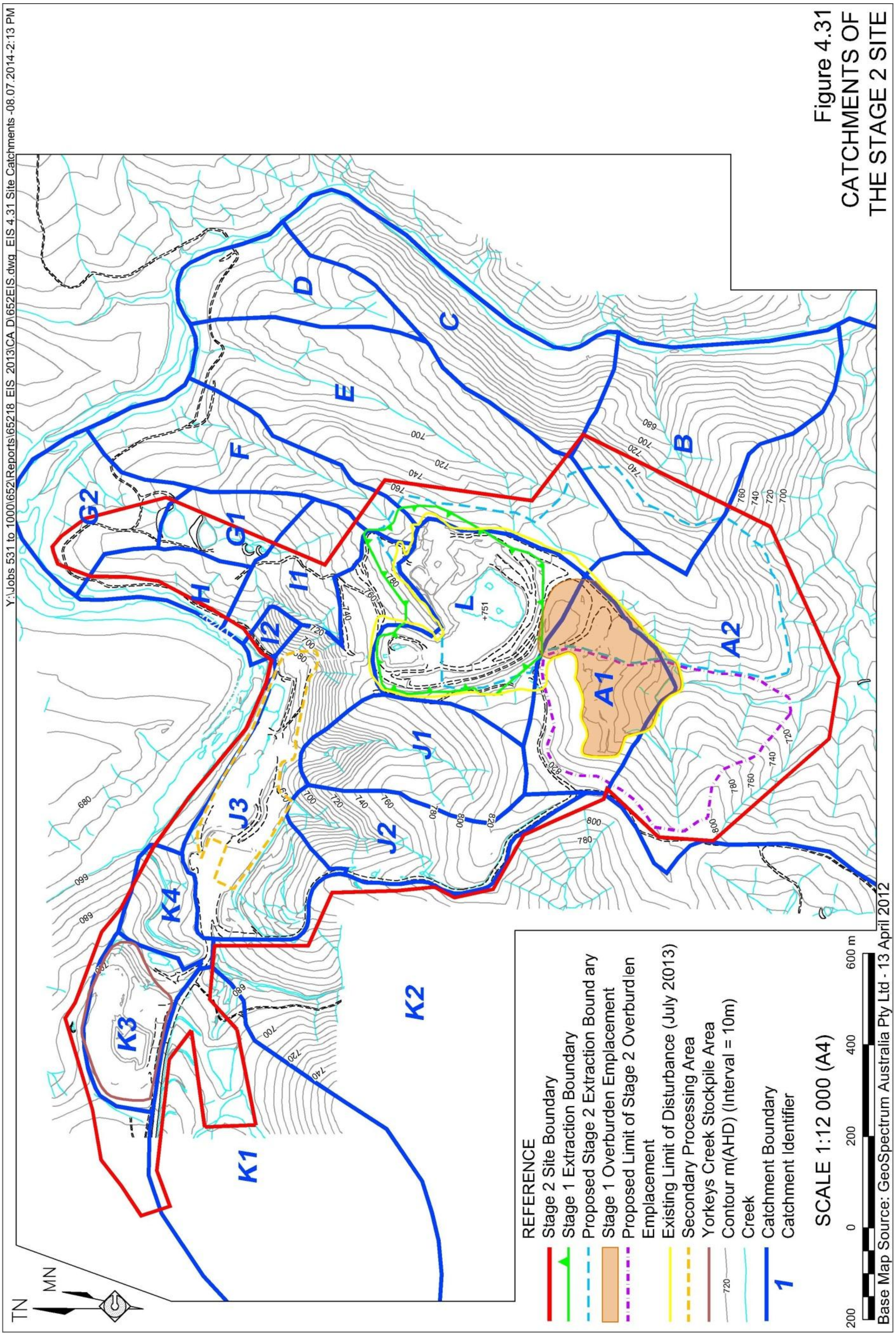


Figure 4.31
CATCHMENTS OF THE STAGE 2 SITE

Table 4.12
Existing Stage 2 Site Catchments and Peak Runoff Volumes

Catchment[1]	Area (ha)	Runoff Volume (m^3)
A1	9.9	4 115
A2	104.9	43 764
B	17.8	7 425
C	12.9	5 388
D	7.0	2 905
E	24.8	10 330
F	9.6	4 011
G1	3.9	1 607
G2	7.5	3 118
H	3.9	1 607
I1	5.2	2 170
I2	0.9	355
J1	9.3	3 898
J2	8.6	3 585
J3	17.6	7 346
K1	42.6	17 784
K2	686.4	286 484
K3	6.0	2 508
K4	3.4	1 427
L	13.3	5 555
Note 1: see **Figure 4.31**		
Source: Modified after Groundwork Plus (2014) – Table 7.		

