Report

Munyabla 1200 Sow Piggery – Hydrogeological Review

KBM Farms

21 September 2018

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21 September 2018

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Via email farmskbm@gmail.com

Dear Kym

Munyabla 1200 Sow Piggery – Hydrogeological Review

Please find enclosed Water Technology's hydrogeological review on aspects regarding the proposed Munyabla 1200 Sow Piggery proposal, specifically the effects that the proposed piggery may have on the availability of groundwater for neighbours to the proposed development and the possible impacts the proposed development may have on the capacity of the targeted aquifer for water supply to the development.

Yours sincerely

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WATER TECHNOLOGY PTY LTD

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1 HYDROGEOLOGICAL ASSESSMENT

KBM Farms proposes to establish a 1200 sow farrow-to-finish piggery at Munyabla, NSW. This development has listed that groundwater will be sourced as the primary water supply for this proposed development. The purpose of this report is to provide an assessment of the hydrogeological environment and an estimate of capacity of the aquifer to support this proposed development and the possible impacts to adjacent groundwater users.

1.1 Setting

The subject property is situated at 553 Dick Knobels Road, Munyabla (35° 24' 31" S, 146° 53' 59" E). The subject land is Lot 1 DP1211821 and Lot 1 DP373967, Lockhart Shire. Landscape is generally flat-lying with an elevation between 190 and 200 mAHD. Land use is cleared agricultural, typically grazing/cropping rotation. Local geology is thin Quaternary sediments of riverine clays, silts, sands and gravels overlying Ordovician to Devonian variably weathered and fractured granites and metasediments of the Lachlan Fold Belt Orogen.

1.2 Environmental

Landscape is within the Bullenbong Creek catchment. Local land gradient is generally northward towards the Murrumbidgee River. Regional land surface gradient is generally westwards.

Property is located:

- to the south and southeast of an ephemeral drainage line [Mittagong Creek] within the Bullengong Creek catchment. The ephemeral nature of this watercourse suggest that it is a losing stream;
- to the south west of an isolated areas of seasonal inundation, likely to be when local surface drainage collects before being lost to infiltration and evapotranspiration;
- ~1km southwest from an ephemeral watercourse with irregular waterholes [Mundawaddery Creek] listed as Riparian Lands Watercourse in the Lockhart Local Environmental Plan 2012. This watercourse is a tributary to the Bullenbong Creek which drains towards the north to the Murrumbidgee River. The presence of (? permanent) waterholes may indicate localised shallow water table or hydrogeologic restrictions in the sub-surface flow associated with this watercourse that causes prolonged exposure of this sub-surface flow;
- ~6 km west southwest from wetlands identified in the Lockhart Local Environmental Plan 2012. These appear to be ephemeral, possibly resulting from local surface run-off indicating that infiltration of surface waters may be restricted by low-permeability subsoils (rather than being expressions of regional shallow water tables);
- ~14 km north west of Doodle Corner Swamp (near Henty) in the Greater Hume Local Environmental Plan 2012. The feature also appears to be ephemeral and local hydrology may operate as described above;

1.3 Hydrogeological setting

Based on the 'Hydrogeological Landscapes for the Murray Catchment Management Authority Eastern Murray Catchment' 2015 assessment by the University of Canberra for the Ryan region (centred ~15 south of the proposed Munyabla piggery development), groundwater within this landscape is primarily found within unconfined fractured rock aquifers (refer Figure 1.1), with groundwater flowing through weaknesses and fracture within the granitic weathered or fresh bedrock. Minor groundwater occurrences may be located within the colluvial and alluvial sediments, but these are likely to be seasonally perched.

There is limited hydrogeological information available for this area. Drillhole information is typically spaced at ~3 to 5 km intervals (refer Figure 1.2). Most drillholes are between 90 and 120 m deep, suggesting a common target depth interval for groundwater supply. The proponents have recently (March 2018) constructed a bore

[GW416900] to 114 m on the property (under Work Licence 40WA417210). Driller's report indicates that weathered granites were encountered to 21 m, then fresh granite to 114 m with groundwater intersected from 74 m. Depth to static groundwater level was reported to be 38 m below ground level indicating that this fractured rock aquifer is semi-confined (sub-artesian) in nature. Bore yield is reported to be 2 L/sec and groundwater salinity is reported to be 2300 mg/L TDS (EC ~4100 µS/cm).

