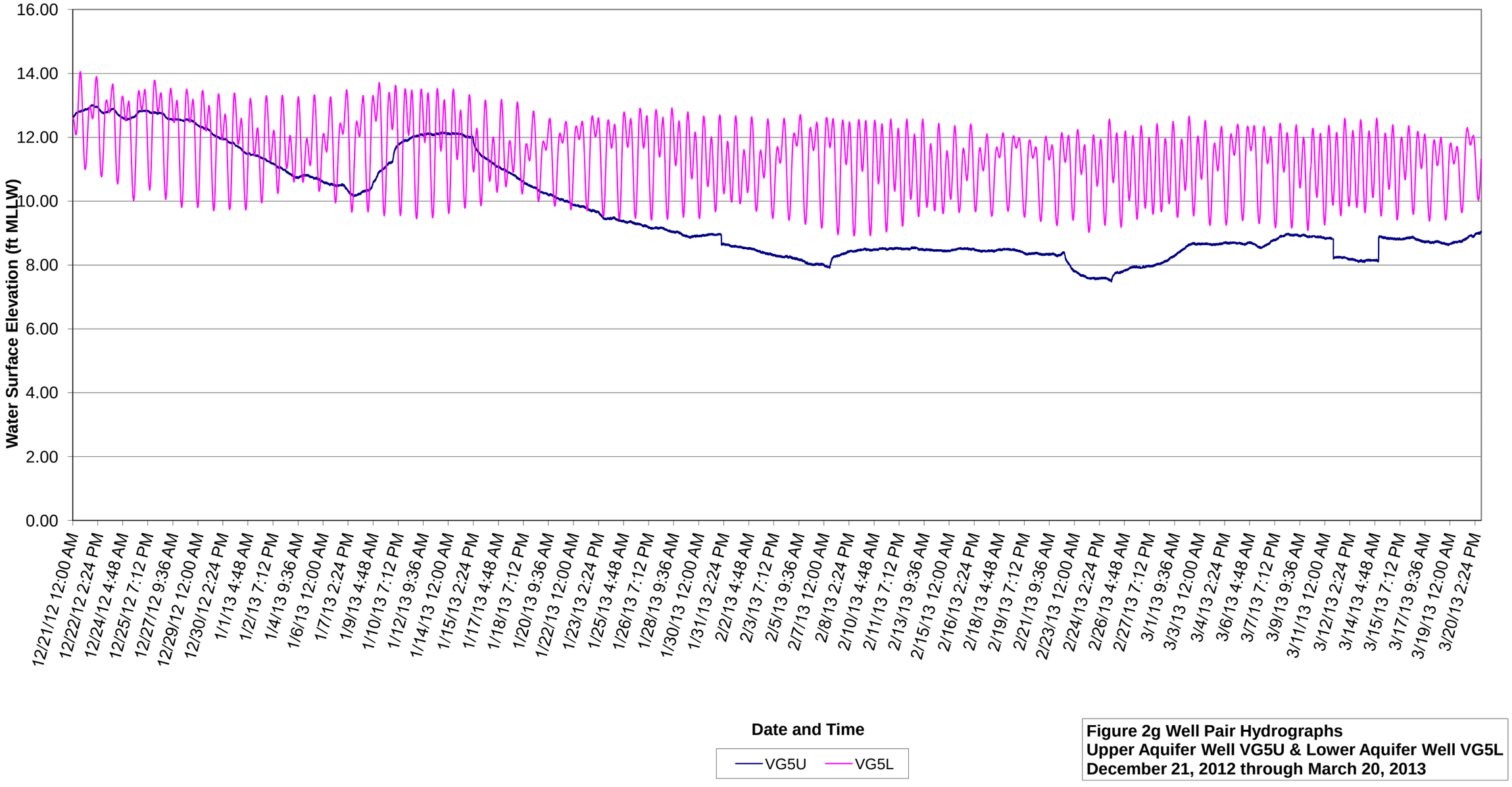


Figure 2g Well Pair Hydrographs
Upper Aquifer Well VG5U & Lower Aquifer Well VG5L
December 21, 2012 through March 20, 2013

