Fraser Earthmoving Construction Pty Ltd

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Part 2 Groundwater Assessment

for the

Howlong Sand and Gravel Expansion Project

State Significant Development 17_8804

Prepared by

Water Technology Pty Ltd

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Groundwater Assessment

Howlong Quarry Expansion – Groundwater Assessment and Numerical Modelling

Fraser Earthmoving Construction

13 March 2020

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EXECUTIVE SUMMARY

The proposed Howlong Sand Quarry Expansion Project aims to expand extraction operations and increase product despatch from the current rate of 30,000 tonnes per annum to 300,000 tonnes per annum. The quarry site is within the Murray River floodplain and accesses the Upper Murray Aquifer groundwater system, close to Howlong, between the Murray River and Black Swan Anabranch. Current operational practices utilise licensed groundwater allocations to provide water supply for the quarry operations.

This report outlines Water Technology's investigations into hydrogeological processes at the materials extraction site. It identifies possible risks to semi-regional groundwater systems, and the impact of the proposed quarry expansion on local groundwater systems. A hydrogeological conceptual model of the Upper Murray Aquifer system is developed in relation to the site.

The Upper Murray Aquifer system is unconfined with groundwater flow westwards, occurring primarily through unconsolidated alluvial sediments. Hydraulic conductivity and transmissivity are moderate to high and the groundwater systems are typically local with short flow lengths loosely defined by topographic catchments. Water quality within these systems is fresh to marginal. Water table depths are shallow to intermediate. Groundwater residence times are typically short to medium, with relatively quick response time to changes in land management. The Murray River and incident rainfall have been identified as the major recharge sources for the aquifer while irrigation leakage was identified as a minor recharge source.

The regulated river level is the prime driver for shallow groundwater level variability near the proposed Sand Quarry Expansion project and the observed fluctuation of the River level is approximately 2.5 m. Groundwater hydrograph data indicates a good hydraulic connection between the river and the alluvial aquifer, for example when the River stage is at low flow the regional shallow groundwater levels adjacent the River drop by a similar magnitude.

The proposed Sand Quarry Expansion project aims to deepen the existing pits and excavate two additional areas. The estimated surface area of the post-mining groundwater-filled pits will be ~42 Ha. The additional evaporative loss from the post-mining pit surface area would need to be accounted for under groundwater extraction licenses. Irrigation use of approximately 7.3 ML/d is proposed to be supplied from the excavated pits. During the development through Stages 1 to 4 it is estimated that groundwater pumping rates for pit dewatering would range from 3.2 ML/d to 7.8 ML/d with a worst case scenario of 10 ML/d at the completion of Stage 4 (this worst case scenario assumes that the entire Stage 4 pit will be open which is not expected to be the case due to the operational challenges this would pose). Groundwater pumping will require appropriate groundwater access licenses and management as the long term storage within the Quarry Site is not sufficient. Water removed from active extraction areas would be used for on-site washing of materials, quarry activities and irrigation activities on the broader property. Water management within the excavated areas would be required to balance storages and to accommodate the anticipated volume of water removed from the active areas.

Drawdown as a result of pit dewatering and proposed irrigation supply has been assessed using a numerical groundwater flow model. The modelling shows that due to the bounding of the River Murray and the Black Swan Anabranch the drawdown effects of the proposed staged development are largely constrained to a localised area between these water bodies. The limited extent of drawdown means that existing users and groundwater dependent ecosystems are not expected to be adversely impacted. The areas impacted by drawdown currently comprise quarrying operations, irrigated floodplain and cleared floodplain areas.

Significant impacts to the River Murray and downstream water users are not predicted to occur as the worst-case dewatering scenario represents only 0.1% of the average minimum daily flow measured in 2019 and would be licenced while water quality would be unchanged as the water levels in the extraction pits would be maintained at levels lower than the river water level thereby maintaining a flow gradient from the river to the pits.

The main long term impact on the hydrogeological behaviour is anticipated to be an increase in the surface area of exposed water table due to an increase in the number of excavation pits. This will increase the rate of groundwater discharge from the Upper Murray Aquifer system, which may need to be accounted for by corresponding licensed extraction of groundwater for irrigation purposes accounted for in water licencing held by the Applicant and incorporated into ongoing irrigation management. The increased depth of excavation of the pits is assumed to fully penetrate the Shepparton Formation Aquifer. The pits will become evaporative and irrigation water supply sinks on the floodplain with localised groundwater flow paths reflecting this. The proposed long term irrigation extractions will maintain pit salinities at between 500 mg/L and 600 mg/L.

To validate the hydrogeological conceptual model and predicted impacts, it is recommended that groundwater monitoring (water level and quality) be undertaken to assess for actual groundwater impacts and that water use through-out the proposed operations are appropriately monitored to account for all water consumed by the proposed development.

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1 INTRODUCTION

This investigation concerns the proposed increase in extraction operations at the existing sand and gravel quarry at 4343 Riverina Highway, approximately 4 km south-east of Howlong. The proposed development includes the planned expansion of the current quarry operation and increase to production from the current rate of 30,000 tonnes per annum to 300,000 tons per annum. Increased production at the site is proposed to be a staged process including the following stages (refer to Figure 1-1 for locations):

- Stage 1 Western Existing Pit;
- Stage 2 Eastern Existing Pit;
- Stage 3 Processing Area and Future Pit;
- Stage 4 Future Pit.

The site is within the River Murray floodplain and accesses the Upper Murray Aquifer groundwater system. Thus, an understanding of hydrogeological processes that operate through this site is crucial for the successful extension and operation of the quarry. Water Technology was engaged to undertake a desktop groundwater assessment and numerical modelling to assess the potential impacts of the proposed quarry expansion.

This report outlines Water Technology's investigations into hydrogeological processes at the materials extraction site. It identifies possible risks to semi-regional groundwater systems, and the impact of the proposed quarry expansion on local groundwater systems. A hydrogeological conceptual model of the Upper Murray Aquifer system was developed for the site and was used to inform the development of a numerical groundwater flow model to quantify groundwater interactions during and after the increased extraction activities.

Fraser Earthmoving Construction currently operates the Howlong Sand and Gravel Quarry. The quarry has been in use for in excess of 60 years and managed by the current operator for the past 6 months. Howlong Sand and Gravel Quarry, managed by Fraser Earthmoving Construction, is considered to be a relatively small operation supplying mainly to private projects and local farms.

Fraser Earthmoving Construction proposes to replace existing outdated equipment and refurbish infrastructure such as roads and bridges to allow for an increased annual extraction volume to service a wider market within the public sector. The proposal will set the annual maximum production limit at 300,000 tpa. The proposed project will provide an important construction resource to support the planned growth of the NSW Riverina region and beyond, providing increased employment to the area.

The proposed Project is a "State Significant Development" (SSD) as defined under the State Environmental Planning Policy (SEPP) (State and Regional Development) (SRD) 2011 and will require development consent under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act).

To date all old and out-dated equipment has been removed from the quarry area and has been replaced with a McCloskey Sandstorm 620 washing and screening system. A new access road has been constructed to avoid remnant vegetation and provide all weather access.

Figure 1-2 shows the site locality, study area and proposed quarry expansion and Figure 1-3 shows the topography, including the outline of the existing pits. The River Murray floodplain through Howlong is an anabranch system, with creeks leaving the Murray and flowing back in further downstream. There are many cut-off meanders and billabongs through the floodplain, formed from old river courses. Despite the complex topography of the river and anabranches, the floodplain is well defined, and in large floods is inundated to the floodplain margins. The quarry site is close to Howlong, between the River Murray and Black Swan Anabranch.

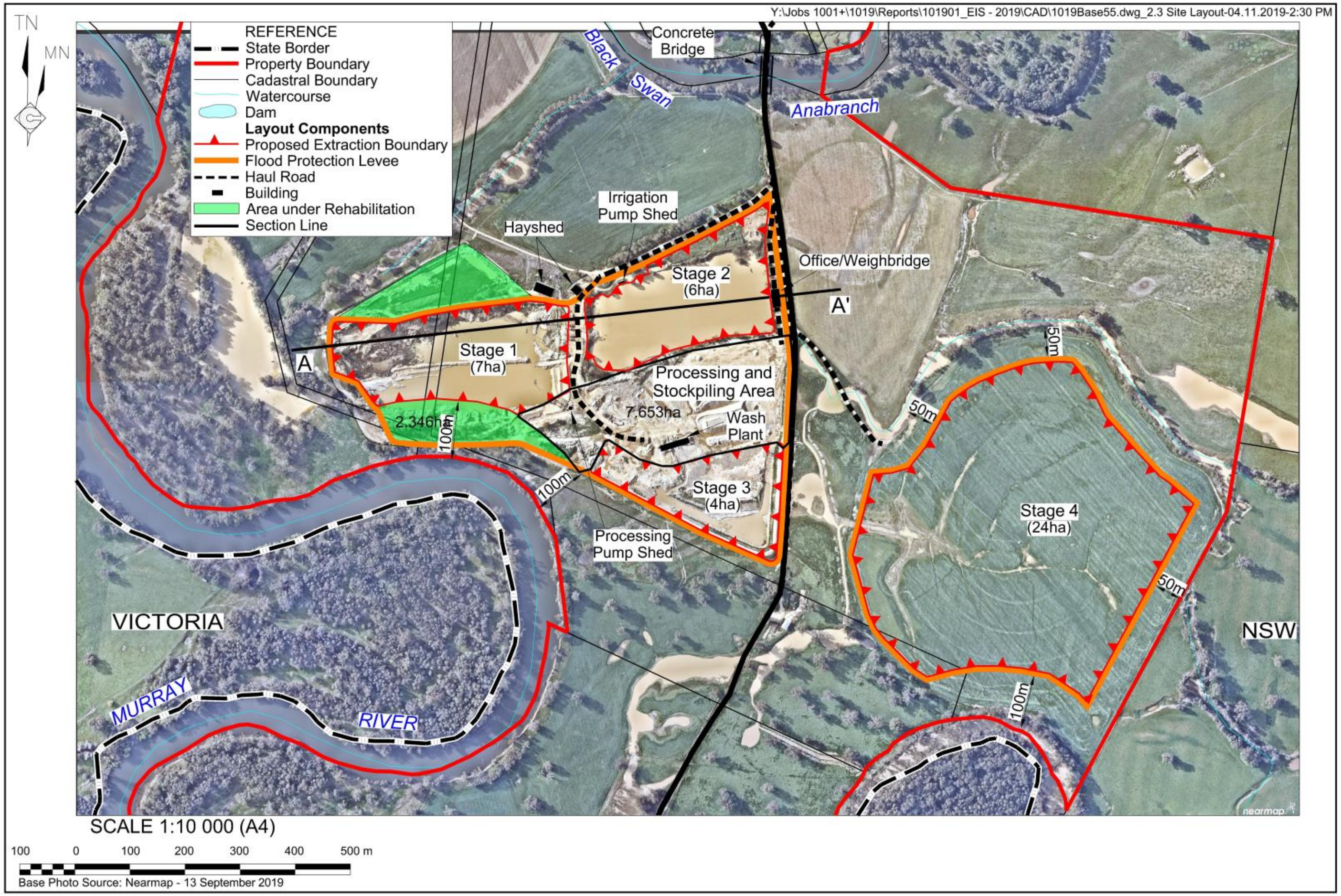

FIGURE 1-1 PROPOSED QUARRY EXPANSION AREA (RW CORKERY & CO, 2020)

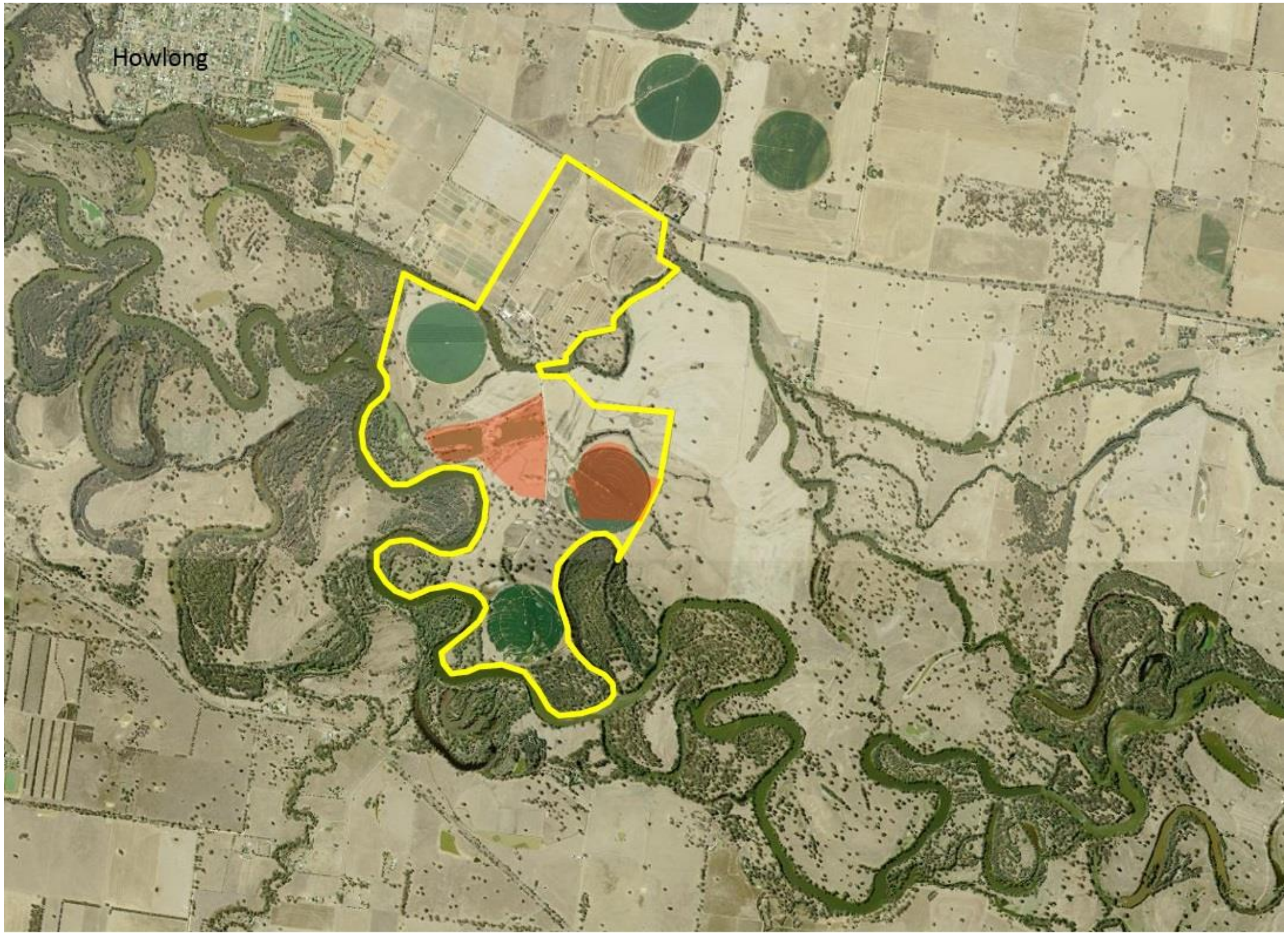

FIGURE 1-2 LOCATION OF STUDY AREA (YELLOW) AND PROPOSED QUARRY AREA (RED)

FIGURE 1-3 FLOODPLAIN TOPOGRAPHY

2 HYDROGEOLOGICAL SETTING

2.1 Murray Alluvium Hydrogeological Landscape

The Murray Alluvium hydrogeological landscape of the Eastern Murray Catchment (Figure 2-1) is described as a depositional environment characterised by alluvial floodplains with flood-runners, ox-bows and levees (Muller et al., 2015). This landscape comprises unconsolidated Quaternary channel and floodplain sediments. Typically, these are sands, gravels and clays. Small patches of windblown sand occur locally as sandy rises. Topsoils in logged and cleared areas are generally thinner and have less organic carbon than undisturbed areas. Stream-bank erosion and compaction due to vehicular traffic are the most common land degradation issues in this landscape.

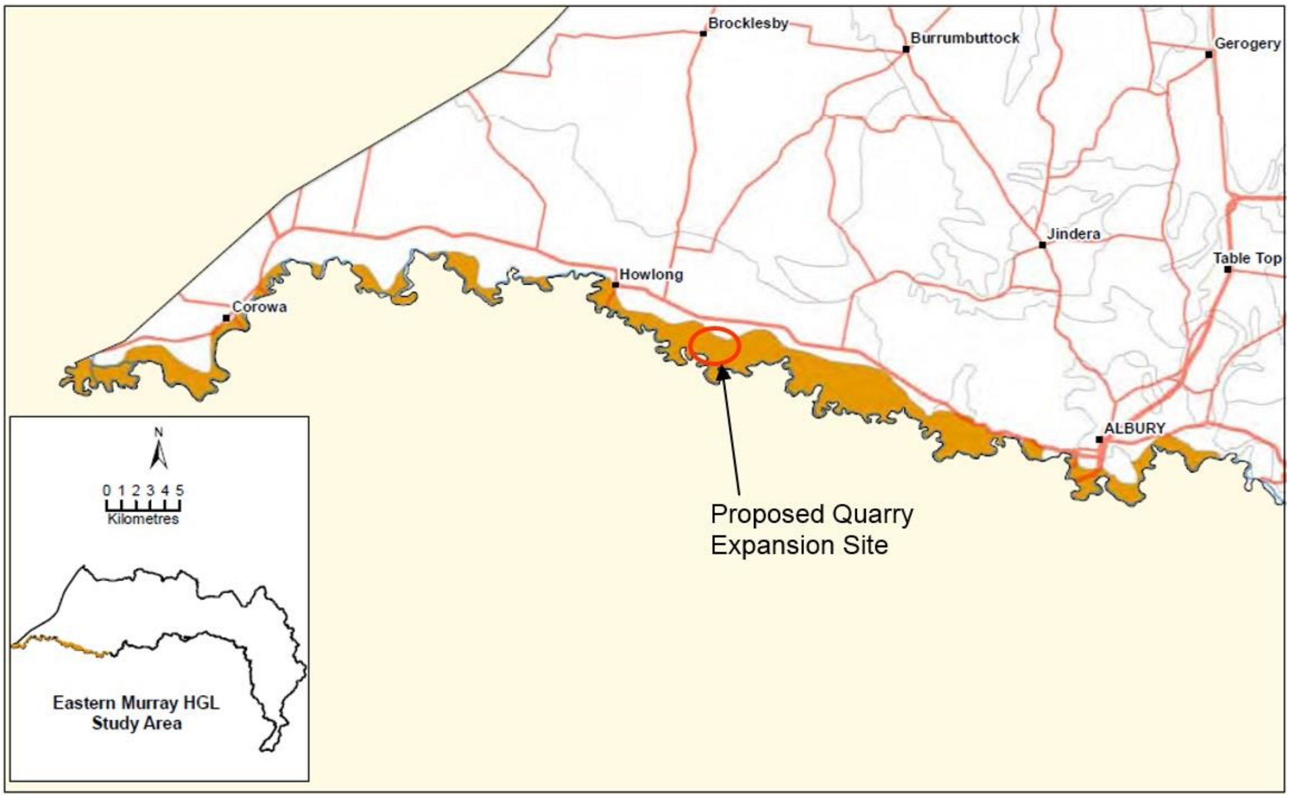

FIGURE 2-1 MURRAY ALLUVIUM HYDROGEOLOGICAL LANDSCAPE (AFTER MULLER ET AL., 2015)

Muller et al. (2015) summarises the aquifers within this landscape as unconfined with groundwater flow occurring primarily through unconsolidated alluvial sediments. Hydraulic conductivity and transmissivity are moderate to high. Groundwater recharge rates are estimated to be high. Groundwater systems are typically local with short flow paths and are loosely defined by topographic catchments. Water quality within these systems is fresh to marginal. Water table depths are shallow to intermediate. Localised perching of water tables occurs above clay lenses during wetter periods. Short to medium groundwater residence times are typical. These landscapes have a medium to fast response time to changes in land management.

