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CASCADE WATER RESOURCES

Subject: Allen Blvd Commercial Site Pumping

Dear Ms. Yates

After reviewing the groundwater study that was conducted this summer and finalized this month by Wood Environment and Infrastructure Solutions, Inc (Wood; see attached), I have been asked by the Allen Blvd Commerical Site design team to address the issue pumping in relationship to the regulatory function of the floodwater storage basin and the observed behavior of Fanno Creek. The Wood report concluded that the total estimated groundwater inflow could range from approximately 100 gallons per minute (gpm) to 330 gpm based on the potential range of both the horizontal and vertical hydraulic conductivities occurring at the site.

This inflow estimate range was based on a very conservative assumption that the groundwater table would be quite high at 187 ft (NGVD29). In fact, the 187 ft level that was assumed is 1.5 feet higher than the highest level observed in four site borings obtained in February 2019 and over five feet higher than the highest level observed in six test pits dug on site in March 2019. The Wood report states: "*Because this estimate is based on a high water table at an assumed elevation of 187 feet, the actual inflow will be less most of the time.*"

So, the current plan is to design a dual pumping system that contains two pumps: one rated at approximately 100 gpm and the other one rated at approximately 300 gpm. These pumps can be operated separately or in combination. If operated in combination the pumping capacity would be ~400 gpm. This provides enough pumping capacity that more than covers Wood's estimate that the groundwater inflow rate could range from approximately 100 to 330 gpm and satisfies Wood's recommended maximum design pumping capacity of 400 gpm.

It should be noted that the 76,575 cubic yards of floodwater storage that has been constructed is not intended to be a typical detention basin. A typical detention basin is generally used to store runoff from contributing watersheds during infrequent rainfall events to reduce downstream peak flows. Instead, this is a storage facility that was mandated by the regulation that requires the replacement of lost floodplain storage that occurs when fill is placed within the 100-year regulated floodplain. The regulation states that any fill volume placed within the 100-year regulated floodplain must be offset by an equivalent amount of floodwater storage on a foot-by-foot basis up to and including the elevation of the 100-year regulatory flood. In fact, the design storage volume of 76,575 cubic yards of floodwater storage being provided was based on a calculation of the amount of flood volume that would exist on the subject property under undeveloped conditions up to the height of the regulatory flood which is 192.2 ft (NAVD88) or 188.7 ft (NGVD29). This calculation was made based on the assumption that the floodwaters would remain on the subject site up to the elevations specified. If the 100-year flood were to occur, however, the bulk of those floodwaters would flow north across Allen Blvd towards Upper Beaverton Creek. Table 1 shows the final estimated floodplain storage volumes being provided to offset the fill planned for the proposed Allen Blvd Commerical Site Development.

The pumping system design requires the installation of automated water level sensors on both the creek and the floodwater storage basin. This will provide the real time data needed for the pumping design consultant (i.e., PumpTech, LLC) to design the control panel that dictates the proper and automatic operation of the installed pumps.

So, what should be the proper operation of the pumps being proposed for instillation? First off, the primary responsibility of the pumping system is to remove the groundwater that could enter the facility and reduce the amount of floodwater storage available in the basin. The smaller pump will provide ~100 gpm of capacity and the larger one will provide ~300 gpm. The smaller pump will only operate when the water level in the pond is equal to or greater than 178.0 ft (NGVD29) and the water level in the creek is above 177.56 ft but below 182.5 ft. This trigger elevation for groundwater pumping of 178.0 ft in the basin is 0.3 feet above the 177.7 ft (NGVD29) bottom of the excavated storage basin. So, the pump with the greatest hours of expected operation is the smaller 100 gpm one designed to control the groundwater level in the basin whenever gravity flow through the flap-gated lower pipe is not available.

The larger pump will primarily be used to assist in the draining of the 24,558 cubic yards of stored water below the 182.5 ft elevation which matches the invert of the 48-inch diameter inflow and outflow pipe that fills and drains the storage basin by gravity depending on the elevation of the creek. So, for this 300 gpm pump to be operating the creek must be within the operational range of 182.5 ft to ~178 ft when gravity drainage through both the upper larger pipe and the lower flap-gated pipe is not available. It would take the 300 gpm pump ~11.48 days to drain these 24,558 cubic yards of stored water. That duration assumes that no gravity drainage through the lower flap gated pipe would be occur during this entire period. However, it also assumes that there is no groundwater inflow during this time which is not a reasonable assumption. So, if we assume the groundwater inflow is 100 gpm then the 300-gpm pump by itself would take ~17.21 days to drain the 24,558 cubic yards of stored water. Once again, this calculation assumes that no water volume would be discharged by gravity through the lower flap gated pipe during this entire time.