With respect to the water quality within the Coxs River Groundwork Plus (2014) reports the following.

- Electrical conductivity (salinity) is low (between 140µS/cm and 740µS/cm) indicative of a freshwater environment.
- pH is generally within the established limits for recreational (ANZECC/ARMCANZ, 2000) and drinking water (NHMRC, 2011) use of 6.5 to 8.5.
- Turbidity of the Coxs River and Yorkeys Creek is variable (0 to 1 300 NTU), reflecting variable flows within these watercourses between years and seasons.
- Biological Oxygen Demand (BOD) is generally below the NHMRC (2011) drinking water criteria of 5mg/L).

- Nitrogen was observed above ANZECC/ARMCANZ (2000) criteria within the extraction area sumps and SD2 which could reflect blasting activities within the extraction area. An elevated concentration was also observed in samples sourced from SD6 and Yorkeys Creek upstream of the Stage 2 Site. Groundwork Plus (2014) considers this reflects the surrounding land use, i.e. grazing, and illustrates that elevated nitrogen concentrations are a feature of local settings as a result of grazing and pasture improvement.
- Metals and Major Ions. Although based on a very limited sample size, only copper and NH_4 concentrations are above ANZECC/ARMCANZ (2000) criteria for Protection of Slightly to Moderately Disturbed freshwaters and Recreational Purpose respectively. These elevated values are considered a result of local geology and agricultural activities respectively.

4.5.2.5 Flooding

While the secondary processing area has been constructed on ‘waterfront land’, as defined by the *Water Management Act 2000*, it is not affected (and therefore not constrained) by local flooding. This assessment is made on the basis of a flood event in February 2005, considered a 1 in 150 year ARI event (Parsons Brinkerhoff, 2005), which did not inundate the secondary processing area. Incorporating an elevated hardstand and bund within 40m of the Coxs River channel, the secondary processing area is likely to affect flows within this stretch of the river when the water level is elevated. Notably, the bund and hardstand have been constructed in accordance with DA 103/94 and Permit No. PAR9012617, issued under the now repealed *Rivers and Foreshores Improvement Act 1948* (RFI Act). As noted in Section 1.5.1, an application for a controlled activity approval to replace PAR9012617 has been lodged with NOW, however, a determination of this application has yet to be received.

It is noted that the Proposal requires no new infrastructure or changes to existing land elevations that would impact on local and regional flood regimes. On the basis that no additional works within the potential flood zone of the Coxs River and Yorkeys Creek, construction of the secondary processing area in compliance with an RFI Act Permit No. PAR9012617, and the documented evidence as to the adequacy of construction within the riparian / flood zone, no further assessment of flooding is warranted. The surface water assessment of Groundwork Plus (2014) supports this conclusion.

4.5.3 Potential Impacts

4.5.3.1 Introduction

The Proposal has the potential to impact upon both the quality and quantity of surface water flowing from the Stage 2 Site. The following subsections identify the potential impacts that have been considered in the design of surface water management controls for the Stage 2 Site.

4.5.3.2 Pollution of Receiving Waters

The potential sources of water pollution from the proposed activities within the Stage 2 Site are as follows.

- Runoff from areas disturbed in advance of and during extraction activities.
- Runoff from stockpiles of topsoil, subsoil and overburden stockpiles.
- Surface runoff from product stockpiles.
- Surface runoff from rehabilitated areas prior to full stabilisation.
- Controlled discharges of water from water storages.
- Uncontrolled discharges of water from water storages.
- Runoff from hardstand areas including roads, processing and other areas.
- Leakage or spillage of hydrocarbons.

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

Section 4.5.4 provides a summary of the design specifications for the controls to be implemented to reduce the potential risk of surface water contamination. Section 4.5.6 presents the residual impacts predicted following the implementation of these controls.

4.5.3.3 Changes to Surface Water Flows

With development of the Proposal, the area of the catchments delineated in **Figure 4.31** would change to reflect the proposed extraction area and overburden emplacement extension. This would also influence the peak runoff under the design (95^{th} percentile 5-day) rainfall event. **Table 4.13** presents the catchments and runoff volumes at the completion of the Proposal, i.e. of the final landform.

Hydrological modelling has been completed by Groundwork Plus (2014) based on the proposed sequence of development and various scenarios for capture, transfer and discharge of water. The proposed design of the surface water management system and associated operational controls presented in Section 4.5.4.1 reflect the final recommendations of Groundwork Plus (2014) with respect to optimal surface water management. Section 4.5.6 reviews the residual impacts on surface water flows, discharge and water quality assuming the implementation of these recommendations.

