APPENDIX B

Tidal Influences on Groundwater Elevation and Movement

From:	Myers, Mike
To:	Wardle, Alexander (DEQ)
Cc:	McCullough, Burt (Burton.McCullough@nrgenergy.com); Christoffersen, Stephen
Subject:	PC 2013-3154, PRGS Automated Gauging and Tidal Influences
Date:	Monday, May 05, 2014 7:24:25 AM
Attachments:	PC 2013-3154 - PRGS Tidal Fluctuation and Groundwater Elevation 5-5-14.pdf

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Alex,

As directed in the March 2014 VDEQ letter, we installed automated groundwater gaugers in wells within close proximity to the Potomac River. They were deployed a couple weeks ago, and we spent time last week interpreting and summarizing the first week's data. They are currently still deployed and collecting automatic gauging data. Attached please find the analysis, interpretation, and summary of the first week's data.

Also, I just recently submitted a Work Proposed AAF for CAP Formulation activities to the NRO address.

Please let us know if you need anything else or require additional information.

Thank you.

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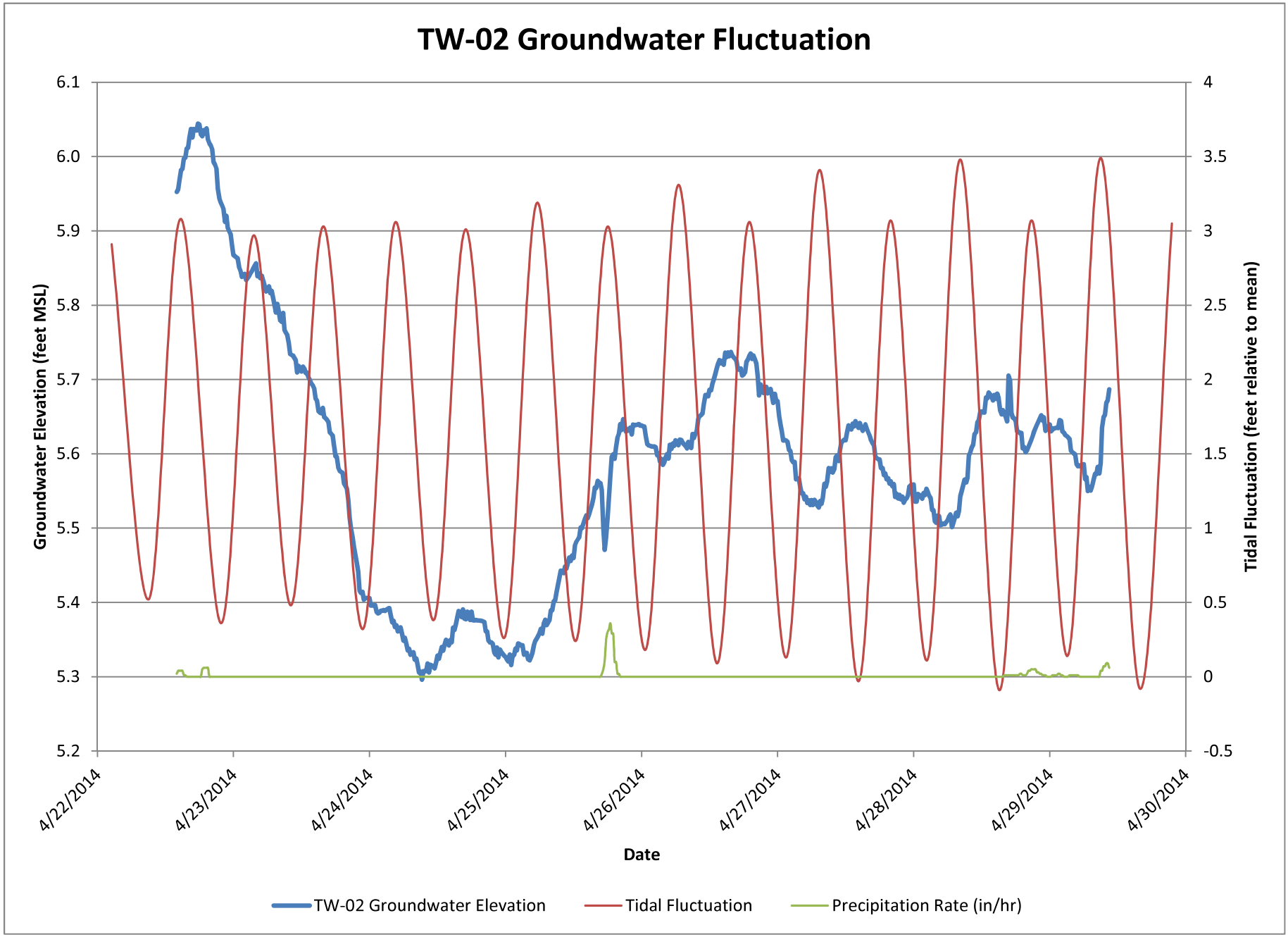
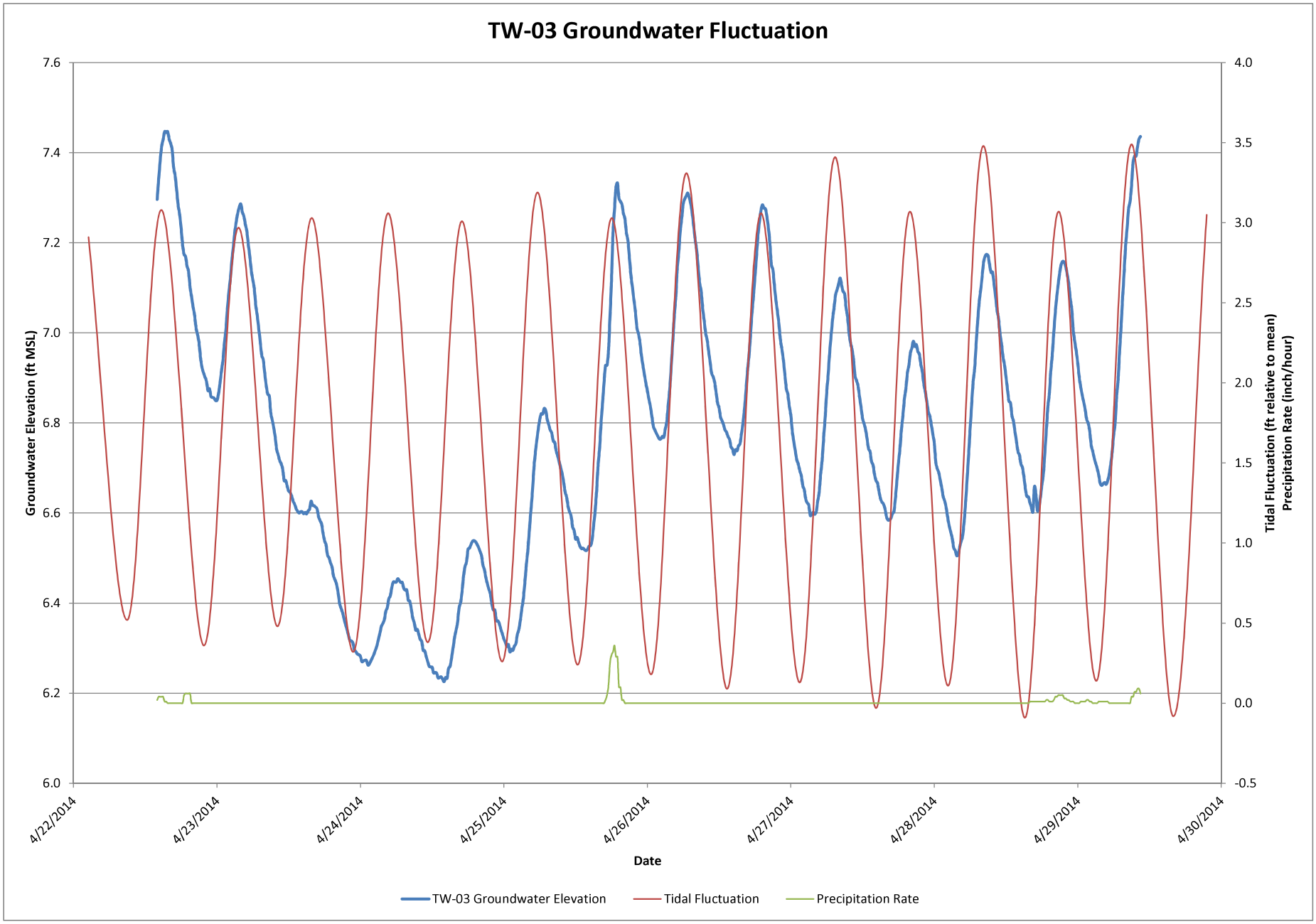
Tidal Influences on Groundwater Elevation and Movement