TABLE 2-1 HYDROGEOLOGICAL PROPERTIES SUMMARY (AFTER MULLER ET AL., 2015)

Hydrogeologic Properties	Range
Aquifer Type	Unconfined; Perching above clay-rich layers
Hydraulic Conductivity	10^{-2} to >10 m/day
Aquifer Transmissivity	2 to >100 m^2/day
Specific Yield	5 to >15%
Hydraulic Gradient	<10%
Groundwater Salinity	EC <1 600 µS/cm
Depth to Water Table	<8 m

2.2 Groundwater Management Area 015

The groundwater resources of the Upper Murray Alluvium have been described by Williams (1989) and Kulatunga (2009). This area is managed as the designated Groundwater Management Area (GMA) 015 (refer Figure 2-2).

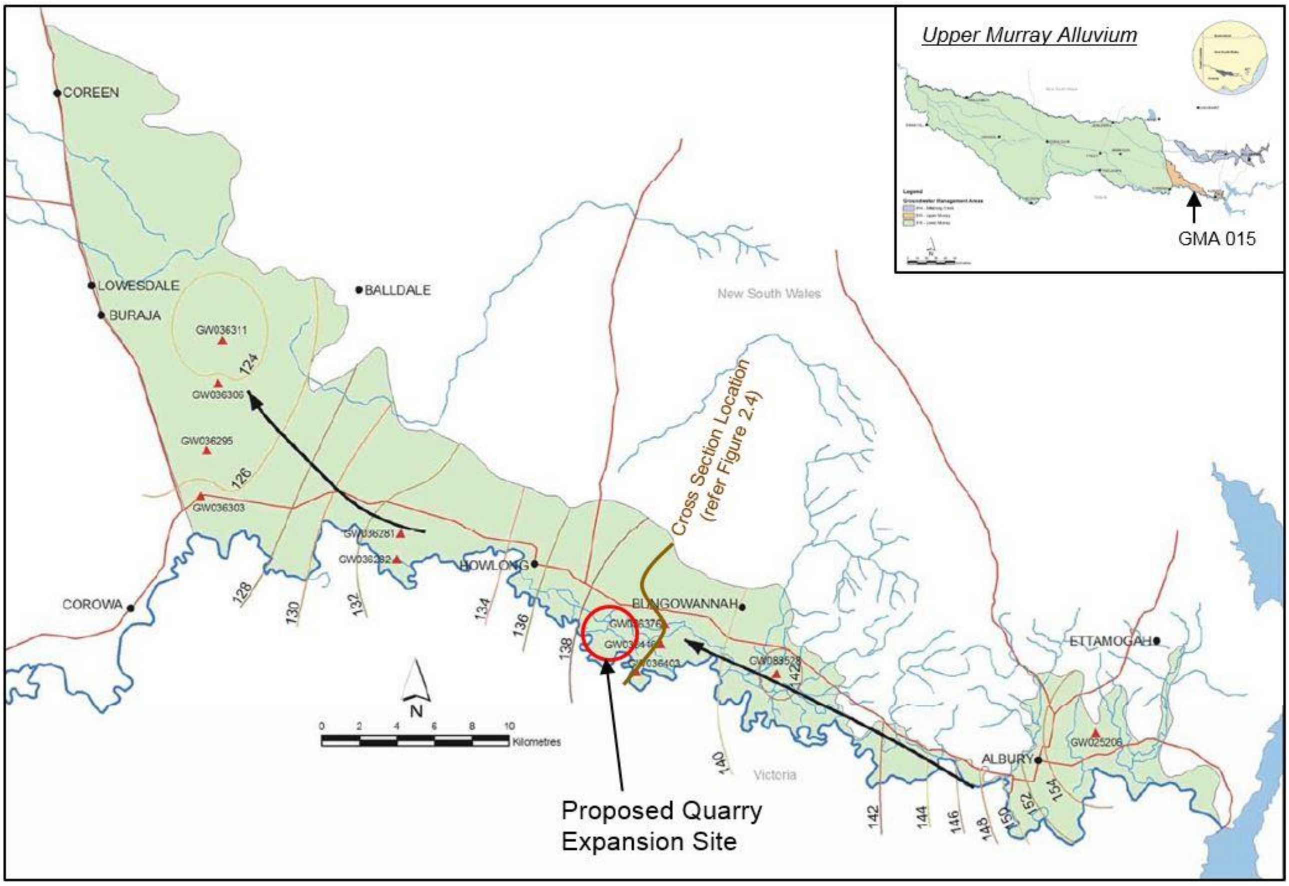

FIGURE 2-2 GROUNDWATER MANAGEMENT AREA 015 SHOWING SHEPPARTON AQUIFER GROUNDWATER HEIGHT CONTOURS (AFTER KULATUNGA 2009)

The region of the proposed Howlong Sand Quarry Expansion is associated with Alluvium deposits up to 140 m thick and contains groundwater of low salinity. These Cainozoic sediments overlie the Palaeozoic metamorphics and granites and are incised within a paleo-erosional valley of these basement rocks. The Cainozoic sedimentary sequence, from youngest to oldest comprises the Coonambidgal Formation, Shepparton Formation, Lachlan Formation and Olney Formation. The following table summarises each of these formations.

TABLE 2-2 CAINOZOIC GEOLOGY AND HYDROGEOLOGY (AFTER WILLIAMS 1989 AND KULATUNGA 2009)

Geologic Formation	Age	Description	Hydrogeology
Coonambidgal Formation	Pleistocene to Recent	Sandy Silt to occasional Cobble, highly micaceous, fawn colour, can be discontinuous across the Flood Plain; upper boundary is a disconformity	Typically contains the water table, may exhibit perched aquifer characteristics; hydraulically connected to Shepparton Formation aquifer. [VAF: AQ100]
Shepparton Formation	Pliocene to Pleistocene	Clay to Gravel, fluviatile meandering stream deposits, Sands are quartzose, brown to yellow colour; Clays are located away from the main Murray alignment, are white, yellow, red-brown and grey; upper boundary is probably a disconformity	Shallow Aquifer; low to medium transmissivity [20 to 250 m^2/day]; subject to evapotranspiration; estimated through-flow adjacent Quarry site at 1,160 m^3/day. Bore yields up to 3 ML/day. Typical target for Stock and Domestic users. [VAF: AQ102]
Lachlan Formation [equiv. to Calivil Fm.]	L Miocene to Pliocene	Clay/Sands/Gravel, poorly sorted, upward fining trends, grey colour, Sands and Gravels are predominantly sub-angular to rounded Quartz, upper boundary is probably a disconformity	Deeper Aquifer; high transmissivities [1 000 to 2,000 m^2/day]; estimated through-flow adjacent Quarry site at 3,150 m^3/day. Bore yields up to 10 ML/day. Typical target for Irrigation [VAF: AQ105]
Olney Formation [Renmark Group]	L Eocene to E Miocene	Interbedded Sand/Clay, predominantly carbonaceous Clay, limited distribution, upper surface is erosional	Not targeted for groundwater in this area [VAF: AQ111]

Note: VAF – Victoria Aquifer Framework; Department of sustainability and Environment 2012

The Upper Murray Alluvium is considered as a single hydrogeological entity. That is, for management purposes, it is considered that the Shepparton and Lachlan Aquifers act as a single hydrogeological unit.

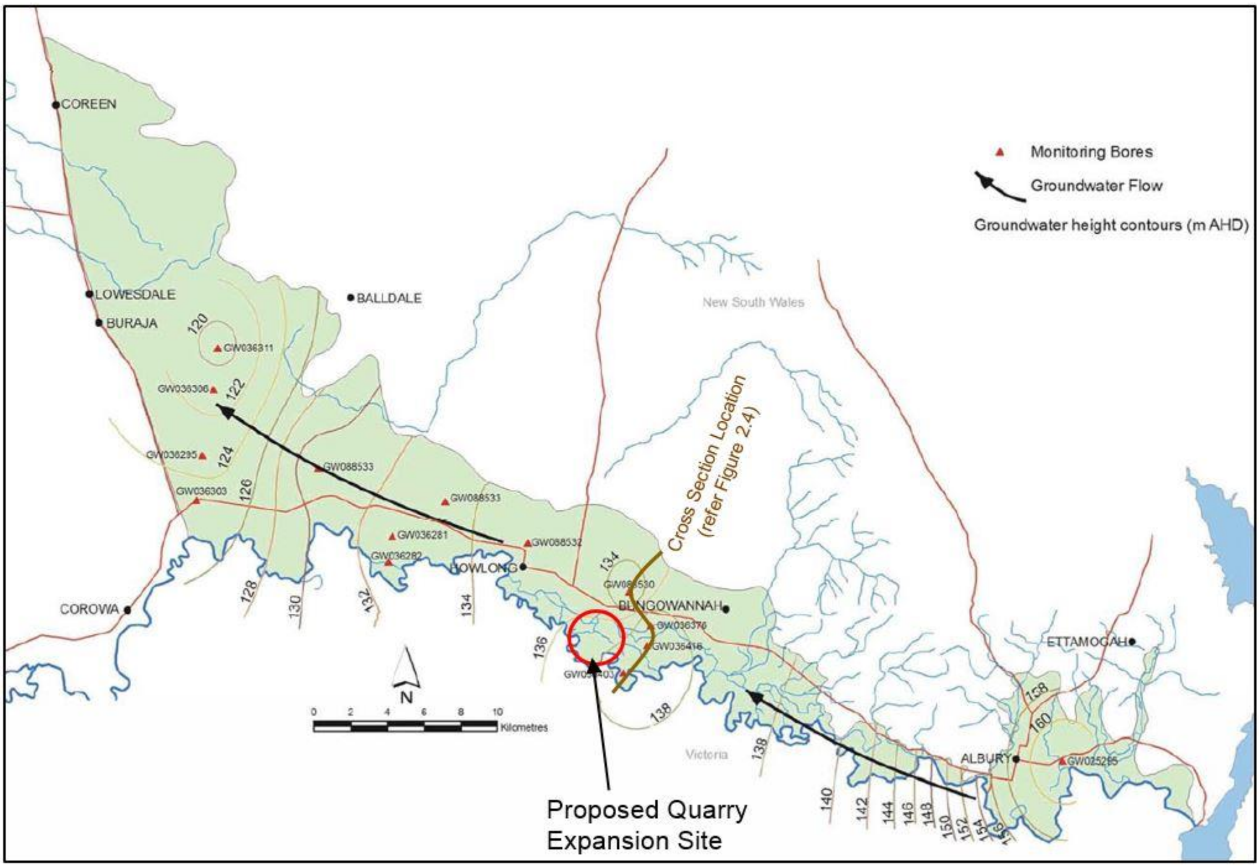

FIGURE 2-3 GROUNDWATER MANAGEMENT AREA 015 SHOWING LACHLAN AQUIFER GROUNDWATER HEIGHT CONTOURS (AFTER KULATUNGA 2009)

The River Murray and rainfall have been identified as the major recharge sources for the aquifer system while irrigation infiltration was identified as a minor recharge source.

Kulatunga (2009) summarises the aspects of the groundwater balance as:

- Recharge via incident rainfall (3% of 650 mm annual average) estimated at 9,700 ML/a;
- Recharge from River Murray leakage (over 61 km reach) estimated at 33,600 ML/a;
- Annual groundwater recharge as determined by 2003/04 groundwater numerical model is 15,300 ML/a, under the current level of development;
- Total groundwater entitlements are 41,125 ML/a (excluding stock and domestic licences) with 95% of the volume allocated for irrigation;
- Groundwater usage has been moderate in relation to full entitlement. The highest recorded usage was just over 16,000 ML in 2006/2007. Just over 12,000 ML was used in 2007/08.

The location of the proposed Howlong Sand Quarry Expansion is in an area where it is assumed the Upper Murray Alluvium aquifers transition from providing base flow to the surface river systems to receiving surface water from the losing surface river systems.

Regional groundwater flow is inferred to be from south-east to north-west, down topographic gradient of the river valley sediments in both the Shepparton and Lachlan aquifer systems as shown in Figure 2-2 and Figure 2-3 respectively.

2.3 Regional Hydrographs

An assessment of the monitored River Murray and groundwater level near the proposed quarry expansion is provided below. Existing groundwater monitoring bores relevant to this investigation are shown spatially in Figure 2-4 and in hydrogeological cross section in Figure 2-5.

The Albury (AWRC 409001) and Corowa (AWRC 409002) River Murray stage elevations and the NSW Office of Water groundwater monitoring bores GW036763, GW036403, GW036416, GW088530, GW088531 and GW030702 are analysed to show water level relationships and time series trends (refer Figure 2-6). Groundwater hydrographs for the Observation Bores are represented in Figure 2-6 and provided in detail in Figure 2-7.

The observed fluctuation of River level, due to regulation, ranges from around 2 m at Albury to around 3.5 m at Corowa. There is an observed relationship between seasonal flow within the River Murray and observed groundwater levels. Close to the river, as shown by groundwater levels in GW036403 located adjacent the River Murray the timing of the oscillation in observed groundwater levels coincides with river level oscillations. At groundwater monitoring sites distant from the river this seasonal relationship becomes less evident and groundwater levels appear more influenced by incident rainfall recharge and/or irrigation season usage, particularly from the Lachlan Aquifer.

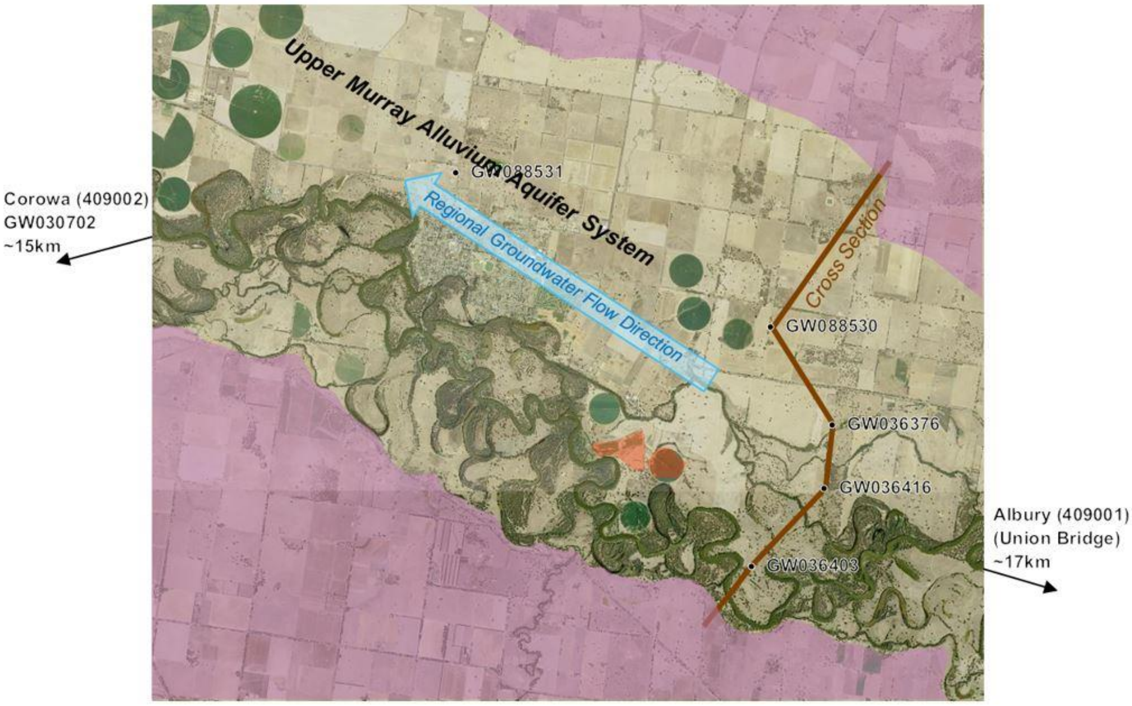

FIGURE 2-4 LOCATION OF RIVER AND GROUNDWATER MONITORING POINTS

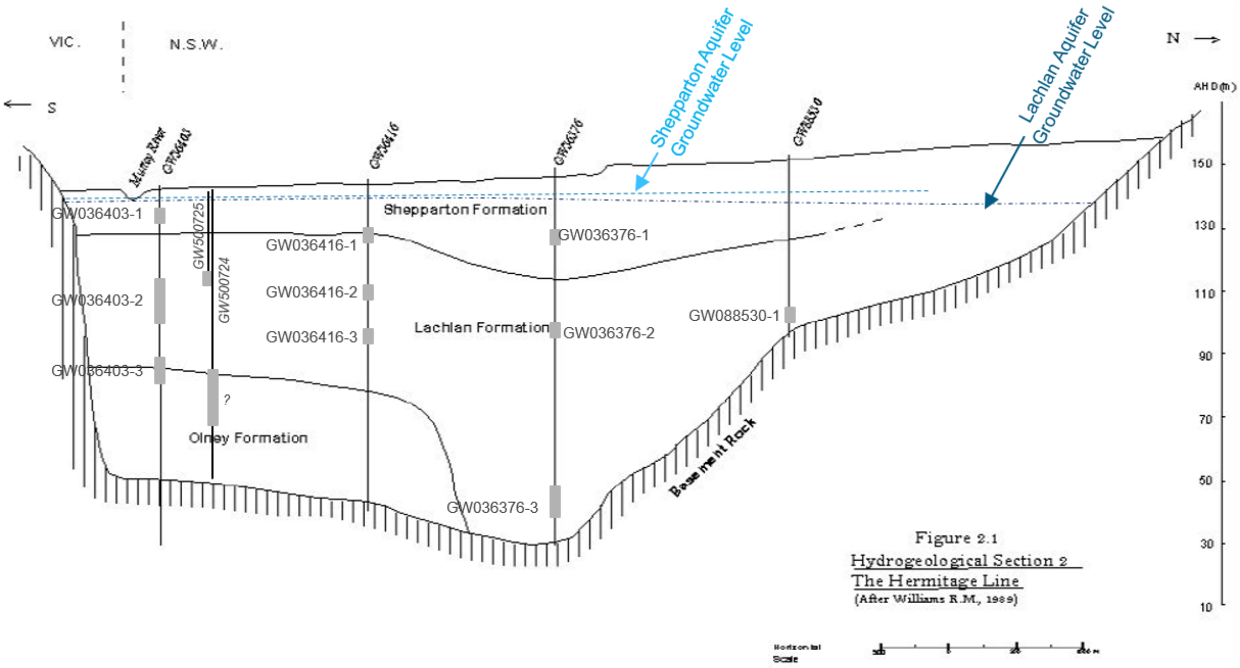

FIGURE 2-5 STYLISED CROSS SECTION ADJACENT THE PROPOSED QUARRY EXPANSION SITE (AFTER KULATUNGA 2009)

