Figure 4B.16
Operational Noise Contours for Selected Scenarios
(A3 / Colour)

Table 4B.21
Predicted Noise Levels – Year 1 Mining and Associated Activities dB(A),L_{max}

Location	Meteorological Conditions							
	Neutral				Inversion			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	20	20	29	32	25	35	36	39
"Surrey"	<20	<20	25	28	<20	32	31	34
"Carlton"	<20	<20	22	25	<20	26	27	30

Location	Meteorological Conditions							
	SSW wind				NNW wind			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	26	37	38	41	<20	<20	27	30
"Surrey"	<20	<20	27	30	<20	34	33	37
"Carlton"	<20	<20	22	25	<20	29	28	32

*Noise sources included in the L_{Amax} calculations:
1. Filling trucks at coal processing facility;
2. Excavator and haul trucks 10m below ground level in the C Pit;
3. Placing overburden at the northern end of the western emplacement area; and
4. Dozer operating at the emplacement area.

Source: Modified after Spectrum Acoustics (2007) – Tables 12 and 13

Table 4B.22
Predicted Noise Levels – Year 5 Mining and Associated Activities dB(A),L_{max}

Location	Meteorological Conditions							
	Neutral				Inversion			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	<20	<20	26	30	24	22	32	35
"Surrey"	<20	<20	<20	21	<20	31	23	27
"Carlton"	<20	<20	<20	<20	<20	28	21	25

Location	Meteorological Conditions							
	SSW wind				NNW wind			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	25	23	34	37	<20	<20	<20	<20
"Surrey"	<20	<20	<20	22	<20	33	25	28
"Carlton"	<20	<20	<20	<20	<20	29	22	24

*Noise sources included in the LA_{max} calculations:
1. Filling trucks at coal processing facility;
2. Excavator and haul trucks 10m below ground level near the southern perimeter of the open cut;
3. Placing overburden at the northern emplacement area (behind 10m bund); and
4. Dozer operating at the northern emplacement area (behind 10m bund).

Source: Modified after Spectrum Acoustics (2007) – Tables 14 and 15

Table 4B.23
Predicted Noise Levels – Year 7 Mining and Associated Activities dB(A),L_{max}

Location	Meteorological Conditions							
	Neutral				Inversion			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	<20	<20	<20	23	24	<20	<20	21
"Surrey"	<20	<20	<20	<20	<20	31	34	37
"Carlton"	<20	<20	<20	<20	<20	28	28	31
Location	**Meteorological Conditions**							
	SSW wind				**NNW wind**			
Source*	1	2	3	4	1	2	3	4
"Costa Vale"	25	28	<20	22	<20	<20	<20	<20
"Surrey"	<20	<20	<20	<20	<20	33	36	39
"Carlton"	<20	<20	<20	<20	<20	29	31	34

*Noise sources included in the LA_{max} calculations:
5. Filling trucks at coal processing facility;
6. Excavator and haul trucks 10m below ground level near the southern perimeter of the open cut;
7. Placing overburden at the southern end of the western emplacement area; and
8. Dozer operating at the emplacement area.

Source: Modified after Spectrum Acoustics (2007) – Tables 16 and 17

4B.5.5.6 Transportation Noise and Vibration

4B.5.5.6.1 Road Transport Noise

The assessment of road traffic noise was conducted as a cumulative assessment of all coal mine related traffic from the proposed Belmont Coal Project and operating Whitehaven and Tarrawonga Coal Mines. The assessment considered the current noise levels received by the "Brooklyn" residence, the closest residence to the transport route to be used by all three mines, as measured through attended road traffic noise measurements conducted by Spectrum Acoustics. Assessment against the noise criteria for Shannon Harbour Road was not undertaken due to there being no non-project related residence along the affected section of road. During the attended noise measurements, the number of truck movements, pass-by noise levels from each truck and overall measured $L_{Aeq(1hr)}$ noise levels was recorded and this has been used to accurately estimate the noise contribution from additional trucks from the Project, as well as cumulative traffic noise levels from all mines. The results of the most recent attended noise measurements are as presented in **Table 4B.24**.

Table 4B.24
Record of Attended Noise Measurements – "Brooklyn" Residence

Location	Date of Measurement	Time Period	Number of coal trucks	Noise level dB(A),$L_{eq(1hr)}$	Criteria	Differential
"Brooklyn"	28 September 2006	11:44am - 12:44pm	24	52.3	60	-7.7
	27 March 2007	8:01am - 9:01am	28	53.2	60	-6.8

Source: Modified after Spectrum Acoustics (2007) – Section 6.7

Light vehicle movements during both surveys contributed less than 40dB(A) and therefore had no influence on the total traffic noise.

Spectrum (2007) notes that for noise sources that are essentially identical in level and duration, a simple logarithmic calculation is sufficient to estimate the noise from differing numbers of sources, ie. the noise from 28 truck movements based on measurement of 24 movements is achieved by adding 10log(28/24) to the noise level from 24 trucks. The logarithmic calculation yields 53.0dB(A) for 28 trucks based on the measured 53.2dB(A) from 24 trucks and differs by only 0.2dB(A), from the measured value (see **Table 4B.24**). This is less than half the measurement error of a laboratory quality sound level meter (Spectrum, 2007).

Table 4B.24 shows calculated heavy vehicle noise levels relative to the measured level from 28 movements (worst case) for estimated maximum hourly truck movements (ie. at least 30% greater than the estimated average values – see Section 4B.4.3) for the three transportation scenarios. Truck numbers are shown beside the predicted noise levels in parentheses.

The results in **Table 4B.25** illustrate that the adopted daytime and night-time traffic noise criteria would not be exceeded at the "Brooklyn" residence (the closest to the transport route) following the commencement of coal transport from the Project Site. As all other residences are more distant from the transport route, no other residence would receive noise levels exceeding the nominated criteria.

Table 4B.25
Predicted Coal Truck Noise Levels dB(A),$L_{eq(1\ hour)}$

Transportation Scenario [1]	Period			
	Day (7:00am – 10:00pm)		Night (10:00pm – 7:00am)	
	Belmont	Total	Belmont	Total
1. Restricted Transportation hours	51.7 (20)	55.0 (42.8)	N/A (0)	N/A (0)
2. 24 hour transportation (restricted)	50.1 (15.3)	54.4 (37.4)	47.6 (7.7)	47.6 (7.7)
3. 24 hour transportation (constant)	49.7 (12.5)	54.0 (34.5)	49.7 (12.5)	49.7 (12.5)
Note 1: See Section 2.9.3.3 for detail on estimated hourly truck movements.				
Source: Modified after Spectrum (2007) – Table 18				

It should be noted that the model predictions presented in **Table 4B.25** were based on the measured noise emissions of existing haul trucks (a mixture of semi-trailers and B-doubles). The Proponent's transport contractor proposes, however, to upgrade the coal haulage fleet to purpose-built B-doubles should 24 hour transportation be approved. Noise measurements of these purpose-built B-doubles, which incorporate the noise mitigation safeguards and controls described in Section 4B.4.4, identified that the pass-by time was slightly increased from 22.2s to 22.7s (due to the speed limiting), resulting in a slightly elevated $L_{Aeq(1\text{-hour})}$ contribution per truck of 56.4dB(A) compared to 56.1dB(A). Spectrum (2007) notes that a difference of 0.3 dB is less than the measurement error of a laboratory quality sound level meter and as such, the results presented in **Table 4B.25** are therefore valid for the proposed new B-double trucks. In actual fact, the general noise mitigation provided by the new B-doubles, eg. speed limitation, use of airbag "road friendly" suspension and disabling of engine compression brakes, would ensure that the measured pass-by noise level would never be exceeded (by limiting speed levels) and potentially sleep disturbing noises caused by short duration, high intensity noise sources (such as engine compression braking or impact of the trailer against the truck body) would be eliminated.

