Appendix 7

Groundwater Impact Assessment

(Total No. of pages including blank pages = 166)

Note: A colour copy of this Appendix is available on the Project CD

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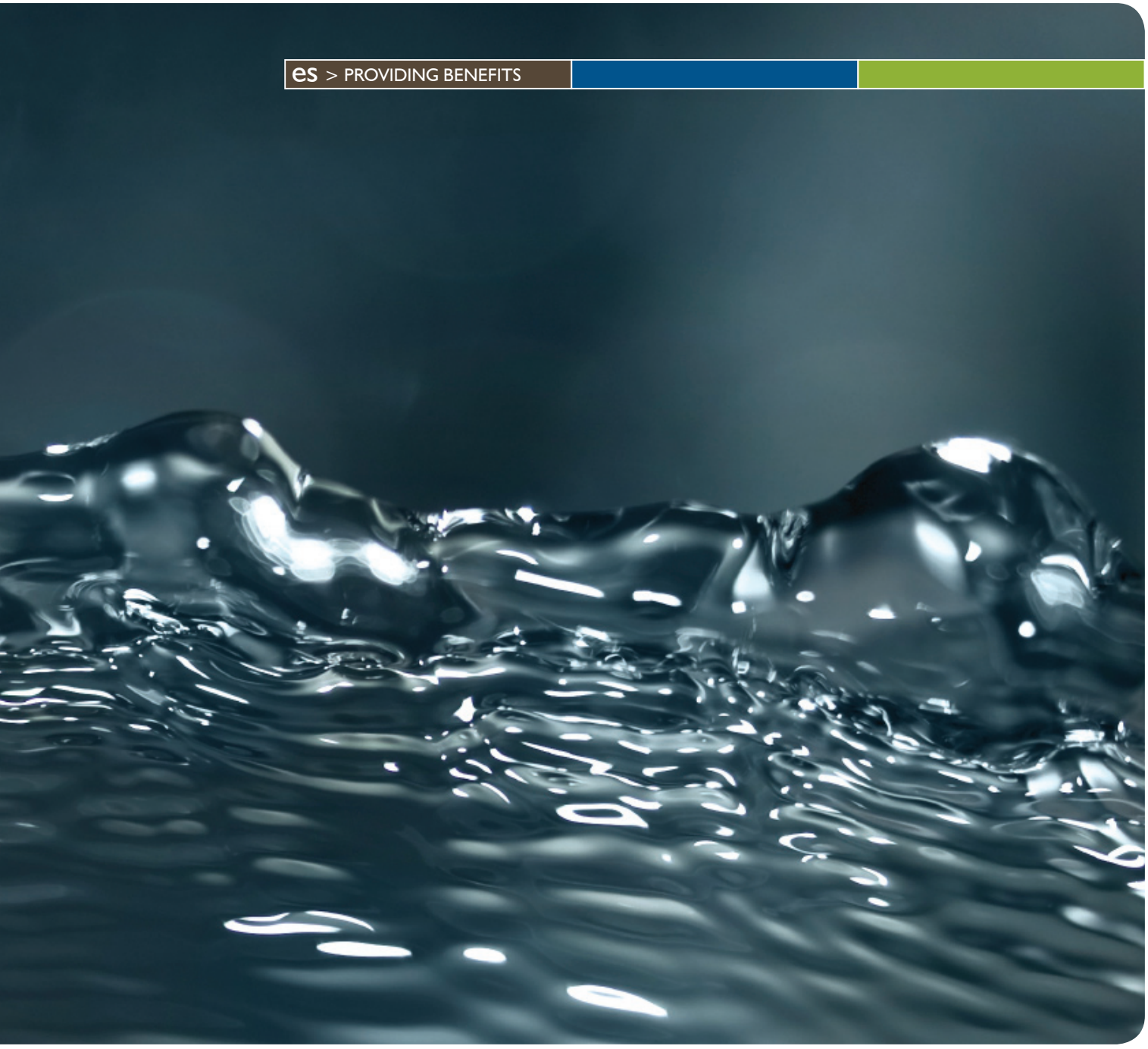
EnvironmentalStrategies
PROVIDING BENEFITS

Avoca Tank Groundwater Assessment

Groundwater Impact Assessment

Job Number 13061

Prepared for RW Corkery & Co PTY Ltd | 8 July 2014



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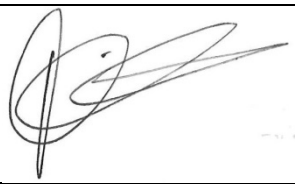
Signed: Reviewer: Tim Chambers Principal Hydrogeologist	
Signed: Reviewer: Rod Harwood Principal Hydrogeologist	

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1 INTRODUCTION

Environmental Strategies Pty Limited (ES) was commissioned by R.W. Corkery & Co. to conduct a groundwater assessment to provide information for inclusion into an Environmental Impact Statement (EIS) for the Avoca Tank Project (the 'ATP') which will form part of Tritton Resources Pty Ltd (the Applicant's) existing operations, the Girilambone Copper Mine and the Tritton Copper Mine.

The ATP Site is located within the Bogan Shire, Parish of Girilambone, County of Canbelego. Under the provisions of the *Bogan Local Environmental Plan 2011*, the ATP Site is zoned Primary Production (RU1). Mining is a permissible land use within this zone, subject to consent by Council.

The Girilambone Copper Mines are a group of mines located approximately 7km northwest of the village of Girilambone and approximately 55km northwest of Nyngan in western NSW. The Applicant currently operates the Girilambone Copper Mine and the Tritton Copper Mine on mining leases ML1280, ML1383 and ML1544. The Applicant is proposing to develop the ATP approximately 2km to the north-northwest of the existing Girilambone Copper Mine and 24km northeast of its Tritton Copper Mine, (Refer to **Figure 1**).

The Girilambone Copper Mine (Refer to **Figure 2**) includes the following operations:

- Murrawombie Open Cut and Underground Portal
- North East and Larsens Open Cuts
- Hartmans Open Cut and Portal.

The ATP is understood to include subsurface workings (long hole open stope) to approximately 500m depth with attendant surface infrastructure. A proposed site layout of the ATP, including project site boundary and proposed disturbance footprint, is provided in **Figure 3 and Figure 4**.

The proposed development will require approval by a Joint Regional Planning Panel, Bogan Shire Council, with the NSW Office of Water being an approval authority under the integrated development provisions of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The NSW Office of Water has issued a Request for Input into Director General's Requirements (DGR) which details the environmental assessment requirements required to be addressed in an Environmental Impact Statement (EIS). The purpose of this groundwater impact assessment is to "address the Director General's Requirements of the EIS to identify groundwater issues and potential degradation to the groundwater resource."

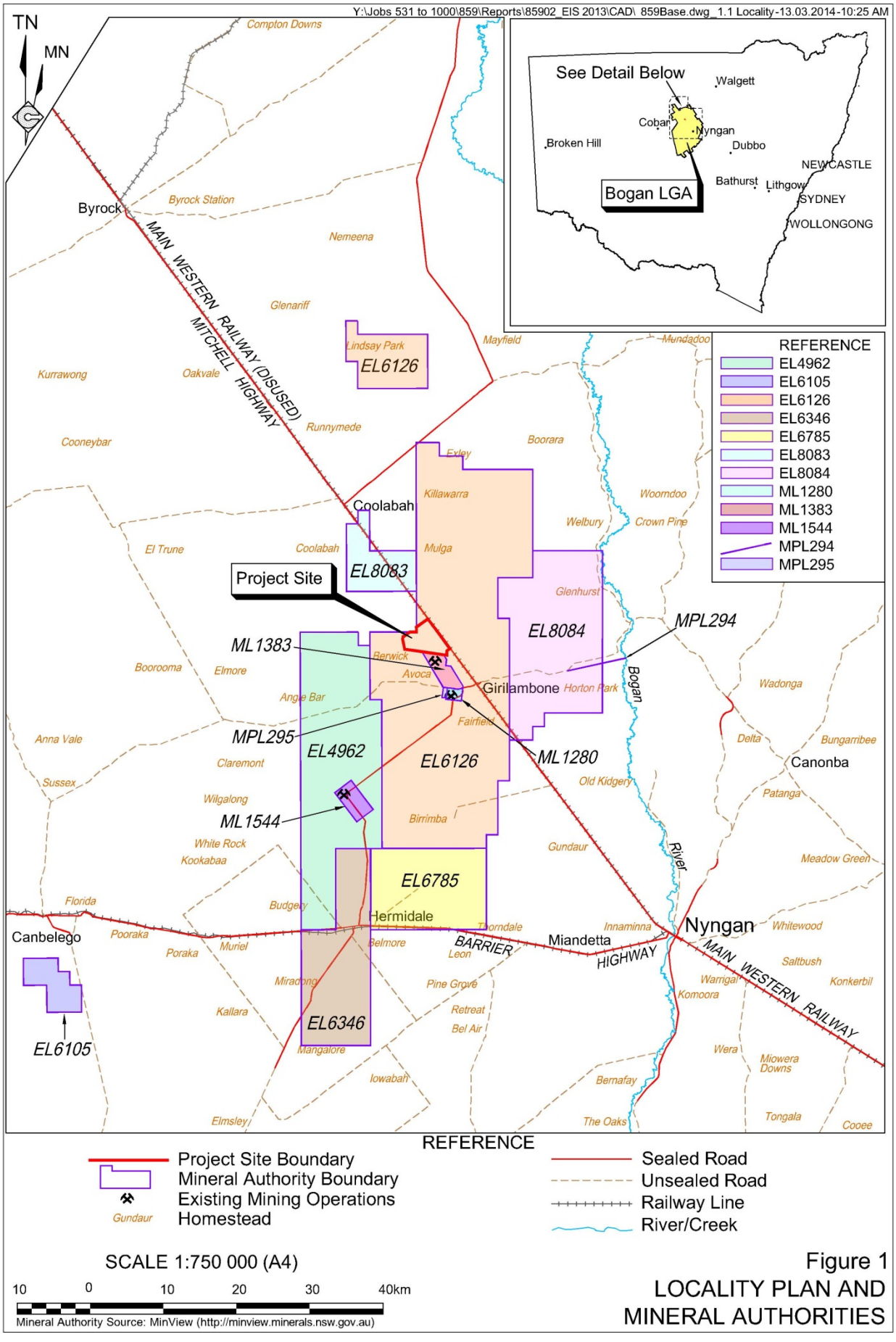


Figure 1
LOCALITY PLAN AND
MINERAL AUTHORITIES

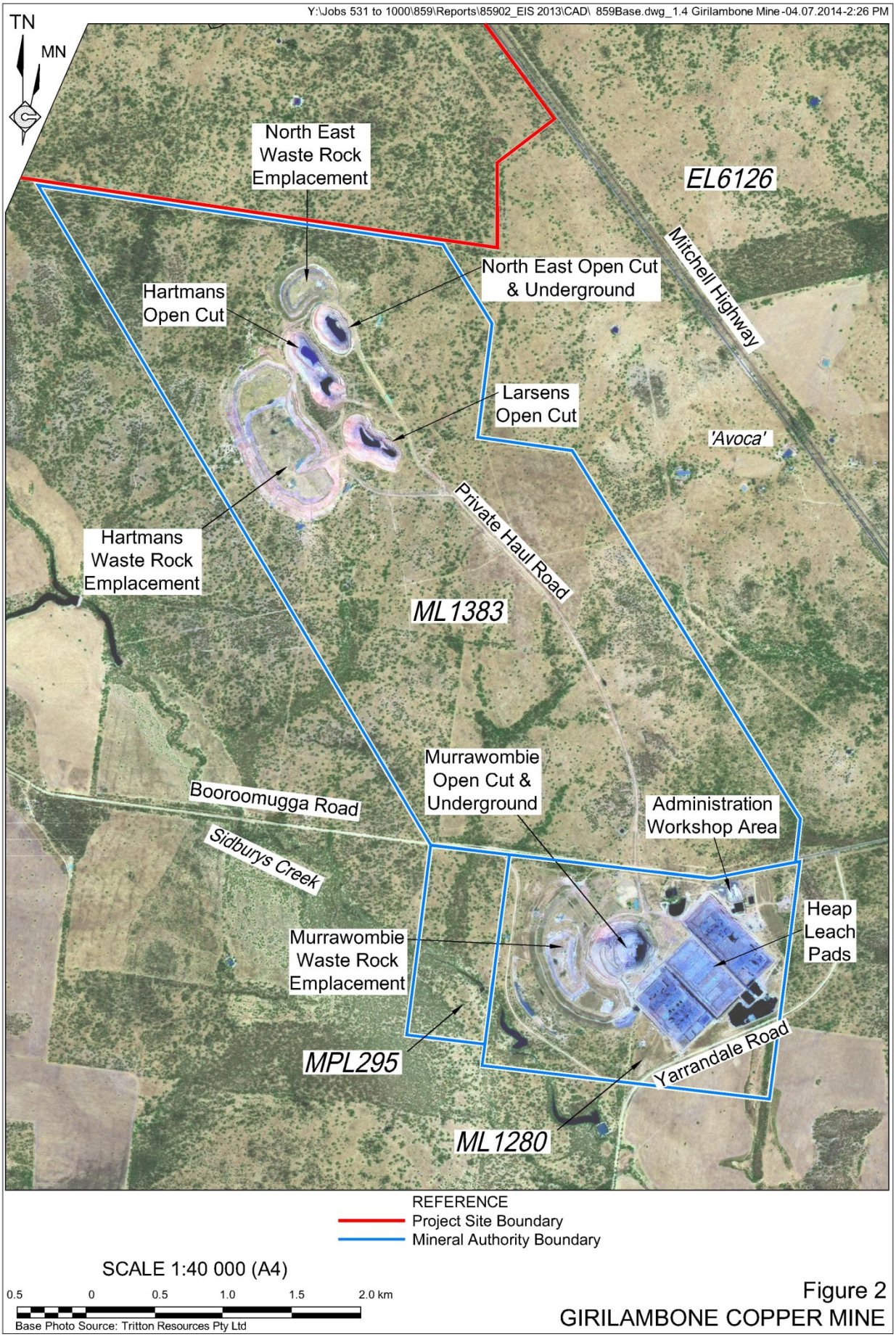
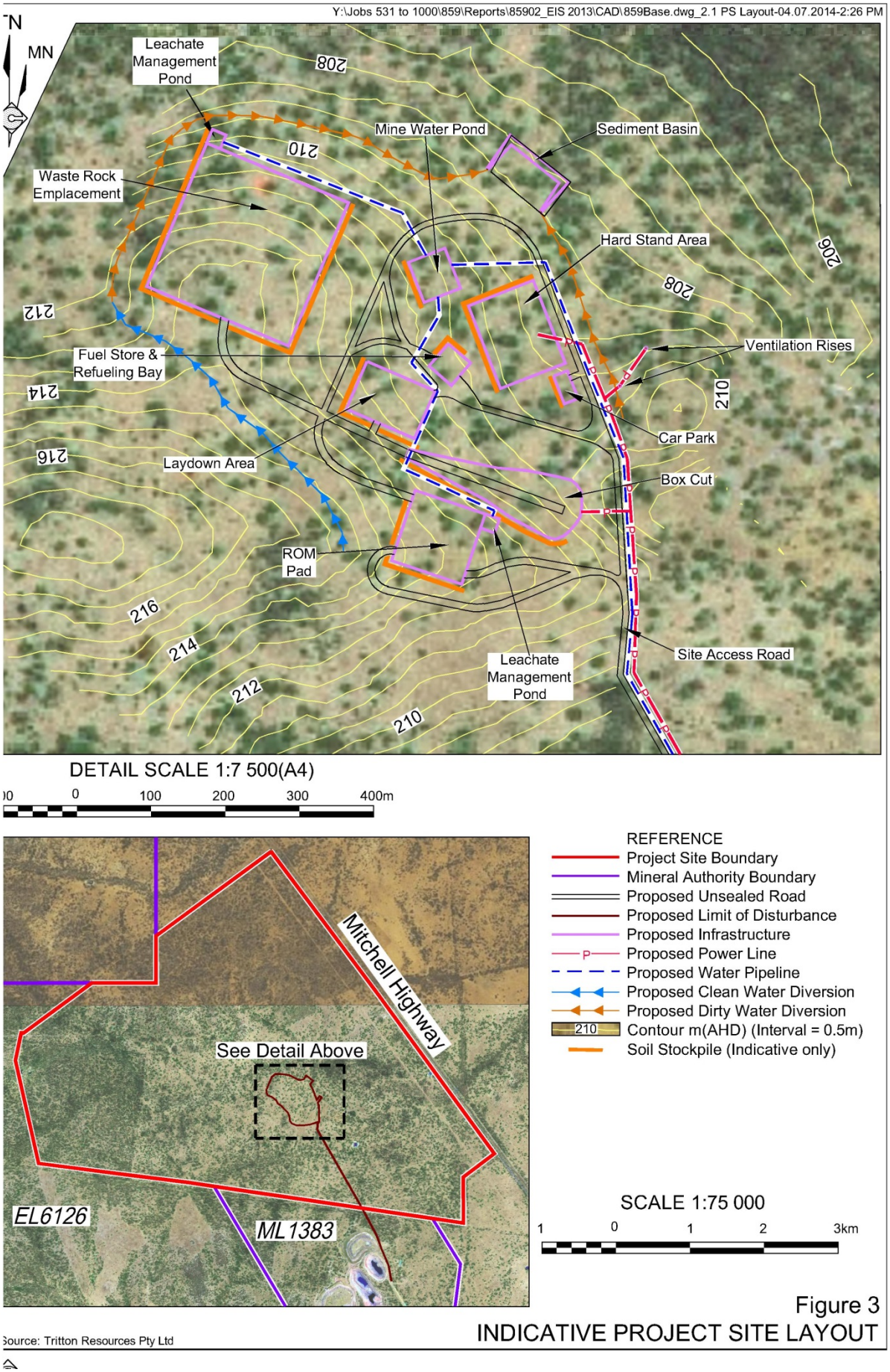


Figure 2
GIRILAMBONE COPPER MINE



Source: Tritton Resources Pty Ltd

Figure 3
INDICATIVE PROJECT SITE LAYOUT

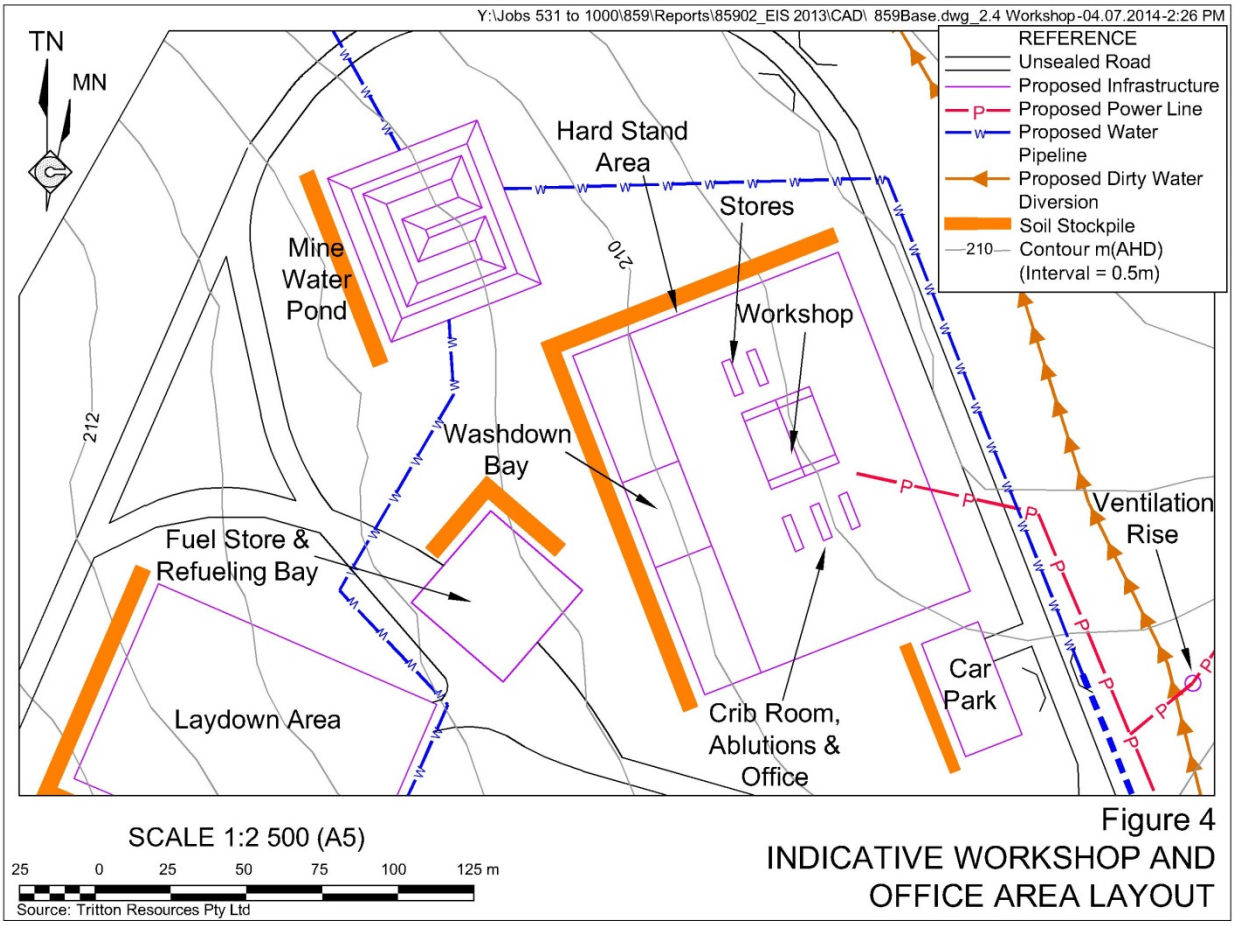


Figure 4
INDICATIVE WORKSHOP AND OFFICE AREA LAYOUT

2 OBJECTIVES

The objective of this report is to provide background information in support of the EIS. The focus of this document is to provide information on the existing environment and constraints for the proposed ATP and provide an assessment of the likely impacts and licences required.

This report has been specifically prepared to provide a description of the existing groundwater environment, including:

- Bores within and surrounding the ATP Site;
- Springs and outflow zones;
- Groundwater dependent ecosystems;
- Aquifers underlying and in the vicinity of the project site; and
- Water quality in identified aquifers.

The objectives of the groundwater impact assessment include:

- An assessment of the likely short term and long term impacts of the proposed development on groundwater resources in the vicinity of the project site; and
- Advice in relation to licencing issues, including what licences will be required, and allocations be sought.

3 SCOPE OF WORKS

In order to meet the required objectives of this report, the following scope of work has been conducted:

1. Review of the ATP Site setting;
2. Review of registered bores and construction details, and internally held bore records at the Applicant's surrounding mining operations;
3. Review of groundwater dewatering activities required to operate the existing subsurface mines in the area;
4. Examination of available maps of groundwater dependent ecosystems, as well as review of topographic and geological maps to identify any potential groundwater discharge areas not formally mapped;
5. Review of existing groundwater data obtained for the other mine workings operated by the Applicant in the area to supplement the regional data available from the bore logs.
6. Perform hydrogeological calculations using proven formulae to estimate potential effects on local groundwater systems using the available understanding of the site geology and hydrogeology, and available estimates of the amount of water required to dewater similar mine workings in the region;

7. Cross reference the predicted effects on the local groundwater system against the existing environment and constraints to determine the potential effects of required dewatering activities;
8. Review of legislation and guidance (particularly the Aquifer Interference Policy issued under the *Water Management Act 2000*) and including the NSW State Groundwater Policy Framework, State Groundwater Quality Protection Policy, State Groundwater Quantity Management Policy and ARMCANZ/ANZECC National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia; and
9. Communication with the NSW Office of Water to discuss licensing requirements for the proposed ATP Site.

4 PROJECT SITE SETTING

The ATP Site is located approximately 2km north of the Girilambone Copper Mine and 24km northeast of its Tritton Copper Mine, 7km northwest of the village of Girilambone, and approximately 55km northwest of Nyngan, along the Mitchell Highway. The site is located in the Central Western Plains of NSW, approximately 620 km west of Sydney, in the Cobar Peneplain Bioregion. This region encompasses the townships of Cobar, Nymagee, Byrock, Girilambone, Lake Cargelligo and Rankins Springs with Louth and Tottenham lying at its boundary.

4.1 GEOLOGY AND SOILS

The Girilambone region is located within the western portion of the Lachlan Fold Belt which consists of Cambrian to Lower Carboniferous rock successions. The eastern margin is truncated by the present coastline in the south and is overlapped by the Permo-Triassic succession of the Sydney Basin and its northern equivalents; The northern margin is overlain by the Mesozoic Great Artesian Basin succession; the southern margin is truncated by the present Tasmanian coastline, and is overlain by Permian and younger successions. The western margin is largely covered by the mainly Cainozoic Murray Basin successions. The final stage of sedimentation and tectonism is the Kanmantoo Fold Belt and the oldest geological activity in the Lachlan Fold Belt are contemporaneous.

Soils in the Girilambone - Hermidale area vary in depth and characteristics with their position in the landscape and are underlain by the Girilambone Group. The Ordovician Girilambone Group consists of rhythmically bedded, poorly sorted, fine to coarse-grained quartzose sandstone with subordinate quartzo-feldspathic sandstone, siltstone and chert, together with minor intercalated basic volcanics and minor conglomerate, marl and serpentinite (Khider & McPhail 2005). These rocks have been weathered to saprolite that forms the rises and low hills (Chan et al. 2002).

In the Girilambone - Hermidale area, the Girilambone Group is overlain by shallow marine volcanic sediments of the Kopyje Group (Suppel & Gilligan 1993). There are also shallow alluvial deposits overlying the Girilambone and Kopyje Groups that are mainly associated with the present-day drainage pattern of Whitbarrow and Pangee Creeks, which generally flow to

the north and northeast of the study area (Chan et al. 2002). A Cambrian-Ordovician sequence of dominantly siliciclastic rock types which have undergone low grade greenschist facies metamorphism outcrops in the area.

Both the Tritton Copper Mine and Girilambone Copper Mine represent the Cobar and Mineshaft Land Systems as described by Walker (1991). Soils of the Cobar Land System are shallow gravely loamy soils, grading to deeper acid and neutral red earths with hardpans down slope and in drainage lines. Soils of the Mineshaft Land System comprise shallow stony, sandy and loamy soils which deepen slightly along drainage lines.

4.2 TOPOGRAPHY

The regional topography is characterised by a gently undulating pediplain with shallow drainage depressions, low ridges and occasional locally prominent hills. The most prominent hill in the region is The Brothers, with an elevation of approximately 287m AHD, located approximately 7.5km to the southwest of the ATP Site. Elevations at the ATP Site, within the limit of disturbance area, range from approximately 215 mAHD in the southwest to 208 mAHD at the northeast (Refer to **Figure 3**).

