Section 4B Potentially Impacted Environmental Features, Management Measures and Impacts

PREAMBLE

This section describes the environmental features within and surrounding the Project Site that would or may be affected by the LOM Project. Information is presented on the existing conditions, proposed design and operational safeguards, and predicted impacts.

Where appropriate, the Proponent's proposed monitoring programs are also described.

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4B.1 GROUNDWATER

The groundwater assessment for the LOM Project was undertaken by RCA Australia (RCA, 2010). The full assessment is presented in Volume 1, Part 1 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following subsections.

4B.1.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery & Co Pty Limited for the LOM Project (Section 3.3 and **Table 3.6**), the potential impacts relating to groundwater requiring assessment and their unmitigated risk rating are as follows.

- Reduced groundwater availability for existing uses (high risk).
- Degradation of groundwater dependent ecosystems (low risk).
- Changes in the hydrology/ geomorphology of the surrounding creek systems (moderate to low risk).
- Impacts on groundwater quality (moderate risk).
- Reduced availability groundwater to local land owners (moderate risk).
- Degradation of aquatic communities (moderate risk).

In addition, the Director-General's Requirements (DGRs) issued by the DoP identified "*Groundwater*" as one of the key issues that requires assessment within the *Environmental Assessment*. The assessment of impacts relating to groundwater is required to include the following.

- Provide a description of the existing groundwater environment.
- Provide a detailed assessment of the potential impacts on groundwater.
- Provide a detailed description of the measures that would be implemented to avoid or mitigate impacts on groundwater.

The groundwater assessment was undertaken in accordance with relevant guideline documents and planning policies.

The potential direct impacts to groundwater that may occur as a result of the LOM Project have been assessed. The groundwater assessment addresses the potential groundwater related effects on existing surface water resources, any groundwater dependent ecosystems (GDEs) and existing groundwater users.

In summary, the following potential impacts related to groundwater were assessed for the LOM Project.

- The potential groundwater in-flows into the LOM Project open cut area.
- The potential effects of dewatering on surrounding groundwater systems.
- The potential groundwater-related effects of the LOM Project on local stream and groundwater systems.
- The potential groundwater-related effects of the LOM Project on local receptors.

4B.1.2 The Existing Environment

4B.1.2.1 Hydrogeological Setting

The main hydrogeological units identified within and surrounding the Project Site are as follows (**Figure 4B.1**).

- Quaternary Sediments. – the alluvium located along Quipolly Creek approximately 2.5km from the Project Site and consisting of sands and gravel.
- Permian Coal Measures – consisting of eight coal seams and interburden strata of sandstones/siltstone and shales.
- Werrie Basalt –consisting of basaltic lava flows with a significant weathered profile of clay. Underlying the coal measures, the weathered clays of the upper basalt profile act to form a clay aquitard providing confinement/semi confinement of the basalt aquifer.

The Permian-aged coal measures have low permeability and porosity due to their compacted nature. The main water-bearing zones occur in the coal seams with minor water-bearing zones in the interburden rocks. The coal measures strata within the Project Site form a closed basin that is surrounded by a low permeability weathered basalt/clay, limiting the interaction of flows between these two aquifers.

The Quaternary sediments alluvial aquifer along Quipolly Creek contains strata of high permeability. Werris Creek does not appear to be supported by an alluvial aquifer and is an ephemeral creek with its flow largely derived from rainfall within the catchment.

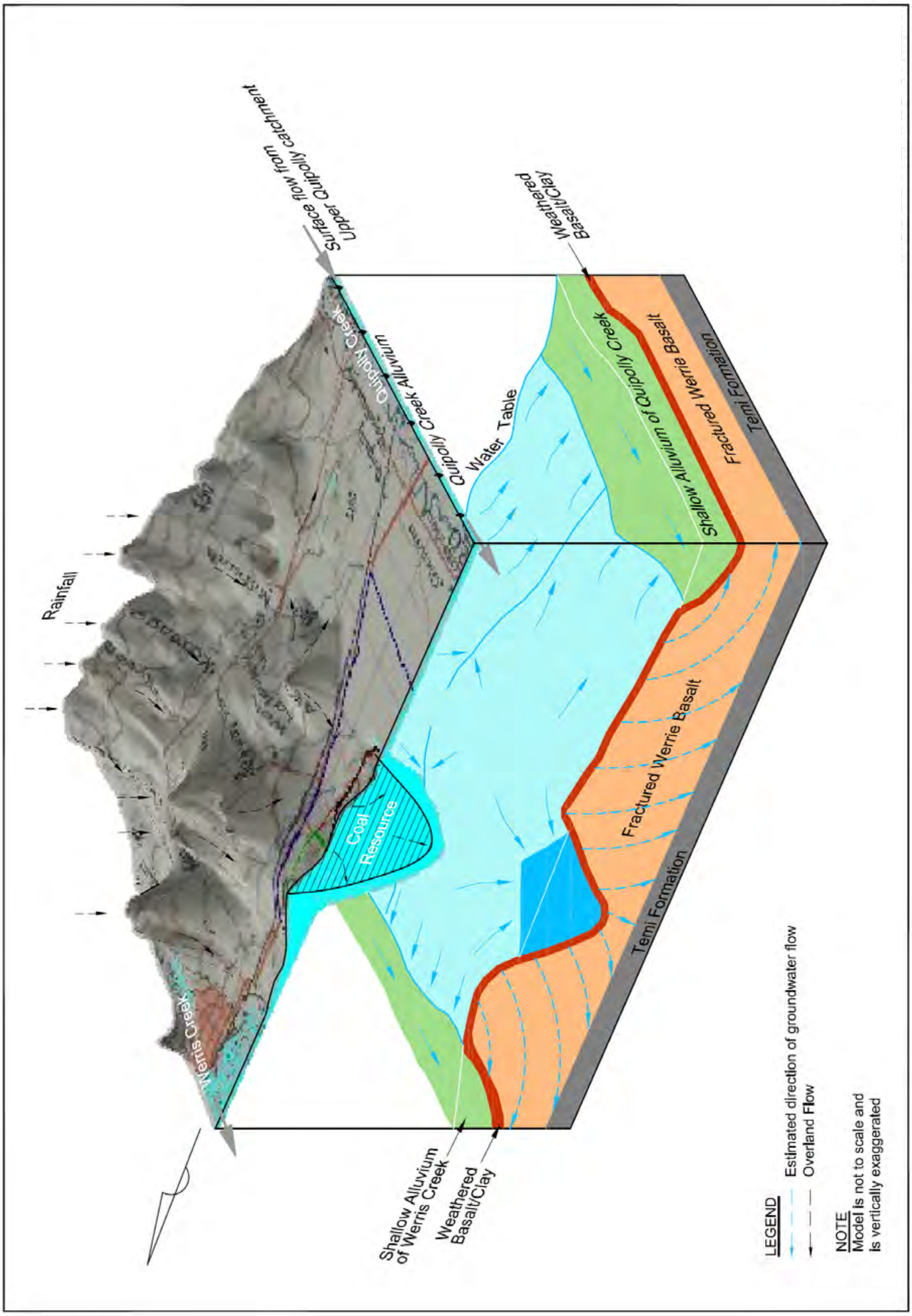
The geological setting relating to the above units has previously been described in Section 2.2. Further information on the regional geological setting is also presented in RCA (2010).

4B.1.2.2 Groundwater Flow and Interaction with Surface Water

Groundwater generally flows to the east and west from the mountain ranges bordering the Project Site before dividing to flow to the north or south through the valley and towards the Werris Creek or Quipolly Creek systems. Groundwater in the Werrie Basalt flows to the southwest and northwest from the topographical high point to the east of the Project Site. Groundwater flow in the Quaternary sediments alluvial aquifer is in a westerly direction, indicating that recharge is governed by surface water flows within the catchment.

There is higher permeability in the associated Quaternary sediments alluvium of Quipolly Creek relative to the underlying basalt/weathered basalt, which would promote horizontal flow through the alluvium. Some connectivity between basalt and alluvium may occur in zones where vertical fracturing intersects the alluvium or where alluvium is sufficiently deep to intersect water bearing basalt layers.

Groundwater within the Quaternary sediments alluvium of Quipolly Creek would provide base flow to the ephemeral creek system. As noted in Section 4B1.2.1, Werris Creek does not appear to be supported by base flows from the Quaternary Sediments alluvium.



Note: Model is not to scale although is vertically exaggerated
Source: RCA (2010) – Figure 11

FIGURE 4B.1
CONCEPTUAL HYDROGEOLOGICAL MODEL ASSOCIATED WITH THE LOM PROJECT

4B.1.2.3 Groundwater Recharge and Discharge Processes

Recharge to the coal measures aquifer is via infiltration from rainfall due to its elevated topography relative to its surrounds. Recharge to the Werrie Basalt aquifer occurs from rainfall and runoff from the surrounding sandstone ridges to the east and west of the Project Site, and to a lesser extent from infiltration leakage through the overlying weathered clay aquitard from the coal measures. The Quaternary Sediments alluvium of Quipolly Creek is recharged by the upper reaches of the Quipolly Creek catchment, as well as by (limited) direct infiltration and discharge from the underlying basalt aquifer.

4B.1.2.4 Groundwater Levels

The groundwater table within the coal measures occurs between 10m and 30m below the surface, between 8m and 52m below the surface within the Werrie Basalt aquifer and between approximately 5m to 9m below the surface within Quaternary Sediments alluvial aquifer. Groundwater monitoring has been conducted since 2005 to monitor the impacts on groundwater levels from the existing Werris Creek Coal Mine open cut operations. The monitoring data indicates that groundwater levels in the monitored bores have remained stable since 2005 with no changes in levels that would otherwise be expected to occur outside natural variation.

Water also occurs in the underground workings of the former Werris Creek Colliery which is situated centrally within the Project Site. Since dewatering of the underground workings commenced to allow for the progression of open cut mining, there have been falls of up to7m recorded in the water levels in the underground workings.

4B.1.2.5 Groundwater Quality

Figure 4B.2 illustrates the locations of current groundwater monitoring locations.

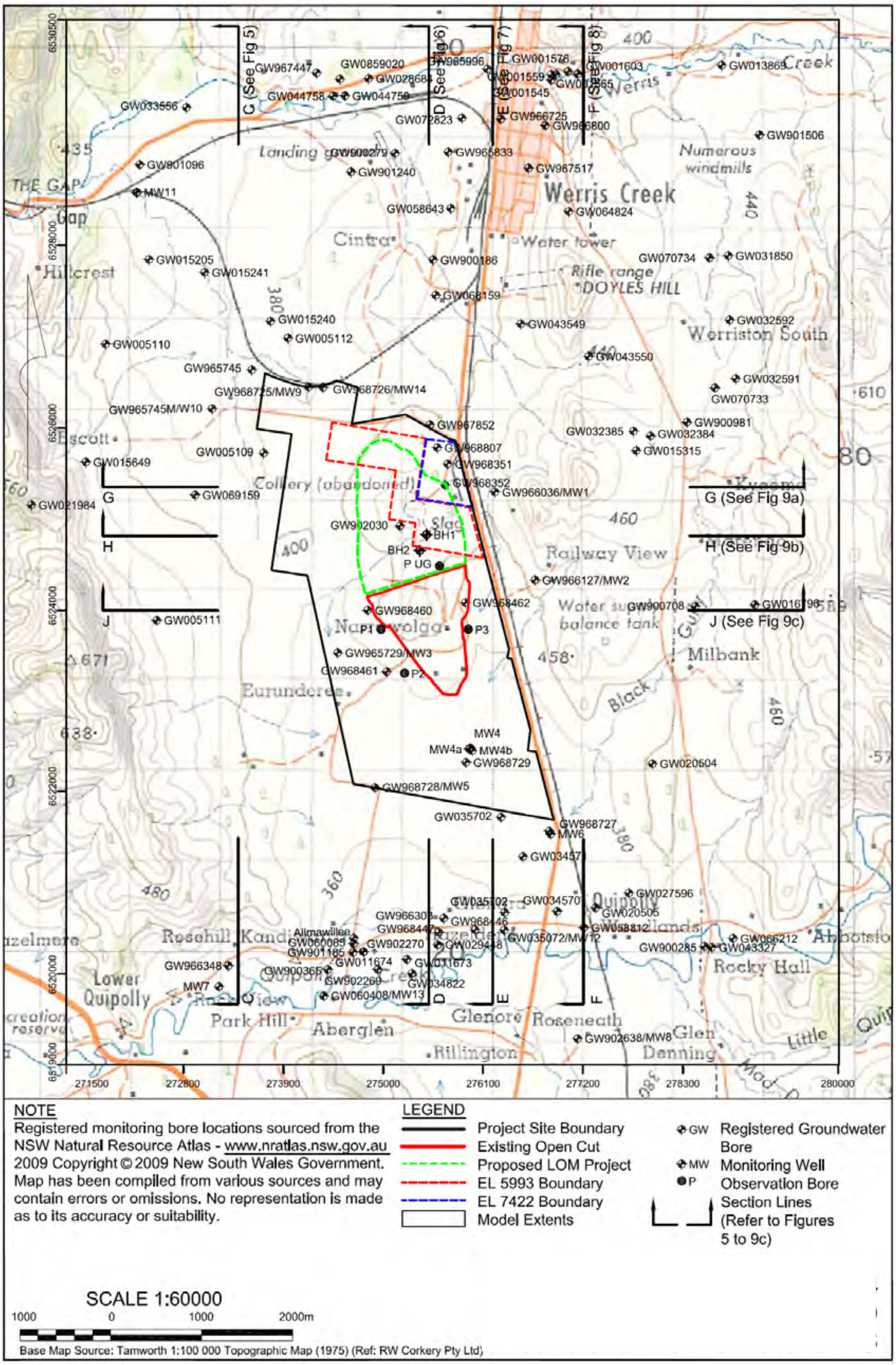
Groundwater within the underground workings and the coal measures beneath the Project Site is slightly acidic with low salinity. Metal levels are generally below the accepted limits for irrigation purposes, with all metal levels being well under the accepted limits for livestock use.

The basalt aquifer has a slightly acidic to neutral pH and is brackish. The concentration levels of other analytes indicate that the water within the basalt aquifer is suitable for irrigation and/or stock use.

The alluvial aquifer is of neutral pH and is fresh to slightly brackish. The concentration levels of other analytes indicate that the water within the alluvial aquifer is suitable for irrigation and/or stock use.

4B.1.2.6 Water Use and Availability

A review of the database maintained by the NSW Office of Water (NOW) was undertaken in May 2010 for the area contained within the model boundaries for the LOM Project (see **Figure 4B.2**). This review determined that 88 registered bores existed within the model boundary (approximately 3km from the LOM Project Site). Of these, 28 are situated in the Werrie Basalt, 22 within the alluvium of Quipolly Creek and the remainder are either unknown or situated within other rock types. Groundwater bores located within the model boundary are generally utilised for stock watering and irrigation purposes. The location of all identified registered bores is presented on **Figure 4B.2**.



Note: Identified cross sections provided as Figures 5 to 10 of RCA (2010)

Source: RCA (2010) – Figure 4

FIGURE 4B.2

REGISTERED GROUNDWATER BORES AND MONITORING BORES

4B.1.3 Groundwater Modelling

4B.1.3.1 Introduction

Groundwater modelling was undertaken using Visual Modflow 2009.1, a three-dimensional modular finite difference groundwater flow model. A briefing on the use of this model, and a description as to how this model was to be used, was provided to officers of NOW at a meeting held at NOW's Tamworth office on 1 July 2010. General support for the model and its use was subsequently provided by NOW.

The model domain comprises an area of 8.5km in the east-west direction by 11km in the north-south direction, in which the proposed limit of open cut mining is located towards the centre of the model. The model boundary conditions are shown in **Figure 4B.3**.

4B.1.3.2 Model Methodology

The groundwater model considered existing data, local and regional site conditions, the proposed open cut mining operations and the resulting impacts surrounding the Project Site.

The initial water table condition for the transient modelling was simulated under steady state conditions, which were assumed to be representative of long-term climatic conditions but also representative of the Project Site conditions. To predict the drawdown effect created by the progressive open cut mining activities associated with the LOM Project, a transient simulation was necessary.

The limit of the open cut mining area was simulated by applying constant head values at the depth of the open cut for various stages of the LOM Project. Dewatering of the underground mine workings was assumed to have been completed prior to commencement of the LOM Project.

The proposed open cut area as proposed for 2012 was simulated to provide the current head condition for the purpose of modelling subsequent scenarios for the LOM Project. Output from each scenario was then compared against the initial pre-mining groundwater condition.

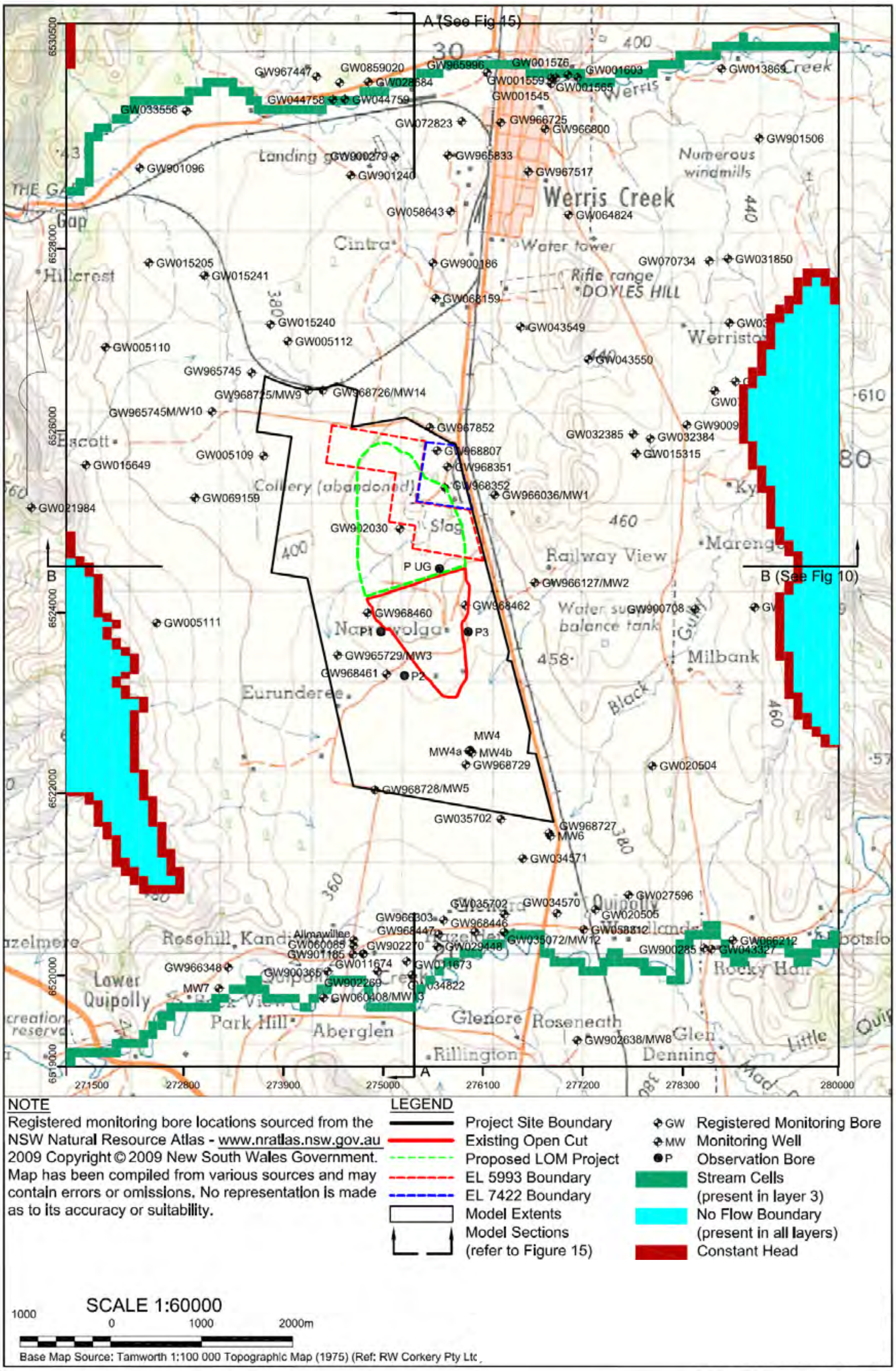
The long-term groundwater condition following completion of the LOM Project was simulated by removing the constant head boundary and varying the permeability of the layers within the void to represent backfilled overburden/interburden. The backfilled overburden/ interburden was modelled as a uniform mass with permeability of 1×10^{-5}m/s and a specific yield of 0.01. This permeability was adopted on the assumption that the void would be loosely backfilled.

4B.1.3.3 Model Assumptions

The model, which comprises seven layers, is discussed in detail in RCA (2010). In summary, the model layers are as follows.

- Layer 1 is approximately 3m in thickness below the topographic surface. It does not contain a water table over the majority of the model domain. In the vicinity of the coal measures, the model increases in depth, determined by interpolation of depths to the base of the G seam.

- Layer 2 comprises a thin layer of 2m in thickness off set from the base of Layer 1. With the exception that in the area of the coal measures it comprises a weathered clay profile and represents the upper weathered layer of basalt that underlies the G coal seam, this layer contains the same properties as Layer 1.



Source: RCA (2010) – Figure 14

FIGURE 4B.3
MODEL BOUNDARY CONDITIONS

- Layer 3 is an interpolated layer with thickness governed by the approximate depth of alluvium in the creek systems.
- Layers 4 and 5 represent the basalt formation with volcanic and conglomerate formations present.
- Layer 6 represents the basalt formation with volcanic and conglomerate formations although less fractured than layers 4 and 5.
- Layer 7 represents the lower Temi Formation at a depth of around 600m below the land surface.

4B.1.4 Potential Impacts on Groundwater Quality and Availability

4B.1.4.1 Potential Hydrogeological Impacts

The potential hydrogeological impacts associated with the LOM Project include the following.

- Aquifer depressurisation and groundwater in-flow into the open cut mining area requiring the management of its volume and treatment. Associated with aquifer depressurisation and in-flow to the open cut is the potential impact on the availability of groundwater to other users, as well as the quality of surrounding aquifers and surface waters.
- Impacts on groundwater systems and the availability of groundwater to other users.
- Impacts of the LOM Project on local stream systems including the removal of base flow due to dewatering from the LOM Project.
- Contamination of groundwater due to hydrocarbon or chemical spills associated with the LOM Project.
- Impacts on groundwater dependent ecosystems (GDEs).

4B.1.5 Management and Mitigation Measures

4B.1.5.1 Groundwater Contamination

Mitigation measures relating to groundwater contamination by hydrocarbons would be implemented in accordance with the existing Werris Creek Coal Mine *Groundwater Contingency Plan*. Any other changes in groundwater quality associated with the LOM Project would result in appropriate measures to mitigate impacts on groundwater quality being developed in consultation with the NOW's hydrogeologists (based on the nature of the impact/issue).

The final void would be filled above the equilibrium water level following the cessation of mining in order to prevent the accumulation of a potentially saline water body, which may possibly contaminate the surrounding aquifers.

4B.1.5.2 Groundwater Availability

In the event that monitoring identifies a reduction in the saturated thickness within any bore which is in excess of the trigger level (see Section 4B.1.6.1), and this is determined to be as a consequence of operations associated with the LOM Project, the Proponent would enter into negotiations with the affected landowner(s) with the intent of formulating an agreement which provides for one or a combination of the following.

- Re-establishment of saturated thickness in the affected bore(s) through bore deepening.
- Establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining.
- The provision of access to alternative sources of water.
- Monetary compensation to reflect increased water extraction costs.

RCA (2010) notes that the geological/hydrogeological parameters of the local aquifer systems are such that the proposed bore modification/replacement measures would be likely to restore any lost yield in groundwater.

4B.1.6 Assessment of Impacts

4B.1.6.1 Impact Assessment Criteria

RCA (2010) used the percentage reduction in saturated thickness predicted at bores surrounding the Project Site as the criteria to assess impacts on groundwater availability. This parameter represents the reduction of standing water within each monitoring or extraction bore. A typically accepted change in saturated thickness, which is considered to be representative of variation from seasonal fluctuations, is 15%. Evaluation against this parameter does not consider the available drawdown within the bore, as this can vary from saturated thickness depending on the location of the pump within the well. Therefore, evaluation of available drawdown for bores identified by the above trigger level would be undertaken as part of the monitoring program outlined in the groundwater component of the *Site Water Management Plan*. Further evaluation would also include a determination of yield.

Groundwater is used for irrigation and watering of livestock in the area surrounding the LOM Project. Consequently, the ANZECC (2000) irrigation and livestock guidelines would continue to be used as trigger levels for water quality as outlined in the existing Werris Creek Coal Mine *Site Water Management Plan*. Additional triggers would continue to be used for electrical conductivity (EC) and pH, whereby a variation of greater than 15% of the background EC value or 0.5 pH units in groundwater (as a result of the LOM Project) would trigger further action.

4B.1.6.2 Mine In-flows

Based on the model simulations, the seepage to the void at various stages of the LOM Project is presented in **Table 4B.1**.

Table 4B.1
Total Seepage to the Void

Time Period	Year 3	Year 7	Year 12	Year 15
Flow Total (m^3/day)	36	137	129	60
Annual In-flow (ML/year)	13	50	47	22
Source: Modified after RCA (2010) – Table 12				

The annual in-flow increases substantially in Year 7 and then decreases in Year 15 due to the synclinal nature of the coal seams and hence the depth of mining. In Years 7 and 12, the coal seams being mined would be at the deepest point and therefore there is more of the aquifer exposed to allow groundwater in-flow. By Year 15, mining of the coal seams would be moving upwards towards the surface (see **Figure 2.12**) which reduces the amount of groundwater in-flow into the open cut void space.

Due to evaporative rates in the area of approximately 1.9m/year, it is expected that evaporation would be greater than infiltration and that the LOM Project would generally operate as a dry mine (given the underground workings would be dewatered prior to the commencement of the LOM Project).

4B.1.6.3 Groundwater Drawdown

The drawdown of the groundwater table predicted by the model at the completion of Year 3, Year 7, Year 12 and Year 15 of the LOM Project are presented in **Figures 4B.4** to **4B.7**. Predicted impacts on each specific bore in the area is summarised in **Table 4B.2**. Modelling predicted that up to a 1.0m drawdown in the water table would occur within the Project Site, reducing to less than 0.1m in the basalt outside the Project Site.

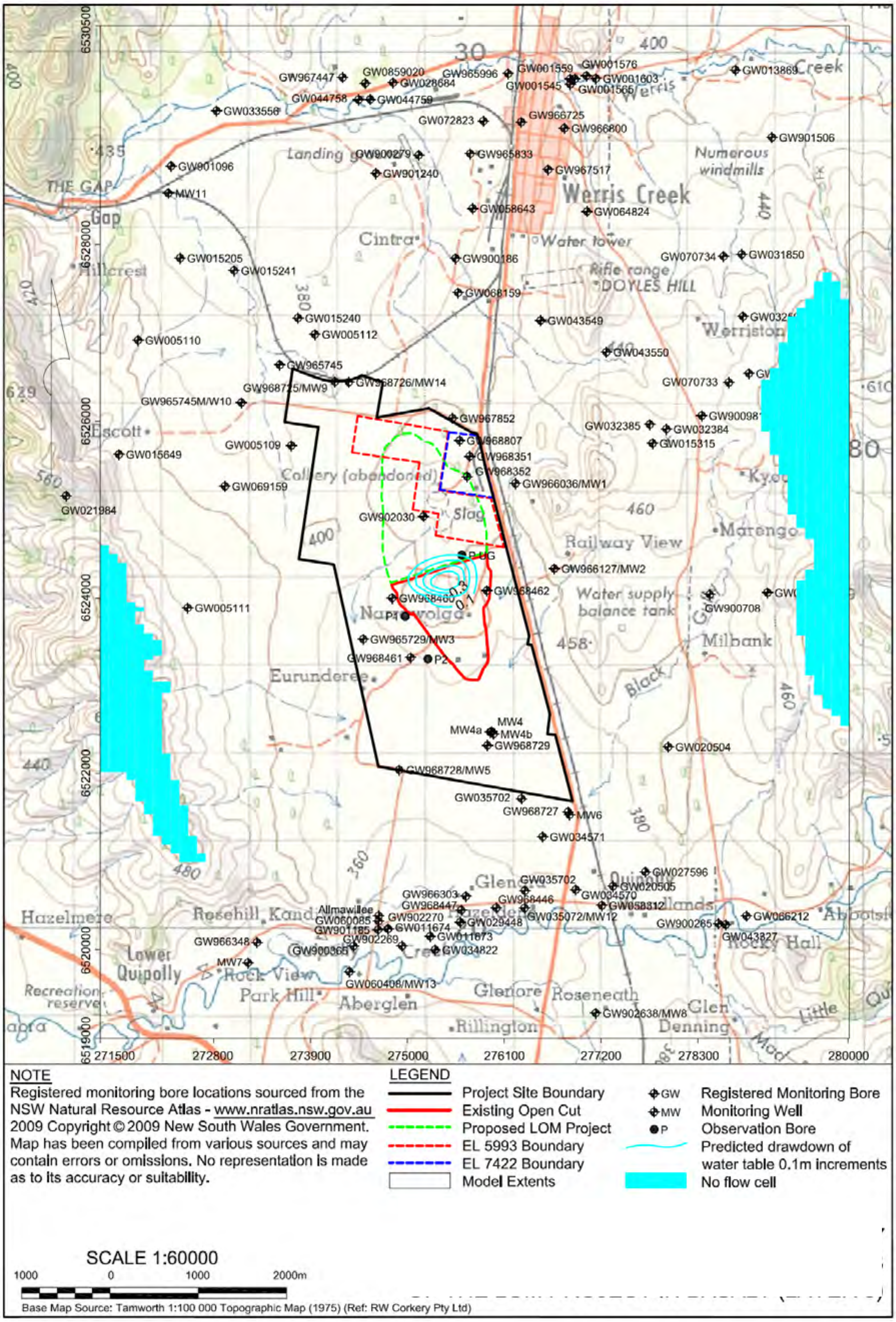
The predicted drawdown of the groundwater table is minimal and, as identified in **Table 4B.2**, would have an impact on the saturated thickness of surrounding groundwater bores well below the nominated trigger level (15% reduction). It is noted that the predicted impacts are reduced from those predicted for the groundwater assessment for the Werris Creek Coal Mine Northern Extension (RCS, 2009). However, the groundwater drawdown predictions of RCA (2010) are considered to be a more accurate reflection of groundwater response to open cut mining, given the additional calibration of the model undertaken using monitoring results collated since the commencement of open cut mining in 2005 and additional basalt aquifer testing undertaken during this assessment.

4B.1.6.4 Post Mining Groundwater Equilibrium

It was predicted that the water table would recover to approximately 325m AHD within 10 years of the completion of mining. The Proponent has committed to backfilling the open cut void to a level approximately 5m above this equilibrium level and a comparison of the final landform and the predicted final groundwater regime shows that the groundwater table would not breach the final surface. Given evaporative rates generally exceed rainfall and the limited catchment of the open cut void, no long-term water body would be formed within the open cut void. Any accumulated water would result from heavy rainfall would be temporary in nature and would be fresh in quality. That is, the backfilling of the open cut void above the groundwater table would prevent the creation of a saline water storage in the final landform.

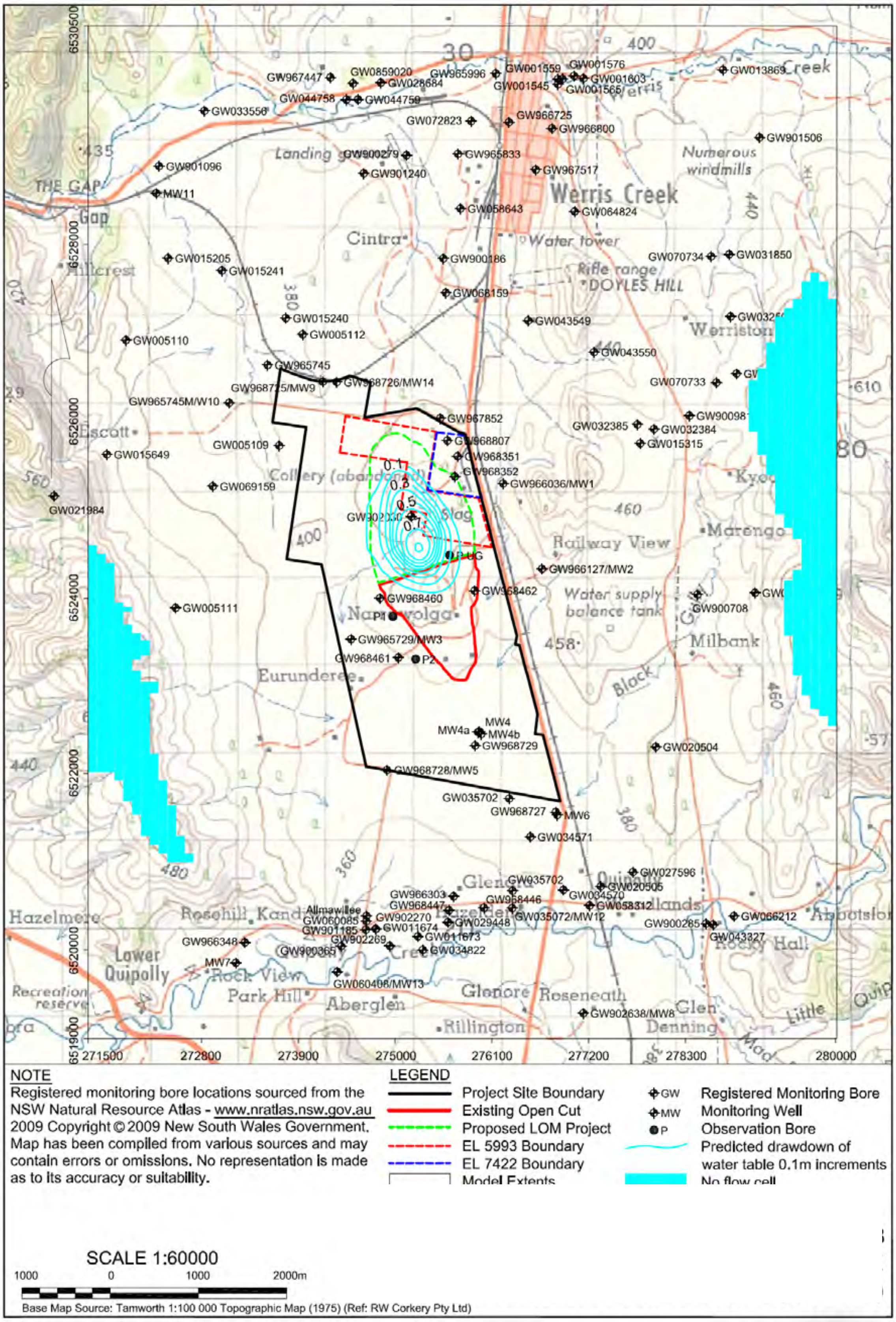
4B.1.6.5 Groundwater Availability

The predicted reduction in saturated thickness was calculated for bores surrounding the Project Site (see **Table 4B.2**). A variation in saturated thickness of 15% was considered to represent a variation outside of naturally occurring variations and was adopted as the trigger criteria for the evaluation of bore impact. RCA (2010) determined that there would be no reductions in saturated thickness predicted to occur within surrounding groundwater bores as a result of the Project.



