NEWFIELDS

TECHNICAL MEMORANDUM

TO: RENE FUENTES (EPA REGION 10)

FROM: PETER TOWNSEND (NEWFIELDS, LLC)

SUBJECT: ESTIMATES OF POTENTIAL WEIR OVERFLOW

DATE: 6/20/2007

CC: ANNE SUMMERS (PORT OF PORTLAND); SEAN SHELDRAKE (EPA REGION 10)

INTRODUCTION

This memo describes the methodology used to estimate the potential rate and duration of weir overflow during filling of the Confined Disposal Facility (CDF) at Port of Portland, Terminal 4. Weir overflow is unlikely to occur because ponded water levels in the CDF can be controlled through management of dredge filling rates and work schedules. This analysis is being done, however, to provide conservative estimates of flow and duration of a discharge under relatively extreme conditions to help evaluate water quality impacts and permitting requirements for CDF construction. The analysis presented herein is conservative (i.e. biased toward conditions conducive to weir overflows) because it is based on an improbable combination of high dredge inflow volumes, low hydraulic conductivity of the berm, and no management intervention, all of which tend to maximize estimates of ponded water elevation in the CDF during filling. In reality, this combination is unlikely to occur.

METHODOLOGY

This analysis uses the same methods as presented in the *Short-Term CDF Hydraulic Boundary Condition* technical memorandum. A spreadsheet model is used to estimate the CDF ponded water elevation using a water balance calculation. The water balance calculation is based on the following relationship:

$$\text{Inflow} = \text{Outflow} + \text{Change in storage}$$

Figure 1 illustrates the components of the water balance. "Inflow" includes dredge inflow from CDF filling operations plus groundwater inflow from the headland area. Dredge inflow is based on the expected duration and rate provided by dredging operation estimates. The following CDF filling scenario was evaluated:

- 25 cubic feet per second (CFS) dredge inflow rate; 11-day duration; 20-hours on and 4-hours off each day.
- Maximum weir elevation of 25 feet NGVD.

NewFields, Inc.
730 17th Street, Suite 925
Denver, CO 80202
303-294-0950 *tel* ~ 303-294-9220 *fax*

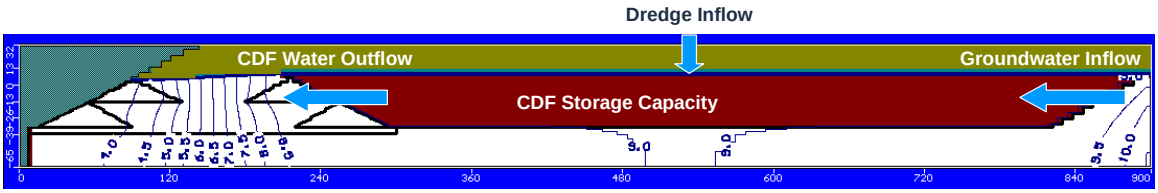

Figure 1: Components of the water balance used in spreadsheet calculation to estimate CDF ponded water elevation during the short-term filling period.

These parameters are based on discussions with the construction contractor (Manson Construction) who evaluated their proposed equipment and reviewed the dredge plan to develop an estimated dredging duration and discharge rate. In order to be conservative for estimating the duration of weir overflows, the upper end of contractor-supplied inflow rates that can be expected from the proposed hydraulic dredging methods, a reasonable scenario for daily operations, and the length of the overall dredging activity at Terminal 4 were considered in the evaluation.

Groundwater inflow and CDF water outflow are estimated by a cross-sectional groundwater flow model. The groundwater model is used to develop a relationship of net groundwater outflow as a function of CDF ponded water elevation. Table 1 lists the assumed hydraulic conductivities (K). The berm fill K estimate is the low end of the range[1] anticipated. Use of the low-end K value will result in the maximum estimate (i.e. upper-bound) of ponded water elevation and potential weir overflow during filling operations.

Table 1: Assumed material hydraulic conductivities.