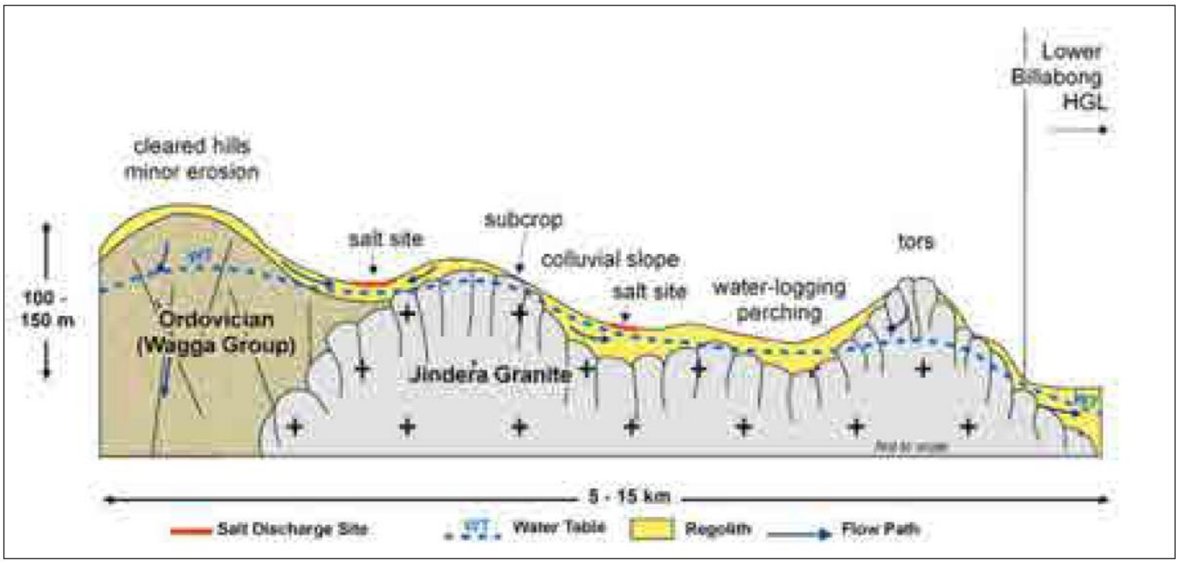

FIGURE 1.1 STYLISED HYDROGEOLOGICAL CROSS SECTION (FROM UNI. OF CANBERRA 2016)