It is therefore demonstrated that the Proponent would be able to transport coal between 10:00pm and 7:00am without noise levels received at residences along the transport route exceeding the nominated night-time noise criteria. The Proponent would maintain dialogue with the residents of the "Brooklyn" and "Weroona" residences, the most proximal to the transport route and only objector to the 24 hour transport operations respectively, to allow for continual improvement of transport operations. Certainly, the upgrading of the haulage fleet as proposed would minimise or eliminate any sleep disturbing noise sources, the noise sources likely to be of greatest impact between the hours of 10:00pm and 7:00am.

4B.5.5.6.2 Rail Traffic Noise

Spectrum Acoustics measured the noise generated by a train pass-by in the rear yard of a Barber St, Gunnedah, property at approximately 20m from the rail line on 12 December 2006. The L_{eq} noise level measured over a period of 83 seconds was 72.3dB(A) with a measured L_{max} noise level of 79dB(A). These measured parameters provide for the following criteria based noise levels.

- L_{Aeq} (9 hr) night - 46.4 dB(A)
- L_{Aeq} (15 hr) day - 44.2 dB(A)
- L_{Aeq} (24 hr) - 42.2 dB(A)

The predicted level of 42.2 dB(A),$L_{eq(24\ hr)}$ is almost 15dB below the DECC criterion of 55dB(A),$L_{eq(24\ hr)}$ (see Section 4B.5.3.3.5).

The north west branch line of the Main Northern Line currently has sufficient train paths to carry up to six coal trains per day. Assuming the unlikely worst case that all six trains (ie. 12 movements) could occur in the day or the night, the predicted cumulative coal train noise levels are as presented in **Table 4B.26**.

Table 4B.26
Predicted Worst Case Cumulative Train Noise Levels

Period	Noise Level (12 Train Movements) (dB(A), L_{Aeq})	Criteria (EPL 3142)
Night: L_{Aeq} (9 hr)	57.2	60
Day: L_{Aeq} (15 hr)	55.0	65
Source: Modified after Spectrum Acoustics (2007) – Section 6.10		

Again, with the line carrying coal trains at full capacity, the resulting noise levels would be below the noise criteria of EPL 3142, held by ARTC.

4B.5.5.6.3 Rail Traffic Vibration

Vibration levels from laden and unladen coal trains have been widely studied in the Hunter Valley. A thorough assessment conducted in 1997 (*Noise and Vibration Assessment, Jerrys Plains Rail Spur, Wilkinson Murray Pty Limited*) found train vibration levels at 20m from the rail line to be considerably less than the 2.82mm/s criterion. In most train vibration measurements at this distance conducted by Spectrum Acoustics (Spectrum Acoustics, 2007), the vibration logger was not triggered when set as low as 0.5mm/s. Train vibration levels associated with the additional train movements of the Project would not result in vibration levels exceeding the nominated criteria.

4B.5.6 Monitoring

A noise monitoring program would be undertaken by the Proponent, in consultation with the DECC, both prior to the commencement of and during the Project. The monitoring would be designed to initially validate the predictions arising from the modelling and then record noise levels against the Project noise criteria. Two forms of monitoring are proposed.

- Noise Model Validation: monthly attended and unattended monitoring at the “Costa Vale” and “Surrey” residences during site establishment activities and during initial 3 months of mining. Assuming validation of model predictions, monitoring would revert to ongoing compliance monitoring.
- Ongoing compliance monitoring: six monthly attended and unattended monitoring at the “Costa Vale” and “Surrey” residences to monitor compliance with operational noise criteria. Six monthly attended monitoring would also be undertaken at the “Brooklyn” and “Weroona” residences, both during daytime and night-time hours, to monitor compliance with traffic noise criteria.

Monitoring would also be considered at any other residence whose occupants consider noise levels attributable to the mine development are excessive.

The results of monitoring would be provided to the DECC / DoP in the AEMR along with the identification of any refinements to safeguards and noise controls implemented as a consequence of the monitoring.

4B.6 BLASTING

The noise and vibration assessment was undertaken by Spectrum Acoustics Pty Ltd (Spectrum, 2007). The full assessment is presented in Part 5 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following sub-sections.

4B.6.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential environmental blasting impacts requiring assessment and their unmitigated risk rating are as follows.

- Vibration from blasts resulting in damage to non-project related buildings and structures (moderate risk).
- Noise and Vibration from blasts impacting on local amenity (moderate risk).
- Noise and Vibration from blasts impacting on local livestock (moderate risk)

In addition, the Director-General’s requirements issued by Department of Planning require that the assessment of blasting and vibration.

The following sub-sections identify the emissions resulting from blasting, the criteria adopted for assessing blast impacts and the proposed design and operational safeguards, and provide an assessment of impacts from the proposed blasting activities at the surrounding residences. The criteria for assessment and the resulting ground vibration and airblast overpressure impacts have been drawn from the blasting component of a noise and vibration assessment conducted by Spectrum (2007).

4B.6.2 Emissions from Blasting

The potential blasting emissions include:

- ground vibrations;
- air vibrations (noise and airblast);
- fly rock; and
- dust.

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:

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

(ii) ground vibration from blasting occurs 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 Project 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.6.3 Assessment Criteria

4B.6.3.1 Annoyance Criteria

The impacts associated with blasting are assessed based on the ANZECC "annoyance" criteria which are routinely specified in project approvals, development consents and environment protection licences for open cut coal mines.

- The recommended maximum overpressure level for blasting is 115dB (Linear).
- The level of 115dB (Linear) may be exceeded for up to 5% of the total number of blasts over a 12 month period, but should not exceed 120dB (Linear) 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.
- Blasting is only permitted during the hours of 9:00am to 5:00pm Monday to Friday, and should not take place on Sundays and Public Holidays.
- Blasting occurs no more than once per day.

Criteria could also be developed based on issues related to building damage. However, as the annoyance criteria discussed above are significantly more stringent than the building damage criteria, they would be taken as the governing criteria for the Project.

4B.6.3.2 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, the Department of Primary Industries - Mineral Resources 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. Invariably, open cut coal mines comparable in size to the proposed Belmont Coal Project operate with a blasting envelope of 100m to 200m from a blast site.

4B.6.4 Design and Operational Safeguards

4B.6.4.1 General Blast Design

Central to all safeguards is the conservative design and careful implementation of each blast to minimise impacts, ie. 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 require 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 Project would 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.6.4.2 Air Vibrations (Noise and Airblast)

When a confined explosive charge (ie. 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, ie. 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 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, eg. 20mm aggregates, are used for stemming;
- 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 be implemented on the basis of the blast monitoring program.

4B.6.4.3 Ground Vibrations

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

(i) the MIC for the blast;

(ii) the distance between the blast and a residence or sensitive structure; and

(iii) the characteristics of the intervening material (rock, soils, geological structures, etc.) through which the ground vibration wave propagates.

Ground vibration would be controlled by ensuring:

- the minimum practicable weight of explosive detonates at an instant, ie. 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, ie. by ensuring that the burden distance and effective sub-drilling are not too large.