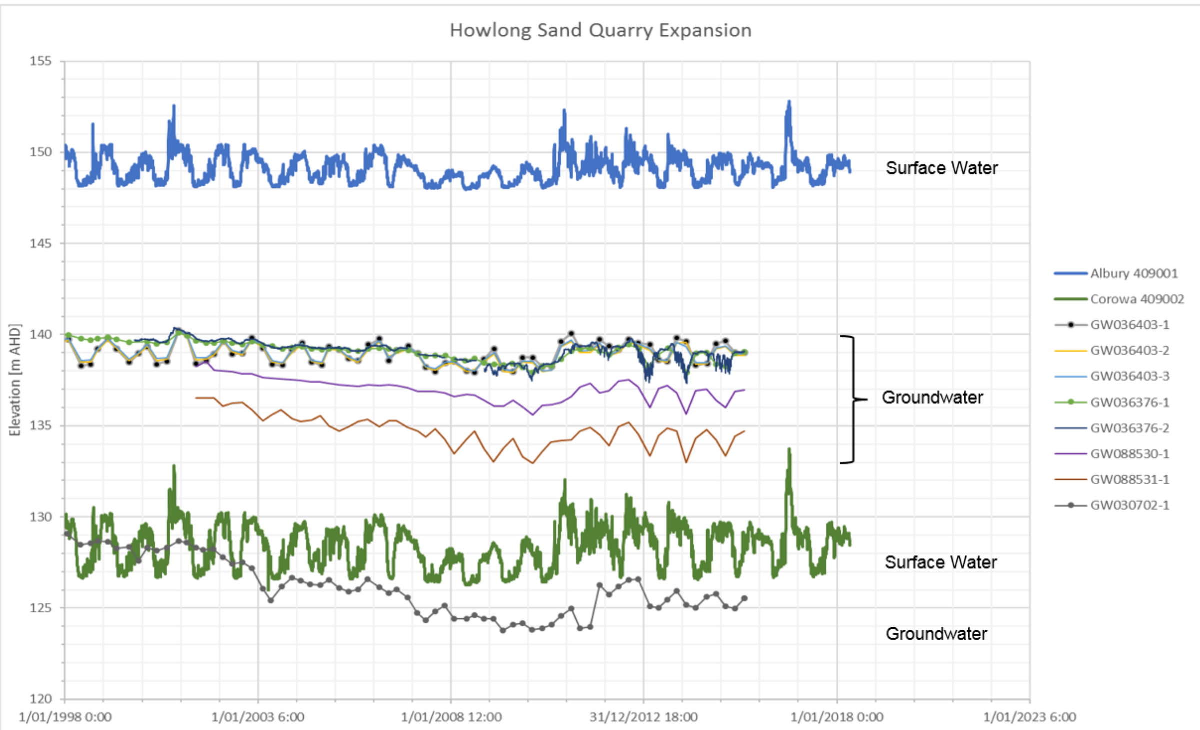

FIGURE 2-6 RIVER MURRAY AND UPPER MURRAY ALLUVIUM AQUIFER SYSTEMS WATER LEVEL COMPARISONS

Groundwater systems subject to local recharge often exhibit a relationship with local rainfall intensity patterns, specifically how actual rainfall varies against short, medium or long-term average rainfall. The analysis of how rainfall varies over time (called the 'cumulative deviation from the mean rainfall' or the 'mass balance') is shown for the rainfall record of Howlong Post Office[1] (refer Figure 2-7). The analysis trends horizontally during periods of average rainfall, trends downwards during periods of below average rainfall and upwards during periods of above average rainfall.

The comparison of this trend analysis with the groundwater level hydrographs indicates a relatively strong correlation at all sites with the exception of GW036403 (located close to the River Murray). This supports the assumption that the River Murray is in good hydraulic connection with the alluvial aquifer, and the adjacent groundwater levels are influenced by variations in river levels.

At each monitoring site where 'nested' piezometers are installed it appears that the Shepparton and Lachlan Aquifers are hydraulically connected as each piezometer trace tends to mirror those within the same 'nest'. Differences in groundwater level elevation within each 'nested' site indicates whether vertical groundwater flow potential is upwards or downwards between the Shepparton and Lachlan Aquifers (refer Figure 2-7 below).

Observation Bores at GW036403 indicate that historically (prior to approximately 2010, during times of low river flow the vertical groundwater flow direction potential between the Shepparton and Lachlan aquifers was upwards, whereas in recent times the vertical groundwater flow direction potential is generally downwards. Observation Bores at GW036416 (located north of the Black Swan Anabranch) indicate the vertical groundwater flow direction potential has remained upwards over time however the groundwater head pressure between monitoring depths, which drives vertical flow potential, has decreased. Observation bores at GW036376 (located further north just outside the high river flow inundation extent) indicate a similar reversal of vertical groundwater flow direction potential over time as GW036403. This impact of the development of groundwater extraction is more evident at this site. Also, the increased groundwater level variation within the Shepparton Aquifer at this site may indicate that this aquifer is utilised for groundwater extraction and/or is more responsive (connected) to the Lachlan Aquifer (and the groundwater extraction stresses imposed on that aquifer).

This reduction in upwards vertical groundwater flow potential may be an indicator that the impacts of the development of groundwater extraction of the Lachlan Aquifer is being felt at the location of these observation bores.

The rainfall trend analysis indicated that since 2015 there has been a slightly upward trend. It is expected that the groundwater level trends at the monitored sites would also show a steady to slightly upward trend to present day.

[1] Howlong Post Office precipitation data taken from "RAINMAN and Streamflow" v4.3 DPI QLD, BoM, Ag WA, NSW Ag, DNRM QLD ICE Media

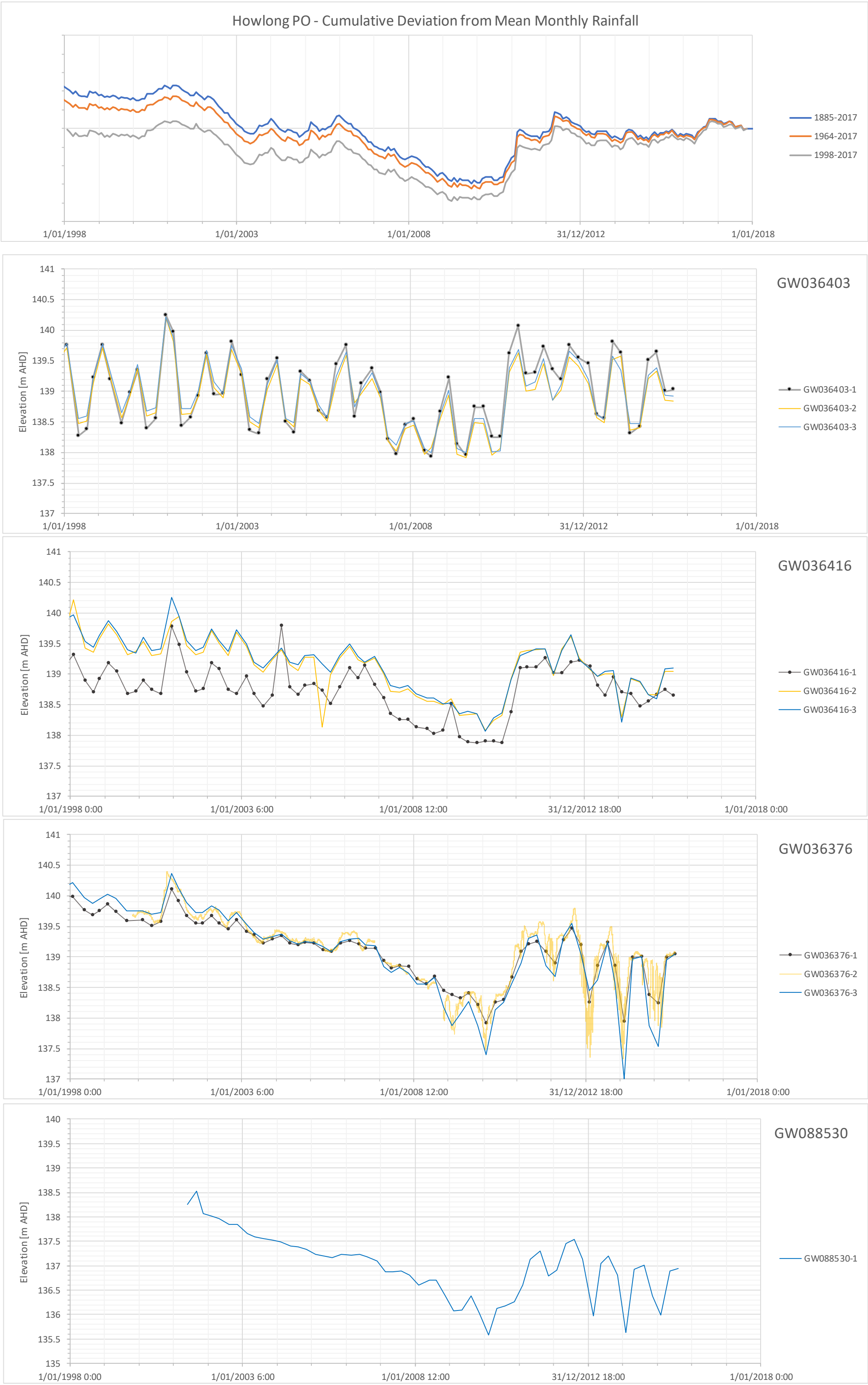

FIGURE 2-7 RAINFALL TRENDS AND GROUNDWATER HYDROGRAPHS FOR OBSERVATION BORES SHOWN IN FIGURE 2-5

3 SITE WATER BALANCE

3.1 Inflows

3.1.1 Regional Groundwater Inflow

Regional groundwater flow processes indicate that groundwater flows into the proposed Howlong Quarry Expansion site from the southeast. The proposed width of the pit excavation is approximated 10% of the established aquifer width and is planned to penetrate to near the base of the Shepparton Aquifer. This depth is approximately 25% of the full saturation depth of the combined Shepparton/Lachlan aquifer and planned total excavation depth does not appear to penetrate the higher yielding Lachlan Aquifer.

3.1.2 Groundwater Inflow to Pits

Water taken during active pit dewatering is considered groundwater and is required to be taken under licence. As the working pit deepens there will be an increased rate of groundwater inflow into the pit during the operational phase.

Site personnel undertook an estimate of groundwater inflow into the existing Pit 1 over a 26 day period at the end of the 2018 irrigation period. A star picket was placed in the ground and the water rise was measured each day. The rate of rise resulted in an estimated inflow of 2.5 ML/d into Pit 1.

3.1.3 Rainfall

It is expected that given the sandy nature of the substrate that rainfall on disturbed land will infiltrate rather quickly and will not be available for collection and use (RW Corkery & Co, 2020). Therefore, it is assumed that rainfall would only be captured when it falls on ponded areas. Rainfall that would be available within ponded areas for each stage has been estimated by RW Corkery & Co (2020) and is summarised below:

- Stage 1 (rainfall captured within the existing Stage 2 pond) – 28.9ML/a.
- Stage 2 (rainfall captured within the Stage 1 pond) – 38.6ML/a.
- Stage 3 (rainfall captured within the Stage 1 and Stage 2 ponds) – 75.6ML/a.
- Stage 4 (rainfall captured within the Stage 1, Stage 2 and Stage 3 ponds) – 99.3ML/a.

Upon closure, it is estimated that approximately 240.3 ML would be captured from rainfall each year.

3.1.4 Licensed Water

Associated with this operation are the following water licences:

- Water Access Licence (WAL) 29975 – 500 shares within the Upper Murray Groundwater Source of the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011. Taking into account carryover entitlements, this licence provides access to the equivalent of 685ML of water per annum.
- WAL 29930 – 890 shares within the Upper Murray Groundwater Source of the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011. Taking into account carryover entitlements, this licence provides access to the equivalent of 1,219ML of water per annum.
- WAL 29915 – 1,500 shares within the Upper Murray Groundwater Source of the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011. Taking into account carryover entitlements, this licence provides access to the equivalent of 2,055ML of water per annum.
- WAL 29969 – 568 shares within the Upper Murray Groundwater Source of the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011. Taking into account carryover entitlements, this licence provides access to the equivalent of 778ML of water per annum.

Water volume allocated through the Upper Murray Aquifer Scheme as an entitlement is based on a share arrangement where the available volume per share is determined annually. This is usually determined at 100% for this GMA. Consideration needs to be given to ensure that, pending the annual share determination, that there is the requisite volume of water available under the proponent's licensed arrangements to enable the dewatering of the working pit.

The Upper Murray Aquifer Scheme is considered over allocated at present, however only ~25% of this allocation is currently utilised. If this percentage of utilisation approached ~33% of allocation, consideration is made by the regulatory authority to reduce the available volume per allocation share to be taken. There is risk to the proposed quarry expansion that, in some years, the operators may not hold adequate volume on their licensed allocation to effectively dewater the working pit. There is provision within the licensing arrangement to either purchase new entitlements or periodically lease allocation to meet dewatering requirements.

3.2 Throughflows

3.2.1 Quarry Operation

The combined storage volume of the of Stage 1 and Stage 2 pits is currently approximately 1,530 ML. This volume is stored as source water for washing processing.

It is estimated that the total water demand for processing is up to 550 ML per annum (RW Corkery & Co, 2020). It is assumed that 95% of this water is returned to the extraction areas following use representing a loss of 80.5ML. Water from processing is returned to the property balancing water storages.

3.3 Outflows

3.3.1 Regional Groundwater Outflow

Regional assessment of groundwater flow processes shown by the constructed groundwater level contours (refer Figure 2-2 and Figure 2-3) suggest that the current quarry and irrigation operations have not invoked local groundwater level decline. It is proposed that groundwater from future pit dewatering will be used for the sand screening process, transferred to centre pivot irrigation or held in balancing storages.

3.3.2 Farm Water Usage

Currently there are 3 large pivots and 4 small pivots with plans for a fourth large pivot in 2020. It is proposed that an irrigation supply of approximately 7.3 ML/d will be sourced from the excavated pits during and post-quarry expansion.

It is proposed that removal of water from the extraction pits for irrigation would be an ongoing component of the water management system for the Quarry Operations. Historically, water for irrigation of the broader land holding has been pumped from the extraction pits. Groundwater inflows,, measured during dewatering have been used firstly for processing with return water or surplus water pumped to irrigation pivots.

3.3.3 Evaporation

Evaporative losses have been calculated based on review of historic evaporation data between 1971 and 2018 available from the SILO database. The annual average evaporation rate over that time has been used for calculation (1523.9 mm/yr) (RW Corkery & Co, 2020).

Based on the progressive extraction stages presented in Figure 1-1, it is estimated that the following evaporation would occur from ponded areas during each stage, when operational.

- Stage 1 (evaporation within the existing Stage 2 pond) – up to 76.5 ML/year.
- Stage 2 (evaporation within the Stage 1 pond) – up to 102.3 ML/year.
- Stage 3 (evaporation within the Stage 1 and Stage 2 ponds) – up to 200.1 ML/year.
- Stage 4 (evaporation within the Stage 1, Stage 2 and Stage 3 pond) – up to 263.0 ML/year.

Upon closure, a total of 636.1 ML would be lost annually through evaporation when all ponds would contain water.

3.3.4 System Operation

When the Sandstorm 620 is in operation water is pumped from the designated water source using an electric pump mounted on a floating barge at a rate of up to 500 m^3/hr. This water is used for washing the aggregate and supplies the cyclones on the plant for washing the sand. Screen processing discharge water is returned to the designated holding pond to remove any heavy particles.

Water drawn from non-operational pits will continue to be used for irrigation in accordance with the current agreement with the landowner. Irrigation pumps currently supply the operating pivots with the pumping rate modified as needed to meet irrigation demand.

Figure 3-1 presents a schematic of water sources and uses for the proposed operation.

It is noted that the maximum rate of screening would not be required for all operating days. The Applicant estimates that approximately 100 days per year would be dedicated to screening operations with the timing for operations driven by demand and requirements for water management. For the purpose of assessment and in order to remain conservative, it has been assumed that operations are occurring over a full year (that is, dewatering is occurring year-round and water is used for irrigation, regardless of the process water demand).

Should it be considered more feasible for the operation, the Applicant may amend the extraction method to include the use of a cutter and suction dredge, which would be connected to processing equipment via a dedicated pipeline and pump. This extraction method would be implemented should it be decided that water management at the Quarry would benefit as opposed to the preferred free dig extraction and haul methods that are currently used at the Quarry. Free dig extraction requires the active extraction area to be completely dewatered, whereas dredging would require that the water levels are maintained to provide sufficient depth for the extraction processes to occur from a floating dredge. This method would reduce the level of groundwater dewatering required for the extraction operations. Use of dredging methods for extraction would require a minor change to the configuration of processing equipment in order to receive the water and raw materials via the dredge pump.

