Evaluation of Wyckoff Groundwater Level Data March 26, 2012 through June 23, 2012

PREPARED FOR: Howard Orlean/EPA Region 10

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

COPIES Chung Yee/ Washington Dept. of Ecology
Marlowe Laubach/USACE
Stan Warner/OMI
Keith Allers/OMI
Richard Brooks/ Suquamish Tribe
Perry Barrett/ City of Bainbridge Island
Jeff Randall/CH2M HILL
Ken Scheffler/CH2M HILL
Carolyn Kossik/CH2M HILL
Krystal Perez/CH2M HILL

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This memorandum summarizes the Wyckoff groundwater level results for the 90-day monitoring period of March 26 through June 23, 2012.

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 new transducers in the 10 well pairs should be downloaded again in October 2012 to maintain a quarterly schedule consistent with the definition of hydraulic containment.

Water Level Data Collection

The March 26 through June 23, 2012 time period represents the next 90-day monitoring period in succession from the previous groundwater level data evaluation memorandum (December 27, 2011 – March 25, 2012). The locations of the wells are shown in Figure 1, wells formerly containing Leveloggers are listed in Table 1, and wells with transducers are listed in Table 1. New Model 705 KPSI™ Level and Pressure Transducers were installed in 22 upper aquifer wells and 18 lower aquifer wells in August 2011 and calibrated in September 2011 and March 2012, replacing the older Solinst Leveloggers. All data are available in e-format upon request.

Table 1 – Wells with Transducers, March 26 – June 23, 2012

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[1,2]	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.

[2] E-07 (not shown on the location map) is located west southwest of E-03

Hydraulic Containment / Isolation Discussion

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. The hydraulic containment at each well pair is evaluated in two steps. First, the average groundwater elevations of the upper and lower aquifers are calculated using the water elevation data recorded every 15 minutes during the monitoring period. Second, the average groundwater elevations are compared. If the average lower aquifer groundwater elevation is greater than that of the upper aquifer, indicating an overall net upward movement of groundwater, then hydraulic containment is demonstrated. If a well pair meets the definition of hydraulic containment, then the ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for that well pair will be greater than 1.

Hydrographs from the 10 well pairs are shown in Figures 2 through 11 for the monitoring period.

Well Pair MW14/CW05

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair MW14/CW05 (Figure 2) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.31 feet MLLW in the lower aquifer (Well CW05) and 5.57 feet MLLW in the upper aquifer (Well MW14). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair MW14/CW05 was calculated to be 1.67, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair MW14/CW05.

Well Pair MW18/02CDMW01

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair MW18/02CDMW01 (Figure 3) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.06 feet MLLW in the lower aquifer (Well 02CDMW01) and 4.47 feet MLLW in the upper aquifer (Well MW18). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair MW18/02CDMW01 was calculated to be 2.03, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair MW18/02CDMW01 .

Well Pair PO03/99CDMW02A

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair PO03/99CDMW02A (Figure 4) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.42 feet MLLW in the lower aquifer (Well 99CDMW02A) and 5.08 feet MLLW in the upper aquifer (Well PO03). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair PO03/99CDMW02A was calculated to be 1.86, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair PO03/99CDMW02A.

Well Pair CW03/CW02

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair CW03/CW02 (Figure 5) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 8.77 feet MLLW in the lower aquifer (Well CW02) and 5.80 feet MLLW in the upper aquifer (Well CW03). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW03/CW02 was calculated to be 1.51, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, there were no occurrences of downward flow potential for well pair CW03/CW02.

Well Pair VG-2U/VG-2L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair VG-2U/VG-2L (Figure 6) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 8.49 feet MLLW in the lower aquifer (Well VG-2L) and 6.73 feet MLLW in the upper aquifer (Well VG-2U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-2U/VG-2L was calculated to be 1.26, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair VG-2U/VG-2L.

Well Pair VG-3U/VG-3L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair VG-3U/VG-3L (Figure 7) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 10.28feet MLLW in the lower aquifer (Well VG-3L) and 5.27 feet MLLW in the upper aquifer (Well VG-3U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-3U/VG-3L was calculated to be 1.95, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair VG-3U/VG-3L.

Well Pair VG-5U/VG-5L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair VG-5U/VG-5L (Figure 8) shows that water levels in the lower aquifer were at all times greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 10.97 feet MLLW in the lower aquifer (Well VG-5L) and 7.90 feet MLLW in the upper aquifer (Well VG-5U). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair VG-5U/VG-5L was calculated to be 1.39, thus demonstrating hydraulic containment.

Over the 90-day period, there were no occurrences of downward flow potential for well pair VG-5U/VG-5L.

Well Pair PO13/VG-1L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair PO13/VG-1L (Figure 9) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 9.02 feet MLLW in the lower aquifer (Well VG-1L) and 5.67 feet MLLW in the upper aquifer (Well PO13). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair PO13/VG-1L was calculated to be 1.59, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 9 downward flow potential events occurred for well pair PO13/VG-1L (when upper aquifer water levels are greater than lower aquifer water levels). The sum of all downward flow potential events over the monitoring period was 15 hours and 45 minutes. The average duration of an event was approximately 1 hour and 45 minutes. The maximum duration of an event was 2 hours and 30 minutes. The average downward flow potential was calculated to be –0.15 feet (the average lower aquifer water elevation minus the average upper aquifer water elevation during the event, with negative value indicating downward flow potential). The maximum downward flow potential was calculated to be -0.38 feet and occurred on April 9, 2012 at 14:10.

Well Pair CW13/VG-4L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair CW13/VG4L (Figure 10) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 11.35 feet MLLW in the lower aquifer (Well VG-4L) and 9.33 feet MLLW in the upper aquifer (Well CW13). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW13/VG4L was calculated to be 1.22, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 50 downward flow potential events occurred for well pair CW13/VG4L (when upper aquifer water levels are greater than lower aquifer water levels). The sum of all downward gradient events over the monitoring period was 283 hours and 15 minutes (approximately 12 days). The average duration of an event was approximately 5 hours and 39 minutes. The maximum duration of an event was 19 hours and 45 minutes. The average downward flow potential was calculated to be –1.01 feet (the average lower aquifer water elevation minus the average upper aquifer water elevation during the event, with negative value indicating downward flow potential). The maximum downward flow potential was calculated to be -2.92 feet and occurred on April 1, 2012 at 19:31.

