memo

Project Name |	Groundwater Monitoring Program	**Date** |	12/7/2020
To / Contact info |	BCWD Board of Managers		
Cc / Contact info |	Karen Kill, District Administrator		
From / Contact info |	Stu Grubb, PG		
Regarding |	2020 Groundwater Elevation and Trends		

Background

The BCWD has established a network of wells for measuring groundwater levels. The network includes residential wells, golf course wells, and DNR observation wells. Water level measurements are recorded hourly at the DNR observation wells using data loggers. Water level measurements are collected annually at the residential wells and golf course wells. Placing data loggers into the residential wells and golf course wells is not feasible due to the pumps and other equipment in the wells.

The data has been collected since 2012. The data is used to identify trends in groundwater levels and changes to groundwater flow over time. Changes to levels and groundwater flow can have significant effects on Brown's Creek and other groundwater dependent natural resources, flooded areas such as Kimbro Basin, and stormwater infiltration practices.

The well network was established to cover the entire watershed district and also to monitor each of the major drinking water aquifers in the watershed district. The distribution of wells by aquifer is:

- Quaternary (Glacial) – 6 wells
- St. Peter – 1 well
- Prairie du Chien – 11 wells
- Jordan/St. Lawrence – 2 wells
- Tunnel City Group – 3 wells
- Multi-Aquifer – 3 wells

Analysis

Residential Wells

Groundwater elevation data from the golf course wells, residential wells (and DNR observation wells) are shown in Table 1. Groundwater elevations increased from 2019 to 2020 with an average increase of 1.36 feet. Increased groundwater elevations were most pronounced in the residential wells. Although 2020 had about average precipitation, the wells and aquifers are apparently still reacting to the above average precipitation in previous years.

DNR Observation Wells

DNR measures water elevations hourly in three observation wells:

- Brown's Creek Park – Deep well completed in the Jordan aquifer
- Brown's Creek Park – Shallow well completed in the Quaternary (glacial) aquifer
- Withrow School – Well completed in the Prairie du Chien aquifer

Groundwater elevation data from the DNR observation wells are shown on Figure 2. The data for the Withrow well shows that the water level continues to rise above the previous high point recorded back in 1996. The groundwater elevation in the Brown's Creek Park – Shallow well does not fluctuate much from year to year because it is hydraulically connected to and influenced by the elevation of Brown's Creek. The Brown's Creek Park – Deep well groundwater elevations also continue to rise. Last year we reported a possible data error in the 2019 data, but the DNR's dataset (provided on their website) indicates that this error has been corrected.

Golf Course Wells

The golf course wells showed similar trends to the other wells. The water level in Stillwater Oaks well #4 at Stillwater Oaks Golf Course varies a lot from year to year, suggesting that something mechanical is affecting the measurements. We will continue to investigate. Two golf course wells could not be measured this year, as indicated in Table 1. The irrigation well at the Stillwater Country Club is difficult to measure because it is deep and has several obstructions in the well pipe. We will are still looking for reliable ways to measure the water level in this well. The Stillwater Oaks 1 well has an unexplained obstruction that is being investigated with the maintenance crew.

Change in Water Levels in Each Aquifer

Groundwater levels in each aquifer were compared to identify trends over time. Residential well and DNR observation well levels were used for the analysis. The golf course wells have not been measured for as long, and the water level readings tend to be less reliable due to the large pumping volume. The data from the golf course wells will be important for future groundwater modeling efforts because it informs how pumping of the golf course affects nearby water resources.

Quaternary (Glacial) Aquifer

Groundwater levels in the shallow Quaternary aquifer wells are shown on Figure 2. Four of the wells show an increase of over 12 feet since 2012. Two of the wells show significantly less increase, about 7 feet. One well shows very little increase, less than two feet. The well that shows the least increase is located in Brown's Creek Park, near Brown's Creek. The water level in the well is stabilized by the relatively constant water level in the Creek and the discharge of groundwater from the aquifer to the Creek. The variation in water levels among the wells indicates the importance of having water level readings from several areas across the watershed.

