Fingerboards Project EES Inquiry and Advisory Committee process

Hydrogeology and Modelling

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Introduction #1/2 – EES tasks

- Engineer and Hydrogeologist; expert in modelling; 40 years' experience; principal author of best practice guidelines (2001) and uncertainty analysis guidance (2018-19); independent since 2014.

- Role in EES: Independent Peer Review (Feb 2019) of the Groundwater Assessment (exhibited as Appendix B to EES Appendix A006):
  - peer review exhibited in Attachment I to EES
  - adopt review as basis for expert witness statement.
- Peer Review concluded modelling is fit for purpose of groundwater-related impact assessment:
  - sensitivity and uncertainty analysis conducted
  - results inform management and mitigation strategies, and support engineering designs and risk management.

Introduction #2/2 – tasks since EES

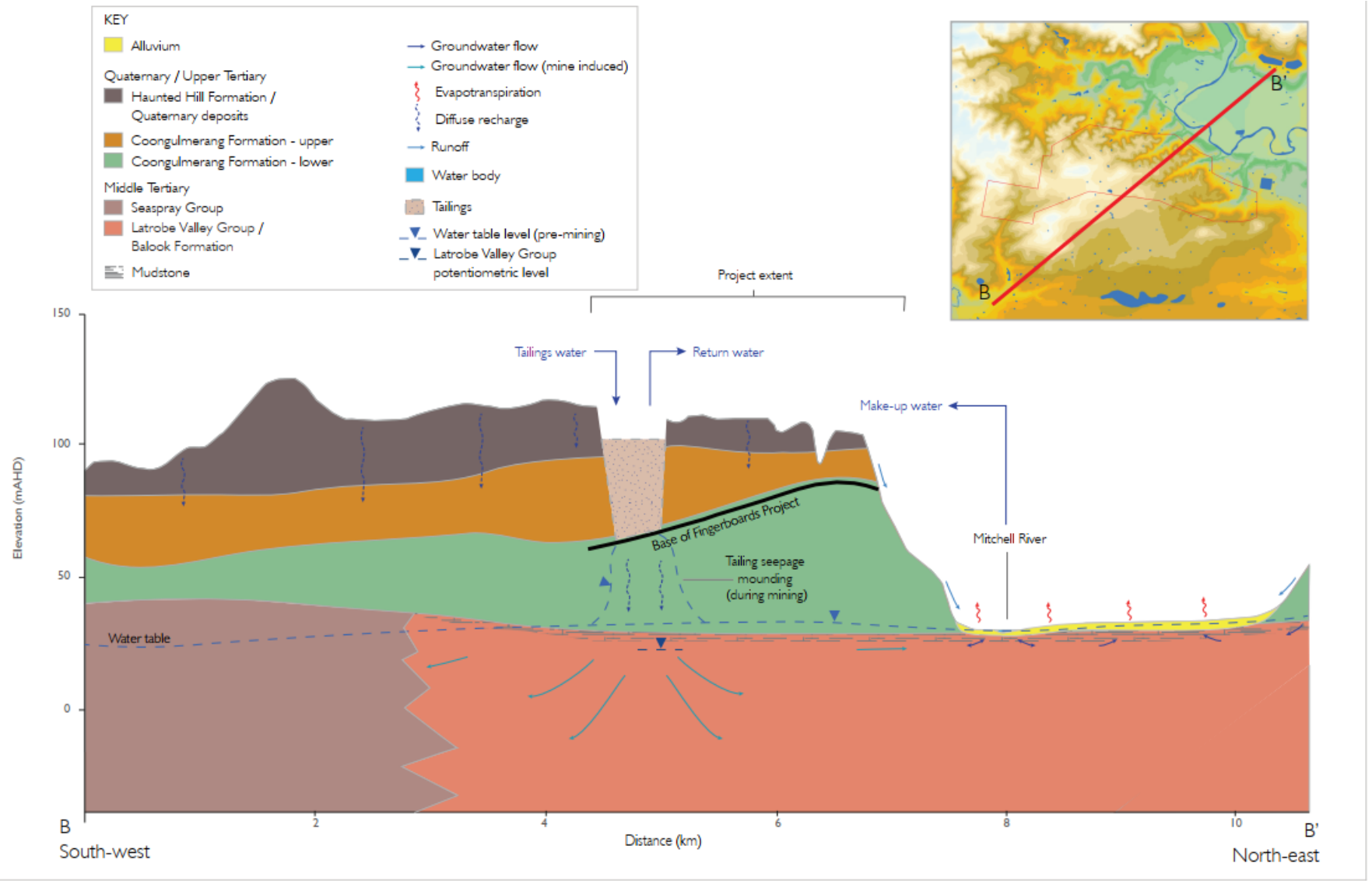
- Under instruction by White & Case:
- Review of selected submissions to EES:
  - Expert witness statement to IAC dated 28 January 2021.