4.5.3.4 Erosion and Sedimentation

Uncontrolled runoff from active operational or cleared areas may lead to sheet, rill and/or gully erosion over areas of the Stage 2 Site. Recognising this potential, surface water management controls have been designed to provide controlled flow paths and minimise the number and velocity of water flows on the Stage 2 Site. Section 4.5.4.2 provides information on the erosion and sediment control measures to be implemented to reduce the potential risk of surface water contamination. Section 4.5.6 presents the residual impacts predicted following the implementation of these controls.

Table 4.13
Existing Stage 2 Site Catchments and Peak Runoff Volumes

Catchment	Area (ha)	Runoff Volume (m^3)
A1	16.5	6 885
A2	87.1	36 352
B	15.3	6 369
C	12.9	5 388
D	7.0	2 905
E	20.6	8 598
F	9.2	3 827
G1	3.9	1 607
G2	7.5	3 118
H	3.9	1 607
I1	5.2	2 170
I2	0.9	355
J1	9.3	3 898
J2	8.6	3 585
J3	17.3	7 229
K1	42.6	17 784
K2	686.4	286 484
K3	6.0	2 508
K4	3.4	1 427
L	31.8	13 285
Source: Modified after Groundwork Plus (2014) – Tables 13 and 14.		

4.5.4 Design and Operational Safeguards

4.5.4.1 Water Management System

Considering the various Stage 2 Site catchment areas, and peak runoff volumes under the design rainfall event (95th percentile 5-day), Groundwork Plus (2014) reviewed the capacity of the various sediment basins and water storages of the Stage 2 Site. **Table 4.14** reviews the existing and proposed capacity of each structure against that calculated to provide the minimum water settlement and sediment storage volume in accordance with DECC (2008b).

As discussed in Section 4.5.2.3, and noted in **Table 4.14**, Groundwork Plus (2014) incorporated conservative assumptions for the catchment volumetric runoff coefficient (C_v) and sediment zone volume to calculate the minimum water settlement and sediment storage zone capacities for each catchment and basin. A C_v of 0.74 was used for all catchments, based on the assumption of the least permeable soil group (Soil Hydrologic Group D). This does not account for the elevated permeability likely on the overburden emplacement and undisturbed catchments with significant ground cover. The calculation used by Groundwork Plus (2014) to estimate sediment storage assumes 50% of the water settlement zone. This approach generally overestimates storage requirements (when compared to the 2 month soil loss method), especially when high runoff coefficients are assumed. Considering the conservative nature of the calculations completed by Groundwork Plus (2014), the minimum storage capacity requirements are likely to significantly overestimate the volume of runoff and sediment accumulating in these structures.

Table 4.14
Existing Water Storage Capacities

Water Storage*	Capacity	95th %ile 5-day Volume Requirement[1]	Surplus / Deficit	Comments
SB1[2]	6ML	11ML	-5ML	SB1 accepts overflow from SD3 and SD4.
SB2b (existing)	2.8ML	4ML	-1.2ML	SB2a, a small dam immediately upslope of SB2b, accepts all runoff initially and acts as a fore-bay to the main sediment basin.
SB2b (proposed)	4.5ML	4ML	0.5ML	
SB3a	3ML	6.2ML	-3.2ML	To be operated temporarily as a fore-bay to SB3b until decommissioned and incorporated into the overburden emplacement
SB3b	12.3ML	12.3ML	0	The optimum design of SB3b remains to be confirmed and would follow additional review of local conditions.
SD1	3.5ML	1.5ML	+2ML	Accepts water pumped from the extraction area sumps. Overflows to SD2.
SD2	5ML	1ML	+4ML	Linked via a pump to both SB1 and discharge point to the Coxs River.
SD5	4ML	22.8ML	-18.8ML	Overflows to SD6.
SD6	8ML	2ML	+6ML	Linked via a pump to SB1.

SB = Sediment Basin SD = Storage Dam * see **Figure 4.32**

Note 1: Groundwork Plus (2014) applied conservative assumptions in calculating the minimum water settlement and sediment storage zones:

- A runoff coefficient of 0.74 for soil hydrologic group D.
- Sediment storage = 50% water settlement volume.

Note 2: As noted in **Figure 4.32**, water from SB1 could be pumped to SD2 or SD6 for storage to maintain 2m freeboard below the discharge spillway.

Source: Modified after Groundwork Plus (2014) – Section 5

The conservative nature of the calculations notwithstanding, the following modifications to the water management system would be undertaken (see **Figure 4.32**).