Well Pair CW08/P-4L

90-Day Monitoring Period (March 26, 2012 through June 23, 2012)

The hydrograph for well pair CW08/P-4L (Figure 11) shows that water levels in the lower aquifer were on average greater than the water levels in the upper aquifer, thus meeting the definition of hydraulic containment.

During the monitoring period, the average groundwater elevation was calculated to be 8.85 feet MLLW in the lower aquifer (Well P-4L) and 6.87 feet MLLW in the upper aquifer (Well CW08). The ratio of the average lower aquifer water elevation to the average upper aquifer water elevation for well pair CW08/P-4L was calculated to be 1.29, thus demonstrating hydraulic containment.

Over the 90-day monitoring period, 84 downward flow potential events occurred for well pair CW08/P-4L (when upper aquifer water levels are greater than lower aquifer water levels). The sum of all downward gradient events over the monitoring period was 356 hours and 30 minutes (approximately 15 days). The average duration of an event was approximately 4 hours and 14 minutes. The maximum duration of an event was 6 hours and 15 minutes. The average downward flow potential was calculated to be -0.84 feet (the average lower aquifer water elevation minus the average upper aquifer water

elevation during the event, with negative value indicating downward flow potential). The maximum downward flow potential was calculated to be –2.46 feet and occurred on April 9, 2012 at 14:40.

Treatment Plant Operations and Precipitation Effects on Vertical Gradients

During the March 26, 2012 through June 23, 2012 monitoring period, Former Process Area (FPA) groundwater extraction well pumps were periodically shut down due to pump maintenance and low water level. Shut downs of the extraction well pumps that occurred for periods of one day or longer (as noted in CH2M HILL operation records) are listed in Table 3. These periods are graphically overlaid with the precipitation records and are shown in Figure 12.

The treatment plant and extraction well systems were operated 24 hours per day and 7 days per week during the monitoring period, with the exception of the dates listed in Table 3, when several extraction wells were shut down for periods greater than 24 hours. The total volume of water pumped was 5,441,652 gallons during the 90-day monitoring period which equates to about 42 gpm over the entire period including all down time regardless of cause. [Note, when fully operating, the system can pump about 57 to 60 gpm.]

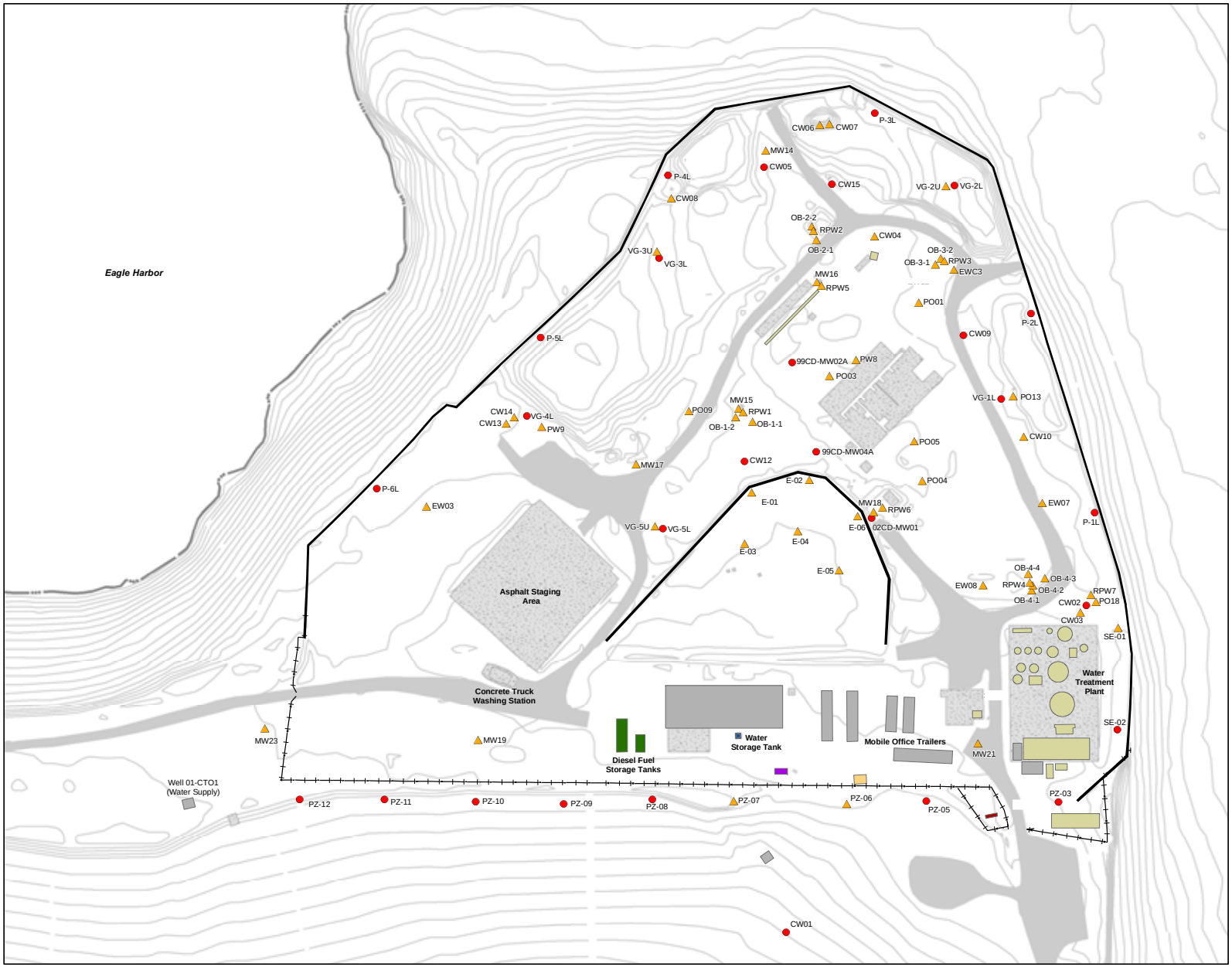
Table 3 – Former Process Area (FPA) Extraction Well Pump Shut down Periods Greater than 1 Day