4.3 CLIMATE

The regional climate is dry continental with hot summers and mild winters. The hottest months occur in both January and February with July being the coldest month (Refer to **Figure 5**). The ATP Site lies in a region that is neither dominated strongly by winter nor summer rainfall, with precipitation events distributed relatively evenly throughout the year (*Straits 2009)*. ES note that over half of the precipitation reported during 2012 observed between February and March, suggesting a summer dominated rainfall cycle was occurring at that time (Refer to **Figure 6**).

The long term mean average annual rainfall for the area is 446.6mm recorded at the Bureau of Meteorology (BOM) Nyngan Airport automatic weather station (Site 051039), approximately 55km south east of the ATP Site. In general, the average rainfall pattern for Nyngan is somewhat variable when taken over a short duration of years. The records which average over many years and a longer time duration than the annual average tend to show that rainfall is distributed relatively evenly throughout the year with slightly higher rainfall occurring in the summer months (Refer to **Figure 3**).

As reported in Straits (2009) the 1 in 100 year rainfall event from 1979 is measured at 2.87mm of rain per hour for 72hrs. Four of these rainfall events have occurred in the area over the past 100 years (*Straits 2009)*.

Based on climatic data from the BOM Nyngan Airport weather station, January is typically the hottest month with an average of 34°C. Winters are mild. July is the coolest month with a mean daily maximum temperature of 16.4°C (Refer to **Figure 5**).

Figure 5: Average Maximum temperatures recorded at Nyngan Airport for 2012

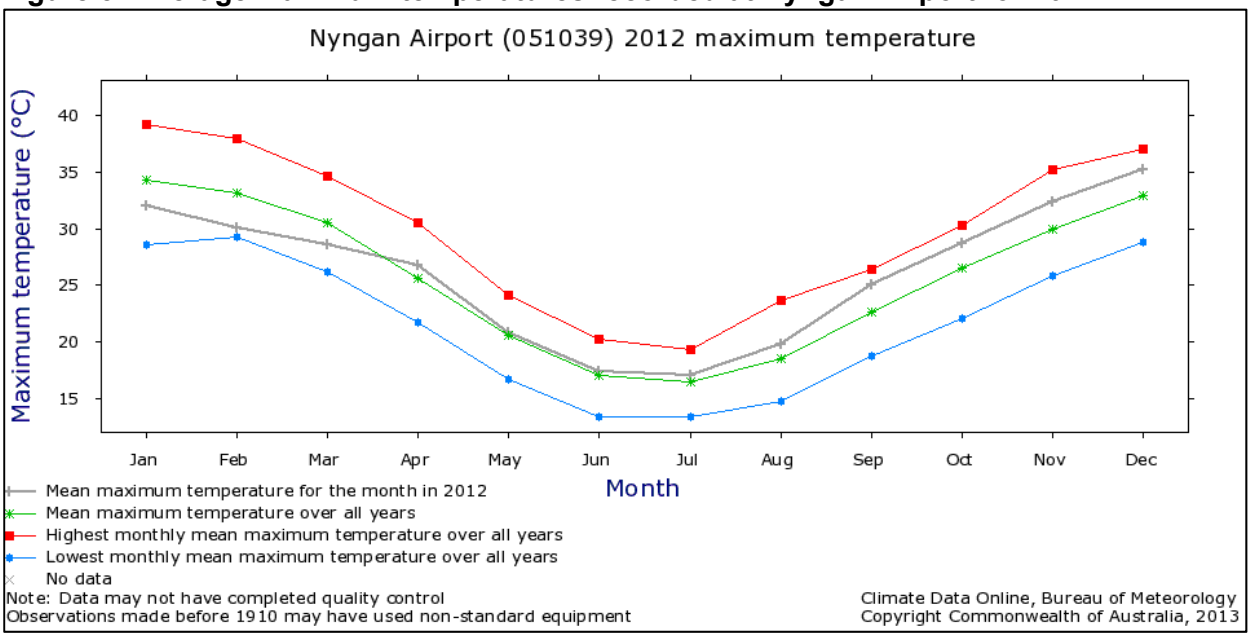
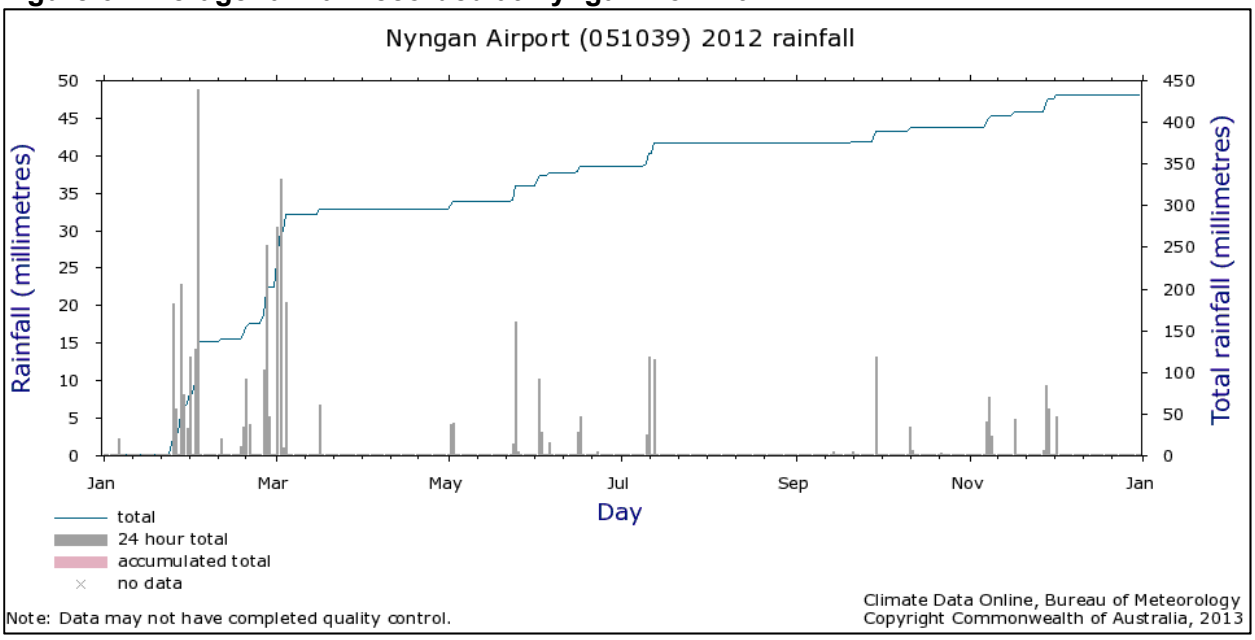


Figure 6: Average rainfall recorded at Nyngan from 2012



5 REVIEW OF REGISTERED BORES

5.1 SUMMARY

In February 2012, OTEK Australia Pty Ltd (OTEK) conducted a Site Information Review and Land Assessment of the Girilambone Copper Mine, including the Murrawombie Pit and the North East Pits (North East Pit, Larsens Pit, and Hartmans Pit) and associated infrastructure. OTEK found that the standing water levels around the Girilambone Copper Mine operations range between 5m and 26m below surface whilst wells in surrounding the ATP Site range between 18m to 127m below surface.

Based on standing water levels, the relative location of Siburys Creek and the predominant bedrock fracture patterns, the primary lateral axis of shallow bedrock groundwater flow beneath the site is likely to the north and west. It is likely that there is vertical migration between the shallow and deeper bedrock aquifers but that could not be assessed at the time of reporting.

R.W. Corkery & Co (May, 2012) summarised that the groundwater environment surrounding the ATP Site at the time of writing their report, may be described as follows.

- Twelve registered bores were located within 10km of the ATP Site. Of these bores, 11 are associated with the company's operations and one is a private bore used for stock purposes.
- Groundwater levels are typically between 8m and 39m below surface, indicating that groundwater is unlikely to discharge to surface or support groundwater dependent ecosystems.
- Groundwater quality is described in one bore only where it is identified as "salty".
- Groundwater is typically hosted within fractured rock aquifers.
- Groundwater yields are typically between 0.01L/s and 1.5L/s.

Water bearing zones during construction of the wells at the Girilambone Copper Mine ranged from 41m to 59m below surface level and have a fracture permeability zone thickness of 6m.

Wells in the 10km of the Girilambone Copper Mine, generally to the south also have a fracture permeability zone thickness of 6m that reduces to shallower depths down catchment from the site. GW042880 is down gradient on the opposite side of the Siburys Creek watershed and intercepts the alluvial system associated with the creek.

5.2 ONSITE REGISTERED BORES

OTEK (2012) found that many of the piezometer wells used for mine monitoring purposes at the North East Pit do not have readily available construction details and were not registered on the NSW Groundwater Works Summary Database. However at the time of writing the report, there are currently three (3) existing monitoring bores listed on the http://nratlas.nsw.gov.au located within the ATP Project Site boundary as shown in **Table 5-1**.

Table 5-1: Onsite Groundwater Bores

Works Request No.	Licence Number	Depth to Water – Standing Water Level (SWL) (m)	Water Bearing Zone (m)	Total Depth (m)
GW805056	80BL620335	39.97	29-65	66.00
GW805057	80BL620336	35.95	47-53	54.00
GW805058	80BL620335	31.04	41-47	48.00
Source: data provided by Tritton				

The onsite groundwater bore locations are provided in Figure 7 below and **Appendix B** for work summary information.

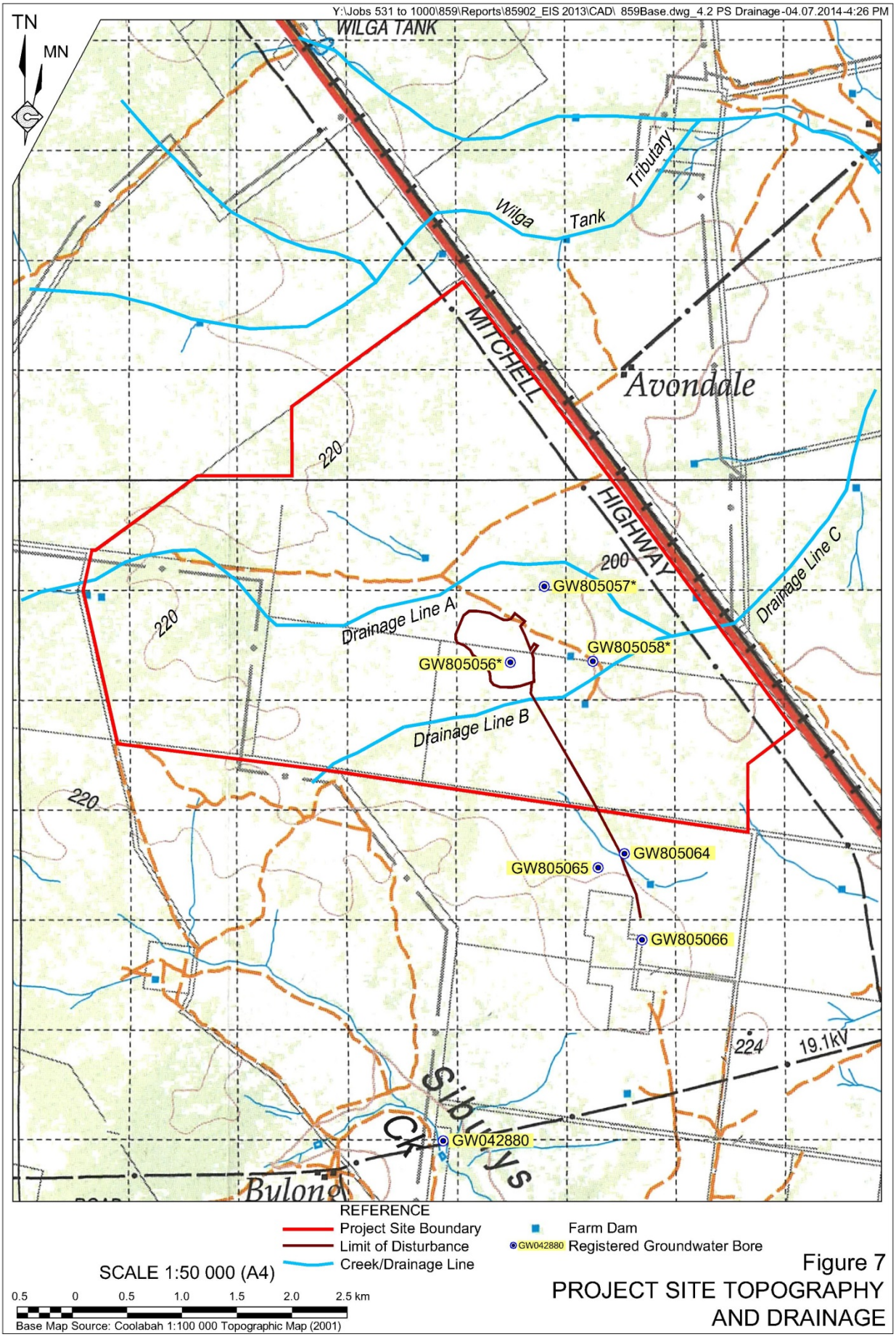


Figure 7
PROJECT SITE TOPOGRAPHY AND DRAINAGE

5.3 OFFSITE REGISTERED BORES

A further 24 groundwater bores listed on the http://nratlas.nsw.gov.au are located within a 20km radius of the Project Site. The majority of these are within the Applicant's current operation at the Girilambone Copper Mine, refer **Table 5-2** and **Appendix B** for work summary information.

Table 5-2: Groundwater Bores Located on Adjoining Properties

Works Request No.	Licence Number	Depth to Water – Standing Water Level (SWL) (m)	Water Bearing Zone (m)	Total Depth (m)
GW805065	80BL620254	82.00	80 – 86	87.00
GW805066	80BL620254	127.00	125 – 131	132.00
GW042880	80BL106391	18.00	22 – 62	62.00
GW805061	80BL620307	24.00	30-36	37.00
GW805062	80BL620254	127.00	125 – 131	132.00
GW805064	80BL620254	64.10	75-81	82.00
GW803782	80BL245097	8.00	28-29	40.00
GW804384	80BL245970	N.R	31-39	43.00
GW803779	80BL245099	11.00	26-28	40.00
GW805063	80BL620255	26.77	125-131	132.00
GW804381	80BL245970	N.R	34-47	52.00
GW804379	80BL245970	N.R	47-52	61.00
GW804382	80BL245970	N.R	34-47	52.00
GW803780	80BL245100	10.60	31-32	40.00
GW803781	80BL245098	39.00	39-40	40.00
GW805059	80BL620337	11.78	15-21	22.00
GW804383	80BL245970	N.R	25-33	40.00
GW804380	80BL245970	N.R	55-57	61.00
GW805167	80WA716017	7.94	N.R	17.56
GW026890	80WA709380	N.R	22.30-22.90 & 26.10-27.50	27.40
GW805060	80BL620338	9.32	12-18	19.00
GW003006	N.R	N.R	N.R	86.00
GW002970	N.R	N.R	21.30	61.30
GW002685	N.R	N.R	26.2 – 32.0	86.90
Note: N.R indicates no result				
Source: http://nratlas.nsw.gov.au				

The nearest groundwater water supply bore (GW026890), which is registered for stock purposes is located approximately 8.5km southeast of the Project Site. Based on the drilling logs, this bore is screened within an unconsolidated formation and not screened within the

fractured rock formation which the ATP Site will intercept. The nearest water supply bore (GW002970), which is registered for stock purposes and within fractured rock, is located approximately 15km to the east of the ATP Site.

6 AQUIFERS AND WATER QUALITY

Groundwater is present predominantly in the bedrock aquifer where groundwater occurs in secondary porosity features (predominantly faults and fractures). Some shallow seepage water may be present at the interface of soils (typically clays derived from weathering of the bedrock) and competent bedrock. This interface seepage is of low yield and is not generally regarded as a water supply aquifer.

6.1 PROJECT SITE

Groundwater quality data obtained by the Applicant in the initial assessment of the bores at the Project Site has been summarised in Table 6-1 presenting the average pH, electrical conductivity (EC) and total dissolved solids (TDS) for each of the bores based on five rounds of monitoring data (November 2012, December 2012, January 2013, February 2013 and March 2013):

Table 6-1: Summary of Average Groundwater Quality at ATP Site Bores

Local Bore ID	Average pH	Average EC (μS/cm)	TDS (mg/L)
GW805056	7.7	20,560	12,920
GW805057	7.6	23,660	14,680
GW805058	7.8	21,480	13,340
Source: The Applicant			

6.2 ADJACENT SITES

Based on March 2013 monitoring data from 32 wells (at the Girilambone Copper Mine site), salinity, measured as total dissolved solids or TDS, has a median value of 13,000 mg/L (electrical conductivity, EC, of 21,000 μS /cm) and is above 4,000 mg/L (EC 7,000 μS/cm) at all locations with an exception between the heap leach pads and Murrawombie Pit) with a TDS of 912 mg/L. Historical measurements in this location range up to 21,000 mg/L. There is a substantial body of monthly monitoring data which is consistent with this assessment, obtained by the Applicant as monitoring data under their existing EPL licence. The data is available on request.

The salinity of the deep fractured groundwater renders it unsuitable for potable or irrigation use. The Australian Drinking Water Guidelines (NHMRC, 2011) indicate an aesthetic barrier to water consumption at a TDS level of 500 mg/L.

NSW DEC (2008) *Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination* indicate that the NSW EPA considers potable use to be a

potential groundwater use where TDS values range up to 2,000 mg/L. Given that the site groundwater is highly saline (TDS mean of 13,000 mg/L) potable use can be ruled out.

With respect to agricultural use, water salinity of over 8,100 μS/cm (TDS 5,000 mg/L) is classified as "extreme salinity" not suitable for irrigation, even of highly salt tolerant crops (ANZECC & ARMCANZ, 2000). The potential use of site groundwater for irrigation can therefore be ruled out.

ANZECC & ARMCANZ (2000) also indicate that whilst TDS values below 4,000 mg/L are suitable for beef cattle, sheep, pigs and horses, loss of production can occur where TDS values are above 6,000 mg/L (10,000 mg/L for sheep). The groundwater is therefore of marginal use and is limited to use for stock watering if at all. The salinity is sufficient, however, to render the water quality as marginal even for that use.

7 CATCHMENTS AND DRAINAGE

7.1 RIVER CATCHMENTS

The ATP ore deposits are located within the 73,300 km^2 Macquarie River catchment, which is part of the Murray-Darling Drainage Division and Murray-Darling Basin. The regional sub-catchment is the Bogan River catchment which flows from south to north through the town of Nyngan (Refer to **Figure 1** and **Figure 8**).

The Bogan River maintains its own catchment within the Macquarie River catchment, running roughly parallel to the Macquarie River, and is connected to the Macquarie River via tributaries, one of which is Gunningbar Creek. Gunningbar Creek is a major water source for the Tritton Copper Mines complex.

Flow in the Bogan River increases with distance downstream, as a result of the regulated supplies of water that enter the lower Bogan River via the Albert Priest Canal, Gunningbar Creek and Duck Creek. Upstream of these effluents at Neurie Plains near Nyngan the mean daily flow is 241 ML, while downstream at Gongolgon the mean flow is over 700 ML/day

There are two primary water storages in the Macquarie River catchment comprising of;

- Windamere Dam on the Cudgegong River (capacity 368,000 ML): and
- Burrendong Dam at the junction of the Macquarie and Cudgegong Rivers (capacity 1,189,000 ML).

These two storages provide security of supply to downstream water users. Water use in the Macquarie River is regulated under the *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source 2003,* made under the *Water Management Act 2000.*

The main surface water resources in the Girilambone area are ephemeral tributary creeks. There are also numerous small to moderate sized surface water storage dams located on properties throughout the area which are filled by rainfall run-off. The water quality in these dams is considered to be good with low salinity, near neutral pH and low metal concentration (Green, et.al. 2011).

Figure 8 The Macquarie Bogan Catchment.

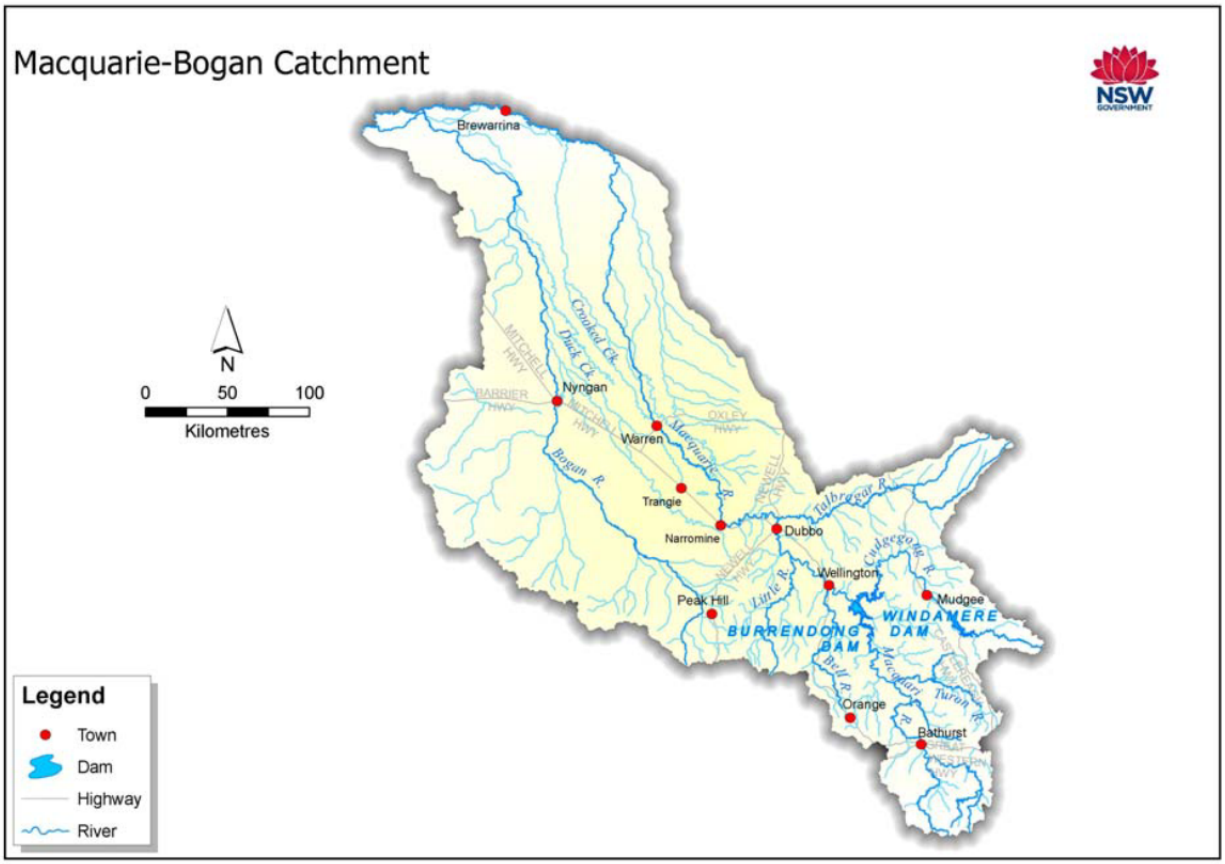


Figure Source: Green D., Petrovic J., Moss P., Burrell M. (2011) *Water resources and management overview: Macquarie-Bogan catchment*, NSW Office of Water, Sydney

7.2 GROUNDWATER CATCHMENTS

The Macquarie-Bogan catchment (refer to) is generally unfavourable for the development of groundwater resources with aquifers in the alluvium being thin and low yielding, and is underlain by fractured rock which yields very little groundwater Water Resources Commission (WRC) 1984 (WRC 1984).

The NSW Murray-Darling Basin (MDB) fractured rock groundwater sources (**Figure 9**) are located within the NSW portion of the MDB. The waters in this groundwater source include all groundwater contained in:

- the Adelaide Fold Belt MDB Groundwater Source
- the Inverell Basalt Groundwater Source
- the Kanmantoo Fold Belt MDB Groundwater Source
- the Lachlan Fold Belt MDB Groundwater Source
- the Liverpool Ranges Basalt MDB Groundwater Source
- the New England Fold Belt MDB Groundwater Source
- the Orange Basalt Groundwater Source
- the Warrumbungle Basalt Groundwater Source
- the Yass Catchment Groundwater Source, and
- the Young Granite Groundwater Source

Figure 9 Groundwater aquifer types of the Macquarie-Bogan catchment

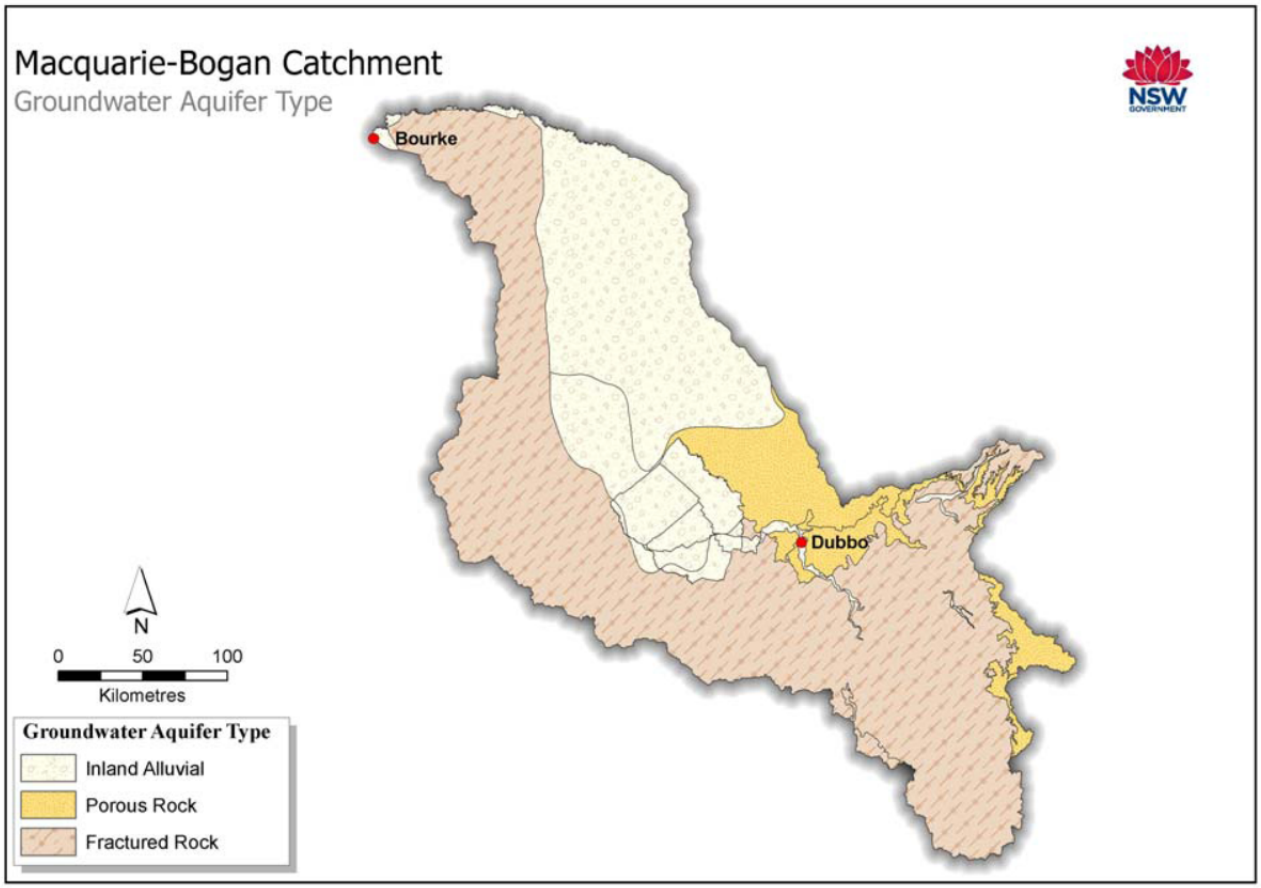


Figure Source: Green D., Petrovic J., Moss P., Burrell M. (2011) Water resources and management overview: Macquarie-Bogan catchment, NSW Office of Water, Sydney.