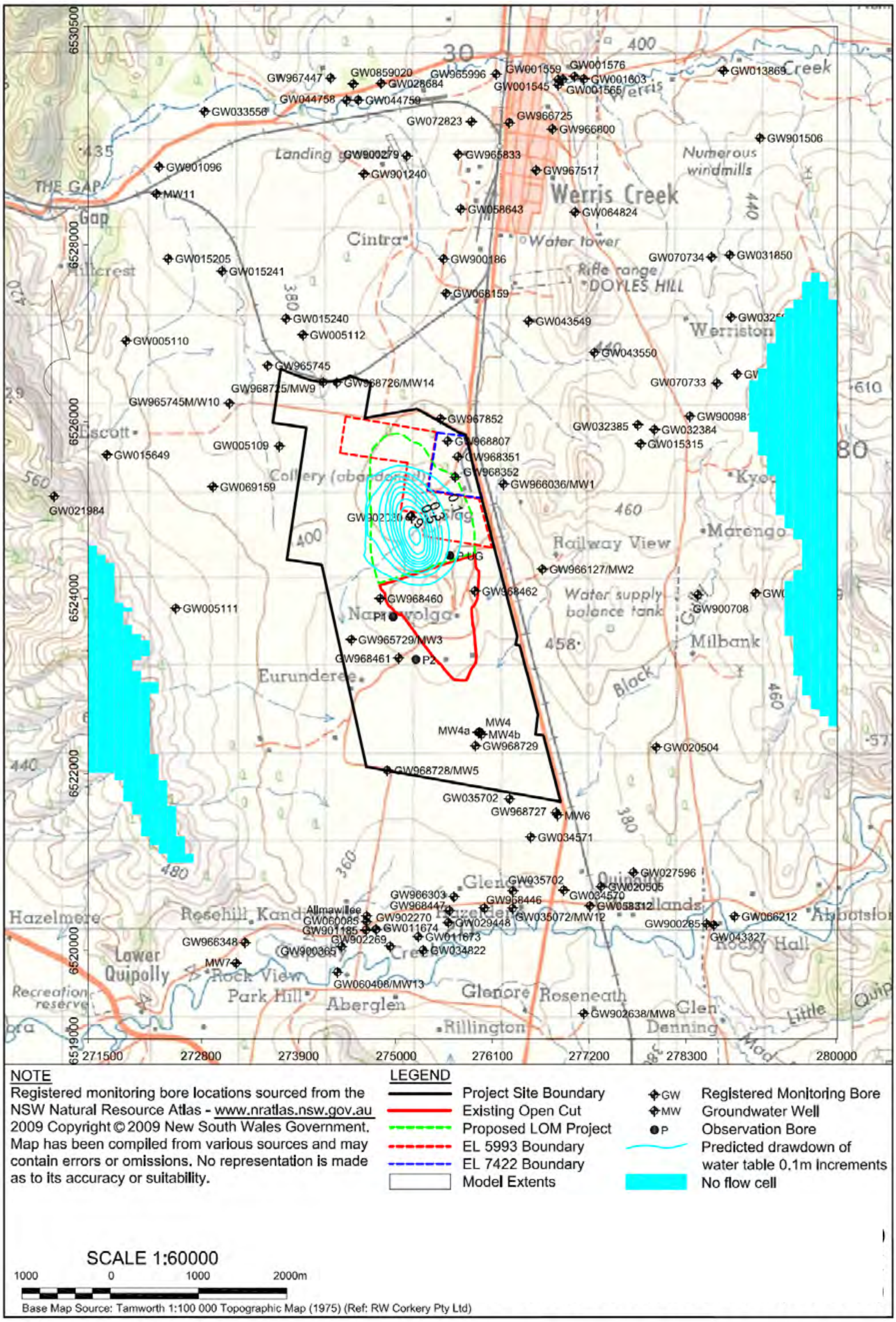
Source: RCA (2010) – Figure 27

FIGURE 4B.4
PREDICTED DRAWDOWN FOR YEAR 3 OF THE LOM PROJECT



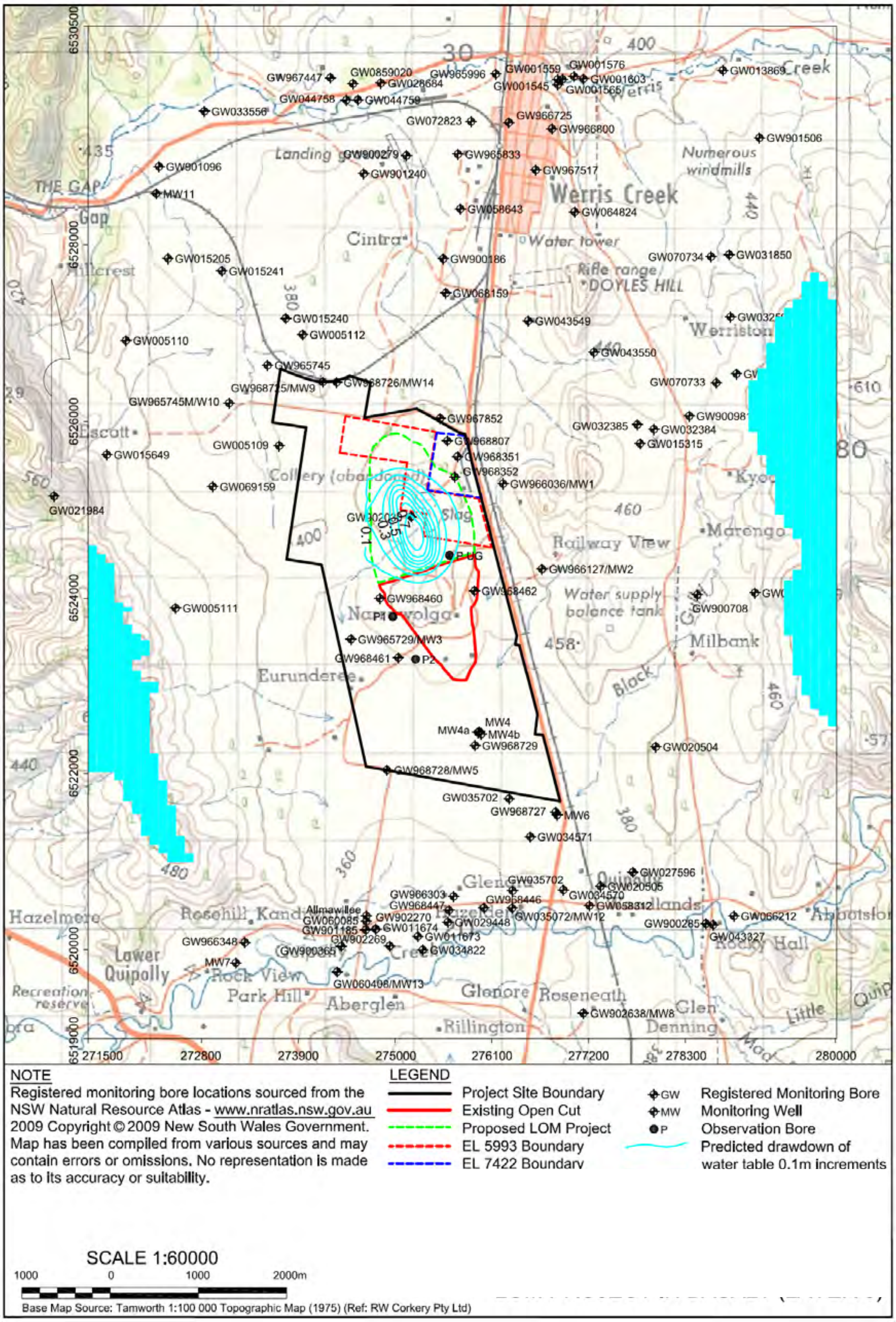
Source: RCA (2010) – Figure 28

FIGURE 4B.5
PREDICTED DRAWDOWN FOR YEAR 7 OF THE LOM PROJECT



Source: RCA (2010) – Figure 29

FIGURE 4B.6
PREDICTED DRAWDOWN FOR YEAR 12 OF THE LOM PROJECT



Source: RCA (2010) – Figure 30

FIGURE 4B.7
PREDICTED DRAWDOWN FOR YEAR 15 OF THE LOM PROJECT

Table 4B.2
Predicted Drawdown and Reduction in Saturated Thickness within 2km of Proposed Mining

Bore No	Property	AGM Easting	AGM Northing	Usage	Approx. Distance from limit of proposed mining (m)	Total Depth (m)	Water Bearing Zone Strata	Yield (L/sec)	SWL [@] (m)	Saturated Thickness (m)	Predicted loss in head (m)	% Reduction in Saturated Thickness	Comments
GW902030	Old Colliery	275169	6524932	Domestic	0	96.6	Coal Measures	33.5	63.1	33.5	0.1	0.3%	Tested 2004
GW968352	Preston Park	275665	6525381	Domestic	10	48.80	Basalt/Water Bearing	1.26	35.3	13.5	<0.1	0.7%	Not Tested
GW968462	Narrawolga	275892	6524087	Monitoring	40	61	Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW968460	Narrawolga	274815	6524004	Monitoring	60	42	Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW968461	Narrawolga	275022	6523326	Monitoring	300	25	Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW965729 (MW3)	Eurunderee	274599	6522941	Stock	600	39.6	Basalt	15.2	24.4	15.2	<0.1	0.7%	Tested 2008
GW966127 (MW2)	Railway View	276770	6524400	Domestic & Stock	820	65.5	Basalt	27.3	38.2	27.3	<0.1	0.4%	Tested 2008
GW968351	Preston Park	275696	6525612	Domestic & Stock	1080	76.2	Basalt	47.8	28.4	47.8	<0.1	0.2%	Not Tested*
MW5	Narrawolga	274900	6522046	Monitoring	1240	28	Basalt	8.2	19.8	8.2	<0.1	1.2%	Tested 2008
GW966036 (MW1)	Hillview	276380	6525100	Domestic & Stock	1250	68.7	Basalt	51.1	17.6	51.1	<0.1	0.2%	Tested 2008
GW967852	Cintra	275501	6526039	Domestic & Stock	1350	80	Shale	NK	NK	NK	<0.1	NK	Not Tested
GW005109	Lot 2, 802219	273671	6525732	Domestic & Stock	1640	79.2	Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW034571	Lot 8 DP751017	276516	6521295	NK	1650	14.6	NK	NK	NK	NK	<0.1	NK	Not Tested
GW069159	Escott	272917	6525270	Domestic & Stock	1700	30.40	WB Basalt	1.26	11.9	18.5	<0.1	0.5%	Not Tested*
GW015240	Escott	273746	6527182	Stock	1800	20.70	Basalt	0.46	13.4	7.3	<0.1	1.4%	Not Tested*
MW6	Narrawolga	276810	6521544	Monitoring	1840	16	Basalt	11.1	4.9	11.1	<0.1	0.9%	Tested 2008
GW900708	Talavera	278418	6524040	Domestic & Stock	1935	192	Basalt	1.4	190.6	1.4	<0.1	7.1%	Tested 2004
GW968729 (MW4b)	Narrawolga	275896	6522327	Monitoring Bore	2000	NK	NK	NK	NK	NK	<0.1	NK	Not Tested
MW4a	Narrawolga	275940	6522469	Monitoring	2000	NK	Basalt	NK	8.9	NK	<0.1	NK	Not Tested
GW900186	NK	275534	6527859	Domestic & Stock	2000	24.30	W.B. Basalt/Basalt	1.26	16.6	7.7	<0.1	1.3%	Not Tested*
GW020505	Woodlands	277320	6520726	Stock	2050	23.8	Alluvial/Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW032385	Hill View	277737	6525973	Stock	2100	97.50	Basalt Yellow Soak	0	28.7	68.8	<0.1	0.1%	Not Tested*
MW14	Cintra	274323	6526454	Monitoring	2240	26	Basalt	15.2	10.8	15.2	<0.1	0.7%	Tested 2008
GW020504	Woodlands	277947	6522311	Stock	2260	18.3	NK	NK	NK	NK	<0.1	NK	Not Tested
MW9	Cintra	274165	6526458	Monitoring	2280	28	Basalt	13.5	14.5	13.5	<0.1	0.7%	Tested 2008
GW005110	Escott	271927	6526927	NK	2300	18.3	Basalt	15.2	3.1	15.2	<0.1	0.7%	Not Tested*
GW005111	Escott	272495	6523889	NK	2400	88.4	Basalt	31.7	56.7	31.7	<0.1	0.3%	Tested 2004
GW015241	Escott	273020	6527721	Stock	2500	51.20	Basalt	0.19	9.1	42.1	<0.1	0.2%	Not Tested*
GW068159	Escott	275563	6527469	Domestic & Stock	2500	58.50	Shale	6.3	NK	NK	<0.1	NK	Not Tested
GW005112	NK	273935	6527001	NK	2650	48.8	Basalt	NK	NK	NK	<0.1	NK	Not Tested
GW965745 (MW10)	Turnbulls	273131	6526225	Domestic	2760	22	Basalt	18.2	3.8	18.2	<0.1	0.5%	Tested 2008
GW901240	Robynville	274631	6528826	Domestic & Stock	3000	28.90	Basalt	2.52	NK	NK	<0.1	NK	Not Tested

[@] SWL (Standing Water Level); Not Tested - Testing not attempted, NK – not known # Taken from Department of Natural Resources. ^ Determined from modelling. * Based on field observations and discussions with owners (2004)

Source: RCA (2010) – Table 11

4B.1.6.6 Impact on Alluvium of Quipolly Creek and Werris Creek

The modelling undertaken by RCA (2010) predicted that there would be no impact to either the Werris Creek or Quipolly Creek alluvial systems as a result of operations associated with the LOM Project. In Section 4B1.6.3, this represents a reduction in the impact from that predicted for the Werris Creek Coal Mine Northern Extension (RCA, 2009). The revised and reduced level of impact is a result of improved groundwater model accuracy due to calibration against groundwater monitoring results (2004 to 2010).

4B.1.6.7 Groundwater Quality

Changes to water quality could potentially occur should significant lowering of the water table result in oxidation of some compounds and changes to the chemical composition. RCA (2010) determined that oxidation of pyritic compounds within the coal seams may occur as a result of operations associated with the LOM Project which could decrease groundwater pH and consequently increase the concentrations of dissolved metals. However, even if this was to occur, there would be limited to no impact on the basalt layer due to the highly impermeable layer between the basalt layer and the coal seams. The interburden between these two layers may also act to neutralise the pH as it is composed of marine sediments and is fairly alkaline (void water at the Werris Creek Coal Mine is slightly to moderately alkaline). The trigger points for the mitigation of impacts associated with a decrease in groundwater quality associated with the LOM Project are discussed in Section 4B.1.6.1.

4B.1.6.8 Groundwater Dependent Ecosystems

An assessment of groundwater dependent ecosystems (GDEs) was completed as part of a Biodiversity Impact Assessment (ELA, 2010). Within the lands surrounding the Project Site, the main GDEs identified are the riparian vegetation and stream-based ecosystems associated with Werris and Quipolly Creeks. Given Werris Creek does not appear to be supported by an alluvial aquifer, and the modelling completed by RCA (2010) does not predict that there would be any reduction the groundwater of the alluvial sediments which provides base flow to Quipolly Creek, it was determined that it would be unlikely that there would be any associated impacts to GDEs as a result of operations associated with the LOM Project.

4B.1.7 Water Licensing

A water licence is required for the interception of the groundwater table during mining operations. The predicted maximum groundwater make during operations is 50ML/year (see **Table 4B.1**). This groundwater make is termed incidental water make by NOW and an aquifer interference licence is required. The Proponent currently holds WAL No 90BL25258 which allows an allocation of 50ML/year. This existing WAL provides sufficient allocation for the predicted incidental water make for the LOM Project.

4B.1.8 Groundwater Monitoring and Contingency Plans

4B.1.8.1 Groundwater Monitoring

Groundwater monitoring would continue to be conducted for the LOM Project in accordance with the Werris Creek Coal Mine's *Groundwater Management Plan.* The contingency plans to mitigate any substantial changes to groundwater quality or availability are summarised in Section 4B.1.8.2.

4B.1.8.2 Contingency Plans

The following contingency measures would be implemented to mitigate any substantial changes to groundwater quality or availability associated with the LOM Project. These contingency measures are drawn from the existing Werris Creek Coal Mine Groundwater Contingency Plan (part of the Werris Creek Coal Mine Site Water Management Plan).

- In the event that routine monitoring indicates that a trigger has been reached (refer Section 4B.1.6.1) or is being approached, the Proponent would commission a hydrogeologist to review the data, with the outcomes of that review, including any recommendations, being subject to discussion and agreement with hydrogeologists from NOW.
- If there is a trigger of pH or EC (refer Section 4B.1.6.1), the monitoring regime would initially be increased for analytes monitored and/or frequency of sampling to confirm the magnitude and extent of the change in water chemistry and verify the change is a consequence of operations associated with the LOM Project.
- Should the saturated thickness trigger level be achieved in any bore (refer Section 4B.1.6.1), the Proponent would notify the affected landowner(s) and, if the Proponent's and NOW's hydrogeologists are of the opinion that the reduction is a consequence of operations associated with the LOM Project, then the mitigation measures identified in the existing Werris Creek Coal Mine Groundwater Contingency Plan would be initiated. The Groundwater Contingency Plan provides for one or a combination of:

  a) re-establishment of saturated thickness in the affected bore(s) through bore deepening;

  b) establishment of additional bores to provide a yield at least equivalent to the affected bore prior to mining;

  c) provision of access to alternative sources of water; and

  d) monetary compensation to reflect increased water extraction costs (if any), for example as a consequence of lowering pumps or installation of additional or alternative pumping equipment.

- An independent authority would also be used where a dispute arises as to the cause of the change, given that groundwater supply and quality can be affected by non-mining-related factors.

4B.2 SURFACE WATER

The surface water assessment for the LOM Project was undertaken by GSS Environmental (GSSE, 2010a). The full assessment is presented in Volume 1, Part 2 of the Specialist Consultant Studies Compendium. A summary of the assessment is presented in the following sub-sections.

4B.2.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (see Section 3.3 and **Table 3.6**) the potential impacts on surface water requiring assessment and their **unmitigated** risk rating are as follows.

- Reduced downstream surface water quality (high risk).
- Reduced flows to downstream vegetation due to a reduction of environmental flows through the Project Site (high risk).
- Reduced flows in surrounding creek systems due to a reduction of environmental flows through the mine site (moderate risk).
- Changes to the coverage and frequency of flooding due to altered flood regimes (high risk).
- Increased flows and/or flooding in natural drainage lines for a short period due to dam failure (high risk).
- Uncontrolled discharge of dirty, saline, contaminated water outside licence conditions (high risk).

The Director-General’s Requirements identified “Surface Water” as one of the key issues that required assessment within the *Environmental Assessment*. The assessment of impacts on surface water is required to include the following.

- A detailed site water balance, including a description of site water demands, water supply and disposal methods.
- Detailed modelling and assessment of potential impacts on:
  - the quality and quantity of existing surface water and groundwater resources;
  - affected licensed water users and basic landholder rights;
  - the riparian, ecological, geomorphological and hydrological values of watercourses: and
  - impacts to agricultural lands.
- A detailed description of the proposed water management system (including all infrastructure and storages) and water monitoring program.
- A detailed description of measures to minimise all water discharges.
- A detailed description of measures to mitigate surface water impacts.

The methodology used in the surface water assessment, to fully address the DGRs, is described in GSSE(2010a). In summary, the methodology comprised both a review of appropriate literature of assessments conducted previously associated with the LOM Project, site inspections, evaluation and interpretation of baseline data acquired from the Project Site, modelling of potential impacts and the design of a site water balance.

The key objectives addressed in the surface water assessment were as follows.

- To prevent the flow of sediment-laden water into watercourses and the flow-on impact of sedimentation on receiving waters, being Quipolly Creek and Werris Creek.
- To control surface flows on rehabilitated areas to ensure minimal soil loss and to maintain adequate soil moisture for plant growth.
- To control discharges from the Project Site and ensure that the quality of any discharges are within the water quality criteria set out in the Environment Protection Licence (EPL) 12290.
- To prevent the in-flow of water into the active work area, wherever possible.
- To ensure site water usage requirements minimise the reliance on groundwater and clean water runoff.
- To ensure there is sufficient water available to meet the LOM Project water requirements.

The following sub-sections describe and assess the existing drainage and surface water environment, identify the surface water management issues, proposed surface water controls, safeguards and mitigation measures. An assessment of the residual impacts following the implementation of these safeguards and mitigation measures is also summarised.

The DGRs for the LOM Project request modelling be completed to assess the potential impact upon surface water and groundwater resources. Based on the likely minimal impact upon surface water quality and quantity, ecological, riparian, geomorphological and hydrological values of watercourses, and the extensive experience of GSSE in assessment and managing similar mining projects, GSSE (2010a) considered that surface water modelling is not necessary in order to assess the impacts of the LOM Project on surface water resources.

4B.2.2 The Existing Environment

4B.2.2.1 Regional Drainage

The Project Site is located within the Liverpool Plains catchment of the wider Namoi River catchment in central northern NSW (see **Figure 4B.8**). The Namoi River catchment covers an area of approximately 42 000km^2(NSW Government Namoi Catchment Management Authority, 2010) and is located within the Barwon-Darling River system in northwestern NSW. Major tributaries of the Namoi River include Coxs and Mooki Creeks, Peel, Cockburn, Manilla, and McDonald Rivers, all of which join the Namoi River upstream of Boggabri.

4B.2.2.2 Local Drainage

The Project Site is positioned between Quipolly Creek in the south and Werris Creek to the north (see **Figure 4B.8**). Werris Creek flows into the Mooki River and then into the Namoi River. Quipolly Creek, while its flow is restricted by the Quipolly Dam located upstream from the Project Site (refer to **Figure 1.2)**, flows into Quirindi Creek, the Mooki River and then into the Namoi River.

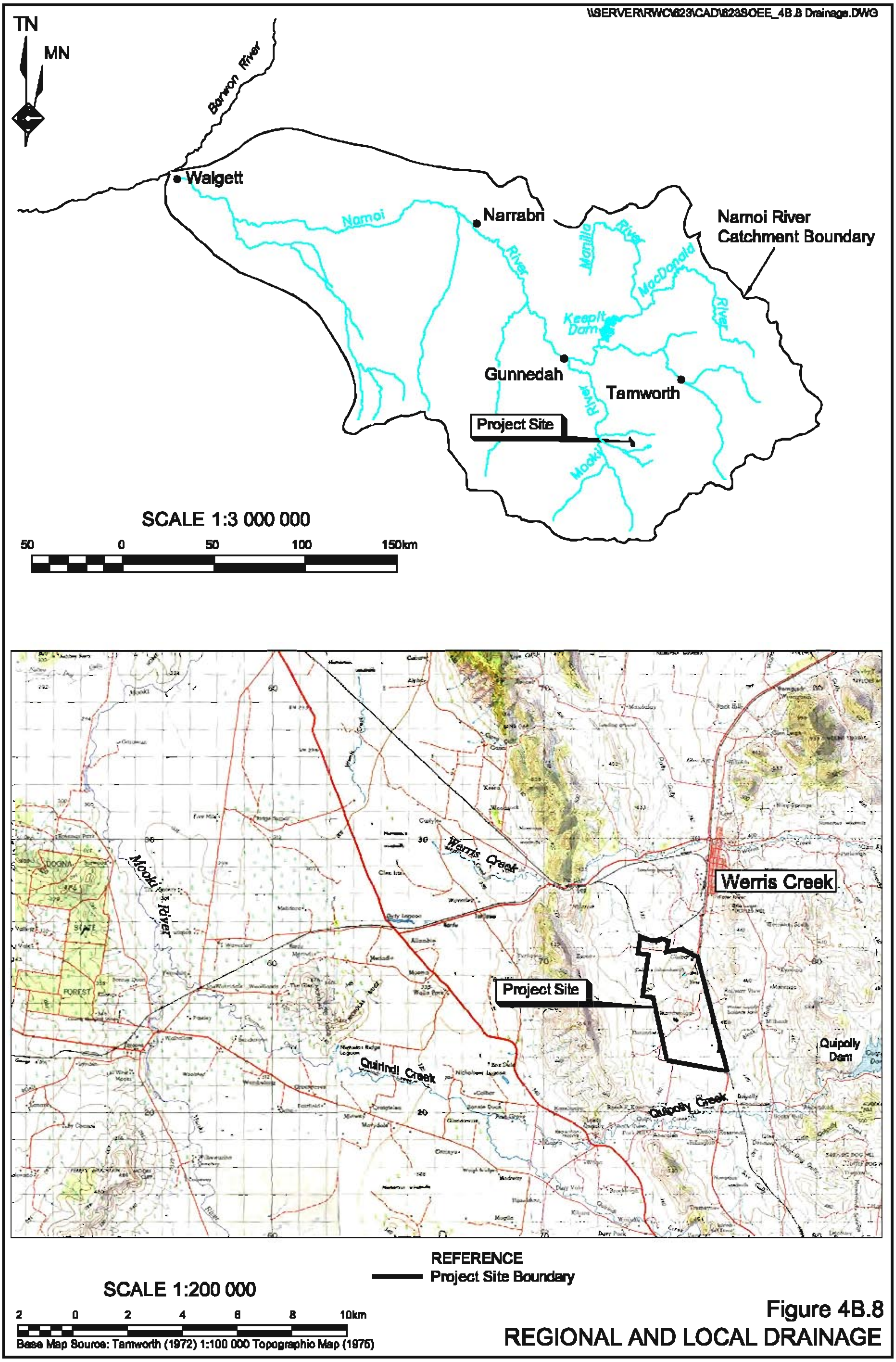


Figure 4B.8
REGIONAL AND LOCAL DRAINAGE

Approximately 210ha of the Project Site lies within the Werris Creek catchment and approximately 700ha lies within the Quipolly Creek catchment. The Project Site itself can be divided into nine catchment areas, as shown in **Figure 4B.9**. Catchments 2, 6, 7 and 9 lie within the Werris Creek Catchment and Catchments 1, 3, 4, 5 and 8 lie within the Quipolly Creek Catchment.

Figure 4B.10 shows the existing water management infrastructure at the Project Site and identifies the three licensed discharge points, referred to as LDPs 10, 12 and 14 located within sediment basins SB2, SB9 and SB10 respectively. Clean water dams (SD4 to SD11), sediment basins (SB1 to SB10), and two void water storage dams labelled VWD1 and VWD2 are also shown on **Figure 4B.10**.

The nine catchment areas within the Project Site are described below.

- **Catchment 1**: Approximately 470ha in area, drainage generally flows in a west to southwesterly direction. It is a clean water catchment with the runoff from this catchment currently diverted around the eastern side of the existing operations and discharging from the Project Site in the south. The water then flows into Back Gully and in turn towards Quipolly Creek some 2.7km south of the Project Site.
- **Catchment 2**: Approximately 75ha in area, drainage generally falls to the northwest. It is a clean water catchment with the runoff water flowing across the “Cintra’ property towards Werris Creek some 3.3km north of the Project Site northern boundary.
- **Catchment 3**: Approximately 170ha in area, drainage generally falls to the south but has been altered by existing open cut mining operations and associated water management structures. The catchment is part of the existing dirty water management system. Controlled discharges from the catchment can occur through LDP10 located within SB2 at the southern end of the Project Site which allows for water to be released off site into Back Gully and in turn towards Quipolly Creek.
- **Catchment 4**: Approximately 180ha in area, drainage generally falls in a south-westerly direction towards Quipolly Creek. The catchment is part of the existing dirty water management system with controlled discharges occurring through LDP12 located within SB9. The released water flows into Back Gully and in turn towards Quipolly Creek.
- **Catchment 5**: Approximately 75ha in area with all runoff contained within the existing mine void. This catchment forms the void water management system. All water within this catchment is contained and re-used on site.
- **Catchment 6**: Approximately 7ha in area, this catchment is part of the dirty water catchment in the north of the existing Werris Creek Coal Mine. Controlled discharges of water off site can occur through LDP14 located within SB10. The released water flows towards Werris Creek.
- **Catchment 7**: Accumulated flows from the northern part of the Project Site and off the properties to the northeast of the Project Site (“Hillview”, “Greenslopes and Banool”, “Werriston South”) flow to the north towards Werris Creek. Bound by Catchment 2 to the west, Catchment 1 to the south, the Werris Creek Rail Siding to the north and the major north-south aligned ridge to the east, the area of this catchment has not been defined.

