Appendix J

CLIMATE CHANGE IMPACTS EVALUATION

Technical Memorandum

To: Dan Smith, City of Tumwater

From: Burt Clothier, LHG, Pacific Groundwater Group

Re: Climate Change Effects on Groundwater in the Tumwater Area

Date: December 1, 2017

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The City of Tumwater (City) desired an assessment of possible effects to its water resources that might result from climate change. Generally, Tumwater-area aquifers have more problems related to groundwater flooding than they do storage depletion. However, the City believes it is prudent to determine if or where climatic changes might influence their water resources.

To assess the possible effects of climate change, we reviewed literature discussing climate change modeling in the Pacific Northwest or Puget Sound region and examined historical water level data from City production wells. The following tech memo provides a qualitative opinion on impacts to Tumwater aquifers.

The Palermo wellfield occasionally exhibits storage depletion but typically it is a seasonal effect related to high pumping rates, inefficient wells, and with natural summertime declines in the aquifer. This wellfield (and the valley aquifer in general) will be the primary focus of this investigation since the Port and Bush Middle School wellfields have high water levels and have historically not exhibited significant drawdown.

SETTING

To provide context for the climatic condition discussion, we first reviewed the general characteristics of the region.

PHYSIOGRAPHY

Thurston County, Washington is located at the southern end of the Puget Sound Lowland basin. The most populous areas of the County (Olympia, Lacey, Tumwater, Yelm) are located in glacial outwash plains. The County also incorporates parts of the Black Hills on the west and Cascade foothills to the east and south. Elevations range from sea-level along the Sound to over 3,870 feet above mean sea level (msl) at Cougar Mountain in the Bald Hills.

The City of Tumwater is located in west central Thurston County, roughly between the Black River and Deschutes River, just south of Olympia. The majority of the City is situated on an upland prairie between the two river valleys. Elevations are typically between 180 and 200 feet msl.

HYDROGEOLOGY

The geology of the area is dominated by glacial deposits in the valleys and tertiary bedrock in the local hills. The Tumwater area is a flat glacial outwash plain with local kettle features. In general, the uppermost aquifer in the plain is highly permeable and readily accepts precipitation. As described by Logan and others (2009), the primary surface and shallow subsurface units are:

Qa – Recent alluvium. This includes sediments deposited by the Nisqually and Black Rivers

Qgos – Vashon recessional outwash sand and gravel. Outwash stream deposits of the receding Vashon glacier. Mainly sands and gravels.

Qgt – Vashon till Compacted, unsorted clay, silt, sand and gravels deposited by the Vashon-age glacier. Drumlins locally occur in this unit to the south of the City.

Qga – Vashon advance outwash. Outwash stream deposits of sand and gravel from the advancing Vashon-age glacier. Also includes deposits of lacustrine clay, silt and sands from pro-glacial lakes.

In general, aquifers in the area receive their water from precipitation that infiltrates into the ground and from surface water bodies (lakes and rivers) that discharge water into the ground. Though winter snow pack can be a meaningful source of water to both surface flows and groundwater infiltration at high elevation, near Tumwater and on the Deschutes and Black Rivers, groundwater and stream hydrographs are dominated by local precipitation rather than the effects of snowmelt. In the City’s high groundwater area, the combination of high local precipitation, flat topography, shallow Qgt, and thin Qgos results in groundwater flooding risks.

CLIMATE

The Tumwater area has a temperate marine climate characterized by warm summers with temperatures averaging 62 °F during the three warmest months (July through September), and cool winters averaging 40 °F during the three coldest months of the year (December through February; NOAA 2016). Average annual rainfall recorded at the Olympia Airport was approximately 52 inches between 2005 and 2015. Over 80 percent of precipitation falls from October through March. January if generally the month with highest precipitation (approximately 9 inches) and July the lowest (approximately 0.5 inches).

EFFECTS OF CLIMATE CHANGE

This review first focuses on the larger picture of climate change effects in the region. Portions of the following were adapted from a technical study produced by the author for the Water Supply Forum Regional Water Supply Resiliency Project (Water Supply Forum, 2016).