Prairie du Chien Aquifer

Groundwater levels in the Prairie du Chien aquifer are shown in Figure 3. Most of the wells show a consistent increase of eight to 10 feet since 2012. One well, the Wiersma well, shows less of an increase. This well has a shallow depth to water and is located closest to Brown's Creek (about 300 feet). The relatively stable water level may indicate that this well and this aquifer are influenced by Brown's Creek.

Other Aquifers

Groundwater levels from the St. Peter, Jordan, and Tunnel City Group aquifers are shown on Figure 4. The wells show similar trends over time, although the increase has not been as great as in some other wells. The Olien well water level has not changed significantly since 2014. This is the closest well to the Saint Croix River, and may show the influence of the river level on the Tunnel City Group aquifer in this area.

Recommendations

The BCWD should continue to collect groundwater elevation data on an annual basis. The long-term data and analyses are important for understanding groundwater conditions and groundwater/surface water interactions throughout the District. The data will be particularly useful for understanding the thermal impairment of Brown's Creek and water level fluctuations in landlocked areas such as the Kimbro Basin.

Table 1. BCWD Groundwater Elevation Measurements 2013-2020

Unique Number	Name	2013 Water Elevation	2014 Water Elevation	2015 Water Elevation	2016 Water Elevation	2017 Water Elevation	2018 Water Elevation	2019 Water Elevation	2020 Water Elevation	Change since last measure
Approximate Date		Aug-13	Aug-14	Sep-15	Oct-16	Oct-17	Oct-18	Oct-19	Oct-20	
Golf Course Wells										
515171	Applewood Hills	887.34			891.84	895.42	894.14		897.65	
151580	Oak Glen Country Club				825.50	825.88	823.56	826.12	825.63	-0.49
151581	Oak Glen Country Club				829.71	830.12	828.16	828.23	828.78	0.55
208038	Stillwater Country Club				769.17	>200	>200	>200		
Stillwater Oaks 1	Stillwater Oaks Golf Club				910.31	913.42	910.11	912.41		
Stillwater Oaks 2	Stillwater Oaks Golf Club				908.89	910.27	909.05	913.60	913.72	0.12
Stillwater Oaks 3	Stillwater Oaks Golf Club	906.36			910.27	911.26	910.07	911.90	912.46	0.56
Stillwater Oaks 4	Stillwater Oaks Golf Club				963.06	Artesian	957.69	970.29	970.16	-0.13
566145	Logger's Trail Golf Course	900.21			904.41	905.62	904.16	905.93	907.20	1.27
667998	Logger's Trail Golf Course				911.29	906.28	905.10	907.34	908.40	1.06
761112	Logger's Trail Golf Course				900.53	901.16	900.09	901.94	903.55	1.61
Domestic Wells										
428563	Ed and Laurie Francis	896.14	898.01	897.56	900.51	902.53	900.91	903.36	906.14	2.78
410987	Dan and Lori Gunderson	900.01	900.99	901.89	904.96	906.98	905.62	907.22	910.22	3.00
196839	Louis J. Bruno	860.70			862.92	867.75	866.75	866.40	870.28	3.88
Leiser	Craig Leiser	929.84	932.13	931.27	932.63	935.11	933.99	935.85	937.65	1.80
James	Alan and Molly James		939.00	937.59	939.62	941.71	940.20	942.14	944.20	2.06
184049	Kirk and Tracy Hillquist	940.29	940.86	939.20	942.27		942.48	944.77	945.61	0.84
Thatcher	Jyneen Thatcher	947.88	951.97	950.55	953.76	955.68	953.19	957.18	958.63	1.45
138188	Rick Vanzwol	927.24	935.48	934.74	937.89	940.02	939.36	941.45	943.96	2.51
479665	John and Michelle Weaver	900.99		899.73	907.27	907.41	906.86	907.77	908.87	1.10
493250	Mark and Sharon Olien	713.74	720.64		721.88	719.97	721.50	721.54	721.89	0.35
525197	James and Marilyn Opp	907.93	909.80	910.04	912.08	913.88	913.02	914.69	917.18	2.49
505390	Larry J and Pamela J Larson		925.98		928.67	930.48	929.18	932.29	933.50	1.21
153485	John P and Carolyn A Rydel	893.98	896.20	895.51	897.42	899.51	898.47	899.31	901.08	1.77
138904	Duane and Margaret		828.79	827.21	829.25	829.91	828.41	830.33	832.27	1.94
406204	Michael and Rita Wiersma	938.96	939.12	939.00	941.10	941.38	940.98		942.78	
Boughten	Larry Boughten					953.73	951.32	954.28	956.81	2.53
DNR Observation Wells										
595649	Brown's Creek Park - Deep	861.73	862.17	862.51	866.32	864.77	865.81	868.11	868.20	0.09
623066	Brown's Creek Park - Shallow	873.13	874.82	874.03	875.53	875.77	875.05	876.84	876.88	0.04
551565	Withrow Elementary School	949.91	952.65	951.16	954.17	956.88	954.91	958.64	959.50	0.86