4B.6.4.4 Dust and other Post-blast Emissions

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

(i) partial or complete ejection of the stemming column;

(ii) the escape of explosion gases through discontinuities and cracks in the face; and/or

(iii) 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 (ie. surface lines), prevents the dust cloud that is formed when such trunklines detonate on a dry dusty surface.

4B.6.4.5 Road Closures

The proposed limit of open cut mining encroaches within 500m of Wean Road (SR 6), both in its current and proposed relocated position. To ensure the safety of traffic on Wean Road, the following safeguards would be implemented.

- For all blasts within 500m of Wean Road (SR 6), the road would be closed with blast notice boards updated at least 24 hours prior to each blast. Road closures would typically occur for a period of between 5 minutes and 10 minutes.
- The road would be inspected by mine personnel and any rock fragments removed from the road surface prior to re-opening.
- The Proponent would also monitor the distance flyrock travels (if any) beyond the designed blast envelope and identify if further safeguards would be required.

4B.6.4.6 Community Notification

Given that blast-generated noise is impulsive and may startle people if unexpected, the Proponent would employ the following blast notification procedures.

- The proposed blasting schedule would be provided to all residents within 3km of the blast, ie. to the residents of each of the “Roseberry”, “Glenroc”, “Yarrawonga”, “Yarrari”, “Belah”, “Costa Vale”, “Surrey” and “Stratford”. The notification procedures, which would include advance notice of the intended date and time of each proposed blast and a verbal confirmation on the day of the blast, would be continued throughout the life of the Project. Documentary evidence of the notification, together with the results of the blast monitoring, would be retained at the mine office.

- The Proponent would erect a blast notice board near the mine entrance on Wean Road (SR 6) notifying passing motorists when the next blast is programmed, and at what time.

4B.6.5 Assessment of Impacts

4B.6.5.1 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 (2007), while dust and other gas emissions associated with blasting are addressed in detail as part of the air quality assessment provided as Part 5 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 Whitehaven Coal Mine over the past 5 years, and Tarrawonga Coal Mine over the past 12 months. During that period, blasts comparable to those planned for the Project have not caused any reported conflicts regarding the personal safety of any neighbouring residents or stock.

It is noted that due to the short duration of the blasts, cumulative impacts were not assessed. Put simply, it would be unlikely for the Project to initiate a blast on the same day as the Whitehaven or Tarrawonga Coal Mine and highly unlikely for blasts to occur simultaneously. As such, there is no need to assess impacts cumulatively.

4B.6.5.2 Assessment Methodology

Based on the initial drilling and blasting parameters presented in **Table 2.4**, airblast overpressure and ground vibration were predicted using the following equations:

$$\text{Airblast Overpressure (OP)} = 165 - 24(\log_{10}(D) - 0.3\log_{10}(Q)),$$

where D is distance from the blast to the assessment point (m), and
Q is the weight of explosive per delay (MIC, kg).

As this equation has often been found to underestimate blast overpressure levels by up to 3dB(A), so 3dB(A) has been added to the predicted levels for presentation in this report.

Blast (Ground) Vibration levels calculated as Peak Particular Velocity, may be predicted using the following equations.

$$\text{PPV} = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \quad \text{, mm/s} \quad \text{(for average ground type)}$$

$$\text{PPV} = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \quad \text{, mm/s} \quad \text{(for hard rock)}$$

where D is distance from the blast to the assessment point (m), and
Q is the weight of explosive per delay (MIC, kg).

Based on the relatively hard conglomerate interburden above and between the coal seams, a coefficient value of 700 is considered appropriate by Spectrum Acoustics (2007) for predicting ground vibrations levels.

4B.6.5.3 Air and Ground Vibration

Figure 4B.17 presents the predicted airblast overpressure and ground vibration using values of 1 500kg and 2 300kg to represent the MICs in medium and large blasts, with the predicted values at the nearest non-project related residence ("Costa Vale") identified.

These curves indicate the Project would be comply with air and ground vibration criteria at the closest, and therefore all of, non-project related residences. As a result, there would unlikely be any significant impact associated with either airblast overpressure or ground vibration on surrounding residences.

Notwithstanding, the Proponent and nominated blasting engineer would closely monitor the blasting impacts and relate measured airblast and ground vibration levels to the MIC and other factors. This information would enable the blasting engineer to adjust the MIC to ensure that blasting criteria are satisfied at all surrounding residences.

4B.6.5.4 Fly Rock

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.6.5.5 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.10). The adoption of the safeguards described in Section 4B.10.5, however, would ensure dust generated as a result of blasting is minimised.

4B.6.5.6 Livestock

The impact of noise generated by the 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.