GENERAL EFFECTS

Predictive climate modeling for the 50 to 100-year period suggests that the Pacific Northwest west of the Cascades will likely have annual precipitation levels that are the same or slightly higher than currently. A larger percentage of the precipitation is expected to happen in the winter and spring months followed by longer and dryer summers. Overall, however, the amount of annual recharge should be roughly the same as today (Bumbaco and Mote, 2010; Mote and Salathe, 2009).

Groundwater sources are generally more resilient to drought than surface water sources. Many groundwater sources appear to be relatively unaffected by short-term events (a few months of lower-than-average rainfall. Nonetheless, there are drought conditions that can stress aquifers in the Puget Sound Lowlands. This past summer is an example of the former when records were set in several places throughout the Lowlands for longest consecutive period without meaningful rainfall, but the overall water year (October 1 to September 30) was average or above average in total rainfall. The drought of 2015 is an example of the latter as both the winter and summer experienced low precipitation, leading some communities to begin water conservation activities.

This generally suggests that groundwater sources will continue to receive similar recharge volumes as currently, which implies that impacts due to climate change will be small. If impacts do occur, it is more likely that they will result from the anthropogenic effects of growth and development, some of which may be influenced by climate change (such as shifts in population, extra water demands in summer dry periods, etc.). Stronger and more frequent winter storms will create stormwater runoff challenges, and potentially exacerbate flooding issues in the City's high groundwater area.

If land use changes due to development or urbanization limit the ability to infiltrate precipitation at or near where it lands, then aquifer recharge could decline. These land-use impacts to groundwater recharge can be largely offset if on-site infiltration is constructed and is maintained. However, if summers become hotter and have fewer meaningful storms, water-demand impacts could stress aquifers seasonally and cause some source vulnerabilities that do not occur currently.

Some lowland, shallow river-valley aquifers will also see more pronounced dry-season water level declines if the aquifer is in direct continuity and dependent on river flow levels. Sections of the Deschutes River near Tumwater are losing over the summer months, but because the high aquifer thickness near Tumwater and the Deschutes is overall a regional discharge point for groundwater, significant dry season declines are not expected.

EXPECTED LOCAL IMPACTS

For the Thurston County area, much of this analysis is based on the Thurston Climate Adaption Plan produced by the Thurston Regional Planning Council (TRPC) in 2016. The report consists of a Science Summary and a Vulnerability Assessment. The study describes the anticipated climatological effects throughout Thurston County, subdivided by the three of the four watersheds included in the County: Nisqually (WRIA 11), Deschutes (WRIA 13), Kennedy-Goldsborough (WRIA 14). The fourth, Upper Chehalis (WRIA 23), was not included.

Similar to the Water Supply Forum investigation, the TRPC study was based on climate modeling by the University of Washington Climate Impacts Group and related work (Mauger, and others, 2015).

The TRPC reports mainly discuss climate change related effects throughout the watershed of the study area in broad terms but differentiate between upland and lowland effects to both surface waters and groundwater. Of greatest concern to Tumwater will be the groundwater effects, but a secondary issue is the possible changes to shallow aquifers in direct continuity with surface water bodies that might be subject to changes in flow patterns or timing (e.g. winter flooding, summer low-flows).

Upland aquifers

For the upland plain though the center of the Tumwater area, few if any significant effects to groundwater supplies are anticipated. TRPC looked at 50 and 80-year scenarios and generally concluded that overall annual precipitation totals will remain roughly similar to today, but that longer summers and wetter winters may occur. Thus, the potential precipitation available to annually recharge the groundwater system is largely unchanged. Based on the general geology of the area and the capacity of the soils and aquifers, we expect that even in cases where summertime production is higher than historically has been the case, the aquifers will receive sufficient recharge to prevent long-term declines. Localized areas could see short-term (i.e. summertime) effects of extra- or over-production, but these cannot easily be predicted based on the regional climate modeling.