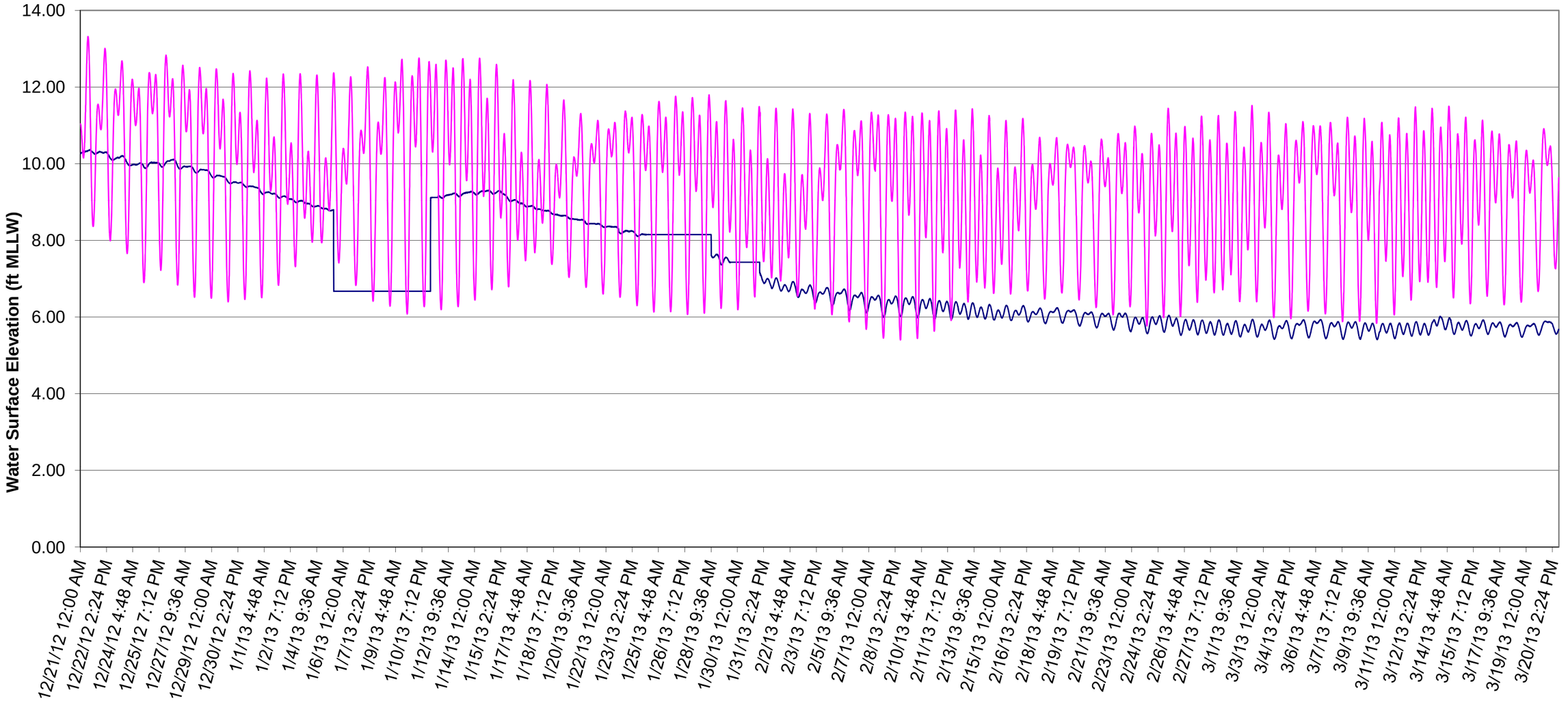


Figure 2h Well Pair Hydrographs
Upper Aquifer Well PO13 & Lower Aquifer Well VG1L
December 21, 2012 through March 20, 2013