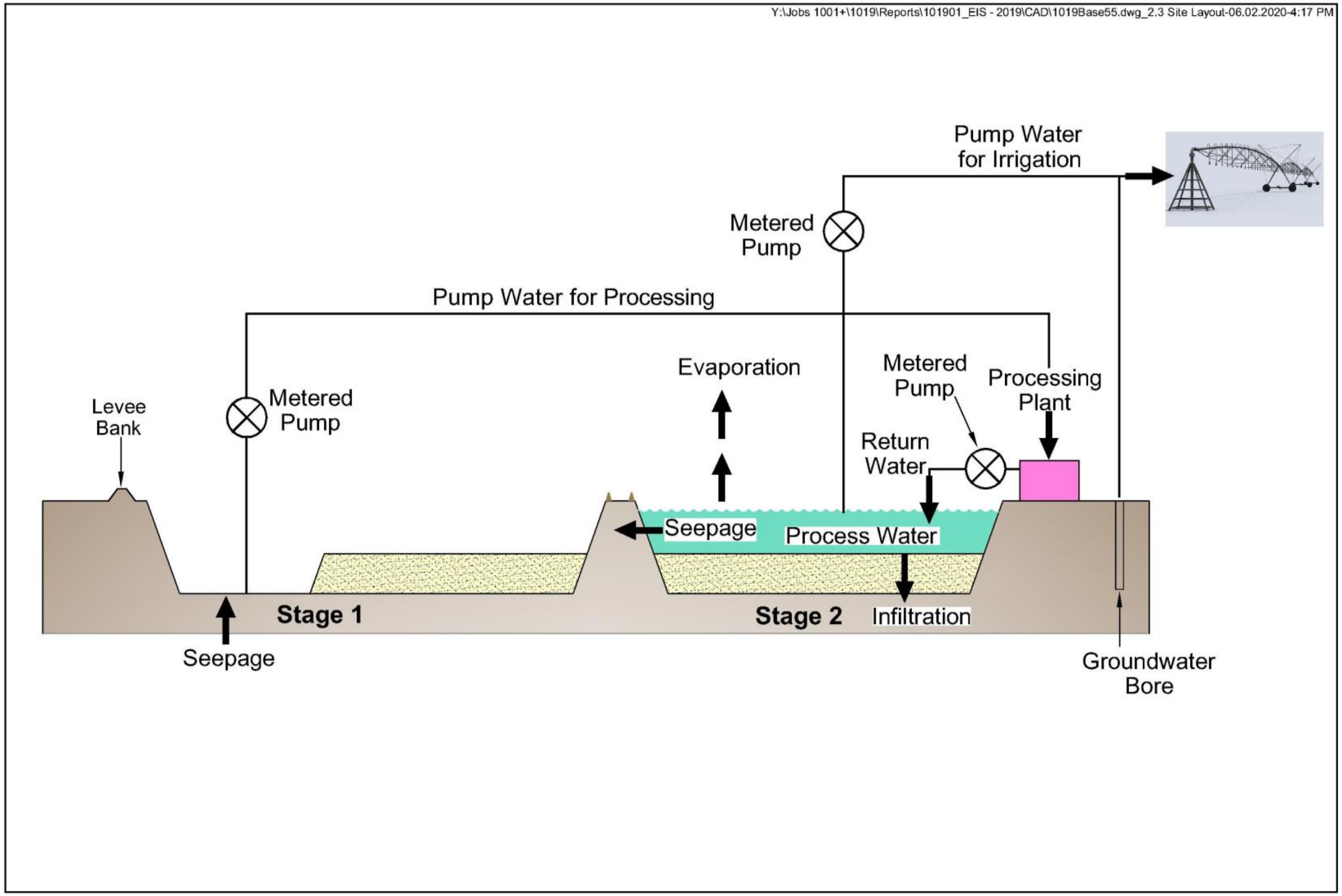

FIGURE 3-1 WATER SOURCE AND USE SCHEMATIC (RW CORKERY & CO, 2020)

4 NUMERICAL GROUNDWATER MODEL

4.1 Model Construction

A numerical groundwater model was constructed based on the review of available hydrogeological, river and climate data using MODFLOW-96 (Harbaugh and McDonald, 1996) on the PMWIN (Chiang and Kinzelbach, 1998) platform. The model extent is shown on Figure 4-1 and comprised the following:

- A length parallel to the river valley of 12 km and a width of 10 km.
- Model cells range from 100 m square to 50 m square in the vicinity of the quarry located in the middle of the model domain.
- 2 layers representing the Shepparton Formation and the Lachlan Formation with adopted aquifer parameters as shown in Table 4-1.
- River cells used to represent the main River Murray channel and the Black Swan Anabranch.

Long term monthly average evaporation and rainfall were adopted from the SILO data source over the period 1971 to 2018. Evapotranspiration (ET) was applied to the width of the river valley at an annual rate of 1,524 mm with an extinction depth of 3 m (i.e. the evapotranspiration flux is linearly interpolated between the maximum ET flux of 1,524 mm at the surface and zero at a depth of 3 m). Areal recharge was applied to the model at a rate equivalent to 3% of the long-term average annual rainfall of 576 mm.

Constant head cells were used at both ends of the model to replicate the reported groundwater flow fields in the Shepparton and Lachlan Formation aquifers.

TABLE 4-1 ADOPTED MODEL AQUIFER PARAMETERS

Model Layer	Type	Thickness (m)	Kh (m/d)	Sy	Ss
1 – Shepparton Formation	Unconfined	25	2	0.15	-
2 – Lachlan Formation	Confined / unconfined	60	20	0.20	10^{-4}

FIGURE 4-1 EXTENT OF NUMERICAL MODEL AND STEADY STATE GROUNDWATER LEVELS IN THE SHEPPARTON FORMATION

FIGURE 4-2 EXTENT OF NUMERICAL MODEL AND STEADY STATE GROUNDWATER LEVELS IN THE LACHLAN FORMATION

4.2 Model Calibration

Following the initial steady state model period to generate starting heads, the 5-year period 2013 to 2018 was adopted for model calibration due to existing analysis of river and hydrograph data. The river levels at the upstream and downstream ends of the model during this period were interpolated from existing flood curves (GHD et. al., 1986).

During this calibration period Pit 1 was represented by drain cells at an elevation of 128 m AHD. The drain package was used to remove groundwater from the model to simulate pit dewatering. Extracted groundwater is not returned into the model. This is the case for the use of drain cells for all model scenarios reported. The existing Pit 2 is currently at an elevation of 133 m AHD and receives water pumped from Pit 1 so is assumed to receive very little groundwater inflow. The modelled river levels and pit inflows are presented below in Figure 4-3. Importantly, the modelled inflow of 2.3 ML/d correlates closely with the measured inflow of 2.5 ML/d.

It is noted the modelling is based on a desktop assessment, with no site-specific groundwater pumping and aquifer testing data available and no local hydrographs on which to calibrate the model. Regional values have been used. The close calibration of pit inflows provides a level of confidence that the model is able to simulate the hydrogeological process occurring at the site. Given this, and within the constraints of observed material properties and available regional data, the model is considered fit for purpose to determine the potential pit dewatering volumes, and the likely extents of drawdown influences due to the pit dewatering.

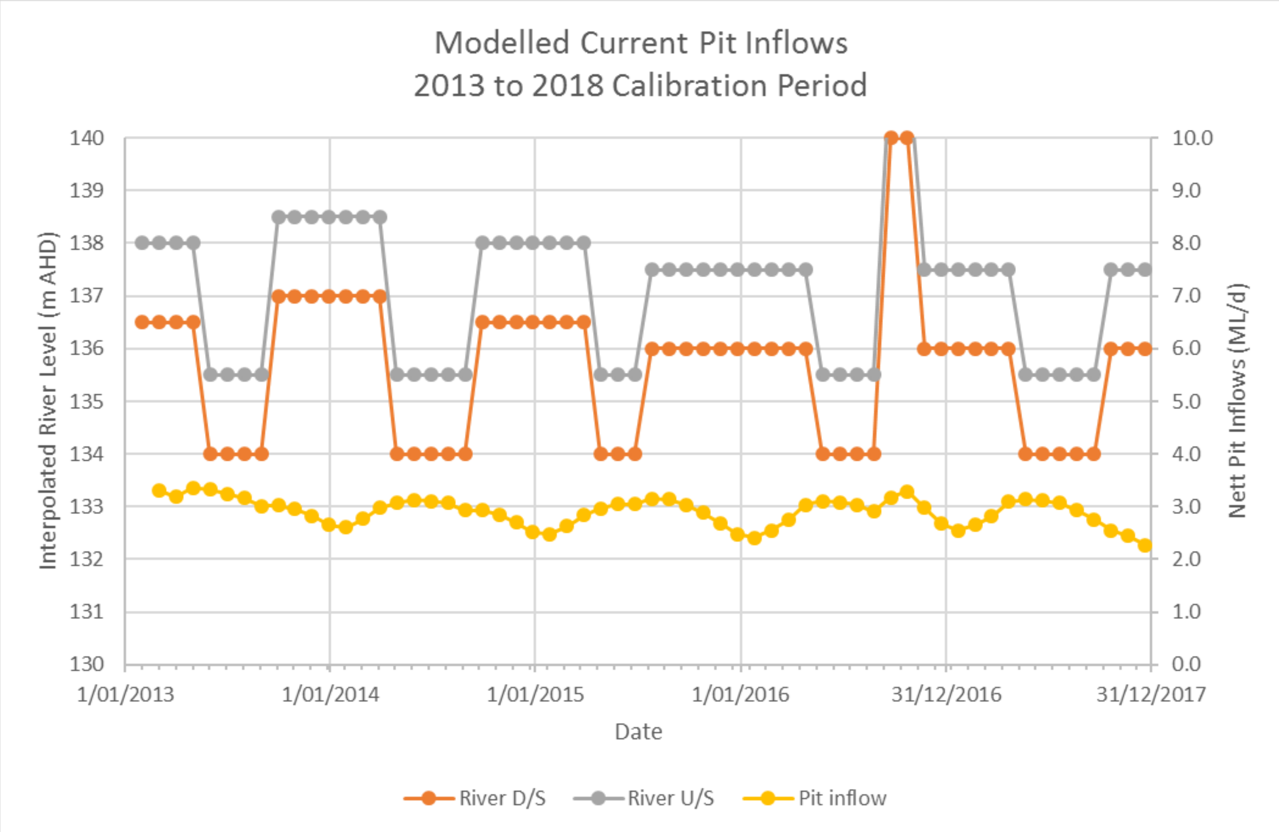

FIGURE 4-3 2013 – 2018 CALIBRATION PERIOD PIT INFLOWS

4.3 Modelled 2020 – 2050 Period

Based on the proposed quarrying schedule a model period of 2020 to 2050 was used to model the expansion of Pit 1, then expansion of Pit 2 followed by excavation of Pit 3. Stages 1 to 3 were developed over a 7 year model period. Pit 4 was assumed to be developed over a period of 23 years, initially as approximately north-south strips, or sub-pits, of 100 m width and eventually as a single large pit. All pits were assumed to be excavated to an elevation of 119 m AHD and allowed to fill after completion. During the expansion period average river levels used for the 5 year calibration period were adopted. The following model results were obtained for estimated pit groundwater inflows:

- Stage 1 expansion over 2 years – 7.2 ML/d.
- Stage 2 expansion over 2 years – 4.1 ML/d.
- Stage 3 excavation over 3 years – 3.2 ML/d.
- Stage 4 excavation over 23 years – 3.8 ML/d to 7.8 ML/d with a worst case scenario of 10 ML/d (this worst case scenario assumes that the entire Stage 4 pit will be open which is not expected to be the case due to the operational challenges this would pose).

Groundwater sourced from pit dewatering is proposed to supply irrigation at the rate of approximately 7.3 ML/d. The numerical groundwater model scenarios have accounted for this by sourcing water from previously excavated pits where the dewatering volume is less than the required irrigation volume. This is detailed below in Table 4-2. Water is sourced from the previous pits by using the MODFLOW Drains package to maintain them at a level required to meet the irrigation demand.

TABLE 4-2 PIT DEWATERING AND WATER SUPPLY SCHEDULE

Pit	Dewatering Volume (ML/d)	Irrigation Demand (ML/d)	Operational Demand (ML/d)[1]	Balance Required (ML/d)	Available Balance Source	Supply Level of Balancing Pit(s) (m AHD)
1	7.2	7.3	0.4	-0.5	-	-
2	4.1	7.3	0.5	-3.7	Pit 1	123
3	3.2	7.3	0.6	-4.7	Pit 1 and 2	127
4 (initial sub-pit)	3.8	7.3	0.7	-4.2	Pits 1, 2 and 3	130
4 (with 2 sub-pits)	7.8	7.3	0.7	-0.2	Pits 1, 2 and 3	132
4 (full pit)[2]	10	7.3	1.1	1.6	Not required	Not required

Notes: 1. Includes water for processing, product moisture loss, dust suppression and evaporation balanced by rainfall.
2. It is not envisaged that pit 4 would be fully open at any single point in time.

It is noted that during Stage 1 (pit 1 dewatering), irrigation demand would slightly exceed dewatering volumes. Irrigation demand would need to be reduced slightly to account for this shortfall. In Stages 2, 3 and when one or two sub-pits are operated in Stage 4, the irrigation demand would need to be sourced from completed pits (up to 4.1 ML/d). As Pit 4 approaches completion, dewatering volumes would exceed irrigation demand and may require further management. It is understood that by Stage 4 substantial revegetation and rehabilitation of land adjacent to the Quarry would be occurring or have been completed. Any surplus water would be irrigated over this land to support vegetation establishment. It should be noted that it is unlikely that Pit 4 would be completely dewatered during development and inflow to a completely dewatered Pit 4 has been assessed to indicate a worst-case scenario for water licencing purposes. Therefore, dewatering volumes at 10 ML/d are not likely to be required with a maximum of 7.8 ML/d expected. Monitoring of dewatering volumes over the life of the operation would be required to ensure that actual dewatering is recorded and compared to modelled predictions.

Note that for modelling purposes the initial Stage 4 sub-pits are assumed to be individually excavated with the modelled dewatering volumes for each as indicated in Table 4-2. As this pit approaches completion, two-sub-pits would be open and dewatered with total dewatering modelled at 7.8 ML/d. If developed as a single large pit, the total pit dewatering volume is estimated to be approximately 10 ML/d. However, it is not envisaged that the full pit would be open at any single point in time due to the operational challenges this would pose.

The modelled groundwater drawdown impacts at the end of each stage are shown on Figure 4-4 for the Shepparton Formation (water table drawdown) and Figure 4-5 for the Lachlan Formation (potentiometric or pressure level reduction). The plotted drawdown zones indicate the area where drawdown is modelled to exceed 0.5 m and includes the drawdown effects of the dewatering of each pit and the supply of irrigation top-up water from previously excavated pits. The modelled aquifer drawdown and pressure reduction levels are relative to modelled groundwater levels at the end of the model calibration period. In all modelled scenarios the confined Lachlan Formation aquifer is not dewatered at any location i.e. the potentiometric level remains above the top of the aquifer.

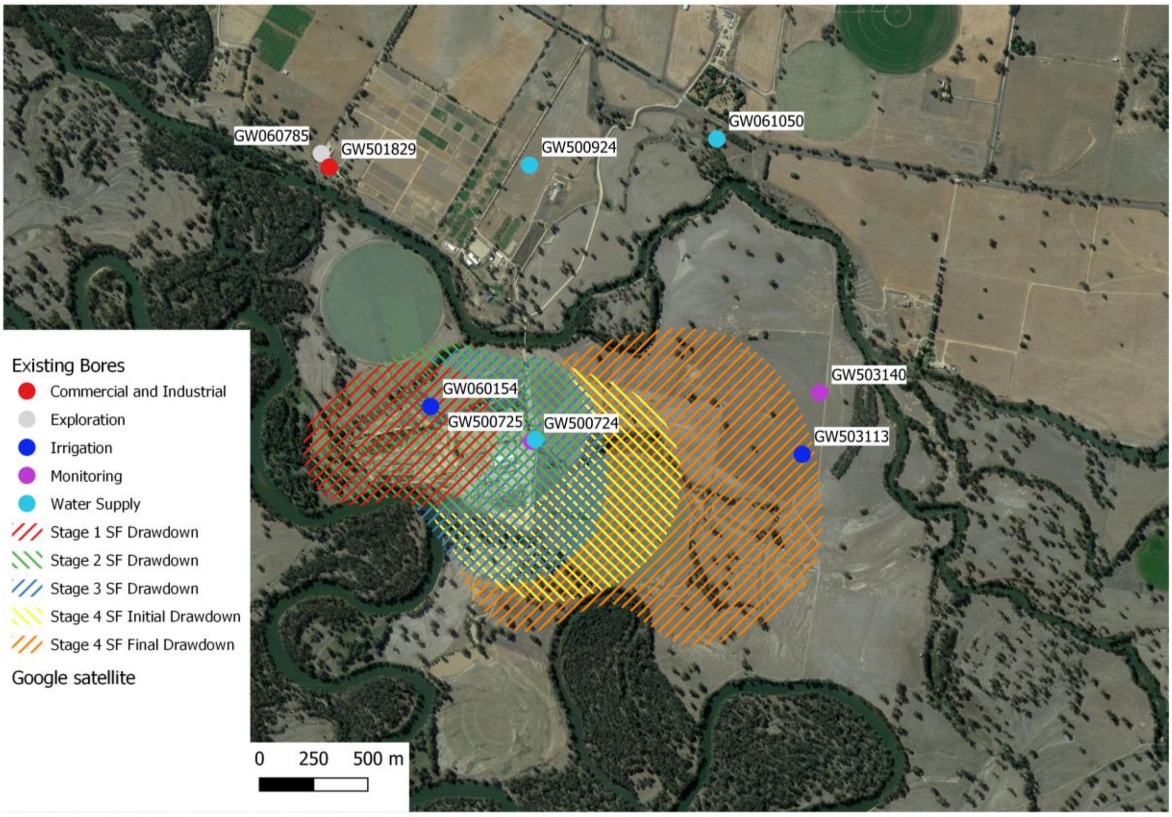

FIGURE 4-4 SHEPPARTON FORMATION (SF) DRAWDOWN >0.5 M

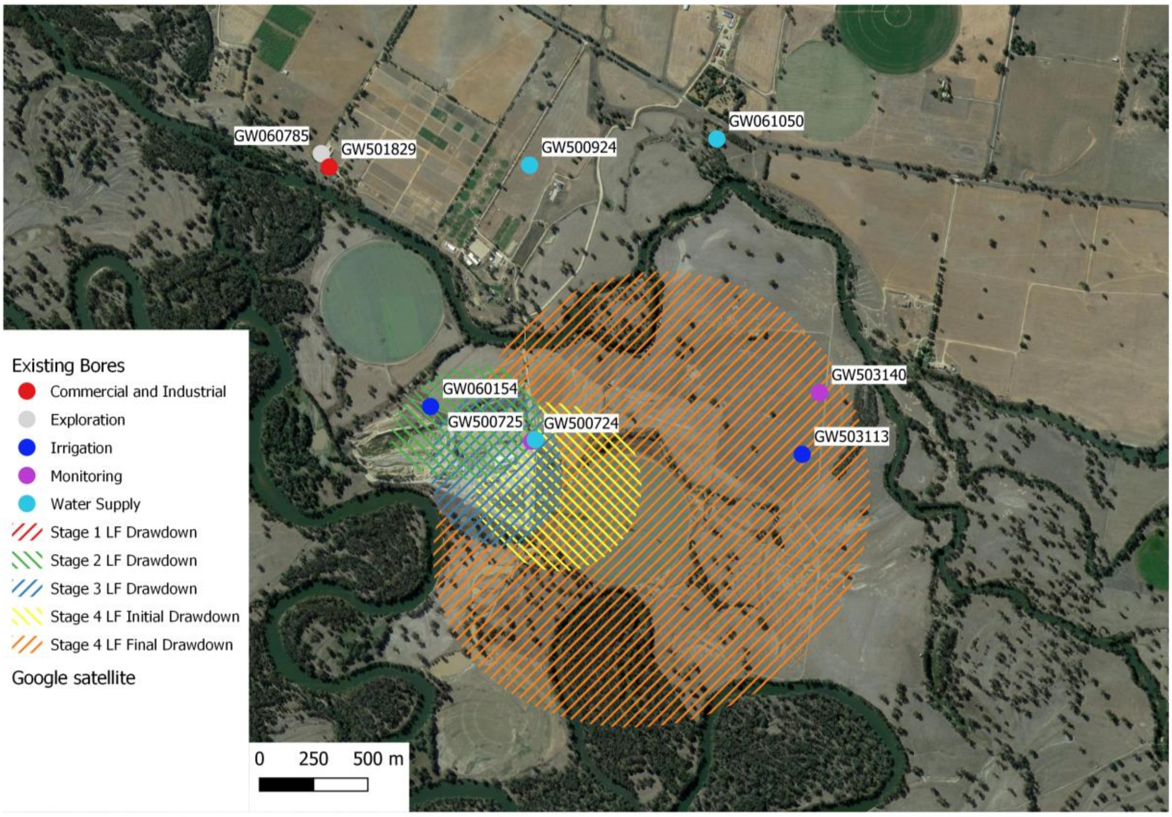

FIGURE 4-5 LACHLAN FORMATION (LF) POTENTIOMETRIC LEVEL REDUCTION >0.5 M

4.4 Post Expansion Recovery Model

The MODFLOW groundwater model was extended to include a 50 year period following completion of the quarry expansion activities. During this period a nett discharge was applied to each pit equivalent to nett evaporation plus the following assumed on-going irrigation extractions:

- Stage 1 – 1.10 ML/d.
- Stage 2 – 1.10 ML/d.
- Stage 3 – 1.10 ML/d.
- Stage 4 – 4.05 ML/d.