Material	Hydraulic Conductivity K (ft/day)
Berm fill	30
Training dikes	2,800
Aquifer	65

A constant head of 3.8 ft NGVD is assumed in the Willamette River. The CDF ponded water is also represented by a constant head. Multiple steady-state flow simulations are performed with the elevation of the CDF ponded water fixed to a value between 3.8 ft and 25 ft. The resulting groundwater outflow from each simulation is recorded. The estimated groundwater outflows are illustrated in Figure 2. A second-order polynomial is fit to the data. The relationship provides the groundwater component in the water balance calculation. An average berm width of 400 feet was used to obtain a total groundwater outflow based on CDF ponded water elevation.

[1] The berm select fill grain-size specification and Hazen approximation was used to estimate the berm K range (range 30-450 ft/day).

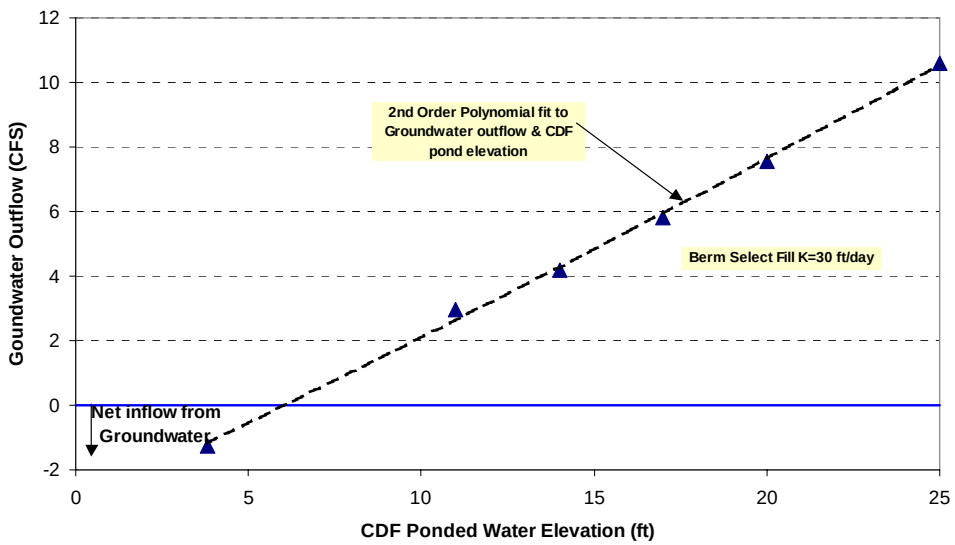

Figure 2: Estimated relationship of groundwater outflow and CDF ponded water elevation.

Storage is the volume of water retained in the CDF. The CDF capacity versus CDF elevation relationship is used to estimate storage. Figure 3 illustrates the CDF elevation versus capacity relationship, as documented in the Terminal 4 Design Analysis Report. Figure 4 illustrates the polynomial fit to these data. The relationship provides the storage component in the water balance calculation. The assumed starting elevation of the water within the CDF was 4.5 feet.

