PEER REVIEW: WEST ANGELAS C&D: HYDROGEOLOGICAL ASSESSMENT

INTRODUCTION

The West Angelas Deposits occur within the Wonmunna Anticline – a major, regional, east-west trending structural feature that forms an upper catchment of Turee Creek. Multiple, discontinuous ore-bodies have been identified some of which are currently being mined. Mining at the C and D deposits is scheduled to commence in 2020 and continue for ~11 years. The project is currently the subject of a Feasibility Study (FS).

Deposit C occurs on the southern margins of a narrow, east-west trending valley along the northern limb of the anticline within mineralized fractured rocks of the Marra Mamba Formation and West Angelas Member of the Wittenoom Formation that dip 30deg to the north along a strike section of approx. 8km. Deposit D occurs on the northern margins of a similar narrow valley along the southern limb of the anticline; it has similar stratigraphy dipping 35deg to the south along a strike section of approx. 15km. Structural complexities occur in the west of this Deposit.

With 30-50% of the ore below water table (BWT), a significant dewatering effort is anticipated with maximum depths of dewatering 70m in Deposit C and 130m in Deposit D.

Data acquisition at the site has been on-going since 2004. Concept studies and analytical modelling were undertaken through 2015-2016. These provided insight into potential dewatering requirements and identified potential water-level drawdown impacts extending into the Karijini National Park (KNP) the eastern boundary of which is located approx. 5km west of the mining areas. The monitor bore network has gradually expanded since 2012 with the equipping of previously drilled mineral resource boreholes and, in 2016, with completion of a detailed PFS field investigation. The PFS programme included drilling and construction of four (4) test bores, 18 monitor bores and 6 VwPs in the mining areas and expanded the investigation area to the west where an additional test bore and 12 monitoring bores were installed. Significant improvement in the resolution of monitoring has also been achieved with the installation of data loggers in all new, and a number of existing, monitor bores.

In addition to dewatering, site water management will also address surface water flows in the Turee Creek East tributaries that drain east to west in the valleys (across the mining areas) before confluence within the KNP, disposal of surplus dewatering product and impact mitigation measures if/as required.

An environmental review (ER) of the Project was completed in June 2017. This identified potentially groundwater-dependent (GDE) vegetation along a 2km reach of Turee Creek within the KNP west of the confluence of a number of tributaries (~7km downstream of the mine areas) where relatively shallow depths to groundwater (<6.5mbgl) are envisaged.

PEER REVIEW

Provisions were made in October, 2017 for an independent peer review of the hydrogeological assessments of the West Angelas C & D Deposits. The key objectives of the review were identified as:

- Review and verify the quantity and quality of hydrogeological information considered as part of the assessment is sufficient to satisfy PFS level understanding and to support an environmental impact assessment under Part IV of the EP Act.
- Review and verify the current conceptual hydrogeological model including an assessment of technical robustness, rigour and level of confidence in the interpretations and analyses;
- Review and verify the numerical groundwater model inputs, design, calibrations and outputs and assess in terms of National Water Commission's Australian Groundwater Modelling Guidelines (2012);
- Provide recommendation to address gaps in the conceptualisation and numerical models.

Independent Groundwater Consultants Pty Ltd was commissioned to undertake the review. The review has been undertaken by Graham Smith, a professional hydrogeologist with 40 years of local and international experience specializing in arid zone hydrogeology with familiarity of the Pilbara and Robe River through site visits, a number of mine development projects and previous Rio Tinto commissions (eg member of Expert Panel; 2015 Pre-Feasibility Study for the Bungaroo mine; Peer Review, Robe River Projects).

The review has involved review of project technical documentation, a 2-day site visit (31st Oct-1st Nov, 2017) and several discussions with technical personnel.

This report presents comment on the 2016 PFS field investigations, current hydrogeological conceptualization and documented groundwater modelling for West Angelas C & D Deposits.

Primary attention has been given to data availability, hydrogeological conceptualisation, analysis and assessment methods, groundwater modelling and impact assessment and proposed future work programmes. The review of the hydrogeological conceptualisations and groundwater models draws on the Australian Groundwater Modelling Guidelines (Barnett et al, 2012).

Key Documents

The primary reference documents provided for review were:

- Pre-Feasibility Study – West Angelas – 2016 Hydrogeological Investigation: Deposit C & D and Western End (RTIO-PDE-0146330; October 2016).
- West Angelas – Deposits C and D Hydrogeological Conceptual Model (RTIO-PDE-0152088; June 2017).
- West Angelas Deposits C & D Regional Groundwater Model (RTIO-PDE-0154308; September 2017).