The Girilambone region is located within the western portion of the Lachlan Fold Belt. The Lachlan Fold Belt MDB Groundwater Source consists of a fractured rock aquifer with a low to moderate level of connection between surface and groundwater. Estimated travel time between groundwater and surface water is considered to be years to a decade. The Lachlan Fold Belt MDB Groundwater Source covers an area of 16,722,000 hectares.

Regional groundwater in the vicinity of the Project Site is low yield and highly saline with EC levels generally between 20,000 and 25,000 µs/cm (Green et.al., 2011). This is consistent with measurements at the Project Site.

The primary permeability of the Girilambone Group rocks is low, with the secondary permeability controlled by fractures, faults and foliation being much higher as highlighted by observations of inflows to underground workings at Tritton and Girilambone operations. The regional groundwater flow direction is thought to be towards the west and northwest. Recharge of the regional groundwater system is thought to be primarily via rainfall infiltration; however a component may come from infiltration through the base of drainage lines and rivers during periods of flow (Green et.al., 2011).

RWC (2012) found that the local hydrogeology is likely to be controlled by the dominant north-northeast trending foliation and faults as well as bedding which dip to the east southeast. The material above the base of weathering is generally thought to be of higher bulk permeability

than the fresh rock beneath, ie, although permeability is still low, due to weathering, is likely to be less structurally controlled. The fresh (relatively) underlying rock is generally of low permeability with groundwater movement controlled by secondary permeability along foliation, fracturing, bedding and faults.

7.3 PROJECT SITE DRAINAGE

The Project Site lies entirely within the watershed north of Siburys Creek, a tributary of the Bogan River. Siburys Creek which is the closest substantial drainage line to Project Site is situated to the south of Murrawombie. The creek flows in a south easterly direction towards the Bogan River and has a catchment area of 385 km^2.

The project site slopes very gently to the east, with the elevation of the western boundary of the site between 215mAHD and 220mAHD and the elevation of the eastern boundary of the exploration site between 200mAHD and 195mAHD. Surface water within the proposed project site is restricted to two dams and a number of small ephemeral streams. After rainfall events, run-off flows as sheet wash rather than channelised flow. Three dams (refer to **Figure 7**) used for stock watering exist within the Project Site (RWC 2012).

The catchment (refer to **Figure 10**) in the local area has a mixture of cleared and woodland areas, both of which tend to have low infiltration rates. As a consequence, runoff is a high percentage of rainfall and tends to produce high peak flows over a short period of time after rain. After rainfall events, runoff on the Project Site tends to flow as sheet wash. Numerous small to moderate sized surface water storage dams are located throughout the area. These fill rapidly during high flow events (RWC, May 2012).

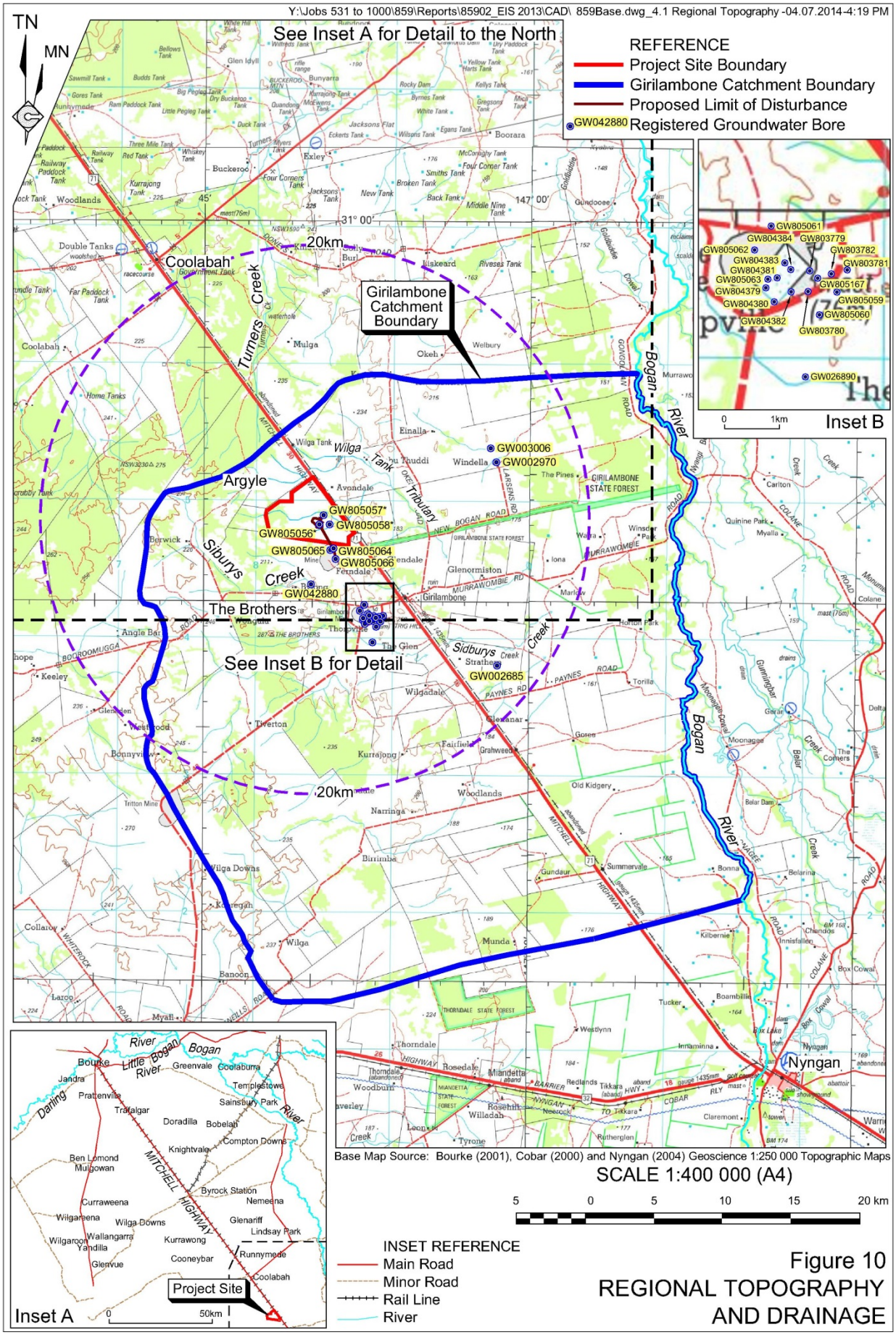


Figure 10
REGIONAL TOPOGRAPHY AND DRAINAGE

The existing surface water management systems at Tritton Copper Mine and Girilambone Copper Mine aim to segregate clean, dirty and contaminated runoff (Refer to **Section 9** for further information on the Applicant's de-watering activities). The following definitions have been adopted for the various runoff types:

- Clean water is defined as runoff from undisturbed bushland catchments.
- Dirty water is defined as runoff from disturbed areas and includes runoff from the waste rock emplacements and stockpiles. This water may contain elevated levels of suspended solids.
- Contaminated water is defined as runoff generated from the processing facilities, open cuts and underground operations. This water may be contaminated by suspended solids, salts and heavy metals etc.

Clean runoff from undisturbed sub-catchments is diverted around disturbed areas to the extent practicable. Dirty water runoff is captured in sediment dams to encourage the settling of suspended solids. Runoff from large storm events overtops sediment dams and generally discharges to downstream containment dams (rather than offsite).

Contaminated water is captured in containment dams or the open cuts. Containment dams at the Girilambone Copper Mine generally overflow offsite, however, Tritton Resources has advised that overflows are rare and occur in emergency situations only (*Straits 2009)*.

8 ECOSYSTEMS

8.1 REGIONAL

The Macquarie-Bogan Catchment previous to European settlement supported a complex mosaic of forests, temperate and semi-arid woodlands, wetlands, shrublands, heaths and grasslands. Large scale clearing and subsequent degradation has reduced many of these vegetation communities to isolated remnants on the less fertile and productive soils. National parks and reserves protect nearly 1,300 km^2 of habitat within the Macquarie-Bogan catchment. Most of the protected areas are found in the upper section of the Macquarie-Bogan catchment.

The aquatic and terrestrial environments of the Macquarie-Bogan Catchment support a range of threatened species and ecological communities that are protected under the *Threatened Species Conservation Act (TSC Act)1995*. Within the Central West CMA region (which includes the Macquarie, Bogan and Castlereagh) there are 42 threatened plant species with 17 of these listed as endangered. The majority of these are associated with the slopes and ranges of the upper catchment. Vegetation communities in the Lower Bogan catchments have been heavily affected by clearing and the remaining native vegetation therefore increases in significance.

8.2 SPRINGS AND OUTFLOW ZONES

No springs or outflow zones were identified in the vicinity of the Project Site.

The search of groundwater dependant ecosystems (See **Section 8.3** below and **Appendix A**) revealed that rivers ten kilometres or more from the site have a low potential of being groundwater fed.

8.3 GROUNDWATER DEPENDANT ECOSYSTEMS

No groundwater dependant ecosystems are apparent in the vicinity of the site. Environmental Strategies conducted a search of the Groundwater Dependent Ecosystems Atlas (Australian Government, Bureau of Meteorology, http://www.bom.gov.au/jsp/weave/gde.html). The area surrounding the Project Site is shown in **Appendix A** and it is apparent that no groundwater dependant ecosystems occur in the vicinity of the Project Site.

8.4 GROUNDWATER VULNERABILITY

Review of the Groundwater Vulnerability Map for the Macquarie catchment published by the Department of Land and Water Conservation, Dubbo, indicates that the area of the Project Site is an area of generally low groundwater vulnerability.

A copy of the groundwater vulnerability map is included in **Appendix A.**

8.5 STYGOFAUNA

Animal species that rely on groundwater are less well known and included invertebrates and microscopic organisms (stygofauna) that live within the pore spaces that make up an aquifer. These organisms can play an important role in maintaining aquifer health and function by keeping pore spaces free from silt and through their role in chemical and nutrient cycling processes (DLWC, April 2002). Stygofauna are likely to be present within the fractured rock aquifer at the ATP Site, however, species abundance and distribution have not been confirmed through testing at the ATP site.

The groundwater quality at the ATP site is understood to be saline (with an EC ranging between 20,560 and 23,660 µS/cm). In the Pilbara and Yilgarn regions in WA, studies have indicated that stygofauna will not be present unless the salinity is less than 60,000 mg/L (Western Australia EPA 2007). Populations in Queensland have been detected in aquifers with EC as high as 19,000 µs/cm, but results indicate that the likelihood of stygofauna presence is significantly lower in aquifers with elevated salinity (Bennison 2012). Results from elsewhere in Australia indicate that stygofauna have been recorded in groundwater with EC levels of 86,900 µS/cm and 74,000 µS/cm (Moulds 2010) but this occurred in only two samples. Based on the saline conditions of groundwater at the site, species abundance and distribution are likely to be low.

9 DEWATERING ACTIVITIES – ADJACENT OPERATIONS

Currently the Project Site has no dewatering infrastructure, but such will be required as the project is developed. It is assumed that the site dewatering system will connect to the existing Tritton Resources Water Management System via the Girilambone North system during development and operation. As discussed in **Section 4**, the existing surface water management system used by Tritton Resources aims to segregate clean, dirty and contaminated runoff and the ATP system will do likewise.

Parsons Brinckerhoff (PB) (August 2011) was commissioned by Tritton Resources, to undertake a water balance assessment of the Tritton Copper Mines surface water management system and to prepare a surface water management plan (SWMP) incorporating improvements.

Based on discussions with the Applicant, PB established that the current pumping system was not automated, and as a result the actual pumping regime may differ from the modelled pumping rules used to create SWMP.

Groundwater intercepted by underground operations at the existing Tritton Mine workings is pumped to the surface and stored as a reticulation system. In the event of potential overflow pipework enables water to be sent to either the Tailings Storage Facility or drainage channels which enables waters to flow into the Tritton Containment Dam.

Information provided from the applicant indicated that the current groundwater make for the Tritton Mine was 111.138 ML per annum, based on the overall average of monthly measurements and estimates. This calculated average groundwater pumping rate from the Tritton Mine equates to approximately 3.524 L per second.

PB concluded that the general water cycle of the system at the Girilambone Copper Mine is as follows.

Hartmans Pit:

- Has a local catchment area of 15.3 ha.
- Supplies water for mining operations at Girilambone North.
- When Hartmans Pit sump volume is less than approximately 10 ML, water from North East Pit and Larsens Pit is pumped in to meet demands.
- Pumping to Hartmans Pit ceases when Hartmans Pit sump volume exceeds 10 ML.
- When Hartmans Pit sump volume exceeds 146 ML as a result of local rainfall-runoff, Hartmans Pit is dewatered to Larsens Pit.
- Results indicate that total dissolved solids, sulphate, chloride, cadmium, cobalt, copper and nickel all exceeded the guideline limit for the relevant criteria and therefore cannot be considered suitable for reuse involving stock or irrigation.

North East Pit:

- Has a local catchment of 8.6 ha.
- Completed to depths of approximately 80 to 126mbgl.
- Annual groundwater make is 87 ML/yr.
- Is generally maintained at less than 10 ML. If Hartmans Pit calls for water, North East Pit pumps to Hartmans Pit if it has water available.
- When the volume of North East Pit exceeds 10 ML, North East Pit is dewatered to Larsens Pit.
- Water stored in North East Pit is reused for mining operations at North Murrawombie.
- The pH is stable ranging between 7 – 8 pH units. EC was also shown to have a stable trend, ranging between 14,000 and 27,000µS/cm.

Larsens Pit:

- Has a local catchment of 11.7 ha.
- Receives water dewatered from Hartmans Pit and North East Pit during wet periods, as well as overflows from sediment dams SB1 and SB2.
- Also receives groundwater make (17 ML/yr), and runoff from the local catchment.

- Water is pumped from Larsens Pit to supply mining operations at North Murrawombie during dry periods when Hartmans Pit sump has inadequate water to meet demands.
- The only other outflow from Larsens Pit is evaporation.
- The bund around Larsens Pit has a local catchment of 39.1 ha.

Murrawombie:

Groundwater make to Larsens and North East declines (some 64 ML/year) is pumped to Hartmans Pit for reuse onsite at Girilambone North, or to Larsens Pit for storage.

Tritton Resources has advised that 64 ML/yr is required at Hartmans Pit to supply underground mining operations at Girilambone North. This water is sourced from groundwater dewatering from Larsens and North East declines.

Currently there is no potable water use at the Project Site or Girilambone North sites, however potable water is trucked to Tritton Mine complex and is utilised in the administration and amenities buildings. Wastewater is treated in onsite septic systems and effluent is reused onsite. Tritton Resources has advised that the potable water demand is 13.8 ML/yr. Tritton Resources currently has a zero discharge policy for dirty and contaminated water, (PB, August 2011).

In the Straits Tritton Dec 2011 - *Annual Environmental Management Report*, the North East piezometers recorded stable groundwater levels. Piezometers located in close proximity to dewatering activities of the northern pits showed an expected groundwater sink. However, piezometers surrounding the North East pits do not appear to be affected by adjacent mining activities with the exception of GNR012 (located equidistant at approximately 180m from Hartmans and North East Pits). Drawdown in this piezometer was affected by operational dewatering at Hartmans pit and was expected to resume on cessation of dewatering activities.

OTEK (2012) confirmed this forming the opinion “it appears that the North East Pit mining operations has had little to no impact on shallow groundwater quality in the vicinity of the pits. The measured contaminants of potential concern (COPC) values in all wells generally correspond to background concentrations and pH is consistently around neutral. It appears that the lateral extent of dissolved COPCs in the shallow aquifer around the North East Pits has been delineated to show no impact”.

10 CONSTRAINTS

There are no identified environmental constraints relating to groundwater in the vicinity of the Avoca Tank development site.

The local groundwater occurs in:

a) Alluvium associated with creek lines and would not be affected by mine activities; and
b) In bedrock fracture systems at depth, which are too saline for beneficial use.

Bores within the area are either owned by Straits Tritton and used for monitoring of mine activities, or are screened in shallow alluvium which would not be affected by changes to the

groundwater system in bedrock at depth, and used for stock watering. There is a marginal potential for the use of groundwater for stock watering (sheep).

No springs or groundwater outflow zones were identified in the vicinity of the Project Site.

No groundwater dependent ecosystems are identified in the vicinity of the Project Site.

10.1 NEAREST WATER SUPPLY WORKS

The nearest groundwater water supply bore (GW026890), which is registered for stock purposes is located approximately 8.5km southeast of the proposed ATP Site. Based on the drilling logs, this bore is screened within an unconsolidated formation and not screened within the fractured rock formation the Avoca Tank Mine will intercept, and it will therefore not be affected by the proposed mine. The nearest water supply bore (GW002970), which is registered for stock purposes and within fractured rock, is located approximately 15km to the east of the ATP Site.

10.2 NEAREST GROUNDWATER DEPENDENT ECOSYSTEM

Based on a review of **Appendix 3** - Map of High Priority GDEs of the WSP for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012), there are no high priority GDEs within at least 150km of the site (including springs, geothermal springs, wetlands and karst) associated with the fractured rock groundwater source). The nearest high priority GDE (spring or geothermal spring) within the NSW Murray-Darling Basin Fractured Rock Groundwater Sources is located approximately 150km to the west of the site.

11 PROPOSED PROJECT SITE DEVELOPMENT

ES understands that the proposed mine excavation development would comprise the following:

- Construction and use of a boxcut and underground portal with a maximum depth of approximately 30m and would require extraction of approximately 200,000 bank cubic metres (bcm) of waste rock; and
- Extraction of the economically recoverable resources to a depth of approximately 500m below ground level using underground long hole open stope mining techniques.

Based on a review of the Avoca Tank Preliminary Mining Schedule, following the initial 30m box cut ES' understanding of the indicative mine construction schedule is listed in **Table 11-1** below.

Table 11-1: Proposed Schedule of Mine Construction

Month of Completion	Base Depth of Mine Development
6 (183 days)	100m
15 (458 days)	200m
27 (824 days)	300m
42 (1281 days)	400m
63 (1922 days)	~500m

12 RELEVANT LEGISLATION, REGULATION AND POLICY FOR GROUNDWATER

12.1 INTRODUCTION

To facilitate the proposed mine development, in relation to impacts of groundwater resources, the following statutory requirements need to be achieved in order to address the NSW Office of Water DGR (provided in full in **Appendix C**).

There are two key pieces of legislation and regulation that control the use and development of land in NSW:

- *Environmental Planning and Assessment Act (1979)* (EP&A Act); and
- *Environmental Planning and Assessment Regulation (2000)* (EP&A Reg).

There are two key parts of legislation for the management of groundwater in NSW:

- *Water Act (1912)*; and
- *Water Management Act 2000* (WMA 2000).

In addition to the above Acts, the relevant plans, policies and regulation are considered the main tools which assist in implementing and defining the provisions of the WMA:

- The Water Management (General) Regulation (2011);
- Water Sharing Plans:
    - Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012);
    - Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012):
        - Lower Bogan River Water Source (2012);
- The NSW State Groundwater Dependent Ecosystem Policy (2002);
- The *NSW Aquifer Interference Policy 2012* (September 2012);
- The NSW Groundwater Policy Framework Document – General (1997);
- The NSW Groundwater Quality Protection Policy (1998);
- The NSW State Rivers and Estuaries Policy (1993); and
- The NSW Wetlands Policy (2010)

A detailed discussion of the regulatory framework as it applies to the project site is presented in **Appendix D** and should be read to provide complete context. Brief summaries and aspects of the regulatory environment directly relating to the ATP are discussed in the sections below.

12.2 WATER MANAGEMENT ACT (2000)

The Water Management Act (2000) – the WMA – is comprehensive water legislation to guide water management activities. The objectives of the WMA were the sustainable and integrated management of the state's water for the benefit of both present and future generations. Under the WMA, the ATP will entail aquifer interference activities as groundwater bearing zones will be intercepted during the proposed works.

A person who is engaged in an aquifer interference activity in connection with the mining or extraction of any material is exempt from section 91A (1) of the Act in relation to the using of water from an aquifer if the water is used in accordance with an aquifer interference approval with respect to that activity.

Aquifer interference approval from the NSW Office of Water will therefore be required for the ATP.

12.3 WATER SHARING PLANS

WSPs are being progressively developed for rivers and groundwater systems across NSW following the introduction of the WMA. Water Sharing Plans made under the WMA are being prepared as Minister's plans under Section 50 of the Act. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

WSPs provide a legislative basis for sharing water between the environment and consumptive purposes. Under the WMA, a plan for the sharing of water must protect each water source and its dependent ecosystems and must protect basic landholder rights.

The Project Site is located within the following WSPs:

- Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012) – *Lachlan Fold Belt MDB Groundwater Source*; and
- Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012) – *Lower Bogan River Water Source.*

The DGR relating to the WSP was to demonstrate how the mining proposal is consistent with the relevant access and trading rules of the WSP. Accordingly, groundwater abstraction licences for the ATP will need to be consistent the WSP for the Lachlan Fold Belt MDB Groundwater Source (see Section 12.5.1).

12.3.1 Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012) – Lachlan Fold Belt MDB Groundwater Source

The NSW Murray-Darling Basin (MDB) fractured rock groundwater sources are located within the NSW portion of the MDB (as detailed in **Section 7.2**).

The Lachlan Fold Belt MDB Groundwater Source covers an area of 16,722,000 hectares. The Project Site is located within the western portion of the Lachlan Fold Belt MDB Groundwater Source which consists of fractured rock aquifer with a low to moderate level of connection between surface and groundwater.

The long-term average annual extraction limit (LTAAEL) for the Lachlan Fold Belt MDB Groundwater Source, which determines the amount of groundwater that can be potentially made available for annual extraction, is 821,250ML per year. Trading of water is permitted within the Lachlan Fold Belt MDB Groundwater Source zone.

Based on a review of **Appendix 3** Map of High Priority GDEs of the WSP for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012), there are no high priority GDEs

within at least 150km of the site (including springs, geothermal springs, wetlands and karst) associated with the fractured rock groundwater source.

12.3.2 Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012)

The Project Site is located within the boundary of the WSP for the Macquarie-Bogan Unregulated and Alluvial Water Sources, however, is not located within the alluvial groundwater source zones (Cudgegong Alluvial, Talbragar Alluvial, Bell Alluvial or the Upper Macquarie Alluvial).

No GDEs have been identified for the four alluvial groundwater sources included in the Macquarie-Bogan Unregulated and Alluvial Water Sources WSP.

The proposed mine is situated within a fractured rock aquifer, with low to moderate level of connection between surface and groundwater and is not within the listed alluvial groundwater source zones specified in the WSP. The potential groundwater impact of the proposed mine is not relevant to this WSP.

12.4 NSW STATE GROUNDWATER DEPENDENT ECOSYSTEMS POLICY (2002)

Base on the DGRs from the NSW Office of Water, the potential impacts to Groundwater Dependent Ecosystems (GDEs) must be considered.

As demonstrated in **Section 8.3 and 10.2** of this report no high priority GDEs are apparent in the vicinity of the site (within 150km).

12.5 NSW AQUIFER INTERFERENCE POLICY (2012)

The purpose of the *NSW Aquifer Interference Policy 2012* is to explain the role and requirements of the Minister administering the WMA in the water licensing and assessment processes for aquifer interference activities under the WMA and other relevant legislative frameworks. The *NSW Aquifer Interference Policy 2012*:

1. clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation; and
2. establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

The ATP activities will result in aquifer interference under the NSW Aquifer Interference Policy (2012) as groundwater will be removed from at least one aquifer. Accordingly, groundwater licencing will be required (see Section 12.5.1 below).

12.5.1 Licensing of Water Taken Through Aquifer Interference

A water licence is required under the WMA (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source; or
- the movement of water from one part of an aquifer to another part of an aquifer; or

- the movement of water from one water source to another water source, such as:
  - from an aquifer to an adjacent aquifer; or
  - from an aquifer to a river/lake; or
  - from a river/lake to an aquifer.

A licence for the removal of water from a water source will be required for the ATP.

12.5.2 Aquifer Impact Assessment

The WMA includes the concept of ensuring "no more than minimal harm" for both the granting of water access licences and the granting of aquifer interference approvals. Aquifer interference approvals are not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates.

Whilst aquifer interference approvals are not required to be granted, the minimal harm test under the WMA is not activated for the assessment of impacts. Therefore, this Policy establishes and objectively defines minimal impact considerations as they relate to water-dependent assets and these considerations will be used as the basis for providing advice to the Minister.

Within the WMA, *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities* are categorised into type of groundwater sources and are presented in **Table 12-1** below:

Table 12-1: Highly and Less Productive Groundwater Source Types

Highly Productive	Less Productive

• Alluvial;
• Coastal Sands;
• Porous Rock;
  ○ Great Artesian Basin - Eastern Recharge and Southern Recharge;
  ○ Great Artesian Basin – Surat, Warrego and Central;
  ○ other porous rock; and
• Fractured Rock.
	• Alluvial;
	• Porous Rock; and
	• Fractured Rock.

The proposed mine development is considered to be located in a Less Productive groundwater source type due to the elevated TDS (>1,500mg/L) and low yield (based on the known sustainable discharge rates reported during the pumping test at Girilambone mine site (ES, June 2013).