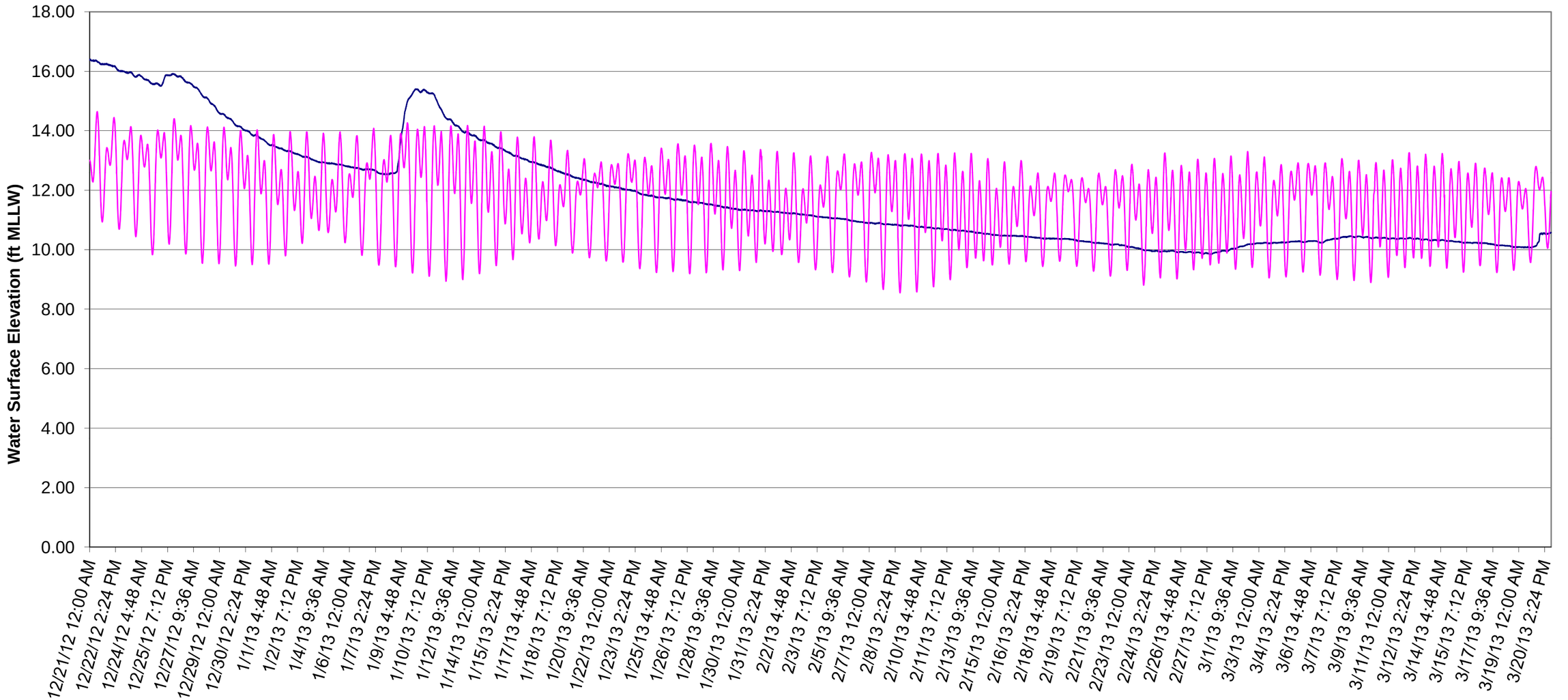


Figure 2i Well Pair Hydrographs
Upper Aquifer Well CW13 & Lower Aquifer Well VG4L
December 21, 2012 through March 20, 2013