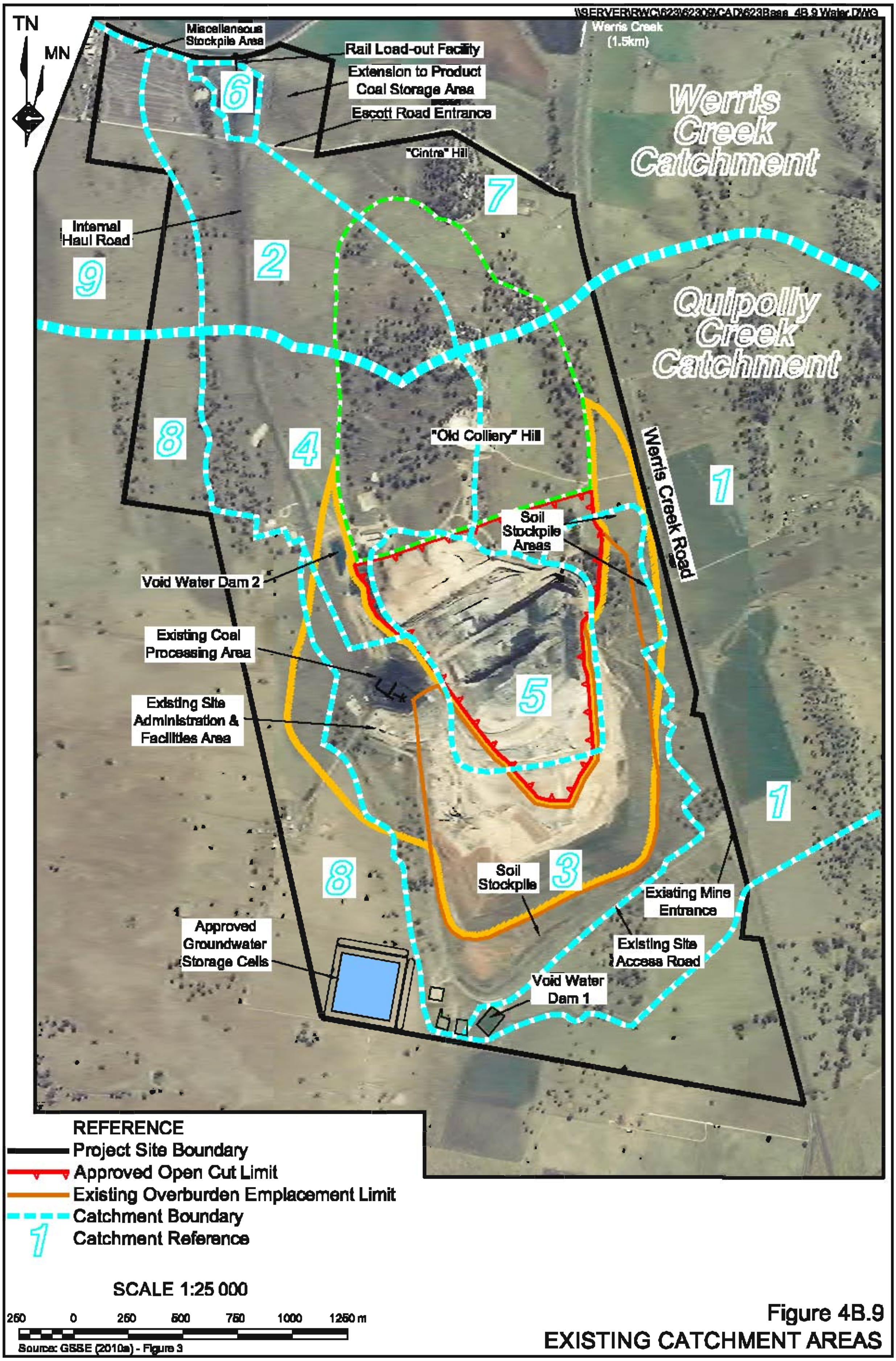


Figure 4B.9
EXISTING CATCHMENT AREAS

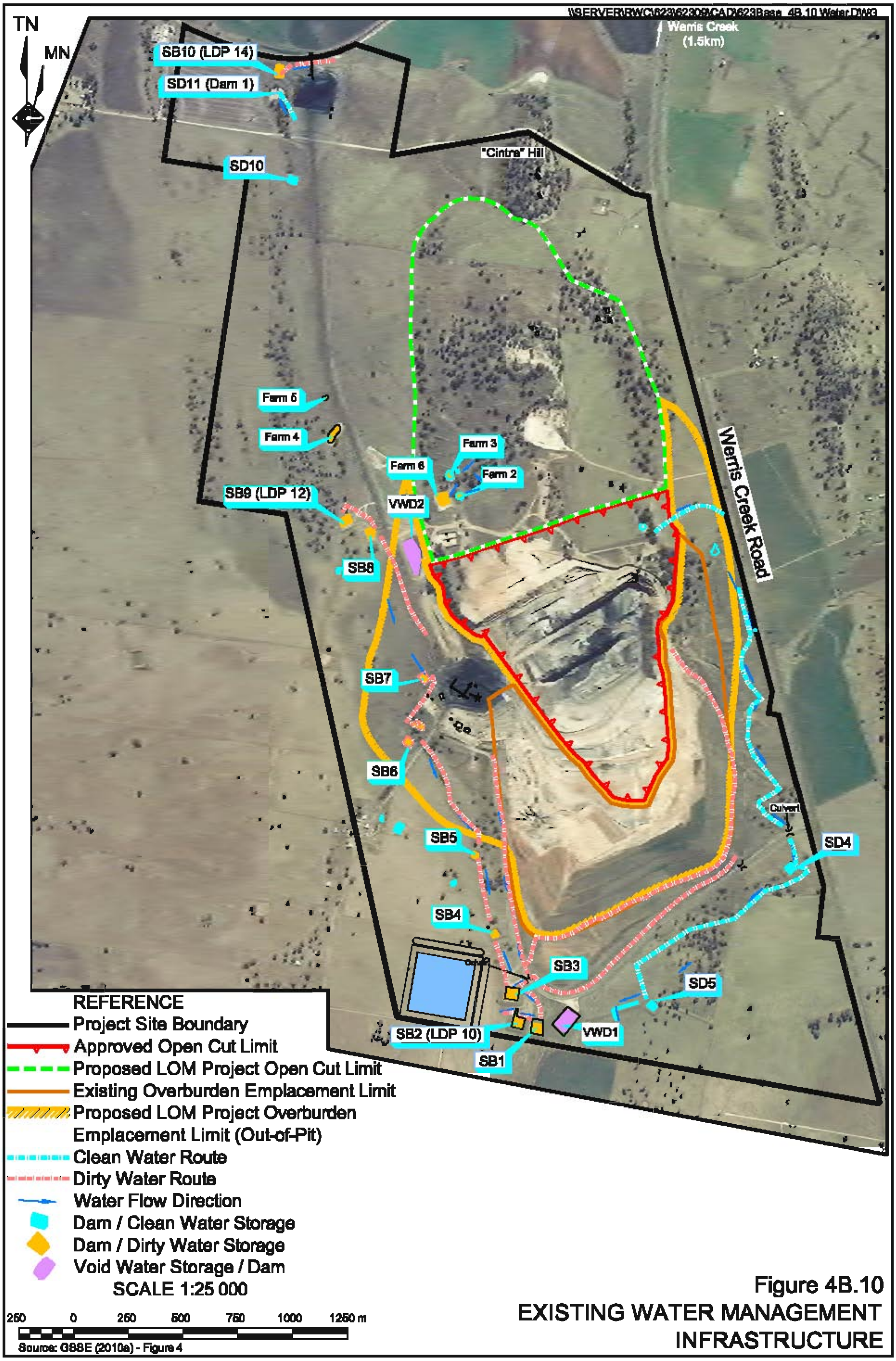


Figure 4B.10
EXISTING WATER MANAGEMENT INFRASTRUCTURE

- **Catchment 8**: Drainage of the southwestern part of the Project Site (west of Catchments 3, 4 and 6) follows the general fall in topography to the south. The area of this large catchment remains undefined and is likely to incorporate several smaller sub-catchments and water flows towards Quipolly Creek.

- **Catchment 9**: Drainage of the northwestern part of the Project Site (west of Catchment 2) follows the general fall in topography to the north. The area of this large catchment, which is partially bound to the south by the Werris Creek Rail Siding remains undefined and is likely to incorporate several smaller sub-catchments as water flows towards Werris Creek.

4B.2.2.3 Existing Project Site Drainage

All the drainage lines within the Project Site are poorly defined with no channels containing significant riparian vegetation, channel banks or bed. The existing natural drainage channels are rather broad, low gradient, pasture covered depressions that accommodate overland flow paths, rather than concise, concentrated flow paths. This is attributed to the small catchment areas and reasonably flat slopes of the Project Site.

All dirty water generated within the Project Site currently reports to sediment basins prior to being discharged (if required and in compliance with EPL12290 conditions) via licensed discharge points (LDPs – see **Figure 4B.10**). As noted above, Catchments 3, 4 and 6 currently report directly to these licensed discharge points.

Surface water released from the Project Site from the licensed discharge points presently flows towards Quipolly and Werris Creeks through small poorly defined drainage paths with no incised channel or clearly defined banks.

4B.2.2.4 Project Site Flooding Potential

There is a negligible chance of flooding occurring within the Project Site from Quipolly and Werris Creeks for the following reasons.

- Quipolly Creek (elevation 345m AHD) is approximately 2.9km south of the Project Site (elevation 360m AHD) and 15m lower than the southern-most point of the Project Site.

- Werris Creek is approximately 3.4km to the north of the Project Site and approximately 40m lower in elevation than the northernmost point of the Project Site.

These factors would inhibit floodwaters from moving out of Quipolly and Werris Creeks and inundating the Project Site. Even in the event of a failure of the Quipolly Dam (located southeast of the Project Site), the area of flooding would be restricted to the southern boundary of the Project Site (RWC, 2004).The slope of the southern section of the Project Site is approximately 1^o and is considered a floodplain (under Part 8 of the *Water Management Act 2000*). Water flowing onto the Project Site from the east of the Werris Creek Road has the potential to result in isolated flooding of the southeastern part of the Project Site if it is not diverted around the Project Site.

4B.2.2.5 General Sensitivity of the Namoi River Catchment

The Project Site is situated within the Namoi River Catchment and is covered by the Namoi Catchment Management Authority (CMA). In January 2007, the Namoi CMA published the Namoi Catchment Action Plan (CAP). The CAP identifies catchment issues and sets measurable management targets with respect to land practices and water quality. The management targets address issues identified as having the most significant impact on the four catchment resources, those being the landscape, people and their communities, native plants and animals, and surface and groundwater systems. For surface and groundwater systems, the overriding catchment target is as follows:

> *"From 2006, there is an improvement in the condition of surface and ground water ecosystems."*

For surface and groundwater management issues, the target specifies that:

> *"From 2006, maintain or improve surface and ground water quality suitable for irrigation, raw drinking water and aquatic ecosystem protection at Gunnedah, Narrabri and Goangra. Target values are determined by:*
>
> - *Australian & New Zealand Environmental Conservation Council Guidelines 2000, for Irrigation Water - Electrical conductivity range of 650 –1300µS/cm; and Aquatic Ecosystem Protection - mean values of Total Endosulphan< 0.03µS/Litre and Atrazine < 0.7µS/Litre; and*
> - *MDBC; River Salinity of 550µS/cm 50% of the time and < 1000µS/cm 80% of the time at Goangra (at time of writing the CAP)."*

The CAP states that the underlying principle to achieving many of these targets is through the use of Best Management Practices (BMPs). In the context of management of surface waters, BMPs refer to the management procedures and practices which are generally considered industry standard. GSSE (2010a) in their assessment, used BMPs associated with the management procedures outlined within the Blue Book (DECC, 2008e).

4B.2.2.6 Surface Water Quality

Existing surface water quality at the Project Site has been determined through existing ongoing monitoring and assessment undertaken in accordance with the EPL12290 conditions. Surface water quality monitoring has been conducted for the three licensed discharge points (see **Figure 4B.10**) and a number of surface water bodies within and surrounding the Project Site. Monitoring campaigns, as part of requirements of EPL12290, have been undertaken after wet weather discharge events and on a regular basis during dry weather conditions.

Wet Weather Discharge Water Quality Data

Wet weather water quality monitoring campaigns have been undertaken during or immediately following rainfall events where surface waters are discharged from the Project Site under licensed conditions. Water samples were collected during these events from the licensed discharge points (SB2/LDP10, SB9/LDP12, and SB10/LDP14) and at upstream and downstream locations (from the Project Site) within Quipolly and Werris Creeks. Although no discharge into Werris Creek has occurred via SB10/LDP14 since 2008, samples from the upstream and downstream locations nonetheless were collected and analysed when the creek was flowing. The samples collected were analysed for electrical conductivity (EC), nitrogen (nitrate), total nitrogen, oil and grease, pH, reactive phosphorus, total phosphorus and total suspended solids.

Surface water data for discharge into Quipolly Creek are presented in **Table 4B.3** while **Table 4B.4** summarises data acquired from samples collected from upstream and downstream of the Project Site in Werris Creek.

Table 4B.3
Water Quality at Licensed Discharge Points and within Quipolly Creek during Wet Weather Discharge

Sample Location	Discharge Date	EC (µS/cm)	Nitrate Nitrogen (mg/L)	Oil and Grease (mg/L)	pH	Reactive P (mg/L)	Total N (mg/L)	Total P (mg/L)	TSS (mg/L)
SB2 / LDP10	7 October 2008	375	-	<2	7.5	-	-	-	22
QC-UP		400	-	<2	7.9	-	-	-	21
QC-DOWN		380	-	<2	7.5	-	-	-	41
SB9 / LDP12	28 November 2008	50	<0.1	<5	7.0	0.74	1.3	0.85	**69**
SB2 / LDP10		360	<0.1	<5	8.5	0.02	0.38	0.05	8
QC-UP		60	0.8	<5	7.4	0.26	2	0.64	2740
QC-DOWN		890	<0.1	<5	7.8	0.1	0.11	0.14	10
SB9 / LDP12	13 December 2008	50	<0.1	10	6.9	0.53	0.85	0.69	**68**
SB2 / LDP10		280	0.5	7	7.5	0.29	1.9	0.47	**154**
QC-UP		220	0.4	7	7.1	0.23	0.6	0.61	466
QC-DOWN		790	<0.1	6	7.8	0.18	0.38	0.22	13
SB2 / LDP10	4 & 6 January 2010	122		<5	7.41				30
QC-UP		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
QC-DOWN		687	-	<5	7.71	-	-	-	10
SB9 / LDP12	15 February 2010	129	0.1	<5	7.9	<0.01	1.5	0.18	**138**
QC-UP		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
QC-DOWN		861	0.02	<5	7.82	0.1	0.3	0.1	10
SB9 (reports to QC)	5 May 2010	173	<0.01	<5	7.98	0.04	1.6	0.35	46
QC-UP		Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
QC-DOWN		1010	0.3	<5	7.99	0.02	0.3	0.15	8

Data in bold exceeds EPL12290 100-percentile criteria
Note: QC-UP refers to an upstream Quipolly Creek location and QC-DOWN refers to a downstream Quipolly Creek location.
Source: Modified after GSSE (2010a) –Table 7

Table 4B.4
Water Quality within Werris Creek Upstream and Downstream Locations

Sample Location	Sample Date	EC (µS/cm)	Nitrate Nitrogen (mg/L)	Oil and Grease (mg/L)	pH	Reactive P (mg/L)	Total N (mg/L)	Total P (mg/L)	TSS (mg/L)
WC-UP	7 October 2008	905	-	<2	7.7	-	-	-	905
WC-DOWN		375	-	<2	7.8	-	-	-	375
WC-UP	28 November 2008	250	0.3	<5	7.7	1.27	3.9	1.99	780
WC-DOWN		230	0.5	<5	7.9	0.88	5.0	3.57	8040
WC-UP	13 December 2008	370	2.5	6	7.8	0.56	4.5	1.29	2350
WC-DOWN		1140	<0.1	7	8.1	0.25	0.45	0.31	40
WC-UP	4 & 6 January 2010*	1270	-	<5	7.87	-	-	-	13
WC-DOWN		668	-	<5	7.71	-	-	-	4
WC-UP	15 February 2010	-	-	-	-	-	-	-	-
WC-DOWN		118	3.87	<5	7.82	0.05	5.8	0.11	62

WC-UP refers to an upstream location within Werris Creek and WC-DOWN refers to a downstream location within Werris Creek
Source: Modified after GSSE (2010a) – Table 8

The three discharge events into Quipolly Creek which have indicated elevated TSS levels were coincident with five-day rainfall levels exceeding 39.2mm (5 day 95th percentile rainfall event) prior to each discharge and were therefore in accordance with the EPL 12290 conditions. The corresponding TSS concentrations at the downstream monitoring location within Quipolly Creek were low, being <15 mg/L, which suggests that those discharge events did not increase TSS concentrations in Quipolly Creek.

Data from the Werris Creek samples (where there has been no discharge from the Project Site since 2008) show very high natural readings of EC and TSS with five of the nine samples summarised in **Table 4B.4** having resulted EC levels above the ANZECC 2000 trigger values for slightly disturbed upland river ecosystems (30 to 350µS/cm).

Dry Weather / Operational Water Quality Data

Data from routine water quality monitoring conducted since April 2008 within the Project Site are presented in **Table 4B.5**. The range of values obtained for each analyte is indicated rather than the median or average. The monitoring locations are shown on **Figure 4B.10** with the exception of storage dams SD1 to SD3 which have been mined through and no longer exist.

Table 4B.5
Operational Water Quality Data from within the Project Site

Sample Location	Sampling Period	pH	TSS (mg/L)	Oil & Grease (mg/L)	EC (µS/cm)	Total P (mg/L)	Total N (mg/L)
Clean Water Dams							
SD1	9 Apr to8 Jul 08	7.7 - 8.1	28 - 36	ND	160 - 220	0.21-0.88	1.4 - 1.9
SD2	9 Apr 08to10 Nov 09	8.1 - 8.9	7 - 21	ND	225 - 260	0.07 - 0.22	1.1 - 1.5
SD3	3 Apr to8 Jul 08	8.5 - 8.7	8 - 24	ND	370 - 400	0.07 - 0.54	1.0 - 1.2
SD4	9 Apr 08to23 Feb 10	8.1 - 9.2	10 - 48	ND	238 - 335	0.05-0.58	0.93 - 1.4
SD5	9 Apr 08to23 Feb 10	7.5 - 9.2	15 - 312	ND	255 - 458	0.08-0.78	1.3 - 3.6
SD11	8 Apr to 10 Jul 08	7.7 - 7.8	32 - 67	ND	150 - 150	0.58 - 1.2	2 - 2.8
Dirty Water (controlled discharge through LDP10 as required)							
SB2	10 Jul 08 to23 Feb 10	7.4 - 8.6	5 - 68	ND	335 - 470	0.01 - 0.19	0.4 - 1.4
SB5	27 Oct 08 to 15 Jan 09	7.6 - 7.8	67 - 120	ND	320 - 380	0.21 - 0.67	1.1 - 1.9
SB6	15 Jan 09 to23 Feb 09	7.6 - 8.2	11 - 92	ND	350 - 1980	<0.01 - 1.12	7.2 - 23.2
Dirty Water (controlled discharge through LDP14 as required)							
SB10	15 Jan 09 to23 Feb 10	7.1 - 8.1	47 - 360	ND	189 - 282	0.7 - 3.5	0.6 - 3.5
Dirty Water (controlled discharge through LDP12 as required)							
SB9	10 Jul 08 to23 Feb 10	7.5 - 8.1	8 - 128	ND	134 - 575	0.9 - 3.3	0.3 - 3.1
Void Water							
VWD 1	15 Jan 09 to23 Feb 09	8.0 - 8.4	5 - 14	ND	845 - 1080	<0.01 - 0.04	0.58 - 4.9
VWD 2	23 Jan 09to23 Feb 10	7.9 - 8.5	3 - 257	ND	932 - 1220	<0.0 1- 0.04	0.6 - 9.1
ND – Not detected							
Source: Modified after GSSE (2010a) –Table 9							

Although EPL 12290 concentration limits criteria do not apply to the data presented in **Table 4B.5**, TSS concentration values in the clean water dams(with the exception of SD5), have historically been less than the 50mg/L limit. Similarly, pH values for the clean water dams were within or very close to the EPL 12290 criteria. The vast majority of pH readings from dirty water dams and void water of the open cut have been within the EPL range, although the TSS concentrations have exceeded the EPL criterion on some occasions in SB5, SB9 and SB10.

Operational water quality data indicate that EC values from licensed discharge point dams ranged from 134uS/cm to 575uS/cm, while the wet weather discharge data indicate lower values (50uS/cm to 360uS/cm), suggesting that during discharge events the additional rainfall/runoff captured within these dams provides a diluting effect.

4B.2.2.7 Existing Surface Water Management

Existing water management at the Werris Creek Coal Mine is centred on the separation of the clean, dirty and void water to enable their appropriate management. All attempts are made to capture and divert clean water runoff around the Project Site so as to avoid its contamination. Void and dirty water are preferentially used over clean water for dust suppression, coal processing, watering of vegetation and other Project Site water requirements.

Existing Clean Water Management

The clean water catchment area comprises a large area to the east of the existing Werris Creek Coal Mine operation. Clean water runoff from catchments to the north and west of the Project Site is prevented from entering disturbed areas primarily through the use of a series of dams and diversion banks constructed around the northern, western and southern boundaries of the active mining area. The current clean water storage dams (labelled SD4, SD5, SD10 and SD11 in **Figure 4B.8**) provide a total storage capacity of approximately 14ML.

Existing Dirty Water Management

Dirty water, generated by rainfall runoff from a number of disturbed areas around the existing mine site is captured and treated in accordance with the *Managing Urban Stormwater: Soils and Construction, 4th Edition (Landcom, 2004)* prior to being used on site or discharged off-site under licensed conditions. The locations of existing dirty water sediment basins (SB1 – SB10) and farm dams (Farm 2 to Farm 6) are shown in **Figure 4B.9**. Dirty water within the existing mine site is managed as follows.

Southern Area – Catchment 3

Dirty water from disturbed areas comprising offices, workshops, coal processing operations, overburden emplacements and areas undergoing rehabilitation, drain via a series of dams and catch drains to sediment basins SB1 to SB7. These sediment basins, providing a total storage capacity of approximately 32.9ML, store and treat dirty water prior to re-use or discharge from the Project Site via LDP10 (SB2). Water levels in sediment basins SB1 and SB3 to SB7 are kept below 50% capacity at all times to ensure that capacity to store more dirty water during rainfall events exists. Since SB2 is the licensed discharge point, it is generally maintained in a dry condition where possible to provide full capacity to store dirty water during rainfall events.

Middle Area – Catchment 4

Dirty water from disturbed areas comprising of the Rail Load-out Road and Explosives Magazine drain via a series of dams and catch drains to Sediment Basins SB8 and SB9, which store and treat dirty water prior to re-use or discharge from the Project Site via the licensed discharge point LDP12 (SB9). Where possible, SB9 is maintained in a dry condition to provide full capacity to store dirty water during rainfall events. SB8 and SB9 provide a total of 7ML storage capacity to the Middle Area catchment while Farm Dams 2 to 6 provide a further 16.15ML of storage. These Farm Dams store and treat dirty water originating from upstream in the catchment before linking up with SB8 and SB9. The storage level within Farm Dam 6 is maintained below 50% where possible to provide additional capacity during rainfall events.

Northern Area – Catchment 6

Dirty water from the Rail Load-out Facility and Product Coal Storage Area is surrounded by catch drains which direct all run-off water to sediment basin SB10. SB10, also the licensed discharge point LDP14, stores and treats dirty water prior to re-use or discharge from the Project Site. It is maintained in a dry condition where possible to provide full capacity (approximately 2.85ML) to store dirty water during rainfall events.

Existing Void Water Management

Void water is generated by rainfall and runoff from within the open cut (forming Catchment 5) and adjacent areas and from groundwater in-flow into the open cut void. Any water collected within the void is drained to sumps. Some of this water may naturally seep underground, however, the majority of water is pumped out to prevent the accumulation of water within the void. Any water pumped from the former underground workings is also classified as void water and is treated within the void water management system.

The void water can be pumped either directly into a water truck for dust suppression, or to dam/s outside the void for storage and re-use on the Project Site. The existing clean water dams and diversion structures act to prevent the majority of overland flows from surrounding lands entering the void water catchment, thereby minimising the quantity of void water to be managed.

The existing void water treatment system includes Void Water Dam 1 and 2 (labelled VWD1 and VWD2 in **Figure 4B.10**) and the approved Groundwater Storage Cells. VWD1, located in the southern area of the Project Site has an approximate capacity of 20ML. VWD2, located in the central area of the Project Site, has a surveyed capacity of 35ML. The approved Groundwater Storage Cells have a capacity of 200ML.

Water from the underground workings is dewatered ahead of open cut mining (if required) and pumped to the void water management system. This water is used preferentially for dust suppression. In operations to date, pumping from the former underground workings has not been required, with water levels dropping as a consequence of seepage from the void spaces into the open cut, which has subsequently been pumped from the void sumps to the existing void water management system.

4B.2.3 Potential Sources of Water Pollution

4B.2.3.1 Potential Pollution Sources during Construction and Operation

The activities identified during the operational phases of the LOM Project with the potential to impact on surface waters would be:

- construction of the Acoustic and Visual Amenity Bund;
- relocation of the various infrastructure areas;
- open cut mining;
- overburden extraction and management;
- coal stockpiling and crushing activities;
- product transportation and vehicular access; and
- machinery maintenance activities.

The manner in which these activities may impact upon surface water quality and quantity may include (but not be limited to) the following.

- Elevated turbidity within surface water runoff.
- Entrainment of coal fines within surface water runoff.
- The potential for elevated mineral and nutrient content in surface water runoff.
- The potential for increased salinity within surface water runoff.
- The potential for elevated levels of hydrocarbons associated with maintenance activities.
- Changes in clean water flows reporting to surrounding watercourses.
- Potential for further alteration to the existing hydrologic regime.

Where the appropriate water management measures (discussed in Section 4B.2.4) are put in place, the potential to impact on surrounding water quality and quantity would be substantially reduced.

4B.2.3.2 Potential Pollution Sources during Decommissioning and Rehabilitation

The likely impacts of the LOM Project and the contaminants of concern during decommissioning and rehabilitation are likely to be similar to those identified for the construction and operation phase of the LOM Project. Notably, the quantity of these contaminants would decrease as rehabilitation work progresses and revegetation is successfully established.

4B.2.4 Water Management Measures and Operational Safeguards

4B.2.4.1 Introduction

The principal objectives of the proposed surface water management for the LOM Project would be to:

- segregate clean and dirty water flows;
- minimise surface flows across disturbed areas;
- design and manage flows in accordance with best practice so that water leaving the Project Site results in a neutral or beneficial effect on water quality in the receiving waters of Quipolly and Werris Creeks; and
- manage surface water appropriately in order to meet the Project's water usage requirements.

4B.2.4.2 Key Water Management Infrastructure

The key water management strategies that would be adopted across the Project Site are summarised as follows.

- Dirty water generated from disturbed areas, such as soil stockpile areas and overburden emplacement areas, as a result of rainfall/runoff would be captured and diverted using contour banks and drop structures in a manner that minimises the potential for concentrated overland flow and subsequent erosion. This water would be channelled through a series of sediment basins to reduce sediment loads prior to discharge under licence conditions. Three dirty water catchments would be maintained, the area of which would change over the life of the LOM Project to reflect the progressive development of the open cut and overburden emplacement. The activities included within each catchment are as follows.
  - Southern Catchment. Areas of disturbance would include the active overburden emplacement (excluding the in-pit section within flows into the open cut), soil stockpiles to the east of the open cut, and the existing Site Administration and Facilities and Coal Processing Areas. Dirty water would be diverted through a series of drains and sediment basins to SB2 (the designated discharge point).
  - Middle Catchment. Areas of disturbance would include the existing dirty water drain and associated dirty water dams along the western boundary of the Project Site, the southern section of the Rail Load-out Road, the relocated Site Administration and Facilities and Coal Processing Areas, the relocated Precursor Storage Facility and Explosives Magazine and additional temporary soil stockpiles. Dirty water would be diverted to SB9 (the designated discharge point).
  - Northern Catchment. Areas of disturbance would include Northern Site Access Road, northern section of the Rail Load-out Road, Product Coal Storage Area and turn-around rail loop.Dirty water would be diverted to SB10 (the designated discharge point).
- Water generated within the open cut, primarily as a result of rainfall/runoff and possible groundwater seepage, would be contained within in-pit sumps. This water would be directed to and contained within the in-pit sumps until it is necessary to pump the water to the void water dams.
- Clean water diversions would be constructed upstream of disturbance areas, wherever possible, to minimise the amount of dirty water to be contained and treated within the dirty water management system. The primary function of these clean water diversions would be to re-direct clean water flowing onto the Project Site from adjacent lands into existing drainage lines.
- Progressive rehabilitation of all available areas would occur to assist in reducing TSS concentrations (and possible high pH and EC levels) in runoff from disturbed areas. This would also reduce the dependence on the sediment controls and help improve water quality.

- The re-use of as much water as possible collected in the open cut, void water dams, groundwater storage cells and/or dirty water dams for dust suppression purposes. This would also minimise the chance of pollution to downstream waterways.
- Sediment control structures would be maintained to design capacities to ensure optimum settling rates. This would be most critical for those 'end-of-line' sediment basins, i.e. licensed discharge points, which discharge from the Project Site.
- Implementation of an effective revegetation, maintenance and monitoring program for all water management infrastructure associated with the Project.

These strategies, as they would impact on key stages of the Project, are discussed in detail in GSSE (2010a) for three scenarios – Year 3, Year 7 and Year 12 of the LOM Project. The management of clean, dirty and void water is discussed for each scenario. It is proposed to maintain the majority of existing water management infrastructure at the Werris Creek Coal Mine for the LOM Project with additional water management measures implemented at key stages to accommodate an increased disturbance area. It is also proposed that all additional dirty water flows would be directed to the existing licensed discharge points as this strategy would best utilise the existing available water management infrastructure. The key changes to the existing water management system for the LOM Project, including the nominated areas of the Southern, Middle and Northern Dirty Water Catchments, are summarised below and shown in **Figures 4B.11** to **4B.13**.

Year 3 Water Management Infrastructure (see Figure 4B.11)

- An additional clean water diversion bund would be constructed in the northern area of the Project Site to divert clean water runoff from the clean water catchment (to the west of "Cintra" Hill) around the Rail Load-out Facility and Product Coal Storage Area.
- The diversion bund along the eastern side of the overburden emplacement area would be extended to the north to accommodate the expanding overburden emplacement area.
- An additional dirty water diversion bund would be constructed around the southwestern boundary to collect dirty water generated from the proposed temporary soil stockpile immediately to the south of SB8 and direct this flow to SB2. As the overburden emplacement area expands, this diversion bund would also act to capture dirty water runoff generated from the overburden emplacement area. The additional dirty water generated from the expanded overburden emplacement area would require additional sediment basin capacity which could be achieved through augmenting existing sediment basins or the construction of new sediment basins of the appropriate dimensions.

