geoconvention
Calgary • Canada • May 15-19 2017

# COSIA Regional Groundwater Solutions Project for the Southern Athabasca Oil Sands – Evolution of A Numerical Model

*Mike Brewster, MSc P.Geol*
*Project Lead COSIA Regional Groundwater Solutions Project, Devon Canada*
*Louis-Charles Boutin P.Eng.*
*Matrix Solutions Inc.*

## Introduction

The Canada's Oil Sands Innovation Alliance (COSIA) Regional Groundwater Solutions (RGS) project was established to evaluate the potential range of change in aquifer pressures resulting from groundwater withdrawals and disposal associated with future in situ bitumen production within the Southern Athabasca Oil Sands (SAOS) region. Main objectives of this project were:

- provide COSIA members with a regional groundwater risk assessment and management tool;
- set a baseline to answer groundwater resource availability questions; and
- evaluate realistic water source and disposal forecasts for industry growth.

The SAOS numerical groundwater flow model was originally developed for the Government of Alberta (GoA) in 2009 (WorleyParsons 2010). The model was loaned to COSIA for the RGS project, where it was updated and re-calibrated to the most recent industry water use data. In 2016, Matrix Solutions Inc. was retained to undertake model update and computationally intensive coupled steady-state and transient calibration using PEST software (Matrix 2016).

## Summary

As a first step, the numerical model's material properties zones, numerical settings, and boundary conditions were modified from its initial state. The number of adjustable parameters was also modified, and Cauchy boundary condition's transfer rates were tied to elements' hydraulic conductivities.

Calibration targets for the inversion included; water table depth, 209 measured hydraulic heads in industrial groundwater wells, 724 hydraulic heads inferred from industry data such as drill stem tests, and 13 years of transient hydraulic head data that was reduced to 21,782 monthly changes in hydraulic head. The calibration process required harnessing the power of cloud computing, allowing for up to 100 model runs to be solved simultaneously for a total of 3,310 hours (equivalent to 138 days of continuous CPU time if the model had been solved in series). Through the inversion process, measured observations were compared to simulated values (i.e. residual). During steady-state calibration, residuals' mean and standard deviation statistics are often used to quantify the precision and accuracy of the calibration misfit quality. These statistics can also be used for transient calibration, although, additional insight can be gained when exploring statics related to residual trends versus time. This presentation describes an innovative approach to computing an arbitrary Global Transient Misfit Quality Indicator (GTMQI) which allows visualization of the spatial distribution of transient misfits, based on statistics.

## Acknowledgements

COSIA Regional Groundwater Solutions Project Participants

Louis-Charles Boutin, Matrix Solutions Inc.

Maxime Claprood, Matrix Solutions Inc.

Gordon MacMillan, previously at Matrix Solutions Inc.

Paul Martin, Matrix Solutions Inc.

**References**

Matrix Solutions Inc. (Matrix). 2016. *Construction and Calibration of the Regional Groundwater Solutions Southern Athabasca Oil Sands Numerical Model of Groundwater Flow.* Report prepared for Canada's Oil Sands Innovation Alliance / Government of Alberta. December 2016.

WorleyParsons Resources & Energy (WorleyParsons). 2010*. Groundwater Flow Model for the Athabasca Oil Sands (In-situ) Area South of Fort McMurray Phase 2.* Report prepared for Alberta Environment. December 17, 2010.