At the request of VDEQ, URS began monitoring the relationship between tidal fluctuation of the Potomac River and on groundwater elevation in the monitoring wells adjacent to the Potomac River. Solinst® Levelogger Edge automatic water level loggers were installed in seven wells (TW-02 through TW-07, and TW-014) located between the Facility and the Potomac River, collecting thermo- and barometric data of groundwater at 15-minute intervals over the course of 7 days. Barometric data were compiled and converted to feet of water using Solinst® Levelogger Software v4.1.0. The water level data were corrected against barometric pressure from a weather station in Braddock Heights, Alexandria, VA, to establish true elevation above mean sea level. The corrected data were then compared to NOAA predicted tidal fluctuations for the Upper Potomac River. The comparison indicates that tidal fluctuations in the Potomac River influence groundwater elevation on a daily scale, but groundwater elevation is more strongly influenced by precipitation events and infiltration. Graphs of measured groundwater elevations in each well are presented alongside predicted Potomac River tidal fluctuations and local precipitation rate in **Appendix A.**

All monitoring wells, except for monitoring well TW-14, show significant variability in groundwater elevation on two scales. These variable elevations behave as a function of the proximity of the wells to the Potomac River (tidal) and of the amount of precipitation affecting the area (meteorological). Monitoring wells TW-03 through TW-07 are located 10 to 30 feet from the Potomac River and have well-defined cyclic rises and falls of the groundwater elevation. The typical range of 0.1 to 0.7 feet per cycle (feet/cycle) is smaller than the predicted tidal fluctuation of the Potomac (approximately 3 feet/cycle), but is likely a product of lagging rise and fall of the water table with changing grade and the rate of infiltration of tidal water into soil. These cyclically fluctuating monitoring wells are all located within 25 feet of the shoreline at low tide. In addition to the tidal signatures, larger multi-day-scale changes in groundwater elevation occur in time with precipitation events. These meteorologically driven changes do not affect the tidal amplitudes, but they do significantly affect the height of the water column, suggesting that precipitation is an important consideration in defining groundwater movement in wells close to the river.

Monitoring wells TW-02 and TW-14 do not exhibit strong cyclic variability that is characteristic of the other five wells. Monitoring well TW-02 is the farthest well from shore (40 feet), representing a section of the water table that may be less affected by tidal influence. Temperature data for TW-02 support this interpretation, as cyclical fluctuations may indicate varying degrees of influence of cooler tidal waters during high tide and warmer groundwater flow during low tide. Monitoring well TW-14 exhibits comparatively little change in groundwater elevation (total range of 0.2 feet) and no discernable tidal signature. However, water level changes at monitoring well TW-14 occur closely with precipitation events, indicating that the movement of water at this section of the Site is predominantly driven by meteorological input.


TW-02 Groundwater Fluctuation
Groundwater Elevation (feet MSL)
Tidal Fluctuation (feet relative to mean)
6.1
6.0
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
4/27/2014
4/28/2014
4/29/2014
4/30/2014
Date
TW-02 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate (in/hr)