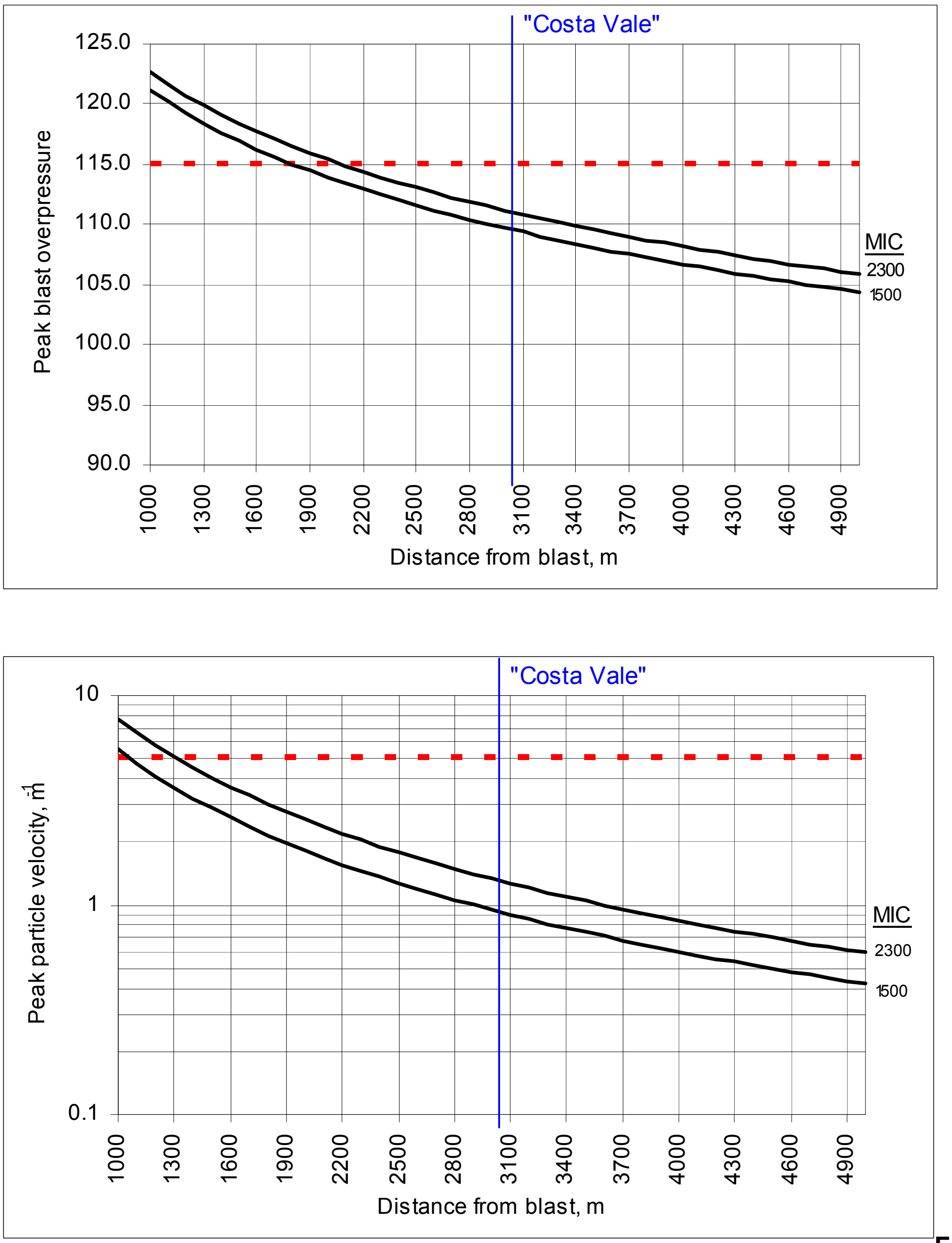

Figure 4B.17
Predicted Airblast Overpressure and Ground Vibration

Animals are generally more affected by airblast 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 affect on eating patterns, feed intake or behavioural 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 XPT passes at speed, but that the sheep, horses and cattle do not seem to react to that vibration.

4B.6.6 Blast Monitoring

All blasts would be monitored. Blast vibration / airblast overpressure monitors would initially be positioned at the "Costa Vale" residence. Additional monitors would be installed, as required, at other surrounding residences and within the Project Site itself. Data obtained would be assessed following each blast and analysed to more accurately determine the local ground characteristics and to develop site laws for the overburden / interburden.

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.

4B.7 SURFACE WATER

The surface water assessment was undertaken by Soil Conservation Service, a division of the NSW Department of Lands. The full assessment (Soil Conservation Service, 2007) is presented as Part 6 of the Specialist Consultant Studies Compendium, with the relevant information from the assessment summarised in the following subsections.

4B.7.1 Introduction

Based on the environmental risk analysis undertaken for the Project (see Section 3.3 and **Table 3.5**), the potential surface water impacts requiring assessment and their unmitigated risk rating are as follows.

- Erosion of natural drainage lines (high risk).
- Erosion of rehabilitated final landform (moderate risk).
- Discharge of sediment-laden or turbid water from the Project Site (high risk).
- Reduced flows to downstream agricultural land and native vegetation (low risk).
- Temporary degradation of downstream water quality through minor discharge/spill of dirty or contaminated water (moderate risk).

- Long term contamination of downstream water quality through major or repeated discharge/spill of contaminated or dirty water (extreme risk).
- Altered flooding patterns and indirect impacts on native vegetation communities and ecosystems (moderate risk).

In addition, the Director-General's requirements issued by the Department of Planning require that the assessment of surface water include a detailed water balance and refer to the *Guidelines for Fresh and Marine Water Quality* (ANZECC), and *Managing Urban Stormwater: Soils & Construction* (Landcom) documents.

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 and an assessment of the residual impacts following the implementation of these safeguards and mitigation measures.

4B.7.2 The Existing Environment

4B.7.2.1 Regional Drainage

The regional drainage is shown on **Figure 4B.18** and shows the Project Site to lie within the Liverpool Plains catchment of the Namoi River Basin of mid-northern NSW. The Namoi River Basin covers an area of approximately 43 000km^2 and incorporates the centres of Tamworth, Gunnedah, Narrabri and Walgett. The Namoi River, one of the main tributaries of the Barwon Darling River system, flows into the Darling River immediately west of Walgett.

Major rivers upstream of the Project Site contributing to flows within the Namoi River in the Gunnedah / Boggabri area include the Manilla, McDonald, Peel and Mooki Rivers. The Manilla and Namoi Rivers flow via Keepit Dam, the largest storage on the Namoi system with a capacity of 425 000ML.

The Namoi River catchment upslope of the Project Site approximates 22 000 km^2.

4B.7.2.2 Local Drainage

The local drainage in the vicinity of the Project Site is also shown on **Figure 4B.18**.

With the exception of approximately 59ha of the Project Site north of Jaeger Lane, which lies within the headwaters of Driggle Draggle Creek, the Project Site and transport route lie within the headwaters of an un-named ephemeral and often ill-defined drainage line which grades in a southerly and southwesterly direction towards the Namoi River. Driggle Draggle Creek is an intermittent ill-defined watercourse which flows to the north of Vickery State Forest and the Whitehaven Coal Mine to Barbers Lagoon and the Namoi River.