In addition to the requirements listed in *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities* (refer to **Table 2, Appendix D**), the following issues also require consideration:

- acidity issues to arise, for example exposure of acid sulphate soils (unlikely at the ATP); and

- waterlogging or water table rise to occur, which could potentially affect land use, groundwater dependent ecosystems and other aquifer interference activities. Specific limits will be determined on a case-by-case basis, depending on the sensitivity of the surrounding land and groundwater dependent ecosystems to waterlogging and other aquifer interference activities to water intrusion.

The second dot point will apply to licencing of groundwater make from the ATP.

12.5.3 Requirements for Aquifer Impact Assessment

A risk management approach to assessing the potential impacts of aquifer interference activities was adopted, where the level of detail required to be provided by the proponent is proportional to a combination of the likelihood of impacts occurring on water sources, users and dependent ecosystems and the potential consequences of these impacts.

As defined under the WMA, the proposed development is located within a confined fractured rock aquifer system, which does not have a 'water table' and the piezometric surface represents 'water pressure' rather than the level at which water will be encountered during excavation or drilling. As such, assuming negligible connectivity with overlying unconsolidated formations, ES consider that only groundwater pressure and groundwater quality minimal impact considerations apply for the proposed Avoca Tank Mine development.

13 GROUNDWATER INFLOW AND DRAWDOWN IMPACTS

The measured standing water level in the three groundwater bores (GW805056, GW805057 and GW805058) within the proposed footprint of the mine ranged from 31.04m to 39.97m bgl, with an average level of 35.65m bgl (refer to **Table 5-1**, **Section 5.2**).

The drilling logs indicated that the shallowest water bearing zone was encountered between 29m bgl (GW805056) and 47m bgl (GW805056) and extended to the depth of drilling (generally 1m below water bearing zone). The existence of water bearing fracture zones below the depth of 66m is unknown.

When water bearing fractured zones are encountered in the walls and/or base of the mine, the piezometric head would need to be lowered to allow excavation of the mine to proceed. Assuming the average standing water level 35.65m bgl is representative of the piezometric head in the vicinity of the mine, the head would have to be lowered to the base of the water bearing fractured zone or in absence of known fractured zones the base of the mine, which would require 464.35m of drawdown assuming continuous water bearing strata to the base of mine. Note that this is a highly conservative assumption and that discrete and discontinuous water bearing zones are more likely.

13.1 CONCEPTUAL MODEL

It is necessary to establish a conceptual understanding of the processes that would take place in the proposed mine in order to assess potential dewatering requirements and associated potential drawdown impacts to groundwater.

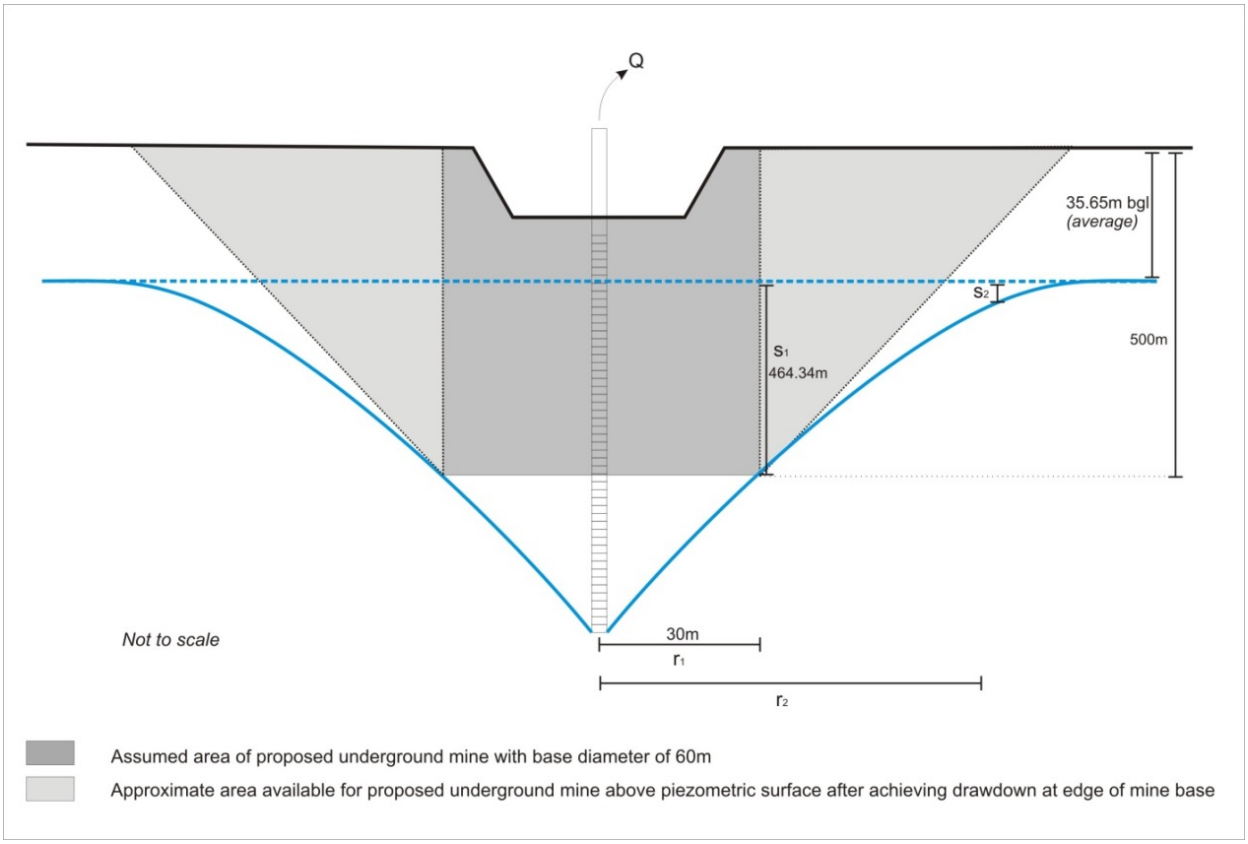
To quantitatively estimate the volume of water of groundwater inflow that would need to be removed from the mine to completely dewater it and predict drawdown surrounding the mine, a

theoretical dewatering bore is located in the centre of the mine development. The cone of depression resulting after pumping (or groundwater inflow) was required to be below the assumed depth (500m bgl) and width (radius of 30m) of the proposed mine development to achieve effective dewatering. The radius was selected based on advice from the Applicant reflecting the proposed mine dimensions.

Based on the proposed development requirements listed in **Section 11**, the estimated lateral extent of the interpreted edge of mineralisation during the initial exploration works documented in a media release (Straits, April 2012) and approximate current mine development lateral extent at Tritton Mine, for the purposes of this assessment, ES have assumed that the proposed mine extends to 500m below ground level (bgl) and with a basal footprint of 0.28ha (assuming a circular area between the three groundwater investigation boreholes, which has a diameter of 60m). This assumed area of the proposed Avoca mine has a maximum underground diameter of 60m with the radius at the base of the mine (r_1) excavation assumed to be 30m. A conceptual diagram of the proposed mine development is provided in **Figure 11** below.

Transient numerical modelling was completed as the mine excavation works are proposed to be completed on a staged schedule, which is listed in **Table 11-1.**

Figure 11: Groundwater Conceptual Model for Quantitative Assessment of Groundwater Inflow and Drawdown



13.1.1 Groundwater Inflow

The amount of groundwater inflow will depend on the depth of the mine, the storage of water in the adjacent fractured rock aquifer, and the transmissivity of the surrounding fractured rock. Based on the results of aquifer testing within fractured rock at nearby Girilambone Mine site

(ES, June 2013) significant volumes (>1ML/day) of groundwater are unlikely to seep into the mine. Information provided from Tritton Mine Resources indicated that the current groundwater make and subsequent discharge rate for the Tritton Mine was calculated to be 0.304ML/day (3.524L/second) which correlates with the aquifer testing results described above.

If groundwater bearing strata was encountered, the most significant seepage would come from localised fractures with potentially limited interconnectivity and storage capacity.

The formation is considered to become more massive with depth, with fractured zones likely to decrease in frequency with depth. The hydraulic conductivity is likely to decrease with depth, particularly in the zone of the ore body.

Considering that the frequency, thickness and depth of water bearing fractured zones below 66m is unknown, a conservative assumption that the water bearing fractured zones are vertically interconnected and extend to the base of the mine, with a water bearing fracture zone thickness of 1m every 100m in mine depth (totalling a saturated thickness of 5m) has been made to approximate homogenous aquifer conditions.

13.1.2 Rainfall

Surface features of the Avoca Tank mine would be constructed in a manner which directs surface water (from rainfall) away from the proposed box cut and mine. This is important to maintain stability in the walls of the box cut. As such, rain inputs to the mine inflow would be restricted to rain that falls directly within the bounds of the box cut. Only some of the rain that falls within the box cut would drain to the base of the box cut and negligible amounts within the mine itself. A large portion of rainfall is likely to evaporate either on the walls or from small pools that may accumulate on the berms. The amount of rain water that reaches the bottom of the proposed box cut would depend primarily on the intensity and duration of the rainfall event, and the amount of evaporation occurring. For example, a large proportion of rain that falls in a low intensity short duration event would stick to the walls and berms of the proposed box cut and would not flow to the base of the proposed box cut. Rain that falls in a long duration, high intensity events has much greater chance of being able to flow to the base of the proposed box cut.

As such, groundwater inflow calculated within this report does not include errant stormwater and reflects only groundwater drawn from the aquifer.

13.1.3 Evaporation

Evaporation is considered to be negligible at the majority of groundwater encountered would be during the underground mine excavation works.

13.1.4 Excavation

If saturated rock is encountered within the mine, some water will be removed with the waste rock and ore, but the amount is considered to be negligible and ignored in this assessment as groundwater is expected to be confined within secondary porosity.

13.2 QUALITATIVE ASSESSMENT OF GROUNDWATER INFLOWS

Based on the results of pumping test data (**Section 13.3.1**) and known groundwater inflows from nearby mines targeting similar deposits within the same formation, ES understand that it is unlikely that significant volumes of groundwater will enter the proposed mine.

ES understand that the proposed ATP Site is comparable in both size and setting to the Applicants surrounding operations. The proposed Avoca Tank mine is located approximately 2.5km north of the North Girilambone Mine Site. Groundwater make estimates have been provided by the Applicant (reported by PB, April 2011), for the three current Tritton Resource mine sites, and are provided in **Table 13-1** below. More recent information provided from the applicant indicated that the average groundwater make for the Tritton Mine was measured at 111ML/yr (which is within one order of magnitude of the estimated groundwater make of 52ML/yr). This calculated average groundwater pumping rate from the Tritton Mine equates to approximately 3.524 L per second.

Table 13-1: Groundwater Make Estimates (for life of mine)

Site	Mine	Annual Groundwater Make (ML/yr)
Girilambone North Mine	Larsons Pit	17
	North East Pit	87
Girilambone Mine	Murrawombie Pit	130
Tritton Mine	Tritton Mine	52 (111)*

*Annual groundwater make based on monthly measurements provided by the Applicant

Based on the measured groundwater make at Tritton Mine (111ML/yr) and estimated groundwater inflow volumes at the two other Tritton Resource mine sites, Girilambone North Mine (104ML/yr) and Girilambone Mine (130ML/yr), a similar volume of groundwater make is expected at the proposed ATP mine.

ES have performed the following quantitative groundwater assessment (**Section 13.3 below**) using aquifer parameters from the fractured rock formation, derived from a pumping test conducted at nearby Girilambone Copper Mine. These values are considered representative of the formation encountered at ATP as site specific measurements has not yet been concluded.

13.3 QUANTITATIVE ASSESSMENT OF GROUNDWATER INFLOWS AND DRAWDOWN

Both Steady State numerical modelling and Time-Variant modelling was conducted to estimate groundwater inflows and predict drawdown as a results of the proposed mine excavation and groundwater abstraction.

The following equations were used to estimate the groundwater inflows and predict drawdown:

- Theis Equation (1935) – Unsteady-state Flow
- Cooper-Jacob Equation (1946) – Unsteady-state Flow (modified Theis Equation)
- Thiem Equation (1906) – Steady State Flow

13.3.1 Aquifer Parameters

In the absence of site specific data, parameters used in the quantitative modelling for the fractured bedrock aquifer adopted from the Girilambone Pumping Test Report (ES, June 2013), are listed in **Table 13-2** below. A range of values were reported, which are represented by Value 1 and Value 2, solutions matched to close and distant observation wells respectively.

Table 13-2: Fractured Rock Aquifer Parameters

Parameter	Value 1	Value 2
Hydraulic Conductivity (m/day)	0.483	0.781
Specific Storage	4.563×10^{-6}	1.565×10^{-6}

The *storativity* (S) of a confined aquifer (or aquitard) is defined as the volume of water released from storage per unit surface area of a confined aquifer (or aquitard) per unit decline in hydraulic head. Storativity is also known by the terms coefficient of storage and storage coefficient.

In a confined aquifer (or aquitard), storativity is defined as:

$$S = S_s b$$

where S_s is the *Specific Storage* and b is aquifer (or aquitard) thickness. Specific storage is the volume of water that a unit volume of aquifer (or aquitard) releases from storage under a unit decline in head by the expansion of water and compression of the soil or rock skeleton. It is therefore a measure of the water holding capacity of the aquifer.

Transmissivity is the product of the average hydraulic conductivity K and the saturated thickness of the aquifer (D). Consequently, transmissivity is the rate of flow under a unit hydraulic gradient through a cross-section of unit width over the whole saturated thickness of the aquifer. The transmissivity defined as:

$$T = Kb$$

where K is the hydraulic conductivity and b is the aquifer thickness.

Based on a saturated aquifer thickness (combined water bearing fracture zone thickness to the base of the mine at 500m) assumed to be 5m (based on the assumed aquifer thickness of 1m per 100m depth), the transmissivity and storativity values were estimated and are listed in **Table 13-3**.

Table 13-3: Estimated Aquifer Parameters

Parameter	Value 1	Value 2
Transmissivity (m^2/day)	2.415	3.905
Storativity	2.2815×10^{-5}	7.825×10^{-6}

13.3.2 Assumptions and Limitations of Quantitative Assessment Methodology

The analytical assessments of groundwater inflows and predicted drawdown presented **Section 13.3.3**, **Section 13.3.4** and **Section 13.3.5** rely on the assumptions outlined below.

It is assumed that water bearing strata will have a uniform transmissivity and storativity, based on the ranges determined from a pumping test at Girilambone (ES, June 2013) which are provided in **Section 13.3.1** above. The intermittent nature of water bearing zones likely to be encountered within the fractured rock formations indicates that the impacted aquifer is not homogenous and infinite. As such, the transmissivity and storage of water bearing zones below the depth of the investigation at Girilambone is unknown.

The assumptions and conditions underlying the quantitative methods in the following sections are:

- The saturated thickness of the aquifer (combined water bearing fracture zone thickness to the base of the mine) was assumed to be 5m (1m metre of saturated thickness for every 100m in depth);
- That the fractured water bearing zone extents to the base of the mine (500m);
- The aquifer is confined;
- The aquifer has a seemingly infinite areal extent;
- The aquifer is a homogenous, isotropic and of uniform thickness over the area influenced by the dewatering;
- Prior to pumping, the piezometric surface is horizontal over the area that will influenced by the dewatering;
- The aquifer is pumped at a constant discharge rate; and
- The well penetrated the entire thickness of the aquifer and thus receives water by horizontal flow;

The analytical methods used to assess potential groundwater inflows ignore the points raised in the qualitative assessment of the aquifer testing data and are therefore considered to be very conservative, and representative of worst case scenarios (maximum dewatering requirements) based on the assumed mine dimensions.

13.3.3 Theis Equation

The Theis equation was used to estimate the flux of groundwater (Q) that would be required to be removed from the mine excavation to completely dewater the assumed void based on the proposed schedule of works plan (transient, unsteady state flow model). Based on the estimated groundwater flux (Q) required to dewater the excavation, the expected drawdown was then determined at different distances from the mine to determine the potential impact to nearby receptors.

In addition to the assumptions listed in **Section 13.3.2** above, the following limiting conditions also apply:

- The water removed from storage is discharged instantaneously with decline of head;
- The diameter of the well is small, i.e. the storage in the well can be neglected; and
- The flow to the well is in unsteady state, i.e. the drawdown differences with time are not negligible, nor is the hydraulic gradient constant with time.

The Theis Equation used to estimate the groundwater inflow and predict drawdown is presented below:

$$s = \frac{Q}{4\pi T} W(u)$$

$$u = \frac{r^2 S}{4Tt}$$

Where:

Q= m^3/day

s= drawdown (m)

T= transmissivity (m^2/day)

W= Theis well function

r= radius (m)

S= storativity (dimensionless)

t= time (days)

13.3.3.1 Groundwater Inflow – Dewater Mine Void

The estimated groundwater inflow volumes are presented in **Table 13-4** below.

The initial piezometric level (average of 3 bores) used in the model was 35.65m, with a mine base radius (r_1) of 30m. The groundwater inflow was calculated at the expected schedule milestone depths as indicated by Tritton Resources.

Table 13-4: Estimated Groundwater Inflow Volumes using Theis Equation.

Mine Excavation Schedule Months	Depth of Mine Excavation (m)	Required Depth of Drawdown (m) at r_1	Estimated Groundwater Inflow (ML/day)	
			T=2.415 S=2.2815x10^{-5}	T=3.905 S=7.825x10^{-6}
6 (183 days)	100	64.35	0.18	0.26
15 (458 days)	200	164.35	0.43	0.61
27 (824 days)	300	264.35	0.65	0.94
42 (1281 days)	400	364.35	0.87	1.26
63 (1922 days)	500	464.35	1.07 (12.4L/s)	1.55 (18L/s)

Based on the above, the estimated groundwater inflow ranged between 1.07ML/day (392ML/yr) and 1.55ML/day (567ML/yr). ES note that the estimated groundwater inflow values are based on limited site specific data and conservative assumptions which result in the overestimation of groundwater inflows. Actual groundwater inflows are likely to be lower than those predicted above, which are likely to be in the order of the measured groundwater make at Tritton Mine (111ML/yr) and estimated groundwater inflow volumes at the two other Tritton Resource mines, Girilambone North Mine (104ML/yr) and Girilambone Mine (130ML/yr). These volumes are within one order of magnitude of the conservative estimate presented here.

13.3.3.2 Drawdown Extent

The piezometric drawdown extent predicted using the Theis equation, based on the maximum estimated groundwater inflow volumes determined in **Section 13.3.3.2**, and the qualitative groundwater make calculated from the Tritton Mine are presented in **Table 13-5** below.

Table 13-5: Predicted Drawdown at 63 months of Mine Operation using Theis Equation.

Distance From Mine Centre (km)	Drawdown at 63 Months			
	T=2.415 S=2.2815x10^{-5}		T=3.905 S=7.825x10^{-6}	
	Q=1.07 ML/day (12.4L/s)	Q=0.304 ML/day (3.524L/s)*	Q=1.55 ML/day (18L/s)	Q=0.304 ML/day (3.524L/s)*
0.5	265	75	287	56
1	217	61	243	48
2	168	48	199	39
4	119	34	156	30
8	72	20	112	22
16	31	9	70	14
32	5	1.5	31	6.2
35	3.5	<1	27	5.3
43	1.2	-	18	3.6
44.5	<1	-	17	3.4
56	-	-	9.5	1.9
67.6	-	-	5.1	<1
94.5	-	-	<1	-

*Qualitative average groundwater make calculation from the Tritton Mine.

Based on the above, the estimated maximum groundwater drawdown extent (considered to be negligible where drawdown is <1m) ranged between approximately 35km and 94.5km. ES note that the numerical models assumes infinite lateral continuity, however, the fractured rock aquifer located at the site is likely to be highly heterogeneous and laterally discontinuous. As such, the actual drawdown extent resulting from the proposed mine is likely to be less than that that predicted above, limited to the lateral extent of the interconnected fractured water bearing zones.

13.3.4 Cooper-Jacob Equation

The Cooper-Jacob Equation, which is based on the Theis formula, was used to estimate the flux of groundwater (Q) that would be required to be removed from the mine excavation to completely dewater the assumed void based on the proposed schedule of works plan (transient, unsteady state flow model). Based on the estimated groundwater flux (Q) required to dewater the excavation, the expected drawdown was then determined at different distances from the mine to determine the potential impact to nearby receptors.

In addition to the assumptions listed in **Section 13.3.2** above, the following limiting conditions also apply:

- The flow to the well is in unsteady state;
- The values of u are small (u<0.01) i.e. r is small and t is sufficiently large.

- The water removed from storage is discharged instantaneously with decline of head;
- The diameter of the well is small, i.e. the storage in the well can be neglected; and

The condition that u will be small in confined aquifer is usually satisfied at moderate distances from the well within an hour or less.

The Cooper-Jacob Equation used to estimate the groundwater inflow and predict drawdown is presented below:

$$s = \frac{2.3Q}{4\pi T} log \frac{2.25Tt}{r^2 S}$$

Q= m^3/day

s= drawdown (m)

T= transmissivity (m^2/day)

r= radius (m)

S= storativity (dimensionless)

t= time (days)

13.3.4.1 Groundwater Inflow – Dewater Mine Void

The estimated groundwater inflow volumes are pretend in **Table 13-6** below.

The initial piezometric level (average of 3 bores) used in the model was 35.65m, with a mine base radius (r_1) of 30m. The groundwater inflow was calculated at the expected schedule milestone depths as indicated by Tritton Resources.

Table 13-6: Estimated Groundwater Inflow Volumes using Cooper-Jacob Equation.

Mine Excavation Schedule Months	Depth of Mine Excavation (m)	Required Depth of Drawdown (m) at r_1	Estimated Groundwater Inflow (ML/day)	
			T=2.415 S=2.2815x10^{-5}	T=3.905 S=7.825x10^{-6}
6 (183 days)	100	64.35	0.18	0.26
15 (458 days)	200	164.35	0.43	0.61
27 (824 days)	300	264.35	0.65	0.94
42 (1281 days)	400	364.35	0.87	1.26
63 (1922 days)	500	464.35	1.07 (12.4L/s)	1.55 (18L/s)

Based on the above, the estimated groundwater inflow ranged between 1.07ML/day (392ML/yr) and 1.55ML/day (567ML/yr). These values match those estimated using the Theis equation, and are considered to be an overestimation of actual groundwater inflows likely to occur. Actual groundwater inflows are likely to be lower than those predicted above, which are likely to be in the order of the calculated groundwater make at Tritton Mine (111ML/yr) and estimated groundwater inflow volumes at the two other Tritton Resource mines, Girilambone

North Mine (107ML/yr) and Girilambone Mine (130ML/yr). These volumes are within one order of magnitude of the conservative estimate presented here.

13.3.4.2 Drawdown Extent

The piezometric drawdown extent predicted using the Theis equation, based on the maximum estimated groundwater inflow flux determined in **Section 13.3.3.2**, are presented in **Table 13-7** below.

Table 13-7: Predicted Drawdown at 63 months of Mine Operation using Cooper-Jacob Equation.

Distance From Mine Centre (km)	Drawdown at 63 Months (m)			
	T=2.415 S=2.2815x10^{-5}		T=3.905 S=7.825x10^{-6}	
	Q=1.07 ML/day (12.4L/s)	Q=0.304 ML/day (3.524L/s)*	Q=1.55 ML/day (18L/s)	Q=0.304 ML/day (3.524L/s)*
0.5	265	75	286	56
1	217	61	243	48
2	168	48	199	39
4	119	34	155	30
8	70	20	111	22
15	25	7	67	14
20.4	3.4	<1	56	10
21.1	<1	-	50	9.8
32	-	-	24	4.6
42.9	-	-	5	<1
45.8	-	-	<1	-

Based on the above, the estimated maximum groundwater drawdown (to <1m) extent ranged between approximately 20.4km and 45.8km. ES note that the predicted drawdown assumes infinite lateral continuity, however, the fractured rock aquifer located at the site is likely to be highly heterogeneous and laterally discontinuous. As such, the actual drawdown extent resulting from the proposed mine is likely to be less than that that predicted above.

13.3.5 Thiem's Equation (1906)

The Thiem equation was used to determine the maximum drawdown distance based on the estimated groundwater inflow volumes (Q) determined in **Section 13.3.3** and **Section 13.3.4**. The Thiem equation is based on the assumptions listed in **Section 13.3.2** and also assumes that the flow to the well is in steady state.

$$Q = \frac{2\pi T(s_1 - s_2)}{2.3Log(r_2/r_1)}$$

Q= m^3/day

s= drawdown (m)

T= transmissivity (m^2/day)

r= radius (m)

S= storativity (dimensionless)

t= time (days)

Based on Theis and Cooper-Jacob estimates for groundwater inflows ranging between 1.07 and 1.55ML/day after 63 months of construction, the maximum extent of drawdown was predicted and presented in **Table 13-8** below.

Table 13-8: Predicted Maximum Drawdown Distance at Maximum Estimated Groundwater Inflow Rates.

Aquifer Assumptions	Groundwater Inflow (ML/day)	Maximum Drawdown Distance (<1m) from Centre of Mine (km)
T=2.415	1.073	21.1
T=3.905	1.552	45.7

The above maximum drawdown values are similar to those calculated using the Cooper-Jacob equation. ES note that the predicted drawdown assumes infinite lateral continuity, however, the fractured rock aquifer located at the site is likely to be highly heterogeneous and laterally discontinuous. As such, the actual drawdown extent resulting from the proposed mine is likely to be less than that that predicted above.

14 POTENTIAL IMPACTS ON GROUNDWATER QUALITY

ES understand Tritton Resources would comply with all relevant industry guidelines to ensure the potential for degradation of groundwater quality at the Mine Site is minimised.

The proposed Avoca Tank mine has potential to be a 'short circuit' for potential contaminants to enter the subsurface and any underlying aquifers.

If groundwater bearing strata are encountered within the ATP mine there is potential for groundwater chemistry to change as the hydraulic head is lowered below the top of the water bearing zone within the proposed mine and rock become exposed to the atmosphere. These potential impacts to groundwater quality are assessed in the following sections.

14.1 POTENTIAL CHEMICAL IMPACTS

The main potential source of groundwater contamination within the proposed underground workings would be the spill of fuel or other hazardous substances. ES understand that the Applicant proposes to use a dedicated fuel store and refuelling bay at the ATP site (refer to **Figure 2.4**).

Refuelling for more mobile equipment should be undertaken in designated bunded areas above ground. Refuelling of less mobile equipment should be undertaken at the work site by a dedicated service vehicle. Spill kits should be kept on site to mitigate any spills from machinery

working within the box cut. Spill response procedures would be documented in an Environmental Management Plan for the site.