- Review Technical Note 01 Centrifuges (18 Jan 2021):
  - Supplementary expert statement dated 28 Jan 2021.

- Reviewed witness statements of Webb (Latrobe Uni), Currell (RMIT) and Muller (EMM/Kalbar), in preparation for the expert conclave on groundwater.

- Contributed to groundwater expert conclave held online (1st April 2021), and subsequent conclave report (30 April 2021).

Conceptual Hydrogeology Overview



Conceptual model- Site based Northeast to southwest cross section

EMM KALBAR RESOURCES LTD

Key Groundwater Issues / Risks

- Changes in groundwater levels due to mining:
  - Groundwater extraction (mine water supply 3 GL/y);
  - Mounding due to seepage from sand tailings (1.7 GL/y);
  - Increased flux to floodplain alluvium and residual flux to river;
  - Increased evapotranspiration flux (from floodplain water table);
  - Drawdown / mounding impacts on existing 3rd party bores;
  - Water quality (not my expertise).
- Risk issues in the context of existing stresses in play:
  - Rainfall recharge and groundwater inflow/outflow largely unchanged;
  - Existing groundwater pumping (13 GL/y or 35 ML/day);
  - Offshore oil / gas depressurisation onshore (>20m since 1990);
  - Injection (Woodglen managed aquifer recharge @ 0.2-0.4 GL/y);
  - River-aquifer interaction (mostly gaining river, but significant data uncertainties re flow gauging, so baseflow estimates approximate);
  - Evapotranspiration (surrogate for groundwater dependent ecosystem 'GDE', but small part of model water balance).