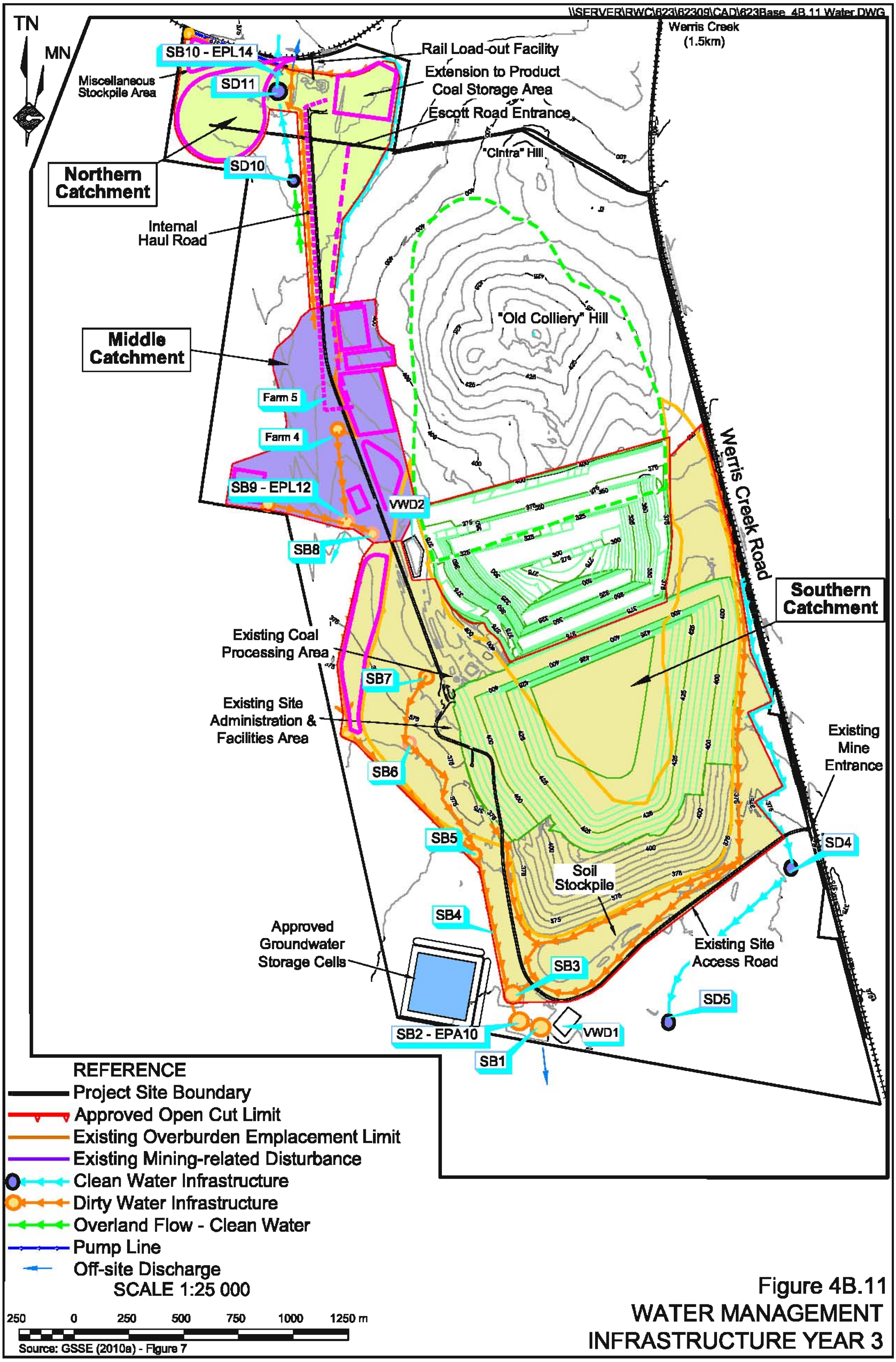


Figure 4B.11
WATER MANAGEMENT INFRASTRUCTURE YEAR 3

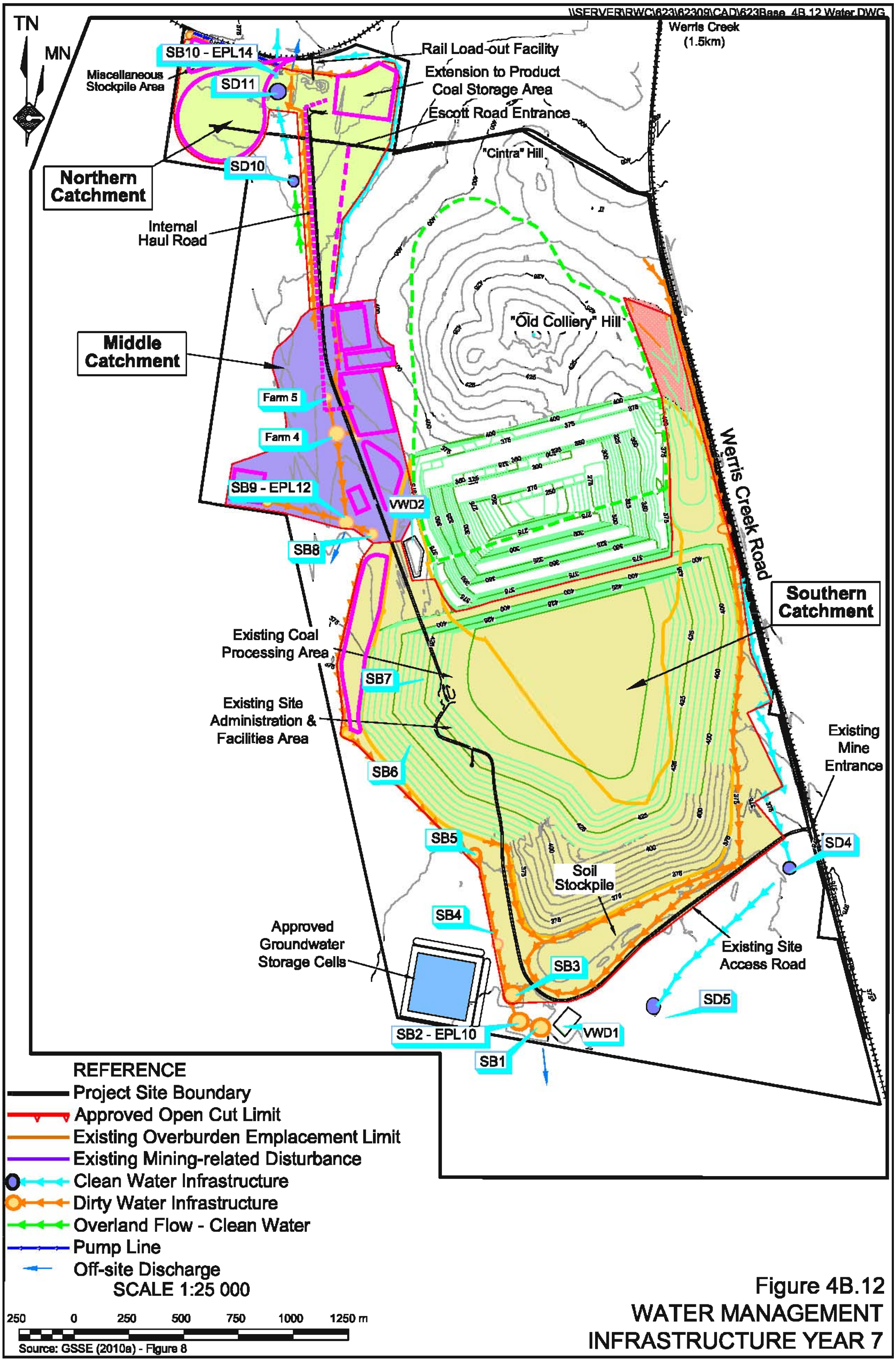


Figure 4B.12
WATER MANAGEMENT INFRASTRUCTURE YEAR 7

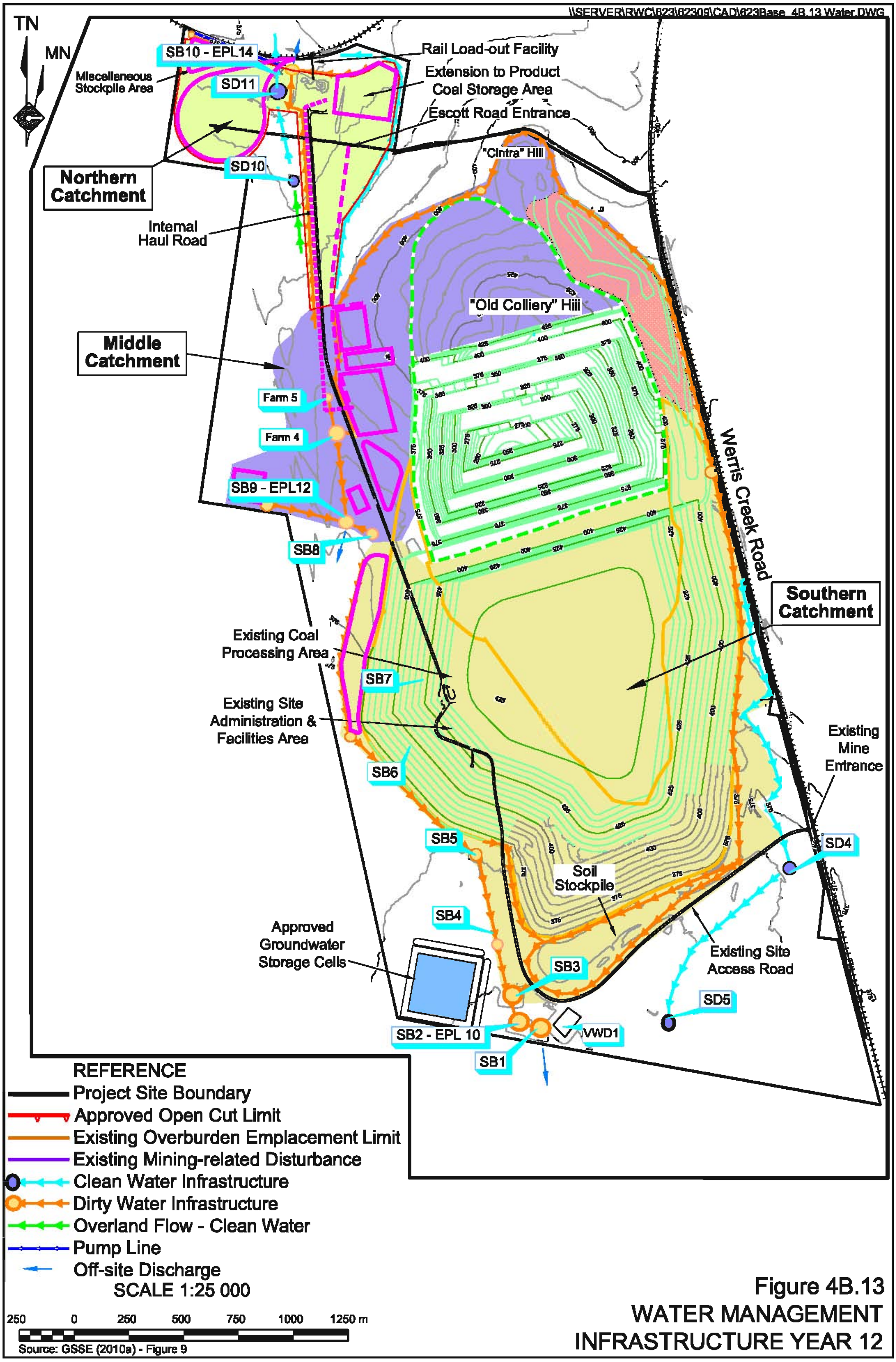


Figure 4B.13
WATER MANAGEMENT INFRASTRUCTURE YEAR 12

- The relocation of the Coal Processing Area and Site Facilities and Administration Area would require additional dirty water diversions to be constructed to capture and treat rainfall/runoff from these areas and help direct flow to SB9. Existing Farm Dams 4 and 5, currently ancillary to the dirty water system, would be converted to dirty water dams to provide additional sediment basin capacity.
- A small sediment trap and dirty water diversion bund would be constructed to direct dirty water runoff from the relocated Explosives Magazine to SB9.
- An additional Void Water Dam (VWD3) would be constructed to supplement the existing void water storage capacity. This dam would be constructed to the north of the relocated Site Administration and Facilities Area, however, the positioning of this dam would be dependent upon the final layout of these facilities.

Year 7 Water Management Infrastructure (see Figure 4B.12)

- The dirty water diversion on the eastern side of the overburden emplacement would be extended to the north to capture dirty flow generated from the Acoustic and Visual Amenity Bund. A small sediment basin would be constructed in the east of the Project Site to treat dirty water runoff from the Acoustic and Visual Amenity Bund, however, it would also be possible to allow this water to be treated in sediment basins further down in the dirty water system.
- With SB6 and SB7 covered by the expanded overburden emplacement, dirty water runoff generated from the overburden emplacement would report to the dirty water diversion constructed to accommodate the temporary soil stockpile on the western side of the Project Site. Additional sediment basin capacity, required to offset the loss of SB6 and SB7 and allow appropriate treatment of dirty water runoff, would be achieved by augmenting existing sediment basins in the south of the Project Site or by constructing additional sediment dams.

Year 12 Water Management Infrastructure (see Figure 4B.13)

- The further expansion of the Acoustic and Visual Amenity Bund to the north would require the construction of an additional dirty water diversion bund to capture dirty water runoff which would otherwise flow to the north. This diversion bund would run around the north of “Cintra” Hill and would run back to the southwest to direct flow to SB9 via the dirty water diversion proposed to capture runoff from the relocated coal processing, amenities and workshop areas.
- Prior to Year 12 of mining, the overburden emplacement area would encroach upon VWD2, which would be removed.

4B.2.4.3 Final Landform Water Management

The water management measures described as part of Year 12 operations (see **Figure 4B.13**) would continue to be utilised through to the end of mine life with various aspects of the water management system incorporated into the final landform, where appropriate. Shaping of the final landform would include shaping of the open cut void to grades nominated in the Rehabilitation and Environmental Management Plan (REMP).Backfilling of the open cut would be undertaken to approximately 325m AHD, a level approximately 5m above the modelled groundwater level equilibrium elevation (RCA, 2010) which would prevent groundwater seepage into the final open cut void.

Clean water diversions utilised throughout the LOM Project would likely be maintained following the cessation of mining. However, these structures may be removed at this time following appropriate consultation with government agencies. Similarly, dirty water management measures in use at the end of mining would be maintained throughout the rehabilitation phase of the LOM Project or until appropriate rehabilitation works have been completed. These structures would then be either retained and incorporated into the final landform, or decommissioned and made stable following appropriate discussions with DECCW and I&I NSW.

Active pumping of void water would effectively cease following the end of mining. The Void Water Dams (VWD1 & VWD3) and groundwater storage cells would be drained, with the banks pushed in, covered with topsoil and rehabilitated.

Rehabilitation and shaping of the final landform would be undertaken in accordance with a modified REMP for the Werris Creek Coal Mine and would include the construction of contour banks and potentially drop structures on steep slopes within the Project Site. The final landform design (see **Figure 2.18**) has taken into consideration that controlling both the quantity and quality of runoff from the final landform during the rehabilitation phase would be essential.

4B.2.4.4 Proposed Water Management Infrastructure Design Features

Clean Water Management Infrastructure

Where clean water diversions are implemented the diversion banks would be constructed, generally in accordance with *Blue Book Standard Drawing SD 5.6*, with the following minimum design specifications.

- Gradient of the diversion banks would be approximately 1%.
- Height of the bank would have at least 400 mm freeboard.
- Channel width would be at least 3 m.
- A level spreader (or sill) would be constructed at the bank discharge point to reduce the risk of erosion at this point, in accordance with *SD 5.6*.
- Within 10 days of construction, pasture would be sown to prevent erosion of the bank and drain.

The clean water diversion channels would be designed to convey the 20 year Annual Recurrence Interval (ARI) storm event, as recommended by the Volume 2E of the *Blue Book* for temporary drainage controls, where the duration of disturbance is greater than 3 years.

Additional temporary clean water diversions may be implemented above the moving highwall in order to divert clean water rainfall/runoff (from the catchment up-slope) away from the active extraction area.

Dirty Water Management Infrastructure

Dirty water diversions would be constructed prior to any disturbance occurring and generally in accordance with *Blue Book Standard Drawing SD 5.6*. The key aspects of the diversion bank design would be to ensure that they convey dirty water to sediment basins and that they are stabilised, e.g. grass cover, jute mesh, rock or otherwise, to prevent erosion of the channel.

The sediment basin capacities for the northern, middle and southern dirty water catchments for the Year 3, Year 7 and Year 12 of the operations (see **Figures 4B.11** to **4B.13**) are shown in **Table 4B.6**, along with existing capacities.

GSSE (2010a) provides more detailed design parameters for the proposed clean and dirty water management infrastructure. This detail would be incorporated into an update Site Water Management Plan which would be prepared for the LOM Project.

Table 4B.6
Existing and Proposed Sediment Basin Capacities for Northern, Middle and Southern Catchment Areas

	Sediment Basin Capacities (ML)			
		Future Total Required Capacity		
Catchment Area	Existing	Year 3	Year 7	Year 12
Northern (SB10)	2.85	4	4	4
Middle (SB9)	23.15[1]	7.25	7.25	15
Southern (SB2)	32.90	36[2]	35[3]	34[4]

Note 1 The available capacity in the Middle catchment would be reduced to 22.3 ML in the first few years of operations as Farm Dam 2 and Farm Dam 3 would be removed by the expanding operations.
Note 2 Includes overburden emplacement and south west soil stockpile
Note 3 Includes overburden emplacement, the south amenity bund and the south west temporary soil stockpile
Note 4 Includes the overburden emplacement, south amenity bund and the south west temporary soil stockpile

Source: Modified after GSSE (2010a) –Table 14

4B.2.5 Water Sources, Water Treatment, Disposal and Discharge

4B.2.5.1 Operational Water Sources and Usage

The majority of water required for the LOM Project would be utilised for dust suppression activities. A nominal amount of potable water for drinking purposes would continue to be sourced from rainwater collected from the Project Site buildings and stored in rainwater tanks which would be supplemented by water trucked in to the Project Site.

Water sources for operational activities would continue to be used in the following order of preference.

- Void water (via in-pit sumps, void water dams and groundwater storage cells).
- Dirty water from the sediment basins, preferentially sourced from the basins with higher EC readings and end of line basins.
- Licensed bores.
- Clean water within the mining lease (via storage dams).
- Water occasionally trucked in from off-site, if required.

4B.2.5.2 Dirty, Saline or Contaminated Water Treatment and Discharge

The following provides an overview of the proposed management of dirty, saline or contaminated water treatment and/or discharge from the Project Site.

Treatment of Dirty Waters

Dirty water would be stored in sediment basins designed to allow for a reduction in TSS concentration to 50mg/L or less (the criteria for TSS concentration of EPL 12290). Where elevated TSS levels are identified within end-of-line sediment basins, i.e. licensed discharge points (LDPs) SB2, SB9 and SB10, and discharge is anticipated, chemical flocculation may be used to help decrease the settling times of the sediment in the water column. Previous trials indicate that TSS concentrations can be effectively reduced via chemical flocculation.

Use of appropriate flocculants, e.g. alum, gypsum or synthetic flocculants such as polyacrylamide, in conjunction with other methods and techniques available to remove solids from sediment-laden water and advice from specialists and relevant government agencies would be undertaken to treat the dirty water prior to discharge off site.

Treatment of Saline Water

Void water produced within the active open cut area and groundwater removed from within the former Werris Creek Colliery underground workings would be pumped to either the void water dams or groundwater storage cells. These structures are (or would be) lined with an appropriately impermeable layer (<1 x 10^{-9}m/s) and segregated from surface drainage. No void water would be discharged from the Project Site.

Controlled Discharge

Controlled discharge of settled and (if necessary) treated, e.g. flocculated, dirty water would be undertaken in accordance with the EPL 12290 when storage levels within respective LDPs (SB2, SB9 and SB10) are greater than 50%. This would provide the capacity to contain more rainfall events and reduce wet weather discharges. Discharge of dirty water in a controlled manner allows adequate settlement of sediment to be achieved prior to discharge. It would also significantly reduce the potential for discharge of sediment-laden water during wet weather events.

Wet Weather Discharge

When discharge occurs during wet weather, it would be undertaken in accordance with the discharge procedures for controlled discharge and the conditions in EPL 12290. Condition L3.4 of EPL 12290 stipulates the TSS concentration limits specified for wet weather discharge may be exceeded for water discharged from the LDPs provided that:

- the discharge occurs solely as a result of rainfall measured at the premises that exceeds 39.2mm over a consecutive 5-day period immediately prior to the discharge event; and
- all practical measures have been implemented to dewater all sediment dams within 5 days of rainfall such that they have sufficient capacity to store runoff from a 39.2mm, 5-day rainfall event.

4B.2.5.3 Contaminated Water and Sewage Disposal

Contaminated water and sewage associated with the LOM Project would continue to be managed in accordance with existing management procedures.

Potentially contaminated runoff from workshop areas and wash down bays would pass through an oil/water separating unit to reduce concentrations of oil and grease. The treated water would then be incorporated into the dirty water management system and eventually report to SB9.

Sewage would be treated by a biocycle sewage treatment system approved by Liverpool Plains Shire Council. Effluent would be drained onto a licensed utilisation area while solid waste would be periodically collected by a licensed waste collection and disposal contractor as required.

The only significant change which would occur as part of the LOM Project would be the relocation of the existing contaminated water and sewage water management facilities to within the relocated Site Administration and Facilities Area. Alternatively, new facilities may be constructed to service these areas. If required, temporary or portable management measures may be utilised during relocation works.

4B.2.6 Site Water Balance

4B.2.6.1 Introduction

The site water balance for the Project Site is based on the proposed water management and infrastructure discussed in Section 4B.2.4. It covers the requirement to address a description of site water demands, water supply and disposal methods. Site water balance calculations were undertaken for Year 3, Year 7 and Year 12, respectively, of the LOM Project and include an assessment of median, dry and wet years. The following sub-sections provide a summary of a detailed water balance prepared by GSSE (2010a).

4B.2.6.2 Water Inputs

Rainfall and Runoff

Rainfall and runoff has been determined using the following BOM statistical annual rainfall measured at the Quirindi Post Office Meteorological Station (1882 to 2010).

- Annual 10th percentile (dry year): 465.5mm.
- Annual 50th percentile (average year): 683.7mm.
- Annual 90th percentile (wet year): 916.8mm.

The catchment areas used were as follows.

- Clean Water Catchment – approximately 480ha (Catchment 1 to the east of the Project Site)
- Dirty Water Catchment – of varying area depending on the status of open cut, overburden emplacement and soil stockpile development, comprising of:
  a) Southern Catchment Area incorporating:
    - the southwest temporary soil stockpile (7.5ha);
    - the southern section Acoustic and Visual Amenity Bund (20.9ha);
    - the existing southern soil stockpile (10.0ha);
    - the undisturbed catchment to the east and west of the overburden emplacement(area varies as the overburden emplacement area expands);
    - the rehabilitated areas of the overburden emplacement (area varies as rehabilitation becomes established and assumed to be 68%, 91% and 91% of the total overburden emplacement for Years 3, 7 and 12 respectively); and
    - the active overburden emplacement (area varies as the overburden emplacement expands and assumed as 42%, 9% and 9% of the overburden emplacement for Years 3, 7 and 12 respectively).

b) Middle Catchment Area incorporating:

- The Site Administration and Facilities Area, Coal Processing Area and temporary central soil stockpile (10.5ha);
- the Precursor Storage Facility and Explosives Magazine (2.6ha);
- the undisturbed catchment (area varies according to expanding operations); and
- the northern section of the / Acoustic and Visual Amenity Bund (12.0ha).

c) Northern Catchment Area incorporating:

- the Product Coal Storage Area and turn-around loop (8.6ha);
- the temporary northern soil stockpile located adjacent to the turn-around loop(1.8ha);
- the undisturbed catchment upslope from the Coal Processing Area (18ha); and
- the Northern Site Access Road and northern section of the Rail Load-out Road.

- Void Water Catchment comprising of:
  - the active mining area, including areas of active mining and the various haul roads that report to the active mining area;
  - the area of the active overburden emplacement area which drains to the mine void; and
  - the undisturbed area (above the highwall).

Groundwater in-flow

The *Groundwater Assessment* (RCA, 2010) predicted the following in-flows into the void.

- Year 3: 13ML/year
- Year 7: 50ML/year
- Year 12: 47ML/year

Groundwater Extraction from Bores

Extraction of water via licensed groundwater extraction bores from the underground workings is currently not required as the amount of seepage into the active void from the underground workings is currently sufficiently managed. However, it is assumed that all of the anticipated 200ML of water in the underground workings would be required to be dewatered by approximately Year 3 of the Project, using the licensed groundwater extraction bores and pumped to the Groundwater Storage Cells. For the purposes of the water balance, it has been assumed that this groundwater would be dewatered at an approximate rate of 67ML per annum and has been considered within the water balance for Year 3 of the LOM Project.

4B.2.6.3 Water Outputs

Evaporation

There would be evaporation losses from the clean, dirty and void water dams and the groundwater storage cells. The assumptions used in calculating evaporative losses are as follows.

- Annual evaporation is estimated to be 1971mm/yr.
- The average annual evaporation loss has been multiplied by a factor of 0.7 to account for the fact that the dams are not always full and that BOM data is pan evaporation.
- The estimated surface area of various water holding bodies throughout the Project would be as presented in **Table 4B.7**.

Table 4B.7
Estimated Surface Areas of Water Holding Bodies

Water holding bodies	Estimated Surface Area of Water Holding Bodies (ha)		
	Clean Water	Dirty Water	Void Water
Existing[1]	2.4	3.7	2.4
Year 3	1.9	4.25	9.7[2]
Year 7	1.9	5.1	9.7
Year 12	1.9	5.4	9.1[3]

Note 1 - Existing data from RWC (2004) water balance
Note 2 - Includes existing VWD1 and VWD2, new proposed VWD3 and groundwater storage cells.
Note 3 - VWD2 will be removed between Year 7 and Year 12 and replaced by VWD3
Source: Modified after GSSE (2010a) –Table 16

Dust Suppression and Crushing/Screening Operations

It was assumed that site water use requirements for the LOM Project would be approximately 192ML per annum for a median rainfall year with a variation of ±10% to account for assumed increases and decreases in water use for dry and wet years, i.e. 211ML dry year and 173ML wet year. For the purpose of the water balance, it was also assumed that water would be sourced from either void water, or dirty and/or clean water sources.

4B.2.6.4 Site Water Balance Summary

A summary of the overall results for the water balance for all years for wet, average and dry years, obtained by combining the results from the void water balance and the dirty water balance is presented in **Table 4B.8**.

Table 4B.8
Total Mine Site Water Balance

	Year 3			Year 7			Year 12		
	Average	Dry	Wet	Average	Dry	Wet	Average	Dry	Wet
Void Water Balance	0	0	29	0	0	20	0	0	0
Dirty Water balance	414	150	674	444	161	734	467	174	785
Total Mine Water Balance	414	150	703	444	161	754	467	174	785

Source: Modified after GSSE (2010a) – Table 19

The results of the site water balance suggest that during wet years the LOM Project may generate excess void water (except in Year 12 operations) which would not be re-used on the Project Site as part of normal operations. The excess void water would be retained within the void water storage system.

The results show that during all years it is likely that there would be excess dirty water which would be discharged from the Project Site using appropriate procedures discussed above.

4B.2.7 Assessment of Impacts

4B.2.7.1 Introduction

Following the adoption of the water management, controls and mitigation measures identified above, the impacts on surface water within and beyond the LOM Project Site have been assessed as described below. The overall conclusion is that there would be minimal impacts as a result of the LOM Project on the surface water catchments, local drainage, and surface water quantity and quality. The surface assessment determined that the cumulative impacts of the LOM Project on the surrounding water environment would likely be environmentally beneficial.

4B.2.7.2 Impacts on Surface Water Catchments

The proposed clean water diversion water management infrastructure and the final landform created following the completion of mining activities and rehabilitation of the Project Site would ensure that reductions to environmental flows are minimised and create only minor changes to the total catchment areas to Werris and Quipolly Creeks.

At the commencement of the LOM Project, the Werris Creek catchment comprises an area of approximately 404km^2 while the Quipolly Creek catchment comprises approximately 190km^2. Over the life of the LOM Project, the disturbed areas within each catchment (subject to the capture and storage of water) equate to approximately 1.5% and 3% of the Werris Creek and Quipolly Creek catchments respectively, a reduction which is unlikely to have any significant impact on water availability within these catchments.

At the completion of the LOM Project, the Werris Creek Catchment would be reduced slightly as rainfall falling on the top and southern side of the Acoustic and Visual Amenity Bund is diverted to the south and into the Quipolly Creek catchment. The Quipolly Creek catchment would therefore be increased, although part of this increased catchment would be captured within the final depression of the landform. These very minor changes to the Werris and Quipolly Creek catchment would have very limited impact on water availability within these catchments or on the larger Namoi River Catchment.

4B.2.7.3 Impacts on the Namoi River Catchment

GSSE (2010a) used Best Management Practices, as outlined in the Blue Book (DECC, 2008e), and address surface water management issues on the Project Site. This measure, in conjunction with the minimal LOM Project-related impacts on the Werris and Quipolly Catchment Creeks, means that the Project would have negligible impacts on the Namoi River Catchment. With specific reference to the Namoi Catchment Action Plan catchment target for surface water systems (see Section 4B.2.2.5), the LOM Project would result in, at worst, the maintenance of water quality flowing from or around the Project Site to Werris and Quipolly Creeks.

4B.2.7.4 Impacts on Local Drainage

The potential impacts of the LOM Project on the local drainage would be minimal due to the mitigation measures to be implemented. Since the LOM Project would constitute an extension to existing mining operations, impacts on natural drainage lines would be minimised. As a result of the proposed clean water diversion, only runoff from disturbed areas of the Project Site would be retained. This equates to an area of approximately 600ha at the full extent of mining operations of which approximately 350ha relates to the proposed LOM Project.

All clean water flowing onto the Project Site would be diverted around the disturbance areas and into existing drainage lines. The clean water runoff from the eastern catchment would be diverted south towards Quipolly Creek. This would result in a large area of clean catchment being diverted around the Project Site and into the natural drainage system rather than being retained for use in dust suppression or operational activities.

The implementation of clean water management infrastructure would assist in maintaining ephemeral flows and sediment movement patterns in the watercourses downstream of the Project Site. Through the provisions in EPL 12290, water of suitable quality contained within the water management system would also be discharged when required via licensed discharge points.

The final landform within the Project Site would be designed so that runoff would, with the exception of flow into the final depression of the partially backfilled open cut void, be free flowing off the Project Site. This would be achieved by the construction of contour banks and channels that are appropriately graded and armoured to prevent additional erosion.

4B.2.7.5 Impacts on Surface Water Quantity

The site water balance model for the Project Site determined that the LOM Project would operate on average, dry and wet years as a net water generator. Discharge of surplus water would occur via licensed discharge points, when required. The diversion bunds at the Project Site would assist in separating and restoring clean water flows to Werris and Quipolly Creeks during rainfall events.

Overall, the potential impacts of the LOM Project through the, operational and rehabilitation phases would be minimal relating to the quantity of surface water that would potentially be discharged from the Project Site.

4B.2.7.6 Impacts on Surface Water Quality

The proposed operating strategy for water management for the LOM Project has been designed to capture all operational dirty water and direct it to sediment basins for capture and treatment. Sediment-laden surface runoff from the rehabilitated areas following construction of the various water management structures would also be treated in the sediment basins. Treatment of water on the Project Site means that water that would be discharged via licensed discharge points would not compromise the quality of water in Werris and Quipolly Creeks.

4B.2.8 Monitoring Program and Reporting Protocol

4B.2.8.1 Monitoring Program

The Proponent currently undertakes water quality monitoring in line with the current *Site Water Management Plan*(SWMP). The SWMP addresses the surface water impact assessment criteria and provides a program to monitor surface water flows and quality upstream and downstream of the confluence of the northern catchments towards Werris Creek and the southern catchments into towards Quipolly Creek.

As the majority of existing water management infrastructure would be retained throughout the LOM Project, the existing surface water monitoring program would be maintained.

The existing licensed discharge points registered under EPL12290 would also be maintained throughout the LOM Project. The impact assessment criteria for surface water is only relevant to water actually discharged from the Project Site via the licensed discharge points. The existing EPL12290 for the Werris Creek Coal Mine contains concentration limits for water discharged through SB2 (LDP10), SB9 (LDP12) and SB10 (LDP14). These criteria would be retained as the on-going water quality criteria for the LOM Project.

The proposed water monitoring program including the monitoring parameters, monitoring locations and frequency are detailed in **Table 4B.9**.

Table 4B.9
Surface Water Monitoring Locations, Frequency and Parameters

Monitoring Site	Monitoring Frequency	Parameters
Licensed Wet Weather Discharge Points: - SB2 (EPA 10) - SB9 (EPA 12) - SB10 (EPA 14)	1. Quarterly. 2. As soon as practicable after any overflow offsite commences and in any case not more than 12 hours after any overflow offsite commencing.	Water quality including, but not limited to: - Total Suspended Solids - Oil & Grease - pH - Electrical Conductivity,
Receiving Waters (US&DS) - WC-U (Werris Creek) - WC-D (Werris Creek) - QC-U (Quipolly Creek) - QC-D (Quipolly Creek)	1. Quarterly. 2. Within 12 hours after any overflow offsite from a sediment dam(s) on the premises occurring.	
Clean, Dirty and Void Water Dams including: - VWD1, VWD2[1], VWD3[2] - GWC1[2], GWC2[2]	Quarterly	
Other dams / storages to be removed / constructed as part of the LOM Project	As required	
Note 1 - Dam will be removed during the Project. Note 2 - Yet to be constructed.		
Source: Modified after GSSE (2010a) – Table 20		

A number of additional dams and sediment basins would be constructed as part of the LOM Project to service additional disturbance areas (see Section 4B.2.4.2). Where the proposed structures are of a permanent nature, quarterly monitoring would be undertaken for these dams as detailed in **Table 4B.9**.

In addition to the proposed monitoring program outlined in **Table 4B.9**, opportunistic sampling within water bodies within or adjacent to the Project Site may also be undertaken. This sampling would assist in assessing the performance of the surface water management system and would help to direct the implementation of additional water management controls, if deemed necessary.

4B.2.8.2 Reporting Protocol

The Proponent would collate surface water analysis data and maintain an up-to-date record of analysis both in hard copy (laboratory reports) and electronic (data) format for the LOM Project. These results would be interpreted as they are received in order to ensure appropriate operational guidance on maintaining water quality within desired parameters.

The results of water quality analyses would be reported in the relevant Annual Environmental Management Report and made available to the Community Consultative Committee members on a regular basis. In the event that an exceedance in surface water quality criteria is identified, the exceedance would be investigated and reported to the relevant agencies in accordance with the requirements of EPL12290 with appropriate mitigation measures adopted to prevent a recurrence.

4B.3 NOISE

The noise and vibration assessment for the LOM Project was undertaken by Spectrum Acoustics Pty Ltd (Spectrum, 2010). The full assessment is presented in Volume 1, Part 3 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following subsections.

4B.3.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (Section 3.3 and **Table 3.6**) the potential impacts relating to noise and vibration requiring assessment and their unmitigated risk rating are as follows.

- Elevated noise levels resulting from construction, mining, transportation and processing activities moving closer to the town of Werris Creek and operations running 24 hours a day resulting in:
  - a reduction of amenity within the surrounding local area (high risk);
  - human-health related issues (high risk);
  - sleep deprivation relating to noise emissions (high risk); and/or
  - impacts on livestock health of native fauna assemblage (moderate risk).
- Sleep deprivation resulting from the noise caused by Project Site and transport operations (low risk).

In addition, the DGRs issued by the DoP identified "***Noise and Vibration*** – *including a quantitative assessment of potential construction, operational, blasting and transport noise impacts*" as one of the key issues that requires assessment at the Project Site. The DGRs require that the noise and blasting assessment refer to the following guideline documents.

- The NSW Industrial Noise Policy (INP) (EPA, 2000).
- The Environmental Criteria for Road Traffic Noise (ECRZTN) (EPA, 1999).
- The Interim Construction Noise Guideline (DECC, 2009).

Both DECCW and Liverpool Plains Shire Council also identify impacts on "*noise amenity*" as requiring assessment, with DECCW noting that the assessment should incorporate real temperature lapse rate data to accurately simulate local inversion conditions.

The following subsections describe and assess the existing noise environment, identify the relevant noise assessment criteria and describe the noise attenuation and other controls, safeguards and mitigation measures proposed by the Proponent. Additionally, the assessment of the residual noise-related impacts following the implementation of these safeguards and mitigation measures are presented.

4B.3.2 Existing Noise Climate

4B.3.2.1 Introduction

Spectrum (2010) completed a review of the existing meteorological and acoustic environment surrounding the Project Site in order to determine the atmospheric conditions under which noise modelling is required and to establish noise criteria at receivers surrounding the Project Site. The following sub-sections provide a summary of the existing meteorological and acoustic conditions.

4B.3.2.2 Meteorological Conditions

Relative Humidity

Atmospheric absorption of mid to high frequency sound is strongly dependent upon relative humidity (RH), with absorption inversely proportional to RH. Relative humidity varies around an average value of 70% under calm daytime conditions (at 20^{o}C). Higher RH is experienced when the temperature drops and a value of 85% RH was adopted for modelling under cooler conditions.

Wind Conditions

Spectrum (2010) reviewed wind roses prepared by Heggies Pty Ltd using daily data collected between September 2007 and August 2008. *Appendix B* of Spectrum (2010) provides the seasonal wind roses, categorised by day, evening and night time periods. The analysis of wind vector components up to 3m/s[1] at angles of $\pm 45^{o}$ relative to each primary direction determined that winds from the northwest and southeast occurred for 30% or more of the time during the following periods.

- Northwest Wind
  - Winter: day time and evening periods.
  - Spring: night time period.
- North-northwest Wind
  - Winter: night time period[2].
- South-southeast Wind
  - Summer: night time period.
  - Autumn: evening and night time periods.

The INP requires that noise modelling consider the noise levels received at local receivers under these ‘prevailing conditions’. Whilst the analysis of winds found that the south-southeast wind did not require assessment during the daytime period in any season, this wind has been considered in all modelled daytime operational scenarios.

Temperature Inversions

Spectrum (2010) completed a temperature inversion study on the Project Site during June 2010. Temperature loggers were placed at three locations for a total vertical separation of 50m (between 395m and 445m AHD).

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[1] The Industrial Noise Policy (INP) requires assessment only under wind conditions of 3m/s or less.
[2] Not modelled as the night time inversion condition provides far greater noise enhancing conditions and represents the worst case scenario.