The pit areas were assigned a hydraulic conductivity of 1,000 m/d and specific yield of 1.0 to simulate open waterbodies. The 50 year post-expansion groundwater contours in the vicinity of the site for the Shepparton Formation are shown below on Figure 4-6 together with the area where modelled drawdown exceeds 0.5m. The excavated areas are modelled to stabilise with groundwater levels lower than ambient levels by approximately 4 m to 5 m and establishing as a groundwater discharge area under the influence of irrigation extraction and evaporation from the water bodies. Most of the drawdown occurs within several hundred metres of the pits (Figure 4-6) and is essentially constrained to an area between the River Murray and the Black Swan Anabranch.

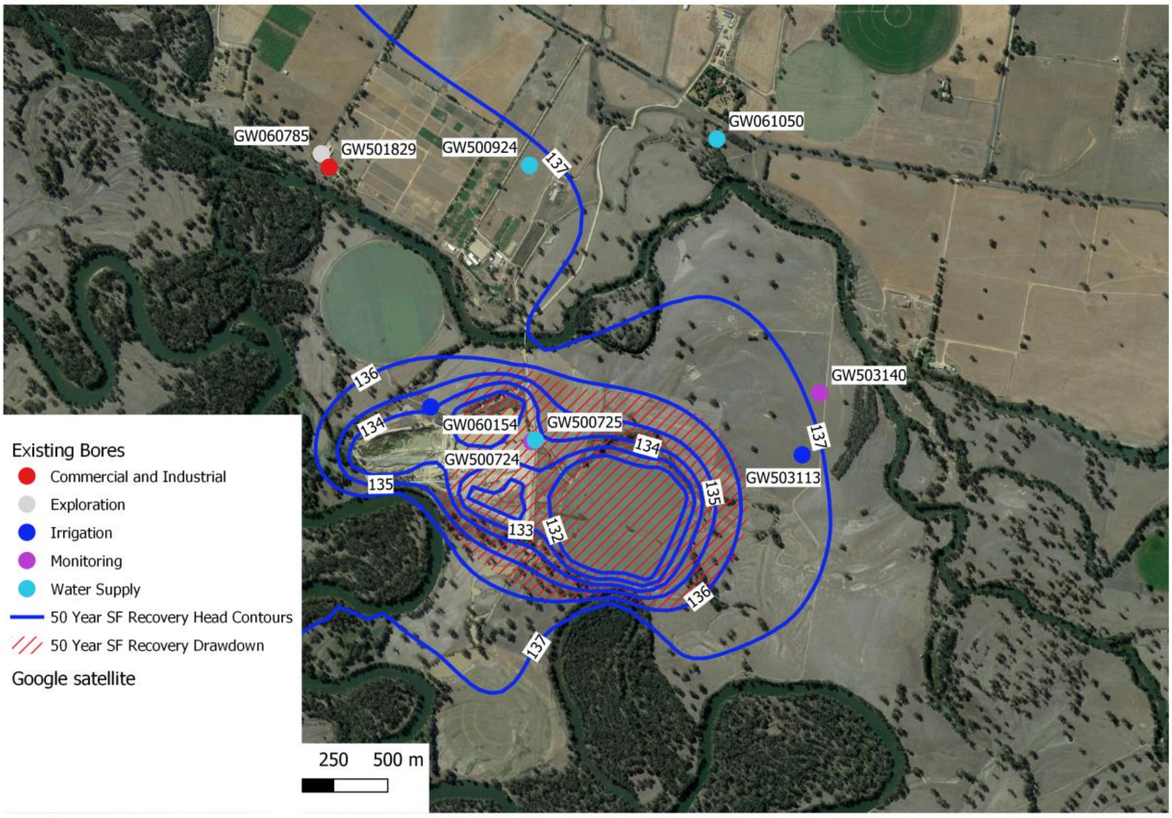

FIGURE 4-6 SHEPPARTON FORMATION (SF) POST-EXPANSION GROUNDWATER CONTOURS AND DRAWDOWN >0.5 M

The 50 year post-expansion groundwater contours in the vicinity of the site for the Lachlan Formation are shown below on Figure 4-7 together with the area where the modelled potentiometric level reduction exceeds 0.5 m. The results indicate that after 50 years there is a small area constrained to within the Stage 4 pit area where the potentiometric level reduction exceeds 0.5 m, with no corresponding impact on nearby registered bores or identified ecological groundwater receptors.

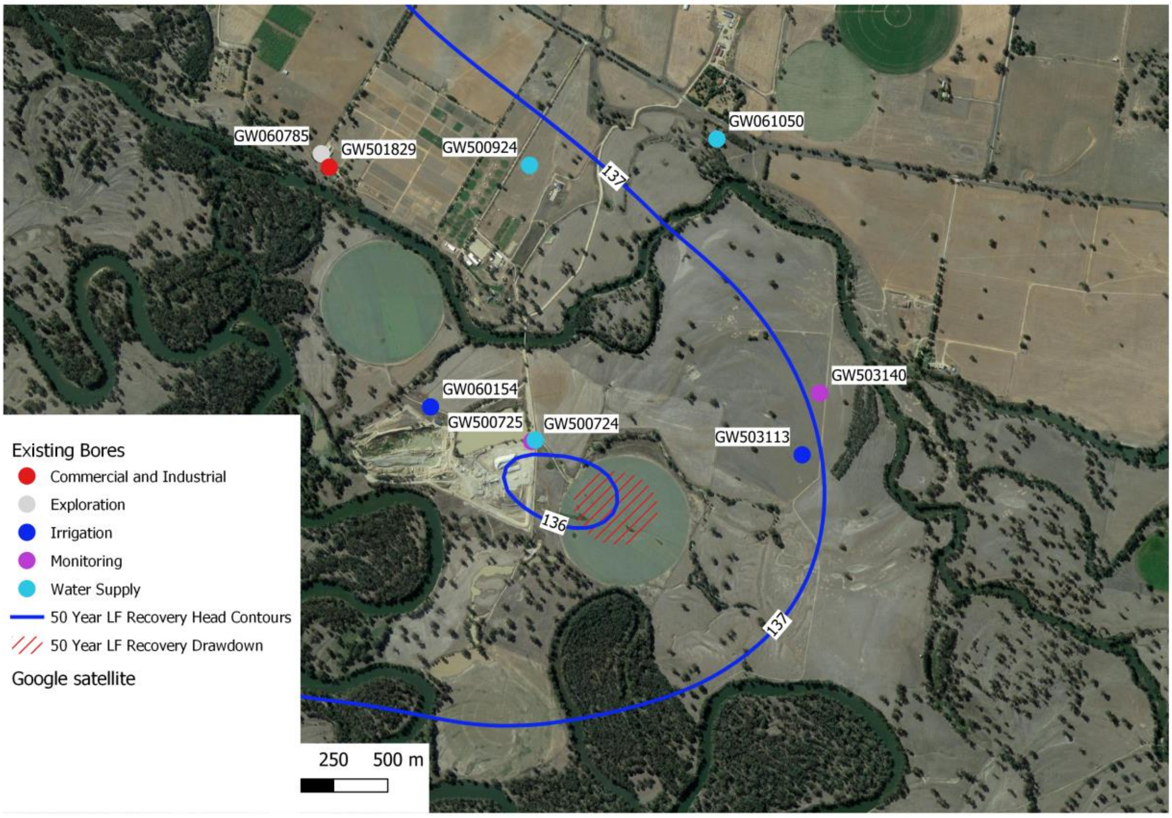

FIGURE 4-7 LACHLAN FORMATION (LF) POST-EXPANSION POTENTIOMETRIC CONTOURS AND POTENTIOMETRIC LEVEL REDUCTION >0.5 M

5 PIT WATER AND SALT BALANCES POST EXCAVATION

As each stage is completed the pit water levels will recover in response to groundwater and rainwater inflow and removal of water for irrigation or industrial use and evaporation. A spreadsheet model was used to model the long-term pit lake recovery levels and salinity with varying groundwater inflow rates depending on pit water level adopted from the MODFLOW model. The SILO 1971 – 2018 monthly average rainfall and evaporation data were used as inputs. Pit geometries were estimated based on a final excavation level of 119 m AHD, batter slopes of 2:1 (V;H) and surface areas as described in the staged development. The results of this modelling are shown on Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 and show that pit levels recover and stabilise within 2 years. Due to the assumed extraction of water for irrigation, the salinity of the pits is maintained at between 500 mg/L and 600 mg/L for an assumed starting groundwater salinity of 450 mg/L.

