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Using Modelling to Improve Wastewater Disposal Strategies

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In the Athabasca Oil Sands where deposits are too deep to mine, steam assisted gravity drainage (SAGD) is commonly used to facilitate the in-situ recovery of bitumen. Despite high water recycle rates, steam generation processes produce wastewater that requires subsurface disposal. The basal McMurray aquifer is the most commonly used disposal zone by SAGD operations. However, where the basal McMurray aquifer is in direct hydraulic communication with the overlying bitumen reservoir, disposal into this zone can create substantial operational challenges for steam injection. Another common challenge is when the basal McMurray aquifer is also being used as a water source zone; in this case the rate and extent of wastewater migration can pose a risk to project operations. As a result, SAGD operators have made significant efforts exploring for and evaluating alternative disposal zones with varying degrees of success. This work explores three distinct modelling efforts that were applied to support three disparate wastewater management questions in the vicinity of the Jackfish and Pike projects.

On behalf of Devon Canada (Devon), Matrix completed several modelling initiatives looking at the risks and benefits of alternative disposal zones. The three separate modelling efforts are considered in this talk are:

1. A 3D model of groundwater flow and particle tracking simulations, which were used to assess the possible effects of fluid injection into the Lower Grand Rapids. The simulations were undertaken to test the hypothesis if an area of stagnant groundwater in the Lower Grand Rapids (which is also interpreted to responsible for the observed high groundwater salinities in this area) has the potential to be an effective zone of containment for disposal fluids.
2. A 2D, highly parameterized model of groundwater flow for the basal McMurray aquifer was constructed and calibrated to assess the effects of groundwater withdrawal and fluid injection on formation pressures near the bitumen reservoirs and to test the feasibility of water use and disposal plans.
3. A 3D model of groundwater flow and mass transport for the McMurray Formation and multiple geostatistical realizations of probable facies distributions were used to assess the likelihood of withdrawing disposal fluids at groundwater supply wells.

It will be illustrated how the three modelling objectives influenced the modelling approach, model parameterization and methods to quantify prediction uncertainty while the hydrogeologic conceptual model for each of the model efforts is largely unchanged since 2006 when Devon submitted their Jackfish 2 Project Environmental Impact Assessment.

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Mr. Gordon MacMillan has 15 years of experience as an environmental consultant providing project management, technical review and technical support for subsurface investigations and environmental impact assessments. Mr. MacMillan provides technical leadership and review to Matrix's Hydrogeology team and is responsible for the technical quality of numerical modelling in western Canada. His experience includes developing conceptual models of groundwater flow from local to regional scales, designing and analyzing longterm aquifer tests, and identifying potential reservoirs for water supply, wastewater disposal and carbon sequestration. Mr. MacMillan has extensive experience providing analytical and numerical modelling of groundwater flow and groundwater transport in support of regulatory applications, groundwater remediation networks and groundwater supply projects.