Between 1 June and 24 June 2010, inversions were observed on 20 of the 23 nights. The 90th percentile equivalent linear inversion strength was 12°C/100m. This inversion strength was adopted in the noise modelling to determine potential night time noise impacts during the winter months[3]. Notably, the measured inversion strength adopted in the noise modelling is significantly greater than the default inversion strength nominated by the INP (3°C/100m). By accounting for the intense inversion strength in the noise modelling (and subsequently in the development of noise mitigation measures), the Proponent considers the maximum noise levels likely to be received at locations surrounding the Project Site. Notably, the high strength inversions (and inversions generally) would be unlikely outside of the winter months. Many of the noise mitigation measures proposed to attenuate noise under these conditions would, however, continue to be implemented and as a result the noise levels received at surrounding locations would be much reduced during non-noise enhancing conditions than might otherwise have been the case if the high strength inversion were not considered. To provide an indication of likely noise levels received at night time outside the extreme inversion conditions, and to illustrate the sensitivity of the model (and noise generation) to inversion strength, noise modelling considering inversion strengths of 6º/100m and 3º/100m was also completed.

Monitoring of temperature at two locations separated by approximately 100m vertical elevation has been commenced at the Werris Creek Coal Mine (November, 2010). This data will be regularly reviewed to provide the Proponent with an indication as to the likely inversion strength and duration at different times of year. This data would then be used, in conjunction with the noise modelling predictions and noise monitoring data collected, to assist in planning the mining schedule over a 12 month period.

Typical calm daytime conditions of no wind, 70% RH and -1°C/100m vertical temperature gradient, i.e. dry adiabatic lapse rate, DALR, was also modelled to predict typical daytime noise levels.

4B.3.2.3 Background Noise Levels

To determine background noise levels, Spectrum (2010) placed noise loggers at three representative locations to the north (on the edge of Werris Creek), northeast and south (on Paynes Road) of the Project Site between 31 May and 6 June 2010. The locations of these noise loggers, and the other residential receiver locations surrounding the Project Site, are presented on **Table 4B.10** and displayed on **Figure 4B.14**.

Noise levels were continuously monitored at 15-minute statistical intervals and the data analysed to determine the L_{90} noise level on each day of monitoring, i.e. the noise level which is exceeded 90% of the time. The L_{90} Rating Background Noise Level (RBL) was then calculated as the median L_{90} noise level over the seven days of the noise survey. **Table 4B.11** provides the calculated RBLs for the three noise logger locations.

4B.3.3 Environmental Noise and Vibration Criteria

4B.3.3.1 Introduction

The following sub-sections summarise the noise and vibration criteria that were used to assess the noise and vibration impacts of the LOM Project on the local environment. As the LOM Project is a continuation of an existing mining operation, construction noise criteria (as provided in the Interim Construction Noise Guideline (DECC, 2009)) are deemed not to apply.

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[3] It is noted that 10% of inversions would be stronger than 12º/100m, however, as it is not possible to categorically nominate a maximum strength, the 90th percentile is considered a reasonable indication of the most severe inversion conditions.

Table 4B.10
Non Project-Related Residences and Noise Logger Locations Surrounding the Project Site

Property Reference	Noise Logger Reference	Property Name	Property Owner
R18		-	R.F. & H.T. Withers
R20		"Tonsley Park"	L. Patterson
R21		-	G.J. Currey
R3a / 3b		-	M.J. Lomax
R101		-	J.L. &G.D. O'Brien
R102		-	J.W. De Haart
R103		-	M.W. & T.M. Parsons
R105		-	W.R. Lewis
R26		-	W.E. Woods
R55		-	R.M. Pitkin
R62	N1[1]	-	P.M. & C.L. Cunningham
R14	N2	-	A. & T. Haling (to be constructed)
R98		"Kyooma"	J. Colville
R99		"Werriston South"[2]	C. Colville
R96		"Millbank"	B. Davison
R17		"Woodlands"	M.M. Doolan & A.E. Hogan
R12		-	B.A. Fletcher
R24		"Hazeldene"	P. George
R15		"Plain View"	R.G. & A.R. Maxwell
R11		"Glenara"	W.H. & S.I. Ryan
R10		-	A. Blackwell
R9		"Gedhurst"	B.R. & A.J. Smith
R8		"Almawillee"	P.A. & T.M. Hird
R7		-	P.R. & J.S. Andrews
R22		"Mountain View"	L.F. & R.M. Parkes
R5		-	R. & A. George
R105	N3	"Park Hill"	N.J. Taylor

Note 1: Approximate location
Note 2: Monitoring completed at a shed on the "Werriston South" property. There is no residence on this property.
Source: Modified after Spectrum (2010) – Table 1

Table 4B.11
Summary of Ambient Noise Levels

Location[1]	Day (7:00am to 6:00pm)	Evening (6:00pm to 10:00pm)	Night (10:00pm to 7:00am)
N1 (R62[2])	31	31	26
N2 (R14)	32	30	21
N3 (R105)	29	27	26

Note 1: see **Figure 4B.14**
Note 2: Approximate location
Source: Modified after Spectrum (2010) – Tables 2 to 4

For the purposes of defining relevant criteria, the DECCW nominate the following times relevant to daytime, evening, night-time periods, i.e. for Monday to Saturday.

- Daytime – 7.00am to 6.00pm
- Evening – 6.00pm to 10.00pm
- Night-time – 10.00pm to 7.00am

For Sundays and public holidays, the night-time period extends from 10.00pm to 8.00am.

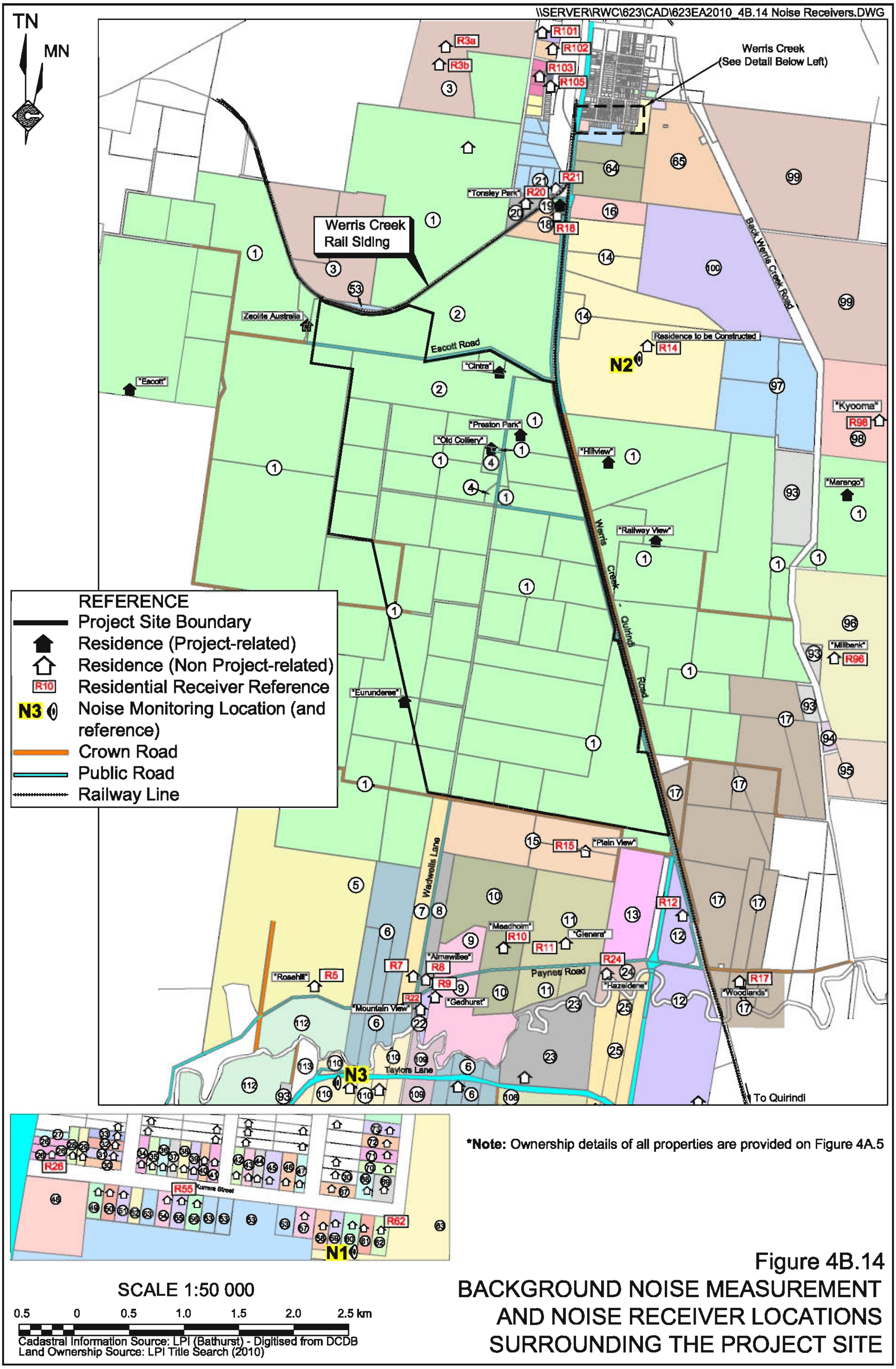

Figure 4B.14
BACKGROUND NOISE MEASUREMENT AND NOISE RECEIVER LOCATIONS SURROUNDING THE PROJECT SITE

4B.3.3.2 Operational Noise Criteria

The INP specifies two noise criteria:

- an *intrusiveness criterion* which limits L_{Aeq} noise levels from the industrial source to a value of 'background plus 5dB(A)';and
- an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed.
- Since there is no existing major industry dominating noise levels at residences surrounding the Project Site, and road traffic noise is not continuous, only the intrusiveness criteria were considered in setting the existing Project-specific operational noise limit.

The existing criterion of 35dB(A),$L_{eq(15\text{-minute})}$ (day, evening and night) at receivers considered in the original acoustic assessment for the Werris Creek Coal Mine (Spectrum Acoustics, 2005) have been retained. Noise monitoring undertaken at locations N1, N2 and N3 suggests that an intrusiveness criteria of greater than 35dB(A) may be applicable to some residences. However, as mining operations may have contributed to background levels at these locations, and through application of the precautionary principle, all remaining receivers have also been assigned a noise criteria of 35dB(A), $L_{eq(15\text{-minute})}$ (day, evening and night).

It is noted that for assessment purposes, residences R26, R55 and R62 reflect the most exposed residences within the residential area of Werris Creek. Compliance at these residences will imply compliance at all other residences within Werris Creek.

4B.3.3.3 Sleep Disturbance Criteria

The DECCW recommends a $L_{1(1\text{-minute})}$ sleep disturbance criterion at building facade of RBL plus 15dB(A).

4B.3.3.4 Road Traffic Noise Criteria

Vehicle noise associated with vehicles travelling within the Project Site is considered to be operational noise. However, vehicle noise associated with vehicle movements on public roads is considered to be road traffic noise. Road traffic noise emissions are managed under the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN).

It is noted that the LOM Project would result in additional traffic travelling on Werris Creek Road and Taylors Lane (between the Project Site and the Kamilaroi Highway). Considered as local roads, in accordance with the ECRTN, the following $L_{Aeq(1hr)}$ road traffic noise criteria would apply to the LOM Project.

- Day (7:00am to 10:00pm) – 55dB(A).
- Evening (10:00pm to 7:00am) – 50dB(A).

4B.3.3.5 Rail Traffic Noise and Vibration Criteria

Product coal would be transported from the Project Site to the Port of Newcastle by train via the North Western Branch and Main Northern Railway Lines. **Table 4B.12** presents the noise limits recommended by Chapter 163 of the ENCM.

Table 4B.12
ECNM Recommended Train Noise Levels

Descriptor	Planning Levels	Maximum Levels
$L_{eq, 24 hour}$	55dB(A)	60dB(A)
L_{max}	80dB(A)	85dB(A)
Source: Modified after Spectrum Acoustics (2010) – Table 5		

In addition, train traffic vibration criteria were determined based on *Appendix B* of *Assessing Vibration: A Technical Guideline”* (AVTG) published by the DECCW. This document established a maximum allowable vibration velocity of 2.82mm/s for train-induced ground vibration, which is typically at frequencies greater than 10Hz (Spectrum, 2010).

4B.3.4 Assessment Methodology

4B.3.4.1 Operational Noise Assessment

The operational noise impacts of the LOM Project have been established by Spectrum Acoustics using the *Environmental Noise Model* (ENM) to predict noise levels at the residential receivers identified on **Figure 4B.14**. The model was constructed by placing the various noise generating sources in either the most exposed location that the mobile equipment would be likely to operate in, or in the proposed location for fixed equipment such as the Coal Processing Area or Rail Load-out Facility. This information was then used to determine estimated noise levels at each of the representative residences for four operational scenarios.

- ***Scenario 1:*** Approximately Year 2 of the LOM Project, the coal processing infrastructure remains in its current location with construction equipment in operation at the site of the relocated coal processing office/workshop areas (see **Figure 4B.15**).
- ***Scenario 2:*** Approximately Year 7, the coal processing infrastructure has been relocated, the open cut has advanced to the lower slopes of “Old Colliery” Hill and the construction of the Acoustic and Visual Amenity Bund has been commenced (see **Figure 4B.16**). This scenario simulates construction of the Acoustic and Visual Amenity Bund roughly mid-way along the bund and would be indicative of worst-case noise generating activities during the construction of the bund. The placement of the bulldozer and haul truck further to the north (by approximately 500m) was simulated, however, this only provides a (approximate) 17% decrease in source-receiver distance to the most affected residences to the north and north-northwest. This would correspond to an increasing in total mining noise levels of approximately 0.5dB. This mining noise increase would, however, be attenuated by the completed construction of the Acoustic and Visual Amenity Bund to the south.
- ***Scenario 3:*** Approximately Year 12, the open cut has advanced through “Old Colliery” Hill and the Acoustic and Visual Amenity Bund has been completed (see **Figure 4B.17**).

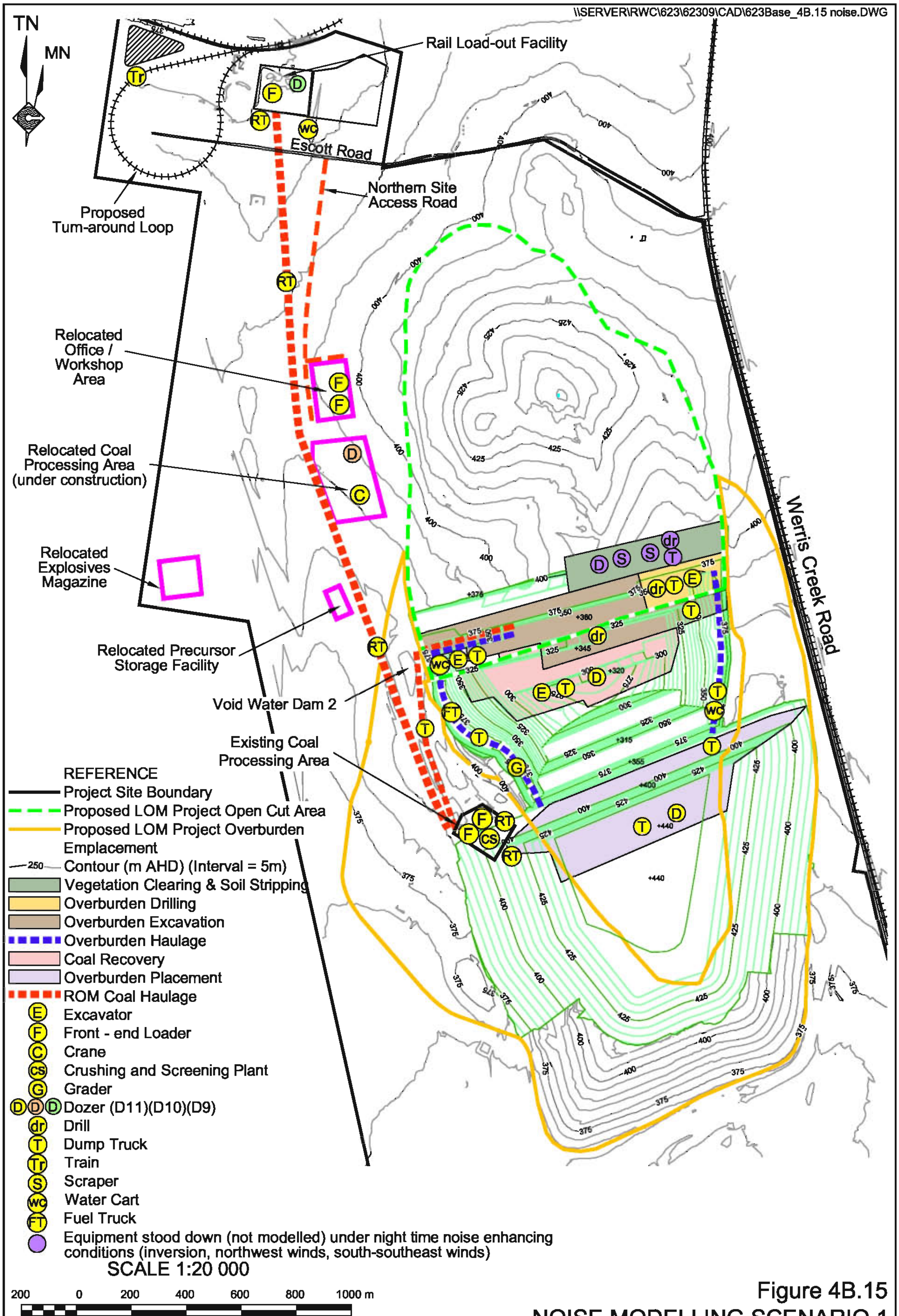

Figure 4B.15
NOISE MODELLING SCENARIO 1

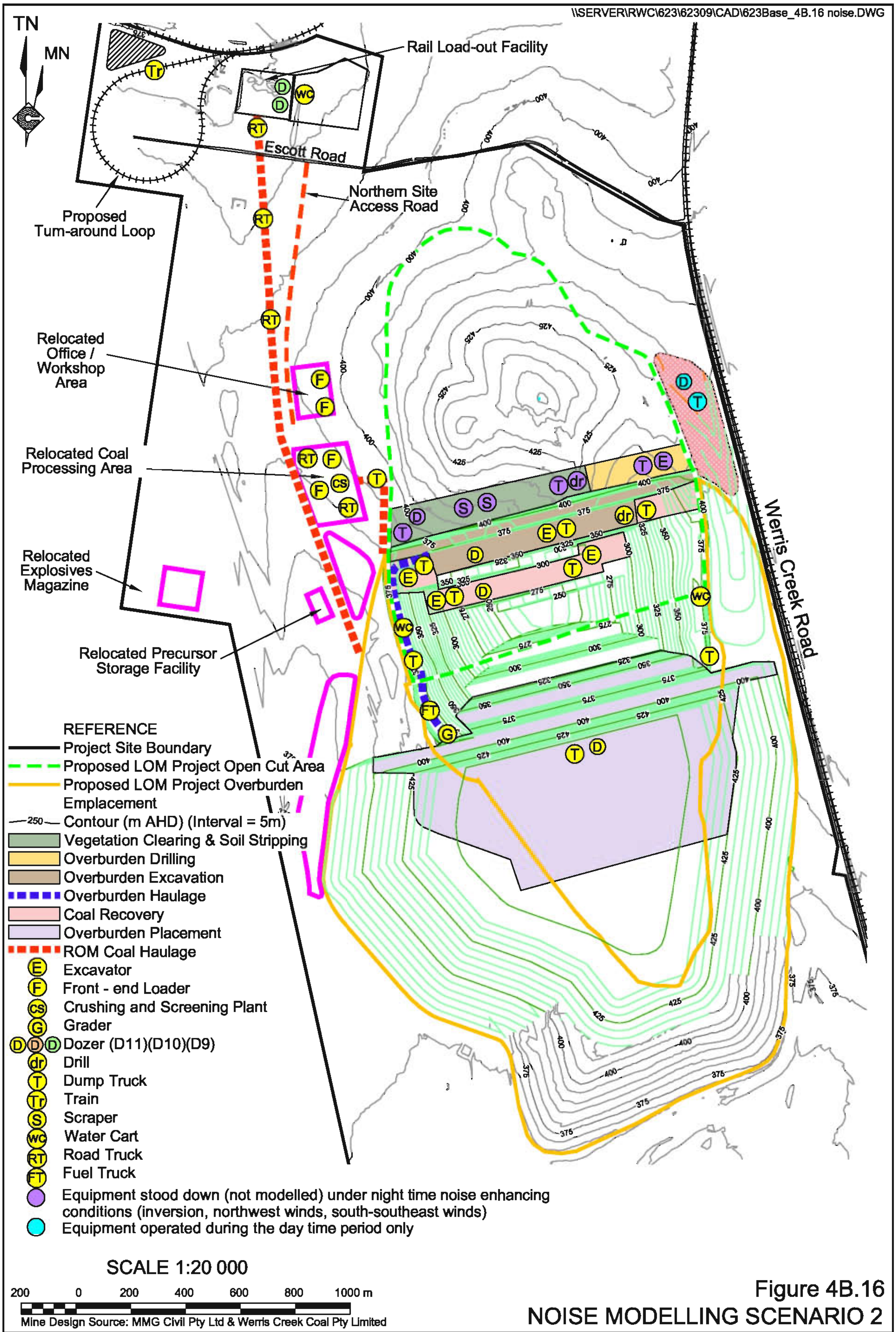

Figure 4B.16
NOISE MODELLING SCENARIO 2

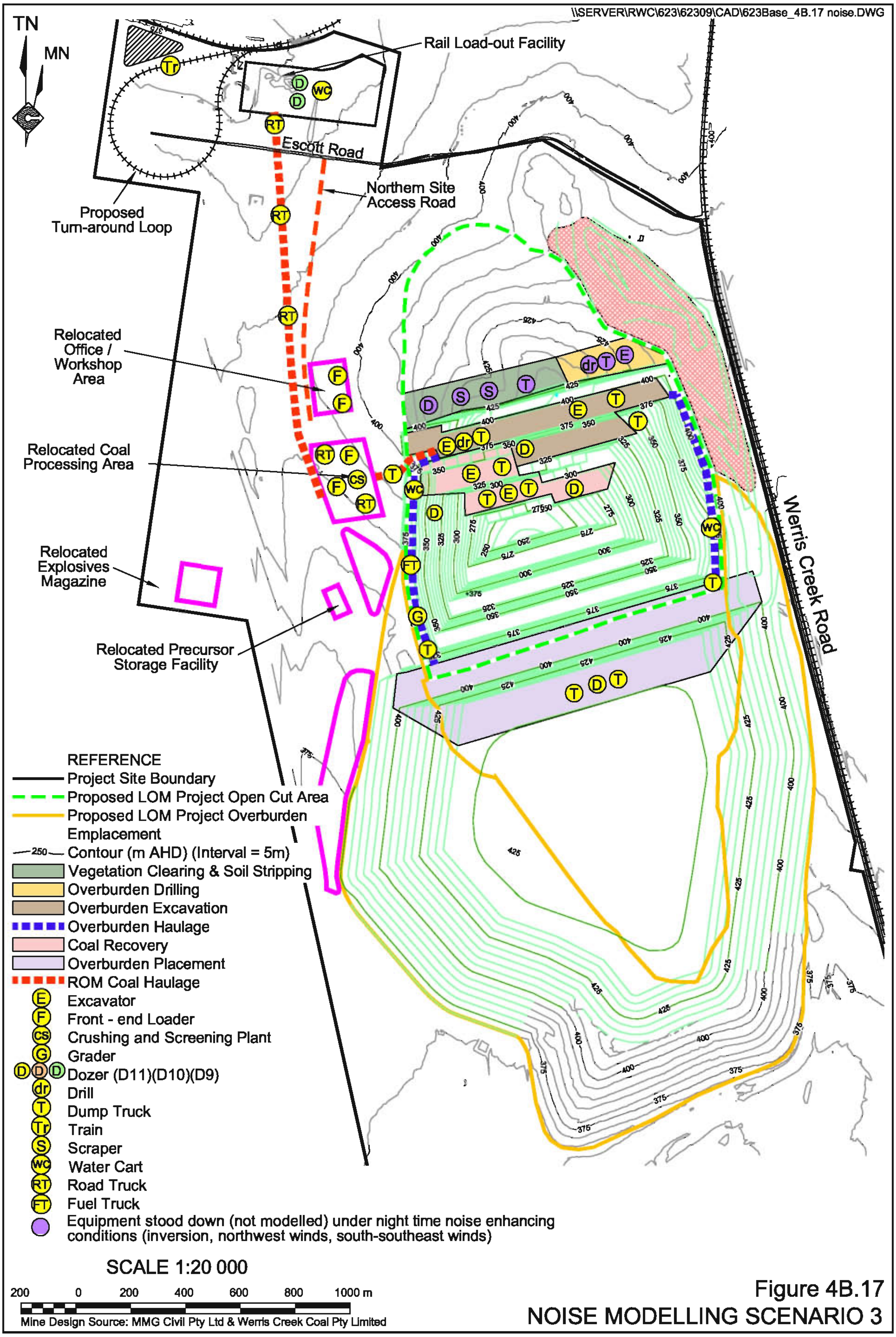

Figure 4B.17
NOISE MODELLING SCENARIO 3

- ***Scenario 4:*** Approximately Year 15, the open cut has almost reached the northern limit of mining and the placement of overburden is restricted to approximately 400m AHD (as the upper lifts of the overburden emplacement have been completed) (see **Figure 4B.18**). The placement of mobile equipment for this scenario simulates the most exposed locations of mobile equipment as the LOM Project approaches completion, i.e. when the most number of equipment would be operating at surface. Simulating the operation of the mobile equipment in a more northerly position would involve placing the majority of the equipment at elevations significantly below surface (to accurately simulate mining operations). This would provide significant noise mitigation and would not represent worst-case operations towards the completion of the LOM Project.

Initial noise modelling was completed assuming that each of the identified noise sources was operating simultaneously and continuously and that the sound power levels of all equipment would correspond with the measured sound power levels presented in *Appendix D* of Spectrum (2010). In accordance with the requirements of the INP, each scenario was modelled to consider the prevailing meteorological conditions likely to be encountered.

- Calm (lapse) conditions: 20°C, 70% RH, no wind, -1°C/100m vertical temperature gradient.
- Temperature inversion:
  - 5°C, 85% RH, inversion strength of +12°C/100m.
  - 5°C, 85% RH, inversion strength of +6°C/100m.
  - 5°C, 85% RH, inversion strength of +3°C/100m.
- South-Southeast Wind: 20°C, 70% RH[4], 3m/s winds from the south-southeast.
- Northwest Wind: 20°C, 70% RH, 3m/s winds from the northwest.

Notably, the noise modelling completed by Spectrum (2010) provides for worst-case noise enhancing conditions which will provide predictions of the maximum noise levels expected at surrounding receivers. Consequently, it should be noted when reviewing the results of noise modelling that these maximum predicted noise levels would be restricted to periods when these noise enhancing conditions prevail. In the case of the inversion conditions, such severe inversions are likely to be restricted to the coldest winter months of June and July, with inversions of lower strength (or no inversion) (and therefore with lower or no noise enhancing properties) occurring during the remainder of the year. The noise enhancing winds from the northwest, north-northwest and south-southeast were only recorded as features of the local environment during the periods noted in Section 4B.3.2.2.

The initial noise modelling determined that under inversion and the prevailing wind conditions, the predicted noise levels at many of the receiver locations exceeded 40dB(A).

As a consequence, the Proponent reviewed the initial noise model results and identified the noise sources making the greatest contribution to the received noise level. Noise attenuation measures, either direct attenuation of the noise source(s), reduction in plant numbers or modification to the location(s) of operating plant, were then investigated and incorporated into the noise model.

[4] 5°C and 85% RH applied to model south-southeast and northwest winds at night.

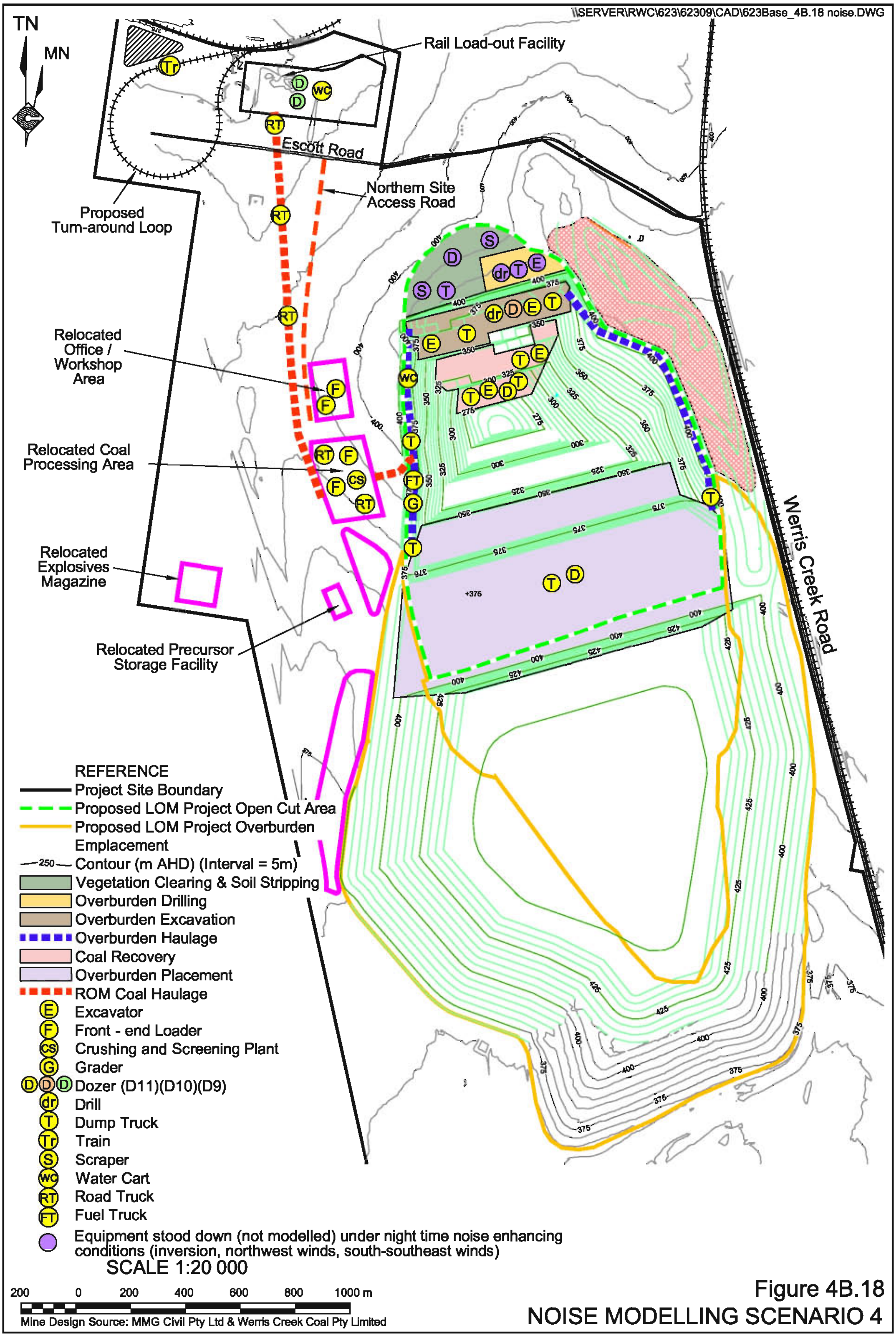

Figure 4B.18
NOISE MODELLING SCENARIO 4

The following provides a summary of the noise attenuation measures that were incorporated into the final iteration of the noise model. Section 4B.3.6.1.3 provides a more detailed assessment as to whether there remain any other reasonable and feasible mitigation measures that could be applied to the LOM Project to reduce noise levels further.

- Acoustic and Visual Amenity Bund. The construction of this earthen barrier to the north of the open cut area would approximately replicate the noise barrier provided by "Old Colliery" Hill. The bund would be most effective as a noise attenuation measure as mining operations move further to the north, i.e. closer to the bund.
- Surface Disturbance Activities. All mobile equipment operating at surface in advance of (to the north of) the open cut, including drills, scrapers, an excavator and other plant involved in surface preparation works, would be stood down under night time noise enhancing conditions.
- Drills. The number of drills operating on the Project Site would be restricted to two (which would be operated below natural ground level under inversion conditions).
- CAT 785 Haul Trucks. An 8dB noise reduction in dynamic sound power level was applied given the commitment of the Proponent to apply manufacturer specified attenuator kits to each truck (at a cost of between $250 000 and $300 000 per truck) and/or alternative measures that achieve the same reduction in sound levels.
- CAT bulldozers (D10/D11). A 7dB noise reduction was applied based on limiting the bulldozers to 1 600rpm in reverse (first gear) when operating in exposed locations under inversion conditions. The 7dB noise reduction has been confirmed by extensive noise testing at the Werris Creek Coal Mine Product Coal Storage Area and the Whitehaven CHPP at Gunnedah.
- Coal Processing Area. An acoustic bund/barrier at least 5m high would be constructed on the northeastern side following relocation of the Coal Processing Area.
- Scenario 1 Operations. Whilst the Coal Processing Area remains in its current location, truck / excavator numbers would be restricted to 10 / 3 respectively under inversion conditions.