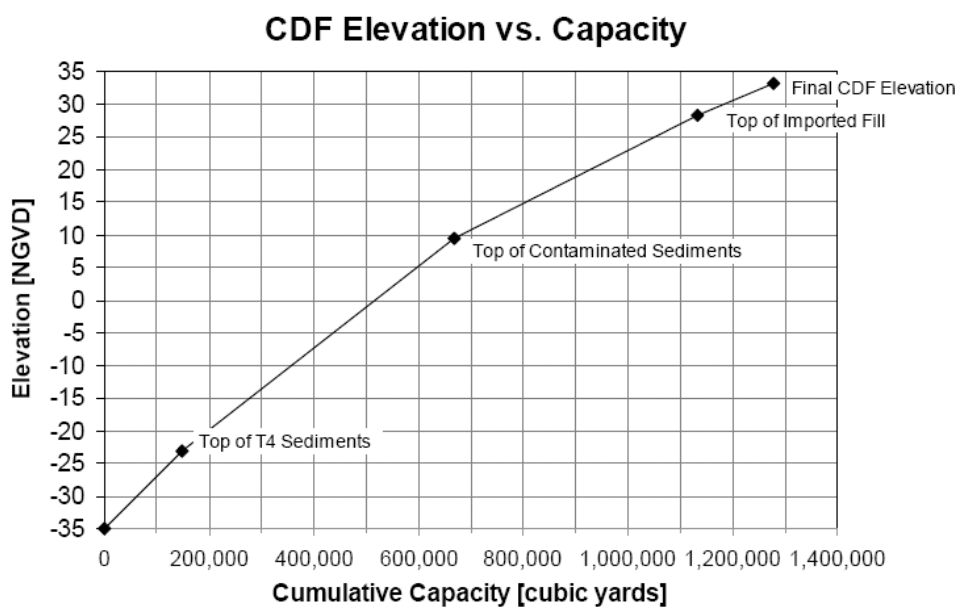

Figure 3: CDF elevation versus storage capacity

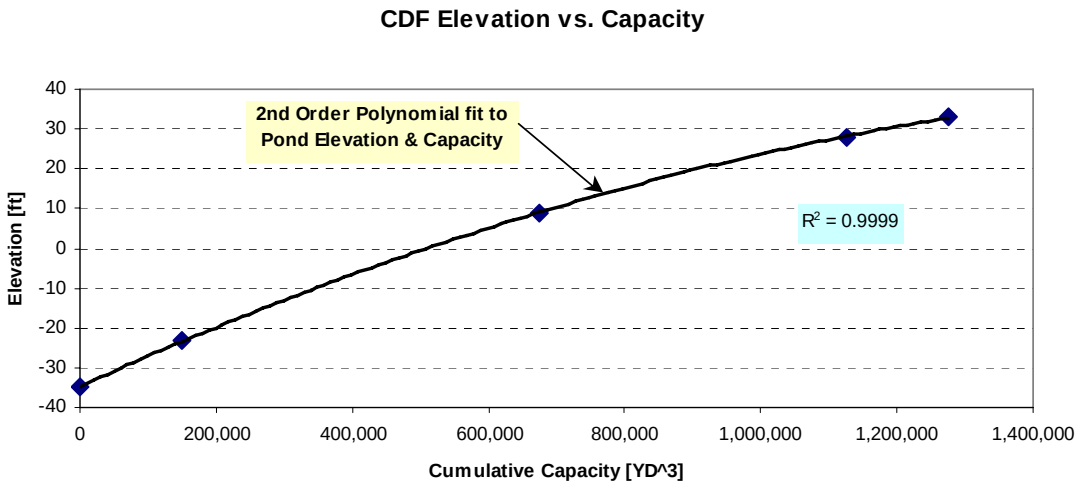

Figure 4: CDF elevation versus storage capacity and 2nd-order polynomial fit to the data.

RESULTS

Using the conservative water balance relationship and components discussed above, it is possible that the maximum CDF ponded water elevation could exceed the maximum weir height and overflow could occur. Figure 5 illustrates the estimated CDF ponded water elevation change and weir overflow rate for the filling scenario of T4 dredging. As shown on Figure 5, the CDF ponded water elevation increases to the maximum weir height of 25 feet during the ninth day of CDF filling. Under these conditions, weir overflow would occur for approximately 1.5 days at a rate of 14.6 CFS before dredging is completed, the pond elevation drops below 25 feet, and overflow ceases.