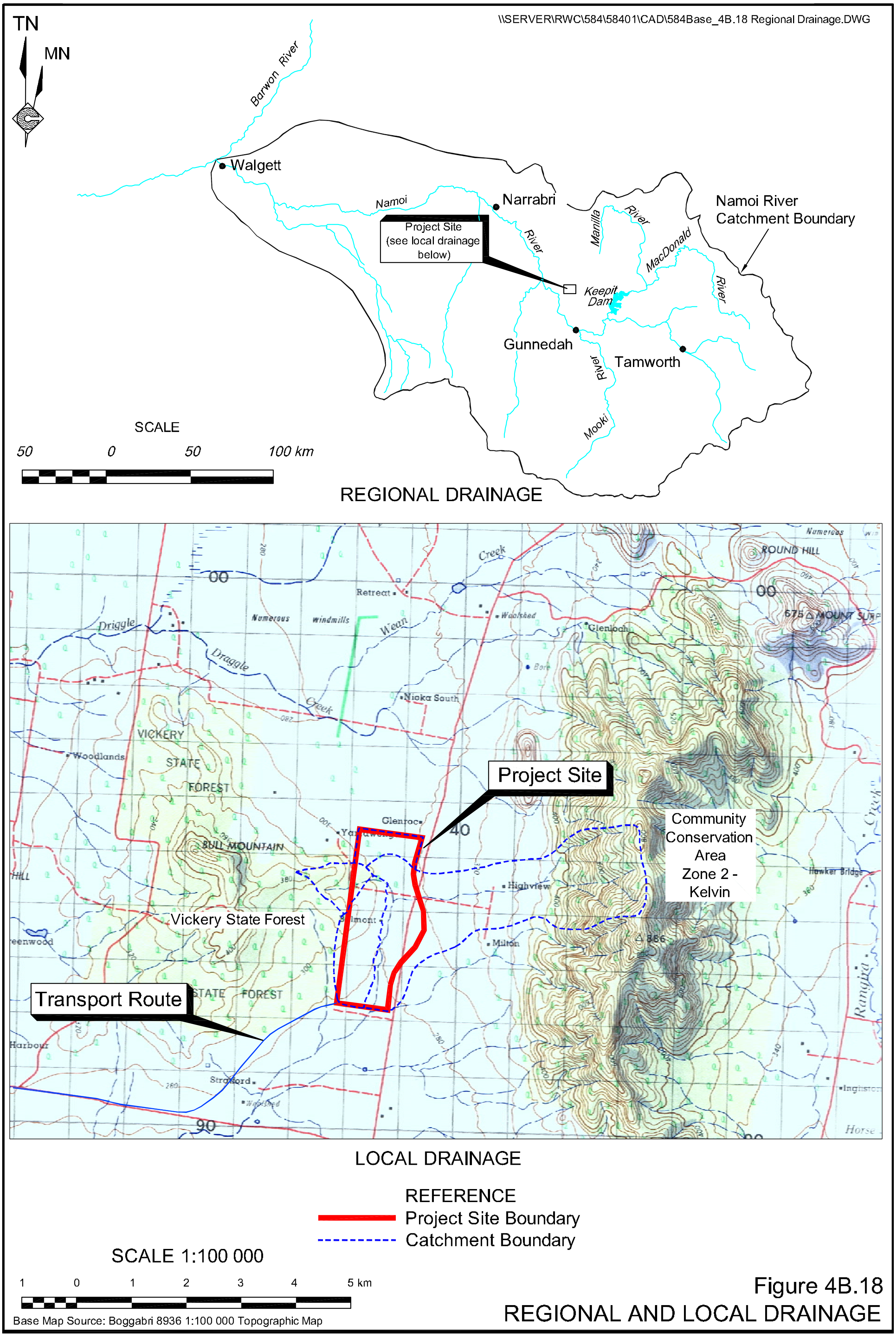

Figure 4B.18
REGIONAL AND LOCAL DRAINAGE

4B.7.2.3 Project Site Drainage

Natural drainage within the Project Site occur as radiating sheet flow and a series of shallow natural ephemeral drainage lines which direct runoff towards the un-named drainage line within the valley floor. Along the northwestern and southwestern boundary of the proposed limit of open cut mining, gilgais, which project up to 0.6m above the adjacent land surface also have a modifying effect on the drainage pattern. Gilgais are areas on heavy clays that are undulating and subsequently fill with water.

Contour banks, excavated and bunded water races and water storages have also substantially modified the natural drainage patterns within and adjacent to the Project Site. Approximately 307ha of the Project Site drains in a generally southerly direction towards the Namoi River (10km away) via a central drainage north-south oriented depression on the Project Site. The remaining 56ha of the Project Site drains to Driggle Draggle Creek to the north of the Project Site.

Table 4B.27 presents a summary of the catchments identified on **Figure 4B.19,** together with an estimate of the annual catchment yield for each of the 10th percentile, mean and 90th percentile annual rainfalls. The catchment yield represents the total volume of water theoretically available for capture within each of the identified catchments.

Table 4B.27
Project Site Catchments and Catchment Yields

Sub-catchment No. (see Figure 4B-19)	Area (ha)	Catchment Yield (ML/yr)		
		10th Percentile Rainfall Event [1]	Mean Rainfall Event [2]	90th Percentile Rainfall Event [3]
Driggle Draggle Creek Catchment				
1	59	108.7	179.4	245.4
Southern Catchment (Namoi River via the Project Site Central Drainage Depression)				
2 (North)	67	41.5	68.4	93.6
2 (West)	155	28.0	46.2	63.3
2 (East)	773	347.4	573.3	784.4
Combined Catchments				
Total	1 014	525.6	867.3	1186.7
1 = 373.6mm/year		2 = 616.4mm/year		3 = 843.4mm/year
Source: Modified after Soil Conservation Service (2007) - Table 1 and Table 4				

To the south and southwest of the Project Site along the transport route, drainage is also generally by radiating sheet flow to shallow natural drainage depressions. Contour banks are also common along the alignment of the transport route through “Brentry” and “Stratford”.

4B.7.2.4 Existing Local Water Storages

There are eight existing dams on the Project Site, the locations of which are shown on **Figure 4B.19**. The total storage capacity of the Project Site farm dams, contour banks and other water impoundments is estimated at 17.2ML. The individual storage capacities of the Project Site farm dams varying from approximately 0.8ML to 5.0ML.

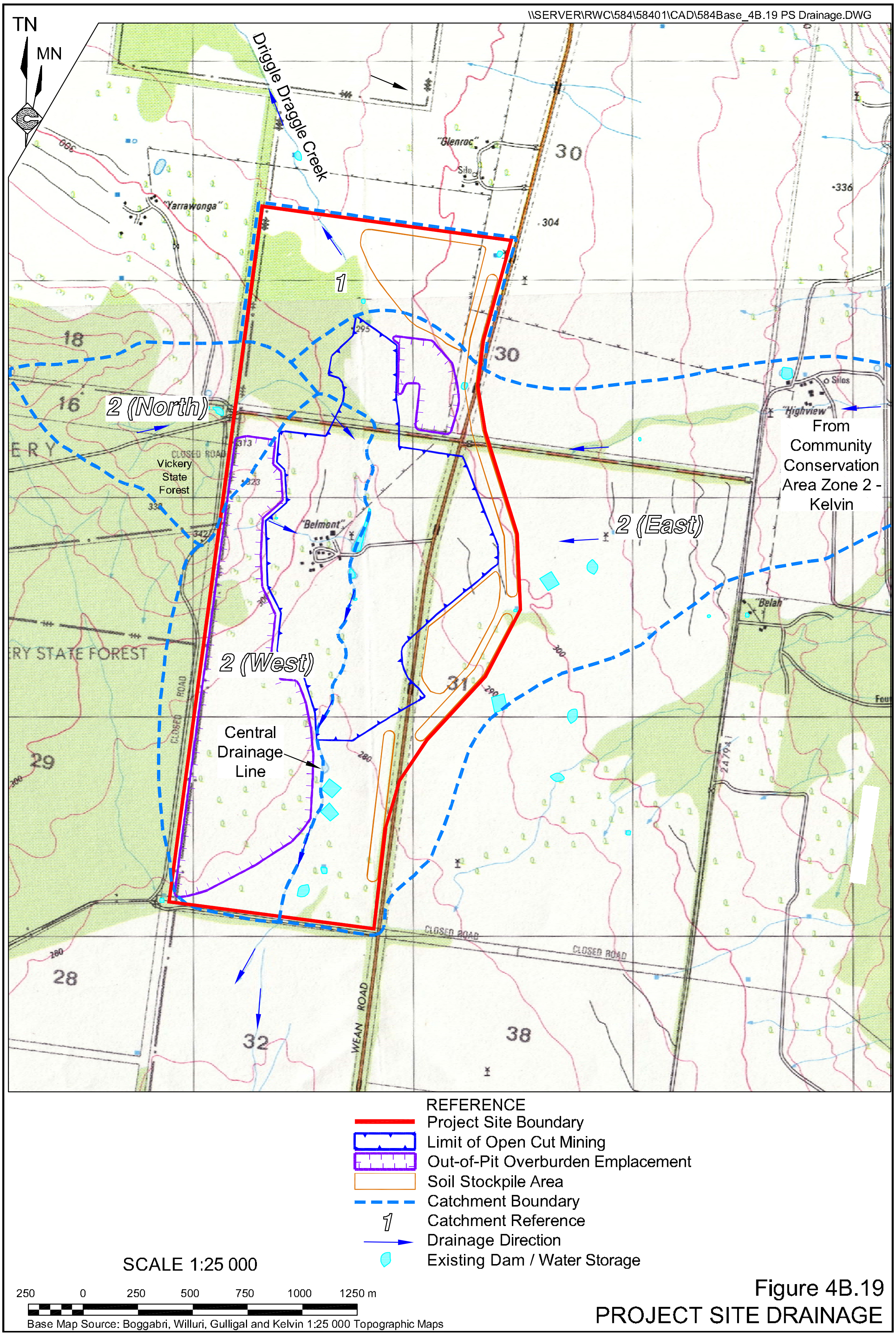

Figure 4B.19
PROJECT SITE DRAINAGE

4B.7.2.5 Surface Water Quality

The water quality of the intermittent flows within the Project Site, the various storages and the Namoi River is a function of meteorological conditions, particularly rainfall intensity within the various catchments, and the nature and extent of surface disturbance present within those catchments. Within the various storages, water quality is also affected by the time since the last inflow and agricultural influences, eg. stock access.

