

Summary of MAR related Papers and Awards

Australasian Groundwater Conference 2019 25-27 Nov 2019 Brisbane

prepared by Peter Dillon for IAH Commission on MAR

There were 5 parallel streams having 300 oral papers and 77 poster papers. As MAR was not a session theme the 17 papers with a focus on MAR were dispersed through the program.

David Schafer (UWA) described the reactive transport processes governing **fluoride release and attenuation** in the Leederville aquifer (Perth Groundwater Replenishment Scheme) using lab batch experiments, field data and PHT3D modelling and showed that carbonate rich fluoro-apatite was the dominant source, peak concentrations were within drinking water guidelines and attenuated through reprecipitation. Adding calcium chloride to injectant was evaluated in lab studies and could be considered, as a backup if needed in future sites if elevated F release is an issue.

Paul Magarey (Groundwater Science) described episodes where ASR with stormwater in a confined aquifer on the Adelaide Plains led to artesian flowing wells. These were due to **cumulative impacts of ASR**, and in part due to decline in groundwater extraction by industry. There is no groundwater management plan for the area although one has been in development for 12 years.

Larysa Hayes (Geoscience Australia) described an interdisciplinary approach to determining the storage capacity of an MAR site in alluvial aquifer on the River Darling using sonic drill core analysis, including clay content, electrical conductivity of pore fluid, downhole geophysics and airborne electromagnetic surveys. This allowed **probabilistic estimates of storage capacity** for MAR design.

Benjamin Birt (Cteq) winner of the inaugural IAH groundwater innovation and technology award- for leading the introduction of **Borehole Nuclear Magnetic Resonance logging** techniques in Australia described how the NMR detected hydrogen in the formation, which had correlations with porosity and with permeability as derived from pumping tests. It has also been used to log existing wells (not with steel casings) at MAR sites, including Perth Groundwater Replenishment Scheme.

Cassie Turvey (RPS) described the feasibility study for improved water management including **MAR in an urbanising area with shallow water table** at Rockingham south of Perth. Subsurface drainage has been installed to prevent excessive rise in water table and these have now become perennial drains. 7ML/ha is discharged, at better quality than native gw and suitable for irrigation, but has high Fe and Mn. Up to 3Mm³/yr will be available in winter for recharge and 3 wells are proposed to be installed 2 with continuous recharge to the confined Leederville aquifer and one ASR well for injection and recovery. The main remaining investigations are to determine the degree of confinement of the Leederville aquifer in this area and treatment requirements for Fe and Mn.

Peter Reeve (Flinders Uni) described the development of experiments using a common standard design from Europe (DEMEAU 2015) for **column studies of fate of selected anthropogenic organic chemicals** in aquifer materials (Port Willunga limestone, Adelaide) with and without biofilms. Preliminary batch studies suggest biofilm presence does not influence sorption to this material but ongoing column study work aims to elucidate whether biofilm presence could impact factors such as biodegradation under differing environmental conditions.

Craig Flavel (Water Technology) described a **pre-feasibility study for MAR opportunities for all of Sri Lanka**. Lack of basic data on aquifers, existing and projected water shortages, and a very short time scale made this an ambitious project that led to recommending several sites for demonstration projects, by necessity focussed on areas where hydrogeology was better defined. Cascade check

dams have been in use for 2000 years in this area to buffer small-scale irrigation and drinking water supplies.

Peter Dillon (CSIRO/Flinders) discussed **possible changes to Australian MAR Guidelines based on a review of experience** in application and in new research in the 10 years since they were produced. Only minor changes are needed, the largest of which is to include temperature as a hazard to be managed in cases of geothermal reinjection, aquifer thermal energy systems and operations where the aquifer is relied on for water quality improvement.

Karen Barry (CSIRO) presented results of field research on the northern Adelaide Plains for the **removal of total organic carbon, total nitrogen and total phosphorus at four stormwater ASR sites**. Analyses were based on comparing frequency distributions for concentrations in injected and recovered water. This showed 50th percentile removals across the 4 sites of 51-59% for TOC, 0-49% for TN and 29-53% for TP. These sites have been in operation for at least 10 years, and no change in removal has been observed over this time, but studies on the fate of removed nutrients would improve understanding of the sustainability of operations.