Date	Wells Shut Down	Reason
April 11 – April 16, 2012	PW-9	Shutdown due to low water level
April 23, 2012 --	PW-6	Shutdown due to low water level
April 23 – April 26, 2012	PW-9	Shutdown due to low water level
April 26 – May 2, 2012	PW-9	Shutdown due to pump maintenance and low water level
April 27, 2012 --	PW-1, EW-2	Shutdown due to low water level
May 4 – May 10, 2012	PW-9	Shutdown due to low water level
May 11 – May 14, 2012	PW-9	Shutdown due to pump maintenance and low water level
May 15 – June 4, 2012	PW-9	Shutdown due to low water level
June 5 – June 11, 2012	PW-9	Shutdown due to low water level
June 11 – 13, 2012	PW-9	Shutdown due to low water level
June 13 – 18, 2012	PW-9	Shutdown due to low water level
June 18 – June 26, 2012	PW-9	Shutdown due to low water level

During the March 26, 2012 through June 23, 2012 monitoring period, downward flow potentials were associated with precipitation events and treatment plant and extraction well system shut downs. Figure 12 shows the cumulative precipitation of 7.85 inches at the site for the monitoring period, with the heaviest precipitation occurring in March and April. Downward flow potentials were observed in 3 of the monitored well pairs during the monitoring period. The maximum downward flow potential observed for 1 of the 3 well pairs, CW13/VG4L, occurred on April 1, 2012, 2 days after 0.91 inches of precipitation

on March 30, 2012, the date of the greatest single-day precipitation during the monitoring period. The maximum downward flow potential observed for the remaining 2 well pairs, PO13/VG1L and CW08/P4L, occurred on April 9, 2012, 7 days after the heavy precipitation on March 30, 2012, and following 1.95 inches of cumulative precipitation from March 30 through April 6, 2012. All of the extraction well pumps were in operation during and following the heavy precipitation event on March 30, 2012. The first extraction well pump shutdown during the monitoring period began after the period of increased precipitation, on April 11, 2012.

All of the upper aquifer hydrographs show a rise in groundwater levels following the 0.91-inch precipitation event on March 30, 2012, and during 1.95 inches of cumulative precipitation from March 30 through April 6, 2012. However, with the extraction and treatment system operating 24/7 for the majority of the monitoring period, the water levels in all of the upper aquifer wells were maintained at levels lower than those in lower aquifer wells for the majority of the monitoring period. This demonstrates that maximizing upper aquifer "recharge storage potential" by keeping the extraction operations at full capacity before and during the wet season allows hydraulic containment to be maintained when the heavy rains begin in the late fall through spring.



Lower Aquifer Well
Upper Aquifer Well
Fence
Sheetpile Wall
Roads
Buildings
Concrete Slab
Structures

N

0 50 100 200 Feet

FIGURE 1

Former Process Area Well Locations

WYCKOFF/EAGLE HARBOR SUPERFUND SITE

File Path: \\bianca\proj\URSGreiner\180776\GIS\Layouts\Former_Process_Area_Well_Locations_v2.mxd, Date: February 12, 2009

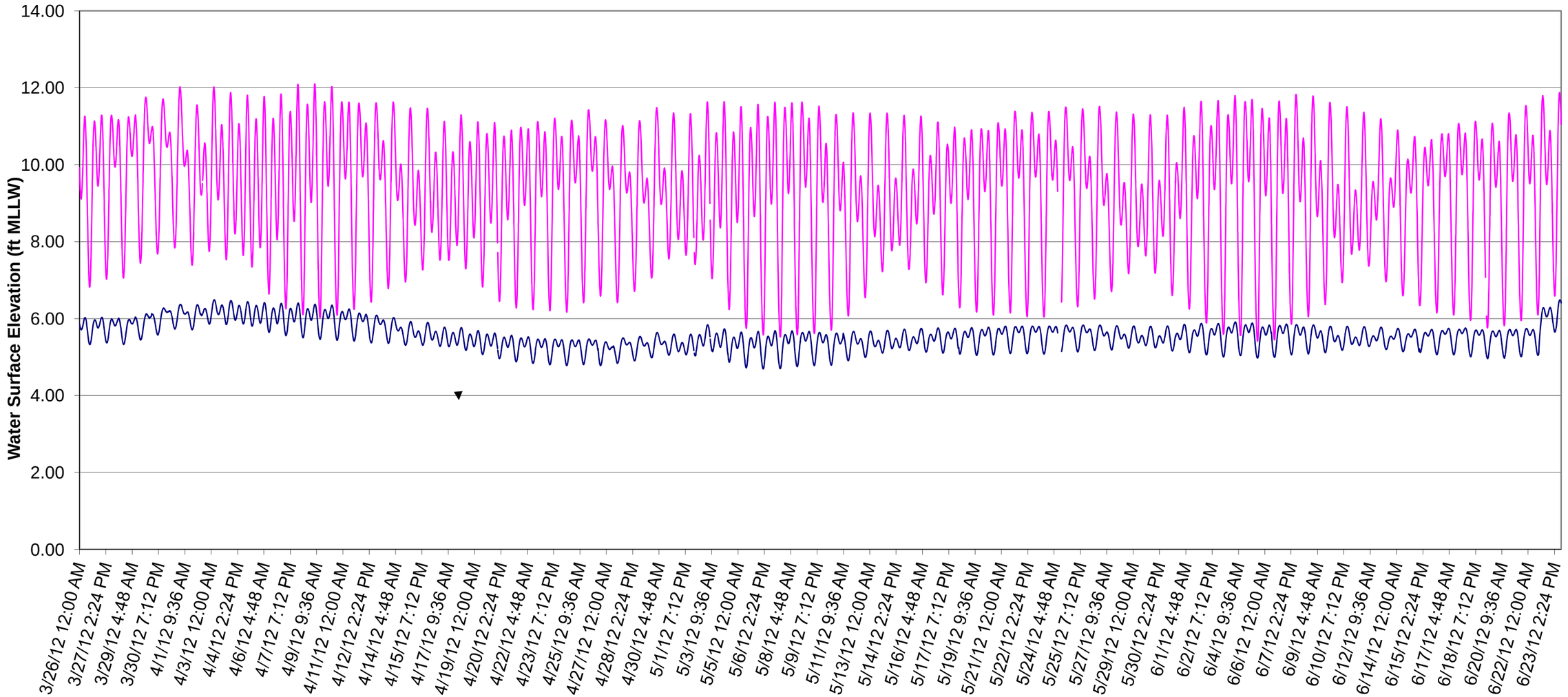


Figure 2 Well Pair Hydrographs
Upper Aquifer Well MW14 & Lower Aquifer Well CW05
March 26, 2012 - June 23, 2012

