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Innovative Approach to Reconciling Regional Cumulative Effects with the Desire for Local Scale Integrated Predictions

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Groundwater in Alberta is one of the major sources of water for industrial projects and municipalities. Withdrawal of groundwater that is in hydraulic communication with surface waterbodies has the potential to contribute to stream flow reduction that can lead to negative environmental effects. In such cases, groundwater-surface water interaction is often one of the key stakeholder concerns. The sciences of hydrology and hydrogeology have provided valuable frameworks, tools and mathematical relationships that enable a better understanding of the hydrologic system. The development of modern software allows linking hydrologic and hydrogeologic sciences; such linkage enables more physical quantification of potential environmental effect such as stream flow reduction during low flow periods.

This presentation describes an innovative approach to completing integrated modelling in North Eastern Alberta using the example of a proposed project that plans to source groundwater from a Quaternary-aged aquifer. The Quaternary-aged aquifer is of regional extent, intersects multiple watersheds, and was identified as having the potential for groundwater – surface water interaction. The potential environmental effect from the proposed groundwater usage is expected to be focussed in the vicinity of the groundwater supply wells in a single sub-watershed. However if the modelling effort were limited to the single sub-watershed: 1) the model boundaries applied to the aquifer would exert an overly-large influence on the predicted effects; and 2) the model predictions would be ignoring the cumulative effects of other operators who are also withdrawing water from the Quaternary-aged aquifer. This challenge of selecting an appropriate spatial extent for integrated modelling is a common problem in the North Eastern Alberta region where there are multiple groundwater users in most regional aquifers.

To solve this problem of scale, a regional numerical model of groundwater flow (using FEFLOW software) was constructed and simulation results were coupled with a local-scale integrated surface water and groundwater model (using MIKE SHE software). The regional subsurface change in hydraulic head was linked to the MIKE SHE model as time-varying boundary conditions. In this manner the proposed project's local environmental effects on the hydrologic system could be assessed while considering cumulative effects on a regional scale.

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