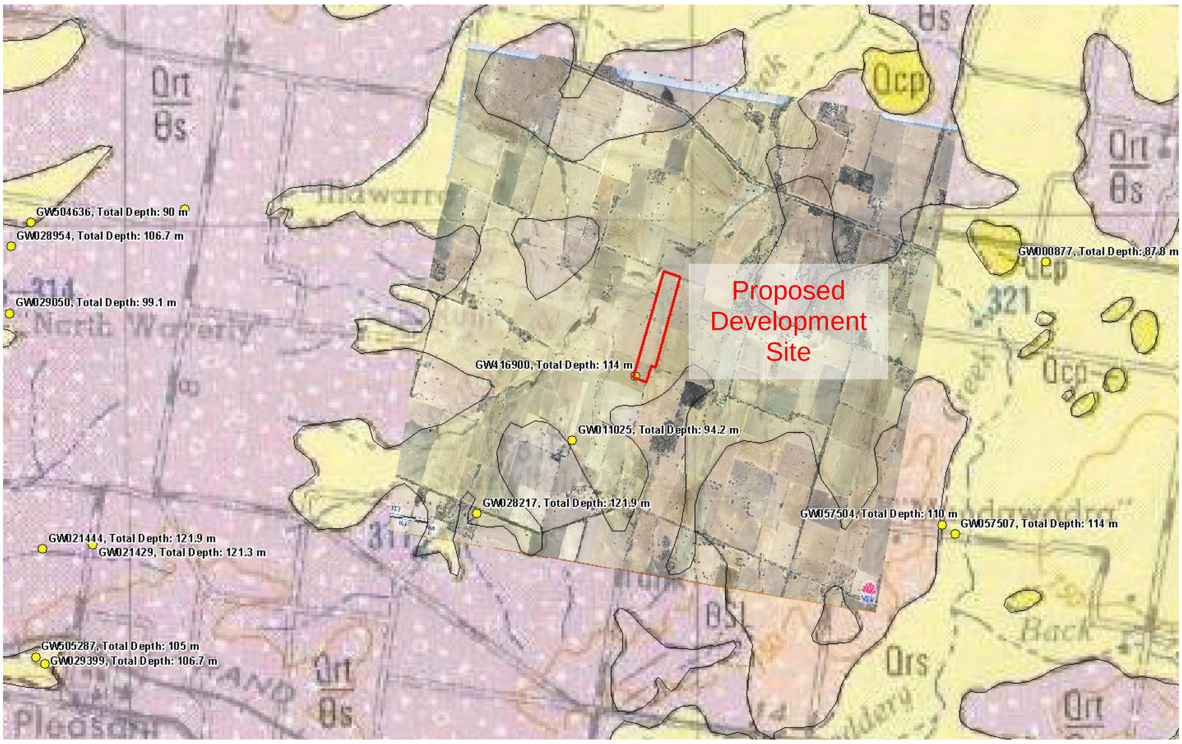

FIGURE 1.2 SURFACE GEOLOGY AND LOCATION OF REGISTERED BORES RELATIVE TO THE PROPOSED DEVELOPMENT

The nearest registered bore [GW011025], ~1500 m to the south west, reported groundwater intersected between 82 and 93 m in fractured Shale, depth to static groundwater level is reported to be 57.3 m below ground level (similarly semi-confined) and bore yield of 0.25 L/sec in August 1954.

Based on the Jerilderie [1976] and Wagga Wagga [1966] 250 k Geological Map Series these bores are likely completed in Metasediments of the Wagga Group [?Os] or Kiandra Group [?Ou], with the Driller classifying drill cuttings from GW416900 as 'granites'. Only the Jerilderie surface geology is shown on Figure 1.2.

The depth of the static groundwater level of greater than 35 m suggests that this semi-confined groundwater system is not discharging to the land surface in the region of the proposed development, so it is anticipated that there are no groundwater dependent ecosystems associated with this targeted groundwater system near the proposed development. Regional land surface topographic gradients drop gradually to the west, so preliminary understanding is that this fractured rock groundwater aquifer system may flow towards the Cullivel/Urana region over 40 km to the west. It is possible that this fractured rock groundwater system discharges as lateral inflow into the Tertiary groundwater systems of the eastern Murray Basin sediments, where saline lakes suggest groundwater discharge to the land surface in that region.

Recharge to this semi-confined fractured rock aquifer system (which is semi-regional in extent) is assumed to be local, from infiltration of rainfall that has not evaporated. Groundwater salinity is poorly documented in the region. The reported 2300 mg/L TDS from GW416900 suggest that only a minor proportion (say 1 to 5%) of the incident rainfall may effectively infiltrate as recharge to this groundwater system. It is likely that recharge would be localised along the drainage lines and in areas where bedrock is exposed (i.e. areas of thin soil on topographic rises). The presence of the thin Quaternary alluvial/colluvial layer may irregularly perch infiltrating water at near-surface depths developing seasonal saturated soils with local shallow water tables.

Groundwater level trends are not monitored in this region, with the closest available data from observation bores located in Wagga Wagga [GW273167 and GW273168] over 50 km to the north east. Although rainfall appears to be evenly distributed throughout the year, the warmer temperatures during the summer months would likely heighten evapotranspiration processes suggesting that the winter period may be the likely period for infiltrating rainfall to recharge the aquifer system. If the evenly distributed rainfall patterns generate streamflow throughout the year then recharge focussed on drainage lines may occur summer and winter.

2 ESTIMATED HYDROGEOLOGICAL IMPACT

There have been no hydrogeological parameter investigations undertaken to-date on the property, so the following assessment is an analytical approach taken from assumed aquifer parameters. Therefore, the results provided must be taken as a guide only and not used as formal proof of the capability of the target aquifer to provide on-going supply to the proposed development or proof of the likely impact on neighbouring groundwater users.