- An additional sediment basin (SB3b) would be constructed beyond the final toe of the overburden emplacement. This would be constructed with a minimum storage capacity of 12.3ML within 6 months of the date on which the development consent is issued. SB3a would be retained as a basin fore-bay until such time as overburden emplacement development progresses over this.
- SB2b would be increased in capacity to at least 4.5ML to provide the minimum settlement and storage requirements for a 95th percentile 5-day rainfall event (with an additional allowance to account for water below effective pumping level) within 6 months of the approval of development consent.

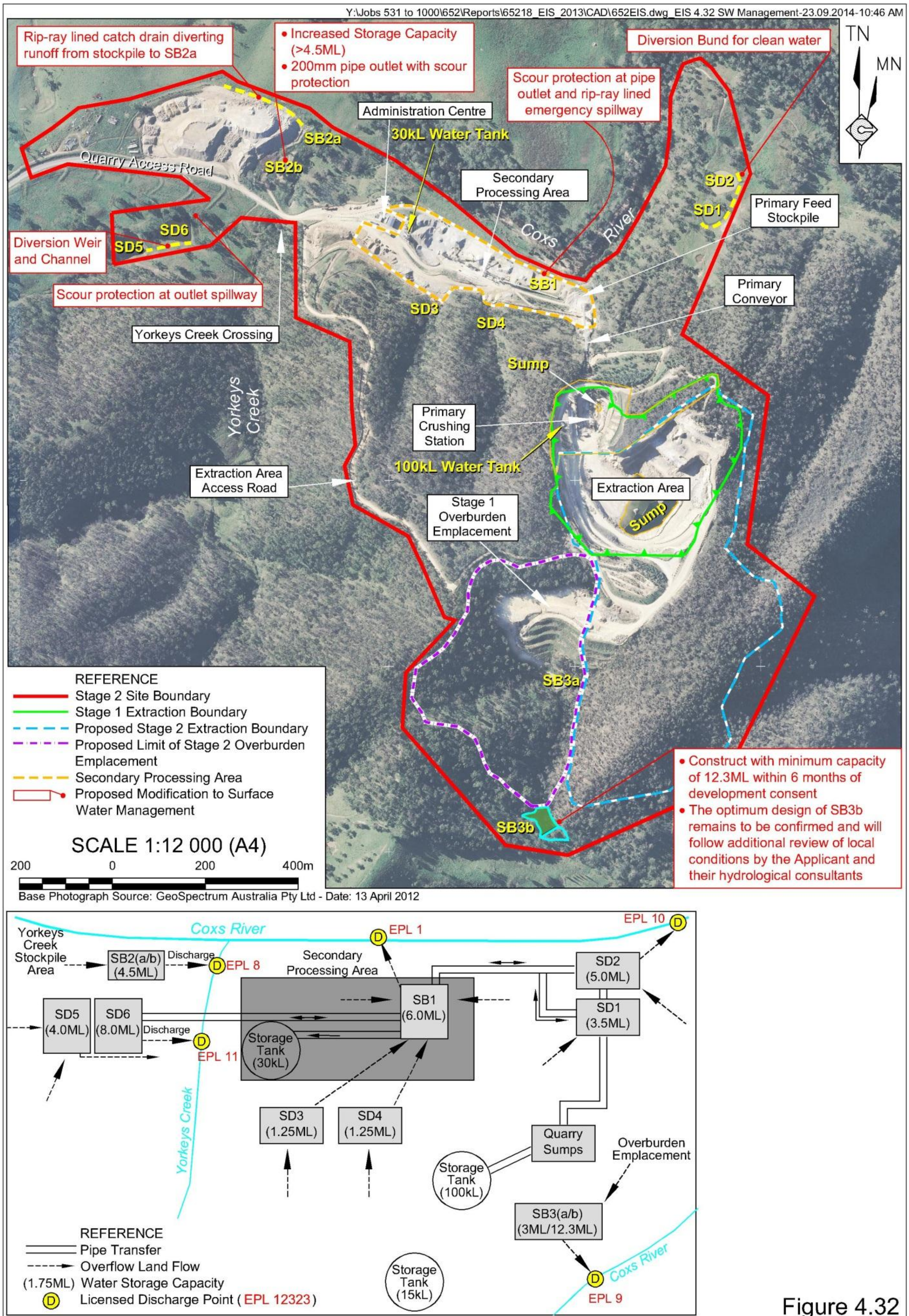


Figure 4.32
MODIFIED SURFACE WATER MANAGEMENT

- An additional diversion weir would be constructed between SD5 and SD6 such that except under exceptional circumstances (e.g. prolonged drought), overflow from SD5 would flow directly to Yorkeys Creek. This would increase the capacity available for SD6 to accept water from SB1 and thereby increase the effective water storage and sediment storage capacity of SB1.
- A diversion bund would be constructed to divert overland flows from the larger clean catchment (to the east) above SD1 and SD2. This would reduce volume of water reporting to these dams which would reduce the requirement for controlled discharge and maximise capacity to receive water from SB1.