Additional documents provided and subjected to partial review commensurate with review focus and objectives included:

- Environmental Review Document: West Angelas Iron Ore Project – Deposit C, D and G Proposal (RTIO-HSE-0311321; June 2017).
- Turee Creek East Geophysical Investigation – Karijini National Park, Pilbara WA

- Water Management – Chapter 9 of Pre-Feasibility Study West Angelas Deposits C & D (version 1.0: February 2017).
- West Angelas Five Year Operational Water Strategy Years 2017-2021 (RTIO-PDE-0152280; June 2017).
- West Angelas Closure Plan July 2017 (FDMS No RTIO-HSE-0228290).

An overview of the content of the three (3) primary references is provided hereunder followed by a summary of the key findings as recorded. This is followed by Review Comments and Recommendations.

Pre-Feasibility Study – West Angelas – 2016 Hydrogeological Investigation: Deposit C & D and Western End: Report Overview

The foundation technical report has been well-prepared and includes the following technical Sections:

Introduction – provides background, location, topography and drainage, tenement information and an overview of previous work

Geology – defines relevant stratigraphy and lithologies, structure and local hydrogeology.

Field Investigation – comprehensive, detailed account of all field activities well supported by Appendices providing all data collected.

Primary works included drilling and construction of 2 test bores, 8 monitor bores in and around C Deposit, 2 test bores, 10 monitor bores in and around D Deposit, 1 test bore and 12 monitor bores in the Western Area (between Deposit C/D and the KNP boundary), 6 VwPs in pit walls and aquifer tests in all test bores.

Test bores were completed at 300mm diameter and targeted the ore-body aquifer in deeper sections of the planned mine at depths in range 130-207m. Monitor bores were 100mm diameter completions in and around the Deposits and 50mm in the Western Area. Gravel packs in all installations extended from the base of the target, slotted horizon to near surface where a bentonite seal was placed within the 6m surface casing.

Pumping Test Results – tests conducted are well described and data tables are provided showing all relevant data. Constant discharge rate tests in the Deposit areas were run, variously, for 3, 4 or 5 days (at rates between 13-50L/s) whilst an extended test (10 days) was undertaken in the Western Area test bore (rate 25L/s).

Results of analysis, including responses from numerous surrounding monitor bores and VwPs, are well-presented with interpreted aquifer thicknesses, transmissivity, hydraulic conductivity and storage parameters cited and accompanied by useful summary observations and interpretations.

KEY FINDINGS

In the area of the C & D Deposits:

- An ore-body aquifer, associated with the mineralized sections of the Marra Mamba Iron Formation (Mount Newman Member) and the overlying Wittenoom Formation, has been identified.
- This aquifer is overlain by 60-80m of Detritals.
- Depth to water in the area of the Deposits is in the range 50-78mbgl.
- Test yields ranged from 13-50L/s with bores showing moderate to good efficiency.
- Bulk hydraulic conductivity of the tested Deposit sections (which comprises the ore-body aquifer and any overlying saturated Wittenoom Formation or Detritals with cumulative thickness range 57-146m) is in the range 0.4-1m/d at 3 sites with a higher value (5.9m/d) assessed at one site.
- The ore-body aquifer appears unconfined with specific yield in the range 0.01-0.049.
- Anisotropy is evident in some test results with elongation of drawdown response along strike. Drawdown responses along strike up to 1,830m distant have been recorded.
- Some degree of hydraulic connectivity between the ore-body aquifer and overlying Wittenoom Formation exists but appears highly variable.
- VwP installations show existence of downward vertical gradients in strata sub-cropping near the core of the anticline.
- A groundwater divide is identified in the area between Deposit C2 and C3 coincident with a reported dyke intrusion. To the east of the dyke groundwater elevations are in the order of 636mamsl; to the west approx. 12m lower. Groundwater elevations around D Deposit fall within range 624-625mamsl. The hydraulic gradient between the Deposit areas and the Western Area is low.
- Water quality (as TDS) in the mine area appears fresh - 424-659mg/L around C Deposit; 513-745mg/L around D Deposit.

In the Western Area:

- Depth to water toward the western area reduces with topographic variation; depths in range 26-32mbgl have been recorded at sites 1-2km east of the KNP boundary and 19mbgl proximal to the boundary. Groundwater elevations, however, are relatively uniform (~623mamsl) over a wide area that extends to WANG-14 (an existing bore located within the KNP area).
- A test yield of 25L/s was developed in the Western Area test bore but apparent well efficiency was anomalously low.
- The hydraulic conductivity of the test section is relatively high (7.6m/d).
- Water samples display a wider range of salinity (388-1061mg/L) than found upstream around the Deposits.