Once the Coal Processing Area is relocated to the north, an increase in the truck / excavator fleet to 13 / 5 could be undertaken without significantly increasing the noise levels received at the receivers surrounding the Project Site. Notably, a truck / excavator fleet of 10 / 3 was also considered for the remaining scenarios under inversion conditions. However, once the 8dB attenuation was applied to the trucks, and without the noise source of the Coal Processing Area in its southern location, the additional noise reduction was minimal (see Section 4B.3.6.1.3 for further assessment of alternative noise mitigation measures).

The noted noise attenuation represents all reasonable and feasible measures that could be applied to the LOM Project as:

- a fleet of 10 trucks and 3 excavators represents the minimum number that could feasibly be operated on the Project Site to ensure the LOM Project is viable;
- the maximum noise attenuation that could reasonably be achieved has been applied to the mining fleet; and other practical measures for reducing noise levels, such as constructing a 5m high noise barrier around the coal processing infrastructure has been applied.

Section 4B.3.5 provides further noise controls that would be implemented by the Proponent to demonstrate that all reasonable and feasible measures to reduce noise levels have been implemented (in accordance with the requirements of the INP).

4B.3.4.2 Sleep Disturbance Assessment

A potential for sleep disturbance would occur during operations within the Coal Processing Area due to general impact noise from the crusher and coal (train) loading operations. Spectrum Acoustics (2010) modelled impact noise under the noise-enhancing atmospheric conditions discussed above using the sound power levels presented in *Appendix A* of Spectrum Acoustics (2010).

4B.3.4.3 Road and Rail Traffic Noise Assessment

Additional road and rail traffic generated by the LOM Project would be of an intermittent rather than constant nature. As a result, the methodology described in the document *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974* published by the US Environmental Protection Agency was used to determine the road and rail traffic noise. The equations used in that assessment are presented as *Equations 1* and *2* of Spectrum Acoustics (2010).

4B.3.4.4 Rail Vibration Assessment

Spectrum (2010) notes that vibration levels from laden and unladen coal trains have been widely studied. These studies concluded that vibrations at a distance of 20m from the track are typically less than 1mm/s. As no residences in the vicinity of the Project Site occur within 20m of the North Western Branch Railway Line and the Main Northern Line, Spectrum (2010) did not consider rail vibration further.

4B.3.5 Design and Operational Safeguards

As noted in Section 4B.3.4.1, initial noise modelling identified that under noise enhancing meteorological conditions, the proposed operation of the LOM Project would be likely to generate noise levels above the nominated intrusiveness noise criteria (35dB(A)) and in excess of 40dB(A). Notably, and as discussed in Section 4B.3.4.1, these noise enhancing conditions would be restricted in occurrence during the year. For non-noise enhancing conditions, the initial noise modelling indicated compliance with the nominated intrusiveness criteria. However, in order to reduce (and maintain) the predicted noise levels experienced at surrounding residences under the noise enhancing conditions, the following management and mitigation measures (or measures that would achieve an equivalent noise level reduction) would be adopted.

Operational Noise Controls

It is noted that the following noise controls have been developed largely as part of an iterative modelling process and represent all reasonable and feasible controls available to the Proponent (see also Section 4B.3.6.1.3). It is considered likely, however, that alternative noise attenuation measures or controls may become available over time which would provide similar or greater levels of noise mitigation than those presented above. As a consequence, the Proponent considers it appropriate that any conditions of the project approval issued with respect to noise do not specifically require application of the identified noise controls, rather that the resultant predicted noise level(s) be met. This will enable the implementation of alternate or other methods of control, if necessary, to achieve the required outcomes. The practical operational noise controls implemented in the noise model for the Project that the Proponent is prepared to adopt are as follows.

- Implement the noise attenuation measures identified and described in Section 4B.3.4.1 (pp. 4B-60 and 4B-61).
- Ensure that all equipment exhibits sound power levels consistent with the schedules in *Appendix F* of Spectrum Acoustics (2010).
- The Acoustic and Visual Amenity Bund would be completed prior to the open cut advancing through the “Old Colliery” Hill.
- During the evening and night-time periods, and periods of noise enhancing winds, overburden emplacement activities would be preferentially undertaken on the lower lifts (at least 20m below the top) of the overburden emplacement. Conversely, overburden would preferentially be placed on the upper lifts of the overburden emplacement during the day time (when noise enhancing winds do not prevail).
- Real-time noise, wind and inversion monitoring would be undertaken and a protocol developed to ensure that operations are managed pro-actively to avoid any exceedance of noise criteria. Further detail on the proposed real-time monitoring is provided in Section 4B.3.7.
- Develop a *Noise Management Plan* (NMP) prior to the commencement of the LOM Project. The NMP would incorporate the specific details of all noise controls and the measures to address noise criteria exceedances and/or complaints.

Transport Noise Controls and Operational Procedures

- Ensure, where practicable, that all employees and contractors enter and exit the Project Site in a courteous manner and without causing undue traffic noise.

4B.3.6 Assessment of Impacts

4B.3.6.1 Operational Noise

4B.3.6.1.1 Noise Modelling Results

This sub-section provides a summary of the results of the noise modelling completed by Spectrum (2010). The results are presented in tabular form for each of the four scenarios, along with a comparison to the nominated noise criteria for each of the 27 residences considered to be representative of the residences potentially affected by noise from the LOM Project.

Figures F1 to F24 contained within *Appendix F* of Spectrum (2010) present these results as derived noise contours[5] to provide an illustration as to the area impacted by noise generated by the LOM Project.

Section 4B.3.6.1.2 provides further review of the noise modelling results, considering the scale and frequency of any exceedance, the mitigation measures proposed and reasonable noise criteria which could be applied for the LOM Project.

Scenario 1

Table 4B.13 provides the predicted noise levels that would be received at each of the representative residences under conditions equivalent to Scenario 1, i.e. operations whilst the coal processing infrastructure remains in its current location, under the six modelled conditions. *Figures F1 to F6* contained within *Appendix F* of Spectrum (2010) present these results as derived noise contours. To provide a better illustration as to the most critical meteorological conditions affecting noise levels, the total number of exceedances for each modelled meteorological condition has been provided.

Exceedances of the nominated operational noise impact assessment criteria are predicted at four residences during the day time (under noise enhancing wind conditions) and 14 residences during the night time (predominantly under 12º/100m inversion conditions). With the exception of Residence R15 ("Plain View"), all predicted exceedances are less than 5dB(A), placing these residences in a noise 'management zone', i.e. exceedance is no more than 5dB(A). Acquisition of this property, or an agreement with the owner / resident of this location, is required in order for the LOM Project to proceed as proposed. The Proponent has commenced negotiations with the owner of this property and expects to obtain an agreement in relation to received noise levels up to 43dB (under severe inversion conditions) or acquisition prior to determination of the LOM Project.

Notably, the number of residences predicted to receive noise levels exceeding the 35dB(A) intrusiveness criterion under less severe inversion conditions (6º/100m) reduces significantly (to only two residences, R12 and R15). Under the INP default inversion conditions (3º/100m), no exceedances of the 35dB(A) noise criterion are predicted. The Proponent has recently commenced monitoring of temperature at two locations separated vertically by approximately 100m to gain an understanding of inversion conditions throughout the year. While data is not yet available, it is expected that the most severe inversion conditions are only likely to occur during the coldest winter months, with 3º/100m or 6º/100m inversions likely to better reflect conditions throughout the remainder of the year. This indicates that the period of time when night time exceedances are likely to occur at most residences would be limited to the coldest winter months.

Importantly, no exceedances were predicted at Residences 26, 55 and 62, which are representative of the most affected locations within the residential area of Werris Creek, illustrating compliance with the nominated day time and night time noise criteria would be achieved.

[5] It is noted that the noise contours are derived from point calculations made by the modelling software. Should a contradictory value be identified when comparing the noise contours to the tabulated results, the point source prediction presented in **Tables 4B.13** to **4B.16** should be considered to be the most accurate.

Table 4B.13
Predicted Noise Levels (Scenario 1) – dB(A),$L_{eq(15\text{-}minute)}$

Residence Reference	**Meteorological Condition**						**Criteria**	**Maximum Differential**
		Inversion			**Wind (3m/s)**			
	Calm	**3^{0}C/100m**	**6C/100m**	**12^{0}C/100m**	**NW**	**SSE**		
				Night Time				
R18	-	29	33	**37**	24	29	35	**+2**
R20	-	29	33	**37**	24	29	35	**+2**
R21	-	29	33	**37**	23	27	35	**+2**
R3a	-	27	30	33	<20	28	35	-2
R3b	-	26	29	33	<20	28	35	-2
R101	-	26	28	32	<20	26	35	-3
R102	-	26	28	32	<20	26	35	-3
R103	-	27	29	33	<20	27	35	-2
R105	-	27	31	34	20	27	35	-1
R26	-	27	30	34	<20	27	35	-1
R55	-	27	31	34	21	26	35	-1
R62	-	27	31	34	22	26	35	-1
R98	-	30	31	34	30	20	35	-1
R14	-	32	34	**38**	32	<20	35	**+3**
R96	-	29	33	**37**	34	<20	35	**+2**
R17	-	30	32	34	35	<20	35	0
R12	-	32	**36**	**38**	**38**	<20	35	**+3**
R24	-	30	32	**37**	35	<20	35	**+2**
R15	-	34	**37**	**43**	**38**	<20	35	**+8**
R11	-	32	35	**39**	**36**	<20	35	**+4**
R10	-	32	35	**39**	35	20	35	**+4**
R9	-	31	35	**37**	32	<20	35	**+2**
R8	-	31	35	**37**	32	<20	35	**+2**
R7	-	31	35	**37**	32	<20	35	**+2**
R22	-	30	34	**36**	31	<20	35	**+1**
R5	-	27	30	32	25	<20	35	-3
Exceedances		**0**	**2**	**14**	**3**	**0**		
				Day Time				
R18	23		-		21	35	35	0
R20	23		-		21	35	35	0
R21	22		-		20	34	35	-1
R3a	20		-		<20	30	35	-5
R3b	20		-		<20	30	35	-5
R101	<20		-		<20	29	35	-6
R102	<20		-		<20	29	35	-6
R103	<20		-		<20	30	35	-5
R105	<20		-		<20	30	35	-5
R26	21		-		<20	31	35	-4
R55	21		-		20	30	35	-5
R62	22		-		21	30	35	-5
R98	23		-		31	20	35	-4
R14	23		-		33	**38**	35	**+3**
R96	21		-		**37**	<20	35	**+2**
R17	24		-		34	<20	35	-1
R12	24		-		**38**	21	35	**+3**
R24	20		-		35	<20	35	0
R15	24		-		**39**	20	35	**+4**
R11	23		-		35	<20	35	0
R10	23		-		34	20	35	-1
R9	21		-		31	20	35	-4
R8	21		-		31	20	35	-4
R7	21		-		31	<20	35	-4
R22	20		-		30	<20	35	-5
R5	<20		-		25	<20	35	-10
Exceedances	**0**		-		3	1		

Source: Modified after Spectrum (2010) – Tables 9 & 10

Scenario 2

Table 4B.14 provides the predicted noise levels that would be received at each of the surrounding residences under conditions equivalent to Scenario 2, i.e. prior to the open cut being developed through "Old Colliery" Hill. *Figures F7 to F12* contained within *Appendix F* of Spectrum (2010) present the results as noise contours to provide an illustration as to the area impacted by noise generated by the LOM Project.

The number of residences for which an exceedance of the nominated operational noise impact assessment criteria are predicted during the day time (under noise enhancing wind conditions) would increase from four to six as mining progresses to the north. Conversely, the number of residences predicted to receive noise levels exceeding the nominated operational night time noise impact assessment criteria would decrease from 14 to eight (with all exceedances experienced under extreme inversion conditions [12°/100m]). Based on the likely distribution of inversion strengths throughout the year, this result indicates that the period of time when night time exceedances are likely to occur at most residences would be limited to the coldest winter months, in the absence of wind and cloud cover. Furthermore, all predicted exceedances would fall within a noise management zone, i.e. all exceedances are predicted to be between 1dB and 5dB.

Again, no exceedances were predicted at Residences 26, 55 and 62, which are representative of the most affected locations within the residential area of Werris Creek, illustrating compliance with the nominated day time and night time noise criteria would be achieved.

Scenario 3

Table 4B.15 provides the predicted noise levels that would be received at each of the surrounding residences under conditions equivalent to Scenario 3, i.e. following the development of the open cut through "Old Colliery" Hill and the completion of the Acoustic and Visual Amenity Bund. *Figures F13 to F18* contained within *Appendix F* of Spectrum (2010) present these results as derived noise contours.

The number of residences for which an exceedance of the nominated operational noise impact assessment criteria are predicted during the day time (under noise enhancing wind conditions) would decrease from eight to four as the influence of the northwest winds is reduced by distance of operations from the Paynes Road residences. During the night time, the number of residences predicted to receive noise levels exceeding the intrusiveness noise criteria would remain relatively consistent at nine (with all exceedances experienced during inversion conditions).

Similar to the previous two scenarios, the number of exceedances reduces to only one (R14) when inversion strength is decreased to 6º/100m, with compliance with the intrusiveness criterion achieved when a 3º/100m inversion is modelled. All predicted exceedances would fall within a noise management zone, i.e. all exceedances are predicted to be between 1dB and 5dB.

Again, no exceedances were predicted at Residences 26, 55 and 62, which are representative of the most affected locations within the residential area of Werris Creek, illustrating compliance with the nominated day time and night time noise criteria would be achieved.

Table 4B.14
Predicted Noise Levels (Scenario 2) – dB(A),$L_{eq(15\text{-}minute)}$

Residence Reference	**Meteorological Condition**						**Criteria**	**Maximum Differential**
	Calm	**Inversion**			**Wind (3m/s)**			
		3^0C/100m	**6C/100m**	**12^0C/100m**	**NW**	**SSE**		
Night Time								
R18	-	30	34	**36**	24	28	35	**+1**
R20	-	30	34	**36**	24	28	35	**+1**
R21	-	29	33	35	23	28	35	0
R3a	-	28	30	33	<20	27	35	-2
R3b	-	28	30	33	<20	27	35	-2
R101	-	26	29	32	<20	25	35	-3
R102	-	26	29	32	<20	25	35	-3
R103	-	27	30	33	<20	26	35	-2
R105	-	27	30	33	<20	26	35	-2
R26	-	27	30	33	20	25	35	-2
R55	-	27	30	33	20	25	35	-2
R62	-	27	30	33	21	24	35	-2
R98	-	30	34	**36**	30	<20	35	**+1**
R14	-	32	34	**37**	32	27	35	**+2**
R96	-	29	33	35	33	<20	35	0
R17	-	25	28	34	30	<20	35	-1
R12	-	27	31	**36**	32	<20	35	**+1**
R24	-	26	30	35	31	<20	35	0
R15	-	29	33	**38**	33	<20	35	**+3**
R11	-	28	32	**36**	32	<20	35	**+1**
R10	-	28	32	**36**	32	<20	35	**+1**
R9	-	27	31	35	30	<20	35	0
R8	-	27	31	35	30	<20	35	0
R7	-	27	31	35	30	<20	35	0
R22	-	27	30	35	29	<20	35	0
R5	-	24	28	31	25	<20	35	-4
Exceedances		0	0	8	0	0		
Day Time								
R18	25		-		25	**39**	35	**+4**
R20	25		-		25	**39**	35	**+4**
R21	25		-		24	**38**	35	**+3**
R3a	20		-		<20	34	35	-1
R3b	20		-		<20	34	35	-1
R101	<20		-		<20	33	35	-2
R102	20		-		<20	33	35	-2
R103	21		-		<20	34	35	-1
R105	21		-		<20	34	35	-1
R26	24		-		21	35	35	0
R55	24		-		22	35	35	0
R62	25		-		22	34	35	-1
R98	20		-		34	<20	35	-1
R14	35		-		**36**	**38**	35	**+3**
R96	23		-		**38**	<20	35	**+3**
R17	<20		-		32	<20	35	-3
R12	<20		-		35	<20	35	0
R24	<20		-		33	<20	35	-2
R15	<20		-		**37**	<20	35	**+2**
R11	<20		-		34	<20	35	-1
R10	<20		-		34	<20	35	-1
R9	<20		-		30	<20	35	-5
R8	<20		-		30	<20	35	-5
R7	<20		-		30	<20	35	-5
R22	<20		-		30	<20	35	-5
R5	<20		-		24	<20	35	-11
Exceedances					**3**	**4**		

Source: Modified after Spectrum (2010) – Tables 11 & 12

Table 4B.15
Predicted Noise Levels (Scenario 3) – dB(A),$L_{eq(15\text{-}minute)}$

Residence Reference	Meteorological Condition						Criteria	Maximum Differential
	Calm	Inversion			Wind (3m/s)			
		3^{0}C/100m	6C/100m	12^{0}C/100m	NW	SSE		
Night Time								
R18	-	30	34	**37**	24	31	35	**+2**
R20	-	30	34	**37**	24	31	35	**+2**
R21	-	29	34	**37**	23	30	35	**+2**
R3a	-	28	30	34	<20	29	35	-1
R3b	-	28	30	34	<20	29	35	-1
R101	-	27	30	32	<20	27	35	-3
R102	-	27	30	32	<20	27	35	-3
R103	-	28	31	33	<20	28	35	-2
R105	-	28	31	33	<20	28	35	-2
R26	-	27	31	34	20	27	35	-1
R55	-	28	31	34	21	27	35	-1
R62	-	28	31	35	22	26	35	0
R98	-	29	33	**36**	30	<20	35	**+1**
R14	-	33	**36**	**39**	32	29	35	**+4**
R96	-	28	31	35	29	<20	35	0
R17	-	26	30	34	30	<20	35	-1
R12	-	25	31	**36**	32	<20	35	**+1**
R24	-	26	32	35	30	<20	35	0
R15	-	29	34	**38**	33	<20	35	**+3**
R11	-	28	33	**36**	31	<20	35	**+1**
R10	-	28	33	**36**	31	<20	35	**+1**
R9	-	27	30	35	28	<20	35	0
R8	-	27	30	35	28	<20	35	0
R7	-	26	30	34	28	<20	35	-1
R22	-	26	30	34	27	<20	35	-1
R5	-	22	27	29	21	<20	35	-6
Exceedances		**0**	**1**	**9**	**0**	**0**		
Day Time								
R18	31		-		30	**40**	35	**+5**
R20	31		-		30	**39**	35	**+4**
R21	30		-		29	**39**	35	**+4**
R3a	25		-		20	34	35	-1
R3b	25		-		20	34	35	-1
R101	25		-		23	33	35	-2
R102	25		-		23	33	35	-2
R103	26		-		23	34	35	-1
R105	26		-		23	34	35	-1
R26	28		-		25	35	35	0
R55	28		-		25	35	35	0
R62	29		-		25	34	35	-1
R98	<20		-		33	<20	35	-2
R14	**37**		-		**39**	**37**	35	**+4**
R96	20		-		34	<20	35	-1
R17	<20		-		29	<20	35	-6
R12	<20		-		32	<20	35	-3
R24	<20		-		30	<20	35	-5
R15	<20		-		34	<20	35	-1
R11	<20		-		31	<20	35	-4
R10	<20		-		30	<20	35	-5
R9	<20		-		27	<20	35	-8
R8	<20		-		27	<20	35	-8
R7	<20		-		27	<20	35	-8
R22	<20		-		27	<20	35	-8
R5	<20		-		23	<20	35	-13
Exceedances	**1**				**1**	**4**		

Source: Modified after Spectrum (2010) – Tables 13 & 14

Scenario 4

Table 4B.16 provides the predicted noise levels that would be received at each of the surrounding residences under conditions equivalent to Scenario 4, i.e. as the open cut approaches the northern limit of mining. *Figures F19 to F24* contained within *Appendix F* of Spectrum (2010) present these results as derived noise contours.

The number of residences for which an exceedance of the nominated operational noise impact assessment criteria are predicted during the day time (under noise enhancing wind conditions) would remain relatively consistent with Scenario 3 at five. During the night time, the number of residences predicted to receive noise levels exceeding the nominated operational noise impact assessment criteria would also remain relatively consistent at eight (with all exceedances experienced during inversion conditions).

With reference to the three inversion conditions modelled, exceedances were only predicted for the severe 12º/100m conditions indicating that night time exceedances are likely to be limited to the coldest winter months. All predicted exceedances would fall within a noise management zone, i.e. all exceedances are predicted to be between 1dB and 5dB.

Again, no exceedances were predicted at Residences 26, 55 and 62, which are representative of the most affected locations within the residential area of Werris Creek, illustrating compliance with the nominated day time and night time noise criteria would be achieved at all residences within Werris Creek.

4B.3.6.1.2 Assessment of Reasonable and Feasible Noise Mitigation Measures

The results presented and discussed in Section 4B.3.6.1.1 identify that even with the implementation of the operational controls and management measures described in Sections 4B.3.4.1 and 4B.3.5, exceedances of the intrusiveness noise criterion are predicted, i.e. may occur under certain conditions.

In light of this, reference is made to *Section 8* of the INP where it is noted that if a regulator / consent authority is satisfied that all reasonable and feasible mitigation measures have been applied, and the predicted noise levels still exceed the Project Specific Noise Limits, "*the regulatory/consent authority can choose to accept the level of impact proposed*". In accepting the level of impact proposed, the regulatory/consent authority should consider the social and economic benefits offered by the project with it stated in *Section 8.1* of the INP that:

> *"Where it can be demonstrated by the proponent that the development offers net benefits, a regulatory/consent authority may consider these as grounds for applying the achievable noise levels, rather than the project-specific noise levels, as the statutory compliance limit."*

The following provides a summary of the noise mitigation measures considered. While this repeats some of the information presented in Sections 4B.3.4.1 and 4B.3.5, it has been included to illustrate that the operational controls and safeguards to be implemented by the Proponent represent all reasonable and feasible measures to attenuate noise.

Table 4B.16
Predicted Noise Levels (Scenario 4) – dB(A),$L_{eq(15\text{-minute})}$

Residence Reference	Meteorological Condition						Criteria	Maximum Differential
	Calm	Inversion			Wind (3m/s)			
		3^{0}C/100m	6C/100m	12^{0}C/100m	NW	SSE		
Night Time								
R18	-	29	33	**37**	25	34	35	**+2**
R20	-	29	33	**37**	25	34	35	**+2**
R21	-	28	33	**37**	24	34	35	**+2**
R3a	-	27	30	34	<20	32	35	-1
R3b	-	27	30	34	<20	32	35	-1
R101	-	25	29	33	<20	30	35	-2
R102	-	25	29	33	<20	30	35	-2
R103	-	26	30	34	<20	30	35	-1
R105	-	26	30	34	<20	30	35	-1
R26	-	27	31	34	21	31	35	1
R55	-	27	31	34	22	31	35	-1
R62	-	27	30	34	23	30	35	-1
R98	-	27	30	33	30	<20	35	-2
R14	-	32	35	**39**	33	<20	35	**+4**
R96	-	27	30	34	32	<20	35	-1
R17	-	27	30	33	32	<20	35	-2
R12	-	30	33	**36**	34	<20	35	**+1**
R24	-	27	31	35	33	<20	35	0
R15	-	32	35	**38**	**36**	<20	35	**+3**
R11	-	30	32	**36**	33	<20	35	**+1**
R10	-	30	32	**36**	33	<20	35	**+1**
R9	-	29	32	35	30	<20	35	0
R8	-	29	32	35	30	<20	35	0
R7	-	29	32	35	30	<20	35	0
R22	-	28	31	34	30	<20	35	-1
R5	-	25	27	30	24	<20	35	-5
Exceedances	**-**	**0**	**0**	**9**	**1**	**0**		
Day Time								
R18	30	-			28	**37**	35	**+2**
R20	30	-			28	**37**	35	**+2**
R21	29	-			27	**37**	35	**+2**
R3a	24	-			20	33	35	-2
R3b	24	-			20	33	35	-2
R101	23	-			<20	32	35	-3
R102	23	-			<20	32	35	-3
R103	24	-			21	33	35	-2
R105	24	-			21	33	35	-2
R26	25	-			24	34	35	-1
R55	25	-			24	34	35	-1
R62	25	-			25	34	35	-1
R98	<20	-			31	<20	35	-4
R14	<20	-			**38**	<20	35	**+3**
R96	<20	-			33	<20	35	-2
R17	<20	-			30	<20	35	-5
R12	<20	-			33	<20	35	-2
R24	<20	-			32	<20	35	-3
R15	<20	-			**36**	<20	35	**+1**
R11	<20	-			33	<20	35	-2
R10	<20	-			32	<20	35	-3
R9	<20	-			29	<20	35	-6
R8	<20	-			29	<20	35	-6
R7	<20	-			29	<20	35	-6
R22	<20	-			28	<20	35	-7
R5	<20	-			25	<20	35	-10
Exceedances	**0**	-			**2**	**3**		

Source: Modified after Spectrum (2010) – Tables 15 & 16

Reasonable and feasible measures to reduce or manage noise levels received at surrounding residences were considered within three categories.

1. Noise reduction / attenuation at source.
2. Reduction in the number of operating noise sources.
3. Active monitoring and management of noise levels.

The specific measures considered within each of these categories are summarised as follows.

Noise Reduction / Attenuation at Source

Spectrum (2010) notes that there are no known reasonable or feasible methods available for reducing noise emissions from the excavators, drills, dozer tracks or topsoil scrapers as attenuator packages for these items do not exist, or are only in the developmental phase. However, as is discussed under the sub-heading of "*Reduction in the Number of Operating Noise Sources*", the Proponent has taken all reasonable and feasible steps to reduce noise emissions from these equipment through restriction on fleet number and operating times.

The above notwithstanding, the Proponent has determined through trials at the Werris Creek Coal Mine that a noise reduction of 7dB can be achieved by restricted engine revolutions and speed on the bulldozers operating on stockpiles. This noise reduction strategy was subsequently adopted.

A thorough investigation of truck noise reduction was also conducted and a commitment has been made to implement the most reasonable and feasible option (which has been included in the noise modelling). The applicability of the CAT extra quiet (XQ) specification trucks to the LOM Project was investigated. However, it was identified that the CAT XQ is only currently available in the CAT XQ793. The CAT 793, with a payload of 400t compared to 250t in the CAT 785, is currently incompatible with existing roads and other infrastructure at the Werris Creek Coal Mine.

In what is believed to be an Australian first, the Proponent has investigated the possibility of retro-fitting the same noise suppression package fitted to the CAT XQ793 to the CAT 785. Advice provided by the manufacturer indicates that the same 8dB reduction in noise achieved in the CAT XQ793 could be achieved in the CAT 785. At a cost of $300 000 per truck (vs $4.9M for the purchase of each XQ793), the Proponent has committed to the application of the noise attenuation package to its existing CAT 785 fleet to achieve a Sound Power level (SWL) reduction of 8dB for each truck.

Based on on-site noise trials of the trucks travelling uphill (121dB(A)) and downhill (125dB(A)) (Spectrum, 2010), and the application of the 8dB reduction in noise, a logarithmic average of 116dB(A) was adopted as the baseline for calculating $L_{Aeq(15\text{-minute})}$ equivalent point sources at 350m spacing along the haul roads.

Spectrum (2010) further notes that adoption of the 8dB attenuation results in the trucks no longer being the dominant noise sources on the Project Site, with the dozers, drills, excavators and train loading activities contributing the majority of noise levels at assessed receivers. Therefore, even if more than 8dB reduction of trucks noise levels were possible, this would not result in meaningful further noise reduction at residential receivers.

The construction of the Acoustic and Visual Amenity Bund to the north of the open cut has been incorporated into the mine design (which incurs additional haulage costs). Various construction scenarios were considered, however, the design and construction scenario presented in the *Environmental Assessment* represents that which provides the most noise attenuation benefit, whilst reducing additional haulage costs.

Following the reduction in the noise emissions from the haul trucks, the crushing plant becomes one of the dominant noise sources. The construction of a noise attenuation barrier of 5m in height has been provided for at the crushing plant reducing this noise source to equivalent with the trucks and other mobile equipment on the Project Site.

Reduction in the Number of Operating Noise Sources

The Proponent has committed to reducing the number of drills to be operated on the Project Site to the lowest number practical for an operation of this size and scale (two).

Acknowledging the exposed nature of equipment operating at surface as the open cut is developed to the north, even after the construction of the Acoustic and Visual Amenity Bund, the Proponent considered various options for restricting the mobile fleet operation to the north of the open cut. Based on the development schedule required to achieve production of 2.5Mtpa, it was determined that development equipment could be stood down for limited periods of time throughout the year without compromising this production level. Based on the noise modelling results, it was determined that the standing down of this equipment should coincide with noise enhancing conditions and resulted in the commitment to not operate surface disturbing equipment to the north of the open cut under night time noise enhancing conditions. *Figures E1* to *E4* of Spectrum (2010) and **Figures 4B.15** to **4B.18** illustrate the fleet reduction commitment.

Whilst the Coal Processing Area remains in its current location, truck / excavator numbers would be restricted to 10 / 3 respectively under inversion conditions. This reduced fleet scenario was also considered following the relocation of the Coal Processing Area (Scenarios 2 to 4). The modelling results indicated, however, that this would have only a very minimal impact on the total mine noise level and therefore the noise level predicted to be received at residences surrounding the Project Site.

Once all the individual noise attenuation measures were considered, a ranking of the noise contribution from the noise sources on the Project Site at critical receiver areas showed similar noise contributions from many sources. This suggests that there are no further dominant noise sources which can be attenuated to result in a significant reduction in total mine noise. This notwithstanding, the following scenarios considering the implementation of further restrictions on mine fleet was undertaken to determine whether these reduction could have a significant impact on received noise levels.

- 2 excavators instead of 5.
- Removal of all drills.
- Reduced truck numbers.

This modelling did not result in a reduction in the noise levels received at the most affected residences likely to be differentiated by human hearing (<2dB(A)). The lack of significant noise reduction is attributable to the almost uniform noise levels generated by the mining fleet across the Project Site creating a “mine hum”. The only way to reduce this “mine hum” such that a difference in the noise level is likely to be recognised at the residential receivers surrounding the Project Site, would be to significantly reduce the mining fleet (by more than 1/3) which, the Proponent advises, would impact on the viability of the mine, i.e. further fleet reduction is not feasible.

Active Monitoring and Management of Noise Levels

Acknowledging that elevated noise levels would be attributable to specific noise enhancing conditions, which are likely to be restricted in occurrence annually, as well during the day, evening and night time periods, the Proponent has committed to implementing a comprehensive real time noise and meteorology monitoring program. The monitoring would provide direct warning / notification to mine management of noise enhancing conditions and elevated noise levels. On receipt of these notifications, mine management would be able to modify operations (if practicable) to relocate noisier equipment within the Project Site, i.e. noise generation at the mine would be reduced as far as reasonably and feasibly possible at the time.

The preceding demonstrates that a thorough review of all possible noise mitigation methods has been completed. Based on the results of this investigation, it is concluded that the noise levels predicted to be received at residences surrounding the Project Site cannot be reasonably or feasibly reduced any further. Section 4B.3.6.1.3 assesses the likely impacts of the noise modelling results on the receivers surrounding the Project Site considering the size and likely frequency of any exceedances of the intrusiveness noise criteria.

4B.3.6.1.3 Assessment of Noise Modelling Results

With the exception of Residence R15 ("Plain View"), the predicted exceedances all fall within the noise management zone, i.e. do not exceed 5dB(A). The Proponent is currently negotiating an agreement with the owner of "Plain View" and anticipates having an agreement in place prior to the commencement of the LOM Project. Once a formal agreement is reached, a copy would be supplied to the DoP and DECCW.

There are several important considerations that should be made when considering the results presented in Section 4B.3.6.1.1 and assessing the impact of the LOM Project on local noise levels.

1. The exceedances of the nominated operational noise impact assessment criteria are only predicted under noise enhancing conditions which would only be experienced for limited periods each year. For example, the noise exceedances associated with noise enhancing winds are only predicted to occur when the modelled wind conditions prevail. As discussed in Section 4B.3.2.2, these wind conditions are generally only a feature of the local environment during specific season and period of day combinations, e.g. spring / night time. On this basis, the predicted exceedances of the nominated operational noise criteria would be unlikely to occur very often or for extended periods.

   It is also noted that the extreme inversion conditions modelled (12°C/100m) are only likely to occur during the coldest winter months. Inversions, if occurring at all outside the winter months, are likely to be far less extreme and have been predicted as only resulting in exceedances at two residences (R15 for Scenario 1 and R14 for Scenario 2). The Proponent has commenced temperature monitoring at locations separated vertically by approximately 100m to provide more detail as to the likely proportional occurrence of inversions of varying strengths. This information would be used to plan mine development and production activities such that operations in the more exposed areas of the Project Site are preferentially undertaken during those periods of the year likely to not experience inversions (or experience only low strength inversions).

2. Conversely to (1) above, under non-noise enhancing conditions, i.e. calm conditions, winds exceeding 3m/s, winds blowing from the northeast to southeast, etc. which are likely to prevail more frequently, the noise modelling demonstrates compliance with the nominated operational noise impact assessment criteria. That is, based on the noise modelling completed, and the implementation of all reasonable and feasible noise mitigation measures, the LOM Project would operate in compliance of the intrusiveness criteria for the majority of the time.

3. The noise predictions provided by **Tables 4B.13** to **4B.16** represent noise levels significantly reduced from those originally predicted. This has been achieved through the implementation of all reasonable and feasible noise mitigation measures (see Section 4B.3.6.1.2). It is considered that the modelled noise levels represent the lowest noise level that could practically be achieved by the Proponent under the conditions modelled.