The ability of the Applicant to increase the capacity of SB1 is constrained as follows.

- Available area. The condensed nature of the secondary processing area is such that the surface area cannot be increased.
- Basin depth. Any increase in depth would likely result in the intersection of subsurface flows associated with the Coxs River. To construct a deeper floor with an impermeable layer would risk geotechnical instability as a result of modified subsurface flows.
- Basin wall height. The height and general construction of the bund wall which forms the basin wall is based on significant review of geotechnical considerations following a failure of the initial dam in 2010. Modification of this design and current construction risks creating further instability in the bund wall.

As an alternative, the Applicant has installed a combined 900mm and 1 050mm pipe outlet with control valve which would enable the operator to control discharge from SB1. In conjunction with the additional capacity available within SD2 and SD6 (i.e. a combined 10ML greater than minimum storage capacity requirements), this should provide for greater control over the frequency and volume of discharges from SB1.

An important component of the Stage 2 Site water management system is, and would continue to be, the ability to discharge water from the various sediment basins and storage dams. In accordance with a Water Management Plan (WMP), which would be updated for the Stage 2 Site following the issue of development consent, the Applicant would apply procedures for the treatment and discharge of water. Subject to review and approval as part of the Stage 2 Site WMP, these procedures would provide for the following.

- A flocculating agent (approved for use by the EPA, e.g. NALCO 8187.15H) would be regularly applied to the sediment basins and storage dams for which controlled discharges are predicted (see Section 4.5.5).
- Discharge of water would be undertaken either:
  - once the sediment basin reaches the identified minimum water settlement and sediment storage capacity; or
  - once the water level in the water storage reaches a nominated level, e.g. discharge level of the installed SB1 discharge pipes; and
  - as soon as practical after a significant rainfall / runoff event resulting in the above.

It is noted that the Applicant would preferentially discharge water to one or more of the other storages on the Stage 2 Site rather than discharge it to the Coxs River. Discharge to the Coxs River or Yorkeys Creek would only occur when there is insufficient capacity within other Stage 2 Site water storages.

- Prior to a controlled discharge and within 24 hours of (and then weekly during) an uncontrolled discharge, a sample of the water would be taken to record various critical parameters (refer to Section 4.5.7). The Applicant would report any exceedance of Locally Derived Water Quality Objectives (refer to 4.5.6.1 and **Table 4.16**) to the EPA in accordance with the POEO Act.

4.5.4.2 Erosion and Sediment Control

The proposed erosion and sediment control features for the Stage 2 Site are presented as *Figures 6* to *18* of Groundwork Plus (2014). In reviewing these figures and the following descriptions, Groundwork Plus (2014) notes the following.

- The location and configuration of proposed structures are conceptual and could be subject to modification to suit future amendments to quarry staging. Designs and locations of the various structures would be formalised within an Erosion and Sediment Control Plan (ESCP) to be prepared following the issue of development consent. The ESCP would be reviewed annually and updated to reflect any changes to the Stage 2 Site and planned or implemented erosion and sediment control measures.
- All stormwater conveyance, retardation and diversion structures (including drains and bunds) would be designed for a 1 in 5 or 1 in 10 ARI design storm event.
- All diversion drains, drainage channels and catch drains would be rock and/or grass lined.
- The proposed sumps within the extraction area would be non-engineered storage structures and no attempt to draw to scale has been made.
- The operation and maintenance of sediment control devices requires that, in the event sediment retention capacity falls below 70% of its design capacity (e.g. following a storm event), these would be de-silted and made fully operational as soon as practicable following the event.
- The flow conveyance and retardation structures, i.e. catch drains, diversion bunds, and the provision of inlet and outlet scour protection for the retardation of flow velocity have been provided for the existing operational areas of the Stage 2 Site. These measures are conceptual and subject to modification as part of the ESCP to be prepared for the Stage 2 Site following the issue of development consent.

Noting the above, the following provides an overview of the erosion and sediment control features for the various component areas of the Stage 2 Site. Significant modifications or additions to current erosion and sediment control management are identified on **Figure 4.32**.

Secondary Processing Area

The full detail of the proposed erosion and sediment control features is provided by *Figure 9* of Groundwork Plus (2014). The primary features are as follows.

- Rip rap-lined catch drains aligned against the toe of the various slopes diverting flow to SB1.
- Diversion bunds constructed at the edge of the terraced level separating the administration centre from the secondary processing area.
- Additional conveyance structures to divert flows to SB1.
- Scour protection at the pipe outlet discharge point of SB1.
- A rip rap-lined emergency spillway from SB1.