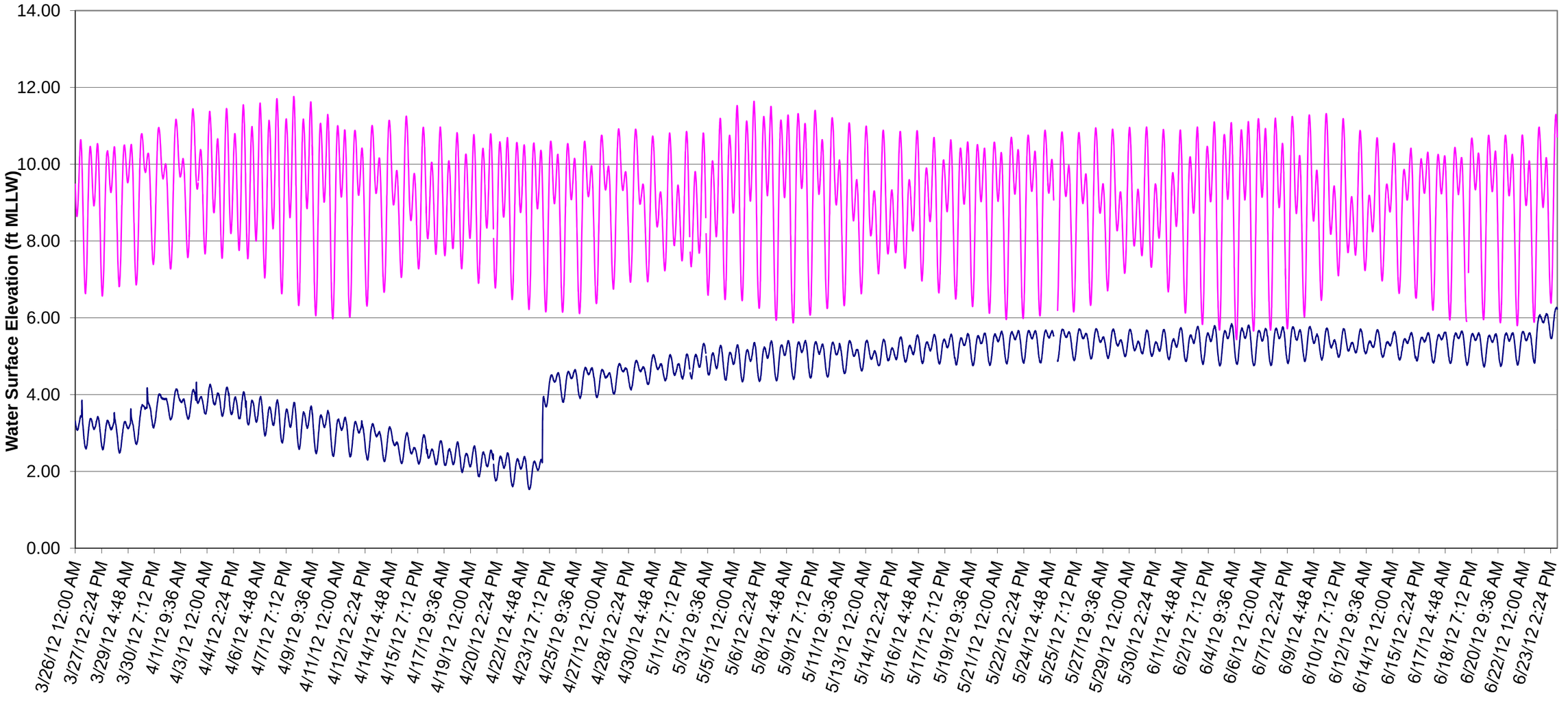


Figure 3 Well Pair Hydrographs
Upper Aquifer Well MW18 & Lower Aquifer Well CDMW01
March 26, 2012 - June 23, 2012

Figure 4 Well Pair Hydrographs
Upper Aquifer Well PO03 & Lower Aquifer Well CDMW02
March 26, 2012 - June 23, 2012