An internal analysis by Lakewood Water District in Pierce County to assess this issue was performed as part of the Regional Water Supply Resiliency Project. While the District has access to several deeper aquifer sequences than is the case for Tumwater, the shallow aquifer effects are comparable as the settings and precipitation conditions are similar. The District found that extended drought effects (such as seen in 2015) would need to occur for seven or more consecutive years before aquifer declines due to decreased recharge and higher production would make the District unable to meet its peak demands (Lakewood Water District, personal communication).

Palermo Wellfield

Of the issues raised by the TPRC reports, the possible effects to shallow aquifers in continuity to river systems stands out as a possible risk. Changes to the flow patterns of the Deschutes River (higher winter storm flows, more frequent low flows in summer), could impact the water levels in the shallow valley aquifer that is tapped by the Palermo wellfield.

The Palermo wellfield is located in the Palermo neighborhood of Tumwater, adjacent to the Tumwater Valley Golf Course in the Deschutes Valley. The wellfield has been active since the 1930s, and currently has seven wells (Wells 1, 3, 4, 6, 8, 16, and 17). Five of these wells are actively pumped, including Wells 4, 6, 8, 16, and 17. Each of these active wells are currently pumped at rates ranging from 260 to 370 gpm. Individual wells at the wellfield have tested yields of 500 gpm or greater, but due to their close proximity and interference drawdown issues, operational pumping rates for the wells are lower than the individually tested well yields. Biofouling of well screens at the wellfield is a recurring issue that also results in lower operational yields.

For the Palermo wellfield, if the low summer river flows affect water levels in the shallow aquifer and water levels are lowered during the summer peak use periods, would the wellfield be able to continue its current level of production. Based on recent records of water levels and production collected by the City's SCADA system and historical pump tests, each of the wells experiences interference drawdown from neighboring wells and likely have some level of on-going efficiency declines due to the bacteria present in the aquifer system (which is most pronounced at the older wells 4, 6, and 8, though could develop at 16 and 17). Most Palermo wells appear to have approximately 20 or more feet of water remaining over the well screen during regular pumping cycles, meaning that a few extra feet of change from changes in the aquifer levels due to lower recharge in the summer would not lead to significant changes in pumping patterns. Well 8 is the main exception to this pattern.

At Well 8, when a depressed summer static water level is assumed at the Palermo wellfield (7 feet below ground surface (bgs) rather than a typical summer water level of approximately 5 feet bgs), and similar drawdown to what is exhibited by recent SCADA data (with Well 8 pumping 265 gpm and being affected by interference drawdown from other pumping wells) is assumed, we estimate the pumping water level would be roughly 2 feet above its screen. If well screens are exposed during pumping, the upper portion of the aquifer is exposed to high oxygen conditions, which can result in either increased bacterial growth or mineral precipitation that can cause future production declines. Because Well 8's yield has declined from 530 gpm (when it was installed in 1982) to roughly 265 gpm currently, it appears that the effects of biofouling will likely be the primary cause of declined yields rather than climate change or extreme weather at Well 8 and other Palermo wells. Redevelopment has not occurred at Well 8 since it was installed, and therefore the City may want to consider this option at some point in the future.

Other Considerations

The TRPC reports note that water quality changes resulting from climate change effects may occur in shallow aquifers in rural areas, where extra stresses from higher demand and low summertime recharge combine to increase the vulnerability of small water systems or individual wells. Risks to larger municipal wells were considered low due to the typically deeper aquifer completions and on-going system management and monitoring.

The reports also consider potential risks from saltwater intrusion that might result from sea-level change. In Thurston County, areas considered to be vulnerable to sea-level changes are concentrated on the coast and estuary areas of low elevation. Likewise, proximity to the coast is the predominant driver for risks of saltwater intrusion to aquifer systems. Tumwater is considered to have low risks for saltwater intrusion due to both elevation above and distance from saltwater.

CONCLUSION

Climate studies for the Pacific Northwest appear in agreement that average annual precipitation quantities will remain close to historical levels, but the timing of the precipitation events may change somewhat. Both the TRPC and Water Supply Forum arrived at the conclusion that groundwater supplies, especially in the glaciated lowlands, should be resilient to the projected climate changes. In general, we believe the risk of negative impacts on local aquifers of the Tumwater area resulting from climate change is low.

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