The proposed underground workings and proposed mine infrastructure such as the waste rock emplacement, leachate management ponds and mine water pond also pose some potential risk to groundwater quality. There is potential that chemicals from these sources may migrate through the soil profile into the underlying groundwater system, however, ES understands that the infrastructure will be constructed to regulatory standards to minimise and mitigate potential groundwater contamination. Routine groundwater monitoring would be required to identify any potential impacts to groundwater throughout the construction, operation and post closure of the ATP mine. ES recommends that a groundwater management plan be prepared for the commencement of mining at ATP Site. The plan should address the need for groundwater level and quality monitoring between the proposed mine and the potential groundwater receptors. The plan should also outline measures that would be put in place to prevent and/or manage and potential contamination issues such as chemical spills within the mine. The plan should also outline post mining measures that would be undertaken to prevent ongoing impacts to groundwater levels and/or groundwater quality.

14.2 POTENTIAL GEOCHEMICAL IMPACTS

The potential acid generating material (sulfidic ores) is likely to be located within or in close proximity to the ore body. Most of the potentially acid generating material will be removed from the mine such that the rock forming the walls of the mine should be mostly free of acid generating material. In addition, groundwater levels would have to be lowered before oxidation would occur. In this situation the local groundwater gradient would be towards the open cut, so potential for any groundwater impacts to reach sensitive receptors is low.

If oxidation of sulphur rich rock causes any loss of groundwater quality the potential impacts could be mitigated by covering the sulphur rich rock with a clay cover and/or water.

15 CONCLUSIONS

Based on the current measured groundwater inflow at the nearby Tritton Mine site (111ML/yr) and the estimated groundwater inflow volumes at two (2) other nearby mines sites (Girilambone North Mine and Girilambone Mine), which target the same mineralisation and are of similar scale in size, the groundwater inflows expected at the proposed ATP Mine are likely to be in the range of 104ML/yr to 130ML/yr.

Quantitative numerical modelling was undertaken to estimate groundwater inflow volumes and predict drawdown at the proposed ATP Mine. The quantitative modelling has estimated groundwater inflow volumes of between 392ML/yr to 567ML/yr, and maximum extent of drawdown (to <1m) between 20.4km and 94.5km from the mine centre.

Given the inherent constraints with the quantitative modelling, such as the conservative model assumptions of infinite lateral extent of water bearing fractures and homogenous, isotropic and of uniform thickness, together with limited site data of unknown vertical extent of water bearing zones, frequency and thickness of water bearing zones, the estimated groundwater inflows and drawdown extents are considered to overestimate actual conditions. Without the collection of further site specific groundwater data and additional modelling of increased complexity, ES consider that the most likely groundwater inflow volumes should be estimated from the current known groundwater inflow volumes at the nearby mine sites. As such, the most likely groundwater take volume is estimated to be 111ML/yr, the average known groundwater inflow from the nearby Tritton Mine site.

In addition to the above, given that the fractured rock aquifer is unlikely to be laterally continuous with limited vertical connectivity, the predicted drawdown extent of between 20.4km and 94.5km from the centre of the mine using the estimated maximum groundwater inflow is considered overestimate actual drawdown extent. As such, ES consider that the most likely maximum extent of drawdown to <1m will be less than 20.4km (the estimated minimum drawndown extent) from the ATP mine centre.

Based on the above conclusions and the inherent limitations of the quantitative assessment, the most likely estimate of groundwater inflow volumes and maximum drawdown extent (<1m) are presented in **Table 15-1** below.

Table 15-1: Most Likely Groundwater Inflow and Drawdown Extent

Most Likely Groundwater Take (ML/yr)	Most Likely Extent of Drawdown (<1m) from Mine Centre (km)
111*	20.4**

* based on qualitative assessment
** based on quantitative assessment using Cooper-Jacob method with qualitative inflow rate of 3.52L/s.

ES consider that groundwater licences for 111ML/yr be obtained from the Lachlan Fold Belt MDB Groundwater Source, located within the NSW Murray-Darling Basin Fractured Rock Groundwater Sources, for the proposed Avoca Mine development. Routine monitoring of groundwater discharge rates from the mine should be undertaken during construction and if the actual measured groundwater take volumes digress from the estimated groundwater inflows above, the volume of groundwater licences should be amended to reflect actual groundwater take.

All proposed groundwater works, including bores for the purpose of investigation, extraction, dewatering, testing or monitoring must be identified and an approval obtained from the NSW Office of Water prior to their installation. This applies to any groundwater monitoring wells that are required to be installed as part of the groundwater management plan.

Based on the findings of the quantitative assessment in comparison to the *NSW Aquifer Interference Policy 2012* (September 2012) NSW *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities*, the following conclusion are made:

1. **Water Pressure (Drawdown)**: The nearest groundwater water supply bore (GW026890), which is registered for stock purposes, is located approximately 8.5km southeast of the proposed ATP Mine. Based on the drilling logs, this bore is screened within an unconsolidated formation and not screened within the fractured rock formation the ATP Mine will intercept, and it will therefore not be effected by the proposed mine. The nearest water supply bore (GW002970), which is registered for stock purposes and within fractured rock, is located approximately 15km to the east. The estimated drawdown at this location, based on the Cooper-Jacob method with inflow rates of 3.524L/s, was 20.4m of drawdown in pressure head. Considering that the bore extends to a depth of 61.3m with the top of water bearing zone encountered at 21.3 it is assumed that there is 40m of available head for pumping. Whilst the estimated drawdown exceeds the minimal impact consideration of 2m of drawdown, based on the above, sufficient available head 19.6m will likely to be available for its intended use if 20.4m of drawdown would occur.
   Furthermore, considering that the estimated drawdown from the model was considered to overestimate the actual drawdown likely to occur as the fractured water bearing zone is likely to be discontinuous and limited in lateral extent, ES consider that the drawdown at this nearest water supply bore will be less than the estimated 20.4m. As such, ES consider that the proposed ATP Mine is unlikely to result in more than minimal impact to groundwater pressure and not to adversely affect any water supply bores.

2. **Water Quality**: The proposed Avoca Tank Mine is unlikely to lower the current beneficial use of the groundwater which is currently considered marginal use for stock watering, though is more likely to be unsuitable for any stock purpose. Based on a review of **Appendix 3** Map of High Priority GDEs of the WSP for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012), there are no high priority GDEs within at least 150km of the site (including springs, geothermal springs, wetlands and karst) associated with the fractured rock groundwater source. There is likely to be minimal impact on groundwater quality to the deep fractured rock aquifer at the proposed ATP mine as it is unlikely to be vulnerable to contamination as there would be a groundwater pressure gradient toward the void during and after the mine closure. This would result in groundwater flow toward the void. If any contamination does occur within the mine void, it is unlikely to migrate from the mine site.
   Considering that the maximum predicted drawdown extent (<1m) was between 20.4km and 94.5km, the proposed ATP Mine is unlikely to result in an impact to groundwater quality or groundwater availability to potential receptors including GDEs.

16 RECOMMENDATIONS

16.1 GROUNDWATER ABSTRACTION LICENCES

ES recommends that groundwater licences should be obtained to allow for the abstraction of 111ML/yr of groundwater from the NSW Murray-Darling Basin Fractured Rock Groundwater Sources – Lachlan Fold Belt MDB Groundwater Source. Groundwater allocations must be obtained from within the Lachlan Fold Belt MDB Groundwater Source.

16.2 GROUNDWATER MONITORING

Routine continuous monitoring and recording of groundwater discharge rates from the mine should be undertaken during construction and if the actual measured groundwater take volumes digress from the estimated groundwater inflows above, the volume of groundwater licences should be adjusted to reflect actual groundwater take.

16.3 GROUNDWATER MANAGEMENT

ES recommends that a groundwater management plan be prepared for the commencement of mining at the ATP Site. The plan should address the need for groundwater level and quality monitoring between the proposed mine and the potential groundwater receptors. The plan should also outline measures that would be put in place to prevent and/or manage and potential contamination issues such as chemical spills within the mine. The plan should also outline post mining measures that would be undertaken to prevent ongoing impacts to groundwater levels and/or groundwater quality.

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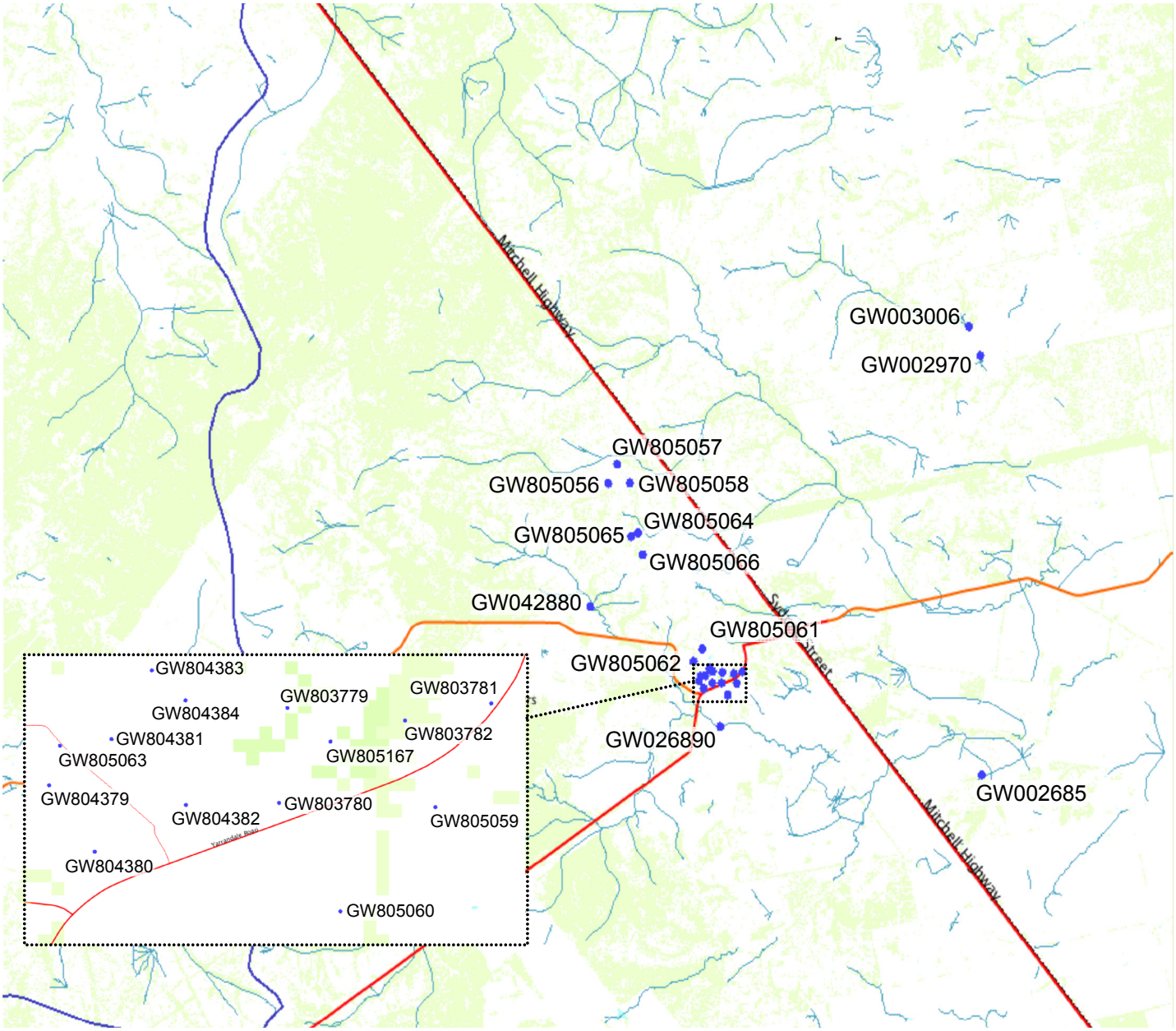
APPENDIX A – SUPPORTING DOCUMENTATION

REGISTERED BORE LOCATIONS

Groundwater Impact Assessment

Avoca Tank Groundwater Assessment

FIGURE 1



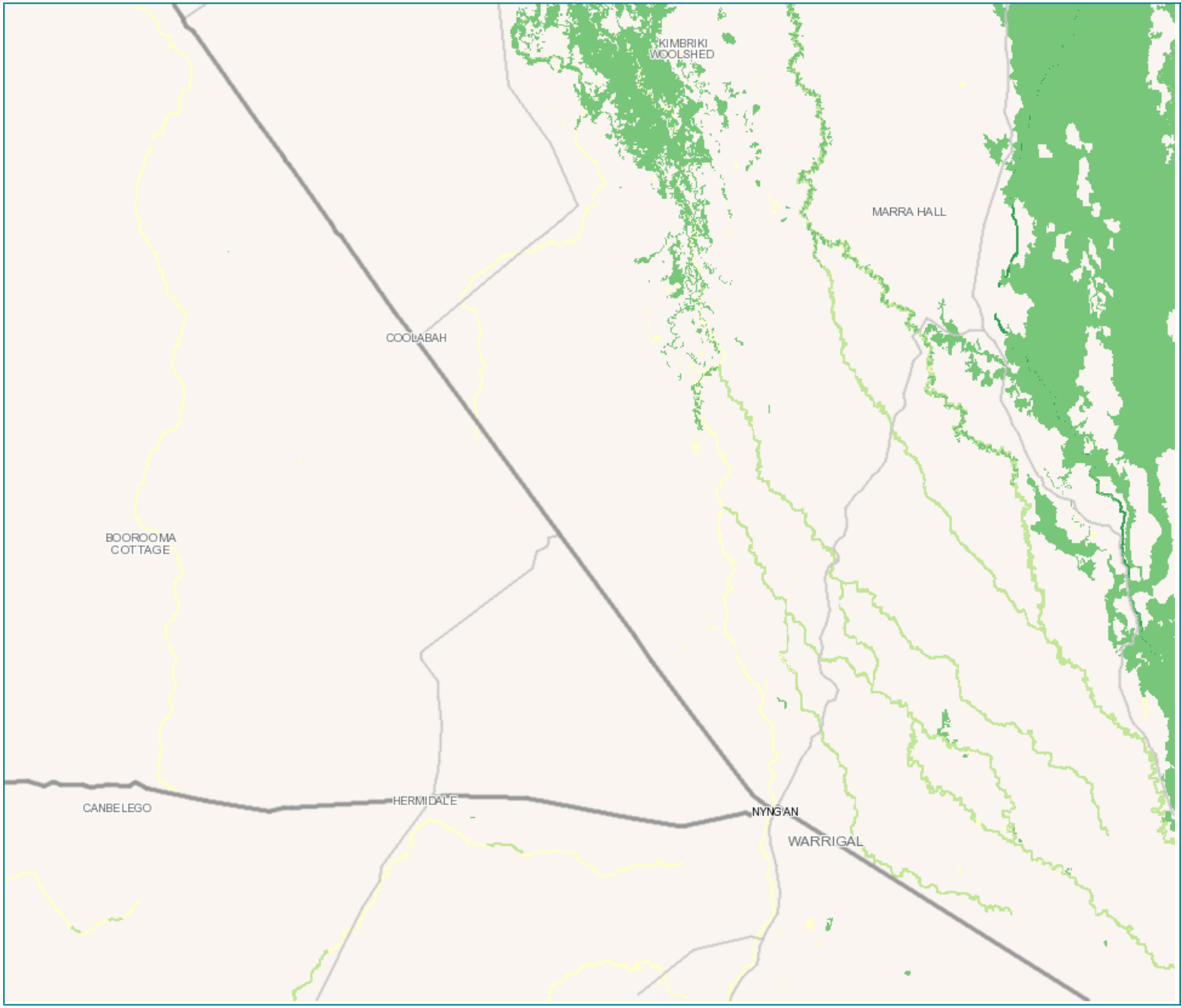
0km 5km 10km 15km 20km 25km 30km 35km 40km

KEY

- Registered Groundwater Bore

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystem Map Report



Girilambone

GDE, Reliant on surface expression of groundwater (rivers, springs, wetlands)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction

GDE, Reliant on subsurface groundwater (vegetation)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction
- No Ecosystems analysed

GDE, Subterranean (Cave & Aquifers)

- Identified in previous study: fieldwork
- Identified in previous study: desktop
- No Ecosystems analysed

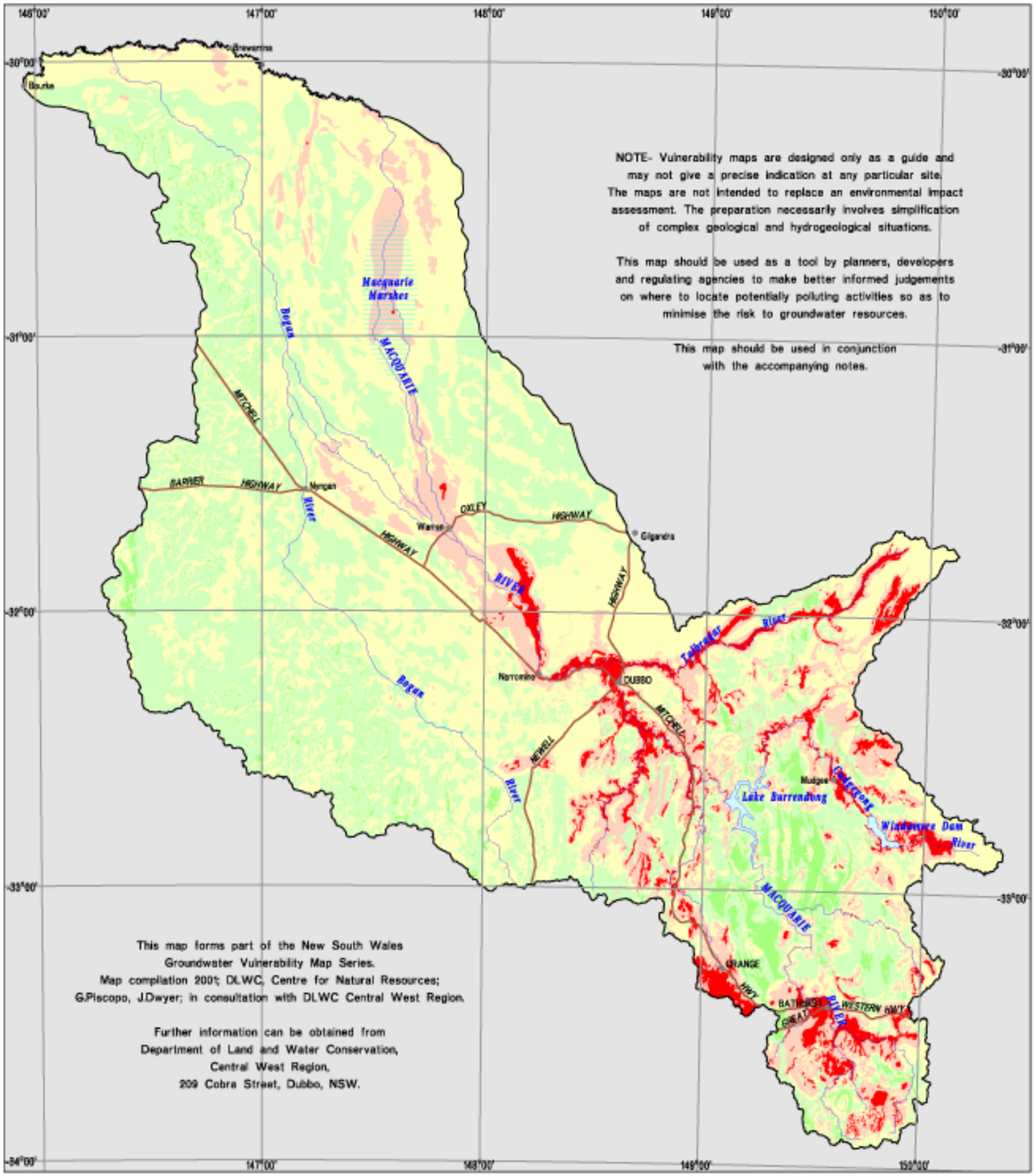
1:844,563

Metres 20,000 40,000 60,000

Data source - Data are assumed to be correct as supplied from Commonwealth, State and Territory data suppliers or referenced projects.

Date: 24 October, 2013

GO TO NOTES



LAND & WATER CONSERVATION

GROUNDWATER VULNERABILITY

MACQUARIE CATCHMENT

MAP LOCALITY

VULNERABILITY RATING

- Low
- Low moderate
- Moderate
- Moderately high
- High

SCALE

20 0 20 40 60 80 100

kilometres

Universal Transverse Mercator Projection

GO TO MAP

LAND & WATER CONSERVATION

Groundwater vulnerability map explanatory notes

Macquarie Catchment

NSW Department of Land and Water Conservation

Groundwater vulnerability map explanatory notes

Macquarie Catchment

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1. Introduction

The Macquarie Catchment Groundwater Vulnerability Map has been produced as part of the implementation of the *Water Management Act 2000,* introduced in an effort to achieve more sustainable water use. The ultimate aim, as part of this implementation, is to complete vulnerability and availability mapping for the whole State of NSW.

There are a variety of uses of the groundwater resources within the catchment, ranging from stock and domestic use to irrigation, town water supply, mining and industrial use, as well as environmental and recreational uses.

Groundwater vulnerability mapping has proven to be a technique in assisting the development of groundwater protection strategies as outlined in the *1995 Guidelines for Groundwater Protection in Australia* (ARMCANZ and ANZECC). These guidelines are part of the National Water Quality Management Strategy.

Groundwater vulnerability mapping is used as a guide in determining which areas are more susceptible to groundwater contamination within the mapped area.

It should be noted that groundwater vulnerability maps are accurate to the scale at which they are produced. The Department of Land and Water Conservation (DLWC) does not endorse the expansion of this scale.

The preparation of groundwater vulnerability maps involves the simplification of complex geologic and hydrogeologic situations. It is therefore important to take into account local site conditions when assessing a particular development. Vulnerability maps are designed only as a guide and are not intended to replace an environmental impact assessment.

GEOGRAPHIC SETTING

The Macquarie Catchment is located in the central northern portion of NSW and encompasses approximately 67,000 square kilometres. It is bordered by the Castlereagh Catchment to the north, the Lachlan Catchment to the south, and the Darling Catchment to the west. The Macquarie Catchment contains two main river courses, the Macquarie River and the Bogan River. These two rivers generally run parallel to each other, with the Bogan located southwest of the Macquarie. These rivers have numerous creeks crossing from one to the other distributing flows. The major tributaries joining the Macquarie in the upper reaches include, the Talbragar River near Dunedoo, Cudgegong River near Mudgee, Turon River near Bathurst, and the Bell and Little Rivers near Wellington.

Major townships encompassed by the Macquarie Catchment include, Bathurst, Mudgee, Orange, Wellington, Dubbo, Warren, Nyngan, and Brewarrina.

The majority of groundwater usage in the Macquarie Catchment is for irrigation purposes. This water is typically abstracted from the alluvial aquifers that are predominant over much of the western portion of the catchment. The presence of this alluvium has resulted in the topography being of very low gradients. The fractured rocks of the Lachlan Fold Belt control the topography east of Narromine, and, as a result, some of this terrain is steep and mountainous.

Rainfall within the Catchment varies from moderately high (around 950 mm/yr) in the east along the Great Dividing Range, to low (<350 mm/yr) in the northwest around Bourke. In general, the climate is

one of cool, moderately wet to dry winters, and hot, dry to very dry summers. This gives an indication of how important the use of groundwater is to the region.

2. Groundwater vulnerability maps

WHY DO WE NEED THEM?

Pressure for the development of the concept of groundwater vulnerability has been generated by the worldwide concern about the problems of groundwater contamination. Groundwater quality issues are receiving widespread attention, and hydrogeologic information is essential for the effective protection and management of groundwater quality. Effective protection should be primarily aimed at the prevention of problems and requires a sound information base to determine, on a continuous basis, the groundwater quality problems that exist and those that may develop in the future.

Groundwater vulnerability maps are used as a guide for the location of future developments in an area, in order to minimise the impact the projected development will have on the surrounding water resources.

The *Draft Guidelines for Groundwater Protection* (AWRC, 1992) states that the 'amount of protection to be afforded an aquifer should be commensurate with both the risk the aquifer is under and the value that the community places on the aquifer'. It should be remembered that, as groundwaters are often linked to surface waters, they too are also indirectly protected by the appropriate siting and management of potentially polluting industry.

GROUNDWATER VULNERABILITY MAPPING

Almost all groundwater resources are vulnerable to various degrees. Vulnerability of groundwater is a relative, dimensionless property that is not directly measurable. It is assessed by using the DRASTIC technique, explained in detail in these notes. The accuracy of its assessment depends, above all, on the amount and quality of representative and reliable data available. The required data is often not available and thus scale of mapping is often limited to broad scale catchment maps.

The fundamental concept of groundwater vulnerability is that some land areas are more vulnerable to groundwater contamination than others. The ultimate goal of the vulnerability map is the subdivision of an area into several units showing the differential potential for a specified purpose and use. Results of vulnerability assessment are portrayed on a map showing various homogeneous areas, sometimes called cells or polygons, which have different levels of vulnerability. Vulnerability maps show only the relative vulnerability of areas within the same map, and do not represent absolute values that can be compared between maps.

The original concept of groundwater vulnerability was based on the assumption that the physical environment may provide some degree of protection (*referred to as the barrier zone*) with regard to contaminants (*the threat*) entering the subsurface water (*groundwater resource*). The earth materials may act as natural filters to screen out some contaminants. Water infiltrating at the land surface may be contaminated but is naturally purified to some degree as it percolates through the soil and other fine grained materials in the unsaturated zone.

A groundwater vulnerability map has been developed for the Macquarie Catchment as part of the implementation of the *Water Management Act 2000*. This will provide the Department of Urban

Affairs and Planning (DUAP),the Catchment Management Board, the Councils of the Macquarie Catchment, and other regulating agencies with a regional tool using a Geographical Information System (GIS) for determining the suitability of various developments in the region in a spatial context. In order to achieve this, a number of spatial attributes need to be mapped, such as geology, depth to watertable, soil properties, slope and any other attribute considered relevant. These are then weighted, and ranked, and are combined to produce a final ranking value using the appropriate algorithm, which defines the groundwater vulnerability. The method used for creating the Macquarie Catchment groundwater vulnerability map is a modification of the DRASTIC approach, first devised by the US EPA.

The following section discusses the modified DRASTIC approach in relation to the Macquarie Catchment study.

VULNERABILITY MAPPING—AN ANALYSIS OF THE DRASTIC TECHNIQUE

The DRASTIC vulnerability mapping technique can generally be referred to as a composite description of all the major geologic and hydrogeologic factors that affect and control groundwater movement, into, through, and out of an area. Similar hydrogeologic parameters therefore produce similar vulnerability. It involves the overlaying of various hydrogeologic settings that are available at the time of the map's production, via a Geographical Information System (GIS).