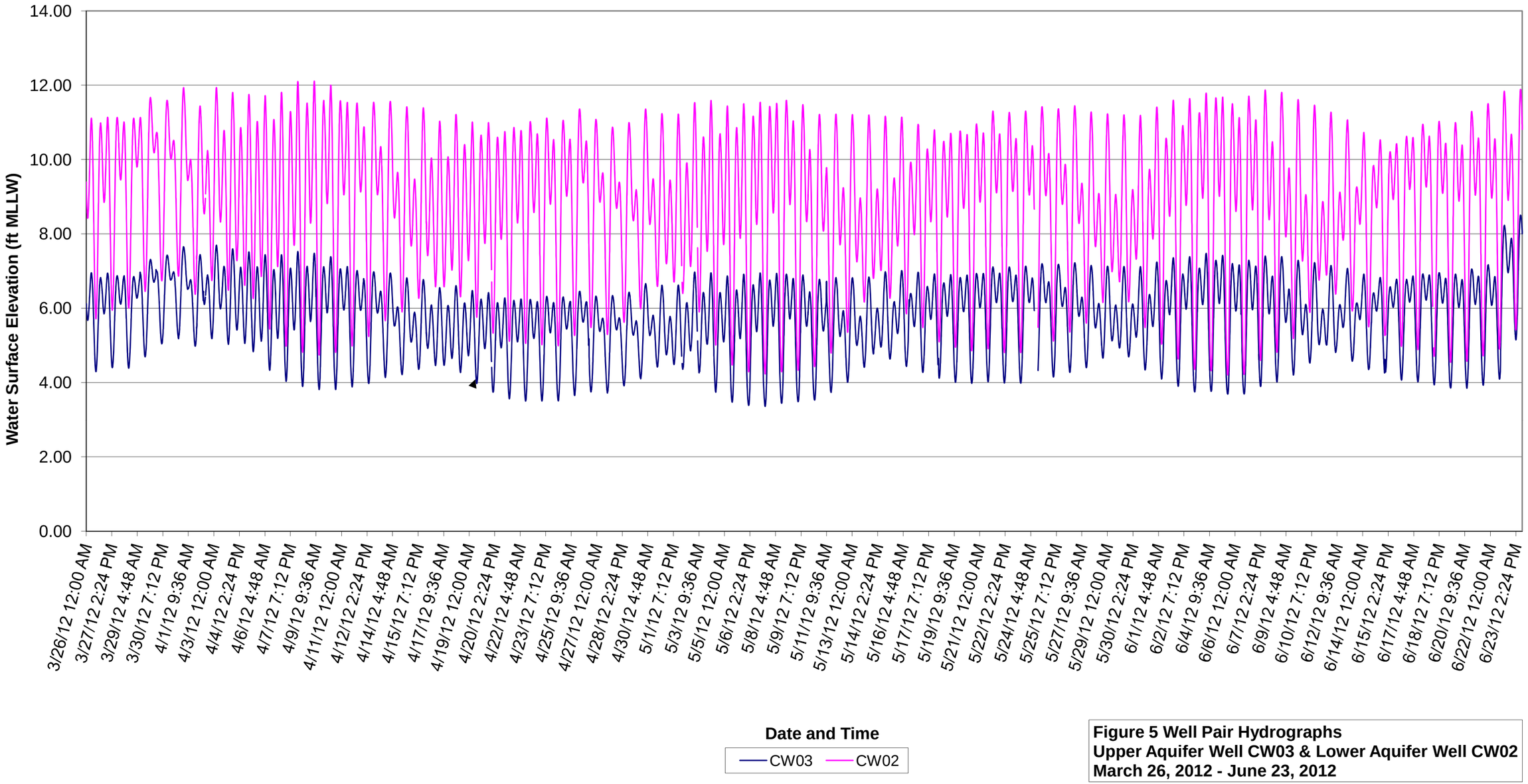


Figure 5 Well Pair Hydrographs
Upper Aquifer Well CW03 & Lower Aquifer Well CW02
March 26, 2012 - June 23, 2012

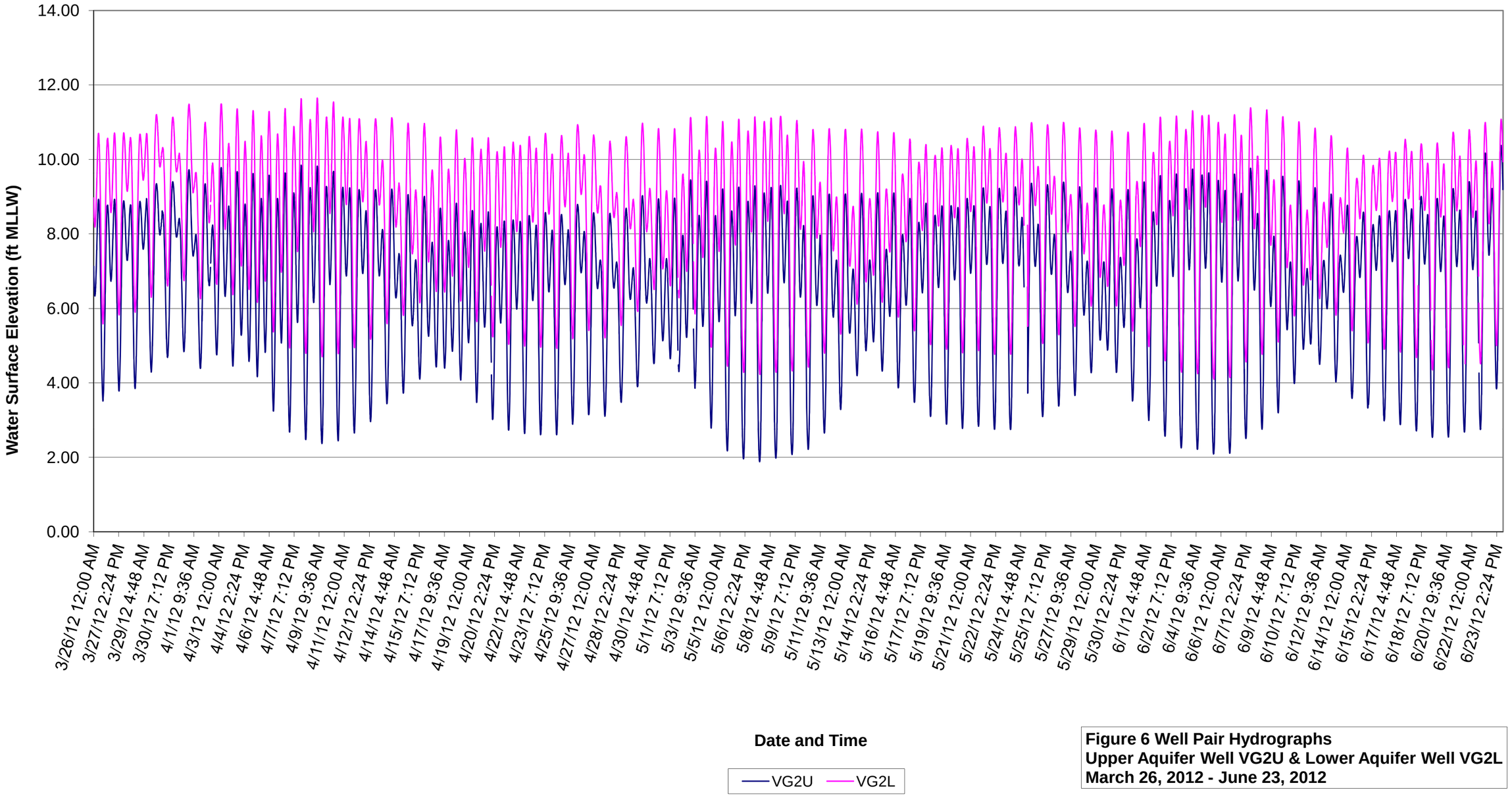


Figure 6 Well Pair Hydrographs
Upper Aquifer Well VG2U & Lower Aquifer Well VG2L
March 26, 2012 - June 23, 2012