West Angelas – Deposits C and D Hydrogeological Conceptual Model (RTIO-PDE-0152088; June 2017).

The conceptual model presented has stated intention to form the foundation for subsequent mathematical modelling to support assessment of life-of-mine (LOM) dewatering and water supply options.

The report provides a summary of the regional setting identifying relevant aspects of the climate, hydrology, geology, stratigraphy and structure. The summaries are well-supported by maps, sections and hydrographs. Previous (2015-2016) studies and data sources are identified with data collected during the 2016 field programme included which provide the primary quantitative data set.

Following a summary of the local hydrostratigraphy, the principal aquifer is cited to be associated with mineralized sections of the Marra Mamba Iron Formation (Mount Newman Member) and the overlying Wittenoom Formation; this is referred to as the “orebody aquifer”. A regional aquifer, associated with weathering of, and development of secondary permeability within the Wittenoom Formation supplemented locally with overlying Detritals, is identified.

All other associated strata in the bedrock sequence, including the Nammuldi and MacLeod Members, un-mineralised Mount Newman Member, un-mineralised or fresh Wittenoom Formation and dolerite dyke intrusives, are reportedly of low porosity and/or permeability with potential to constrain groundwater flow. The Mount Sylvia Formation and Mt McRae Shale that overly the Wittenoom Formation and appear on the basin margins are similarly described.

Hydrographs from 24 monitor bores are presented (November 2016 to February 2017) with observation made that responses to rainfall events are “negligible” across the area. A single exception is noted – WANG-14 – located within the KNP where a ~1.3m water level rise associated with rainfall in February 2017 is recorded and attributed to shallow depth to water (~7mbgl).

Groundwater levels in the Deposit C and D areas are presented and compartmentalisation associated with a dolerite dyke noted. Groundwater flow east to west is indicated under low gradients. Cross-sections indicate that regional groundwater outflow is constrained in the west by the barrier created by the Mount Sylvia Formation and Mt McRae Shale with consequent upward flux to the near-surface, streambed environment within the KNP.

Based on the depth of groundwater in the area and defined geology and structure (ie closed basin with no areas of groundwater inflow), the assumption is made that groundwater discharge occurs only through evapotranspiration in the downstream western area where riparian vegetation including a potential GDE has been identified. A potential rate of evapotranspiration of 0.05GL/year is cited.

Water quality analyses for four test bores are presented on a Piper diagram with observation that all showed similar values for cations and anions. The groundwater is reported as fresh with EC range 968-1,790uS/cm.

A water balance section is included with the stated objective of determining likely volumetric inputs for the processes identified. Attention, however, is given solely to aquifer recharge with an estimate of 0.2-0.9GL/year developed from a chloride mass balance that assumes even distribution across the entire catchment.

The key themes of the hydrogeological conceptualization are listed and summarized below:

- Orebody aquifer associated with mineralised horizons

- Significant regional aquifer associated with Wittenoom Formation extending to the west.
- Compartmentalization created by intrusive dykes.
- Hydraulic barriers associated with (a) un-mineralised Marra Mamba Iron Formation at base of the Deposits and (b) the Mount McRae Shale to the north, south and west of the Deposits.
- Rainfall recharge to orebody aquifer and immediate vicinity of Deposits, is low.
- A greater degree of rainfall recharge may occur in the vicinity of the potential GDE where shallower groundwater levels occur but this will be offset in this area by discharge resulting from evapotranspiration.
- Groundwater abstraction will be from storage.

West Angelas Deposits C & D Regional Groundwater Model (RTIO-PDE-0154308; September 2017).

The numerical model was developed based on the aforementioned hydrogeological conceptualization with cited objectives of assessing:

- Dewatering strategy and volumes for Deposit C2 (west of the dyke) and Deposit D.
- Impacts of drawdown extension (resulting from dewatering operations) to the KNP.

The report provides an overview of climate, topography, geology, hydrology, hydrogeology, conceptual hydrogeology and water balance well supported by figures and maps. Model set-up is described as a single layer with cell dimensions 50m square in pit areas and 100m squares elsewhere. The top of the layer is defined by topography and the base by recorded geology. The active model domain delineates a closed basin bounded to the north, south and west by the impermeable Mount McRae Shale and to the east by dykes/structures that have been shown to compartmentalize groundwater levels. The model extends into the KNP to the area of the potential GDE. Recharge is applied, through a single distributed zone, by the Modflow recharge package and evapotranspiration discharge (EVT) in the area of the potential GDE by way of the Modflow drain package.