Each hydrogeologic setting describes topography, soil type, bedrock type, estimate of rainfall and net recharge, depth to watertable (DTWT), aquifer yield, relative hydraulic conductivity (K) and any particular features associated with the setting that are available.

DRASTIC is an acronym for the most important mappable features within the hydrogeologic setting which control groundwater pollution.

These features are:

- D Depth to watertable
- R (Net) Recharge
- A Aquifer media
- S Soil media
- T Topography (slope)
- I Impact of Vadose Zone Media
- C Conductivity (Hydraulic) of Aquifer.

To assess groundwater pollution potential within hydrogeologic settings, numerical ranking is used on the DRASTIC features. There are 3 significant parts, Weights, Ranges, and Ratings.

Weights

Each DRASTIC feature is assigned a weight relative to each other in order of importance from 1–5; the most significant is allocated five, the least significant is allocated one.

The DRASTIC technique, by its inference, attempts to identify those features important in determining vulnerability of groundwater resources. However, each study area will need to be assessed as to the importance of each specific feature for its area. For example, topography is obviously more important in a mountainous area than in the flat plains country. Also, some features will be taken into consideration in the production of other features. For example, topography will influence the

production of a depth to watertable map in a fractured rock terrain, as well as represent itself in a topographic (slope) map.

Table 1. Assigned weights for DRASTIC features for the Macquarie Catchment

Feature	Weight
Depth to watertable	4
Net recharge	2
Aquifer media	5
Soil media	2
Topography	1
Impact of Vadose Zone media	5
Hydraulic conductivity of aquifer	Not used

Ranges

For each DRASTIC feature, ranges or significant media types for the feature's upper and lower limits within the catchment have been devised based on its impact on pollution potential.

Ratings

The ratings for each DRASTIC feature are assigned a value between 1 and 10. The rating enables the ranking of the ranges found in each DRASTIC feature map. These ratings provide a relative assessment between ranges in each feature.

The DRASTIC Index, that is the pollution potential (*vulnerability*) at any one cell or polygon on the map, is determined as:

Pollution Potential = DrDw + RrRw + ArAw + SrSw + TrTw + IrIw + CrCw
where r = rating and w = weight

The computed (*via GIS*) DRASTIC index identifies areas which are likely to be susceptible to groundwater contamination relative to one another. *The higher the DRASTIC index the greater the groundwater pollution potential.*

It must be remembered that the DRASTIC technique provides a relative evaluation tool and is not designed to provide absolute answers. It offers planners and developers a categorisation of areas, based on the level of site investigation expectation, when considering the groundwater resources for an area.

FEATURE DEFINITION

Depth to watertable

This is an important feature as it determines the depth of material through which a contaminant must travel before reaching the watertable. In general, attenuation capacity increases as the depth to water increases. This is due to the fact that deeper water levels result in a longer travel time, therefore residence time, for any potential contaminant. The presence of low permeability layers, which confine aquifers, will also limit the travel of contaminants into an aquifer. Where an aquifer is confined, depth

to water should be redefined as the depth to the top of the aquifer. For semi-confined aquifers a decision must be made as to whether it is more appropriate to consider the aquifer as unconfined or confined.

The Depth to Watertable (DTWT) feature, for the Macquarie Catchment, was created by combining actual DTWT data with topography as the principal surface aquifers are located in unconsolidated sediments and fractured aquifers, and are therefore considered to be unconfined. The groundwater is predominantly contained in the fractured and unconsolidated sediment aquifer system, which generally recharge locally. A depth to watertable map was constructed from the departmental records of standing water levels, with 5 metre contour intervals.

Recharge

Net Recharge represents the amount of water that penetrates the ground surface and reaches the watertable. This recharge water is available to transport a contaminant vertically to the watertable and horizontally within the aquifer. In addition, it controls the volume of water available for dispersion and dilution of the contaminant in the vadose and saturated zones. In general, the greater the recharge, the greater the potential for groundwater pollution.

The components incorporated in the recharge feature for the Macquarie Catchment were slope, rainfall and soil permeability. A more detailed breakdown of the factors employed, as well as the resulting equation and ratings are discussed in the range and ratings tables devised for the Catchment.

Aquifer media

Aquifer medium governs the route and path length (*groundwater flow system*), within the aquifer. The path length is important in determining the time available for attenuation processes, such as sorption, reactivity, and dispersion, to occur. The aquifer medium also influences the amount of effective surface area of materials with which the contaminant may come in contact within the aquifer. The route which a contaminant will take can be strongly influenced by fracturing, porosity, or by an interconnected series of openings which may provide preferential pathways for groundwater flow.

For the Macquarie Catchment, the aquifer media was defined by its geology. Geology has been grouped into 8 broad categories including, alluvium 1 and 2 (*unconsolidated sediments of varying permeabilities*), porous consolidated sediments (*sedimentary rocks*), limestone, volcanic (*Tertiary volcanics differentiated from other volcanic rocks due to their columnar nature*), plutonic/igneous 2 classes (*Carboniferous intrusions*, *Devonian to Ordovician aged intrusions*) and metasediments (*fractured Palaeozoic rocks including volcanics*).

Soil media

Soil has a significant impact on the amount of recharge which can infiltrate to the watertable, and hence on contaminant movement. The presence of fine-textured materials, such as silts and clays, can decrease relative soil permeability and restrict contaminant migration. Moreover, where the soil zone is thick, the attenuation processes of filtration, biodegradation, sorption, and volatilisation may be significant. Soil media can be described in terms of its textural classification and ranked in order of pollution potential.

For the Macquarie Catchment vulnerability map, a soil permeability map was produced using 1:250,000 soil landform information (MDBSIS, 1999). The map was compiled by approximating soil permeability for soil landforms in the Macquarie Catchment. A soil scientist from the CNR Cowra Research Station (Dr Brian Murphy) classified the soil landforms of the catchment into five classes.

This map was suitable to be used for the soil media vulnerability feature map, as well as a component map for the development of the impact of Vadose Zone map.

Topography

Topography is considered as the slope, and slope variability of the land surface. Topography helps to control pollutant run off or retention on the surface. Slopes that provide a greater opportunity for contaminants to infiltrate will be associated with higher groundwater pollution potential. Topography influences soil development and therefore has an effect on contaminant attenuation.

Slope percentages for the Macquarie Catchment were calculated using the Digital Elevation Model (DEM) data. Slope was then classified and ranked for use in the topography component map.

Impact of the Vadose Zone

The Vadose Zone refers to the zone above the watertable which is unsaturated or discontinuously saturated. The type of Vadose Zone media determines the attenuation characteristics of the material including the typical soil horizon and rock above the watertable. The media also controls the path length and routing, thus affecting the time available for attenuation and the quantity of material encountered. The routing is strongly influenced by any fracturing present.

The factors considered important in defining the impact of Vadose Zone in the Macquarie Catchment include soil permeability, and depth to watertable. A more detailed breakdown of the factors employed, as well as the resulting equation and ratings, are discussed in the range and rating tables devised for the Catchment.

Hydraulic conductivity

Hydraulic conductivity is defined as the ability of aquifer materials to transmit water, which in turn, controls the rate at which groundwater will flow under a given hydraulic gradient. The rate at which the groundwater flows, also controls the rate at which it enters the aquifer. Hydraulic conductivity is controlled by the amount and interconnection of void spaces within the aquifer that may occur as a consequence of intergranular porosity, fracturing and/or bedding planes.

For the purposes of the Macquarie Catchment groundwater vulnerability map, hydraulic conductivity has been incorporated into the soil media map in the form of soil permeability. The absence of spatially complete data for hydraulic conductivity has meant that this component of the map has been removed. The soil media component map has been classified into ranges where high permeability is associated with higher pollution potential and slow permeability is associated with lower pollution potential.

3. Range and rating tables for the Macquarie Catchment groundwater vulnerability map

Within the Macquarie Catchment, the features, which were deemed important in the development of the groundwater vulnerability map, included depth to watertable, recharge, aquifer media, soil media, topography, and impact of Vadose Zone.

Ranges and ratings for the DTWT, topography, and aquifer media are given in Tables 2, 3, and 4 respectively.

Table 2. Ranges and ratings for depth to watertable

Range (m)	Rating
< 5	10
5–10	8
10–15	6
15–20	4
>20	1
Weight 4	

Table 3. Ranges and ratings for topography

Range (slope %)	Rating
< 2	10
2–0	8
10–20	5
20–33	2
>33	1
Weight 1	

Table 4. Ranges and ratings for aquifer media

Range (geology type)	Rating
Alluvium 1	10
Alluvium 2	6
Porous Sedimentary	6
Limestone	9
Volcanic (Tertiary)	7
Igneous 1 (Carboniferous)	5
Igneous 2 (Palaezoic)	3
Metasediments	1
Weight 5	

The derivation of the Recharge, Vadose Zone Impact, and Soil Media maps is discussed in the following text.

RECHARGE

This feature is generated as a map, which is specific to the study area. The map is generated from an equation that incorporates available features, which are believed to be important to the recharge component of the study area. The equation calculates the ability of an area to act as a recharge zone relative to another area. The factors used to generate the recharge map for the Macquarie Catchment

include slope, soil permeability and rainfall. DTWT and aquifer media are considered to be minor contributors. However, as they are used as other component maps, they will not be used in the recharge map. Assigning relative permeability factors to the basic soil classification groups within the catchment has created the soil permeability map.

The following equation is used to generate a *recharge value*. This recharge value is then grouped into a range of values that are given a rating for use in the final DRASTIC calculation.

Recharge value = Slope % + Rainfall + Soil permeability
Where:

Slope

Range (%)	Factor
<2	4
2–10	3
10–33	2
> 33	1

Rainfall

Range (mm)	Factor
>850	4
700–850	3
500–700	2
<500	1

Soil permeability

Range	Factor
High	5
Mod-high	4
Moderate	3
Slow	2
Very slow	1

The maximum recharge value is: 13
The minimum recharge value is: 3
The rating table for recharge is shown in Table 5.

Table 5. Ranges and ratings for recharge

Range	Rating
11–13	10
9–11	8
7–9	5
5–7	3
3–5	1
Weight 2	

IMPACT OF VADOSE ZONE

As discussed previously this feature attempts to classify that zone of soil and regolith (*saprolite*) found above the watertable, known as the Vadose Zone, with regard to its ability to allow any potential contaminant to move to the aquifer. The Vadose Zone for the purposes of the Macquarie Catchment vulnerability map incorporates soil permeability and DTWT. The equation used incorporates the factors believed to be important to the Vadose Zone for the study area. The equation provides a *Vadose Zone Value* for a particular area that is defined by these factors, and is relative to another zone within the context of the study area. This *Vadose Zone Value* is then grouped into a range of values, which are given a rating for use in the final DRASTIC calculation.

Impact of Vadose Zone = Soil Permeability + DTWT
Where:

- Soil attenuation type is unavailable at the required scale, and it does not exist over the entire catchment. Hence soil permeability is used, and factored for its contribution to the Vadose Zone impact.
- Depth to watertable has previously been used, but it is factored for its contribution to the Vadose Zone impact.

Soil permeability

Range	Factor
High	5
Mod-high	4
Moderate	3
Slow	2
Very slow	1

Depth to watertable (m)

Range	Factor
< 5	5
5–10	4
10–15	3
15–20	2
>20	1

The maximum *Vadose Zone impact value* is: 10
The minimum *Vadose Zone impact value* is: 2
The ratings for *Vadose Zone impact* are displayed in Table 6.

Table 6. Ranges and ratings for Vadose Zone impact

Range	Rating
8–10	10
6–8	8
4–6	5
3–4	3
2–3	1
Weight 5	

SOIL MEDIA

The soils feature attempts to classify the unique soil of the study area with regard to its ability to allow any potential contaminant to move through this zone towards the aquifer. The soil media component map for the Macquarie Catchment was constructed using 1:250,000 soil landform data from the Murray Darling Basin Soil Information Strategy (MDBSIS, 1999). Soil landforms were assessed as to their likely saturated soil permeability for the dominant soil landform. These were then classified into one of the five classes listed as follows.

The ranges and ratings for soils have been classified as outlined in Table 7.

Table 7. Ranges and ratings for permeability in soil media

Range	Factor
High	10
Mod-high	8
Moderate	6
Slow	4
Very slow	1
Weight 2	1

4. Groundwater vulnerability classification in the Macquarie Catchment

Five classes of vulnerability ranking have been chosen to describe the relative assessment of the probability of a groundwater resource to contamination: '*low*', '*moderately low*', '*moderate',* '*moderately high*' and '*high*'. These classes are shown as distinct colours on the vulnerability map.

HIGH

High vulnerability ranked groundwater resources are predominantly found in the unconfined, shallow, highly permeable aquifers or highly fractured locally recharged basaltic and granite terrains. Quaternary alluvial aquifers in the upland river systems of the catchment are characterised by permeable soils and shallow depth to watertable. They include alluvial aquifers associated with the Macquarie River from Lake Burrendong down to Narromine, and extending some 60 km north towards Warren; and the alluvium of Talbragar and Cudgegong Rivers from the headwaters at Windamere Dam. The fractured rock terrains around Orange and Bathurst are also considered highly vulnerable due to relatively high recharge potential and shallow watertable.

MODERATELY HIGH

Moderately high vulnerability ranked groundwater resources are similarly characterised by mostly unconfined and shallow fractured groundwater systems in the upland part of the catchment. This vulnerability class is not limited to one geological group and in fact reflects the importance of depth to watertable and the Vadose Zone on groundwater vulnerability. Areas where these conditions occur include the meta-sedimentary terrains north of Orange and granite terrains around Bathurst, Mudgee, and the Macquarie River from Narromine down to and encompassing the Macquarie Marshes.

MODERATE

Moderate vulnerability areas are associated generally with moderate slopes, porous geology, watertable greater than 10 metres, and moderate recharge. This vulnerability class includes the Tertiary basaltic terrains upstream of Coolah as well as the Triassic and Jurassic sedimentary rocks of the Sydney and Great Artesian Basins (GAB intake beds). Although depth to water is relatively deep in the GAB intake beds, care should be taken when siting development in these areas due to the nature of the GAB's importance as a groundwater resource to the farming community. This area is considered very sensitive due to its recharge potential. A considerable part of the south of the basin is recharged from this area and thus development should be carefully considered for its pollution potential prior to consent being granted. Alluvium downstream of Dubbo with moderate to slow soil permeability and low rainfall also falls into this class.

LOW–MODERATE

Low–Moderate vulnerability is the dominant classification with the majority of the western part of the catchment falling into this category. Fractured Palaeozoic meta-sediments and the wide expanses of alluvium west of Narromine characterised by low rainfall, flat slopes and an often-deep watertable are in this class. The meta-sediments (including the Palaeozoic volcanics) in the upland part of the catchment also largely fall within this classification class due to a deeper watertable and steep slopes.

LOW

Low vulnerability ranked groundwater resources are generally characterised by a deep watertable, meta-sedimentary geology and very steep slopes (i.e. greater than 33% slope). These areas are limited to the upland part of the catchment upstream of Lake Burrendong.

LEVEL OF ASSESSMENT REQUIRED

Groundwater vulnerability maps do not consider the chemical nature of the pollutant in assessing vulnerability. They are concerned only with the hydrogeologic setting, which makes the groundwater susceptible to contamination from a surface source.

When a development application is being prepared, or considered, it is important that the impact of the development, on both surface and groundwater resources is assessed. It is important to know who uses these resources (beneficial use) and the current groundwater quality. Potentially polluting groundwater developments should not be allowed within highly vulnerable areas. Where such activities are proposed, significant engineering measures would be necessary to minimise the risks of pollution.

The following Table is a guide to the amount of groundwater assessment required for a development that requires consent in any of the five-aquifer vulnerability classes.

Table 8. Groundwater assessment for developments that require consent

Vulnerability classification	Groundwater assessment requirements
Low	Groundwater contamination assessment report A desk study is required to identify the concerns and potential risk to groundwater or the environment, and the need for any further action to be presented in the development application. A standard format hydrogeological report would most likely result.
Low-moderate	Site investigation with monitoring A potential risk is indicated by the vulnerability map requiring site investigation and groundwater monitoring. The extent of work should involve a limited amount of site investigation, soil and water sampling and testing, definition of flow systems and reporting, in addition to a desk study.
Moderate	Detailed site investigation and monitoring For moderate vulnerability areas, or where the previous levels of investigation indicate a demonstrated risk to groundwater, a detailed groundwater site investigation is required. The work should include an ongoing monitoring program, details on the protection design factors, (natural attenuation, physical barriers, etc) in addition to the previous levels of investigation.
Moderately high	Demonstrated groundwater protection system The risk to groundwater, as demonstrated by the vulnerability map, is an area in which contamination to groundwater cannot be tolerated. The work should include a desk study, detailed site investigation, and implementation of an on-going monitoring program, as indicated above. In addition, the protection design system incorporating natural attenuation, hydraulic barriers, physical barriers etc, needs to be demonstrated, to be effective. The proposal will need to include a feasibility plan for a clean-up, in addition to a detailed monitoring and ongoing assessment program.
High	Demonstrated remedial action plan/prohibition This classification identifies the area as having a potential risk so great as to warrant a demonstrated remedial action plan. The work should include a desk study, site investigations, ongoing monitoring, plus a demonstrated remedial action plan for clean-up, which analyses the effectiveness of the remediation approach in achieving designated water quality criteria. The financial capacity of the responsible party to enact the plan should also be evaluated. In the event that the risk to groundwater is unacceptable, an activity may be banned by the responsible authority.

Source: Modified from the Australian Water Resources Council (AWRC), *Draft Guidelines for Groundwater Protection*, (1992).

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APPENDIX B – REGISTERED GROUNDWATER BORE DETAILS

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 4, 2014

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW026890

Works Details (top)

GROUNDWATER NUMBER	GW026890
LIC-NUM	80WA709380
AUTHORISED-PURPOSES	STOCK
INTENDED-PURPOSES	STOCK
WORK-TYPE	Bore
WORK-STATUS	(Unknown)
CONSTRUCTION-METHOD	(Unknown)
OWNER-TYPE	Private
COMMENCE-DATE	
COMPLETION-DATE	1966-01-01
FINAL-DEPTH (metres)	27.40
DRILLED-DEPTH (metres)	27.40
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	FERNDALE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	(Unknown)
NORTHING	6539593.00
EASTING	488295.00
LATITUDE	31 16' 40"
LONGITUDE	146 52' 37"
GS-MAP	0037D2
AMG-ZONE	55
COORD-SOURCE	GD.,ACC.MAP
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	1

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	1

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
22.30	22.90	0.60	Unconsolidated	9.10		0.16			Over 14000 ppm
26.10	27.50	1.40	Unconsolidated	9.10		0.16			Over 14000 ppm

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	0.85	0.85	Loam Red Sandy		
0.85	3.35	2.50	Clay Red Gravel		
3.35	7.16	3.81	Gravel Hard Bands		
7.16	9.30	2.14	Clay Yellow		
9.30	13.72	4.42	Rock Yellow		
13.72	22.25	8.53	Clay		
22.25	22.86	0.61	Sand Coarse Water Supply		
22.86	26.06	3.20	Clay		
26.06	27.43	1.37	Sand Coarse Water Supply		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW042880

Works Details (top)

GROUNDWATER NUMBER	GW042880
LIC-NUM	80BL106391
AUTHORISED-PURPOSES	MINING
INTENDED-PURPOSES	INDUSTRIAL
WORK-TYPE	Bore
WORK-STATUS	(Unknown)
CONSTRUCTION-METHOD	Rotary Air
OWNER-TYPE	Private
COMMENCE-DATE	
COMPLETION-DATE	1975-10-01
FINAL-DEPTH (metres)	62.00
DRILLED-DEPTH (metres)	62.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	N/A
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	(Unknown)
NORTHING	6543836.00
EASTING	483793.00
LATITUDE	31 14' 22"

LONGITUDE	146 49' 47"
GS-MAP	0037D1
AMG-ZONE	55
COORD-SOURCE	GD.,ACC.MAP
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	108

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	108

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1	1	Casing	Threaded Steel	-0.30	40.70	152			Suspended in Clamps
1	1	Opening	Slots - Vertical	35.00	41.00	152		1	SL: 0mm; A: 8mm

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
22.00	62.00	40.00	Fractured	18.00					Salty

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	6.00	6.00	Soil Clayey Quartz Veined Schist Very Weathered Chloritic		
6.00	8.00	2.00	Schist Weathered Chloritic Quartz Veined		
8.00	10.00	2.00	Schist Weathered Chloritic Quartz Veined		
10.00	14.00	4.00	Schist Weathered Chloritic Quartz Veined		
14.00	16.00	2.00	Schist Weathered Chloritic Chloritic Quartz Veined		
16.00	22.00	6.00	Schist Weathered Chloritic Quartz Veined		

22.00	40.00	18.00	Schist Weathered Chloritic Water Supply Quartz Veined
40.00	48.00	8.00	Schist Chloritic Water Supply Quartz Veined Fresh
48.00	62.00	14.00	Schist Chloritic Water Supply Quartz Veined

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Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW803779

Works Details (top)

GROUNDWATER NUMBER	GW803779
LIC-NUM	80BL245099
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rotary Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2008-09-25
FINAL-DEPTH (metres)	40.00
DRILLED-DEPTH (metres)	40.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE COPPER MINE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	11.00
SALINITY	
YIELD	1.00

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541519.00
EASTING	488373.00
LATITUDE	31 15' 38"

LONGITUDE	146 52' 40"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	21 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	3.00	200			Rotary Air
1		Hole	Hole	3.00	40.00	120			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 9	0.00	25.00	80	74		Glued; Seated on Bottom; End cap
1	1	Opening	Slots - Diagonal	25.00	40.00	80			PVC Class 9; Sawn; SL: 150mm; A: 2mm; Glued
1		Annulus	Crushed Aggregate	0.00	9.00	120	80		
1		Annulus	Bentonite	9.00	10.00	120	80		
1		Annulus	Waterworn/Rounded	10.00	40.00	120	80		Graded; GS: 5-7mm

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
26.00	28.00	2.00		11.00		1.00		1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	2.00	2.00	Fill, backfill		
2.00	40.00	38.00	Sandstone, weathered		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW803780

Works Details (top)

GROUNDWATER NUMBER	GW803780
LIC-NUM	80BL245100
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rotary Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2008-09-24
FINAL-DEPTH (metres)	40.00
DRILLED-DEPTH (metres)	40.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE COPPER MINE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	10.60
SALINITY	
YIELD	0.10

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541148.00
EASTING	488345.00
LATITUDE	31 15' 50"

LONGITUDE	146 52' 39"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	21//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	3.00	200			Rotary Air
1		Hole	Hole	3.00	40.00	120			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 9	0.00	25.00	80	74		Glued; Seated on Bottom; End cap
1	1	Opening	Slots - Diagonal	25.00	40.00	80			PVC Class 9; Sawn; SL: 150mm; A: 2mm; Glued
1		Annulus	Crushed Aggregate	0.00	9.00	120	80		
1		Annulus	Bentonite	9.00	10.00	120	80		
1		Annulus	Waterworn/Rounded	10.00	40.00	120	80		Graded; GS: 5-7mm

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
31.00	32.00	1.00		10.60		0.10		1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Clay, red		
1.00	2.00	1.00	Gravel, red		
2.00	40.00	38.00	Sandstone, weathered		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW803781

Works Details (top)

GROUNDWATER NUMBER	GW803781
LIC-NUM	80BL245098
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rotary Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2008-09-27
FINAL-DEPTH (metres)	40.00
DRILLED-DEPTH (metres)	40.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE COPPER MINE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	39.00
SALINITY	
YIELD	0.01

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541537.00
EASTING	489056.00
LATITUDE	31 15' 37"

LONGITUDE	146 53' 6"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	Rd Adj 22//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	3.00	200			Rotary Air
1		Hole	Hole	3.00	40.00	120			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 9	0.00	25.00	80	74		Glued; Seated on Bottom; End cap
1	1	Opening	Slots - Diagonal	25.00	40.00	80			PVC Class 9; Sawn; SL: 150mm; A: 2mm; Glued
1		Annulus	Crushed Aggregate	0.00	9.00	120	80		
1		Annulus	Bentonite	9.00	10.00	120	80		
1		Annulus	Waterworn/Rounded	10.00	40.00	120	80		Graded; GS: 5-7mm

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
39.00	40.00	1.00		39.00		0.01		1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Clay, red		
1.00	40.00	39.00	Sandstone, weathered		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW803782

Works Details (top)

GROUNDWATER NUMBER	GW803782
LIC-NUM	80BL245097
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rotary Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2008-09-26
FINAL-DEPTH (metres)	40.00
DRILLED-DEPTH (metres)	40.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE COPPER MINE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	8.00
SALINITY	
YIELD	0.10

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541470.00
EASTING	488767.00
LATITUDE	31 15' 39"
LONGITUDE	146 52' 55"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	3.00	200			Rotary Air
1		Hole	Hole	3.00	40.00	120			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 9	0.00	25.00	80	74		Glued; Seated on Bottom; End cap
1	1	Opening	Slots - Diagonal	25.00	40.00	80			PVC Class 9; Sawn; SL: 150mm; A: 2mm; Glued
1		Annulus	Crushed Aggregate	0.00	9.00	120	80		
1		Annulus	Bentonite	9.00	10.00	120	80		
1		Annulus	Waterworn/Rounded	10.00	40.00	120	80		Graded; GS: 5-7mm

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
28.00	29.00	1.00		8.00		0.10		1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Clay, red		
1.00	40.00	39.00	Sandstone, weathered		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804379

Works Details (top)

GROUNDWATER NUMBER	GW804379
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-11
FINAL-DEPTH (metres)	61.00
DRILLED-DEPTH (metres)	61.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541216.00
EASTING	487574.00
LATITUDE	31 15' 48"

LONGITUDE	146 52' 10"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	1//822426

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	61.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	61.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	43.00	61.00	89			PVC Class 12; Casing - Drilled Holes; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	61.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	30.00	40.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
47.00	52.00	5.00							

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Colluvium		
1.00	52.00	51.00	Schist, highly oxidised, with minor quartz throughout, high quartz 21-38m, water @ 47m		
52.00	61.00	9.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804380

Works Details (top)

GROUNDWATER NUMBER	GW804380
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-11
FINAL-DEPTH (metres)	61.00
DRILLED-DEPTH (metres)	61.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	870.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6540957.00
EASTING	487727.00
LATITUDE	31 15' 56"

LONGITUDE	146 52' 16"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	21//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	61.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	61.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	43.00	61.00	89			PVC Class 12; Casing - Drilled Holes; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	61.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	30.00	40.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
55.00	57.00	2.00							870.00

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	2.00	2.00	Colluvium		
2.00	57.00	55.00	Schist, oxidised & minor quartz, high quartz 8-9m, 11-13m, 27, 31-33m, 36m, 38m, 41, 44-48m, 50, 52-53m, 55m		
57.00	61.00	4.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804381