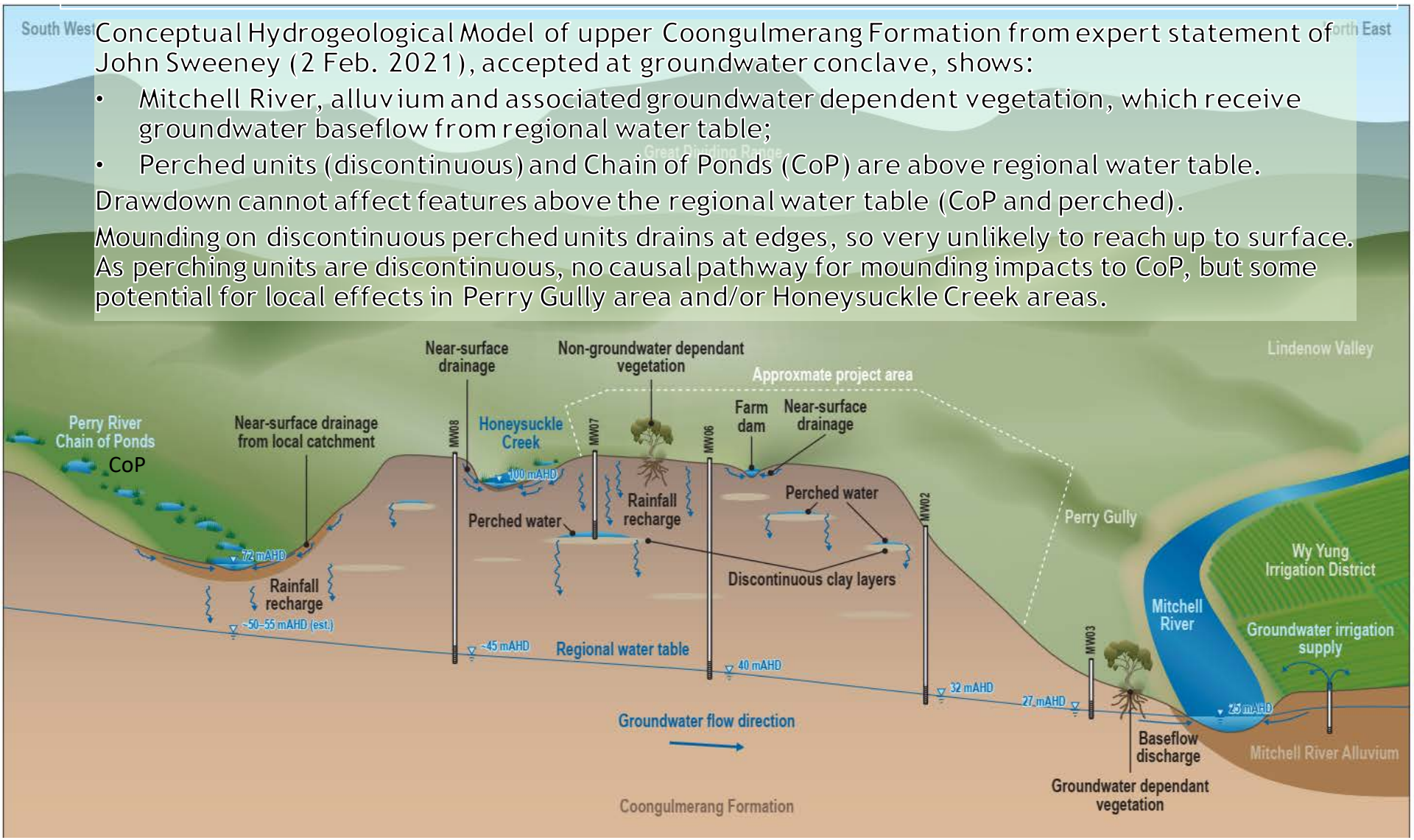
Conceptual Hydrogeology – Perching / CoP

Conceptual Hydrogeological Model of upper Coongulmerang Formation from expert statement of John Sweeney (2 Feb. 2021), accepted at groundwater conclave, shows:

- Mitchell River, alluvium and associated groundwater dependent vegetation, which receive groundwater baseflow from regional water table;
- Perched units (discontinuous) and Chain of Ponds (CoP) are above regional water table.

Drawdown cannot affect features above the regional water table (CoP and perched).

Mounding on discontinuous perched units drains at edges, so very unlikely to reach up to surface. As perching units are discontinuous, no causal pathway for mounding impacts to CoP, but some potential for local effects in Perry Gully area and/or Honeysuckle Creek areas.



Peer Review of EES – summary #1/3

- No standard procedures for groundwater assessments; focus on Australian Groundwater Modelling Guidelines;
- AGMG best practice methods applied (eg. model extent, layers, grid, boundary conditions, parameters);
- Consistent with available information / data, drilling and testing, and hydrogeological conceptualisation;
- Bias towards conservative assumptions where needed (eg. offshore oil/gas; zero time lag for tails seepage);
- Conceptualisation is mature, based on investigations over many years, implemented competently.

Peer Review of EES – summary #2/3

- Sound model 'history match' calibration, meets key criteria simultaneously:
  - 27 bores and 61 years of hydrological and climate variability 1958-2019, inc. large stresses of pumping & depressurisation;
  - Groundwater levels: time series, contours/flows, statistics;
  - Aquifer parameters and recharge consistent with available info;
  - Flux stresses/constraints (consistent with Mitchell River baseflow; and model includes existing groundwater pumping at 35 ML/d, which is 4x the Kalbar groundwater supply of 8 ML/d).
- Methods and results consistent with best practice requirements to reduce non-uniqueness – the principle that multiple combinations of parameters may be equally good at fitting historical measurements.
- Model is fit for the purpose of groundwater assessment, noting sensitivity and uncertainty analysis conducted.