Andrew Ross (ANU) spoke on his **summary of costs and benefits derived from 26 operational MAR sites**. Sites using natural waters had lower costs than using recycled waters and infiltration schemes had lower costs than those with recharge wells. Benefits derived from avoided costs or net value of additional agricultural production gave benefit: cost ratios between 1.5 and 7.5. The full results will be published in a UNESCO book in 2020 on MAR case studies.

Louise Lennon (Jacobs) described a desktop study to assess the **feasibility of several water supply options including MAR for developing agriculture in part of the Northern Territory**. Water use is less than allocation at present and options included (a) do nothing different, (b) training and capacity building for farm use to increase to allocation, (c) small scale MAR at sites with identified potential, and (d) store water in above ground dams. Taking account of production and transport costs for the most profitable crops, (b) was most economic, followed by (c) or (a) with (d) last. However more investigations are required to produce specific designs and costs.

Yogesh Jadega (ACT Gujarat, India) evaluated **community-centric aquifer management strategies in coastal regions of Gujarat with a focus on local aquifer management institutions** for self-dependent adherence to managing water demand, and for monitoring and maintenance of stream bed recharge structures.

James Hansen (Qld Gov) spoke about a prefeasibility study to assess the **potential for sand dams and subsurface dams**. This 'Underground Technologies Prefeasibility Study' was a broad-scale GIS study produced mapping products to identify alluvial areas with prospects for further investigations for increasing subsurface water storage.

Kirstten Brouns (Mandalay Resources) described potential for aquifer recharge for **mine water disposal** (which she correctly said was not MAR) where a gold and antimony mine at Costerfield in Central Victoria had been given a Research, Development and Demonstration Licence to reinject 730ML of dewatering water into the same saline aquifer for recirculation to avoid expanding surface water storage and treatment plant. They would be monitoring including the movement of a nitrate and antimony plume in the aquifer.

Jonathon Hanna (BHP Resources) described **BHPs return of dewatered water at iron ore mines to aquifers for future beneficial use**. This was an integral part of BHPs mine plans at 5 sites, and accounted for an increasing proportion of the 65Mm³/yr of water produced,. BHP aim to maximize

MAR to accord with BHP's Water Stewardship Position Statement aligned with UN SDG 6. Technical uncertainties included estimation of future volumes of extraction and of MAR capacity. Good quality water was needed to support minesite rehabilitation at mine closure.

Mal McGivern (BHP) followed by describing a surplus water operationalisation program to address **controls and managing the environmental, regulatory, operational and maintenance risks and interconnections with potable water sources.**

Ryan Morris (RDM Hydro) and Lauren Helm (Origin Energy) described the removal of screens and **under-reaming of wells to reverse the clogging of deep wells used for reinjection of desalinated and deoxygenated coal seam gas associated water.** In five renovated wells the injection capacity was increased 50% at only 15% of the cost of a new well. The cause of clogging was iron precipitation from corrosion of mild steel casing even at low oxygen concentrations, and an anti-corrosion additive is expected to prolong the life of wells and ultimately further under-reaming is also possible.

Many other papers of broader relevance in hydrogeology including impact assessment on GDEs, geophysics, advances in large data analytics and visualization, uncertainty analysis, isotopes, monitoring methods were also presented.

MAR-Relevant Award Winners

At inaugural IAHA Aust Chapter Awards, Steve Parsons and team from Jacobs won the **Groundwater industry excellence award**, for the West Gate Tunnel Project. Jacobs led the design of groundwater recharge schemes to manage groundwater drawdown, contaminant movement and ground settlement impacts.

Dr Benjamin Birt led the team from QTEC, to win the **IAH groundwater innovation and technology award**- for leading the introduction of Borehole Magnetic Resonance logging techniques in Australia. NMR was a significant contributor to the detailed characterisation of permeability and porosity of target aquifers for the Perth Groundwater Replenishment Scheme.