Works Details (top)

GROUNDWATER NUMBER	GW804381
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-12
FINAL-DEPTH (metres)	52.00
DRILLED-DEPTH (metres)	52.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	10000.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541396.00
EASTING	487783.00
LATITUDE	31 15' 42"

LONGITUDE	146 52' 18"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	2/3/986

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	52.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	52.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	29.00	52.00	89			PVC Class 12; Casing - Hand Sawn Slot; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	52.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	20.00	25.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
34.00	47.00	13.00							

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Colluvium		
1.00	47.00	46.00	Schist, oxidised & minor quartz, high quartz @9m, 11-12m, 19m, 33m & water at 34m		
47.00	52.00	5.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804382

Works Details (top)

GROUNDWATER NUMBER	GW804382
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-13
FINAL-DEPTH (metres)	52.00
DRILLED-DEPTH (metres)	52.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	9170.00
YIELD	1.50

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541140.00
EASTING	488033.00
LATITUDE	31 15' 50"

LONGITUDE	146 52' 27"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	21//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	52.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	52.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	28.00	52.00	89			PVC Class 12; Casing - Hand Sawn Slot; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	52.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	20.00	25.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
34.00	47.00	13.00				1.50			9170.00

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Colluvium		
1.00	47.00	46.00	Schist, oxidised, & minor quartz, high quartz @ 16m & 33m, water # 34m		
47.00	52.00	5.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804383

Works Details (top)

GROUNDWATER NUMBER	GW804383
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-13
FINAL-DEPTH (metres)	40.00
DRILLED-DEPTH (metres)	40.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	6220.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541665.00
EASTING	487918.00
LATITUDE	31 15' 33"

LONGITUDE	146 52' 23"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	7/5/986

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	40.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	40.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	22.00	40.00	89			PVC Class 12; Casing - Hand Sawn Slot; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	40.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	15.00	20.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
25.00	33.00	8.00							6220.00

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Colluvium		
1.00	8.00	7.00	Sandstone, oxidised & minor quartz, high quartz @ 5m, 7m & 8m,		
8.00	33.00	25.00	Schist, oxidised, high quartz @ 9, 11, 14, 18, 20, 21, 28 & 33m, water @ 25m		
33.00	40.00	7.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW804384

Works Details (top)

GROUNDWATER NUMBER	GW804384
LIC-NUM	80BL245970
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Rot. Rev. Circ. Air
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2010-08-13
FINAL-DEPTH (metres)	43.00
DRILLED-DEPTH (metres)	43.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	
SALINITY	9160.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541548.00
EASTING	488031.00
LATITUDE	31 15' 37"

LONGITUDE	146 52' 27"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	6/10/986

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	43.00	125			Rot. Rev. Circ. Air
1	1	Casing	PVC Class 12	0.00	43.00	89	79		Screwed and Glued; Driven into Hole; Seated on Bottom; End cap
1	1	Opening	Slots - Horizontal	25.00	43.00	89			PVC Class 12; Casing - Hand Sawn Slot; SL: 70mm; A: 1mm; Screwed and Glued
1		Annulus	Waterworn/Rounded	0.00	43.00	125	89		Graded; GS: 3.2-6.4mm
1		Annulus	Bentonite	15.00	25.00	125	89		

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
31.00	39.00	8.00							9160.00

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	2.00	2.00	Colluvium		
2.00	26.00	24.00	Sandstone, oxidised, & minor quartz, high quartz @ 6m, 8m, 11m & 26m		
26.00	39.00	13.00	Schist, oxidised, water @ 31m		
39.00	43.00	4.00	Schist, fresh		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Tuesday, July 2, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805056

Works Details (top)

GROUNDWATER NUMBER	GW805056
LIC-NUM	80BL620335
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-07-24
FINAL-DEPTH (metres)	66.00
DRILLED-DEPTH (metres)	66.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	AVOCA TANK
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	39.97
SALINITY	10688.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6548184.00
EASTING	484403.00
LATITUDE	31 12' 1"

LONGITUDE	146 50' 11"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	144//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	144 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	66.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	59.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	59.00	65.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	51.00	53.00	125	89		
1		Annulus	Waterworn/Rounded	53.00	66.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
59.00	65.00	6.00		39.97				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	2.00	2.00	Siltstone, extremely weathered, red
2.00	15.00	13.00	Siltstone, heavily weathered, white/brown
15.00	31.00	16.00	Siltstone, moderately weathered, white/brown
31.00	57.00	26.00	Siltstone, weakley weathered, grey/white
57.00	60.00	3.00	Siltstone, fresh, grey/white
60.00	66.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805057

Works Details (top)

GROUNDWATER NUMBER	GW805057
LIC-NUM	80BL620336
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-07-23
FINAL-DEPTH (metres)	54.00
DRILLED-DEPTH (metres)	54.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	AVOCA TANK
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	35.95
SALINITY	10707.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6548874.00
EASTING	484713.00
LATITUDE	31 11' 39"

LONGITUDE	146 50' 22"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	10//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	10 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	54.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	47.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	47.00	53.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	44.00	45.00	125	89		
1		Annulus	Waterworn/Rounded	45.00	54.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
47.00	53.00	6.00		35.95				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	2.00	2.00	Siltstone, extremely weathered, brown/red
2.00	35.00	33.00	Siltstone, moderately weathered, white/brown
35.00	48.00	13.00	Siltstone, moderately weathered, grey/brown/white
48.00	54.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Tuesday, July 2, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805058

Works Details (top)

GROUNDWATER NUMBER	GW805058
LIC-NUM	80BL620335
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-07-24
FINAL-DEPTH (metres)	48.00
DRILLED-DEPTH (metres)	48.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	AVOCA TANK
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	31.04
SALINITY	9856.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6548194.00
EASTING	485153.00
LATITUDE	31 12' 1"

LONGITUDE	146 50' 39"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	144//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	144 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	48.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	41.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	41.00	47.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	33.00	35.00	125	89		
1		Annulus	Waterworn/Rounded	35.00	48.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
41.00	47.00	6.00		31.04				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	2.00	2.00	Siltstone, extremely weathered, red/white
2.00	26.00	24.00	Siltstone, weakly weathered, grey
26.00	32.00	6.00	Siltstone, moderately weathered, grey/brown
32.00	38.00	6.00	Siltstone, weakly weathered, grey
38.00	42.00	4.00	Siltstone, fresh, grey
42.00	48.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805059

Works Details (top)

GROUNDWATER NUMBER	GW805059
LIC-NUM	80BL620337
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-28
FINAL-DEPTH (metres)	22.00
DRILLED-DEPTH (metres)	22.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE LEACHATE PONDS
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	11.78
SALINITY	19200.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541132.00
EASTING	488869.00
LATITUDE	31 15' 50"

LONGITUDE	146 52' 59"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	35//864483

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	36 864483

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	22.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	15.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	15.00	21.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	12.00	13.00	125	89		
1		Annulus	Waterworn/Rounded	13.00	22.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
15.00	21.00	6.00		11.78				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	1.00	1.00	Topsoil, surface, red/brown
1.00	16.00	15.00	Siltstone, moderately weathered, brown/grey
16.00	22.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805060

Works Details (top)

GROUNDWATER NUMBER	GW805060
LIC-NUM	80BL620338
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-27
FINAL-DEPTH (metres)	19.00
DRILLED-DEPTH (metres)	19.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE LEACHATE PONDS
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	9.32
SALINITY	19840.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6540725.00
EASTING	488551.00
LATITUDE	31 16' 4"

LONGITUDE	146 52' 47"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	2//833281

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	2 833281

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	19.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	12.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	12.00	18.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	8.00	10.00	125	89		
1		Annulus	Waterworn/Rounded	10.00	19.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
12.00	18.00	6.00		9.32				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	2.00	2.00	Siltstone, extremely weathered, red/brown
2.00	13.00	11.00	Siltstone, moderately weathered
13.00	19.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805061

Works Details (top)

GROUNDWATER NUMBER	GW805061
LIC-NUM	80BL620307
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-29
FINAL-DEPTH (metres)	37.00
DRILLED-DEPTH (metres)	37.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	24.00
SALINITY	4992.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6542338.00
EASTING	487672.00
LATITUDE	31 15' 11"

LONGITUDE	146 52' 14"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	Rd Adj 3//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	3 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	37.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	30.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	30.00	36.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	26.00	28.00	125	89		
1		Annulus	Waterworn/Rounded	28.00	37.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
30.00	36.00	6.00		24.00				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	1.00	1.00	Topsoil, surface, red/brown
1.00	3.00	2.00	Siltstone, heavily weathered, yellow/brown
3.00	8.00	5.00	Siltstone, heavily weathered, yellow/white
8.00	18.00	10.00	Siltstone, heavily weathered, white/light brown
18.00	24.00	6.00	Siltstone, heavily weathered, brown/red/grey
24.00	27.00	3.00	Siltstone, heavily weathered, white/grey
27.00	30.00	3.00	Siltstone, moderately weathered, brown/red/grey
30.00	32.00	2.00	Siltstone, moderately weathered, brown/white/grey
32.00	37.00	5.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805062

Works Details (top)

GROUNDWATER NUMBER	GW805062
LIC-NUM	80BL620255
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-28
FINAL-DEPTH (metres)	139.00
DRILLED-DEPTH (metres)	139.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	78.46
SALINITY	16640.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541900.00
EASTING	487368.00
LATITUDE	31 15' 25"

LONGITUDE	146 52' 2"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	3//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	2 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	139.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	132.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	132.00	138.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	128.00	130.00	125	89		
1		Annulus	Waterworn/Rounded	130.00	139.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
132.00	138.00	6.00		78.46				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	17.00	17.00	Siltstone, heavily weathered, orange/white
17.00	65.00	48.00	Siltstone, moderately weathered, orange/grey
65.00	83.00	18.00	Siltstone, weakly weathered, grey/red
83.00	111.00	28.00	Siltstone, bleached, limonite, light grey
111.00	121.00	10.00	Siltstone, hgihly bleached limonite, light grey/green
121.00	133.00	12.00	Siltstone, weakly weathered, grey/red
133.00	139.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Friday, July 5, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805063

Works Details (top)

GROUNDWATER NUMBER	GW805063
LIC-NUM	80BL620255
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-29
FINAL-DEPTH (metres)	132.00
DRILLED-DEPTH (metres)	132.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	26.77
SALINITY	12992.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6541370.00
EASTING	487610.00
LATITUDE	31 15' 43"

LONGITUDE	146 52' 11"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	1//822428

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	2 751315

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	132.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	125.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	125.00	131.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	121.00	123.00	125	89		
1		Annulus	Waterworn/Rounded	123.00	132.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
125.00	131.00	6.00		26.77				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	1.00	1.00	Topsoil, extremely weathered
1.00	14.00	13.00	Siltstone, moderately weathered, orange/grey
14.00	35.00	21.00	Siltstone, moderately weathered, light red/grey
35.00	40.00	5.00	Siltstone, moderately weathered, grey/white
40.00	126.00	86.00	Siltstone, weakly weathered, grey/white
126.00	132.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Tuesday, July 2, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805064

Works Details (top)

GROUNDWATER NUMBER	GW805064
LIC-NUM	80BL620254
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-28
FINAL-DEPTH (metres)	82.00
DRILLED-DEPTH (metres)	82.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	64.10
SALINITY	12160.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6546446.00
EASTING	485442.00
LATITUDE	31 12' 58"

LONGITUDE	146 50' 50"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	138//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	147 824129

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	82.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	75.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	75.00	81.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	74.00	76.00	125	89		
1		Annulus	Waterworn/Rounded	76.00	82.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
75.00	81.00	6.00		64.10				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	4.00	4.00	Siltstone, extremely weathered, red
4.00	48.00	44.00	Siltstone, moderately weathered, orange/white
48.00	76.00	28.00	Siltstone, weakly weathered, light grey/orange/white
76.00	82.00	6.00	Siltstone, fractured

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Tuesday, July 2, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805066

Works Details (top)

GROUNDWATER NUMBER	GW805066
LIC-NUM	80BL620254
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-27
FINAL-DEPTH (metres)	132.00
DRILLED-DEPTH (metres)	132.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	127.00
SALINITY	9600.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6545662.00
EASTING	485601.00
LATITUDE	31 13' 23"

LONGITUDE	146 50' 56"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	147//824129

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	147 824129

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	132.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	125.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	125.00	131.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	120.00	122.00	125	89		
1		Annulus	Waterworn/Rounded	122.00	132.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
125.00	131.00	6.00		127.00				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT
0.00	1.00	1.00	Topsoil, surface, red/brown		
1.00	45.00	44.00	Siltstone, heavily weathered, light brown		
45.00	52.00	7.00	Siltstone, moderately weathered, brown/grey/black		
52.00	60.00	8.00	Siltstone, heavily weathered, light brown		
60.00	86.00	26.00	Siltstone, moderately weathered, brown/grey/white		
86.00	125.00	39.00	Siltstone, grey/black		
125.00	132.00	7.00	Siltstone, fractured		

Groundwater Works Summary

For information on the meaning of fields please see Glossary
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Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805167

Works Details (top)

GROUNDWATER NUMBER	GW805167
LIC-NUM	80WA716017
AUTHORISED-PURPOSES	ENVIRONMENT REHABILITATION
INTENDED-PURPOSES	ENVIRONMENT REHABILITATION
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	(Unknown)
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2009-06-17
FINAL-DEPTH (metres)	17.56
DRILLED-DEPTH (metres)	17.56
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	GIRILAMBONE COPPER MINE
GWMA	811 - CENTRAL WEST FRACTURED ROCKS
GW-ZONE	-
STANDING-WATER-LEVEL	7.94
SALINITY	
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	R.L. at W.L.M.Pt.
NORTHING	6541388.00
EASTING	488517.00
LATITUDE	31 15' 42"
LONGITUDE	146 52' 46"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22//861603

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	22 861603

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	17.56	200			(Unknown)
1	1	Casing	P.V.C.	0.00	0.00	200			

Water Bearing Zones (top)

no details

Drillers Log (top)

no details

Groundwater Works Summary

For information on the meaning of fields please see Glossary
Document Generated on Tuesday, July 2, 2013

Print Report

Works Details Site Details Form A Licensed Construction Water Bearing Zones Drillers Log

Work Requested -- GW805065

Works Details (top)

GROUNDWATER NUMBER	GW805065
LIC-NUM	80BL620254
AUTHORISED-PURPOSES	MONITORING BORE
INTENDED-PURPOSES	MONITORING BORE
WORK-TYPE	Bore
WORK-STATUS	Equipped - bore used for obs
CONSTRUCTION-METHOD	Down Hole Hammer
OWNER-TYPE	Mines
COMMENCE-DATE	
COMPLETION-DATE	2012-06-28
FINAL-DEPTH (metres)	87.00
DRILLED-DEPTH (metres)	87.00
CONTRACTOR-NAME	
DRILLER-NAME	
PROPERTY	YARRANDALE ROAD
GWMA	-
GW-ZONE	-
STANDING-WATER-LEVEL	82.00
SALINITY	6400.00
YIELD	

Site Details (top)

REGION	80 - MACQUARIE-WESTERN
RIVER-BASIN	421 - MACQUARIE RIVER
AREA-DISTRICT	
CMA-MAP	8235
GRID-ZONE	55/2
SCALE	1:100,000
ELEVATION	
ELEVATION-SOURCE	
NORTHING	6546319.00
EASTING	485201.00
LATITUDE	31 13' 2"

LONGITUDE	146 50' 41"
GS-MAP	
AMG-ZONE	55
COORD-SOURCE	GPS - Global Positioning System
REMARK	

Form-A (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	138//751315

Licensed (top)

COUNTY	CANBELEGO
PARISH	GIDALAMBONE
PORTION-LOT-DP	147 824129

Construction (top)

Negative depths indicate Above Ground Level;H-Hole;P-Pipe;OD-Outside Diameter;
ID-Inside Diameter;C-Cemented;SL-Slot Length;A-Aperture;GS-Grain Size;Q-Quantity

HOLE-NO	PIPE-NO	COMPONENT-CODE	COMPONENT-TYPE	DEPTH-FROM (metres)	DEPTH-TO (metres)	OD (mm)	ID (mm)	INTERVAL	DETAIL
1		Hole	Hole	0.00	87.00	125			Down Hole Hammer
1	1	Casing	PVC Class 12	0.00	80.00	89	79		Screwed; Seated; End cap
1	1	Opening	Slots - Horizontal	80.00	86.00	89			PVC Class 12; Mechanically Slotted; SL: 20mm; A: 5mm; Screwed
1		Annulus	Bentonite	77.00	78.00	125	89		
1		Annulus	Waterworn/Rounded	78.00	87.00	125	89		Graded; GS: 2-3mm; Q: .2m³

Water Bearing Zones (top)

FROM-DEPTH (metres)	TO-DEPTH (metres)	THICKNESS (metres)	ROCK-CAT-DESC	S-W-L	D-D-L	YIELD	TEST-HOLE-DEPTH (metres)	DURATION	SALINITY
80.00	86.00	6.00		82.00				1.00	

Drillers Log (top)

FROM	TO	THICKNESS	DESC	GEO-MATERIAL	COMMENT

0.00	2.00	2.00	Topsoil, surface, red/brown
2.00	46.00	44.00	Siltstone, heavily weathered, yellow/white/light brown
46.00	70.00	24.00	Siltstone, moderately weathered, light brown/yellow/grey/white
70.00	80.00	10.00	Siltstone, grey/yellow/blue
80.00	85.00	5.00	Siltstone, fractured
85.00	87.00	2.00	Siltstone, grey/yellow/blue

APPENDIX C – SUMMARY OF DIRECTOR GENERAL'S REQUIREMENTS

WATER		
Environment Protection Authority 04/09/2013	**The Proposal** • Provide details of the project that are essential for predicting and assessing impacts to waters: a) including the quantity and physio-chemical properties of all potential water pollutants and the risks they pose to the environment and human health, Including the risks they pose to Water Quality Objectives in the ambient waters (as defined on www.environment.nsw.gov.au/ieo.using technical criteria derived from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, ANZECC 2000). b) the management of discharges with potential for water impacts. c) drainage works and associated infrastructure; land-forming d) and excavations; working capacity of structures; and water resource requirements of the proposal. • Outline site layout, demonstrating efforts to avoid proximity to water resources (especially for activities with significant potential impacts eg effluent ponds) and showing potential areas of modification of contours, drainage etc. • Outline how total water cycle considerations are to be addressed showing total water balances for the development (with the objective of minimising demands and impacts on water resources). Include water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options.	**Section 1-11** **Section 6 & 14** **Section 7** **Section 7** **Section 9 & 11** **Figures 1-4** **Section 9**
	The Location • Describe the catchment including proximity of the development to any waterways and provide an assessment of their sensitivity/significance from a public health, ecological and/or economic perspective. The Water Quality and River Flow Objectives on the website: www.environment.nsw.gov.au/ieo should be used to identify the agreed environmental values and human uses for any affected waterways. This will help with the description of the local and regional area.	**Section 7**
	The Environmental Issues **Describe Baseline Conditions** Describe existing surface and groundwater quality - an assessment needs to be undertaken for any water resource likely to be affected by the proposal and for all conditions (e.g. a wet weather sampling program is needed if runoff events may cause impacts). *Note: Methods of sampling and analysis need to conform with an accepted standard (e.g. Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECCW 2004) or be approved and analyses undertaken by accredited laboratories).* • Provide site drainage details and surface runoff yield.	**Section 6** **Section 7**

	• State the ambient Water Quality and River Flow Objectives for the receiving waters. These refer to the community's agreed environmental values and human uses endorsed by the Government as goals for the ambient waters. These environmental values are published on the website: www.environment.nsw.gov.au/ieo. The EIS should state the environmental values listed for the catchment and waterway type relevant to your proposal. NB: A consolidated and approved list of environmental values are not available for groundwater resources. Where groundwater may be affected the EIS should identify appropriate groundwater environmental values and justify the choice.	**Section 6**
	• State the indicators and associated trigger values or criteria for the identified environmental values. This information should be sourced from the ANZECC 2000 Guidelines for Fresh and Marine Water Quality (http://www.deh.gov.au/water/quality/nwqms/volume1.html)(Note that, as at 2004, the NSW Water Quality Objectives booklets and website contain technical criteria derived from the 1992 version of the ANZECC Guidelines. The Water Quality Objectives remain as Government Policy, reflecting the community's environmental values and long-term goals, but the technical criteria are replaced by the more recent ANZECC 2000 Guidelines). NB: While specific guidelines for groundwater are not available, the ANCECC 2000 Guidelines endorse the application of the trigger values and decision trees as a tool to assess risk to environmental values in groundwater.	**Section 6.2 & 14**
	• State any locally specific objectives, criteria or targets, which have been endorsed by the government e.g. the Healthy Rivers Commission Inquiries (www.hrc.nsw.gov.au) or the NSW Salinity Strategy (DLWC, 2000) (www.dlwc.nsw.gov.au/care/salinity/#Strategy).	**Section 12 & Appendix D**
	• Where site specific studies are proposed to revise the trigger values supporting the ambient Water Quality and River Flow Objectives, and the results are to be used for regulatory purposes (e.g. to assess whether a licensed discharge impacts on water quality objectives), then prior agreement from the EPA on the approach and study design must be obtained.	**NA**
	• Describe the state of the receiving waters and relate this to the relevant Water Quality and River Flow Objectives (i.e. are Water Quality and River Flow Objectives being achieved?). Proponents are generally only expected to source available data and information. However, proponents of large or high risk developments may be required to collect some ambient water quality / river flow / groundwater data to enable a suitable level of impact assessment. Issues to include in the description of the receiving waters could include: a) lake or estuary flushing characteristics. b) specific human uses (e.g. exact location of drinking water offtake). c) sensitive ecosystems or species conservation values. d) a description of the condition of the local catchment e.g. erosion levels, soils, vegetation cover, etc.	**NA**

	e) an outline of baseline groundwater information, including, but not restricted to, depth to watertable, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment.	**Section 5, 6, 7, 8, and 9**
	f) historic river flow data where available for the catchment.	**NA**
	Assess impacts	**Section 14**
	• No proposal should breach clause 120 of the Protection of the *Environment Operations Act 1997* (Le. pollution of waters is prohibited unless undertaken in accordance with relevant regulations).	
	• Identify and estimate the quantity of all pollutants that may be introduced into the water cycle by source and discharge point including residual discharges after mitigation measures are implemented.	**Section 14 & 16**
	• Include a rationale, along with relevant calculations, supporting the prediction of the discharges.	**Section 14 & 15**
	• Describe the effects and significance of any pollutant loads on the receiving environment. This should include impacts of residual discharges through modelling, monitoring or both, depending on the scale of the proposal. Determine changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, wetland hydrologic regimes and groundwater).	**Section 14 & 15**
	• Describe water quality impacts resulting from changes to hydrologic flow regimes (such as nutrient enrichment or turbidity resulting from changes in frequency and magnitude of stream flow).	
	• Identify any potential impacts on quality or quantity of groundwater describing their source.	**Section 14 & 15**
	• Identify potential impacts associated with geomorphological activities with potential to increase surface water and sediment runoff or to reduce surface runoff and sediment transport. Also consider possible, impacts such as bed lowering, bank lowering, instream siltation, floodplain erosion and floodplain siltation.	
	• Identify impacts associated with the disturbance of acid sulfate soils and potential acid sulfate soils.	
	• Containment of spills and leaks shall be in accordance with the technical guidelines section 'Bunding and Spill Management' of the Authorised Officers Manual (EPA, 1995) (http://www.environment.nsw.gov.au/mao/bundingspill.htm) and the most recent versions of the Australian Standards referred to in the Guidelines. Containment should be designed for no-discharge.	
	• The significance of the impacts listed above should be predicted. When doing this it is important to predict the ambient water quality and river flow outcomes associated with the proposal and to demonstrate whether these are acceptable in terms of achieving protection of the Water Quality and River Flow Objectives. In particular the following questions should be answered: a) will the proposal protect Water Quality and River, Flow Objectives where they are currently achieved in the ambient waters; and b) will the proposal contribute towards the achievement of Water Quality and River Flow Objectives over time, where they are not currently achieved in the ambient waters.	

	• Consult with the EPA as soon as possible if a mixing zone is proposed (a mixing zone could exist where effluent is discharged into a receiving water body, where the quality of the water being discharged does not immediately meet water quality objectives. The mixing zone could result in dilution, assimilation and decay of the effluent to allow water quality objectives to be met further downstream, at the edge of the mixing zone). The EPA will advise the proponent under what conditions a mixing zone will and will not be acceptable, as well as the information and modelling requirements for assessment. *Note: The assessment of water quality impacts needs to be undertaken in a total catchment management context to provide a wide perspective on development impacts, in particular cumulative impacts.* • Where a licensed discharge is proposed, provide the rationale as to why it cannot be avoided through application of a reasonable level of performance, using available technology, management practice and industry guidelines. • Where a licensed discharge is proposed, provide the rationale as to why it represents the best environmental outcome and what measures can be taken to reduce its environmental impact. • Reference should be made to relevant guidelines e.g. Managing Urban Storm water: Soils and Construction (Landcom, 2004), and Guidelines for Fresh and Marine Water Quality ANZECC 2000).	
	Describe management and mitigation measures • Outline stormwater management to control pollutants at the source and contain them within the site. Also describe measures for maintaining and monitoring any stormwater controls. • Outline erosion and sediment control measures directed at minimising disturbance of land, minimising water flow through the site and filtering, trapping or detaining sediment. Also include measures to maintain and monitor controls as well as rehabilitation strategies. • Describe waste water treatment measures that are appropriate to the type and volume of waste water and are based on a hierarchy of avoiding generation of waste water; capturing all contaminated water (including stormwater) on the site; reusing/recycling waste water; and treating any unavoidable discharge from the site to meet specified water quality requirements. • Outline pollution control measures relating to storage of materials, possibility of accidental spills (eg preparation of contingency plans), appropriate disposal methods, and generation of leachate. • Describe hydrological impact mitigation measures including: a) site selection (avoiding sites prone to flooding and waterlogging, actively eroding or affected by deposition). b) minimising runoff. c) minimising reductions or modifications to flow regimes. d) avoiding modifications to groundwater. • Describe groundwater impact mitigation measures including: a) site selection. b) retention of native vegetation and revegetation. c) artificial recharge.	**Section 14 & 16**

	d) providing surface storages with impervious linings. e) monitoring program. Describe geomorphological impact mitigation measures including: a) site selection. b) erosion and sediment controls. c) minimising instream works. d) treating existing accelerated erosion and deposition. e) monitoring program.	**Section 14 & 16**
	• Any proposed monitoring should be undertaken in accordance with the Approved Methods for the *Sampling and Analysis of Water Pollutants in NSW* (DECCW 2004).	**Section 14 & 16**
Office of Water 03/10/2013	NSW Office of Water requires the EIS for the proposal to demonstrate the following: 1. Adequate and secure water supply for the proposal. Confirmation that water supplies for construction and operation are sourced from an appropriately authorised and reliable supply.	
	2. Identification of site water demands, water sources (surface and groundwater), water disposal methods and water storage structures in the form of a water balance. The water balance is to outline the proposed water management on the site and to also include details of any water reticulation infrastructure that supplies water to and within the site.	**Section 13**
	3. An impact assessment on adjacent licensed water users (surface and groundwater), riparian ecosystems and groundwater-dependent ecosystems. This is to meet the requirements of relevant state policy such as the NSW Aquifer Interference Policy, in addition to the objects and principles of the *Water Management Act 2000* which can be accessed at the following link: http://www.water.nsw.gov.au/vVater-managementiLaw-andPolicy/default.aspx.	**Section 13 & 15**
	4. An assessment of the potential to intercept groundwater and predicted maximum annual dewatering volumes, water quality and disposal/retention methods. This is to also include the modelled zone of influence for a number of stages both during mining operations and post mine life until equilibrium is achieved. This is to meet the requirements of the NSW Aquifer Interference Policy.	**Section 13 & 15**
	5. An impact assessment of the construction, operation and final landform of the proposed onsite waste rock emplacement, water management ponds and other potentially contaminating facilities. This is to include an assessment of the processing, management and disposal of potentially contaminating materials at the Tritton Copper Mine.	
	6. An assessment of any proposed modification to surface water management including modelling of redistribution of waters and an assessment of impact on neighbouring properties and the associated watercourse and floodplain.	