During the preparation of the *Environmental Assessment*, the local area was experiencing drought conditions and there was no opportunity to collect surface water quality data from any of the drainage lines on or adjacent to the Project Site.

Notwithstanding the absence of flows, a single sample was collected from an impoundment of water on the central drainage line on the "Belmont" property (BS-1) in 2002. **Table 4B.28** presents the analysis results of this sample and for six sites on Driggle Draggle Creek and its tributaries (WW-1 to WW-6) in the area of the Whitehaven Coal Mine (prior to mine development).

A review of the data presented in **Table 4B.28** shows a similarity in water quality in Driggle Draggle Creek, its tributaries and the "Belmont" impoundment, a not unexpected result given the similarity in catchments, land use and geology.

4B.7.2.6 Flooding Potential

Regional (Namoi River) Flood Events

Much of the Gunnedah Local Government Area comprises a natural floodplain and has always been associated with flooding at times of high flow in the Namoi, Peel and Mooki River catchments. The most extensive floods occur when high flows in the Mooki and Namoi Rivers coincide. The Namoi River is also influenced by the Manilla and Peel Rivers upstream. Downstream of Gunnedah, the low river gradient and flat topography can combine to cause widespread shallow inundation on both sides of the main Namoi River channel.

Occurrence of floods is irregular, with critical flood levels having been recorded in every month of the year. The most severe floods have occurred during the months of January and February when summer cyclonic systems reach the area, or in June and July following the influence of upper low pressure cells. Flood levels can be modified to some degree by the management of Keepit Dam, 55km upstream of Gunnedah (**Figure 4B.18**). Keepit Dam, though primarily operated as a conservation storage, can be used for flood mitigation by controlling releases of water before and after flood levels peak, and preventing any release coinciding with high flood levels in the Peel River, a major tributary joining the Namoi between Keepit Dam and Gunnedah.

A review of the aerial photographs presented with Namoi Valley Floodplain Atlas shows that all components of the Project Site lie in excess of 10m above the floodplain as defined by the 1955 floods, with the nearest area of inundation being located some 7km to the south of the Project Site. However, although no component of the Project Site would be liable to flooding, up to 13km of Blue Vale Road may be subject to inundation in a major flood event, thereby preventing access between the Project Site and the Whitehaven CHPP and Rail Loading Facility.

Table 4B.28
Local and Project Site Water Quality

Parameter	Unit	Sample Site						
		BS-1[1]	WW-1[2]	WW-2[2]	WW-3[2]	WW-4[2]	WW-5[2]	WW-6[2]
Total P	mg/L	4.7	NR	96.0	97.2	98.7	102.3	NR
Nitrogen (Nitrate)	mg/L	<0.01	NR	6	2	4	5	NR
Sulphate	mg/L	11	1	10	9	9	8	1
Bicarbonate	mg/L	41	48	81	96	107	73	50
Chloride	mg/L	56	2	6	4	5	8	3
Cadmium (tot)	mg/L	<0.001	NR	<0.001	<0.001	<0.001	<0.001	NR
Lead (tot)	mg/L	<0.001	NR	0.02	0.02	<0.001	0.02	NR
Zinc (tot)	mg/L	0.01	NR	0.02	0.02	0.01	0.02	NR
Copper (tot)	mg/L	0.006	NR	<0.01	0.01	0.01	0.01	NR
Manganese (tot)	mg/L	0.008	NR	0.15	0.05	0.12	0.20	NR
Iron (tot)	mg/L	29	5	13	8	7	19	20
Potassium	mg/L	27	5	14	9	13	5	5
Sodium	mg/L	43	11	12	13	14	42	19
Magnesium	mg/L	3	2	5	10	5	4	2
Calcium	mg/L	8	6	12	12	19	9	5
Conductivity	µS/cm	360	98	151	165	185	154	98
pH		6.9	6.8	8.8	8.4	9.1	8.4	7.8

Sources:
1 – Whitehaven Coal Mining Pty Ltd (2002)
2 – Coal and Allied (Namoi Valley Coal Project EIS (1986))

Local Flood Events

Local flooding issues considered relevant for the Project Site is the water that flows from east to west out of the Community Conservation Area Zone 2 – Kelvin within Catchment 2 (East) (see **Figure 4B.19**). This flooding would be restricted to localised runoff and would therefore recede within approximately 24hrs to minor flows after the cessation of rain.

Short term local inundation of areas to the south and east of the "Stratford" residence is reported to occur as a consequence of significant rainfall events in the Vickery State Forest / Community Conservation Area Zone 2 – Kelvin.

4B.7.2.7 General Sensitivity of the Namoi River Catchment

The surface water flows on and around the Project Site provide a small contribution to the combined flows within the Namoi River catchment. This water is important to local landowners that use the water from local creeks for stock watering and/or crop irrigation purposes, with any changes in water availability potentially detrimental to the existing land uses. The impact on Namoi River catchment flows during periods of floods and low flows would be negligible given the level of regulation and the size of the upper catchment in relation to the Project Site.

The surface water flows are also important to the ecological health of the Namoi River, ie. the fauna and flora which rely on good quality water. A release of contaminated water from the Project Site could significantly impact on the health of flora and fauna as well as downstream water users.

There are no public health sensitivities associated with the existing surface water catchment that would be affected by the Project.

4B.7.3 Surface Water Management Issues

4B.7.3.1 Introduction

The Project has the potential to impact upon both the quality and quantity of surface water flowing from the Project Site. The following sub-sections identify the potential impacts that have been considered in the design of surface water management controls for the Project Site. Section 4B.7.4.4 then addresses the controls to be implemented to avoid or maintain these impacts at an acceptable level.

4B.7.3.2 Potential Sources of Water Pollution

The potential sources of water pollution from the proposed activities within the Project Site are as follows.

- (i) Runoff from areas disturbed in advance of and during mining.
- (ii) Runoff from stockpiles of topsoil, subsoil and overburden.
- (iii) Surface runoff from ROM coal and coal product stockpiles.
- (iv) Surface runoff from rehabilitated areas prior to full stabilisation.
- (v) Discharge of mine waters (if occurring).
- (vi) Runoff from hardstand areas including roads, coal processing area and Site Facilities Area.
- (vii) Leakage or spillage of hydrocarbons.

Suspended solids, ie. sand, silt, clay or coal particles in water and hydrocarbons are therefore likely to be the major sources of pollution.

4B.7.3.3 Potential Changes to Surface Water Quantity

Development of the Project would necessitate the clearing of vegetation and construction of hardstand areas which could potentially result in increased surface water runoff within the affected sub-catchment and subsequently from the Project Site. It is more likely, however, that the volume of water leaving the Project Site would decrease marginally as a result of surface water being captured within the open cut and additional water storages constructed on the Project Site to provide for operational water requirements. The Proponent has considered its "maximum dam capacity" under the *Water Management Act 2000* (WMA Act) in the design of water management controls and storages to ensure any decrease in the quantity of water leaving the Project Site is acceptable and within the 10% permissible harvestable right applicable to the Proponent's landholding.