The University of Canberra (2015) assessment adopted hydrogeological parameters shown in Table 2.1. The approach taken for this assessment is a more conservative one to allow for the high level of uncertainty due to the limited investigation data available.

TABLE 2.1 HYDROGEOLOGICAL PARAMETERS

Hydraulic Parameter	Ryan HGL (Uni. Of Canberra)	This Assessment
Aquifer Type	Unconfined to Semi-Confined Fractured Rock	Semi-Confined Fractured Rock
Regional Rainfall [mm]	500-600	500-600
Hydraulic Conductivity [m/day]	Moderate [10^{-2} to 10]	1.25×10^{-1} and 1
Aquifer Transmissivity [m^2/day]	Moderate [2 to 100]	5 and 40
Specific Yield	Low to Moderate [<15%]	0.5% and 5.0%
Hydraulic Gradient	Gentle to Moderate [<30%]	5 to10%
Groundwater Salinity [µS/cm]	Marginal [800 to 1600]	4100
Depth to Water Table [m]	Intermediate [2 to 8]	38
Typical Catchment Size [ha]	Small to Medium [<1000]	Large
Flow Length Scale [km]	Local to Intermediate [<10]	~50
Recharge Estimate (mm)	Moderate to High	5 to 25 [1 to 5% Rainfall]
Residence Time	Medium [years]	Not Assumed
Responsiveness to Change	Fast to Medium [months to years]	Not Assumed

Predicting the impacts of groundwater extraction from fractured rock aquifer systems is difficult due to the variability and connectivity of fracture zones. Fracture zones may be controlled directionally, be extensive or disconnected or be compartmentalised in nature leading to a high degree in uncertainty when assessing impacts from groundwater extraction.

When assumptions are adopted in impact assessments, this can lead to adopting homogeneous character to aquifer systems that may not be present. Assumptions can spread the predicted impact evenly across a zone whereas the actual impact may be focussed along an alignment due to the orientation of the fracture zones that hosts the aquifer targeted for extraction. Impacts may also not be observed where predicted due to unresolved disconnected fracture-based permeability.

The capacity of the aquifer to support the proposed demand of 30 to 40 ML/a [1 to 1.3 L/sec continuously] is approached analytically using the Theis Solution (refer Figure 2.1and Figure 2.2). It is understood that continuous pumping of groundwater is not the likely operational practise. It is likely that the bore would be pumped at a higher rate (say 2 L/sec) and rested intermittently. The use of continuous pumping at the nominated rates is used to represent groundwater extraction demand for analytical purposes. Other factors, such as the used of captured and stored roof runoff may assist in reducing the actual demand placed on this groundwater resource.