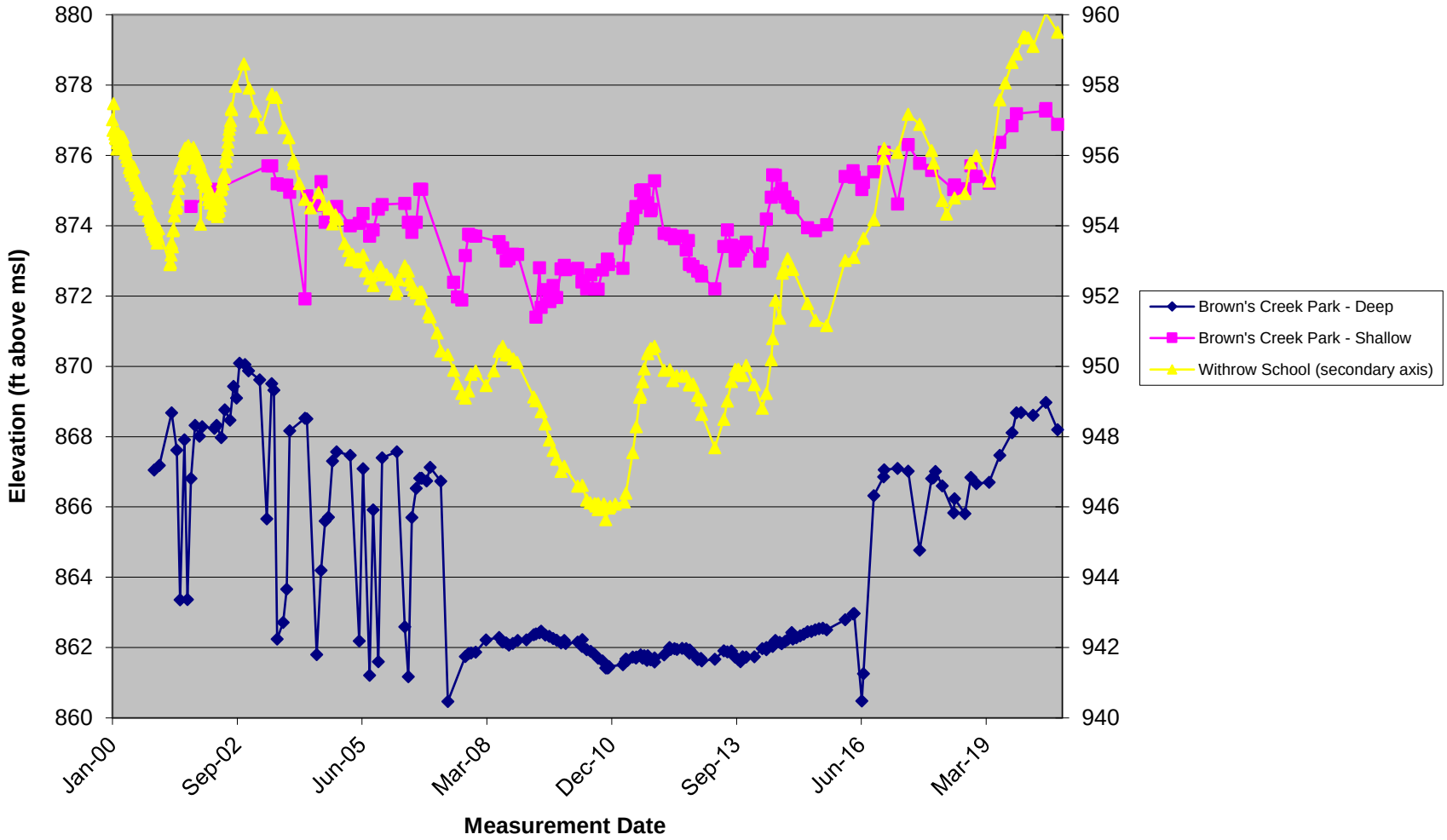

Figure 1. BCWD Groundwater Elevations – DNR Observation Wells