4B.7.3.4 Erosion and Sedimentation

Uncontrolled runoff from overburden emplacements under construction, soil stockpiles or other cleared areas, including runoff as a result of localised flooding, may lead to sheet, rill and/or gully erosion over areas of the Project Site. Recognising this potential, the surface water management controls have been designed to provide controlled flow paths and minimise the number and velocity of water flows on the Project Site. Reference is also made to management controls that would reduce the erosion and sedimentation risk posed by localised flooding events.

4B.7.3.5 Dryland Salinity

Dryland salinity is the accumulation of salts within the soil profile and has been recognised as an issue of concern within the Namoi Valley. The Project has limited potential to increase dryland salinity as the bulk of the deep rooted vegetation is located outside of the proposed area of disturbance.

4B.7.4 Water Management Measures and Operational Safeguards

4B.7.4.1 Introduction

For management purposes, the surface water catchments within the proposed areas of disturbance have been divided into three categories, namely:

- **"Clean" -** surface runoff from catchments undisturbed or relatively undisturbed by construction, mining or related activities and from rehabilitated catchments;

- **"Dirty" -** surface runoff from areas disturbed by construction or activities such as soil, overburden and coal stockpiling, and rehabilitation (until stabilised), all of which could contribute suspended solids to the surface water; and
- **"Contaminated" -** surface water containing hydrocarbons or any other contaminant other than suspended solids above DECC or ANZECC (2000) criteria.

The key principles in managing surface water within and around the Project Site would be to:

- divert clean water away from disturbed areas;
- capture dirty water and treat it so that it could be discharged in accordance with relevant DECC and ANZECC guidelines;
- capture and treat contaminated water prior to discharge from and/or re-use on the Project Site; and
- maintain as much vegetation cover (particularly grass) as possible.

The water management controls identified in Section 4B.7.4.3 are drawn from a Surface Water Assessment prepared by Soil Conservation Service (2007) to address the above principles (see Part 5 of the *Specialist Consultant Studies Compendium*). The water management controls and operational safeguards firstly consider management of water quantity followed by the water quality aspects, contingency plans, monitoring and long term management of the landforms within the Project Site. The water management controls were developed on the basis of a worst-case scenario, that of the Project in full operation with the overburden emplacement at its fullest extent and without any vegetative cover.

It should be noted that Soil Conservation Service (2007), whilst comprehensive in its assessment of Project Site surface water flow and the design of water management structures for the described Project, is essentially conceptual in terms of the positioning and number of structures. As the development and operation of the Project progresses, some variation to the structures may be required. However, the design of any variations would reflect the overall objectives and principles included in Soil Conservation Service (2007).

4B.7.4.2 Water Quantity

4B.7.4.2.1 Introduction

The primary goal in managing the quantity of water captured/discharged within the Project Site is to ensure sufficient water is captured to meet the operational requirements of the Project. The capture of dirty water would be maximised such that clean water captured and used by the Project remains within the maximum dam capacity of the Project Site. Section 4B.7.4.2.2

presents the calculated maximum dam capacity for the Project Site and additional land owned by the joint venture partners. Sub-section 4B.7.4.2.3 presents a water balance for the Project Site to identify the quantities of water available during the life of the mine.

4B.7.4.2.2 Maximum Dam Capacity

The maximum dam capacity for the Project Site was determined in the following manner.

Maximum Harvestable Right	=	Catchment Area (ha)	x	Multiplier[8] Value
	=	366 x	0.07	
	=	25.6ML		

It should be noted, however, that the Proponent's landholdings in the vicinity of the Project Site exceed more than 3 000ha allowing for an additional maximum dam capacity of more than 184ML/year available (3 000ha – 366ha = 2 634 x 0.07 = 184ML).

4B.7.4.2.3 Site Water Balance

As noted in Section 2.4.4.3, it is estimated that between 75ML and 100ML of water would be required annually for operational purposes. The location and design of water management structures has been engineered to maximise the proportion of this available yield captured within primarily dirty water storages, with additional water captured within clean water storages (see **Figure 4B.20**). Based on the location and design of these water management structures, **Table 4B.29** presents the annual catchment yields for the dirty water and clean water on the Project Site. **Table 4B.29** also accounts for the capture of water external to the Project Site but within the catchments of the Project Site and on properties owned by the Proponent.

The availability of water to meet the environmental and operational requirements of the Project during the site establishment and operational phases is discussed as follows.

Site Establishment Phase

During the site establishment phase, water would be required for dust suppression but not operational activities. A conservative estimate of water requirements during this phase (based on the estimated water use during the operational phase presented in Section 2.4.4.3) would be 25ML for exposed surfaces and 25ML for the construction of the transport route, ie. 50ML (over 6 to 12 months). While dirty water containment and storage structures would be progressively constructed to maximise the capture of water flowing off structures such as the overburden emplacements and stockpile areas (see **Figure 4B.20**), reliance would be initially placed on existing structures to provide the bulk of the 50ML.