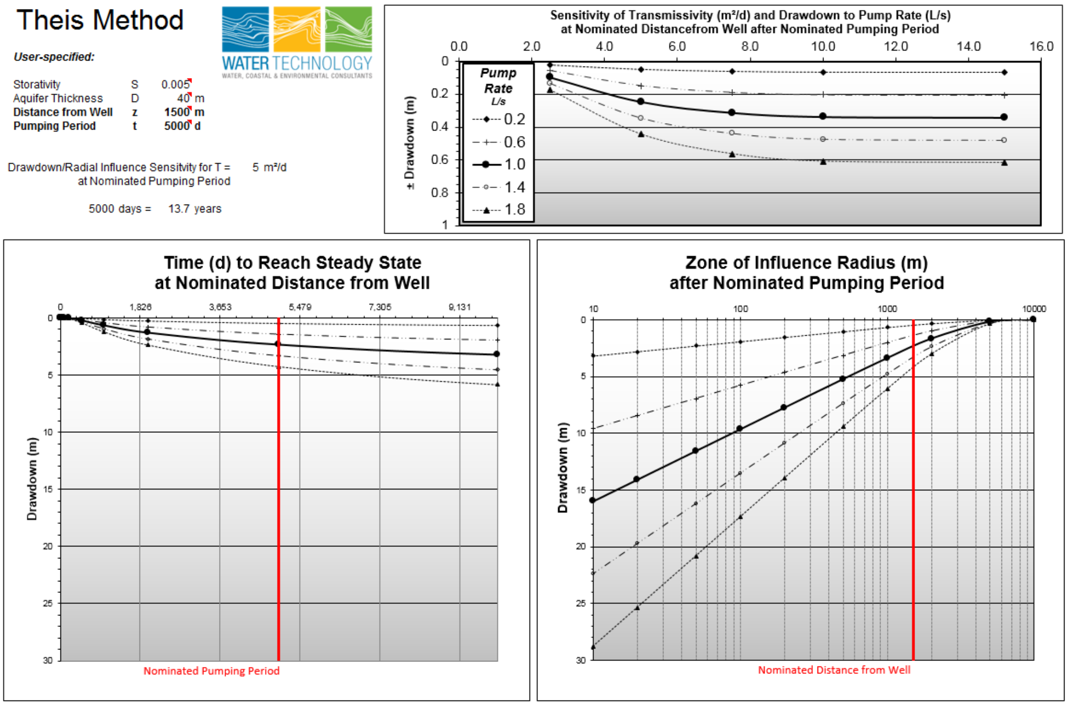

FIGURE 2.1 THEIS SOLUTION TO ASSESS AQUIFER CAPACITY – CONSERVATIVE PARAMETERS

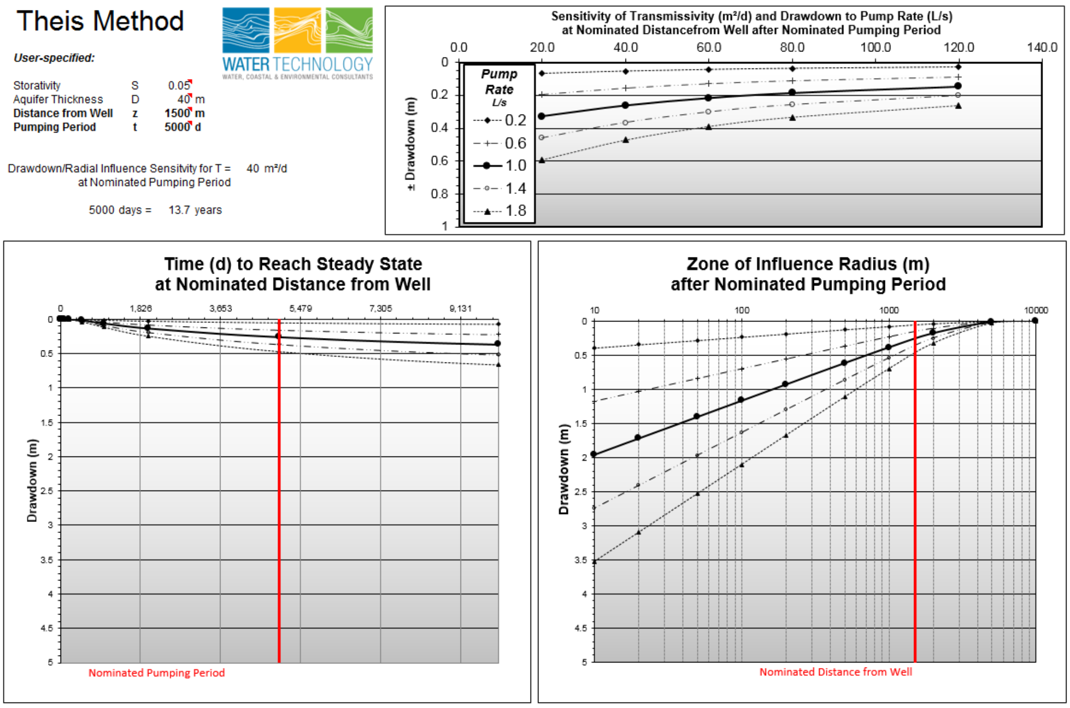

FIGURE 2.2 THEIS SOLUTION TO ASSESS AQUIFER CAPACITY – MID-RANGE PARAMETERS

2.1 Aquifer Capability

Considering the above, the following assessment on aquifer capability is provided.