Some might feel that 17.21 days or even 11.48 days is too long of a time to take to ensure the storage facility has it's designed capacity available before the next flood occurs. To address that concern Cascade Water Resources (CWR) examined 24 years of historic stage and flow data from 1991 to 2015 at both the USGS gages on Fanno Creek (i.e., one located at 56th Ave and the other at Durham Rd.) The original intent of the analysis was to compute flood reoccurrence intervals at each gage and utilize standard flow transfer techniques to develop peak flow and recurrence estimates at the Allen site.

The analysis found 18 historic flood events over this period that had clear peaks observed at both gages. So, a total of 18 flood events were found over the 24-year period examined. Based on the computed flow transfers to the Allen site and the rating curve developed from the FEMA approved hydraulic model, the estimated range of peak floodwater levels at the Allen site varied from 183.6 ft to 187.5 ft (NVGD29). All these events would have flowed into and out of the storage facility, if it existed, with the smallest of these events reaching an estimated maximum height of 183.6 ft which would represent a 1.1 ft depth of water within the 48-inch pipe. Although six different years experienced two flood events each year (i.e., 1994, 2003, 2005, 2010, 2012, and 2015), no two floods occurred in the same water year. In fact, the shortest period of time observed between any two floods was almost 7 months or 187 days. That only occurred because the flood event of 6/6/2010 was only one of the two floods that occurred outside of the traditional November 1st through April 30th wet period in Western Oregon. The other non-wet period flood event occurred on 10/27/1994. The month with the most observed floods was December with 6; followed by January with 4; then March with 3; February with 2; and November with 1. Although some flood events could have been missed due primarily to missing gage records, this analysis clearly shows that there is no history of back-to-back floods on Fanno Creek with several months expected to pass between any two flood events that would be larger enough to flow into the storage facility.

Neither of these pumps are expected to operate whenever the creek level exceeds 182.5 ft (NVGD29). Also, in times of extremely high groundwater inflow and where the creek is within the operational elevation range, the larger pump or even both pumps could be used to control groundwater inflow to the basin that can't be discharged to the creek by gravity. This ensures that up to 400 gpm of pumping capacity could be provided if an extreme situation requires it.

Sincerely,

Cascade Water Resources, LLC

Roger Sutherland, PE
Principal Water Resources Engineer & President

Table 1 - Floodplain Storage Volume Calculations for the Proposed Allen Blvd Commercial Site Development

Winter Low Water Elevation:	181.06 (NAVD88)	177.56 (NGVD29)
10-yr Flood Elevation:	191 (NAVD88)	187.5 (NGVD29)
100-yr Flood Elevation:	192.2 (NAVD88)	188.7 (NGVD29)

Elevation (ft - NAVD88)	Elevation (ft - NGVD29)	Existing Volume (yd^3)	Proposed Pond Volume (yd^3)*	Proposed Parking Volume (yd3)	Proposed Volume (yd3)*	Proposed Increase in Storage Volume (yd3)
182	178.5		3870	0	3870	**3870**
183	179.5	0	8832	0	8832	**8832**
184	180.5	0	13934	0	13934	**13934**
185	181.5	0	19175	1	19176	**19176**
186	182.5	44	24558	40	24598	**24554**
187	183.5	850	30083	253	30336	**29486**
188	184.5	4627	35754	673	36427	**31800**
189	185.5	13158	41569	1691	43260	**30102**
190	186.5	26852	47517	3501	51018	**24166**
191	187.5	43867	53575	6718	60293	**16426**
192	188.5	62468	59654	13798	73452	**10984**
192.2	188.7	**66361**	60870	15705	**76575**	**10214**

*Proposed Pond Volumes at or below 182.5' won't be realized until stream elevations reach higher than 182.5' NVGD (Culvert invert filling pond will be set to 182.5' NVGD)

**Existing Elevations based on S&F Land Services survey dated 12/18/2018
***Proposed Volumes based on Land Use grading concept dated 10/26/21

****Final Grades to be modified to adjust for variations in detailed design grading and field survey.
Slight modifications to elevations may be required to balance final floodplain calculations and to meet final site layout.
*****Walls may be required around pond and parking

Total Existing Floodplain
66,361 CY
Total Proposed Floodplain
76,575 CY