	7. An impact assessment of any proposed works within or adjacent to watercourses and adequate provision of buffer requirements. This is to also include proposed pipelines and temporary or permanent vehicle crossings within the project application area. Ability to achieve the principles of the *Water Management Act 2000* and the requirements of the "Guidelines for Controlled Activities on Waterfront Land' will be required. The relevant guidelines can be accessed at the following link: http://www.water.nsw.gov.au/WaterLicensing/Approvals/Controlled-activities/default.aspx.	
	8. Preparation of a surface water management plan and groundwater management plan to integrate the proposed water balance and management for the site and to identify adequate mitigating and monitoring requirements for both water quality and water volume.	**Section 14**
	9. Existing and proposed water licensing requirements in accordance with the *Water Act 1912* and *Water Management Act 2000* (whichever is relevant). This is to demonstrate that existing licences (include licence numbers) and licensed uses are appropriate, and to identify where additional licences are proposed. The proponent will be required to ensure they hold adequate licensed entitlement commensurate with the anticipated volume of groundwater take prior to this take occurring. Groundwater take includes the volume of water intercepted by the proposed activities both via the underground mine and any extraction bores, in addition to any ongoing take induced by groundwater inflows and evaporative loss when the mine workings begin to fill. The maximum annual requirements need to be regularly reviewed through updates of modelling and reviews of metering data.	**Section 13 & 15**
	10. Adequate mitigating and monitoring requirements to address surface water and groundwater impacts.	**Section 14, 15 & 16**
	Groundwater Source The assessment is required to identify groundwater issues and potential degradation to the groundwater source and provide the following:	
	• Details of the predicted highest groundwater table at the development site.	**Section 13**
	• Details of any works likely to intercept, connect with or result in pollutants infiltrating into the groundwater sources.	**Section 13**
	• Details of any proposed groundwater extraction, including purpose, location and construction details of all proposed bores and expected annual extraction volumes.	**Section 13**
	• Describe the flow directions and rates and the physical and chemical characteristics of the groundwater source.	**Section 6 & 13**
	• Details of the predicted impacts of any final landform on the groundwater regime.	**Section 13**
	• Details of the existing groundwater users within the area (including the environment) and include details of any potential impacts on these users.	**Section 5 & 13**
	• Assessment of the quality of the groundwater for the local groundwater catchment.	**Section 5 & 6**
	• Details of how the proposed development will not potentially diminish the current quality of groundwater, both in the short and long term.	**Section 14 & 15**
	• Details on preventing groundwater pollution so that remediation is not required.	**Section 14**

	• Quantification of impacts on groundwater dependent ecosystems (GDEs).	**Section 8, 13 & 15**
	• Details on protective measures to minimise any impacts on groundwater dependent ecosystems.	**Section 15**
	• Details of proposed methods of the disposal of waste water and approval from the relevant authority.	**Section 7**
	• Assessment of the potential for saline intrusion of the groundwater and measures to prevent such intrusion into the groundwater aquifer.	**Section 6**
	• Details of the results of any models or predictive tools used to predict groundwater drawdown, inflows to the site and impacts on affected water sources.	**Section 13**
	Where potential impact/s are identified the assessment will need to identify limits to the level of impact and contingency measures that would remediate, reduce or manage potential impacts to the existing groundwater resource and any dependent groundwater environment or water users, including information on:	**Section 13 & 15**
	Details of any proposed monitoring programs, including water levels and quality data.	**Section 16**
	• Reporting procedures for any monitoring program including mechanism for transfer of information.	**Section 16**
	• Description of the remedial measures or contingency plans proposed.	**Section 16**
	Licensing	**Section 15**
	• All proposed groundwater works, including bores for the purpose of investigation, extraction, dewatering, testing or monitoring must be identified in the proposal and an approval obtained from the Office of Water prior to their installation. Approved SSD and SSI projects may be excluded from the requirement for approvals due to Section 89J and 115ZG of the *Environmental Planning and Assessment Act 1979*.	
	• All predicted groundwater take must be accounted for through adequate licensing.	**Section 15**
	Groundwater Dependent Ecosystems (GDEs) The assessment is required to identify any impacts on GDEs. GDEs are ecosystems which have their species composition and natural ecological processes wholly or partially determined by groundwater.	**Section 8, 12, 15, 16 & Appendix D**
	GDEs represent a vital component of the natural environment. GDEs can vary dramatically in how they depend on groundwater from having occasional or no apparent dependence through to being entirely dependent. GDEs occur across both the surface and subsurface landscapes ranging in area from a few metres to many kilometres. Increasingly, it is being recognised that surface and groundwaters are often interlinked and aquatic ecosystems may have a dependence on both.	
	Ecosystems that can depend on groundwater and that may support threatened or endangered species, communities and populations, include:	
	• Terrestrial vegetation that show seasonal or episodic reliance on groundwater.	
	• River base flow systems which are aquatic and riparian ecosystems in or adjacent to streams/rivers dependent on the input of	

	groundwater to base flows. • Aquifer and cave ecosystems. • Wetlands. • Estuarine and near-shore marine discharge ecosystems. • Fauna which directly depend on groundwater as a source of drinking water or that live within water which provide a source. The *NSW Aquifer Interference Policy and* the *NSW Groundwater Dependent Ecosystem Policy* provides guidance on the protection and management of GDEs. It sets out management objectives and principles to: • Ensure the most vulnerable and valuable ecosystems are protected. • Manage groundwater extraction within defined limits thereby providing flow sufficient to sustain ecological processes and maintain biodiversity. • Ensure sufficient groundwater of suitable quality is available to ecosystems when needed. • Ensure the *precautionary principle* is applied to protect GDEs, particularly the dynamics of flow and availability and the species reliant on these attributes. A number of gazetted WSPs list and map priority GDEs and set out the management strategies and actions for sharing and protecting groundwater quality, quantity and dependent ecosystems. As indicated above, any GDEs that may be affected significantly need to be clearly identified and the impacts quantified to enable proper assessment.	
	Surface Water The Office of Water is responsible for the management of rivers, estuaries, wetlands and adjacent riverine plains so they can sustain environmental, social and economic uses for the people in New South Wales.	**NA**
	<u>Watercourse/Riparian</u> The assessment is required to consider the impact of the proposal on the watercourses and associated riparian vegetation within the site and provide the following: • Identify the sources of surface water. • Details of stream order (using the Strahler System). • Details of any proposed surface water extraction, including quantity, purpose, location of existing pumps, dams, diversions, cuttings and levees. • Details of available surface water licences that could be purchased to account for any proposed extractions. • Detailed description of any proposed development or diversion works including all construction, clearing, draining, excavation and filling. • An assessment of the impacts of the proposed methods of excavation, construction and material placement on the watercourse and associated vegetation.	**NA**

	• A detailed description of all potential water related environmental impacts of any proposed development in terms of riparian vegetation, sediment movement, water quality and hydrologic regime. • A description of the design features and measures to be incorporated into any proposed development to guard against anything more than minimal long term actual and potential environmental disturbances, particularly in respect of maintaining the natural hydrologic regime and sediment movement patterns and the identification of riparian buffers. (See note below). • Details of the impact on water quality and remedial measures proposed to address more than minimal adverse effects. Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. Refer to NSW Office of Water Guidelines for Controlled Activities (July 2012) available via: http://www.water.nsw.gov.auiWater-Licensing/Approvals/Controlled-activitles/default.aspx	

APPENDIX D – DETAILED DISCUSSION OF WATER REGULATIONS

RELEVANT LEGISLATION, REGULATION AND POLICY FOR GROUNDWATER

INTRODUCTION

To facilitate the proposed mine development, in relation to impacts of groundwater resources, the following statutory requirements need to be achieved in order to address the NSW Office of Water DGR (provided in full in **Appendix C**).

There are two key pieces of legislation and regulation that control the use and development of land in NSW:

- *Environmental Planning and Assessment Act (1979)* (EP&A Act); and
- *Environmental Planning and Assessment Regulation (2000)* (EP&A Reg).

There are two key parts of legislation for the management of groundwater in NSW:

- *Water Act (1912)*; and
- *Water Management Act 2000* (WMA 2000).

In addition to the above Acts, the relevant plans, policies and regulation are considered the main tools which assist in implementing and defining the provisions of the WMA:

- The Water Management (General) Regulation (2011);
- Water Sharing Plans:
    - Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012);
    - Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012):
        - Lower Bogan River Water Source (2012);
- The NSW State Groundwater Dependent Ecosystem Policy (2002);
- The *NSW Aquifer Interference Policy 2012* (September 2012);
- The NSW Groundwater Policy Framework Document – General (1997);
- The NSW Groundwater Quality Protection Policy (1998);
- The NSW State Rivers and Estuaries Policy (1993); and
- The NSW Wetlands Policy (2010)

THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT (1979)

The *Environmental Planning and Assessment Act (1979)* requires the potential effects on groundwater of proposed developments to be assessed as part of the environment impact assessment process. The EP&A Act establishes the hierarchy of planning instruments that apply to the Proposal. These instruments and all relevant legislation applying to the proposal are summarised in the following sections. It also provides for the preparation of environmental planning instruments which may control, restrict or limit development at local, regional and State levels. The EP&A Act also applies to State government agencies issuing approvals, including licences for groundwater extraction.

THE WATER ACT (1912)

The Water Act (1912) came into force at the turn of the last century and represented a different era in water management in NSW. The Water Act (1912) is being progressively phased out and replaced by the WMA, however, some provisions remain in force.

WATER MANAGEMENT ACT (2000)

The Water Management Act (200) – the WMA – is comprehensive water legislation to guide water management activities. The objectives of the WMA were the sustainable and integrated management of the state's water for the benefit of both present and future generations, in particular:

- to apply the principles of ecologically sustainable development;
- to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality;
- to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:
    - benefits to the environment;
    - benefits to urban communities, agriculture, fisheries, industry and recreation;
    - benefits to culture and heritage;
    - benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water;
- to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources;
- to provide for the orderly, efficient and equitable sharing of water from water sources;
- to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna;
- to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users; and
- to encourage best practice in the management and use of water.

To achieve the objectives, the WMA recognises the need to allocate and provide water for the environmental health of rivers and groundwater systems, whilst also providing licence holders with access to water and greater opportunities to trade water through the separation of water licences from land. The main tool the WMA provides for managing the State's water resources are the Water Sharing Plans (refer to **Section 12.3**). The Water Sharing Plans (WSP) are used to set out the rules for the sharing of water in a particular water source between water users and the environment and rules for the trading of water in a particular water source. When a WSP commences the Water Act (1912) is superseded by the WMA. WSPs have been developed for all the major regulated river systems, their associated major aquifers and a number of unregulated systems.

The WMA defines an aquifer as a ‘geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water. This differs from the well held belief that an aquifer is an economic supply of groundwater capable of pumping for a beneficial use.

Due to major changes required by the legislation, the Act has been progressively implemented. Since 1 July 2004 the new licensing and approvals system has been in effect in those areas of NSW covered by operational WSP.

To assist in implementing and defining the provisions of the WMA, regulations have been made, including:

- Water Management (General) Regulation 2011, which supersedes two former Regulations with some amendments: the Water Management (General) Regulation 2004 and the Water Management (Water Supply Authorities) Regulation 2004.

An aquifer interference regulation took effect in NSW on 30 June 2011. The Water Management (General) Regulation 2011 defines an "aquifer interference activity" as:

a) the extraction of sand,
b) the extraction of road base material.

In addition, the WMA defines an "aquifer inference activity" involving any of the following:

a) the penetration of an aquifer,
b) the interference with water in an aquifer,
c) the obstruction of the flow of water in an aquifer,
d) the taking of water from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations,
e) the disposal of water taken from an aquifer in the course of carrying out mining or any other activity prescribed by the regulations

In relation to aquifer interference activities, the WMA specifies that:

a) the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and
b) the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.

An aquifer interference approval confers a right on its holder to carry out one or more specified aquifer interference activities at a specified location, or in a specified area, in the course of carrying out specified activities (including mining operations).The *NSW Aquifer Interference Policy 2012* was released in September 2012 (refer to **Section 12.5**). This policy sets out the requirements for assessing the impacts of aquifer interference activities on water resources.

For the purposes of section 96 (a) of the Act, the matters to be taken into consideration by the Minister in considering whether or not to grant an aquifer interference approval include whether the amount of water taken in the course of carrying out the aquifer interference activity to which the approval relates will exceed the total extraction limit for the aquifer set out in any relevant management plan (e.g. WSPs). An aquifer interference approval is not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to the aquifer, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates.

It is understood that unsaturated flow and perched groundwater are excluded from the aquifer interference policy.

A person who is engaged in an aquifer interference activity in connection with the mining or extraction of any material is exempt from section 91A (1) of the Act in relation to the using of water from an aquifer if the water is used in accordance with an aquifer interference approval with respect to that activity.

This reform was implemented to ensure equitable sharing of groundwater amongst all water users. The Water Management (General) Regulation 2004 has now been replaced by the Water Management (General) Regulation 2011.

WATER SHARING PLANS

WSPs are being progressively developed for rivers and groundwater systems across NSW following the introduction of the WMA. Water Sharing Plans made under the WMA are being prepared as Minister's plans under Section 50 of the Act. These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

WSPs provide a legislative basis for sharing water between the environment and consumptive purposes. Under the WMA, a plan for the sharing of water must protect each water source and its dependent ecosystems and must protect basic landholder rights.

WSPs also recognise the economic benefits that commercial users such as irrigation and industry can bring to a region. Upon commencement, access licences held under the Water Act 1912 are converted to access licences under the WMA and land and water rights are separated. This facilitates the trade of access licences and can encourage more efficient use of water resources. It also allows new industries to develop as water can move to its highest value use.

In conjunction with other provisions of the WMA, WSPs also set rules so that commercial users can continue to operate productively. In general, commercial licences under the WMA are granted in perpetuity, providing greater commercial security of water access entitlements. These WSPs aim to:

- clarify the rights of the environment, basic landholder rights users, town water suppliers and other licensed users;
- define the long-term average annual extraction limit (LTAAEL) for water sources;
- set rules to manage impacts of extraction; and
- facilitate the trading of water between users.

WSPs have been developed for major aquifers in NSW with each of these plans divided into 'groundwater sources'. Water sharing plans for groundwater specify:

- water sources covered by the plan;
- environmental water provisions;
- requirements for water for basic landholder rights;
- requirements for water for extraction under access licences;

- limits to the availability of water – determining long-term extraction limits;
- limits to the availability of water – available water determinations;
- rules for granting access licences;
- rules for managing access licences;
- rules for water supply work approvals;
- access licence dealing rules;
- mandatory conditions on access licences and water supply work approvals; and
- rules on how the plan may be amended;

The Project Site is located within the following WSPs:

- Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012) – *Lachlan Fold Belt MDB Groundwater Source*; and
- Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012) – *Lower Bogan River Water Source.*

The DGR relating to the WSP was to demonstrate how the mining proposal is consistent with the relevant access and trading rules of the WSP.

Water Sharing Plan for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012) – Lachlan Fold Belt MDB Groundwater Source

The NSW Murray-Darling Basin (MDB) fractured rock groundwater sources are located within the NSW portion of the MDB (as detailed in **Section 7.2**).

The Lachlan Fold Belt MDB Groundwater Source covers an area of 16,722,000 hectares. The Project Site is located within the western portion of the Lachlan Fold Belt MDB Groundwater Source which consists of fractured rock aquifer with a low to moderate level of connection between surface and groundwater.

The long-term average annual extraction limit (LTAAEL) for the Lachlan Fold Belt MDB Groundwater Source, which determines the annual amount of groundwater that can be potentially made available for extraction, was 821,250ML/year. Trading of water is permitted within the Lachlan Fold Belt MDB Groundwater Source zone.

Based on a review of **Appendix A** Map of High Priority GDEs of the WSP for the NSW Murray-Darling Basin Fractured Rock Groundwater Sources (2012), there are no high priority GDEs within at least 150km of the site (including springs, geothermal springs, wetlands and karst) associated with the fractured rock groundwater source.

Water Sharing Plan for the Macquarie-Bogan Unregulated and Alluvial Water Sources (2012)

The Project Site is located within the boundary of the WSP for the Macquarie-Bogan Unregulated and Alluvial Water Sources, however, is not located within the alluvial groundwater source zones (Cudgegong Alluvial, Talbragar Alluvial, Bell Alluvial or the Upper Macquarie Alluvial).

No GDEs have been identified for the four alluvial groundwater sources included in the Macquarie-Bogan Unregulated and Alluvial Water Sources WSP.

The proposed mine is situated within a fractured rock aquifer, with low to moderate level of connection between surface and groundwater and is not within the listed alluvial groundwater source zones specified in the WSP. The potential groundwater impact of the proposed mine is not relevant to this WSP.

NSW STATE GROUNDWATER DEPENDENT ECOSYSTEMS POLICY (2002)

Base on the DGRs from the NSW Office of Water, the potential impacts to Groundwater Dependent Ecosystems (GDEs) must be considered.

As demonstrated in **Section 8.3 and 10.2** of this report no high priority GDEs are apparent in the vicinity of the site (within 150km).

NSW AQUIFER INTERFERENCE POLICY (2012)

The purpose of the *NSW Aquifer Interference Policy 2012* is to explain the role and requirements of the Minister administering the WMA in the water licensing and assessment processes for aquifer interference activities under the WMA and other relevant legislative frameworks. The *NSW Aquifer Interference Policy 2012*:

3. clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation; and
4. establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water-dependent asset.

Under the WMA an aquifer is defined as a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water. More generally, the term 'aquifer' is commonly understood to mean a groundwater system that is sufficiently permeable to allow water to move within it, and which can yield productive volumes of groundwater. Groundwater is all water that occurs beneath the ground surface in the saturated zone. A groundwater system is any type of saturated geological formation that can yield anywhere from low to high volumes of water. For the purposes of the *NSW Aquifer Interference Policy 2012*, the term aquifer has the same meaning as groundwater system and includes low yielding and saline systems.

Aquifer interference activities may take water from the water source in which they exist as well as connected groundwater and surface water sources. Even where there is no take of water, aquifer interference activities can still affect the functioning of aquifers which can impact water users and dependent ecosystems.

Licensing of Water Taken Through Aquifer Interference

A water licence is required under the WMA (unless an exemption applies or water is being taken under a basic landholder right) where any act by a person carrying out an aquifer interference activity causes:

- the removal of water from a water source; or
- the movement of water from one part of an aquifer to another part of an aquifer; or
- the movement of water from one water source to another water source, such as:
    - from an aquifer to an adjacent aquifer; or
    - from an aquifer to a river/lake; or

- from a river/lake to an aquifer.

Assessment Process for Aquifer Interference Activities

The NSW Office of Water's assessment of impacts on water sources and water dependent ecosystems and subsequent advice and proposed conditions of approval as input to the planning process for a project is based on an "account for, mitigate, avoid/ prevent, and remediate" approach. In practice this means the assessment and subsequent advice will be based on the proponents':

1. (a) ability to demonstrate that they have the ability to obtain the necessary licences in order to account for the take of water from any relevant water source.; or
   (b) ability to demonstrate that the proposal has been designed in such a way as to prevent the take of water where applicants are unable to meet the requirements specified in point 1 above; and
2. ability to demonstrate that adequate arrangements will be in place to ensure that the minimal impact considerations specified in *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities* are achieved; and
3. proposed remedial actions for impacts greater than those that were predicted as part of the relevant approval. The assessment will include:

(a) consideration of the potential types and risks of unforeseen impacts that may occur during the operational phase or post-closure of the aquifer interference activity; and

(b) whether the proposed mitigation, prevention or avoidance strategies will minimise these risks; and

(c) whether the proposed remedial actions are adequate, should the proposed risk minimisation strategies in (b) fail; and

(d) advice on what further mitigation, prevention, avoidance or remedial actions may be required; and

(e) appropriate conditions that maintain any mitigation, prevention, avoidance or remediation actions until they are no longer required to keep the impacts at or below the predicted levels.

Aquifer Impact Assessment

The WMA includes the concept of ensuring "no more than minimal harm" for both the granting of water access licences and the granting of aquifer interference approvals. Aquifer interference approvals are not to be granted unless the Minister is satisfied that adequate arrangements are in force to ensure that no more than minimal harm will be done to any water source, or its dependent ecosystems, as a consequence of its being interfered with in the course of the activities to which the approval relates.

Whilst aquifer interference approvals are not required to be granted, the minimal harm test under the WMA is not activated for the assessment of impacts. Therefore, this Policy establishes and objectively defines minimal impact considerations as they relate to water-dependent assets and these considerations will be used as the basis for providing advice to the Minister.

The minimal impact considerations have been developed for impacts on groundwater sources, connected water sources, and their dependent ecosystems, culturally significant sites and water users.

The potential impacts of the aquifer interference activity are assessed against the minimal impact considerations specified in *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities*, as well as any specific rules in a relevant WSP.

For each of the highly productive and less productive groundwater sources thresholds for key minimal impact considerations have been developed. These thresholds deal with water table and groundwater pressure drawdown as well as groundwater and surface water quality changes.

This Policy will adopt an adaptive management approach to the minimal impact considerations which means they will be regularly reviewed and updated, if required, based on scientific information and experience during implementation.

Groundwater Source Categories

The policy divides groundwater sources into two categories, "highly productive" and "less productive". Highly productive groundwater is defined in this Policy as a groundwater source that is declared in the Regulations and based on the following criteria:

a) has total dissolved solids of less than 1,500 mg/L, and
b) contains water supply works that can yield water at a rate greater than 5 L/sec.

Furthermore, the *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities* are categorised into type of groundwater sources and are presented in **Table D** below:

Table D1: Highly and Less Productive Groundwater Source Types

Highly Productive	Less Productive

• Alluvial;
• Coastal Sands;
• Porous Rock;
  ○ Great Artesian Basin - Eastern Recharge and Southern Recharge;
  ○ Great Artesian Basin – Surat, Warrego and Central;
  ○ other porous rock; and
• Fractured Rock.
	• Alluvial;
	• Porous Rock; and
	• Fractured Rock.

The proposed mine development is considered to be located in a Less Productive groundwater source type due to the elevated TDS (>1,500mg/L) and low yield (based on the known sustainable discharge rates reported during the pumping test at Girilambone mine site (ES, June 2013).

In addition to the requirements listed in *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities*, the following issue also require consideration:

- acidity issues to arise, for example exposure of acid sulphate soils; and
- waterlogging or water table rise to occur, which could potentially affect land use, groundwater dependent ecosystems and other aquifer interference activities. Specific limits will be determined on a case-by-case basis, depending on the sensitivity of the surrounding land and groundwater dependent ecosystems to waterlogging and other aquifer interference activities to water intrusion.

Requirements for Aquifer Impact Assessment

A risk management approach to assessing the potential impacts of aquifer interference activities was adopted, where the level of detail required to be provided by the proponent is proportional to a combination of the likelihood of impacts occurring on water sources, users and dependent ecosystems and the potential consequences of these impacts.

The following information is required to enable the assessment of the proposed mining development against the minimal impact considerations in *Table 1 – Minimal Impact Considerations for Aquifer Interference Activities of a Less Productive Groundwater Source in Porous and Fractured Rock*:

- establishment of baseline groundwater conditions including groundwater depth, quality and flow based on sampling of all existing bores in the area potentially affected by the activity, any existing monitoring bores and any new monitoring bores that may be required under an authorisation issued under the Mining Act 1992 or the Petroleum (Onshore) Act 1991;
- a strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans. For example, returning water of an acceptable quality to the affected water source during periods when flows are at levels below which water users are not permitted to pump;
- details of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right. Consideration will need to be given to any relevant distance restriction requirements that may be specified in any relevant water sharing plan or any remediation measures to address these impacts;
- details of potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources;
- details of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems;
- details of potential for increased saline or contaminated water inflows to aquifers and highly connected river systems;
- details of the potential to cause or enhance hydraulic connection between aquifers;
- details of the potential for river bank instability, or high wall instability or failure to occur; and
- provide estimates of all quantities of water that are likely to be taken from any water source during and following cessation of the activity and all predicted impacts associated with the activity

Table D2: Summary of Less Productive Groundwater Sources for Fractured Rock Water Sources Requirements for Minimal Impact Considerations for Aquifer Interference Activities.

Minimal Impact Consideration	Requirement
Water Table	1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variation, 40m from any: (a) high priority GDE; or(a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant WSP 2. If more than 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40m from any: a) high priority GDE; or(a) high priority GDE; or (b) high priority culturally significant site; listed in the schedule of the relevant WSP if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2m decline cumulatively at any water supply work then make good provisions should apply.
Water Pressure	1. A cumulative pressure head decline of not more than 2m decline, at any water supply work. 2. If the predicted head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provision apply.
Water Quality	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

The proposed development is located within a confined fractured rock aquifer system, which does not have a 'water table' and the piezometric surface represents 'water pressure' rather than the depth at which water would be encountered during excavation or drilling. As such, assuming negligible connectivity with overlying unconsolidated formations, ES consider that only groundwater pressure and groundwater quality minimal impact considerations apply for the proposed Avoca Tank Mine development.