Yorkeys Creek Stockpile Area, Catchment K1 (SD5 and SD6)

The full detail of the proposed erosion and sediment control features is provided by *Figure 10* of Groundwork Plus (2014). The primary features are as follows.

- A perimeter bund established around the Yorkeys Creek stockpile area.
- Rip rap-lined catch drains aligned against the toe of the stockpile diverting runoff to SB2a and SB2b.
- Increase in the capacity of SB2b to 4ML.
- A rock filter bund constructed to the east and west of SB2b to allow for natural seepage of runoff from the vegetated ground between the stockpile and SB2b.
- Installation of a 200mm pipe outlet with scour protection for discharge from SB2b to Yorkeys Creek.
- A diversion bund from the discharge point of SD5, around SD6 and to a scour protected discharge area of Yorkeys Creek.
- Scour protection at the in-flow and outlet spillways of SD5 and SD6.

Extraction Area Access Road

The full detail of the proposed erosion and sediment control features is provided by *Figure 8* of Groundwork Plus (2014). The primary features are as follows.

- Maintenance of the existing excavated sediment traps (ESTs) along the length of the road.
- Rip rap lining of roadside catch drains channelling runoff to the ESTs.
- 1.5m high diversion bund on the outer slope edge of the road to prevent uncontrolled release of water to this side (other than via an EST).
- Emergency spillways maintained from each EST.
- Rip rap lining provided to bunded channels which divert flows from the profiled lower slope west between the extraction area Access Road towards SB1.

Extraction Area and Overburden Emplacement

The full detail of the proposed progressive construction of erosion and sediment control features is provided by *Figures 11* to *18* of Groundwork Plus (2014). The primary features are as follows.

- Establishment of a perimeter bund around areas of construction for the relevant stage of development.
- Construction of diversion bunds, and bunded diversion channels, upslope of the perimeter of the impact footprint for each stage to divert runoff around areas of disturbance and into natural drainage.
- Construction of SB3b beyond the toe of the extended overburden emplacement with a capacity of 12.3ML. Scour protection would be installed on the inlet to, and emergency spillway from the basin.
- Construction of catch drains along the edge of each overburden emplacement lift diverting runoff to rock-lined chutes and ultimately SB3b via a bunded diversion channel.
- Maintenance of stormwater pipes between the extraction area sump, primary crushing station sump and SD1.

All structures would be designed in accordance with the relevant standard drawings and other design requirements of Landcom (2004) and DECC (2008b). The final design and information on other monitoring and maintenance activities to be implemented would be included in an Erosion and Sediment Control Plan for the Austen Quarry to be prepared following the issue of development consent.

4.5.4.3 Stormwater and Erosion and Sediment Control Monitoring and Maintenance

Table 4.15 provides the monitoring and maintenance program to be implemented by the Applicant for the various stormwater and erosion and sediment control structures.

4.5.5 Hydrological Modelling (Including a Site Water Balance)

4.5.5.1 Introduction

Groundwork Plus (2014) constructed an MS-Excel based daily probabilistic water balance model to analyse the frequency and volume of discharge from the various Stage 2 Site water storages under dry (15^{th} percentile) and wet (90^{th} percentile) rainfall scenarios (see **Table 4.1**) and incorporating dewatering of the extraction area based on the conceptual hydrogeological model for seepage generated by Ground Doctor (2014) (refer to Section 4.12). *Section 6.3* of Groundwork Plus (2014) provides the general assumptions made and applied as part of the water balance model.

The following subsections provide the results of the water balance assessment for the various water storages and sediment basins of the Stage 2 Site (see **Figure 4.32**), based on the application of the recommended water management measures nominated in Section 4.5.4.1 and erosion and sediment control features nominated in Section 4.5.4.2.

Table 4.15
Stormwater and Erosion and Sediment Control Monitoring and Maintenance Plan

