GROUNDWATER & ENVIRONMENT NEWSLETTER

A PERIODIC NEWSLETTER COMPILED FOR HYDROGEOLOGICAL & ENVIRONMENTAL PROFESSIONALS IN W.A. INDUSTRY, MINING & RESOURCE COMPANIES

Issue 9, July 2008

GROUNDWATER NUMERICAL MODELLING

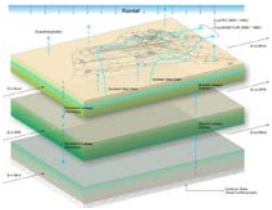
The process of quantifying & predicting the groundwater flow within an aquifer system using a computer representation. A successful model may incorporate degrees of complexity of a natural system which may not be adequately represented by simple/ idealised analytical or water balance models. It will allow predictions of response to stresses, such as abstraction, landuse & climate changes etc.

Conceptual Hydrogeological Models

A conceptual model is a description & idealised quantification of groundwater occurrence, flow mechanisms, controls on flow and interactions with other natural systems, such as:

- Time variant abstractions
- Discharges to/ from surface water
- Loss by evapotranspiration/ support phraeotophytic vegetation/ leakage
- Recharge from direct rainfall/ leakage/ artificial recharge/ aquifer storage & recovery (ASR) etc

A conceptual model demonstrates the hydrogeological understanding of the aquifer, forming the basis for the numerical model.



Hydraulic Models

Hydraulic models provide a description of the groundwater occurrence & flow. They are the initial fundamental step in aquifer representations. Types of hydraulic models were discussed in Issue 5. Typical applications include:

- Sustainable resource assessments
- Abstraction Impact/ interference
- Borefield management
- Dewatering assessments
- Baseflow impact on discharges
- Wellfield protection zones.

SOLUTE TRANSPORT

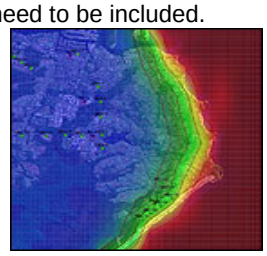
Solute transport models are built upon an initial calibrated hydraulic model. They seek to describe the movement of natural or man-made chemicals within groundwater in response to migration down the flow path or imposed stresses such as abstractions.

Natural Systems

Examples where movement of background chemicals may be important:

- Seawater intrusion from abstraction at the coastline (e.g. Bunbury)
- Saline intrusion into a freshwater aquifer (e.g. Gascoyne River floodplain)
- Management of (light) fresh groundwater lenses above (dense) saline groundwater on small islands (e.g. Rottnest).

Models used for these assessments include e.g. MODFLOW/MT3DMS with SEAWAT variable density flow module, where density/ viscosity/ heat transfer effects need to be included.



Contaminants

Contaminants are chemicals, water of differing quality or energy introduced into an aquifer that impairs/ prevents the beneficial use of groundwater (e.g. drinking water/ support of aquatic ecosystems etc). Typical examples:

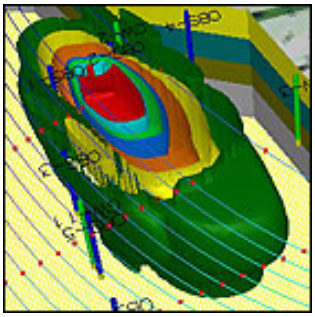
- Boiler blow-down (hot) water discharged into an unlined pond
- Point sources, e.g. Leaking underground storage tanks (USTs), typically hydrocarbons from service stations, chemicals etc
- Diffuse sources, e.g. excess fertiliser applications as run-off recharge.
- Waste injection (e.g. licensed deep WI operation in Kwinana)
- ASR systems, where water (e.g. treated sewage) is recharged to temporarily store additional water. (e.g. Water Corporation Groundwater Replenishment Trial to the Leederville Aquifer at Beenyup)

It is often necessary to predict solute movement impacting on natural groundwater quality/ abstractions or discharge to surface water bodies.

Solute Transport Models

The movement of solutes within groundwater is affected by advection (movement within bulk groundwater flow, dispersion (spreading), density variations, heat transfer and chemical reactions (e.g. adsorption, hydrolysis, biochemical decomposition etc). Numerical models need to represent the significant conceptual complexities of the system; models typically used for these assessments include:

- MODFLOW with:
  - MT3DMS: 3D multi-species with reactive transport
  - RT3D: reactive solute transport
- FEFLOW: finite element model
- MARS2D/3D (finite-element model for groundwater & LNAPL migration with:
  - Biof&t: transient multi-solute L/DNAPL flow simulation



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Next issue – Modeling LNAPL recovery

Slurp/ suck or vent?

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