Using the conservative and mid-range hydrogeological parameters (refer Table 2.1) assumed for the fractured rock aquifer system targeted for this proposed development it is estimated that, to pump continuously at 1 to 1.3 L/sec, drawdown at 10 m from the proposed production bore would be 16 to 20 m (for conservative aquifer parameters) or 2 to 2.5 m (using mid-range aquifer parameters).

The chosen aquifer parameters suggest that a zone of drawdown influence may extend ~5 km radius from the point of extraction after 5000 days (13.7 years) from this analytical solution. There is no information on regional groundwater flow processes such that it is uncertain if aquifer boundary conditions exist that may influence these long-term drawdown estimates.

Similarly, how the groundwater salinity may be affected by long-term extraction is unknown also. Stressing this fractured rock aquifer by pumping for the proposed development may cause it to draw on connected aquifer systems (likely adjoining fractured rock aquifer systems) that may have differing groundwater salinity. The result of this stress may cause the target aquifer to vary in groundwater salinity, which may influence the on-going suitability of this groundwater resource for the proposed development water supply.

2.2 Projected Impacts to Neighbouring Groundwater Users

Considering the above, the following assessment on likely impacts to neighbouring groundwater users is provided.

Using the conservative and mid-range hydrogeological parameters (refer Table 2.1) assumed for the fractured rock aquifer system targeted for this proposed development it is estimated that to pump continuously at 1 to 1.3 L/sec drawdown at 1500 m (the distance to the nearest registered bore GW011025) from the proposed production bore would be between 2.4 and 4 m (for conservative aquifer parameters) or 0.3 and 0.4 m (using mid-range aquifer parameters) after 5000 days (13.7 years) continuous pumping.

It is noted that under the aquifer parameter assumptions made that the predicted drawdown at 1500 m has not reached steady state. The lack of available hydrogeological data means that the confidence of long-term predictions remain low.

It is uncertain whether this bore [GW011025], constructed in 1954, is currently in operation. It is understood that it has previously been used for stock water supply purposes. Given the reported height of groundwater standing above the water cut interval [~25 m as reported in the Work Summary Report], it is assumed that the projected impact of the proposed development would not prevent the on-going use of this bore for stock water supply purposes.

Bore [GW028217] is located ~4 km, to the south west, from the assumed production bore [GW416900]. This bore is listed as also being used for stock water supply purposes. Apart from being constructed to target the (assumed) same fractured rock aquifer system, there is limited information available for this bore. It is anticipated that, assuming the aquifer parameter chosen for this groundwater assessment are reasonable, the utilisation of bore GW028217 will not be impacted by the utilisation of groundwater by the proposed development.

Please note: This impact assessment assumes a circular zone of influence, however the directional control that fracture zones may impose on fractured rock groundwater flow systems may reorientate this zone of impact (i.e. shortening it in one direction and lengthening it in another direction) to more of an oval-shaped zone of impact. This aspect of spatial control is not able to be accounted for due to the limited amount of hydrogeological data available for the Munyabla region.

3 WATER SHARING PLANS

Water Sharing Plans (WSP) aim to achieve sustainable groundwater extraction by limiting extractions to a proportion of the aquifer recharge, leaving a representative portion for environmental requirements, namely aquifer through flow and groundwater dependent ecosystem needs.

3.1 Groundwater Sharing Plans

The proposed development is located within the Lachlan Fold Belt Groundwater Management Area (GMA) of the NSW Murray Darling Basin Fractured Rock Area, within the Murrumbidgee Catchment.

The Lachlan and South Western Fractured Rock and New England Fractured Rock and Northern Basalts Water Resource Plan (WRP) Areas have been subdivided into nine Sustainable Diversion Limit (SDL) resource units based on their geological characteristics. The Lachlan Fold Belt MDB SDL unit (GS20) consists of strongly deformed/metamorphosed marine sedimentary rocks, cherts, siltstones, and mafic to intermediate volcanic and plutonic rocks of early Cambrian to Devonian age from 541 to 359 million years ago. This is the most extensive of the groundwater systems and ranges from the Great Dividing Range through to the western rangelands around Cobar. It provides stock and domestic groundwater supplies across its extent. The salinity of the groundwater tends to increase westward as the climate becomes more arid and the topography has less relief.