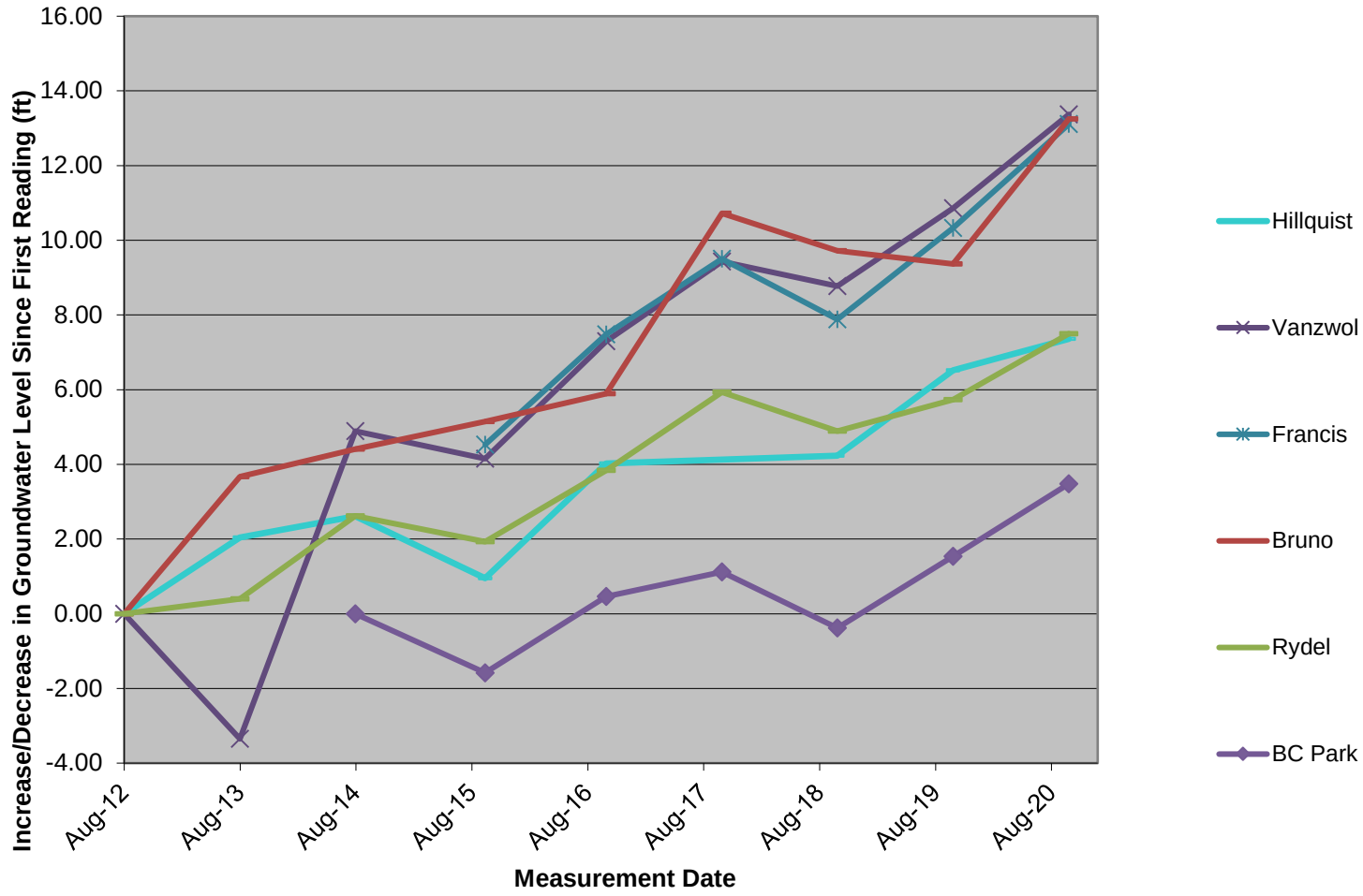

Figure 2. BCWD Groundwater Level Change Over Time - Quaternary (Glacial) Aquifer Wells