Inspection	Minimum Frequency	Performance Criteria	Response
Inspect water conveyance structures such as catch drains, contour drains and diversions.	Following significant rainfall events	Erosion in areas adjacent to water conveying structures.	Eroded areas will be Rip rapped as soon as practicable.
		Overtopping of water conveying structures (identified by the scouring of the drain batters perpendicular to the direction of flow).	The drain will be cleaned of sediments and rip rapping replaced to the original design specifications. Rehabilitation with suitable grasses in the catchment of the drain may be required to reduce sediment loading.
		Deposition of material in the water conveying structure greater than half the design depth.	Sediment/grit will be removed from the structure and used in rehabilitation works.
Inspect potential sediment storage capacity of sediment dams.	Following significant rainfall events.	30% of the total sediment capacity remaining.	Sediment will be removed from the structure and used in Inspect potential rehabilitation works.
		Overtopping of the sediment dams.	To recycle dam water to ensure that adequate free storage is maintained for the collection and holding of runoff.
Inspect check dams, rock armouring and rip rap.	Following significant rainfall events.	Check dam walls have collapsed or rip rap has moved.	Larger sized rocks will be used in the construction of check dams and rip rap or the drain will be concreted or redesigned.
Inspect culverts, pipe inlets and outlets.	Following significant rainfall events.	Check for erosion of inlets and outlets.	Rip rap inflows and outflows of pipes where erosion has been observed.
		Debris build-up in pipe inlets or outlets or in culverts.	Remove debris.
		Overflow of pipes.	Check pipes for debris or blockages and remove the offending materials.
Note: Significant rainfall event >25mm/day			
Source: Groundwork Plus (2014) – Table 42			

4.5.5.2 Extraction Area

Assuming the continued dewatering of the extraction area, either by transfer of water to the 100kL water tank (200kL/week) or by discharge to SD1 and/or SB1, no uncontrolled discharges would occur from the extraction area. The average rate of discharge would vary between 0 and 1.13ML/day, which is within the capacity of the existing dewatering infrastructure (which could cater for up to 1.9ML/day). Groundwork Plus (2014) predicts that annual discharge to SD1 would vary from 0 during a dry weather (15^{th} percentile rainfall) conditions to 65.1ML during a wet weather (80^{th} percentile rainfall) conditions. The effect of this dewatering on the function of SD1 and SD2 is discussed in Section 4.5.5.3.

4.5.5.3 Storage Dams 1 and 2

The water balance modelling indicates that under both the dry and wet weather conditions, there would be no uncontrolled discharges of water from SD1 or SD2 (even considering dewatering of the extraction area – see Section 4.5.5.2).

Controlled discharge of water would be required following significant rainfall events to retain sufficient capacity within the water storages to accept water from the extraction area and runoff from the upslope catchments. Groundwork Plus (2014) predicts that the annual volume of controlled discharge to the Coxs River would vary between 7.5ML and 21.8ML under dry weather (15th percentile rainfall), and 37.2ML and 73.5ML under wet weather (90th percentile rainfall) conditions. Treatment and discharge would be undertaken as soon as practical following each rainfall / runoff event.

The total volume of controlled discharge would be reduced further by constructing a clean water diversion around SD2. This would reduce the total discharge volume requirement to between 1.9ML and 16.3ML under dry weather (15th percentile rainfall), and 29.2ML and 65.5ML under wet weather (90th percentile rainfall) conditions annually.

4.5.5.4 Sediment Basin 1

Assuming the transfer of water from SB1 to SD6 and SD2 to maintain the minimum 2m (2.34ML) freeboard within the basin, Groundwork Plus (2014) predicts up to five uncontrolled discharges of a combined 10.1ML under dry weather (15th percentile rainfall) conditions, and six uncontrolled discharges of a combined 46.9ML under wet weather (90th percentile rainfall) conditions, from SB1. This is a significant reduction from a predicted 10 discharges of 38ML (under dry conditions) and 23 discharges of 102.3ML (under wet conditions) predicted without the implementation of the management measures discussed in Section 4.5.4.1.

Groundwork Plus (2014) also modelled the performance of SB1 if the capacity was increased to 11ML in order to provide for water settlement and sediment storage capacity for a 5-day 95th percentile rainfall event. The modelling, which does not include the transfer of water from SB1 to SD6 and/or SD2[3], predicted this would result in 24 uncontrolled discharges totalling 60.1ML under dry weather (15th percentile rainfall) conditions and 22 uncontrolled discharges totalling 97ML under wet weather (90th percentile rainfall) conditions. The implementation of this option to increase the capacity of SB1, notwithstanding the constraints nominated in Section 4.5.4.1, would provide little overall benefit.

Although it is acknowledged there would be benefits in increasing the design storage capacity of SB1 to meet the regulatory requirements, this does not provide any greater benefit over the proposed water management strategy. As discussed in Section 4.5.4.1, there are significant constraints on increasing in the storage capacity of SB1, and it is assessed that the cost and possible indirect implications of undertaking this work is not warranted given the proposed water management strategy provides for greater control over discharges from the secondary processing area catchment.

[3] The active transfer of water between SB1 and other storage dams was not included in this scenario given the sediment basin would be constructed to the design requirements of Landcom (2004).