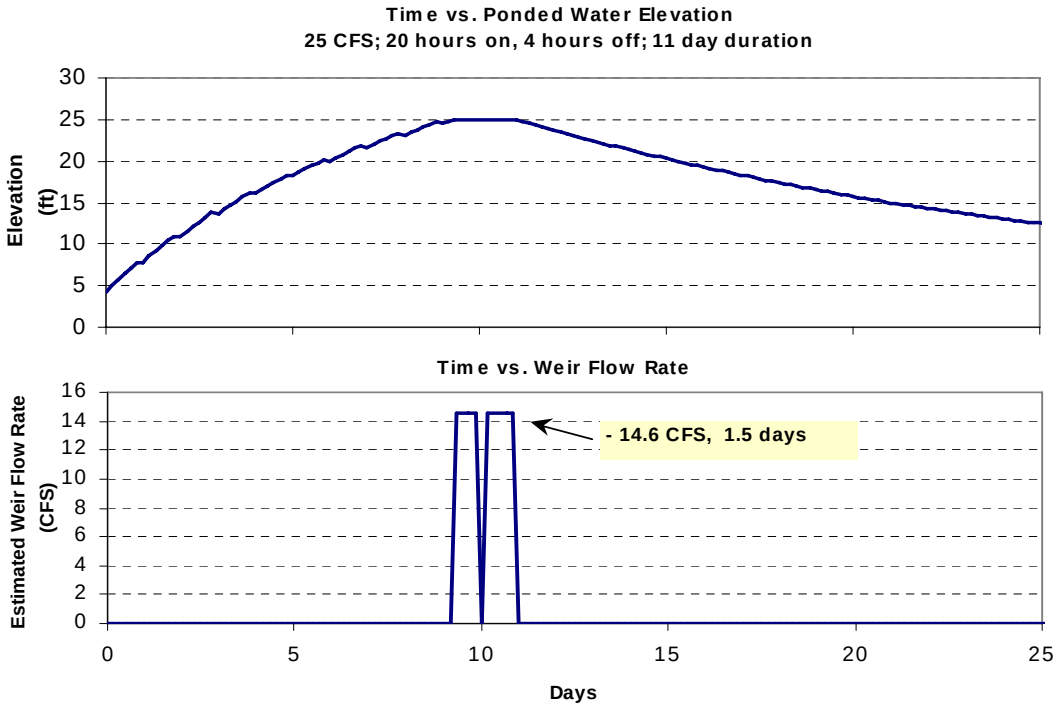

Figure 5: Estimated CDF ponded water elevation and weir overflow rate.

LIMITATIONS AND UNCERTAINTIES

The duration of the filling scenario (11 days) assumes a dredging production rate of about 350 cubic yards of sediments per hour (cy/hr). This production rate corresponds to a conservatively high estimate of the volume of water to be pumped into the CDF for the case of a 17-inch dredge, the Terminal 4 sediment types, and the pumping distance. Under ideal conditions a dredge of this size could have production rates as high as 500 to 700 cy/hr, but would not increase the flow rate of water being pumped compared to a 350 cy/hr production rate. Because the dredge works at a higher production rate, the dredging would be completed sooner, perhaps in 5 to 8 days rather than the assumed 11 days. The dredge would pump at the same flow rate of water but with higher percent solids, thereby operating at a higher efficiency. Therefore, a shorter duration filling event would result in a lower peak elevation of the ponded water at the end of dredging. Thus, weir overflow would be less likely.

The weir overflow estimate is based on the low-end estimate of berm K, which represents a conservative scenario of weir overflow potential. Although the assumed K is at the low-end of the K range for the berm fill, the filling of the CDF could potentially reduce the berm and alluvium K over time as finer-grained sediments in the dredged material fill the pore space of these coarser-grained berm and foundation materials. The lower hydraulic conductivity would result in a lower CDF water outflow through the berm and alluvium. This scenario would result in a more rapid increase in CDF ponded water elevation and, potentially, an increase in weir overflow rate and duration. Minimizing the suspended sediment within the ponded water during CDF filling could help to reduce potential "clogging" effects. Moreover, modifications to dredging operations could also be used to minimize weir overflow as necessary.

Finally, the groundwater model used to estimate outflow from the CDF is based on a steady-state model. A steady-state model does not account for storage in the berm and alluvium. Thus, the estimated CDF water outflows through the berm and alluvium are under predicted. In other words, as the CDF water level rises, the berm and alluvium would provide additional storage capacity compared to the model predictions. The result is a larger volume of CDF water flowing into the berm and alluvium, a less rapid increase in CDF ponded water elevation, and a decrease in weir overflow duration.