4. The Proponent proposes to implement real-time noise and meteorological monitoring surrounding the Project Site. This monitoring would enable mine management to have an accurate real-time record of the noise levels being received at selected residences, or potential noise enhancing conditions which could lead to elevated noise levels at these residences. The monitoring would have two positive impacts on noise management at the Project Site.

   a. As a minimum measure, mine management could ensure that the noise levels received do not exceed the approved noise criterion at any non-project-related residence. In the event that exceedances occur or are considered likely to occur based on developing meteorological conditions,, mine management could enforce restrictions on operations to reduce the noise generated on the Project Site.
   b. Further to (a) above, the real-time monitoring would also allow mine management to modify operations within the Project Site prior to an exceedance occurring, i.e. as noise levels increase or inversion conditions strengthen the Proponent could review operations and either stand down equipment not absolutely required to meet mine production requirements or move equipment to less exposed locations within the Project Site.

5. Management measure (4a) above would be adopted as a minimum standard. Management measure (4b) would be implemented as far as practically possible (recognising that reduced equipment operation was not considered a feasible option over a long period of time and therefore not incorporated into the noise modelling of Spectrum (2010)).

With respect to *Section 8* of the INP again, it is assessed that the LOM Project offers considerable social and economic benefits to the Werris Creek community and wider Liverpool Plains LGA (see Section 4B.14 and Section 6.3.3). Therefore, in the absence of further reasonable or feasible noise reduction methods, the adoption of the elevated noise levels within a "noise management zone" (36dB(A) to 40dB(A)) under specific meteorological conditions is considered justified. **Table 4B.17** presents a consolidated list of the proposed Project Specific Noise Criteria for the 27 representative residences considered reasonable to apply for the LOM Project.

Table 4B.17
Proposed Project Specific Noise Criteria

Residence Reference#	Owner	Assessment Period	
		Daytime	Evening/Night
R18	Withers	40	37
R20	Patterson	39	37
R21	Currey	39	37
R3a / R3b	Lomax	35	35
R101	O'Brien	35	35
R102	De Haart	35	35
R103	Parsons	35	35
R105	Lewis	35	35
R26	Woods	35	35
R55	Haling	35	35
R62	Cunningham	35	35
R98	J. Colville	35	36
R14	Haling	39	39
R96	Davison	38	37
R17	Doolan & Hogan	35	35
R12	Fletcher	38	38
R24	P. George	35	37
R15[1]	Maxwell	39	40
R11	Ryan	35	39
R10	Blackwell	35	39
R9	Smith	35	37
R8	Hird	35	37
R7	Andrews	35	37
R22	Parkes	35	36
R5	R. & A. George	35	35

Note 1: A night-time criterion of 40 dB(A) has been recommended, although a predicted level of 43 dB(A) under inversion conditions places this receiver in a noise affectation zone

Source: Modified after Spectrum Acoustics (2010) – Table 18

4B.3.6.2 Operational Rail Noise

The Proponent leases the Werris Creek Rail Siding from ARTC to enable coal trains to access the Rail Load-out Facility. Previously, the noise associated with the movement of trains along this section of the rail network was considered in accordance with rail transportation noise (see Section 4B.3.3.3), however, on the advice of the Department of Planning this noise has been considered operational noise of the LOM Project and should be considered in accordance with Operational Noise Criteria (see Section 4B.3.3.2). Given the short duration of each individual event, the $L_{eq\ (15\text{-minute})}$ noise level generated by the slow passage of the coal train along the Werris Creek Rail Siding[6] was calculated by Spectrum (2010) at the nearest residences as follows: R20 [50dB(A)]; R18 [43dB(A)]; and R21 [57dB(A)]. Spectrum (2010) notes that L_{max} noise levels would be at least 15dB(A) higher.

These noise levels are significantly in excess of the intrusiveness and sleep disturbance noise criterion. However, it should be noted that the LOM Project would not result in any change to noise generating activities than has been undertaken for the past five years. In fact, through construction and operation of the turn-around loop, a major source of noise received at these residences, idling loco's, would be moved an average of 1 200m further away, i.e. there would be an improvement in the current noise environment.

[6] The noise generated by the idling loco during coal loading to the train is included in the noise modelling results presented in **Tables 4B.13** to **4B.16**.

Options available to reduce the noise levels received at the affected residences are limited as it is not feasible to reduce the noise level generated by the train (as the loco's, wagons and rail line are infrastructure not owned by the Proponent) and the construction of an acoustic barrier on both sides of the rail line is not practically achievable (nor considered to be aesthetically suitable). Noise mitigation options available are therefore limited to those that could be implemented at each residence, e.g. installation of double glazed windows and air conditioning. The Proponent has commenced discussions with the affected land owners / residents regarding the predicted noise levels and possible mitigation measures that could be implemented with the intention of negotiating an agreement related to the operation of coal trains on the Werris Creek Rail Siding. A copy of the negotiated agreement would be forwarded to the DoP and DECCW once obtained.

4B.3.6.3 Sleep Disturbance

Predicted sleep disturbance impact noise levels (maximum over the four operational scenarios) at all modelled residences are presented in **Table 4B.18**. Given compliance with the $L_{A1(1\text{-minute})}$ noise levels at R18, R20 and R21, compliance at the residences further north (R3a, R3b, R101, R102, R103 and R105) is implied and no specific model results were obtained.

Table 4B.18
Predicted Maximum Noise Levels – dB(A),$L_{A1(1\text{-minute})}$

Residence Reference	Owner	Meteorological Condition: Inversion 12^0C/100m	Meteorological Condition: NW wind 3 m/s	Meteorological Condition: SSE wind 3 m/s	Criterion dB(A)
R18	Withers	41	26	40	45
R20	Patterson	41	26	40	45
R21	Currey	41	26	40	45
R3a / R3b	Lomax	38	24	38	45
R101	O'Brien	38	23	37	45
R102	De Haart	38	23	37	45
R103	Parsons	37	24	37	45
R105	Lewis	37	24	37	45
R26	Woods	38	24	37	45
R55	Pitkin	37	23	37	45
R62	Cunningham	37	23	37	45
R98	Colville	33	33	<20	45
R14	Haling	42	34	21	45
R96	Davison	39	36	<20	45
R17	Doolan & Hogan	37	37	<20	45
R12	Fletcher	41	41	22	45
R24	P. George	39	38	<20	45
R15	Maxwell	46	42	21	45
R11	Ryan	41	39	<20	45
R10	Blackwell	41	37	<20	45
R9	Smith	39	35	<20	45
R8	Bird	39	35	<20	45
R7	Andrews	39	35	<20	45
R22	Parkes	38	35	<20	45
R5	R. & A. George	34	27	<20	45
Source: Modified after Spectrum (2010) – Table 19					

With the exception of Residence R15, the predicted maximum noise levels in **Table 4B.18** are all below the sleep disturbance criterion. Maximum noise levels would exceed the sleep disturbance criteria by 1dB at Residence R15, during Scenario 1 operations. Notably, during Scenario 1 this residence is also predicted to be subject to operational noise levels more than 5dB(A) greater than the 'intrusiveness' noise criterion. The Proponent is negotiating with the owner and resident of Residence R15 to allow for the elevated operational and sleep disturbance noise levels during Scenario 1 operations, i.e. while the Coal Processing Area remains in its current location. An agreement with the owner of R15 is anticipated prior to the commencement of the LOM Project.

4B.3.6.4 Road Transportation Noise

The closest residence to the transport route between the Project Site and the Kamilaroi Highway is Residence R6 (see **Figure 4A.6**) which is approximately 42m from the centre of Taylors Lane. Using the equations referenced in Section 4B.3.4.2, and considering a maximum of 10 truck pass-bys within a 1 hour period, with each pass-by having a sound power level of 108 dB(A), Spectrum (2010) predict the traffic noise level received at a distance of 42m from the transport route over a 1 hour period would be 48.4 dB(A). This is 6.6dB below the daytime road traffic noise criterion and 1.6 dB below the night-time road traffic noise criterion.

4B.3.6.5 Rail Transportation Noise

Rail noise from trains generated by the LOM Project would potentially impact on two types of residents.

- rural residents where the trains would pass by reasonable quickly at speed; and
- suburban residents generally closer to the rail line than rural residences and where the trains would travel at lower 'town' speeds.

Rural Residents

Spectrum (2010) used an accepted equation and measured coal train pass-by noise levels to generate predicted rail noise received at distances up to 50m from the rail line. **Figure 4B.19** presents these predicted rail noise levels (for one to six train movements per 24 hours).

The closest residence to the Main Northern Railway Line is R12 (Fletcher) at a distance of approximately 20m.Based on a maximum number of four trains per day, which averaged over 24 hours would provide for five train movements during the day and three train movements at night, reference to **Figure 4B.19**suggests that rail noise levels would approximate 57dB(A) during the day ($L_{eq(15hour)}$) and 53dB(A) during the night ($L_{eq(9hour)}$). This is below the design goals of 65dB(A),$L_{eq(15hour)}$ during the day and 60dB(A),$L_{eq(9hour)}$ during the night .

Suburban Residences

Spectrum (2010) reviewed train noise monitoring data collected at Scone, NSW, over a 24-hour period during February 2010. The monitoring location was near a residential facade at 15m from the rail line which is considered to approximate the closest practical location of a suburban residence to the rail line. Based on the recorded noise level of the coal train pass-bys, a night-time noise contribution of approximately 56dB(A),$L_{eq(9hour)}$ from six train pass-bys was calculated (4dB below the night time design goal of 60 dB(A),$L_{eq(9hour)}$). Extrapolating to the likely maximum of three night time coal trains generated by the LOM Project per night, the train noise contribution at a distance of 15m from the rail line would be 53dB(A),$L_{eq(9hour)}$ (7dB below the night time design goal).

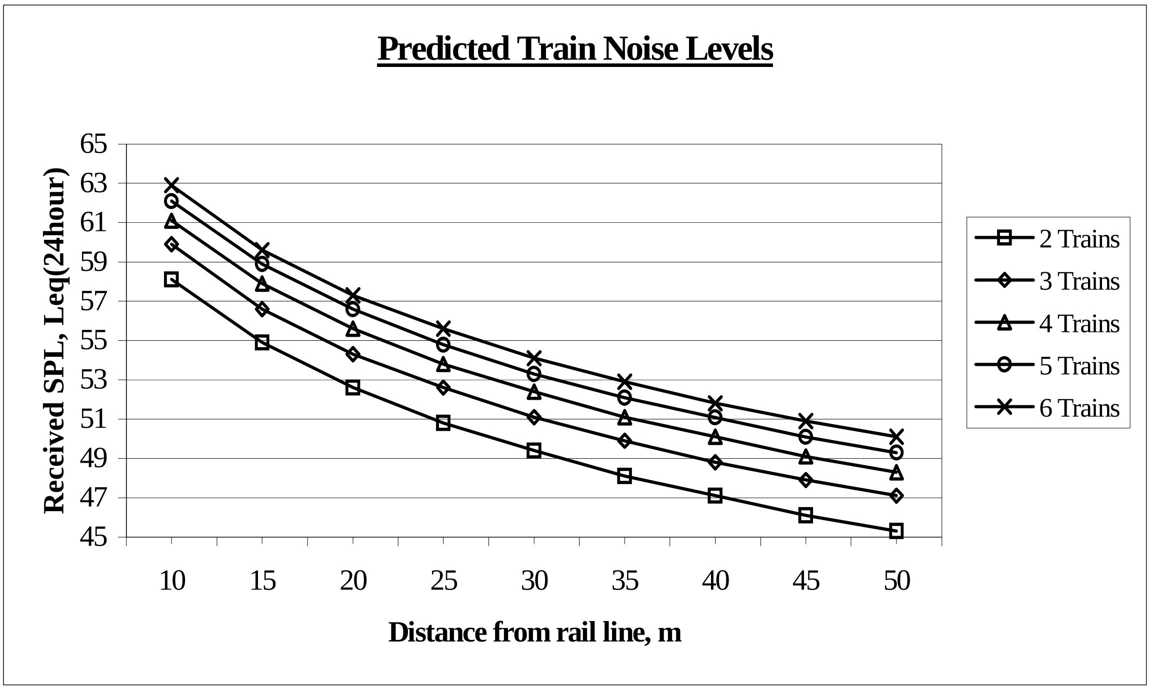

FIGURE 4B.19
NOISE MODELLING SCENARIO 4 – YEAR 15 (DAY TIME OPERATIONS)
Source: Spectrum (2010) – Figure 7

4B.3.7 Monitoring

The Proponent currently implements a Noise Monitoring Program (NMP) with attended noise compliance monitoring conducted at the locations shown on **Figure 1.8**.

- "Tonsley Park".
- "Cintra".
- "Marengo".
- "Almawillee".
- "Glenara".
- "Railway Cottage".

The Proponent would continue this monthly attended noise monitoring with additional receivers included in an updated NMP to possibly include:

- R55 or R62 within Werris Creek;
- "Kyooma";
- "Millbank";
- "Greenslopes and Banool"; and
- any other residential receiver as instructed by the DoP.

As noted in Section 4B.3.5, the Proponent would also implement a real-time noise monitoring program with monitoring to be conducted at the most affected receiver based on the prevailing conditions at the time. The location of real time noise monitoring, along with procedures for managing monitoring results would be developed and incorporated into an updated NMP prior to the commencement of the LOM Project (or within 6 months of project approval). The development of the updated NMP would be undertaken in consultation with DoP and DECCW.

To accompany the real-time noise monitoring, the Proponent would also implement a real-time meteorological monitoring program. This would include real-time monitoring of wind speed and direction (to identify when noise enhancing wind conditions are experienced) and real-time monitoring of inversion conditions. The use of real-time meteorological data in the management of mining operations would be documented within the NMP.

4B.4 BLASTING

An assessment of blasting-related impacts was included as part of the noise and vibration assessment for the LOM Project undertaken by Spectrum Acoustics Pty Ltd (Spectrum, 2010). The full assessment is presented in Volume 1, Part 3 of the Specialist Consultant Studies Compendium. Relevant information from the assessment is summarised in the following subsections.

4B.4.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery & Co Pty Limited for the Project (Section 3.3 and **Table 3.6**) the potential impacts relating to noise and vibration requiring assessment and their unmitigated risk rating are as follows.

- Structural damage to buildings or structures from airblast overpressure (moderate risk).
- Structural damage to buildings or structures from ground vibration caused by blasting (moderate risk).
- Nuisance or impacts on local amenity resultant from blasting (high risk).

In addition, the DGRs issued by the DoP identified "*Noise and Vibration – including a quantitative assessment of potential construction, operational, **blasting** and transport noise impacts*" as one of the key issues that requires assessment at the Project Site. The DGRs require that the noise and blasting assessment refer to the following guideline documents.

- The Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC, 1990).
- Assessing Vibration: A Technical Guideline (DEC, 2006).

Both DECCW and Liverpool Plains Shire Council also identify impacts related to blasting as requiring assessment.

The following sub-sections identify the blasting emissions that must be managed, relevant assessment criteria and describe the controls, safeguards and mitigation measures proposed by the Proponent. Additionally, the assessment of the residual blasting-related impacts following the implementation of these safeguards and mitigation measures are presented.

4B.4.2 Blasting Emissions

Emissions resultant from blasting that could potentially constrain the proposed LOM Project are as follows.

- Ground vibrations.
- Air vibrations (referred to as airblast overpressure).
- Fly rock.
- Dust.

However, each of these emissions is highly transient and, through the implementation of appropriate safeguards in blast design and procedures, can be limited to a level where it is likely that:

i) the safety of the public, mine employees and visitors is not threatened;

ii) ground vibration from blasting is at acceptable levels and ensures the continued integrity of any nearby dwellings, structures and facilities;

iii) noise and ground and air vibrations have no impact on livestock adjacent to, or on, the mine site;

iv) noise and air vibration levels at nearby residences are within acceptable limits and compatible with the safety and comfort of human beings; and

v) the generation of dust is minimised and maintained at acceptable levels.

4B.4.3 Assessment Criteria

4B.4.3.1 Annoyance Criteria

The DECCW commonly adopts blasting assessment criteria based on the human comfort criteria identified in the document *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990* published by the Australian and New Zealand Environment and Conservation Council (ANZECC). These criteria have been adopted for the LOM Project blasting and are as follows.

- The recommended maximum overpressure level for blasting is 115dB(L).
- The level of 115dB(L) may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120dB(L) at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10mm/s at any time.

Building damage assessment criteria are nominated in AS 2187.2-1993 *Explosives – Storage, Transport and Use Part 2: Use of Explosives*, however, as the ANZECC annoyance criteria are more stringent, these are taken as the governing criteria for the LOM Project.

4B.4.3.2 Safety Criteria

It is fundamental that blasting does not injure any person or animal or damage property through the generation of fly rock. Blasting, by its very nature, requires rocks to be broken and propelled away from the blast site.

For the purposes of this document, the area in which blasted rock should normally fall is referred to as the blast envelope with any rock propelled beyond the blast envelope referred to as "fly rock". From a safety perspective, I&I NSW typically nominates a distance of 500m from a blast in an open cut coal mine as a safe distance. This distance is not site specific and consequently is recognised to be conservative. Experience gained to date at the Werris Creek Coal Mine, and at other similarly sized open cut coal mines, indicates that a blasting envelope of 100m to 200m from a blast site would be more than adequate.

4B.4.4 Design and Operational Safeguards

4B.4.4.1 General Blast Design

Central to all safeguards is the conservative design and careful implementation of each blast to minimise impacts, i.e. designing each blast to satisfy environmental and public safety requirements as the first priority, with ongoing blast design refinement based on measured operational and environmental performance. Blast design and implementation would be undertaken by a suitably qualified blasting engineer and/or experienced and appropriately certified shot-firer.

Careful design is also fundamental to safe, successful blasting. Industry has developed best practice procedures centred around the design of blasts that ensure:

- airblast overpressure and ground vibration levels are within nominated limits;
- the required fragmentation (the size of broken rock) is achieved; and
- all rock that is blasted is contained in a pre-determined blast envelope.

Blast design for the LOM Project would continue to include the following features to meet these industry standards.

- Ensuring that burden distances and stemming lengths are such that explosion gases are almost completely without energy by the time they emerge into the atmosphere.
- Ensuring that charges consistently detonate in carefully designed sequences.

4B.4.4.2 Airblast Overpressure

When a confined explosive charge, i.e. a charge within a blasthole detonates, the resulting explosion gases break and then displace the rock to produce a well fragmented and loose pile of blasted rock (or muckpile).

If some of the gaseous expansion energy escapes into the atmosphere, it is manifested as:

- Noise – the audible part of the air vibration spectrum; and
- Airblast – the remaining sub-audible part of the air vibration spectrum.

Airblast is also created where a rock face, i.e. a rock/air interface, is heaved forwards or upwards by the explosion gases. However, where blast design is sub-standard, airblast can vibrate buildings, thereby disturbing or possibly annoying or worrying the occupants. The noise level created by a blast is, however, a very poor indicator of damage potential.

Noise and airblast generation would continue to be controlled by ensuring that all, or nearly all, of the explosion energy is consumed in fragmenting and displacing the overburden by the time the gases vent (via the broken burden rock and/or ejected stemming material) into the atmosphere. This objective would be met by ensuring that:

- blasthole spacing is implemented in accordance with blast design;
- the burden distance and stemming length are carefully selected and then implemented precisely;
- appropriate materials, e.g. quality stemming is used;
- charges detonate in the correct sequence and with inter-row delays that provide good progressive release of burden; and
- the maximum weight of explosive detonated in a given delay period (the maximum instantaneous charge (MIC)) is limited to conservative and proven levels.

Subsequent refinements of these controls would continue to be implemented on the basis of the blast monitoring program.

4B.4.4.3 Ground Vibration

When a confined explosive charge detonates, a fraction of the liberated energy is manifested as seismic energy, i.e. as ground vibrations. The magnitude of ground vibrations depends upon:

- the MIC for the blast;
- the distance between the blast and a residence or sensitive structure; and
- the characteristics of the intervening material (rock, soils, geological structures, etc.) through which the ground vibration wave propagates.

Ground vibration would continue to be controlled by ensuring:

- the minimum practicable weight of explosive detonates at an instant, i.e. minimising the MIC, by using the maximum number of delay periods in each blast; and
- most of the energy liberated by the charge(s) on a given delay number is consumed in providing good fragmentation, adequate displacement and/or a loose, highly diggable muckpile, rather than in creating ground vibrations, i.e. by ensuring that the burden distance and effective sub-drilling are not too large.

4B.4.4.4 Dust and other Post-blast Emissions

When a blast is initiated, some dust would be created as a result of:

- partial or complete ejection of the stemming column;

- the escape of explosion gases through discontinuities and cracks in the face; and/or
- impacts between rock fragments and between rock fragments and the active floor of the mine.

Blast-generated dust would be minimised by ensuring that stemming columns are not ejected for considerable distances into the atmosphere. Stemming column lengths would be such that their ejection velocities are low.

Additionally, the blasting contractor would be required to use aggregates for blasthole stemming and to use Nonel delay-type or electronic detonators to initiate charges. The use of Nonel-type delay or electronic detonators would avoid the requirement for detonating cord downlines and, with the absence of detonating cord trunklines, i.e. surface lines, prevents the dust cloud that is formed when such trunklines detonate on a dry dusty surface.

4B.4.4.5 Fly Rock

Through monitoring of blasts initiated at the Werris Creek Coal Mine to date, the Proponent has confirmed that fly rock has always been confined to the area immediately surrounding the blast. To be conservative, and to ensure no impacts on personnel or equipment, the Proponent proposes to maintain a blast exclusion zone of 500m around each blast. All mobile equipment and personnel would be required to be relocated to at least 500m from the site of the blast prior to initiation and remain outside the blast exclusion zone until the shot firer confirms it is safe to re-enter.

It is noted that the open cut would encroach within 250m of Werris Creek Road and the Main Northern Railway Line, with approximately 15% of the LOM Project open cut located between 250m and 500m from Werris Creek Road. Therefore, when blasting is to be undertaken within 500m of the road and/or rail line, the safeguards, controls and management measures would be implemented in accordance with existing "*Whitehaven Coal Procedure – Road Closure*" developed by the Proponent in consultation with Liverpool Plains Shire Council and ARTC.

1. Notification of Road Closure
    - The public is notified a minimum of 7 days prior to blasting of impending road closures by signage on Werris Creek Road and a notice in the Werris Creek Flyer and Quirindi Advocate.
    - Residents of the properties immediately surrounding the Project Site are notified by phone call prior to every blast, with possible road closure information provided.
    - Emergency services, ARTC and Liverpool Plains Shire Council are notified of blasting and road closures each week by fax. Emergency services and ARTC are also notified by phone on the morning of each blast.
2. Timing of Road Closure
    - Road closures will be restricted to be between 9:30am and 2:30pm Monday to Friday, and generally around 1:15pm. That is, road closures will avoid peak traffic times and school bus service hours of operation.

3. Blast Design, Determination of Road Closure Requirement and Blast Operation

   - A bund wall of at least 6m in height (the toe of the out-of-pit overburden emplacement or Acoustic and Visual Amenity Bund) is constructed between the open cut and Werris Creek Road.
   - Blasts within 500m of the road/rail line are designed to throw material away from this infrastructure.
   - All blasts within 350m of Werris Creek Road require road closure.
   - Should blasting occur within 200m of the rail line, a short term possession of the rail line is to be instigated[7].
   - A risk assessment is completed for each blast between 350m and 500m of the road/rail line to determine whether road closure is required. If road closure is not considered necessary, at least two observers with blast warning signs are positioned at appropriate locations on Werris Creek Road to inform approaching traffic of impending blast and to monitor for fly rock and dust.
   - Should fly rock be observed, or there be dust movement towards the roadway, the observers are to take immediate action to stop traffic entering the affected area. If affecting the rail line, the Upper Hunter (2) Train Controller will be contacted on 02 4902 7911.

4. Road Closure Procedure

   - Blast sentries and traffic controllers will be positioned on Werris Creek Road at least 10 and 30 minutes prior to the scheduled blast respectively.
   - Warning signs will be in place (with the traffic controllers) at least 30 minutes prior to the scheduled blast.
   - The shot firer will contact the traffic controllers to confirm they are in position. A second call will then be made to confirm the blast exclusion zone is clear.
   - Following the completion of the blast, the road will be inspected for fly rock and was identified as clear re-opened for traffic.

5. Road Clean-up Procedure

   - If fly rock is identified on the road, the traffic controllers are to remain in position and maintain the road closure.
   - A standby clean-up crew will be mobilised immediately to remove any debris from the road.
   - On clearance of the debris, the road is re-opened.

6. Rail Closure Procedure

   Rail line closures are to be in accordance with Category A type blasting identified in the "*Guidelines for Blasting in Close Proximity to ARTC Infrastructure*". Category A type blasting is that within 200m and 500m of a rail line.

   - Blasting is only to occur when the rail line is clear of trains for 2km in both directions.

[7] The design of the LOM Project open cut remains at least 250m from the Main Northern Rail Line.

- If the road observers become aware of any rail traffic movements he is to immediately notify the shotfirer.
- The blast will be delayed until the rail traffic has passed the blast area.
- Should fly rock be observed, or there be dust movement towards the rail line, the observers contact Upper Hunter (2) Train Controller on 02 4902 7911.

The Proponent would continue to monitor the distance fly rock travels to ensure that the blast envelope remains appropriate. If necessary, the Proponent would increase the nominated blast exclusion zone to ensure safety of site personnel, livestock, motorists and/or rail traffic is not jeopardised.

4B.4.4.6 Community Notification

Community notification of blasting would be as identified in the "*Whitehaven Coal Procedure – Road Closure*" (see Section 4B.4.4.5 [1]).

4B.4.5 Assessment Methodology

Standard equations for predicting blast overpressure and ground vibration levels, sourced from the United States Bureau of Mines, are presented for airblast overpressure and ground vibration.

Airblast Overpressure

OP = 165 – 24(log10(D) – 0.3 log10(Q)) [dB(L)]

Where:

- *D* is distance from the blast to the assessment point (m); and
- *Q* is the weight of explosive per delay (kg).

Ground Vibration

$$\text{PPV} = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \text{ [mm/s]}$$

Where:

- *D* is distance from the blast to the assessment point (m); and
- *Q* is the weight of explosive per delay (kg).

Spectrum (2010) analysed blast data at the existing Werris Creek Coal Mine from 2009 and 2010 to modify the standard equations and produce specific blast vibration and airblast overpressure 'site-laws' for use in prediction of future blast levels at residential receivers. Further detail on the development of these site laws is provided by Spectrum (2010).

4B.4.6 Assessment of Impacts

4B.4.6.1 Introduction

This sub-section assesses the potential impacts associated with blast-induced ground and air vibration, fly rock and dust. The potential blast-induced noise and vibration impacts are addressed in detail in Spectrum (2010), while dust and other gas emissions associated with blasting are addressed in detail as part of the air quality assessment (Heggies, 2010) provided as Part 4 of the *Specialist Consultant Studies Compendium*.

The predictions of impacts discussed in this sub-section are supported by the experience gained during the mining operations at the Werris Creek Coal Mine over the past 5 years, as well as other operating mines in the region. During that period, blasts comparable to those planned for the LOM Project have not caused any reported conflicts regarding the personal safety of any neighbouring residents or stock.

4B.4.6.2 Air Overpressure and Ground Vibration

Using the methodology described in Section 4B.4.5, and considering the closest distances of surrounding receivers to the LOM Project open cut area, Spectrum (2010) calculated airblast overpressure (OP) and vibration (PPV) levels for various typical MIC values. **Table 4B.19** provides a summary of these calculations.

Table 4B.19
Predicted Blast Overpressure and Vibration Levels

Receiver[1]		Distance (m)	MIC (kg)					
			400		800		1200	
			OP	PPV	OP	PPV	OP	PPV
R20	Patterson	1740	111	1.4	113	1.7	115	1.9
R55	Pitkin[2]	2680	107	0.9	109	1.1	110	1.2
R14	Haling	1315	114	1.8	116	2.3	118	2.6
R96	Davison	2580	107	0.9	109	1.1	111	1.3
R15	Maxwell	2525	107	0.9	109	1.1	111	1.3

Note 1: see Figure 4B.13
Note 2: These residences reflect the most exposed residences within the residential area of Werris Creek. Compliance at these residences will imply compliance at all other residences within Werris Creek
Source: Modified after Spectrum (2010) – Table 21

The results in **Table 4B.19**indicate that the ground vibration criterion of 5mm/s would not be exceeded at any receiver for the range of likely blast sizes. Overpressure levels may exceed the 5% exceedance level of 115dB at Receiver R14 (see **Figure 4B.14**) for blasts greater than 520kg MIC at Receiver R14 (1 315m from the LOM Project open cut area). Spectrum (2010) undertook further calculations and identified that the airblast overpressure criteria would likely be met (for 1 200kg MIC blasts) when blasting is at least 1 690m from the residence.

For the first 10 years of the LOM Project, all blasts would remain at least 1 690m from R14, and as the current average blast MIC is less than 1 200kg, there would be no impact on the blasting frequency nominated in Section 2.5.5.5 (10 blasts per month). Following Year 10, it is anticipated that up to half the blasts within the LOM Project open cut would be within 1 690m of R14. Should the MIC be reduced to 520kg to achieve the airblast overpressure criteria, an additional 5 blasts per month would be required (a total of 15 blasts per month). This would not impact on the overall operation of the LOM Project.

It is important to note, however, that many blast design options are available to the Proponent’s blasting contractor to reduce air overpressure. Through ongoing monitoring of blasts over the initial 10 years of the LOM Project, the most effective mitigation strategies would be identified and implemented to each blast emissions equivalent to those modelled using an MIC of 520kg.

Also of note, Receiver R14 is yet to be constructed and overpressure criteria would not be applicable until the residence has been constructed and is occupied. Once occupied, a blast monitor should be placed at this residence to monitor blast levels.

4B.4.6.3 Fly Rock

As noted in Section 4B.4.4.5, experience at the Werris Creek Coal Mine indicates that a blast exclusion zone of 500m would be more than adequate for fly rock. In fact, blasting has encroached to within 350m of Werris Creek Road without incident. Approximately 15% of the LOM Project open cut area falls between 250m and 500m of Werris Creek Road with several blasts likely to be required within zone from commencement of the LOM Project to about year 13 of operations.

Given the operational experience to date, which confirms that fly rock has not been observed outside the immediate open cut footprint, and the proposed road and rail closure procedure to be adopted, it is assessed that the proposed approach to blast design and monitoring of any rock propelled from the blast site would ensure that an acceptable level of impact is achieved and that no person or stock is endangered.

4B.4.6.4 Dust and Other Gas Emissions

Dust and other gas emissions generated as a result of blasting are assessed as part of an air quality impact assessment (see Section 4B.5). The adoption of the safeguards described in Section 4B.5.5, however, would ensure dust generated as a result of blasting is minimised.

4B.4.6.5 Livestock

The impact of noise generated by the LOM Project on livestock has been assessed through reference to Hunt (1999), a report which assessed the impacts of noise, blasting and dust deposition on livestock and pastures, and the results of the noise modelling undertaken.

Animals are generally more affected by airblast overpressure than ground vibration resulting from blasting. Research into the effects of sonic booms from aircraft (Bond, 1974), which are similar in character to airblast waves, has shown that while an initial startle response after each boom was noticed in beef cattle or ponies, the degree of startle declined rapidly after the first boom and no effect on eating patterns, feed intake or behavioral activity was noted.

Animals exposed to ground vibration for the first time would startle but, without continuance of the vibration, would normally settle quickly and with each additional exposure, the startle response would diminish. Hunt (1999) reported that in paddocks of the Orange Agricultural College adjacent to a rail line, it is common to feel ground vibrations as the passenger train passes at speed, but that the sheep, horses and cattle do not seem to react to that vibration.

4B.4.7 Blast Monitoring

The Proponent currently conducts blast monitoring at surrounding residential and structural receivers in accordance with an approved Blast Monitoring Program (BMP). Blast monitoring is currently undertaken at the following receivers (see **Figure 1.8**).

- Southern end of Kurrara Street, Werris Creek.
- “Greenslopes and Banool” to the northeast of the Project Site.
- “Tonsley Park” to the north of the Project Site.
- “Cintra” within the Project Site.
- A culvert beneath the Main Northern Railway Line adjacent to the entrance to the Liverpool Plains Shire Council quarries.
- “Glenara” on Paynes Road to the south of the Project Site.

All blasts would continue to be monitored at these locations, with airblast overpressure and ground vibration recorded. Following each blast, the blast monitors would be downloaded and the monitoring results forwarded to the appropriate mine personnel for review and, if required reporting. Data obtained would be assessed and analysed to more accurately determine the local ground characteristics and to refine site laws for the ongoing blasting of overburden / interburden.

4B.5 AIR QUALITY

The air quality assessment was undertaken by Heggies Pty Ltd. As part of this assessment the emissions from loaded coal wagons and greenhouse gas emission sources associated with the LOM Project were also identified and quantified. The full assessment is presented in Volume 1, Part 4 of the Specialist Consultant Studies Compendium (Heggies, 2010). This section summarises the assessment of overall air emissions from the LOM Project.

4B.5.1 Introduction

Based on the risk analysis undertaken by R.W. Corkery & Co Pty Limited for the LOM Project (see Section 3.3 and **Table 3.6**), the potential air quality impacts requiring assessment and their **unmitigated** risk ratings are as follows.