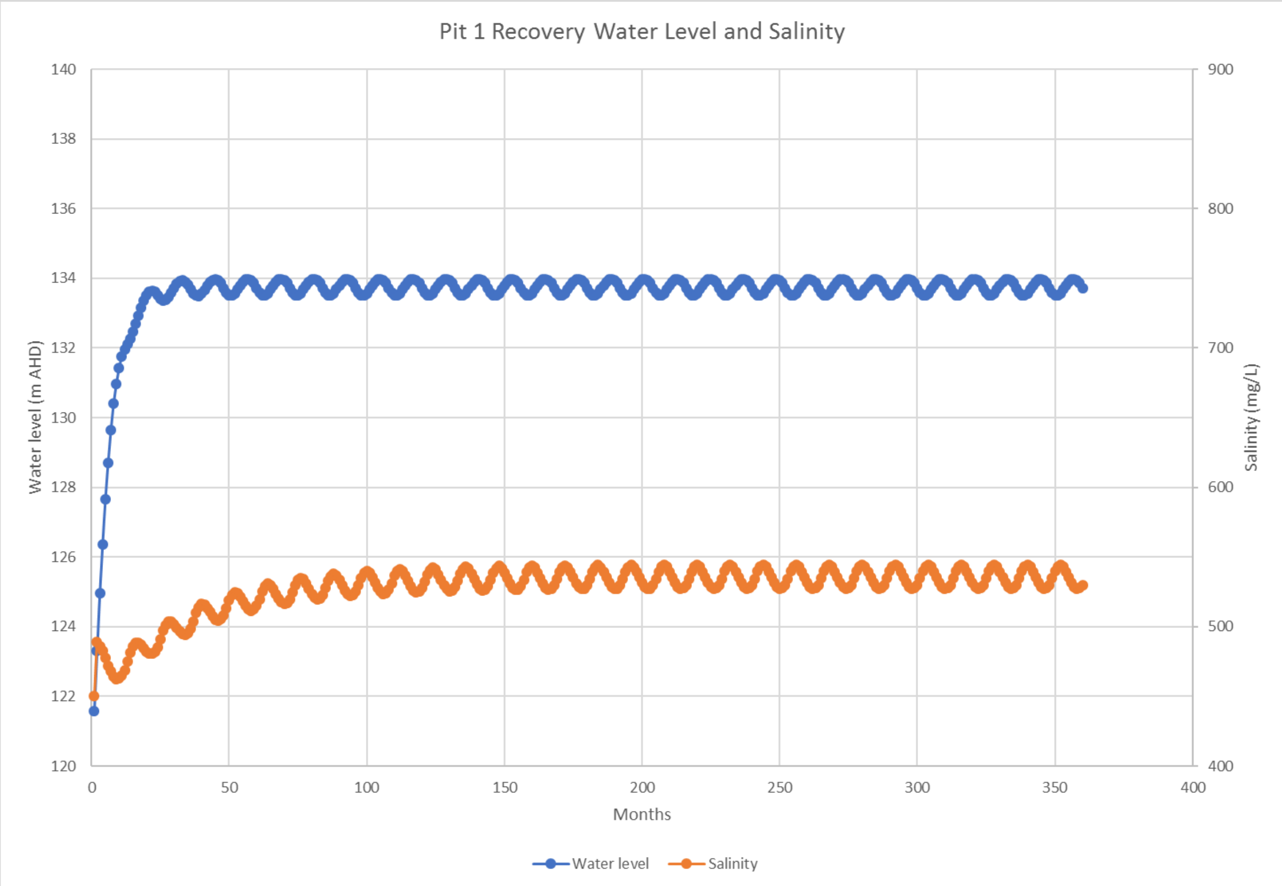

FIGURE 5-1 PIT 1 RECOVERY WATER LEVEL AND SALINITY

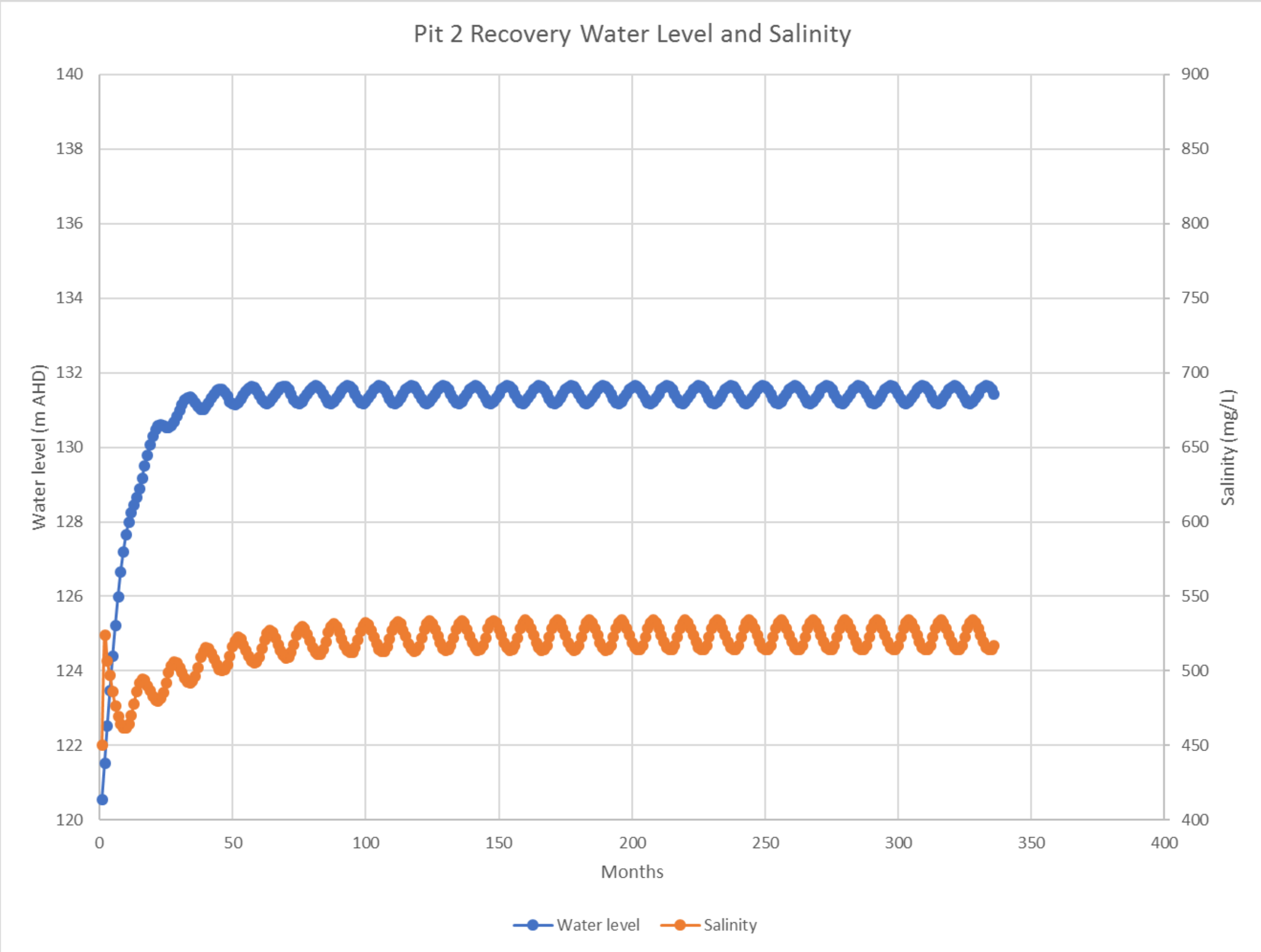

FIGURE 5-2 PIT 2 RECOVERY WATER LEVEL AND SALINITY

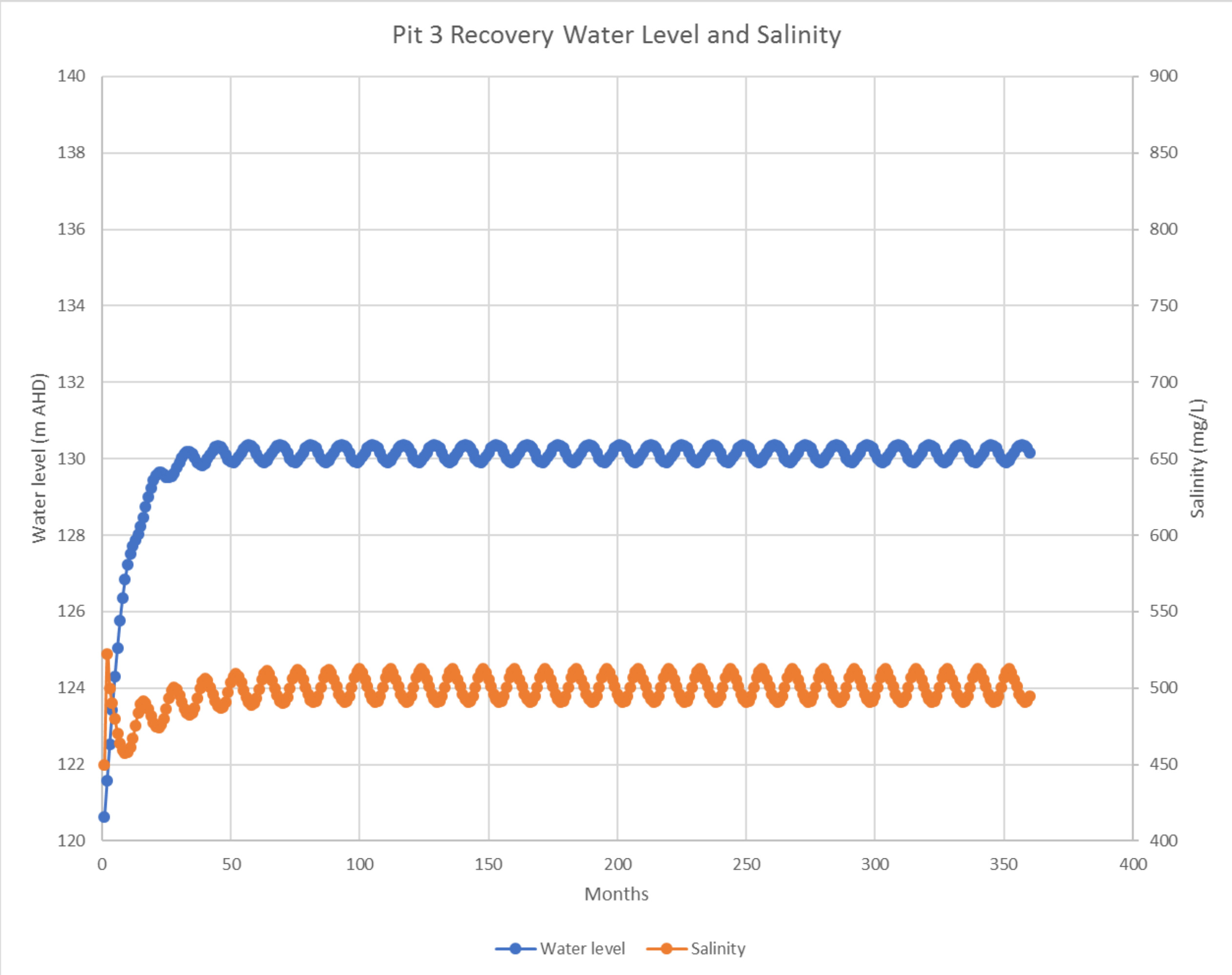

FIGURE 5-3 PIT 3 RECOVERY WATER LEVEL AND SALINITY

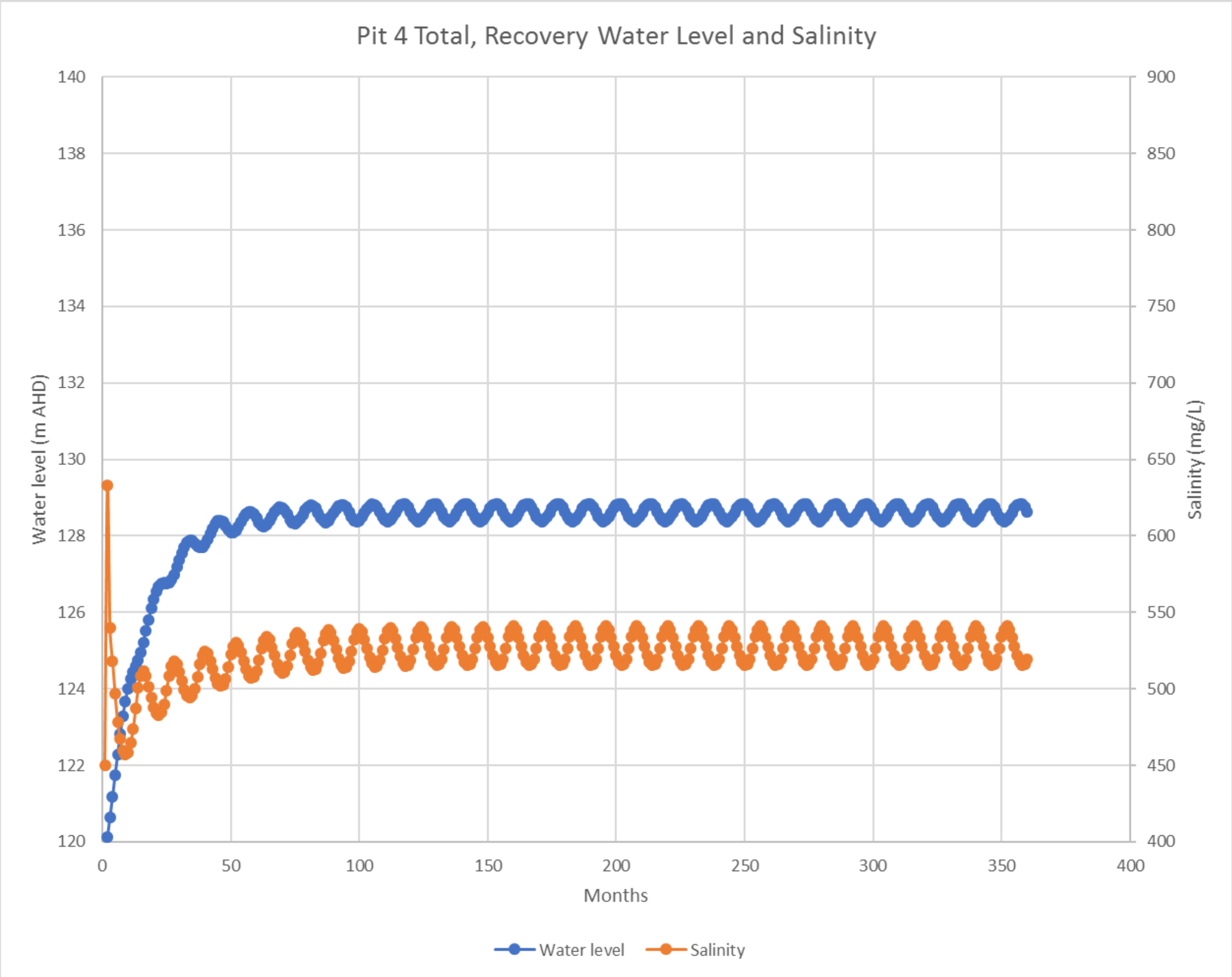

FIGURE 5-4 PIT 4 RECOVERY WATER LEVEL AND SALINITY

6 FUTURE WATER MANAGEMENT

6.1 During Expansion Stages

Based on the numerical groundwater modelling it is anticipated that the following groundwater inflow volumes will require management:

- Stage 1 expansion over 2 years – 7.2 ML/d.
- Stage 2 expansion over 2 years – 4.1 ML/d.
- Stage 3 excavation over 3 years – 3.2 ML/d.
- Stage 4 excavation over 23 years – 3.8 ML/d to 7.8 ML/d with a worst case scenario of 10 ML/d (this worst case scenario assumes that the entire Stage 4 pit will be open which is not expected to be the case).

The following annual allocations would be needed to cover the anticipated pit inflows detailed above and the anticipated demand described in Section 3:

- Stage 1 expansion over 2 years – 2,628 ML/y inflow due to excavation but a total draw of 2,777 ML/y to meet expected operational and irrigation demand.
- Stage 2 expansion over 2 years – 1,497 ML/y inflow due to excavation but a total draw of 2,795 ML/y to meet expected operational and irrigation demand.
- Stage 3 excavation over 3 years – 1,168 ML/y inflow due to excavation but a total draw of 2,851 ML/y to meet expected operational and irrigation demand.
- Stage 4 excavation over 23 years – 1,387 ML/y to 2,847 ML/y inflow due to excavation but a total draw of 2,890 ML/y to meet expected operational and irrigation demand.

A worst-case outcome of 3,650 ML/d was identified in modelling that assumes that the entire stage 4 pit is open. While it has been assessed, the proponent has indicated that this outcome is not considered realistic for the operation due to the operational challenges this would pose. Therefore, a maximum licenced entitlement of 2,890 ML/y would be required during extraction operations (Stage 4).

Pit water balance modelling shows that there will not be enough available storage capacity in each pit stage to receive pumped groundwater from each subsequent stage. Pumped groundwater will therefore require appropriate on-site balancing storage and irrigation demand during the staged expansion program.

The modelling shows that due to the bounding of the River Murray and Black Swan Anabranch the drawdown effects of the proposed staged development are constrained to an area between these water bodies and to within less than 1 km along the floodplain from the quarrying operations. These areas currently comprise quarrying operations, irrigated floodplain areas or cleared floodplain areas. An assessment of impacts to existing users and the environment is provided in Section 7.

6.2 Post Quarrying

The understood post-quarry plan is to allow excavated pits to remain open to naturally fill with water and be rehabilitated as wetlands with the option to provide irrigation water supplies as previously described.

The proponents will need to account for the irrigation take and evaporative losses from the pits in their water license entitlements. An annual allocation of 3,075 ML/y would be needed to cover the on-going irrigation extractions (2684 ML/y) and the anticipated nett evaporation (391 ML/y), defined as the total evaporation minus direct rainfall input to the ponds.

7 HYDROGEOLOGICAL IMPACT ASSESSMENT

7.1 Overview

The impacts described in this section have been assessed using the outputs from the numerical groundwater flow model described in Section 4 and the pit water and salt balance models described in Section 5. The assessment follows the NSW Aquifer Interference Assessment Framework. The groundwater sources that may be impacted include the Shepperton and Lachlan Formation aquifers which are regulated under the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources (2011). The site is within the Unregulated Middle Murray Extraction Management Unit.

The Shepperton and Lachlan Formation aquifers are defined as 'highly productive' and fall within the 'alluvial' sub-grouping as defined by the NSW Aquifer Interference Policy (2012). Assessment of impacts from the proposed development to the water table and water quality have been made as required under this policy. No known culturally significant sites would be impacted by the development.

7.2 Existing Users

The location of known existing groundwater wells (existing users) are provided in the drawdown plots in Figure 4-4, Figure 4-5, Figure 4-6 and Figure 4-7. Well locations were downloaded from the Australian Groundwater Explorer[2] and cross checked with information held within the NSW Groundwater online portal[3].

Three registered groundwater wells are located on the property (GW060154, GW500724 and GW500725). It is understood that these wells are not used, and all water for quarry operations and irrigation is currently sourced from existing pits.

Assessment of the predicted drawdown contours against the location of other existing users (i.e. wells not located on the property) shows that drawdown is less than 2 metres in all cases which is the drawdown threshold as defined in the NSW Aquifer Interference Policy (2012).

Drawdown of up to 0.5 m is predicted at wells GW503113 and GW503140 during the operational phase of the Stage 4 excavation (Figure 4-4 and Figure 4-5). Well GW503140 is listed as a monitoring well and its status is abandoned while well GW503113 is listed as an operational irrigation well. GW503113 is 54 m deep with a reported standing water level of 4 m and a yield of 30 L/s. Given the available drawdown of up to 50 m in the well and the high yield, the proposed operations are unlikely to have any noticeable impact on this well. Once pit dewatering ceases, the drawdown at these wells is predicted to reduce to less than 0.5 m (Figure 4-6 and Figure 4-7).

7.3 Groundwater Dependant Ecosystems

The Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources (2011) states that at the time of publication, no high priority Groundwater Dependent Ecosystems (GDEs) have been identified in the area covered by the plan.

In the absence of any defined high priority groundwater dependent ecosystems, data from the Australian GDE Atlas published by the National Water Commission (2012) has been assessed to identify potential GDE locations near the study site. The GDE atlas is based on broad scale analysis, existing data sets and remote sensing. GDEs are categorised as:

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[2] http://www.bom.gov.au/water/groundwater/explorer/map.shtml
[3] https://realtimedata.waternsw.com.au/water.stm

- Aquatic ecosystems that rely on the surface expression of groundwater; this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs.
- Terrestrial ecosystems that rely on the subsurface presence of groundwater; this includes all vegetation ecosystems.
- Subterranean ecosystems; this includes cave and aquifer ecosystems.

The locations of potential terrestrial and aquatic GDEs are provide in Appendix A. There are no subterranean ecosystems identified within the study extent.

The modelling shows that due to the bounding of the River Murray and Black Swan Anabranch the drawdown effects in the Shepparton Formation (i.e. the water table aquifer which is accessible to vegetation) are largely constrained to an area between these water bodies. Once pit dewatering has ceased, the pit lakes will recover, and they will be used to supply water for irrigation. The groundwater level is predicted to return to within 4 to 5 m of the pre-dewatering groundwater level adjacent the pits. The greatest drawdown occurs within several hundred metres of the pits in areas which do not contain large stands of existing vegetation as shown in Figure 4-4 and Figure 4-6. It is possible that some level of effect may be felt in localised areas directly adjacent the pits, depending on the degree of reliance these vegetation communities have on the groundwater system.

Cross river drawdown impacts are not expected in the Shepparton Formation, and vegetation communities outside of the area between the River Murray and Black Swan Anabranch are not expected to be impacted by the proposed development. Vegetation communities located along the Riverbank (within 10 m) are also not expected to be impacted as the extraction of water from the pits is not expected to alter the river level, and hence groundwater levels immediately adjacent the river will continue to be driven by the stage height of the river.

7.4 Water Quality

The main long-term impact on the hydrogeological behaviour of the area is anticipated to be an increase in the surface area of exposed water table due to an increase in the number of excavated pits. There are currently two pits excavated covering an area of 13 hectares. This will increase to four pits covering a total area of ~42 hectares.

This will likely increase the rate of groundwater discharge from the Upper Murray Aquifer System driven by the evaporative loss from the pit lakes. If required, the increased discharge can be accounted for by a corresponding decrease in the licensed extraction of groundwater for irrigation purposes.

The pits will become irrigation water supply and evaporative sinks on the floodplain with localised groundwater flow paths reflecting this. Groundwater flow will be towards the pits and hence no impacts to the local groundwater salinity are expected. Due to the extraction of water for irrigation, the salinity of the pits is maintained at between 500 mg/L and 600 mg/L for an assumed starting salinity of 450 mg/L.

If flooding does occur, these water bodies will be diluted, the impacts of which are considered to be negligible given the relative proportion of flood waters compared to water held within the pits.

7.5 Potential Impacts on the River Murray

It is considered that the water quality and flow risks of pit excavations on the River Murray will be low because:

- The maximum ‘worst case’ modelled dewatering volume of 10 ML/d represents 0.5% of the minimum (winter) daily river flow at Howlong based on 2019 data (which is representative of historical river stage heights), and approximately 0.1% of the average minimum daily flow for 2019. Given the existing use of water from the Quarry for irrigation activities, the change in dewatering volumes is likely to be much lower than the maximum predicted outcomes.

- Based on the numerical groundwater modelling, the nett effects of evaporation and irrigation extractions will result in the pit levels being maintained below river level and it is unlikely that water held in the extraction pits would flow to the Murray River (i.e. the flow gradient is from the river to the pits). Hence, water quality impacts on the River Murray are considered unlikely.

The Applicant has committed to reinstatement of a 100 m buffer between the river and extraction operations in Stage 1 against the southern edge, adjacent the edge nearest the River Murray (refer Figure 7-1). The area identified as “Area Under Rehabilitation” is the intended location of the landform rehabilitation. The rational for this activity is to promote an increased buffer between the Stage 1 pit and the River Murray and to provide a wider vegetated zone to ensure stability and minimise erosion potential.

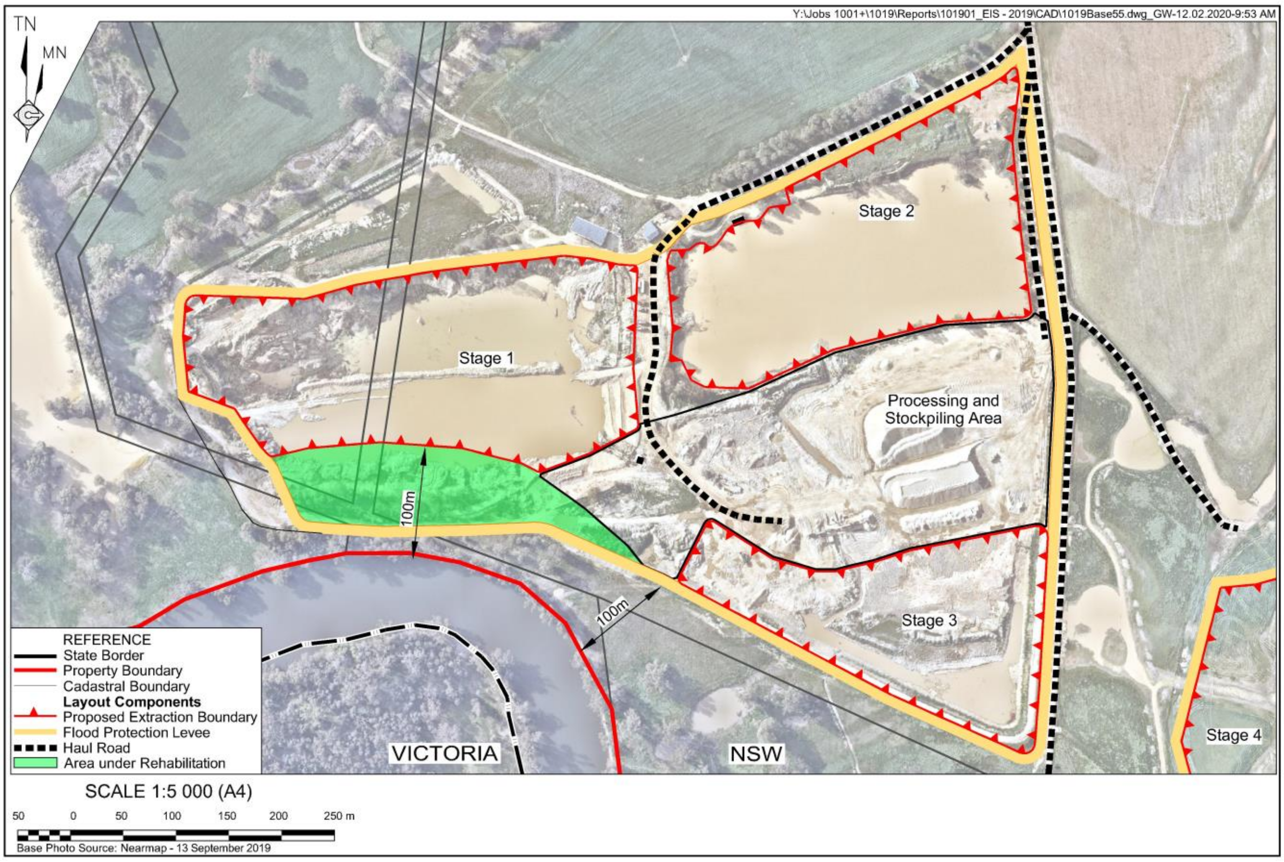


FIGURE 7-1 PROPOSED PIT 1 PARTIAL FILL OPTION

An engineered fill campaign would be required to ensure the stability of the rehabilitated area, and the hydrogeological implications of this would be influenced by the type of material deposited, the dimensions of the fill zone and the compaction of the material. It is proposed that the fill materials will be primarily clay-based material removed from the Stage 1 and 2 pits. The fill zone is proposed to be an initial target for revegetation to establish Red Gum Woodland.