Groundwater in this fractured rock SDL unit is stored and transmitted through fractures, joints, bedding planes, faults and cavities within the rock mass. The ability to transmit economic quantities of water depends on the interconnection of these higher permeability features. Groundwater flow is often strongly influenced by their orientation. The degree of weathering of the rock mass also plays a significant role in the availability of groundwater resources.

Recharge to these systems is primarily through infiltration from rainfall, runoff and surface water. Groundwater may discharge naturally in localised areas as springs where there is a permeability change in the rock mass, at the break-of-slope or where there is a change in soil texture. Groundwater discharges may also contribute base flows to streams particularly in the high rainfall, topographically dissected landscape in the tablelands and slopes in the east. Bore yields from the fractured rocks is generally less than 3 litres per seconds (L/s)

A SDL resource unit defines the boundary of an SDL area under the Basin Plan. SDLs represent the maximum long-term average quantities of water that can be taken for consumption in any one year, i.e. the long-term average annual limit. In the Lachlan Fold Belt SDL area there was listed 18,110 Stock and Domestic Bores, 1,024 Production bores and 31 Local Water Utility bores in the August 2017 Status and Issues Paper[1]. The Lachlan Fold Belt SDL is estimated at 259,000 ML/y, with Access Licence allocation volume at 73,146 Shares (at 1 ML/Share per year) and estimated average annual extraction at 5,163 Ml. There are no SDL monitoring bores near Munyabla.

To utilise groundwater as a water supply for this proposed development the proponents will need to apply for:

- Water Use Approval;
- Water Access Licence (WAL) – initially for zero share allocation;
- Available volumetric shares (to match the projected demand volume) on the open water market.

It is understood that there a no licenced points of groundwater extraction in the Munyabla area. This low density of groundwater demand is likely to favour the granting of an authority to take groundwater, assuming there are adequate allocation entitlements available on the market to procure.

[1] Lachlan and South Western Fractured Rock (GW11) and New England Fractured Rock and Northern Basalts (GW17) Water Resource Plans Groundwater Status and Issues Paper 4 August 2017. NSW DPI Water

4 RECOMMENDATIONS

The following recommendations are presented to provide hydrogeological data and information to further understand the groundwater resource targeted for the proposed piggery development. The undertaking of these recommendations will provide supporting evidence as to what extent of impact this proposed development will have on the targeted groundwater resource and set benchmark parameters to understand how possible future development of this groundwater resources may impact this proposed development's (if approved) ability to continue to take groundwater.

- Undertake a step test (four stages at 60 min/stage) and a medium term (greater than two day) continuous rate aquifer (pump) test on the proposed production bore to ascertain the bore loss characteristics and inform on hydrogeological parameters of the targeted aquifer.
- Establish a 'back-up' production bore 20 to 50 m from bore GW416900. This additional bore can be used as an observation bore to better understand spatial impacts of long-term use of this groundwater resource. It may be advantageous to also equip this bore and use each alternatively, monitoring both. This would spread the stress on the aquifer system to some degree and keep both bores in operational condition (in case there is failure of the main production bore).
- Monitor all bores on the property (and potentially neighbouring properties if Managers are amenable) for depth to groundwater level (under non-pumping conditions) monthly and sample the groundwater to determine salinity six-monthly. This data will inform both the operators and regulating authorities of the seasonal behaviour of the groundwater resource and of potential developing impacts from the establishment and on-going operation of the proposed piggery development.
- Investigate alternative water sources to supplement the water supply options for the proposed piggery development, such as:
  - roof run-off capture – Initial estimate of ~14,300 m^2 of roof area is proposed. For a 570 mm average rainfall at 80% capture may realise ~6.5 ML/a of water – this option may be stored on the surface or selectively recharge to the targeted aquifer;
  - surface water capture and enhanced recharge – this option may utilise surface water run-off into existing farm dams by promoting infiltration (or directly draining filtered groundwater) to the targeted aquifer locally.

Most importantly, our project team is passionate about its work, which will be reflected in the quality of our project deliverables.

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