- Increased deposited dust levels and suspended particulate matter concentration (extreme risk).
- The release of sulphur dioxide and its associated odour relating to a spontaneous combustion outbreak (moderate risk).
- Reduced local amenity due to the production of nitrogen oxide from blasting operations (moderate risk).
- Greenhouse and other gas emissions (extreme risk).
- Minor health impacts associated with emissions of sulphur dioxide and nitrogen oxide (moderate risk).

The DGRs issued by the DoP identified air quality as one of the key issues that requires assessment for the LOM Project. The assessment is required to include:

- a quantitative assessment of potential air quality impacts including dust emissions from rail wagons;
- a qualitative assessment of the potential Scope 1, 2 and 3 greenhouse gas emissions of the project;
- a qualitative assessment of the potential impacts of greenhouse gas emissions on the environment;
- an assessment of all reasonable and feasible measures that could be implemented on site to minimise greenhouse gas emissions and ensure the project is energy efficient.

The assessment of air quality was undertaken in accordance with *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DECCW, 2005) also known as the *Approved Methods*.

The air quality issues addressed as part of the air quality assessment relate to the following.

- Generation of dust by construction, operational, rail transport and rehabilitation activities throughout the Project Site and in the surrounding areas.
- Emissions of greenhouse gases – principally carbon dioxide (CO_2) and methane (CH_4) during and following the mining of the coal.

The following sub-sections describe the existing air quality environment surrounding the LOM Project Site, air quality criteria used to assess the LOM Project impacts on the environment, proposed operational safeguards and mitigation measures, and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.5.2 Existing Air Quality

4B.5.2.1 Introduction

The description of the existing air quality at the Project Site was derived from site-specific air quality data, acquired as part of the existing Werris Creek Coal Mine ambient air quality monitoring network. The current network comprises four dust deposition gauges and five high volume air samplers (HVAS), four which measure particulate matter of less than 10 microns in diameter (PM_{10}) and one which measures total suspended particulates (TSP). Another three dust deposition gauges have also been used in the past, but are no longer used due to the consolidation of the network. The locations of both the current and previous air quality monitors are shown in **Figure 4B.20.**

The average air quality values reported in this assessment have been derived from data measured between September 2004 and December 2009 for dust deposition and between September 2007 and March 2010 for particulate matter. The results of dispersion modelling are based on air quality and meteorological data from September 2007 to August 2008. This year was chosen for dispersion modelling as it included a meteorological data set which is complaint with the *Approved Methods.* This data set was also used for the modelling for Modification 5 of the current development consent and therefore allows a good comparison of potential air quality impacts between Modification 5 and the proposed LOM Project.

4B.5.2.2 Dust Deposition

Particles that have an aerodynamic diameter sufficiently large so as not to be suspended in air (typically >35μm) are referred to as deposited dust. Dust deposition data acquired from deposition gauges over approximately five years of monitoring showed the annual average dust deposition rate (based on the insoluble solids component) in the area surrounding the current mining operations ranged between 0.7 and 7.4g/m^2/month. The annual average of 7.4g/m^2/month has been recorded at WCA6 (**Figure 4B.20**), which is directly on the southern boundary of the existing operations. All other deposited dust monitoring locations have been consistently below the DECCW ambient air quality guideline average of 4g/m^2/month.

The annual average for the modelling period (September 2007 to August 2008) in the area surrounding the current mining operations ranged between 0.6 and 4.6g/m^2/month. Again, the annual average of 4.6g/m^2/month was recorded at WCA6 (see **Figure 4B.20**), which is directly on the southern boundary of the existing operations. All other deposited dust monitoring locations during the modelling period were below the DECCW ambient air quality guideline average of 4g/m^2/month.

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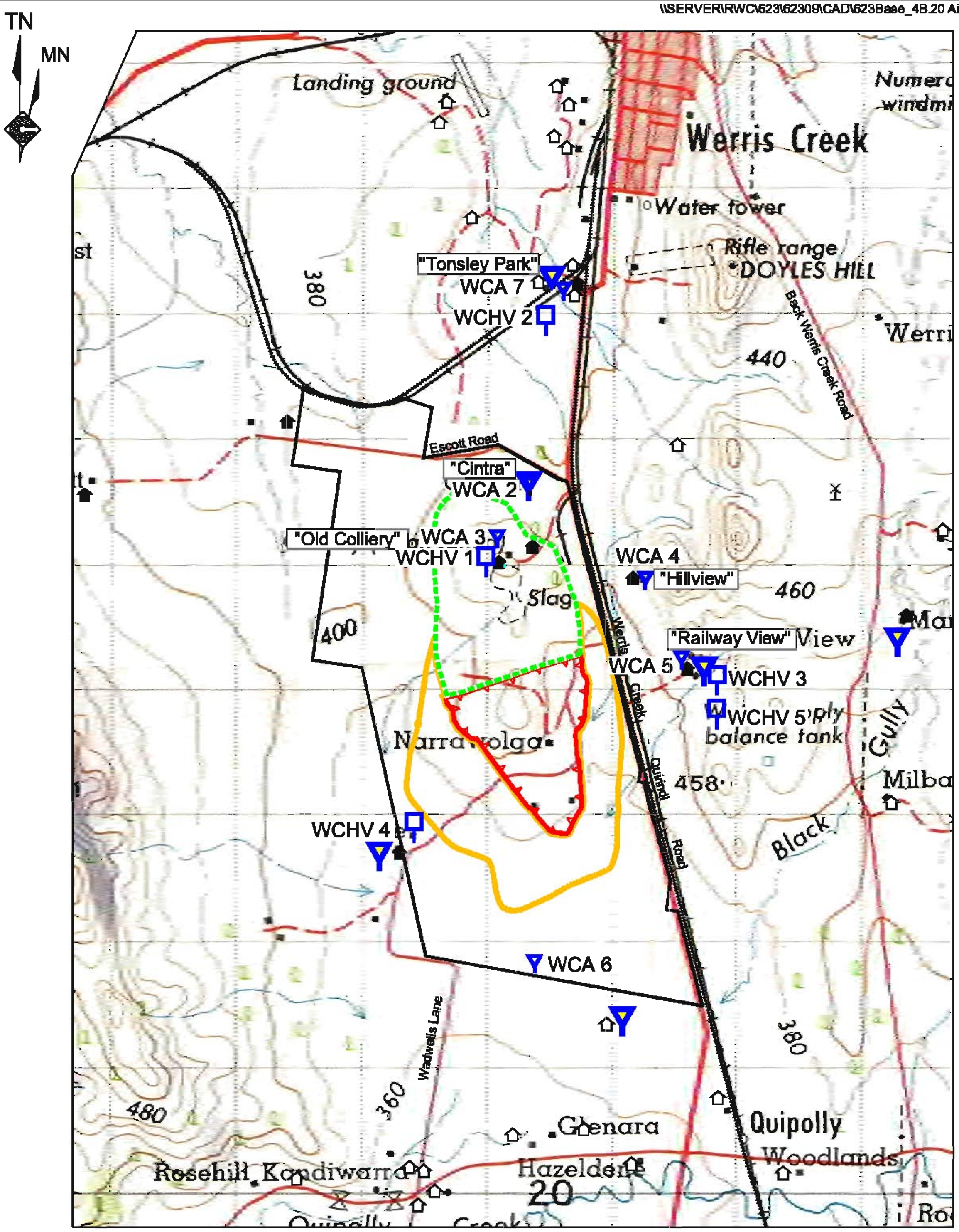

REFERENCE
- Project Site Boundary
- Approved Open Cut Limit
- Proposed LOM Project Open Cut Limit
- Proposed LOM Project Overburden Emplacement Limit (Out-of-Pit)
- Deposited Dust Monitoring Location
- High Volume Air Sampler

SCALE 1:50 000

0.5 0 0.5 1.0 1.5 2.0 2.5 km

Source: Heggies (2010a) - Figures 9 & 10

Figure 4B.20
CURRENT AND PREVIOUS AMBIENT AIR QUALITY MONITORING LOCATIONS

4B.5.2.3 Particulate Matter

Total Suspended Particulates (TSP)

The annual average TSP concentration, comprising airborne particles of less than 35µm in aerodynamic diameter, measured at one monitoring location to east of the current mining operations was 30.1µg/m^3 over the entire data set and 25.0µg/m^3 over the modelling period (September 2007 to August 2008). The values are well below DECCW ambient air quality guideline value for TSP of 90µg/m^3.

Particulate Matter PM_{10}

The annual average PM_{10} concentrations, comprising airborne particulate matter with less than 10µm aerodynamic diameter, measured by the four HVAS that measure PM_{10} were between 14.0 and 17.9µg/m^3 over the entire data set and between 11.5 and 17.9µg/m^3 over the modelling period (September 2007 to August 2008). These annual average PM_{10} concentrations were also well below the DECCW ambient air quality guideline for PM_{10} of 30µg/m^3.

The measured 24-hour average PM_{10} concentrations have generally been compliant with the DECCW 24-hour average ambient air quality guideline of 50µg/m^3. The exceptions are generally related to slight exceedances recorded at monitoring sites that are on property now owned by the Proponent. The maximum 24-hour average PM_{10} concentrations recorded during the modelling period (September 2007 to August 2008) were between 41 and 52µg/m^3, again with the one slight exceedance of the DECCW criteria of 50µg/m^3 occurring at a monitoring location on property that is now owned by the Proponent.

Particulate Matter $PM_{2.5}$

$PM_{2.5}$ concentrations are not currently monitored. Therefore the existing air quality environment with regards to $PM_{2.5}$ concentrations cannot be provided.

Emissions from Coal Transport Operations by Rail

Dust emissions from loaded coal wagons originating from the Project Site make up a proportion of the TSP component that is currently monitored. However the actual TSP component from loaded coal wagons from the Werris Creek Coal Mine is currently not measured.

4B.5.2.4 Summary of Existing Background Air Quality

Table 4B.20provides a summary of the background concentrations of $PM_{2.5}$, PM_{10}, TSP and dust deposition that have been used in modelling assessments of potential air quality impacts of the LOM Project.

4B.5.3 Air Quality Criteria

The following air quality criteria apply to the LOM Project.

- The annual goal for TSP is 90µg/m^3.
- The 24-hour maximum goal for PM_{10} is 50µg/m^3.
- The annual average goal for PM_{10} is 30µg/m^3.
- The 24-hour average guideline for $PM_{2.5}$ of 25µg/m^3.
- The annual average guideline for $PM_{2.5}$ of 8µg/m^3.
- An annual average maximum increase in deposited dust levels of 2g/m^2/mth.
- A maximum annual average deposited dust level goal of 4g/m^2/mth.

Table 4B.20
Ambient Air Quality Environment for Assessment Purposes

Air Quality Parameter	Averaging Period	Assumed Background Ambient Level	Comment
TSP	Annual	30.2µg/m^3	Based on the data set from the DECCW air quality monitoring station in Tamworth.
PM_{10}	24-Hour	Daily Varying	Based on the data set from the DECCW air quality monitoring station in Tamworth. Where data from the Tamworth data set was determined to be as a result of a regional event (refer to Section 6.2.2 of Heggies (2010)), the data has been replaced for that day with the annual average PM_{10} concentration recorded at the Tamworth monitor of 15.1µg/m^3.
	Annual	15.1µg/m^3	
$PM_{2.5}$	24-Hour	None assumed	Assigning an appropriate ratio of PM_{10}/$PM_{2.5}$ to a single PM_{10} concentration or ranges of concentrations is generally not possible due to the wide range of sources contributing (soil erosion, industrial activities, combustion etc.). As $PM_{2.5}$ is not a DECCW adopted assessment criterion, no $PM_{2.5}$ background concentration has been assumed.
	Annual	None assumed	Refer comment related to 24-hour $PM_{2.5}$.
Dust Deposition	Annual	0.6 g/m^2/month	Based on annual average at WCA1 (**Figure 4B.19**) which is considered the best representation of background levels due to its location.
Source: Modified after Heggies (2010) – Table 11			

4B.5.4 Potential Sources of Air Contaminants

4B.5.4.1 Particulate Emissions

Project activities that would contribute to the particulate emissions inventory from the LOM Project are related to specific construction and demolition, operational, on-site transportation and off-site transportation (including rail transport) activities are as follows.

The particulate emission sources are indicated for each activity.

- Vegetation clearing.
  - Clearing of larger vegetation by bulldozer.
- Topsoil stripping.
  - Topsoil removal by excavator or bulldozer.
  - Transportation of topsoil to stockpiles by haul truck.
  - Placement of topsoil on stockpiles.
  - Stockpile management by bulldozer.
- Blasting.
  - Drilling of blast holes.
  - Blasting.

- Overburden management.
  - Overburden to haul truck by excavator.
  - Overburden/interburden transportation to overburden emplacement or Acoustic and Visual Amenity Bund by haul truck.
  - Placement of overburden on the overburden emplacement.
  - Overburden management by bulldozer.
- Coal management.
  - Loading of coal to haul truck by excavator.
  - Transportation to ROM stockpile by haul truck.
  - Placement of coal to ROM/product stockpiles.
  - ROM and Product coal stockpile management by bulldozers.
  - Movement of coal from ROM pad to breaker by front-end loader.
  - Crushing and screening of coal.
- Haul route management.
  - Grading of haul roads.
- Stockpiles and open areas.
  - Wind erosion of stockpiles and open areas.
- Product management.
  - Loading of product coal into trucks for transportation to product coal stockpile or domestic markets.
  - Transportation of product coal to the product coal stockpile or domestic markets by trucks.
  - Loading of rail load-out bins and coal trains via conveyors.
  - Transportation of product coal via train to the Port of Newcastle.

4B.5.4.2 Greenhouse Gas Emissions

Sources of greenhouse gas emissions (carbon dioxide, methane, water vapour) are anticipated to remain the same as current operations and include the following.

- Combustion of diesel during mining and ancillary activities.
- Transportation of coal off site and distribution of coal products.
- Fugitive emissions from coal seams.
- Use of explosives.
- The use of purchased electricity within the Project Site.
- End use of coal products.

4B.5.5 Operational Air Quality Controls

4B.5.5.1 Introduction

The Proponent would apply a wide range of air pollution control measures to ensure air quality standards are not compromised by LOM Project activities. These operational controls have been categorised as either dust control measures, controls for other air contaminants, or greenhouse gas mitigation measures.

4B.5.5.2 Dust Control Measures

Appropriate dust control measures would be implemented for the LOM Project to minimise dust emissions from a number of sources. The majority of the dust control measures summarised in **Table 4B.21**are currently implemented at the Werris Creek Coal Mine. The individual potential sources of dust and proposed controls are also listed in **Table 4B.21**.

Table 4B.21
Dust Control Measures

Dust Emission Source	Operational Controls
Vegetation Clearing	• Trunks, branches and litter from clearing operations would be retained for mine site rehabilitation. • No cleared vegetation would be burnt. • Groundcover removal would be limited in advance of mining to be consistent with operational requirements.
Soil Stripping	• Where practicable, soil stripping would be undertaken at a time when there is sufficient soil moisture to prevent significant dust lift-off. • The Proponent would avoid stripping soil in periods of high winds.
Overburden Emplacement	• During operations that are similar to operations modelled in Scenario 1, overburden emplacement would be suspended on the top lift of the overburden emplacement area when winds are from a northerly direction and greater than 3m/s over more than four consecutive 15 minute periods.
Coal Transfer, Crushing and Screening	• Water application would be applied at the feed hopper, crusher and at all conveyor transfer and discharge points. • All conveyors would be fitted with appropriate cleaning and collection devices to minimise the amount of material falling from the return conveyor belts. • Coal processing activities would cease during periods of concurrent high winds and temperatures which cause coal dust dispersal, independent of water applications.
Wind Erosion from Exposed Surfaces and Stockpiles	• Water would be applied to exposed surfaces, with emphasis on those areas subject to frequent vehicle / equipment movements which may cause dust generation and dispersal. • Regular watering of internal haul roads would be conducted. • Coal stockpiles would be watered prior to stockpiling. • There would be speed limit restrictions on all vehicles and equipment on the Project Site. • Equipment exhausts would be positioned to avoid exhausts impinging on the ground and causing dust lift-off. • Progressive rehabilitation of areas of disturbance once they are no longer for mining purposes.
Drilling Operations	• Water injection would be used on drill rigs.
Product Transport	• All product coal trucks would be covered prior to leaving the Project Site. • Locomotives would be regularly maintained to ensure compliance with exhaust emission standards. • Product coal would be watered prior to leaving the Project Site via rail.
Source: Werris Creek Coal Pty Limited	

4B.5.5.3 Control Measures for Other Potential Air Contaminants

Earthmoving equipment and on-site vehicles would be fitted with exhaust controls which satisfy the DECCW emission requirements. All equipment would be properly maintained to ensure no unacceptable exhaust emissions occur. The Proponent has committed to the removal of any vehicle or item of mobile equipment from the Project Site deemed not to be compliant with DECCW guidelines.

The Proponent would efficiently use diesel to minimise diesel fume generation by:

- optimising and scheduling vehicle operations;
- maintaining engines according to manufacturers' guidelines and keeping tyres at optimum pressure;
- minimising vehicle idling time; and
- possibly use alternative fuels with a reduced carbon content.
- The above control measures relating to diesel fumes are also relevant to controlling odour arising from the mobile equipment fleet. The generation of odour on either the ROM coal stockpile or product coal stockpile (arising from localised spontaneous combustion) would be avoided and / or minimised through monitoring of each stockpile. In the unlikely event that localised spontaneous combustion is detected on either stockpile, the Proponent would isolate the affected coal, drench the coal with water and either process or despatch the subject coal as quickly as possible.

4B.5.5.4 Greenhouse Gas Mitigation Measures

The Proponent is committed to reducing greenhouse gas emissions. An *Energy Savings Action Plan* (ESAP) (Denis Cooke and Associates, 2010) has been developed and approved by the DoP. Potential energy and greenhouse gas emissions reductions for the LOM Project may include but not be limited to:

- a review of the air compressor system;
- reducing the number of conveyors and removal of diesel power packs in the relocated crushing plant; and
- an investigation into replacing product coal transportation to the product coal stockpile by semi-trailers with a conveyor system.

4B.5.6 Assessment of Impacts

4B.5.6.1 Introduction

An assessment of impacts from the LOM Project was undertaken for both dust generating activities and greenhouse gas (GHG) emissions. In the case of the impacts of the dust generating activities, this was primarily undertaken through computer modelling to establish likely concentrations of $PM_{2.5}$, PM_{10}, TSP and deposited dust likely to be generated within the Project Site, including the amount of $PM_{2.5}$, PM_{10}, and TSP generated by loaded coal wagons originating from the Project Site on the towns of Werris Creek and Quirindi. In the case of the impacts of greenhouse emissions, a quantitative assessment was undertaken, and the estimates from the LOM Project were compared with the National and State GHG emissions.

Dust emissions from the proposed LOM Project were modelled using the DECCW's and US EPA's approved CALPUFF (Version 5.8) Dispersion Model software. CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes. Input data required for this modelling were sourced from modelling to predict three dimensional meteorological data and air pollution concentrations. The *Air Pollution Model* (TAPM – version 3) was used for meteorological predictions from a single station meteorological file. This approach was used to replicate the approach taken to modelling for Modification 5 of DA-172-7-2004 approval and therefore more accurately determine any changes to predicted impacts associated with the LOM Project from those predicted in the assessment of Modification 5.

Details of the modelling methodology employed for impact predictions, and the pollutant sources and emission data used in the modelling are provided in *Sections 7, 8* and *9* of Heggies (2010). Details of the residences/properties used in the modelling are provided in *Section 3* of Heggies (2010).

Prior to modelling predictions of TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates attributable to the LOM Project, as well as predicting the amount of TSP emissions associated with loaded coal wagons originating from the Project Site, inventories of all emission sources along with the emission estimates were determined for three operational scenarios.

The emission inventories determined for the three scenarios are presented in Section 4B.5.6.2 while the dispersion modelling results are presented in Section 4B.5.6.3.

4B.5.6.2 Emission Inventories and Assessments of Operational Scenarios

The estimates for TSP, PM_{10} and $PM_{2.5}$(including the proportion of emissions from loaded coal wagons associated with the LOM Project) concentrations used for dispersion modelling were derived based on the three operational scenarios described below and are summarised in **Tables 4B.22**to **4B.24**. Details of the calculations conducted, specific activities that were considered in preparing the emissions inventory, and the emission factors used for each scenario are given in *Section 8* and *Appendix D* of the *Air Assessment Report* (Heggies, 2010).

Table 4B.22
Particulate Emissions from Plant and Equipment Sources

Particle Type	Modelled Scenario (tpa)		
	Scenario 1	Scenario 2	Scenario 3
TSP	1,501	1,394	1,528
PM_{10}	407	474	579
$PM_{2.5}$	60	70	83
Source: Modified after Heggies (2010) – Table 17			

Table 4B.23
Particulate Emissions from Wind Erosion Sources

Pollutant	Area	Modelled Scenario (tpa)		
		Scenario 1	**Scenario 2**	**Scenario 3**
TSP	Active disturbance areas	36.6	48.8	22.7
	Rehabilitated Areas	0.24	0.50	0.93
	ROM Pad	0.31	0.71	0.71
	Product Coal Storage Area and Rail Load-out Facility	0.40	1.22	1.22
Total		**37.5**	**51.2**	**25.5**
PM_{10}	Active disturbance areas	18.4	24.5	11.4
	Rehabilitated Areas	0.12	0.25	0.47
	ROM Pad	0.16	0.36	0.36
	Product Coal Storage Area and Rail Load-out Facility	0.20	0.61	0.61
Total		**18.8**	**25.7**	**12.8**
$PM_{2.5}$	Active disturbance areas	2.8	3.7	1.7
	Rehabilitated Areas	0.02	0.04	0.07
	ROM Pad	0.02	0.05	0.05
	Product Coal Storage Area and Rail Load-out Facility	0.03	0.09	0.09
Total		**2.9**	**3.9**	**1.9**

Note: Emissions based on emission rates of 249 kg/ha/yr for TSP, 125 kg/ha/yr for PM10 and 19 kg/ha/yr for $PM_{2.5}$. Emissions controls applied – 99% for rehabilitated areas, 50% for water sprays of ROM and Load out area. No controls applied to active disturbance areas.

Source: Modified after Heggies (2010) – Table 18

Table 4B.24
Total Particulate Emissions from the LOM Project

Pollutant	Modelled Scenario (tpa)		
	Scenario 1	**Scenario 2**	**Scenario 3**
TSP	1,538	1,445	1,553
PM_{10}	426	500	592
$PM_{2.5}$	63	74	85

Source: Modified after Heggies (2010) – Table 19

The following three scenarios were modelled to assess the likely impact of the LOM Project on the air quality of residential receivers surrounding the Project Site.

Scenario 1 – Approximately Year 3 of the LOM Project

Scenario 1 represents coal extraction at the southernmost point of the existing approved open cut area. It also represents coal processing operations in the existing location, prior to being relocated to the north, and prior to the shortening of the Rail Load-out Road between the Coal Processing Area and Rail Load-out Facility.

Scenario 2 – Approximately Year 7 of the LOM Project

Scenario 2 represents coal extraction in the mid-point of the LOM Project life and also represents a year when construction of the Acoustic and Visual Amenity Bund is to be undertaken. This scenario also accounts for the new location of the Coal Processing Area.

Scenario 3 – Approximately Year 15 of the LOM Project

Scenario 3 represents coal extraction activities at the northernmost point (closest to the town of Werris Creek) of the proposed LOM Project open cut area in approximately Year 15 of the LOM Project.

Modelling of a fourth scenario, covering the activities occurring at the mine during Year 12 of proposed operations, was considered. However, Heggies (2010) considered that Scenarios 1 to 3 adequately represent the southern-most and northern-most extremities of the mining operations, incorporating the relocation of the processing plant and covering the range of locations of plant and equipment items expected across the Project Site. Maximum impacts at the receptors to the south of the Project Site have been covered in Scenario 1, to the north in Scenario 3, and to the east in Scenario 2. Notably, Scenario 2 (Year 7) was specifically modelled to identify the impacts upon receptors prior to the construction of the Acoustic and Visual Amenity Bund. Heggies (2010) note that modeling Year 12 would not provide any additional information over and above that which is already provided relating to the three modelled years of operation.

4B.5.6.3 Dispersion Modelling Results

Dispersion modelling predictions of TSP, PM_{10} and $PM_{2.5}$ concentrations and dust deposition rates attributable to the LOM Project are given below for the three scenarios assessed. The predicted proportion of TSP emissions from loaded coal wagons associated with the LOM Project is also discussed.

Particulate Matter as TSP

Based upon the input data and assumptions of the modelling study, the modelling results indicate that the annual average TSP concentrations would be substantially lower than the DECCW guideline at nearby non project-related residences/properties. **Table 4B.25** presents a summary of the predicted ground-level annual average TSP concentrations at nearby residences/properties.

Table 4B.25
Predicted TSP Concentrations - Annual Averages

Location*	Annual Average TSP Concentrations (µg/m^3)			
	Background	Predicted Impact	Cumulative Impact	Assessment Criterion
Scenario 1				
Worst-affected residence/property (R20)	**30.2**	**12.6**	**42.8**	**90**
Scenario 2				
Worst-affected residence/property (R20)	**30.2**	**13.8**	**44.0**	**90**
Scenario 3				
Worst-affected residence/property (R14)	**30.2**	**17.1**	**47.3**	**90**
Note *: see **Figure 4B.13**				
Source: Modified after Heggies (2010) – Table 22				

Particulate Matter as TSP from Coal Transport Operations by Rail

Coal transport operations by rail in Werris Creek are included within the incremental predictions of TSP provided in **Table 4B.25**. Coal transport operations by rail in Werris Creek associated with the LOM Project contribute a predicted maximum of 1.9µg/m^3 to ambient TSP concentrations at the residences/properties modelled, which is approximately 2% of the DECCW criterion for TSP.

Incremental annual average TSP concentrations in Quirindi peak at 18µg/m^3 at the rail centreline, reducing to 6µg/m^3 at 130m. With the addition of a background concentration of 30.2µg/m^3 results in the Project criterion being met at all distances from the rail centreline for annual average TSP for emissions from rail transport associated with the LOM Project travelling through Quirindi.

Particulate Matter as PM_{10}

Based upon the input data and assumptions of the modelling study, **Table 4B.26** presents a summary of the predicted ground-level annual average PM_{10} concentrations, and **Table 4B.27** presents a summary of the predicted ground-level 24-hour maximum PM_{10} concentrations at the nominated residences/properties.

A detailed discussion of the modelled results for PM_{10} can be found in *Section 10.1.3* of Heggies (2010). Based upon the input data and assumptions of the modelling study, the modelling results indicate that the annual average PM_{10} concentrations would be substantially lower than the DECCW guideline at nearby non project-related residences/properties.

Annual average PM_{10} concentrations are predicted to satisfy the criterion of 30µg/m^3 at all the modelled residence/properties for all modelled scenarios.

Table 4B.26
Predicted PM_{10} Concentrations – Annual Averages

Location	Annual Average PM_{10} Concentrations (µg/m^3)			
	Background	Predicted Impact	Cumulative Impact	Assessment Criterion
Scenario 1				
Worst-affected residence/property (R20)	**15.1**	**4.3**	**19.4**	**30**
Scenario 2				
Worst-affected residence/property (R20)	**15.1**	**4.9**	**20.0**	**30**
Scenario 3				
Worst-affected residence/property (R14)	**15.1**	**6.1**	**21.2**	**30**
Source: Modified after Heggies(2010) – Table 24				

Table 4B.27
Predicted PM_{10} Concentrations – 24-Hour Maximum

Location	24 Hour Average PM_{10} Concentrations (µg/m³)			
	Background	Predicted Impact	Cumulative Impact	Assessment Criterion
Scenario 1				
Worst-affected residence/property (R15)	**Daily Varying**	**28.1**	**47.7**	**50**
Scenario 2				
Worst-affected residence/property (R18)	**Daily Varying**	**20.8**	**44.6**	**50**
Scenario 3				
Worst-affected residence/property (R14)	**Daily Varying**	**39.4**	**60.7**	**50**
Source: Modified after Heggies(2010) – Table 26				

Maximum 24-hour PM_{10} concentrations are predicted to satisfy the criterion of 50µg/m³ at all the modelled residence/properties with the exception of three occasions at residence/property 14 in Scenario 3 (60.7µg/m³, 52.8µg/m³ and 51.2µg/m³). These three exceedances of the 24-hour PM_{10} criterion occur during days with average south-southwesterly and west-southwesterly winds and wind speeds of between 2.4m/s and 5.2m/s. R14 has not yet been constructed, but is likely to be located approximately 0.5km from the eastern boundary of the Project Site. During these wind conditions, particulate emissions from all sources at the Project Site (activities within the pit, haul roads, crushing and screening plant etc.) would impact upon this residence/property, during Scenario 3, when activities are proposed to be at the northern extent of the Project Site boundary.

These predicted high concentrations are shown to be greatly influenced by incremental concentrations from mining activities (39.4µg/m³, 37.7µg/m³ and 27.4µg/m³ respectively). The Acoustic and Visual Amenity Bund would be constructed prior to Scenario 3 operations commencing and therefore, this 8m to 25m high bund, occupying a length of 2.2 km along the northeastern boundary of the Project Site would afford significant protection to this residence/property and assist in retaining a significant proportion of the generated particulate within the Project Site boundary. Specific quantification of the protection provided by the bund is not possible within the dispersion modelling exercise. Coal transport operations by rail are included within the incremental predictions of PM_{10} provided in **Table 4B.27**.

Particulate Matter as PM_{10} from Coal Transport Operations by Rail

Coal transport operations by rail in Werris Creek are included within the incremental predictions of PM_{10} provided in **Tables 4B.26** and **4B.27**. Coal transport operations by rail associated with the LOM Project contribute a predicted maximum of 3.2µg/m³ to maximum 24-hour PM_{10} concentrations at the residences/properties modelled, which is approximately 6% of the DECCW criterion.

The incremental concentrations of PM_{10} (maximum 24-hour average) from LOM Project-related rail transport through Quirindi peak at approximately 34µg/m³ at the rail centreline and decrease to 15µg/m³ at 130m from the rail centreline. At a 10m distance from the rail centreline, incremental concentrations are in the order of 30µg/m³. The addition of the maximum 24-hour average background concentration from Tamworth (31.9µg/m³) results in some PM_{10} (maximum 24-hour average) concentrations exceeding the NSW DECCW criterion of 50µg/m³ at distances up to 100m from the rail centreline. This result represents a worst case assessment as the maximum incremental 24-hour average PM_{10} concentrations being assessed with the maximum 24-hour average background concentration from Tamworth being added. Therefore, the exceedance predicted is dependent on the maximum increment and maximum background occurring within the same 24-hour period and therefore the results of the modelling should be viewed as highly conservative.

There are currently 26 available rail paths through Werris Creek and Quirindi each day, with coal, grain and other products being transported in quantities that are likely to vary on a daily, weekly and monthly basis. Assessing the cumulative impact of these rail movements on 24-hour PM_{10} concentrations is difficult given the varying nature of emissions from trains carrying different cargos and coal products. However, in order to provide an overview of the possible cumulative impact of coal transport by rail, Heggies (2010) assumed that all 26 train passages were of coal carrying trains (from Werris Creek and other mines), with the coal being of the same quality and state of process (crushed and screened). Based on these assumptions, the maximum incremental 24 hour average PM_{10} concentration could be up to 260µg/m^3 at 10m from the rail centreline (26/3 x 30µg/m^3). Addition of a background concentration of 30.2µg/m^3 results in a potential cumulative 24 hour average PM_{10} concentration of up to 291µg/m^3 at 10m from the rail centreline. It is noted that on days when the maximum number of rail movements are generated by the LOM Project, coal transport generated by the LOM Project would contribute 11.5% to this total.

The general assessment of cumulative impacts undertaken by Heggies (2010) clearly shows that the responsibility for particulate management and mitigation is a shared one. The Proponent has committed to engaging in discussions with rail network management (Australian Rail Track Corporation Ltd [ARTC]) and the rail freight carrier (Pacific National [PN]) and formalised this commitments by writing to ARTC and PN on 22 November 2010 to engage them in dialogue regarding the possibilities of initiating air quality monitoring within Quirindi and/or dust control strategies which could be initiated to reduce the impact of dust from loaded coal wagons on this, and other communities.

Particulate Matter as $PM_{2.5}$

The dispersion modelling predictions for $PM_{2.5}$ should be viewed as indicative only as due to a lack of $PM_{2.5}$ monitoring data or studies providing an appropriate ratio with which to calculate $PM_{2.5}$ concentrations from PM_{10} or TSP concentrations. Predicted incremental concentrations of $PM_{2.5}$ only have been compared to the annual average Project criterion of 8µg/m^3 and the 24 hour Project criterion of 25µg/m^3. Based upon the input data and assumptions of the modelling study, **Table 4B.28** presents a summary of the predicted ground-level annual average $PM_{2.5}$ concentrations, and **Table 4B.29** presents a summary of the predicted ground-level 24-hour average $PM_{2.5}$ concentrations at the nominated residences/properties.

Table 4B.28
Predicted $PM_{2.5}$ Concentrations - Annual Averages

Location	Annual Average $PM_{2.5}$ Concentrations (µg/m^3)		
	Background	Predicted Impact	Assessment Criterion
Scenario 1			
Worst-affected residence/property (R20)	**None assumed**	**2.9**	**8**
Scenario 2			
Worst-affected residence/property (R14)	**None assumed**	**2.7**	**8**
Scenario 3			
Worst-affected residence/property (R14)	**None assumed**	**3.1**	**8**
Source: Modified after Heggies (2010) – Table 28			