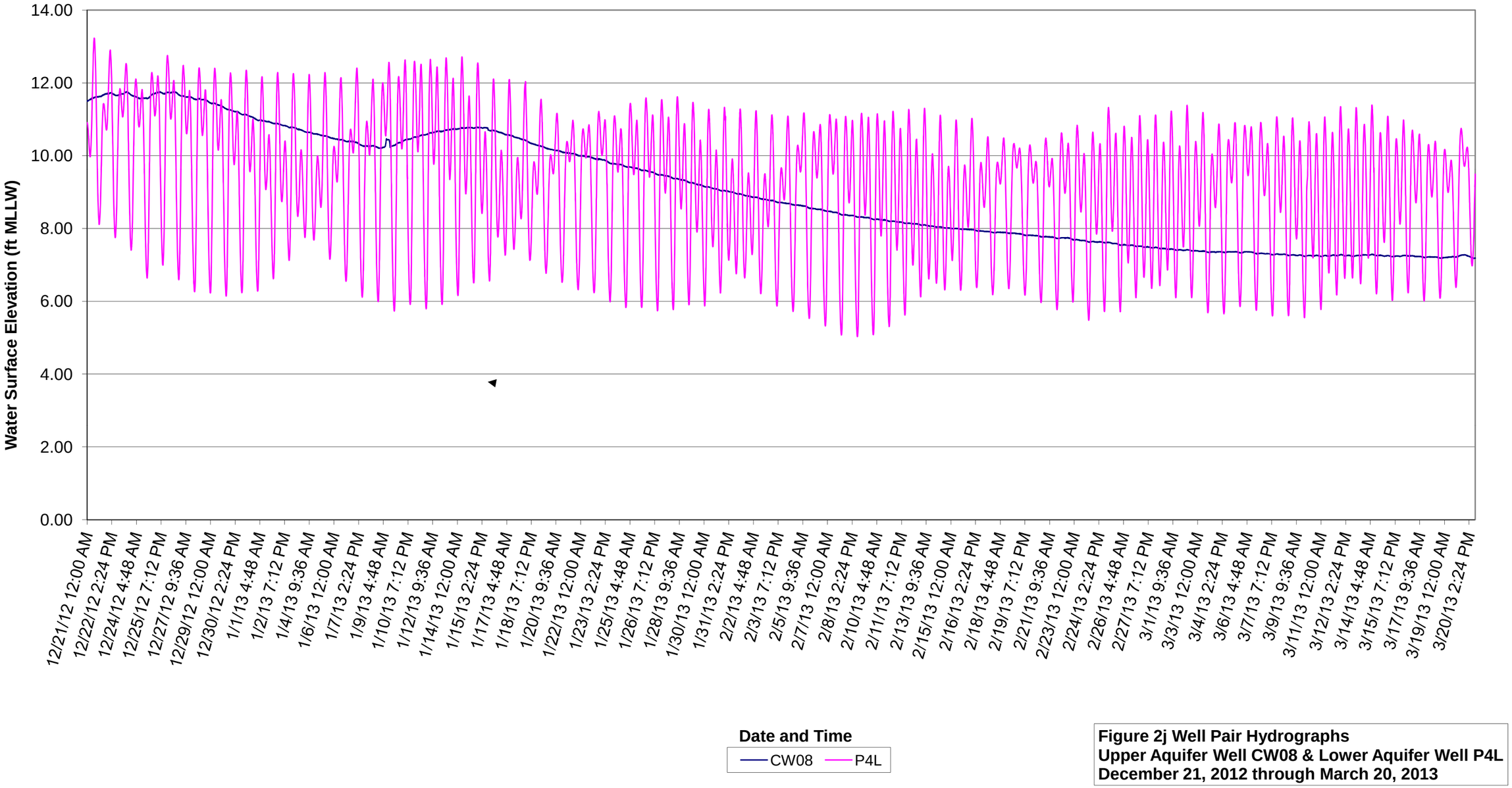


Figure 2j Well Pair Hydrographs
Upper Aquifer Well CW08 & Lower Aquifer Well P4L
December 21, 2012 through March 20, 2013