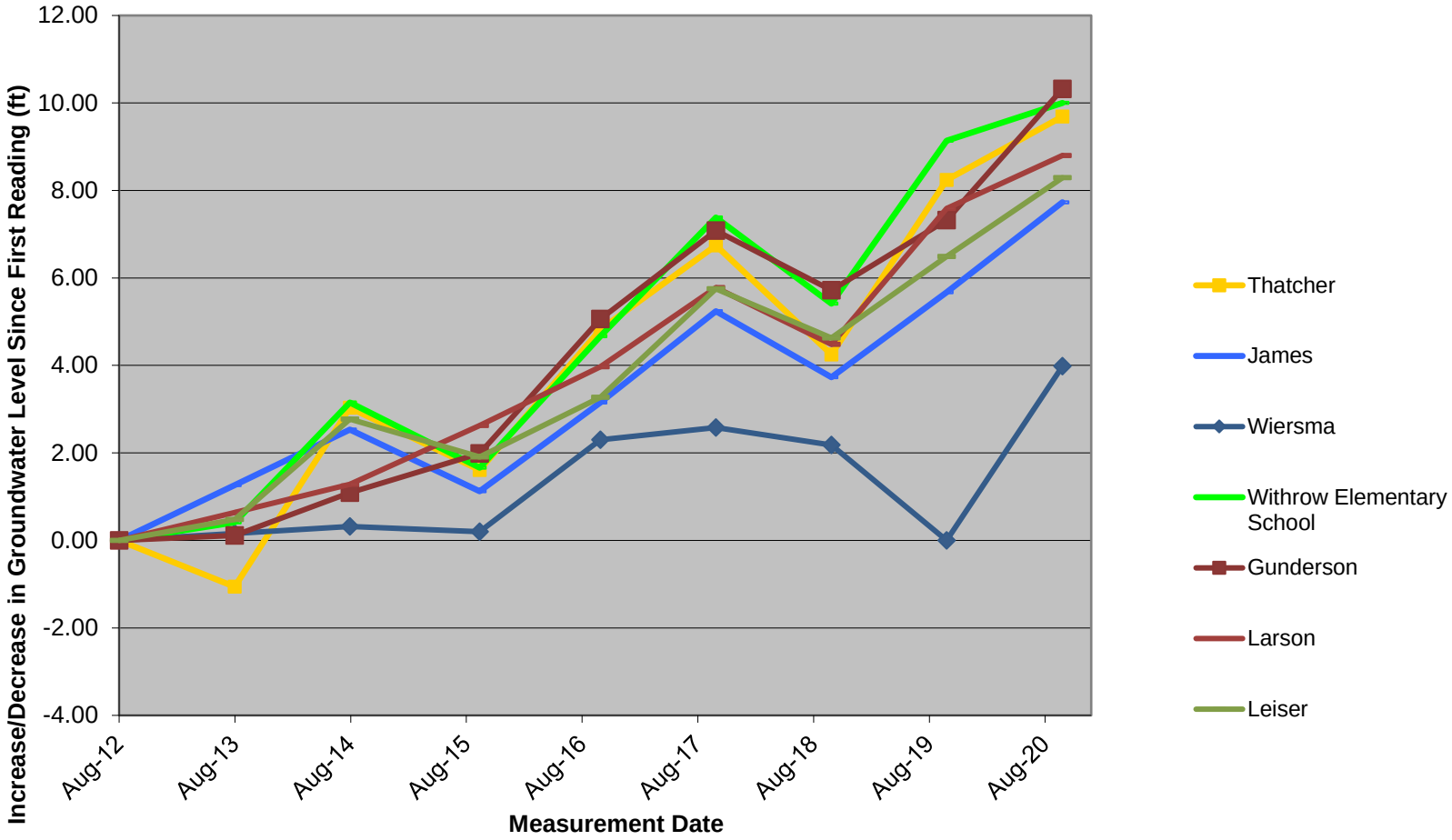

Figure 3. Groundwater Level Change Over Time – Prairie du Chien Aquifer Wells