Steady-state calibration is described based on the water balance where recharge and EVT discharge equates at 0.05GL/year. It is noted that, for recharge, this application equates to 0.54mm/year or 0.15% of the average annual rainfall for period 2010-2016. Different values of hydraulic conductivity (single value throughout the model) and conductance (for the drain) were applied to obtain a best-fit with observed water levels. The accepted parameters, reportedly providing the closest match, were a value of 5m/d for hydraulic conductivity and 100^2/d for drain conductance.

Predictive simulations that are based on the dewatering requirements of the base case PFS mine plan (Option 5A) are described (for Pits C2, D1, D2 and D3). Four dewatering strategies were assessed addressing sensitivity of results to unconstrained specific yield (S_y); values of 1%, 3% (base case), 5% and 10% were considered. Abstraction rates for dewatering bores were assigned based on field experience and ranged from 10-20L/s.

The predictive dewatering simulations were run for the period 2020-2030 on a monthly basis and thereafter annually for a further 100 years to enable assessment of drawdown post-mining.

KEY FINDINGS

The key findings reported, well supported by time series production graphs, hydrographs and drawdown contours, are as follows:

- The total number of dewatering bores required will be between 13 and 22
- All dewatering targets can be achieved where Sy=1% but not for the deeper benches at pit bottoms for the base case or higher Sy.
- For the base case, peak abstraction will be 14.5ML/d (range 8.6-24.7ML/d).
- Cumulative LoM dewatering volume for the base case will be 21.7GL (range 10-52.8GL).
- Water level drawdown will extend into KNP for all scenarios during mining.
- The extent of drawdown is expected to continue to expand for many years post-mining.
- Drawdowns near the potential GDE area may reach 3m (Sy=10%) to 8m (Sy=1%) with maximum levels reached between 2040-2070.
- Under the low-recharge regime, there will be no recovery of groundwater to pre-mining levels.

Model assumptions are clearly identified.

Planned Future Works

Planned works, to be undertaken during the course of the Feasibility Study, cited in various documents, include:

- Validation of the hydrogeological conceptualization.
- Confirmation of the occurrence of barrier to the NW of Deposit C (surface geological mapping)
- Review stratigraphy and basement geology (database reviews).
- Evaluate impact of the absence of Mount McRae Shale NW of Deposit C.
- Improve understanding of surface-groundwater interaction (water quality sampling).
- Upgrade the model as and when new conceptual, basement morphology/dyke and properties information become available.
- Monitor water levels in the potential GDE area to obtain reliable baseline data.

REVIEW COMMENTS

Data Availability

The geological characterization in and around the Deposits has been well established and an extensive groundwater monitoring network developed. Surface geological mapping enables clear definition of basin boundaries. Hydrogeological characterization of many of the units found at the site is assumed but may be considered appropriate given the wealth of experience gained in similar sites in the Pilbara. Groundwater level hydrographs presented are of limited duration and likely do not reflect the data record. Notable absences from the data set are (a) discrete properties for the Wittenoom Formation (reported to represent the regional aquifer) and the downstream calcretes and (b) surface water flow records and/or estimates.

Notwithstanding, the combined data set is considered to provide an adequate foundation for PFS assessment.

PFS Field Programme

The field investigations have been done to a high standard. Standard drilling and development techniques have been employed supported by detailed logging and downhole surveys. Well construction, for the most part, adopts standard practices with the exception that screened (target) horizons would preferably have been isolated (ie bentonite seals should have been placed at greater depth to avoid provision of a conduit for shallow groundwater to drain vertically through the annular gravel pack). Standard aquifer test procedures, scope and analysis techniques have been adopted.

The aquifer parameters determined for the ore-body aquifer appear reasonable and the anisotropy observed is as would be expected. An element of uncertainty exists, however, as to whether unconfined conditions prevail throughout. The observation of drawdown impacts over almost 2km suggests possibility of local confinement. Consideration should be given to re-assessment of the test results from the Western Area. Explanations should be sought for (a) the anomalously low apparent well efficiency, (b) the variation between parameters deduced from the drawdown responses in the test well and nearby observation bore, (c) the relatively minor drawdown in the observation bore located 7m west and (d) the occurrence of a response 1,490m to the east.