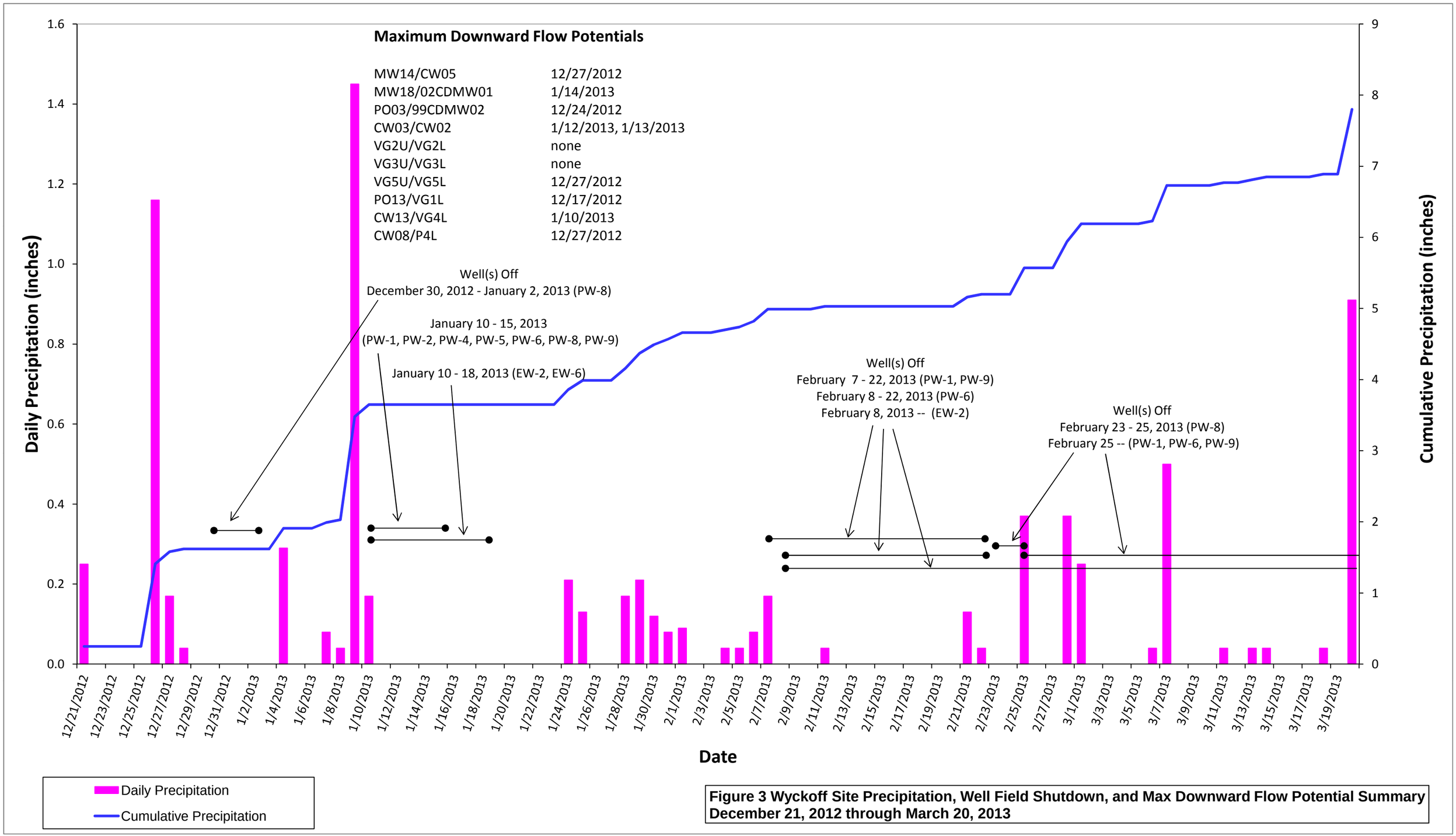


Figure 3 Wyckoff Site Precipitation, Well Field Shutdown, and Max Downward Flow Potential Summary December 21, 2012 through March 20, 2013