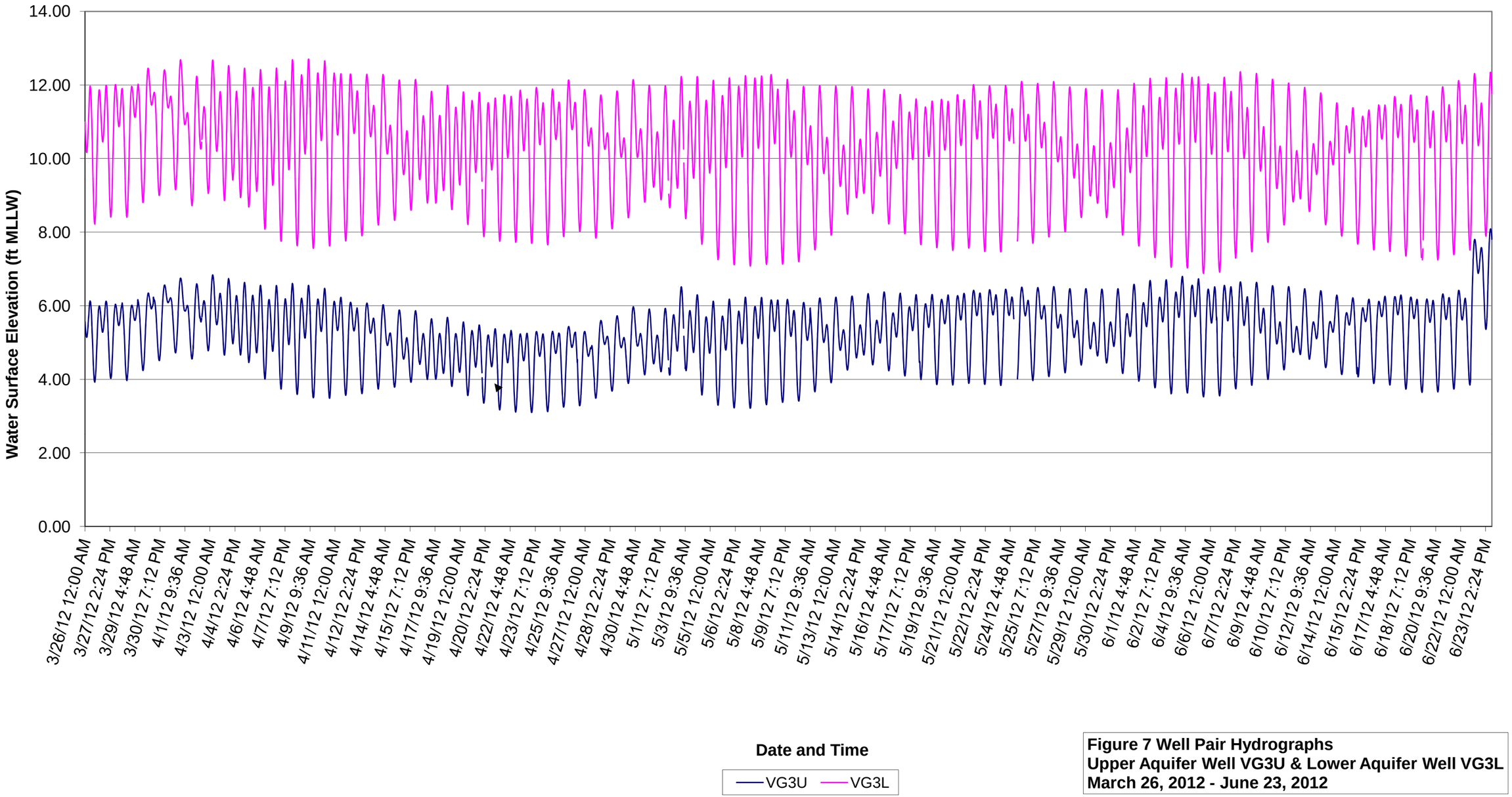


Figure 7 Well Pair Hydrographs
Upper Aquifer Well VG3U & Lower Aquifer Well VG3L
March 26, 2012 - June 23, 2012

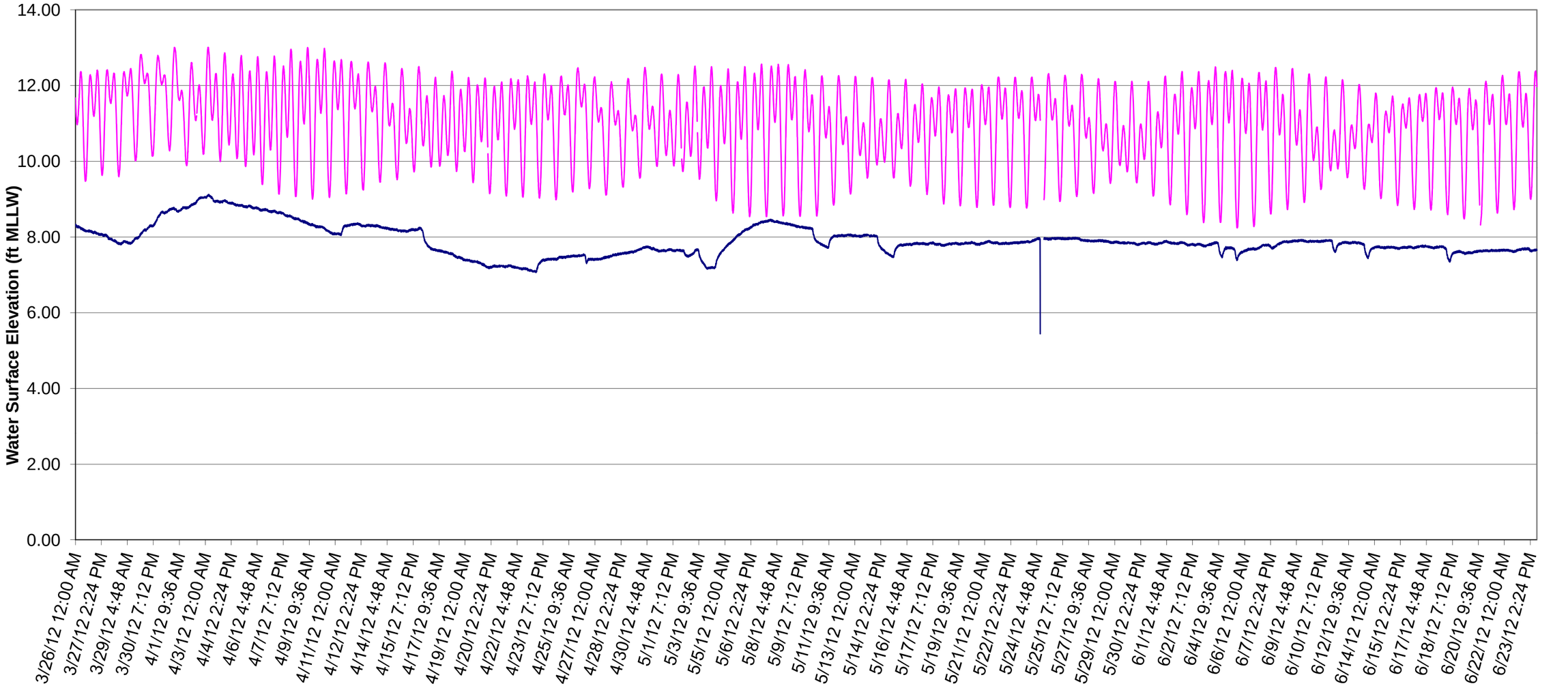


Figure 8 Well Pair Hydrographs
Upper Aquifer Well VG5U & Lower Aquifer Well VG5L
March 26, 2012 - June 23, 2012