Conceptualisation

Based on the envelope lithologies and minimal hydraulic gradients through the mine area, the general concept of a closed basin[1] with abstraction primarily from storage is supported. The existence of an ore-body aquifer has been adequately demonstrated but it has not been firmly established at West Angelas that a significant regional aquifer associated with the Wittenoom

[1] *As has been recorded, confirmation of the occurrence and establishment of the depth of the barrier strata NW of Deposit C needs to be pursued*).

Formation occurs. This is assumed based on experience in other project areas and appears reasonable but confirmation should be sought. Support is also given to the compartmentalisation effected by dykes and the likelihood that direct recharge from rainfall is low.

Indirect recharge, such as will occur from infiltration of bedrock runoff (from the steep rocky slopes around the basin and near the mine areas) and streamflow has not been considered. Evidence for the former process may be provided by the downward vertical gradients observed in the VwP installations but the contributions to flux toward the ore-body or regional aquifer would likely be negligible given the impermeable nature of this strata. It is the latter process, however, that is recognized as the dominant recharge mechanism in the Pilbara and its absence from the water balance is considered to provide a high degree of conservatism especially in light of the reported occurrence of run-off generating rainfall events (>35mm/day), and thus possible periods of streamflow at least once a year.

Groundwater outflow from the basin has also been excluded from the water balance which essentially dictates the established concept that recharge must be equivalent to EVT losses.

The existence of a general low recharge and low-groundwater flow regime throughout most of the basin, where depths to water commonly exceed 50m, is supported and reasonably leads to the conclusion that regional groundwater flux to the KNP and potential GDE area is minor. This is not necessarily, however, the case in these down-gradient areas where a number of surface water tributaries traverse, and ultimately coalesce, within a calcrete-dominated environment where depths to water are relatively shallow.

The calcretes that have been mapped within the KNP (and underlie the potential GDE area) and have been logged sub-surface in several western area boreholes, may play an important role in local hydrogeology/flow processes and warrant further detailed assessment.

In the first case, calcrete aquifer properties (k and S_y) may be significantly greater than the values currently being considered. Where higher hydraulic conductivities exist, the potential exists for groundwater throughflow at higher rates[2] than currently envisaged and outflow downstream of the potential GDE[3].

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[2] *Whilst the section width of the calcretes will limit flux, the potential for augmented groundwater outflow through weathered and fractured bedrock strata beneath the streambed cannot be discounted. Whilst the occurrence of the Mount McRae and Mt Sylvia Shales is demonstrable, the nature of this strata beneath the streambed calcretes is uncertain. It is conceivable that the course of the Turee Creek in the potential GDE area owes its origin to a fault/fracture zone thereby compromising the impermeable, barrier properties that have been assumed. This issue was not resolved by the geophysical survey which was unable to establish a base to the valley calcrete within the 25-30m depth of penetration.*

[3] *No surface expressions of groundwater in the streambed were observed or have been reported upstream of the assumed barriers. Such expressions could reasonably be expected where the flow section is heavily constrained by impermeable barriers at shallow depth but is inconclusive; it may confirm minimal throughflow (as currently conceptualized) or reflect greater transmissivity of the flow section allowing greater flux.*

Support for this notion may be given by the "flattening" of the hydraulic gradient where saturated calcretes recorded and also observations from the aquifer test in the Western Area[4].

Secondly, the prospect exists that the calcretes – that occur at relatively shallow depth and may have elevated storage potential - receive significant (and at least annual) indirect recharge through local bedrock runoff and the infiltration of flood waters[5] from several tributaries that coalesce immediately upstream of the potential GDE area. Groundwater level rises (~1.3m) during high rainfall events have been noted at one site (WANG-14) and it is considered likely that:

- such increases in groundwater storage are widespread in the KNP;
- the seasonally elevated groundwater levels will generate and sustain (for the period of groundwater level recession) increased groundwater flow through the sub-surface streambed environment that hosts the potential GDE.

Support for these premises is provided by:

- detailed examination of the hydrographs for the Western Area monitor bores which show a water level rise of 250mm (in bores MB16WAW004, -05, -06, -07, -08) following February rainfall[6].
- The recession curve of WANG-14 which shows, after 6 months (August 2017) a water level still 290mm above the pre-rainfall event baseline level.