Given the small scale of the works (depth and breadth compared to extraction), the minor changes to hydraulic connectivity due to the compaction of materials used for construction would be unlikely to significantly change groundwater flow patterns. While ponding of water around the structure may occur, this is likely to be minor. It is also noted that extraction within Stage 1 would occur over two years, after which time the extraction area would refill with groundwater providing additional stability.

7.6 Impacts Associated with Dredging

This approach has not specifically been modelled however it is unlikely to significantly change the outcomes of the assessment in terms of water quality and quantity at bores on neighbouring properties, groundwater dependent ecosystems, flow contributions and water quality in the Murray River. The extraction of groundwater for quarrying under the dredging scenario would be less than that using the free dig extraction method. It is expected that irrigation water would continue to be taken from the existing non-operational pits under this scenario.

8 GROUNDWATER MONITORING AND MANAGEMENT

To ensure that the assumptions used in this groundwater assessment are valid it is recommended that groundwater monitoring be undertaken to assess for actual groundwater impacts and that water use throughout the proposed operations are appropriately monitored to account for all water consumed by the proposed development.

8.1 Groundwater Monitoring

Groundwater monitoring should be established at the upgradient and downgradient extremities of the proposed quarry expansion site to provide regional inflow and site outflow parameters to show that the new activity has not caused detriment to the aquifer system. Suggested new groundwater monitoring sites are shown on Figure 8-1 below.

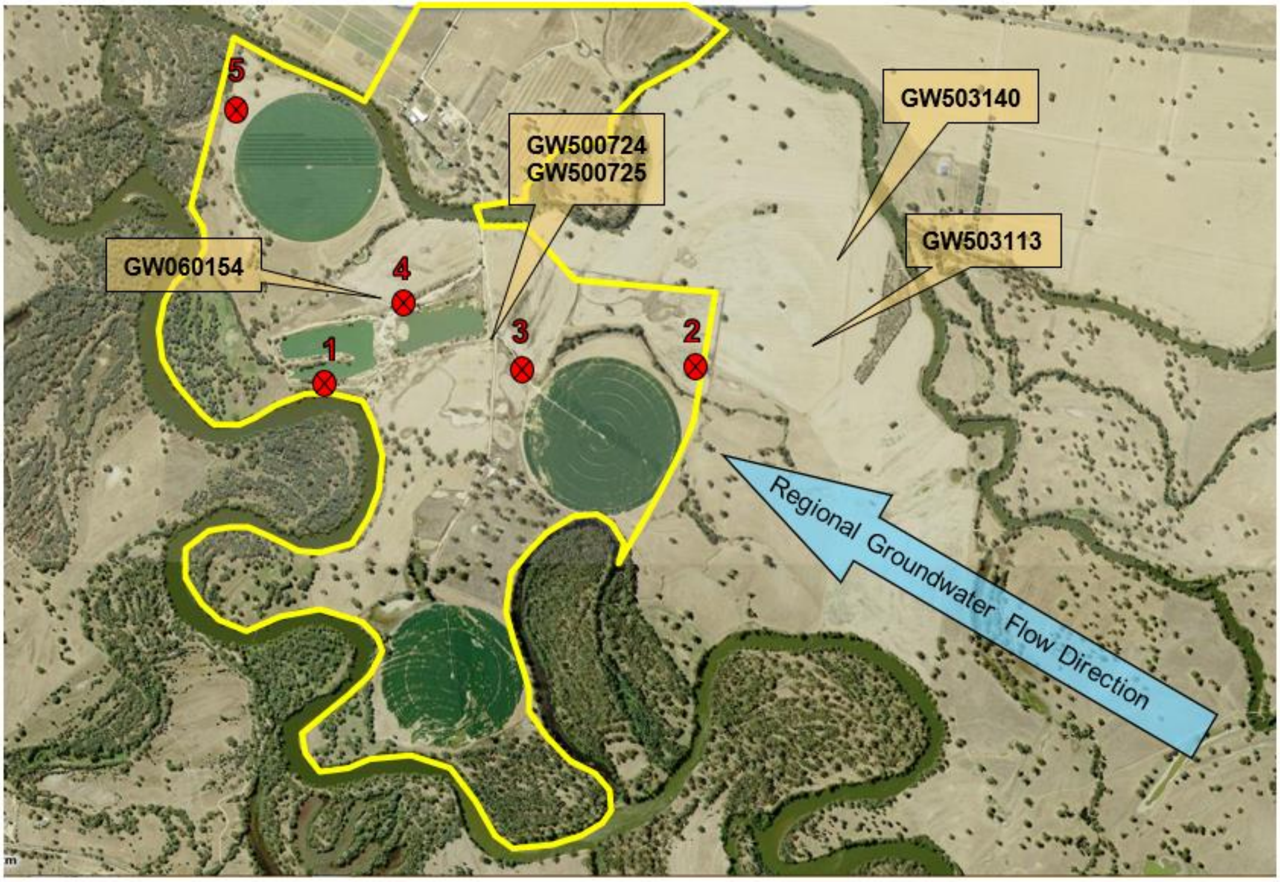


FIGURE 8-1 EXISTING BORES AND PROPOSED GROUNDWATER MONITORING SITES

Suggested New Monitoring Bore Sites [

Site locations are suggested, located adjacent infrastructure (access roads, fences) for ease of access and to be out of the way of other land-use activities.

It is assumed that the observation bores adjacent pits will be constructed to at least the anticipated maximum pit excavation depth to allow for an understanding of how the groundwater is behaving during the periods the pits are dewatered to their maximum depth.

These bores should be screened over the full depth of sediment saturation (i.e. from above standing groundwater level to base of bore). This will ensure that if there is a need to sample for contamination then there is opportunity to take a sample from any depth of the saturated monitoring interval.

Bores should be sealed to prevent surface water inflow during times of high river flow. This needs only to be done when flooding is expected, and the seal only needs to be in operation for the period of flooding.

Site Descriptions

Site 1. Located between the River Murray and Stage 1 pit, to sample for water moving either way between the River and the pit. Should penetrate to a depth (at least 5m) below invert of River Murray water course to help understand possible groundwater movement during times of no flow in River;

Site 2 Located at the 'Groundwater Inflow' end of the property (can be moved due to access issues). This is to understand the quality of groundwater coming into the property. Try to keep it away from the location of Stage 4 (current irrigation area) so that the land-use activity does not influence the sampling/monitoring of this bore;

Site 3 Located between Stages 1,2 & 3 and Stage 4 to assist in understanding what the irrigation activity may be having, and when Stage 4 is active, what the hydraulic relationship is between Stage 3 (decommissioned and full of water) and Stage 4 (active sand extraction). Sited near GW500724 & GW500725 to investigate how the shallow groundwater responds if/when these bores are pumped;

Site 4 Located immediately down hydraulic gradient from Stages 1,2 & 3, to understand immediate impact to shallow groundwater from each pit stage activity, also to sample for water quality issues that may enter the shallow groundwater system from the pits.

Site 5 Located at the most down-hydraulic gradient point on the property to provide assurance that no detrimental impacts are leaving the site.

A summary of existing bores located on or adjacent the quarry site is provided to ascertain if any of this infrastructure can be utilised for groundwater monitoring purposes.

TABLE 8-1 EXISTING BORES ON AND ADJACENT TO THE SITE

Number	Purpose/ Status	Constructed	Cased to [m bGL]	Screened to [m bGL]	Target Aquifer	Comment
GW060154	Unspecified	1/1/1984	?	?	Shepparton	Stationary pumps from Pit 2 for irrigation 4 ML/day
GW500724	Production Stock/ Domestic Test Bore	25/3/1998	?	?	Lachlan Aquifer	Used for irrigation ~10 ML/day
GW500725	Production Stock/ Domestic	23/3/1998	25	27	Shepparton Aquifer	
GW503113	Irrigation	1/6/2005	46	54	Lachlan Aquifer	250mm [10"] bore. Driller indicated yield at 30 L/sec
GW503140	Test Bore Irrigation **Abandoned**	3/12/2001	0	N/A	N/A	No casing; 116 mm [4.5"] hole drilled to 68 m Driller indicated yield at 15 L/sec

Hydrogeological parameters to monitor include:

- Depth to groundwater level (below surveyed reference point) monthly;
- Salinity of groundwater annually, prior to the release of water from the Hume Dam;
- Water quality parameters as required to ascertain that on-site activities have not contaminated groundwater, initial quarterly analysis of EC, pH, TSS, TPH, Oil and Grease, reducing to bi-annual once trends have been established;
- River Murray stage height adjacent Stage 1 Pit, coincident with groundwater monitoring schedule.

8.2 Water Balance Metering

As the dewatering of an actively excavated pit is considered the taking of groundwater (under licence), if water is returned to a pit during the quarry processes it is recommended that all water moved across the site be metered to ensure that water taken once from a pit is not considered as taking groundwater again if it is diverted from pit storage. The recommended locations of metres are provided in Figure 3-1.

Meters should be read at least monthly, or as frequently as required to ensure water balance assumptions are maintained.

Monitoring and analysis of the water balance as the project progresses will enable confirmation of future extraction rates.

9 SUMMARY

Numerical groundwater modelling analysis indicates that during the development through Stages 1 to 4, the following estimated dewatering pumping rates may be required:

- Stage 1 expansion over 2 years – 7.2 ML/d.
- Stage 2 expansion over 2 years – 4.1 ML/d.
- Stage 3 excavation over 3 years – 3.2 ML/d.
- Stage 4 excavation over 23 years – 3.8 ML/d to 7.8 ML/d with a worst case scenario of 10 ML/d (this worst case scenario assumes that the entire Stage 4 pit will be open which is not expected to be the case).

It is proposed that water sourced from the pits will supply approximately 7.3 ML/d for irrigation. The modelling includes the proposed irrigation supply and shows that due to the bounding of the River Murray and Black Swan Anabranch the drawdown effects of the proposed staged development are constrained to an area between these water bodies and to within less than 1 km along the floodplain from the quarrying operations. The limited extent of drawdown means that existing users and groundwater dependent ecosystems are not expected to be adversely impacted. The areas impacted by drawdown currently comprise quarrying operations, irrigated floodplain and cleared floodplain areas.

Modelling shows that as each of the pits are completed, they will not have enough capacity to receive groundwater pumped from subsequent stages. The pumped groundwater will require management in the form of on-site use for screening and other quarry activities, on-site balancing and appropriate levels of irrigation to accommodate the anticipated volumes. It is understood that by Stage 4 substantial revegetation and rehabilitation of land adjacent to the Quarry would be occurring or have been completed. Any surplus water would be irrigated over this land to support vegetation establishment.

The increased depth of excavation of the pits is assumed to fully penetrate the Shepparton Aquifer. The pits will become irrigation supply and evaporative sinks on the floodplain with localised groundwater flow paths reflecting this. Due to the assumed post-quarrying extraction of water for irrigation, the salinity of the pits is maintained at between 500 mg/L and 600 mg/L for an assumed starting salinity of 450 mg/L.

Significant impacts to the River Murray and downstream water users are not predicted to occur as the worst-case dewatering scenario represents only 0.1% of the average minimum daily flow measured in 2019 and would be licenced. Water quality would be unchanged as the water levels in the extraction pits would be maintained at levels lower than the river water level thereby maintaining a flow gradient from the river to the pits.

The main long-term impact on the hydrogeological behaviour of the area is anticipated to be an increase in the surface area of exposed water table due to an increase in the number of excavation pits. This will likely increase the rate of groundwater discharge from the Upper Murray Aquifer System and can be accounted for by a corresponding decrease in the licensed extraction of groundwater for irrigation purposes. Eventually, the groundwater inflows into the excavated pits will be driven by extraction from the pits for irrigation supply purposes, and operational requirements for the quarrying activities will be minimal. This integration of quarrying with irrigation supply will be beneficial in terms of constraining the drawdown impact areas, as per the modelled results, and also in establishing a draw of relatively fresh groundwater into the pits to reduce pit water salinity increases due to evaporative concentration from the pit water bodies.

To validate the predicted impacts in this groundwater assessment it is recommended that groundwater monitoring be undertaken to assess for actual groundwater impacts and that water use through-out the proposed operations are appropriately monitored to account for all water consumed by the proposed development.

10 REFERENCES

CAF Consulting 2017. *Howlong Sand Quarry Expansion – 4343 Riverina Highway, Howlong, Preliminary Environmental Assessment.* for Fraser Earthmoving Construction. Version C

Chiang, W. and Kinzelbach, W. (1998). *Processing Modflow. A Simulation System for Modeling Groundwater Flow and Pollution*.

RW Corkery & Co. (2020). Howlong Sand and Gravel Expansion Project, Environmental Impact Statement, prepared for Fraser Earthmoving Construction Pty Ltd

Gutteridge Haskins & Davey Pty. Ltd., Cameron McNamara Pty. Ltd. Laurie Montgomerie and Pettit Pty. Ltd. Murray (1986). *River Flood Plain Atlas*. Rural Water Commission of Victoria Water Resources Commission of New South Wales.

Harbaugh, A.W. and McDonald, M.G. (1996). *User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model*. USGS Open-File Report 96-485.

Kulatunga N., 2009, *Upper Murray Alluvium, Groundwater Management Area 015: Albury to Corowa, Groundwater Resources Status Report – 2008*. NSW Department of Water and Energy, Sydney

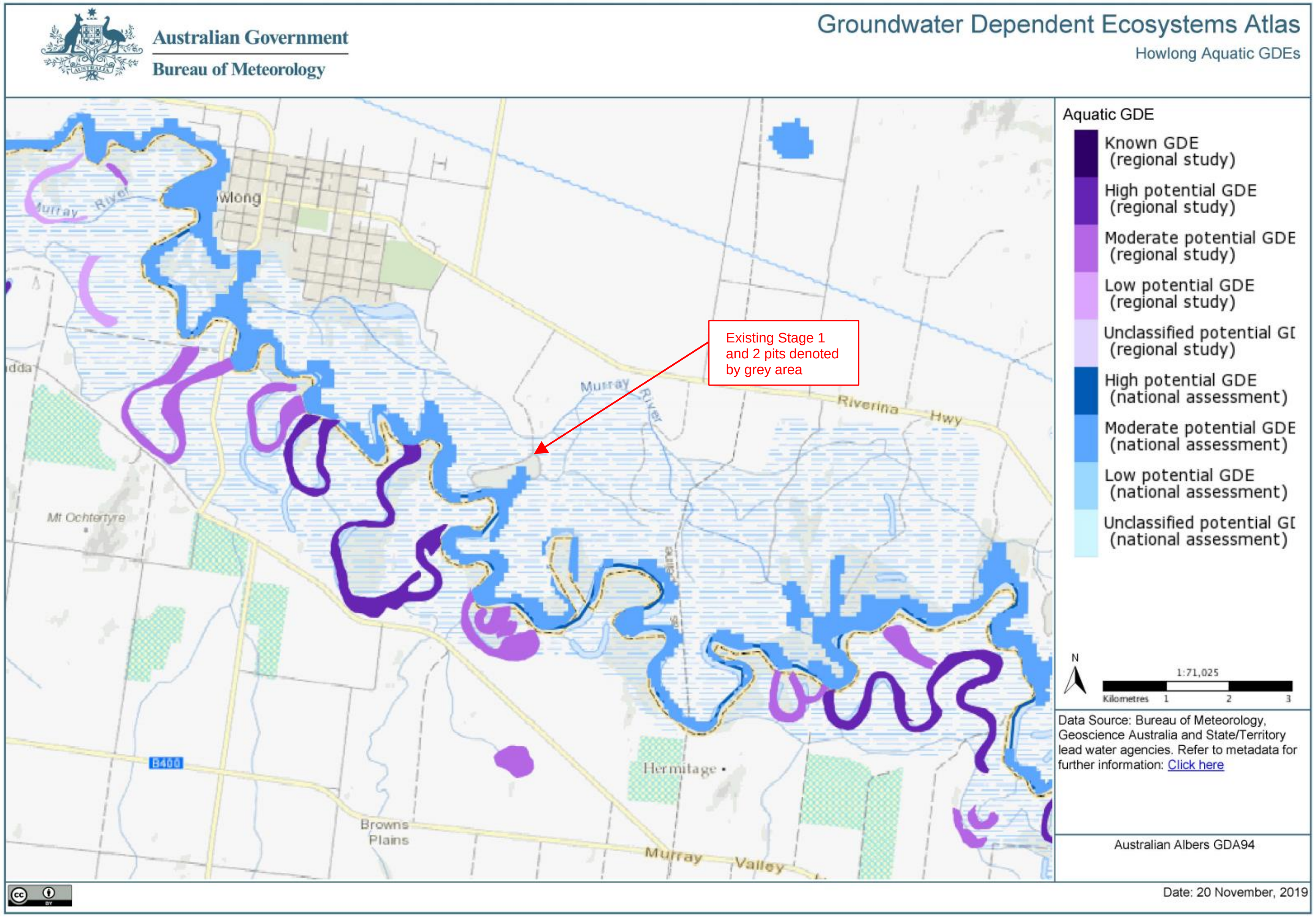
Muller, R., Nicholson, A., Wooldridge, A., Jenkins, B., Winkler, M., Cook, W., Grant, S. and Moore C.L. (2015). *Hydrogeological Landscapes for the Eastern Murray Catchment*. Office of Environment and Heritage, Sydney, NSW.