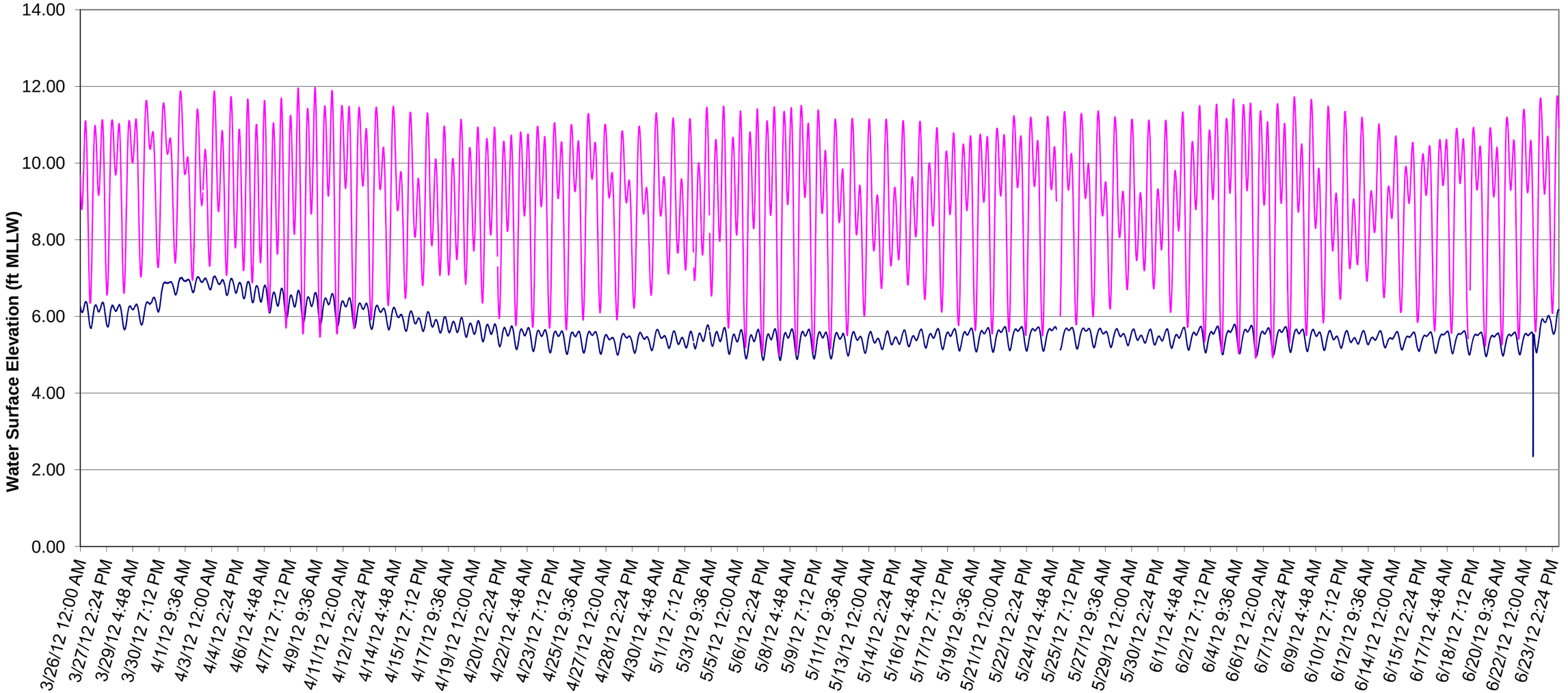


Figure 9 Well Pair Hydrographs
Upper Aquifer Well PO13 & Lower Aquifer Well VG1L
March 26, 2012 - June 23, 2012

