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**PACIFIC**

**WATER RESOURCES, INC.**

4905 SW Griffith Drive, Suite 100, Beaverton, Oregon 97005

503.671.9709  
Fax: 503.671.0711  
info@pacificwr.com  
www.pacificwr.com

February 9, 2010 (Revised February 22, 2010)

Joel B. Komarek, PE  
Project Director  
Lake Oswego Interceptor Replacement  
4101 Kruse Way  
Lake Oswego, OR 97034

**Re: Drawdown Time Analysis for Oswego Lake  
PWR File #1294**

Dear Joel:

Pacific Water Resources, Inc. (PWR) estimates the drawdown time of Oswego Lake to 79 feet (NGVD29) would be 21 days using the 48-inch bifurcation valve together with other lake outlets including the main spillway, the 2x3 sluice gate, and the Lakewood Bay drain (20 cfs for the first 5 feet). PWR estimates the drawdown time to 79 feet would increase to 41 days if the bifurcation valve were not used. PWR estimates (for both conditions) that 63 more days would be needed to draw down the lake 3 additional feet to 76 feet, or 84 and 104 total days, respectively, with and without opening the bifurcation valve. The attached drawdown plots and table present this information in more detail.

The following paragraphs briefly describe the calculations and other issues related to these estimates.

PWR understands that the City requires estimated lake drawdown time for planning construction operations on the Lake Oswego Interceptor Replacement project. Previously PWR performed numerous studies of lake stage related to flooding events. These included PWR's June 2000 *Lakewood Bay Flood Protection at North Shore Road Bridge* report, followed in June 2003 by *Evaluation of Flood Management Alternatives for Oswego Lake and Canal*.

These studies evaluated specific flood management scenarios for the City and were based on a spreadsheet model (described in the referenced reports) of the lake during flood conditions. Work done in 2003 improved the spreadsheet model and developed a calibrated HEC-HMS simulation of the February 1996 flood event. A plot of simulated versus observed lake stages for that event matches within about 0.5 feet (see attachment). In 2005 PWR continued refining the spreadsheet and HEC-HMS models with additional studies on flow diversions at Oswego Canal from the Tualatin River. That work was done in support of updated FEMA floodplain mapping.

Thus PWR's previous lake stage studies involved flood events that resulted in a well calibrated model with high confidence of certain inflows and outflows. For this drawdown study the original spreadsheet model was modified since draining the additional lake volume without modeling inflow was not previously simulated. In particular, stage-storage and stage-discharge relationships were updated and refined.

Stage-storage relationships were extended down to the sluice gate invert (elevation 76.14) using lake bathymetry provided by the Lake Oswego Corporation (LOC). The lake is significantly deeper than this, but the sluice gate is the lowest point that drains to daylight. Areas of constant contour elevation were determined using GIS mapping techniques. These areas were converted to volumes using the conic method.

Also, discharge hydraulics were extended down to the inverts of the sluice gate (invert 76.14) and the bifurcation valve (outlet invert 79.64). This was done using standard hydraulic relationships based on structure measurements taken during previous assignments. Equations for culverts and orifice control were used as appropriate for the sluice gate, and a step-backwater analysis was done for the bifurcation valve-flume outlet path. Discharge estimates were performed for partial and full flow conditions on each structure and curves developed of flow versus stage. PWR retained the previously developed elevation-discharge curve for the spillway (invert 96.14) and modeled outflow through the Lakewood Bay drain as a constant 20 cfs for the uppermost 5 feet, below which the bay would be cut off from the main lake at North Shore Road (per communication from LOC, and consistent with bathymetric mapping). The lake drawdown would not noticeably change if the Lakewood Bay drain were not used.

Drawdown time was calculated using a 60 minute time step for most of the simulation period. A longer 1-day time step was used for the lowermost elevations (below about elevation 77) to obtain a drawdown time to within 0.1 feet of the requested full drawdown of 76 feet. Standard reservoir routing equations as described in our June 2000 report (noted above, p 12) were used. The major difference with this drawdown routing was that **no inflow was included**.

Thus the drawdown estimates are the shortest possible. Much longer times are likely at the lowest elevations and the lake may not be able to be drawn down to 76 feet at all during the winter months. The modeled assumption of no inflow is certainly false, but provides a best-case limit. Groundwater exfiltration may add enough inflow to significantly extend drawdown times. Below 78 feet, outflow from the lake is less than 13 cfs. Below 77 feet, outflow is less than 4.5 cfs. Groundwater may contribute more than these outflows, which will limit drawdown to a higher elevation.

Furthermore, stormwater runoff from the local watershed will cause the lake elevation to rise significantly. A previous lake drawdown of about 10 feet (down to about 89 feet) was filled again using only rainfall starting in mid-December to the end of February (2-1/2 months, about 75 days). With no lake outflow, that 75-day runoff would fill the lake from 76 feet to 88.5 feet. The drawdown time from 88.5 feet to 76 feet would be 78 days with opening the bifurcation valve and 87 days without the bifurcation valve. If the rainfall and outflow occur together, the drawdown time would be even longer (lower average head and outflow). The lake will function as a very large detention basin and will accumulate storage from multiple back-to-back rainfall events days apart. ***Continuous modeling would be needed to estimate the potential fluctuation in lake drawdown elevation during the construction window.***

***PWR recommends that we modify our model to use historic inflow records for Springbrook Creek to model the stage-duration probabilities for Oswego Lake.***

A related issue is the degree of calibration of the outflow hydraulics. PWR's previous modeling work focused on the high flows and the overflow spillway hydraulics and was very well calibrated

(see attached figure 6 from a previous report). Anecdotal information from the LOC indicates that the lake drained 10 feet in 7 days, which means five full days plus an unknown portion of the first and last days. This is consistent with our model.

***We recommend that as the lake is drawn down, the City record the stage versus time along with inflows from Springbrook Creek*** (the largest drainage) so that the outflow hydraulics can be better calibrated. This in turn will allow the potential fluctuation in lake water surface elevation during the draw-down window to be better anticipated.

Another issue is whether the rapid initial drawdown might destabilize lake shorelines. From the drawdown plots (see attachments) it is estimated that lake stage may initially drop nearly two feet per day. As this occurs water stored in the banks and behind the seawalls of the lake will leave the soil pores to follow the declining lake surface. We understand from the Lake Oswego Corporation that bank sloughing has not been an issue during previous drawdowns.

As we described above, drawdown rates slow significantly in the bottom one-third of the curve. This is due to the lower driving head on the sluice gate (there is no flow through the bifurcation below 79.64 feet). Groundwater exfiltration may limit drawdown. Also, surface water runoff from storm events may cause rapid increases in lake stage.

Please feel free to contact me with any questions about this analysis, or if we can be of further assistance in looking at some of these issues.

Sincerely,  
Pacific Water Resources, Inc.



Seth Jelen, PE  
Principal Engineer

xc: files

Attachments:

1. Figure 6 – HMS Model Calibration, Lake Oswego Elevation – February 1996 Flood
2. Plots of Lake Drawdown Curves