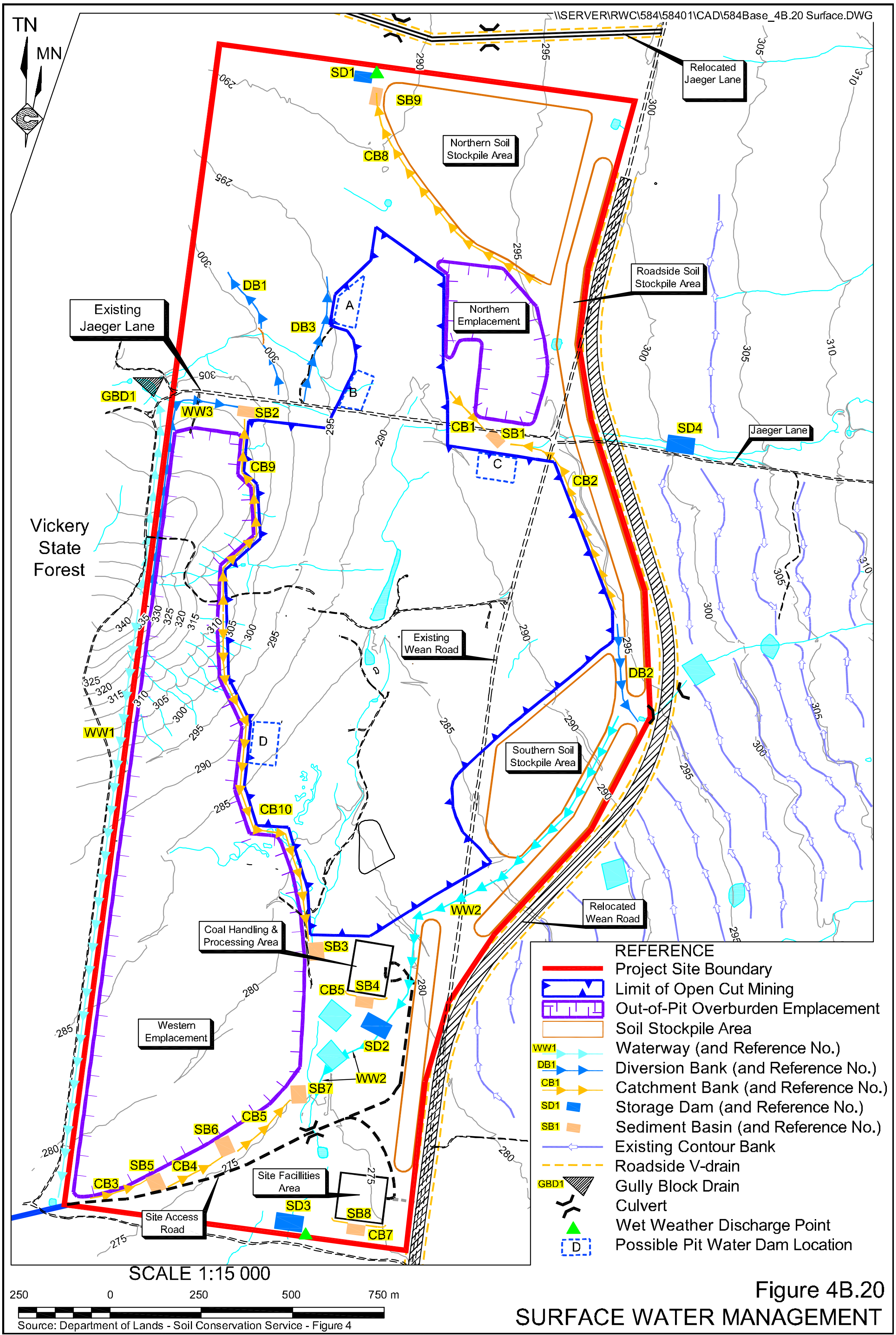

Figure 4B.20
SURFACE WATER MANAGEMENT

Table 4B.29
Annual Catchment Yields

Catchment[1]	Area (ha)	Yield (10th Percentile 373.6mm) (ML/year)	Yield (50th Percentile 619.9mm) (ML/year)	Yield (90th Percentile 843.4mm) (ML/year)	Associated Water Storage (ML)
"Dirty" water from northern emplacement	9	3.36	5.58	7.59	2
"Dirty" water from western emplacement and ROM coal stockpiles	74	27.65	45.87	62.41	13
Open cut area	60	22.42	37.19	50.60	11
Groundwater inflow	Negligible				
Total Dirty Water		**53.42**	**88.65**	**120.61**	**26**
"Clean" water from within the Project Site southern catchments (Catchment 2)	888	331.76	550.47	748.94	23.6
"Clean" water within the Project Site northern catchment	50	18.68	31.00	42.17	2
"Clean" water external to the Project Site but within the Project Site catchments and on Proponent-owned properties	634	236.86	393.02	534.72	44.4
Total Clean Water		**587.30**	**974.48**	**1325.82**	**70**
Total Clean and Dirty Water		**640.72**	**1063.13**	**1446.43**	**96**
Mine Water Requirements		100	100	100	
Total Balance		**540.72**	**963.13**	**1346.43**	**96**
Note 1: see **Figure 4B.19**					
Source: Soil Conservation Service (2007) – Table 5					

In 2002, the Proponent constructed five dams on the "Roseberry" property (of combined capacity 12ML) (represented by the rectangular water storage structures on **Figure 4B.20**), primarily to provide water prior to the construction of dirty water storage structures and development of the open cut. These dams have been placed within Catchment 2 (East) with a yield calculated to be in excess of 600ML per year (even during a low rainfall year) (see **Table 4B.29**) and as such would be able to capture and provide sufficient water to service the initial dust suppression requirements of the Project Site.

Operational Phase

Table 4B.25 indicates that even during dry years (10th percentile rainfall), sufficient water would be available from a combination of dirty water (including the open cut area) and clean water sources to meet operational water requirements. Given the catchment yields exceed water storage volumes in the average years (50th percentile) and wet years (90th percentile), it is expected that a discharge of surface water may occur.

4B.7.4.3 Water Quality

4B.7.4.3.1 Introduction

Figure 4B.20 identifies the major water management structures (storage dams and sediment basins) to be progressively installed throughout the life of the Project.

The principle water management structures for capturing and storing water which has flowed over disturbed areas of the Project Site are as follows.

- Catch banks (CB) – to intercept potentially sediment-laden water and direct it to the sediment basins. Catch banks would also be used to collect clean water and direct it to the storage dams.
- Sediment basins (SB) – for the detention and treatment of potentially sediment-laden water prior to its discharge to natural drainage lines or the storage dams.

The principal water management structures to divert and / or store clean water flows are as follows.

- Diversion banks / drains (DB) and waterways (WW) – to divert clean water away from areas of disturbance and thereby minimise the volume of potentially sediment-laden water requiring treatment.
- Storage dams (SD) - for the containment of "clean" water collected from undisturbed catchments and/or settled and clarified discharges from sediment basins.

Silt-stop fencing and/or straw bales would be employed as temporary measures as appropriate.

Sections 4B.7.4.3.2 to 4B.7.4.3.4 describe the proposed water management control structures to be constructed on the Project Site and which are illustrated on **Figure 4B.20**.

4B.7.4.3.2 Diversion, Collection and Storage of Clean Water

Diversion, collection and storage of clean water would be achieved using a series of diversion banks (prefix DB, **Figure 4B.20**.), waterways (prefix WW, **Figure 4B.20**) and Storage Dams (prefix SD, **Figure 4B.20**) which would be constructed prior to surface disturbance activities within the relevant sub-catchment.

The diversion banks would prevent water which would flow from out of Vickery State Forest (Catchment 1) and into the open cut and divert this water to the northern Driggle Draggle Creek catchment instead. This diversion would also require the construction of a small "gully block" dam (GBD-1) to collect the water from the catchment prior to diversion. Specifications for the two diversion banks to be constructed are presented in **Table 4B.30**.

Table 4B.30
Diversion Bank Specifications

Structure ID	Catchment Area (ha)	Channel Bottom Width (m)	Channel Grade (%)	Bank Height (m)	Sill Width (m)	Slope Below Sill (%)
DB1	40	4	0.2	0.8	8	3
DB2	15	3	0.2	0.8	6	2
DB3	5	2	0.2	0.8	6	2
Source: Modified after Soil Conservation Service (2007) – Table 6						

The waterways would provide a revised drainage path for water flowing from the east and west of the Project Site, which ultimately flows into the central drainage depression. Specifications for the two diversion banks to be constructed are presented in **Table 4B.31**.

Table 4B.31
Diversion Bank Specifications

Structure ID	Waterway Width (m)	Bank Height (m)
WW1 / WW3	12	0.7
WW2	Initially 25 before extending to 35 once it links with the central drainage depression.	0.8 – 1.0
Source: Modified after Soil Conservation Service (2007) – Table 6		

The storage dams constructed on the Project Site (in addition to the existing dams retained) would provide for storage of the clean water flowing over the Project Site. **Table 4B.32** presents the specifications of the storage dams to be constructed.

Table 4B.32
Storage Dam Specifications

Structure ID		Catchment Area (ha)	Volume (m^3)	Depth (m)	Dimensions length x width (mxm)	Outlet Width (m)	Sill Width (m)
Driggle Draggle Creek Catchment							
GBD-1	Gully Block Dam to capture water from Catchment 1 prior to diversion to Driggle Draggle Creek catchment.	60	1 000	3	28x26	4	8
SD-1	On the northern boundary of the Project Site.	124	1 400	3	30x30	6	9
Southern Catchment							
SD-2	Below the discharge of WW2	590	5 000	3	50x50	15	35
SD-3	On the southern boundary of Project Site	888	5 000	3	50x50	20	40
SD-4	Upstream of Relocated Wean Road at crossing of Jaeger lane	177 [1]	2 000	3	30x30	4	8

Note 1: The majority of the rainfall and runoff is diverted away from the dam to the south via existing contour banks. The effective catchment is estimated to be <30ha.
Source: Modified after Soil Conservation Service (2007) – Table 7