Norm Crawford: Recommendations to POS

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# Notes on HSPF Modeling of Miller, Walker and Des Moines Creeks:

## Linkages between HSPF and Hydrus/Slice

The land surface surrounding the new runways and taxiways at Seatac is modeled as outwash grass, a type of pervious land segment (PERLAND). The active runoff flowpaths for outwash grass are surface runoff and groundwater; interflow is not modeled. Surface runoff is small and has previously been neglected. The only significant active flowpath is groundwater.

The impervious surfaces of the new runways and taxiways can be modeled as an HSPF impervious land segment (IMPLAND). Surface runoff from the runways and taxiways flows into swales where infiltration into the fill will occur. This infiltration can be added to the percolation below the root zone (AGWI) found by modeling the land surrounding the new runways and taxiways as outwash grass with a DEEPFR parameter of zero. Any surface runoff from the pervious land should be accounted for and sent to the proper flowpath.

Percolation from the pervious land below the root zone and infiltration of surface runoff from the impervious land are input to Hydrus. This inflow to Hydrus accounts for actual evaptranspiration from the pervious land and actual evaporation from impervious surfaces. The Hydrus inflows move vertically and are attenuated and delayed by amounts approximately proportional to the depth of the fill before it reaches a cell in the Slice model.

The Slice model handles lateral flow toward the toe of the new fill in the drain layer and in the soils that overlie the Vashon till, and calculates flux through the Vashon till into underlying Vashon advance soils. The Slice model includes an assumption in each cell for the elevation of the water table relative to the Vashon till layer. The water table in a cell may be;

- (i) above the surface of the Vashon till.
- (ii) below the Vashon till
- (iii) within the Vashon till

If the water table is above the surface of the Vashon till, no seepage occurs through the till — there is no hydraulic gradient across the till. If the water surface is below the Vashon till, seepage through the till is proportional to the hydraulic gradient across the till, which will include any water depth in the soils or drain layer above the till. If the water surface is within the Vashon till seepage through the till calculated as in (ii) but is reduced by one-half.

The water table elevation in each Slice model cell is fixed, invariant in time.

The following are a summary of recommendations for additional runs of HSPF and Hydrus/Slice. Most of these recommendations have been discussed with the modelers who are doing the runs.

1) Calculate the runoff (SURO) from the impervious surfaces within the new fill areas with an HSPF IMPLAND segment. This will properly account for surface retention and actual evaporation from the runways/taxiways.
2) Calculate the infiltration (AGWI) into the pervious areas surrounding the new runways and taxiways with an HSPF PERLAND segment for outwash grass with a DEEPFR parameter of zero.
3) Use the combined impervious surface runoff (1) and pervious active groundwater inflow (2) to represent the percolation below the root zone. This is the input to Hydrus.
4) Account for any surface runoff (SURO) from the outwash grass PERLAND segment. This surface runoff may be small but its fate should be included for completeness.

(steps 5 and 6 are identical to prior model runs)

5) Hydrus moves water vertically into the Slice cells, delaying and attenuating the AGWI flux and infiltrating runoff from impervious surfaces.
6) Slice moves water laterally to the toe of the fill (or to the last active cell that is down gradient) as 'groundwater outflow' to a stream, and moves water across the Vashon till as 'till seepage' where the hydraulic gradient across the till allows.

(steps 7 and 8 differ from prior model runs)

7) Reduce the till seepage by 0.33 (multiply by 0.67) to account for inactive groundwater recharge (DEEPFR).
8) Sum the groundwater outflow and the reduced till seepage. Return this combined flow to the stream without additional routing (INFLOW IVOL).

In step 7), any losses to inactive groundwater must occur at depth in the Vashon advance formation. It is reasonable to believe that the fraction of inflow to the Vashon advance formation that is lost to inactive groundwater will be the same after construction of the fill as that found prior to construction of the fill.

In step 8), a choice must be made for handling flows that will return to stream channels. Till seepage in the Slice model is not delivered to the toe of the fill, but occurs along the cross-section. It can be argued that attenuation of till seepage will occur as water is moving toward the toe of the fill. A groundwater element for outwash grass with the calibrated recession constant was used in prior runs to attenuate till seepage.

There are two contrary arguments to this approach. First, if attenuation is occurring in the Vashon advance formation then the water table elevation in this formation would be time variable. The fixed water table elevations used in the Slice model to calculate till seepage and groundwater outflow above the till would be incorrect. Second, the fill cross-section is man-made. Flowpaths in the fill are very different than the flowpaths calibrated in HSPF. There is no basis for assuming that a calibrated recession rate for active groundwater outflow from outwash grass is applicable to the groundwater flowpath within the Vashon advance formation.

Time delay and attenuation in the fill is calculated by Hydrus. When the Hydrus outflows are used in the Slice model, the presence of the drain layer limits the hydraulic gradient across the Vashon till and further attenuates the flow entering the Vashon advance formation. Adding still more attenuation through HSPF groundwater storage in the Vashon advance formation will not greatly change the timing of groundwater outflow from this formation to streams.

Given the Slice model assumption of a fixed water table in the Vashon advance formation, it is more reasonable to move water to the toe of the fill without further attenuation, i.e. return the till seepage direct to the stream.

## Additional Issues

9) The pervious land areas given in the Miller/Walker Creek Master Area Table master tables do not correspond with the areas in the HSPF input files for the 1994 condition at Miller and Walker Creeks and for the future scenario at Walker Creek. There are no 1994 calibration values in this spreadsheet. These differences should be reconciled.
10) The Hydrus/Slice model calculates runoff from an area of 128 acres (Miller 111.67 acres, Walker 16.33 acres). An area of 124.27 acres was removed from HSPF (116.22 acres Miller, 8.05 acres Walker). Even if the distribution of the areas between Walker and Miller is different due to the different future and 1994 basin boundaries, the total area should be equal.
11) Future base flows from the SDW1A infiltration (Reach 47, 2nd outlet) and SDW1B flow splitter (Reach 47, 2nd outlet) are lost in the HSPF model. These flows should be re-infiltrated to a pervious land segment as active groundwater inflow and returned to the creek. The input file should be changed to include these flows.

All other HSPF setups have checked out. Tracey is currently checking the full water balance in Des Moines and expects to finish this task by Oct 3rd.

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