TW-03 Groundwater Fluctuation
Groundwater Elevation (ft MSL)
Tidal Fluctuation (ft relative to mean)
Precipitation Rate (inch/hour)
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
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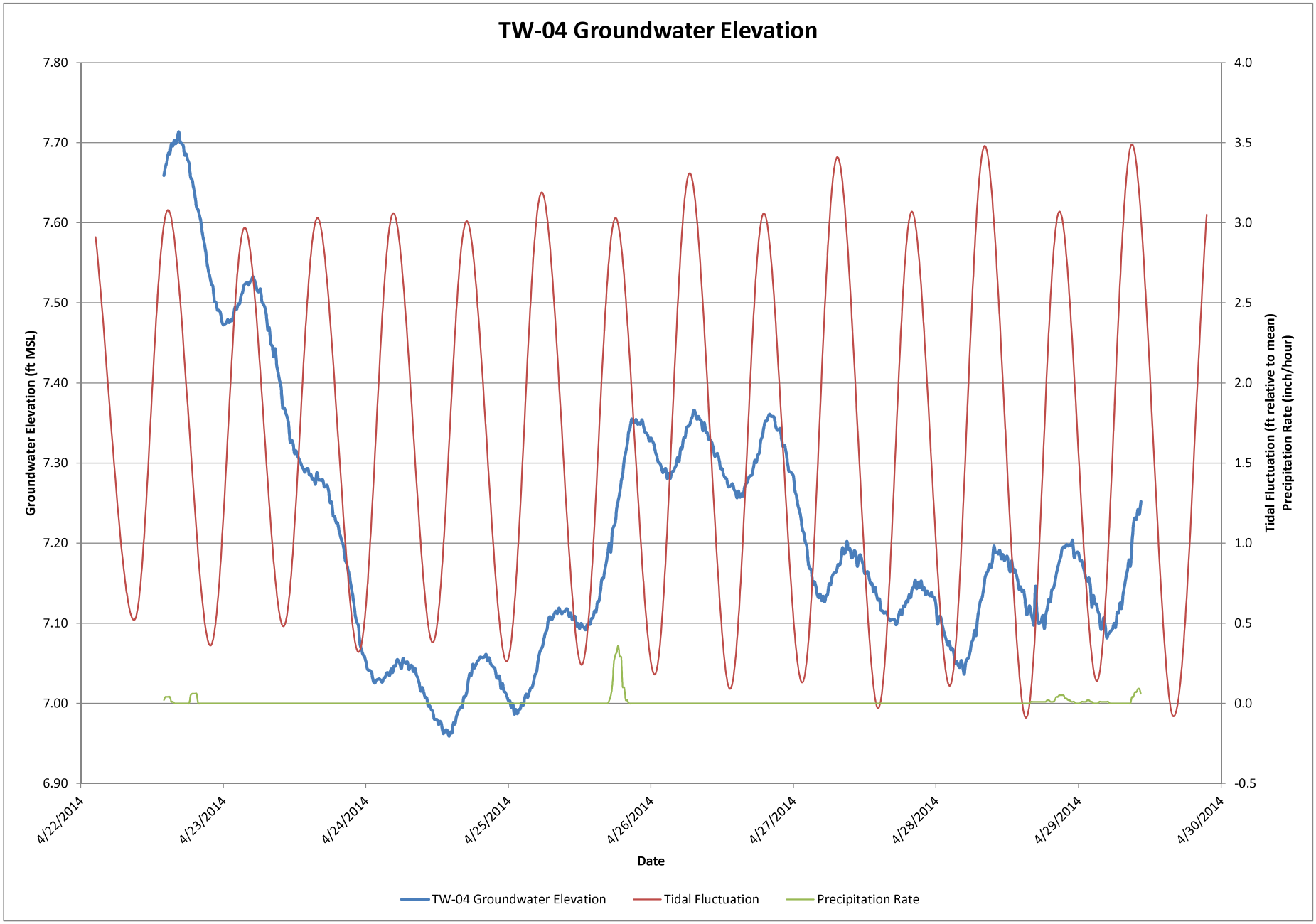
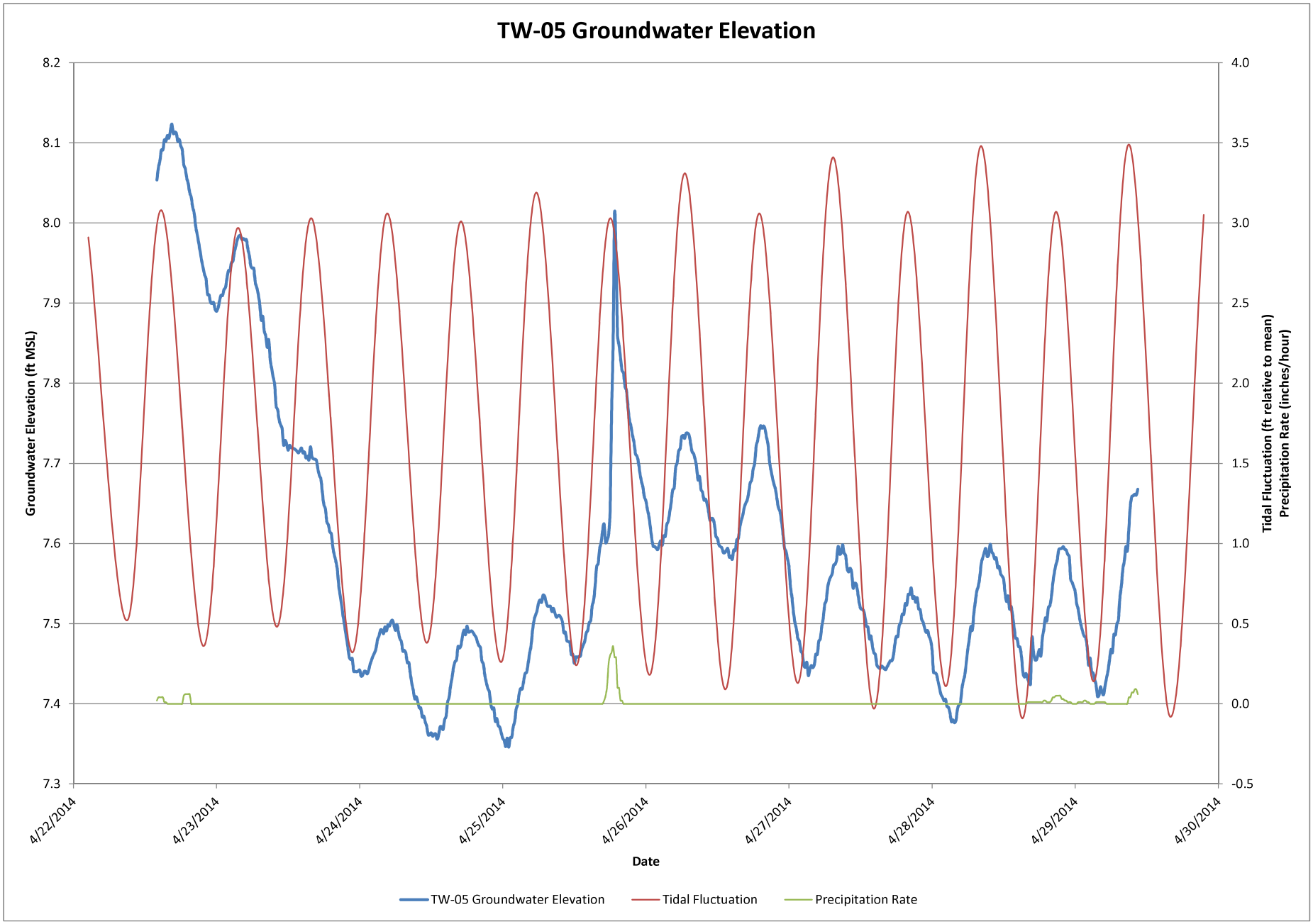
4/28/2014
4/29/2014
4/30/2014
Date
TW-03 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate


TW-04 Groundwater Elevation
Groundwater Elevation (ft MSL)
Tidal Fluctuation (ft relative to mean)
Precipitation Rate (inch/hour)
7.80
7.70
7.60
7.50
7.40
7.30
7.20
7.10
7.00
6.90
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
4/27/2014
4/28/2014
4/29/2014
4/30/2014
Date
TW-04 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate


TW-05 Groundwater Elevation
Groundwater Elevation (ft MSL)
Tidal Fluctuation (ft relative to mean)
Precipitation Rate (inches/hour)
8.2
8.1
8.0
7.9
7.8
7.7
7.6
7.5
7.4
7.3
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
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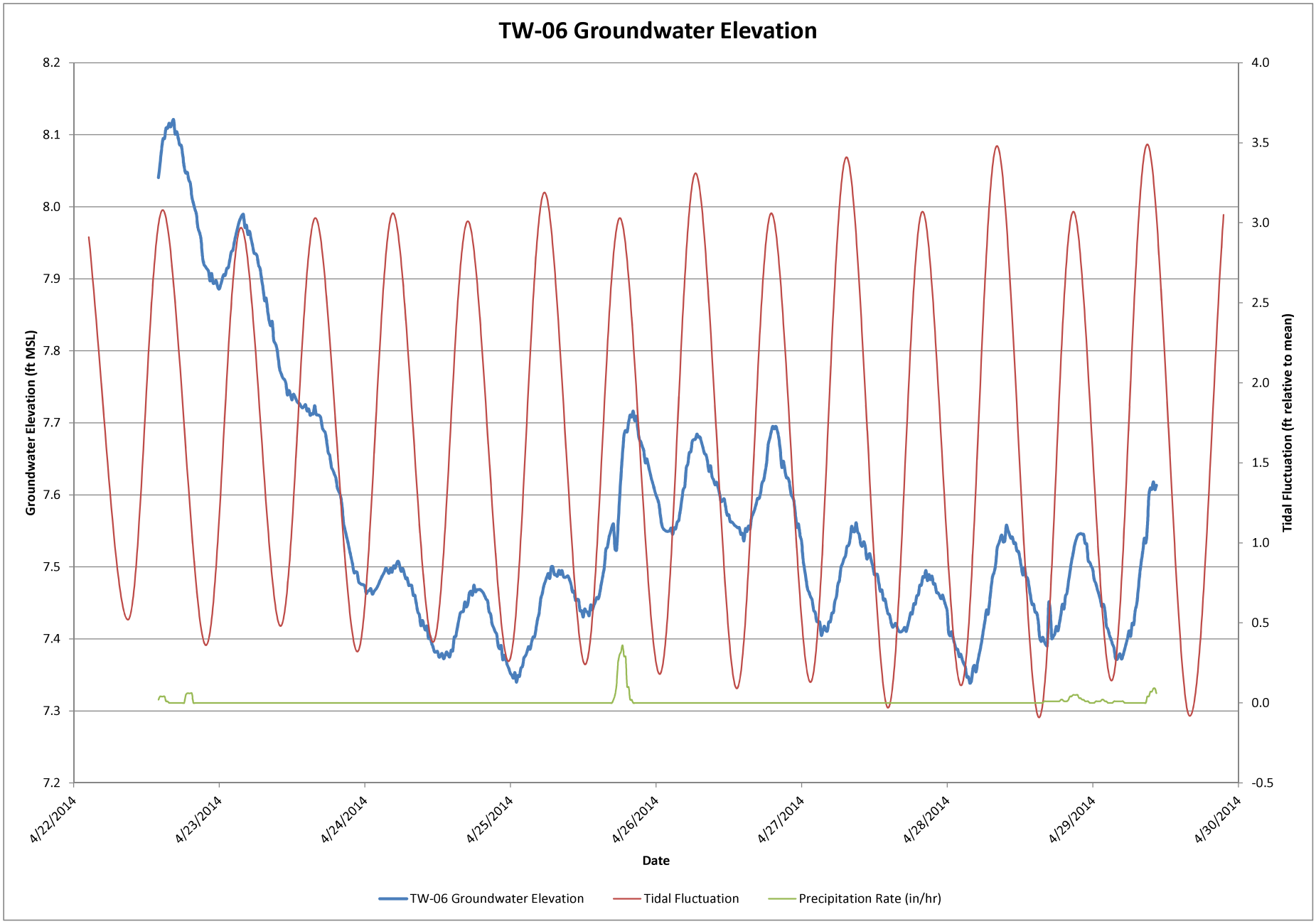
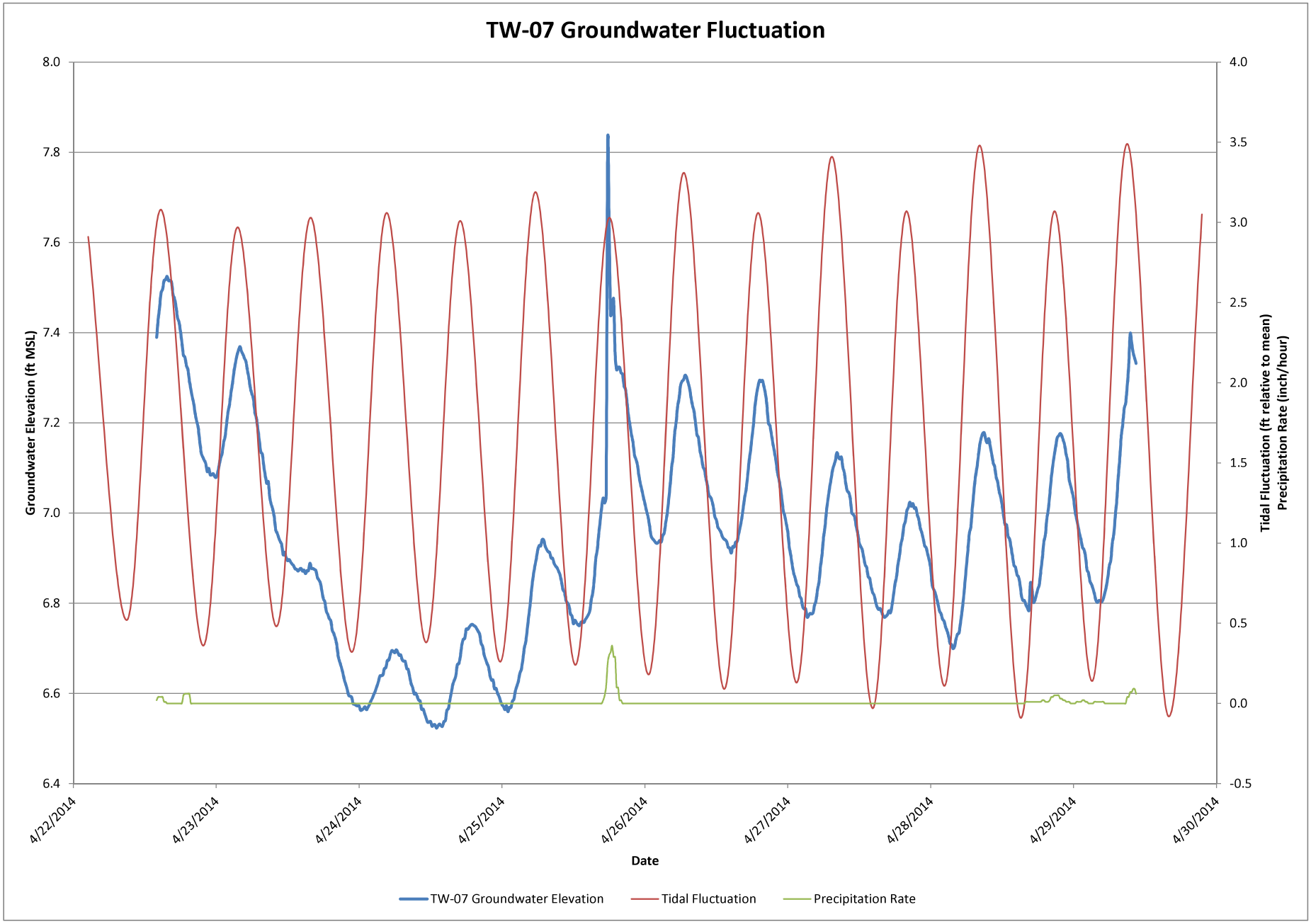
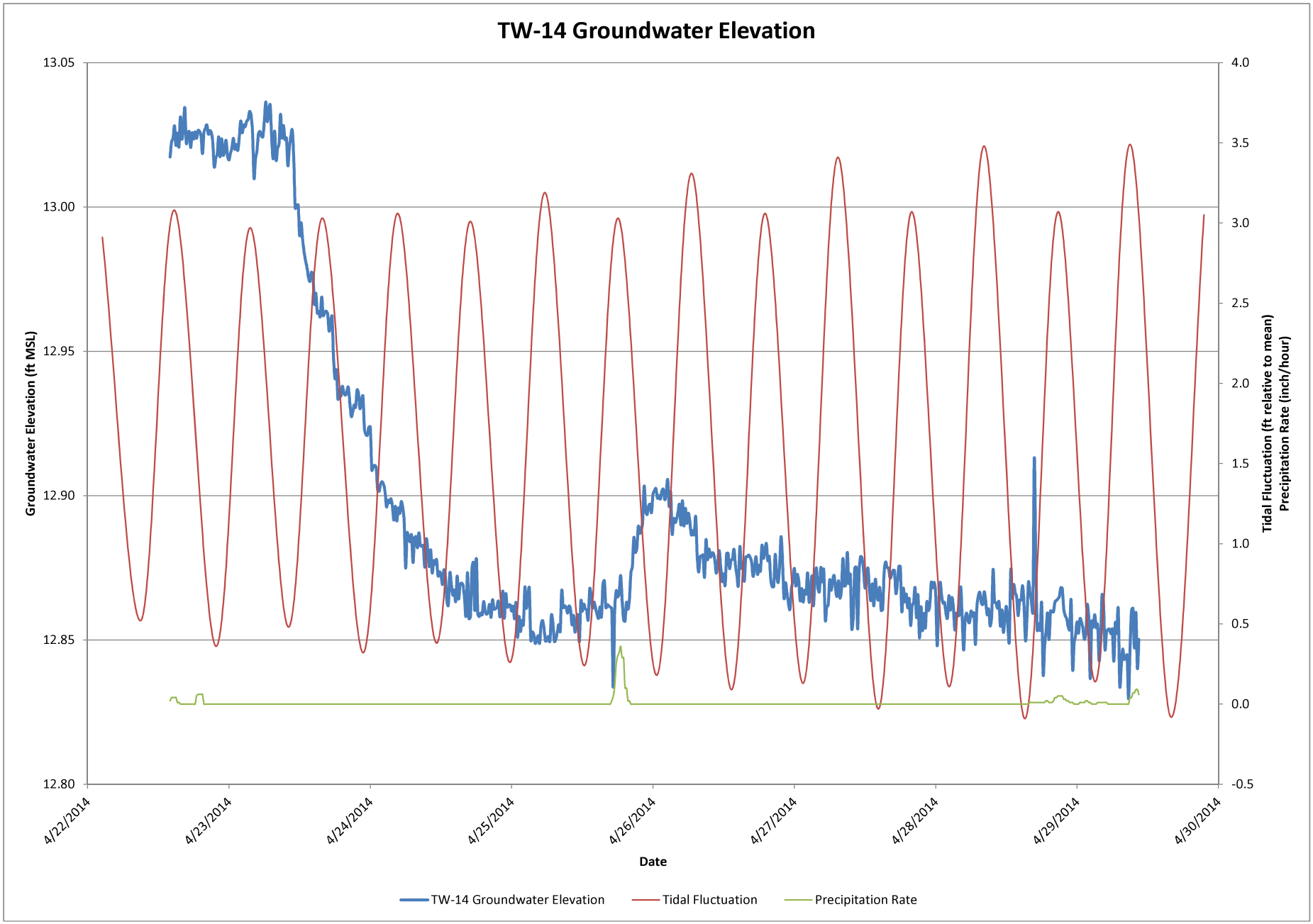
4/30/2014
Date
TW-05 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate


TW-06 Groundwater Elevation
Groundwater Elevation (ft MSL)
Tidal Fluctuation (ft relative to mean)
8.2
8.1
8.0
7.9
7.8
7.7
7.6
7.5
7.4
7.3
7.2
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
4/27/2014
4/28/2014
4/29/2014
4/30/2014
Date
TW-06 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate (in/hr)


TW-07 Groundwater Fluctuation
Groundwater Elevation (ft MSL)
Tidal Fluctuation (ft relative to mean)
Precipitation Rate (inch/hour)
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
4/27/2014
4/28/2014
4/29/2014
4/30/2014
Date
TW-07 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate


TW-14 Groundwater Elevation
Groundwater Elevation (ft MSL)
13.05
13.00
12.95
12.90
12.85
12.80
Tidal Fluctuation (ft relative to mean)
Precipitation Rate (inch/hour)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
4/22/2014
4/23/2014
4/24/2014
4/25/2014
4/26/2014
4/27/2014
4/28/2014
4/29/2014
4/30/2014
Date
TW-14 Groundwater Elevation
Tidal Fluctuation
Precipitation Rate