NSW Department of Primary Industries (2012). NSW Government policy for the licensing and assessment of aquifer interference activities

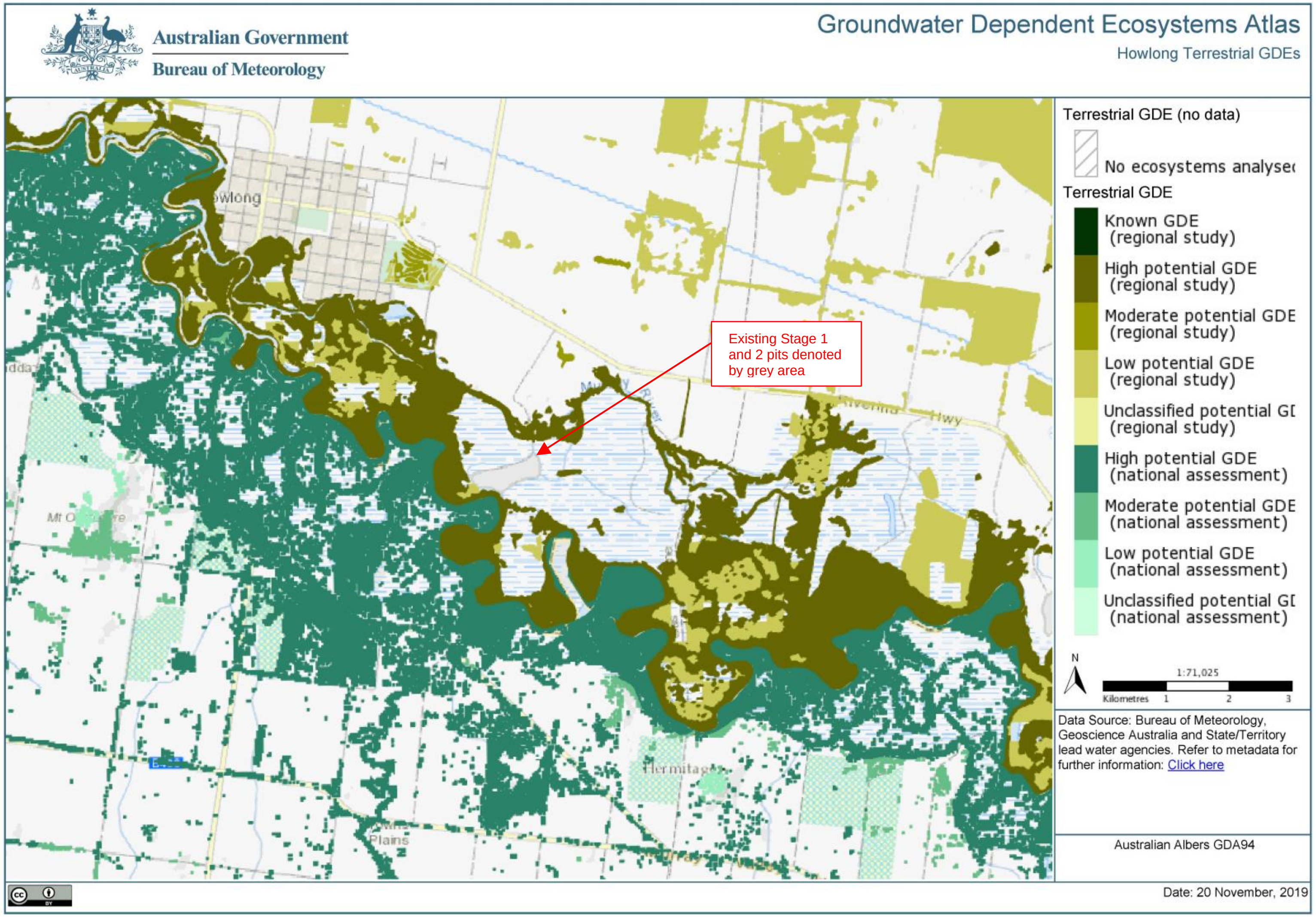
Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011

Williams R.M. 1989. *Groundwater Resources of the Unconsolidated Sediments Associated with the Murray River Between Albany and Corowa, NSW*. Water Resources Commission Technical Services Report 89.001

APPENDIX A
GROUNDWATER DEPENDANT ECOSYSTEMS



Australian Government
Bureau of Meteorology
Groundwater Dependent Ecosystems Atlas
Howlong Aquatic GDEs
Aquatic GDE
Known GDE (regional study)
High potential GDE (regional study)
Moderate potential GDE (regional study)
Low potential GDE (regional study)
Unclassified potential GI (regional study)
High potential GDE (national assessment)
Moderate potential GDE (national assessment)
Low potential GDE (national assessment)
Unclassified potential GI (national assessment)
Existing Stage 1 and 2 pits denoted by grey area
Murray River
Riverina Hwy
Mt Ochtertyre
B400
Hermitage
Browns Plains
Murray Valley
1:71,025
Kilometres 1 2 3
Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: Click here
Australian Albers GDA94
Date: 20 November, 2019


Australian Government
Bureau of Meteorology
Groundwater Dependent Ecosystems Atlas
Howlong Terrestrial GDEs
Existing Stage 1 and 2 pits denoted by grey area
Terrestrial GDE (no data)
No ecosystems analysed
Terrestrial GDE
Known GDE (regional study)
High potential GDE (regional study)
Moderate potential GDE (regional study)
Low potential GDE (regional study)
Unclassified potential GI (regional study)
High potential GDE (national assessment)
Moderate potential GDE (national assessment)
Low potential GDE (national assessment)
Unclassified potential GI (national assessment)
N
1:71,025
Kilometres 1 2 3
Data Source: Bureau of Meteorology, Geoscience Australia and State/Territory lead water agencies. Refer to metadata for further information: Click here
Australian Albers GDA94
Date: 20 November, 2019

APPENDIX B
Aquifer Interference Assessment Framework

NSW GOVERNMENT | Department of Primary Industries Office of Water

AQUIFER INTERFERENCE ASSESSMENT FRAMEWORK

Assessing a proposal against the NSW Aquifer Interference Policy – step by step guide

Note for proponents

This is the basic framework which the NSW Office of Water uses to assess project proposals against the **NSW Aquifer Interference Policy (AIP).**

The NSW Aquifer Interference Policy can be downloaded from the NSW Office of Water website (www.water.nsw.gov.au under Water management > Law and policy > Key policies > Aquifer interference).

While you are not required to use this framework, you may find it a useful tool to aid the development of a proposal or an **Environmental Impact Statement (EIS)*.***

We suggest that you summarise your response to each AIP requirement in the tables following and provide a reference to the section of your EIS that addresses that particular requirement. Using this tool can help to ensure that all necessary factors are considered, and will help you understand the requirements of the AIP.

Table 1. Does the activity require detailed assessment under the AIP?

	Consideration	Response
1	Is the activity defined as an aquifer interference activity?	Yes
2	Is the activity a defined minimal impact aquifer interference activity according to section 3.3 of the AIP?	No

Note for proponents

Section 3.2 of the AIP defines the framework for assessing impacts. These are addressed here under the following headings:

1. Accounting for or preventing the take of water
2. Addressing the minimal impact considerations
3. Proposed remedial actions where impacts are greater than predicted.

1. Accounting for, or preventing the take of water

Where a proposed activity will take water, adequate arrangements must be in place to account for this water. It is the proponent's responsibility to ensure that the necessary licences are held. These requirements are detailed in Section 2 of the AIP, with the specific considerations in Section 2.1 addressed systematically below.

Where a proponent is unable to demonstrate that they will be able to meet the requirements for the licensing of the take of water, consideration should be given to modification of the proposal to prevent the take of water.

Table 2. Has the proponent:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Described the water source(s) the activity will take water from?	Upper Murray Groundwater Source of the Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources 2011	
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	The following groundwater extraction requirements are estimated to maintain dry working pits for each of the quarry stages. Stage 1 – 2628 ML/a Stage 2 – 1497 ML/a Stage 3 – 1168 ML/a Stage 4 – 1387 to 2847 ML/a with a worst case of 3650 ML/a Refer to the Groundwater Assessment for the Howlong Quarry Expansion for further details (Water Technology, 2020).	
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	Up to 3075 ML/a may be taken to support ongoing irrigation from the excavated pits. All water extracted would be within available licensed limits.	
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (refer to Table 3, below)	Yes Refer to the Groundwater Assessment for the Howlong Quarry Expansion for further details (Water Technology, 2020).	
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	Yes Refer to the Groundwater Assessment for the Howlong Quarry Expansion for further details (Water Technology, 2020).	
6	Described how any licence exemptions might apply?	No exemptions apply.	

	AIP requirement	Proponent response	NSW Office of Water comment
7	Described the characteristics of the water requirements?	The water is required to be extracted to facilitate dry working conditions in quarry pits. Excess water is proposed to be used for irrigation. Refer to the Groundwater Assessment for the Howlong Quarry Expansion for further details (Water Technology, 2020).	
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	Yes – see Section 3.1.4 of Water Technology (2020)	
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	The project can meet the rules of the relevant WSPs.	
10	Determined how it will obtain the required water?	The necessary allocation is secured	
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	The activation of the entitlement would not impact future available water determinations as the majority of the water is currently taken for irrigation practices in conjunction with the existing operation.	
12	Considered actions required both during and post-closure to minimize the risk of inflows to a mine void as a result of flooding?	A series of levees would be constructed to limit flooding impacts – see Section 2.4.5 of the EIS (RWC, 2020)	
13	Developed a strategy to account for any water taken beyond the life of the operation of the project?	Water take would be required in perpetuity to account for evaporation from ponds and to support irrigation. All water extracted will be within licensed limits.	
Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? No. Due to the bounding of the River Murray and Black Swan Anabranch the drawdown effects of the proposed staged development are constrained to an area between these water bodies and to within less than 1 km along the floodplain from the quarrying operations. The limited extent of drawdown means that existing users and groundwater dependent ecosystems are not expected to be adversely impacted. The areas impacted by drawdown currently comprise quarrying operations, irrigated floodplain and cleared floodplain areas. If **YES,** items 14-16 must be addressed.			
14	Considered any potential for causing or enhancing hydraulic connections, and quantified the risk?	N/A	

	AIP requirement	Proponent response	NSW Office of Water comment
15	Quantified any other uncertainties in the groundwater or surface water impact modelling conducted for the activity?	N/A	
16	Considered strategies for monitoring actual and reassessing any predicted take of water throughout the life of the project, and how these requirements will be accounted for?	See Section 8.1 of Water Technology (2020). To validate the predicted impacts it is recommended that groundwater monitoring be undertaken to assess for actual groundwater impacts and that water use through-out the proposed operations are appropriately monitored to account for all water consumed by the proposed development.	

Table 3. Determining water predictions in accordance with Section 3.2.3
(complete one row only – consider both during and following completion of activity)

	AIP requirement	Proponent response	NSW Office of Water comment
1	**For the Gateway process**, is the estimate based on a simple modelling platform, using suitable baseline data, that is, fit-for-purpose?	N/A	
2	**For State Significant Development or mining or coal seam gas production**, is the estimate based on a complex modelling platform that is: • Calibrated against suitable baseline data, and in the case of a **reliable water source,** over at least two years?	The MODFLOW groundwater model has used regional aquifer parameters and heads, observation bore data, river level fluctuations and existing pit inflow measurements as a guide to calibration. Refer to the Groundwater Assessment for the Howlong Quarry Expansion for further details (Water Technology, 2020).	
	• Consistent with the Australian Modelling Guidelines?	Yes.	
	• Independently reviewed, robust and reliable, and deemed fit-for-purpose?	The groundwater model was constructed and run by WatSec Environmental and has been reviewed and managed by Water Technology.	
3	In all other processes, estimate based on a desk-top analysis that is: • Developed using the available baseline data that has been collected at an appropriate frequency and scale; and • Fit-for-purpose?	N/A	

Other requirements to be reported on under Section 3.2.3

Table 4. Has the proponent provided details on:

	AIP requirement	Proponent response	NSW Office of Water comment
1	Establishment of baseline groundwater conditions?	Yes, refer to Section 2 Hydrogeological Setting (Water Technology, 2020).	
2	A strategy for complying with any water access rules?	The project will operate within water access rules without need for a specific strategy.	
3	Potential water level, quality or pressure drawdown impacts on nearby basic landholder rights water users?	Groundwater model drawdown and pit recovery salt and water balances have been used to quantify these impacts, refer to Section 4 Numerical Groundwater Model and Section 5 Pit Water and Salt Balances Post Excavation (Water Technology, 2020).	
4	Potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources?		
5	Potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems?		
6	Potential for increased saline or contaminated water inflows to aquifers and highly connected river systems?		
7	Potential to cause or enhance hydraulic connection between aquifers?	Refer to drawdown maps in Section 4 Numerical Groundwater Model for Layers 1 (Shepparton Formation) and Layer 2 (Lachlan Formation) (Water Technology, 2020).	
8	Potential for river bank instability, or high wall instability or failure to occur?	Based on anecdotal evidence from the Applicant, ongoing operations would not impact bank stability of the Murray River or the Black Swan Anabranch.	
9	Details of the method for disposing of extracted activities (for coal seam gas activities)?	N/A	

2. Addressing the minimal impact considerations

Note for proponents

Section 3.2.1 of the AIP describes how aquifer impact assessment should be undertaken.

1. Identify all water sources that will be impacted, referring to the water sources defined in the relevant water sharing plan(s). Assessment against the minimal impact considerations of the AIP should be undertaken for each ground water source.
2. Determine if each water source is defined as 'highly productive' or 'less productive'. If the water source is named in then it is defined as highly productive, all other water sources are defined as less productive.
3. With reference to pages 13-14 of the Aquifer Interference Policy, determine the sub-grouping of each water source (eg alluvial, porous rock, fractured rock, coastal sands).
4. Determine whether the predicted impacts fall within Level 1 or Level 2 of the minimal impact considerations defined in Table 1 of the AIP, for each water source, for each of water table, water pressure, and water quality attributes. The tables below may assist with the assessment. There is a separate table for each sub-grouping of water source – only use the tables that apply to the water source(s) you are assessing, and delete the others.
5. If unable to determine any of these impacts, identify what further information will be required to make this assessment.
6. Where the assessment determines that the impacts fall within the Level 1 impacts, the assessment should be 'Level 1 – Acceptable'
7. Where the assessment falls outside the Level 1 impacts, the assessment should be 'Level 2'. The assessment should further note the reasons the assessment is Level 2, and any additional requirements that are triggered by falling into Level 2.
8. If water table or water pressure assessment is not applicable due to the nature of the water source, the assessment should be recorded as 'N/A – reason for N/A'.

Table 5. Minimal impact considerations

Aquifer	Alluvial aquifer
Category	**Highly Productive**

Level 1 Minimal Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work. **Water pressure** A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the base of the water source to a maximum of a 2 metre decline, at any water supply work. ~~**OR**, for the Lower Murrumbidgee Deep Groundwater Source:~~ ~~A cumulative pressure head decline of not more than 40% of the post-water sharing plan pressure head above the top of the relevant aquifer to a maximum of a 3 metre decline, at any water supply work.~~	Level 1 – Acceptable' Water level impacts are described in Section 7 of the Groundwater Assessment (Water Technology, 2020). The Water Sharing Plan for the Murray Unregulated and Alluvial Water Sources (2011) states that at the time of publication, no high priority groundwater dependent ecosystems have been identified in the area covered by the plan. There are no know culturally significant sites within the study area. Declines in excess of 2 metres at water supply works are not predicted. The modelling shows that due to the bounding of the River Murray and Black Swan Anabranch the drawdown effects of the proposed staged development are largely constrained to an area between these water bodies and hence drawdown is constrained to a very localised area surrounding the pits.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity. No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. No mining activity to be below the natural ground surface within 200 metres laterally from the top of high bank or 100 metres vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a reliable water supply.	Level 1 – Acceptable Solute transport modelling has not been undertaken. Evaporative concentration will raise the salinity of pit water over time. The salinity of the pits is maintained at between 500 mg/L and 600 mg/L for an assumed starting salinity of 450 mg/L. Historic operations have encroached within 30m of the high bank of the Murray River. A 100m buffer from the Murray River would be reinstated under the Proposal. Based on the numerical groundwater modelling, the nett effects of evaporation and irrigation extractions will result in the pit levels being maintained below river level and it is unlikely that water held in the extraction pits would flow to the Murray River (i.e. the flow gradient is from the river to the pits). Hence, water quality impacts on the River Murray are considered unlikely.

Aquifer	Alluvial aquifer
Category	Highly Productive

Level 1 Minimal Impact Consideration	Assessment
Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 metres laterally from the top of high bank and 100 metres vertically beneath a highly connected surface water source that is defined as a reliable water supply.	Level 1 – Acceptable as above

3. Proposed remedial actions where impacts are greater than predicted.

Note for proponents

Point 3 of section 3.2 of the AIP provides a basic framework for considerations to consider when assessing a proponent's proposed remedial actions.

Table 6. Has the proponent:

AIP requirement		Proponent response	NSW Office of Water comment
1	Considered types, scale, and likelihood of unforeseen impacts *during operation*?	Yes – water management has been carefully planned to balance inflows with irrigation and other uses.	
2	Considered types, scale, and likelihood of unforeseen impacts *post closure*?	Yes – water management would be continued post-extraction with measures to account for passive management post-closure, if required.	
3	Proposed mitigation, prevention or avoidance strategies for each of these potential impacts?	Yes – See Section 8 of Water Technology (2020)	
4	Proposed remedial actions should the risk minimization strategies fail?	Yes – See Section 8 of Water Technology (2020)	
5	Considered what further mitigation, prevention, avoidance or remedial actions might be required?	Yes – See Section 8 of Water Technology (2020)	
6	Considered what conditions might be appropriate?	Standard conditions are considered appropriate.	

4. Other considerations

Note for proponents

These considerations are not included in the assessment framework outlined within the AIP, however are discussed elsewhere in the document and are useful considerations when assessing a proposal.

Table 7: Has the proponent:

AIP requirement		Proponent response	NSW Office of Water comment
1	Addressed how it will measure and monitor volumetric take? (page 4 of the AIP)	Yes – See Section 8 of Water Technology (2020)	
2	Outlined a reporting framework for volumetric take? (page 4 of the AIP)	Yes – See Section 8 of Water Technology (2020) Reporting of water take would be presented in an Annual Review and at the end of each water year.	

More information

www.water.nsw.gov.au

Disclaimer:

This is a draft document produced as a guide for discussion, and to aid interpretation and application of the NSW Aquifer Interference Policy (2012). All information in this document is drawn from that policy, and where there is any inconsistency, the policy prevails over anything contained in this document.
Any omissions from this framework do not remove the need to meet any other requirements listed under the Policy.

The information contained in this publication is based on knowledge and understanding at the time of writing (March 2020). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the Department of Primary Industries or the users independent adviser.

Published by the NSW Department of Primary Industries.

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