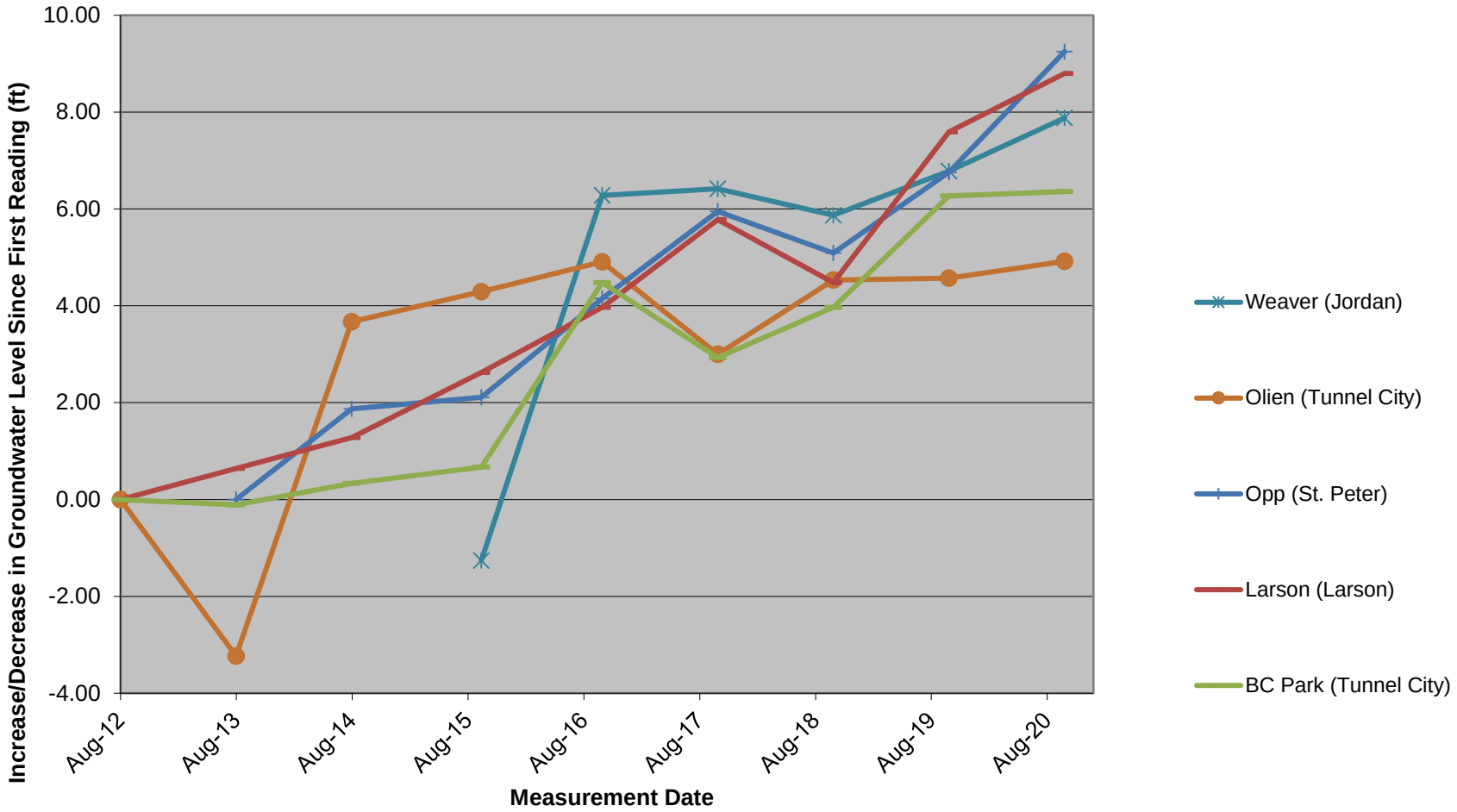

Figure 4. Groundwater Level Change Over Time - Wells in All Other Aquifers