Peer Review of EES – summary #3/3

- Uncertainties tested:
  - Aquifer parameters and extents;
  - Rainfall recharge and evapotranspiration (ET);
  - Climate change effects on recharge and ET;
    - consistent with DELWP guidelines (2016);
  - Mine water balances and Tailings seepage rates;
  - River bed conductance (governs river-aquifer interaction flux).

- Overall low to medium risk context (arguably) in terms of incremental groundwater-related impacts:
  - Drawdown less than existing oil & gas depressurisation effects;
  - Mounding significant but limited to near-mine;
  - Effects substantially dissipate post-mining within 10-20 years.

Responses to Submissions #1/2

- Considered 5 submissions: # 291, 514, 692, 716, 813.
- #291: EES provides adequate basic info and model is suitable for scenarios to inform licensing decisions.
- #514: I concur with recommendations re EMF / WAA.
- #692, #716, #813: many issues raised are derivative of the AECOM peer review, which were adequately addressed by the Coffey response (both presented in EES Attachment I); I concur with Coffey response.
- Pumping test issues raised, but higher importance attributed than warranted re model fundamentals;
  - pump test results give one data point, and provide some confidence to agencies re site-specific testing;
  - model depends on many other data points from investigations over many years, and uncertainty analysis was conducted.

Responses to Submissions #2/2

- Perched aquifer definition (item 5c of my statement): perched conditions are isolated (discontinuous) and not connected to the regional water table and thus are not affected by drawdown of the water table.
  - Section 7.12.1 of EES groundwater assessment (Appendix B to Appendix A006) describes almost no evidence of perching from hundreds of bores drilled; MW07 notable exception;
  - Previous work (GHD 2010; Vic. Aquifer Framework) does not identify major low permeability unit within Coongulmerang.

- Depth to water table typically >30m (~20m @ COP);
  - mounding greater than 2m is largely contained to mine area;
  - any mounding on perched units would drain at edges, so very unlikely to reach up to surface; perching units are discontinuous, so no causal pathway for mounding impacts to CoP.

Groundwater Expert Conclave #1/2

- Perching / CoP issues discussed above; not affected by main regional impacts of drawdown and mounding.
  - potential for some local impacts (Perry Gully / Honeysuckle Ck).

- Centrifuge – Technical Note 01 (28 Jan 2021), plus addendum statement Jarrah Muller (8 Feb 2021);
- Fine tails -> Centrifuges -> dried placement:
  - no seepage from fine tails (no change, already assumed in EES model);
  - reduced water loss, so less demand for water supply;
  - less uncertainty as not reliant on climate for evaporation.
- Sand tails -> less to place as more goes to fine tails;
  - less throughput -> less seepage from sand tails;
  - EES assumed 1.71 GL/y (54 L/s) seepage from sand tails;
  - Centrifuge changes -> seepage = 1.15 GL/y (36.4 L/s) (one third less).
- Reduced seepage from sand tails not yet modelled.

Groundwater Expert Conclave #2/2

- Updated water balance modelling, with uncertainty;
  - Basic assumption of Mitchell River winterfill licence (~3GL/y).
  - Updated modelling shows winterfill provides bulk of water supply most years, with groundwater providing backup:
    - 90% of years, less than 0.5 GL from groundwater borefield;
    - 10% of years, maximum 2.0 GL from groundwater borefield.
- If no winterfill licence from Mitchell River, make-up demand is ~3 GL/y, to be sourced from groundwater;
  - EES scenarios included 3 GL/y from groundwater for 15 years;
  - EES scenarios included sand tails seepage at 1.71 GL/y, but centrifuge changes reduce seepage by one third to 1.15 GL/y.
  - EES scenarios can be considered operationally 'conservative' in terms of over-estimating drawdown and mounding in context of centrifuge changes, assuming winterfill licence.
  - Adequate information for EES, but SRW submission indicated more pumping tests & modelling will be needed for licensing.

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