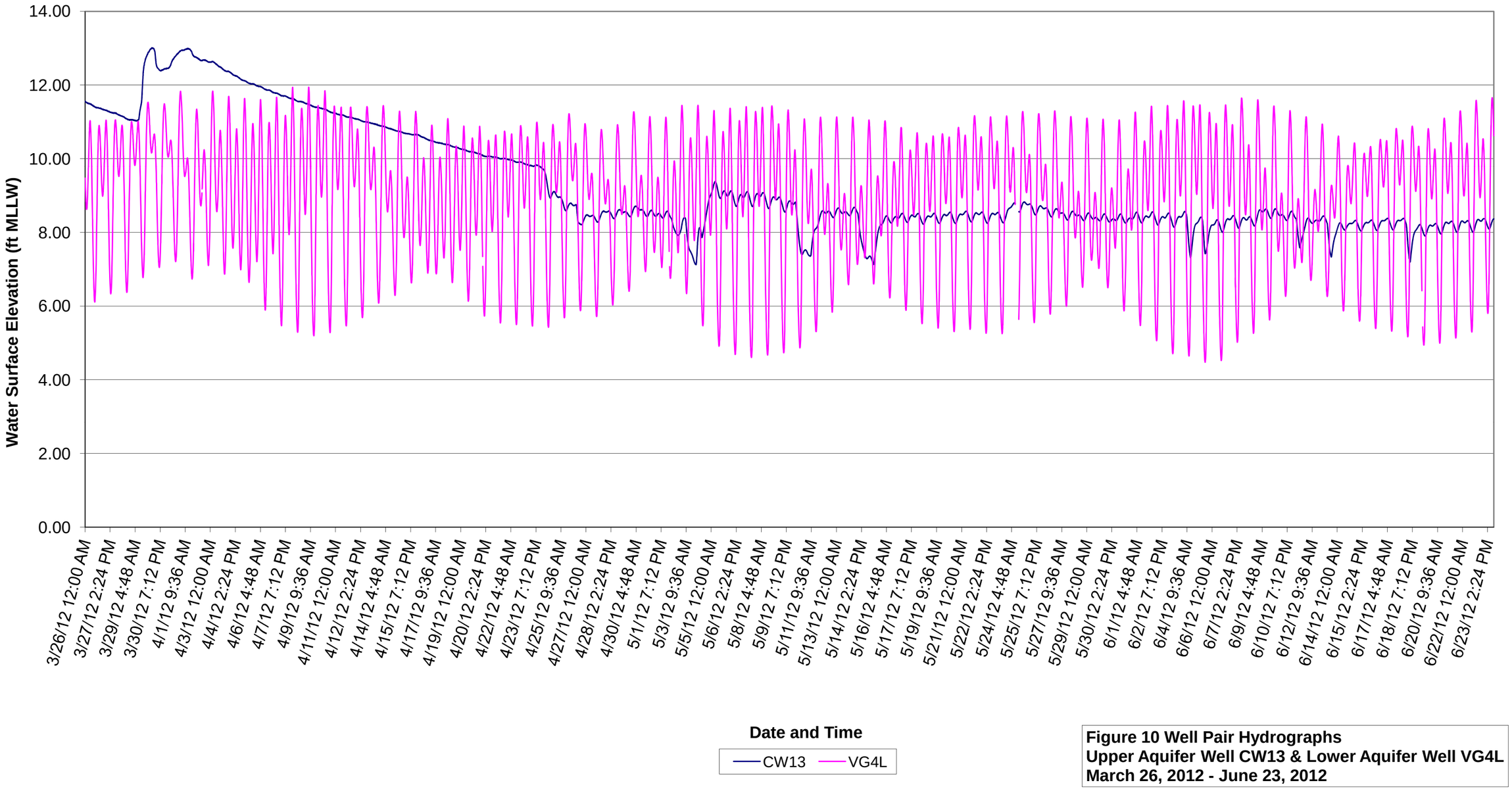


Figure 10 Well Pair Hydrographs
Upper Aquifer Well CW13 & Lower Aquifer Well VG4L
March 26, 2012 - June 23, 2012

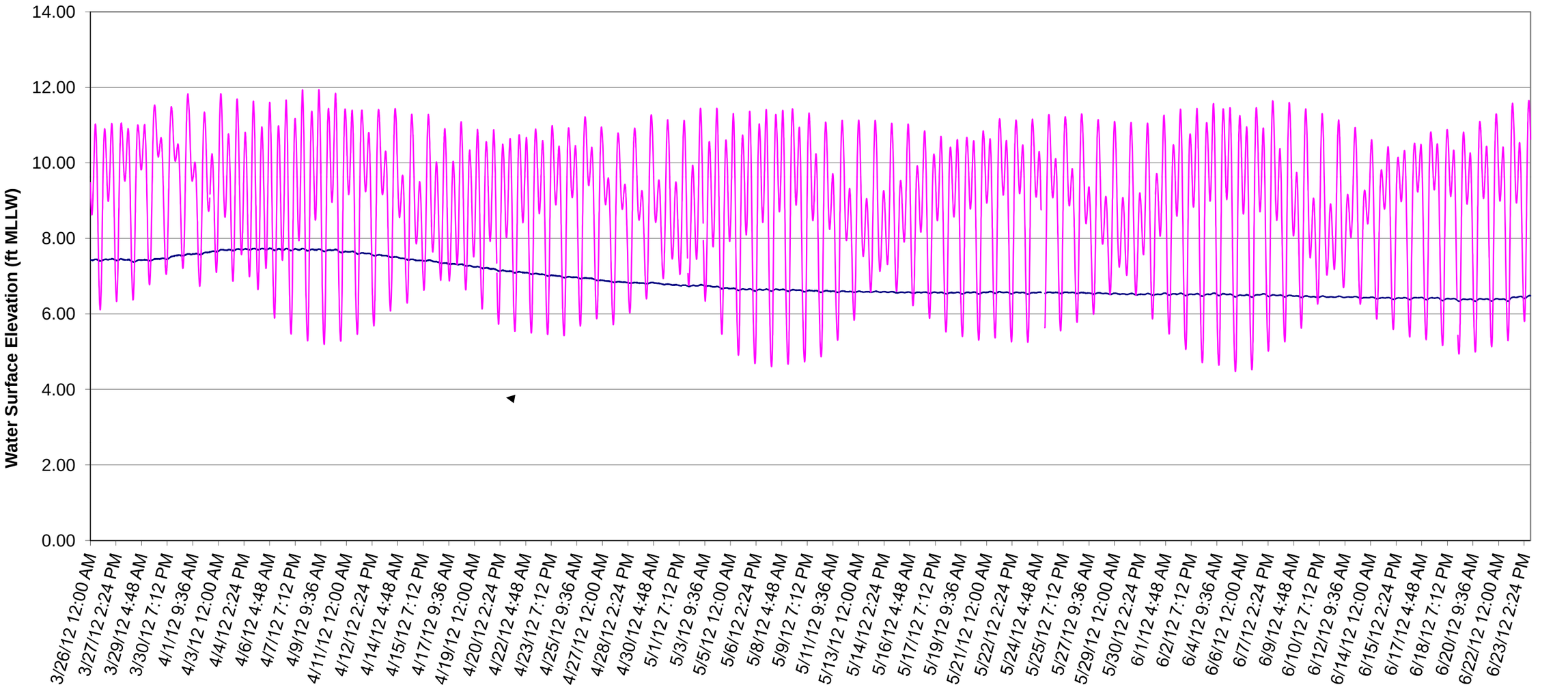


Figure 11 Well Pair Hydrographs
Upper Aquifer Well CW08 & Lower Aquifer Well P4L
March 26, 2012 - June 23, 2012

Maximum Downward Flow Potentials

MW14/CW05	none
MW18/02CDMW01	none
PO03/99CDMW02	none
CW03/CW02	none
VG2U/VG2L	none
VG3U/VG3L	none
VG5U/VG5L	none
PO13/VG1L	4/9/2012
CW13/VG4L	4/1/2012
CW08/P4L	4/9/2012

Well(s) Off
April 11 - 16, 2012 (PW-9)
April 21, 2012 -- (PW-6)
April 21 - 26, 2012 (PW-9)
April 26 - May 2, 2012 (PW-9)

April 27, 2012 --
(PW-1, EW-2)

Well(s) Off
May 4 - May 10, 2012 (PW-9)
May 11 - May 14, 2012 (PW-9)
May 15 - June 4, 2012 (PW-9)
June 5 - June 26, 2012 (PW-9)

Daily Precipitation (inches)

Cumulative Precipitation (inches)

Date

Daily Precipitation
Cumulative Precipitation

Figure 12 Wyckoff Site Precipitation, Well Field Shutoff, and Max Downward Flow Potential Summary March 26 through June 23, 2012