Given the above, an alternative conceptualization may be developed in which what is considered to be a more realistic recharge regime (to include indirect recharge) is adopted with consequent increase in groundwater throughflow within, and outflow from, the Turee Creek East calcretes (and, potentially, underlying fractured bedrock). Where this concept can be validated by investigations and future monitoring it may reasonably be postulated that:

- the saturated calcretes essentially act as a seasonally replenished reservoir that will sustain higher rates of groundwater flow to downstream areas.
- any established GDE may owe its existence and long-term sustainability to such an assured supply.

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[4] *The water level at this site (33mbgl) is located near the top of a 28m thick section of calcrete. The slotted section of the test bore extends from 46-88mbgl intersecting the basal 10m of calcrete and underlying Wittenoom Formation dolomite/cherts and Mt Newman Member BIF/cherts. Drawdown in the test bore after 10 days (~19m) did not reach the base of the calcrete. If the hydraulic conductivity of the bedrock strata is in the order of 1m/d as found typical near the Deposits, it is conceivable that the adopted, relatively high transmissivity at this site (~400m^2/d) reflects enhanced conductivity of the calcrete (~12m/d).*

[5] *Resource studies providing estimates of infiltration from streamflow events in the Pilbara (using a streamflow infiltration hydrograph approach) indicate potential for recharge of 0.01-0.05GL/per flow day/per km (ref: Groundwater Assessment of the North-west Hamersley Range; WA Dept. of Water Hydrogeological record series, Report no. HG62, August 2016). With 4 tributaries traversing the calcretes within the KNP upstream of the potential GDE area, a recharge potential in the order of 0.8GL/year exists with a single flow event of 10 days.*

[6] *If the 250mm water level rise observed represented an average for the water level rise over the 20km^2 area of calcretes within the KNP and the specific yield of the calcretes was 0.2, this would reflect recharge of 1GL.*

Numerical Groundwater Model

The model honours the conceptualization in relation to geology, basin geometry and flow processes and accordingly balances EVT and RECH where the latter, evenly distributed - equivalent to 0.54mm/year (or 0.15% of MAR) - appears quite low.

The steady-state WLs and resultant low hydraulic gradient appear reasonable but it is noted that the plot of observed and simulated steady-state WLs appears to show systematic over-prediction of WLs down-gradient and the converse up-gradient which warrants inspection.

The simplified approach of adopting a single, isotropic layer with uniform bulk hydraulic conductivity is considered to provide reasonable estimates for dewatering rates and cumulative volumes (+/-50%) within what, for the mine areas at least, are considered to be reasonable bounds of S_y.

Predictions of the magnitude, extent and timing of drawdown impacts to the west of the mine areas, however, are only considered to indicate "potential" with such simplifications and exclusion of anisotropy. Given the high degree of conservatism adopted in relation to recharge, and the prospect that the aquifer properties of the extensive, downstream calcretes may be greater than currently assumed and thereby will impact drawdown propagation, the indicated potential of drawdown and extent in the KNP is considered likely to be excessive.

Summary

Quantity and quality of data and hydrogeological information is sufficient to satisfy PFS-level understanding.

The existence of an ore-body aquifer has been established which appears, at least locally, to have a degree of hydraulic connection to the overlying Wittenoom Formation; such connectivity has not been established at all sites.

The basic themes of the hydrogeological conceptualization are supported but the omission of the dominant recharge mechanism is considered to introduce a high degree of conservatism.

The modelling approach is simplistic but does provide reasonable estimates for dewatering rates and cumulative volumes appropriate to PFS level of assessment. The model predictions also have value in indicating the potential for drawdown impacts within KNP but the magnitude and progression of such impacts are considered to be over-stated.

Uncertainties in conceptualisation and necessity to upgrade the model have been identified and should be adequately addressed with the planned FS works.

Recommendations

Tasks identified for execution during the course of the FS are fully supported. Consideration should also be given to:

- Development of an alternative conceptualization as outlined herein.
- Obtain discrete aquifer properties for the regional aquifer (Wittenoom Formation) and the calcretes.

- Modelling of the aquifer test in the Western Area.
- Monitor surface water flows to the KNP. Develop surface water flow estimates and/or assessment of the utility and application of the WA Dept. of Water's streamflow infiltration hydrograph approach.
- Review hydrographs from the downstream Turee Creek B borefield area with a view to identifying frequency and scale of flow (recharge) events.
- Upgrade the model based on the alternative conceptualisation introducing indirect recharge, the anisotropic ore-body aquifer, the regional aquifer (Wittenoom Formation) and the calcrete. Consider hydraulic connection between the ore-body aquifer and regional aquifer in sensitivity.