4.5.5.5 Storage Dams 5 and 6

On the basis of the water management proposed in Section 4.5.4.1, Groundwork Plus (2014) predicts up to 26 uncontrolled discharges totalling 8.7ML under dry weather (15^{th} percentile rainfall) conditions and 22 uncontrolled discharges totalling 4.9ML under wet weather (90^{th} percentile rainfall) conditions. Notably, this water is predominantly runoff from the sealed road and grassed paddocks.

4.5.5.6 Sediment Basin 2b

Constructed and maintained in accordance with the requirements of Landcom (2004) and DECC (2008b), Groundwork Plus (2014) predicts between 13 and 22 controlled discharges totalling 9.9ML to 21.5ML under dry weather (15^{th} percentile rainfall) and wet weather (90^{th} percentile rainfall) conditions respectively.

There would be no uncontrolled discharge under dry weather (15^{th} percentile rainfall) conditions, with a predicted eight uncontrolled discharges totalling 1.2ML under wet weather (90^{th} percentile rainfall) conditions.

4.5.5.7 Sediment Basin 3b

Based on the construction of a 12.3ML capacity structure, Groundwork Plus (2014) predicts between 17 and 22 controlled discharges totalling less than 65ML annually. Under dry weather (15^{th} percentile rainfall) conditions there would be no uncontrolled discharges, however, a single 3 day discharge of 1.4ML is predicted under prolonged wet weather (90^{th} percentile rainfall) conditions. It is noted that this is as expected when considering the guidance provided by *Table 6.1* of DECC (2008b).

4.5.6 Assessment of Impacts

4.5.6.1 Impact Assessment Criteria

Catchment Hydrology

There are no formal criteria with which to assess the impact of any changes to catchment hydrology, i.e. catchment area and peak runoff. The approach to identifying that any change has been minimised and any detrimental effects with respect to condition of the catchment or downstream water users is identified involved comparing existing catchment areas and peak runoff volumes with those predicted under the Proposal.

Erosion and Sediment Control

The objective is to minimise the potential for, and actual erosion and sedimentation of the Site. Criteria for total suspended solids (TSS) of water runoff apply.

Water Quality

Based on the use and sensitivity of the receiving waters of any discharge from the Stage 2 Site, the Environmental Values attributed to these with respect to the River Flow and Water Quality Objectives of the EPA are as follows.

- Ecosystem Protection (aquatic plants, fish and other flora and fauna habitat) for slightly to moderately disturbed stream (SMDS Protection).
- Agricultural use (Livestock Water Guideline).
- Drinking water for human consumption (Drinking Water Guideline).
- Recreation (Recreation Guideline).

Objectives for the quality of water discharged to the Coxs River and Yorkeys Creek for the identified Environmental Values of the receiving environment have been derived from the following sources.

1. The guidelines published by the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMANZ) *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC/ARMANZ, 2000) for ecosystem protection, agricultural use and recreation.
2. The Australian Drinking Water Guidelines (NHMRC, 2011), or guidelines provided by the Annual Water Quality Monitoring Report 2011-12 of the Sydney Catchment Authority (SCA, 2012) (for those water quality characteristics that may be expected to be improved through treatment processes), for drinking.
3. Established Background Reference Condition for the upstream environment (where this exceeds the ANZECC/ARMANZ, 2000) nominated criteria, and where the number of samples exceeds the minimum recommended, e.g. turbidity.
4. Environment Protection Licence (EPL) 12323.

Table 4.16 provides the locally derived water quality objectives (LDWQOs) generated through consideration of the noted guidelines and data.

Table 4.16
Locally Derived Water Quality Objectives

Page 1 of 2

Type	Parameter	Numerical Guideline	Unit	Source	Background Reference Condition	Site Water Quality Objective
Physico-chemical	pH	6-8.5		SCA (2012)	7.2-7.7	6-8.5
	EC	-	µS/cm	Background Reference	322	322
	Dissolved Oxygen	-	%	-	-	-
	Biological Oxygen Demand	5	mg/L	Drinking Water		
	Turbidity	40	NTU	Background Reference	10	10
	Total Suspended Solids	30	mg/L	EPL 12323	8	30
	Total Dissolved Solids	2 500	mg/L	Livestock Water	250	2 500

Table 4.16 (Cont'd)
Locally Derived Water Quality Objectives

Page 2 of 2

Type	Parameter	Numerical Guideline	Unit	Source	Background Reference Condition	Site Water Quality Objective
Metals / Metalloids	Al (pH<6.5)	200		Drinking Water		200
	Al (pH>6.5)	55	µg/L	SMDS Protection	-	55
	As	10		Drinking Water		10
	Ba	2 000				2 000
	Be	60				60
	Cd	0.2		SMDS Protection		0.2
	Cr (VI)	1				1
	Co	1.4				1.4
	Cu	1.4				1.4
	Pb	3.4				3.4
	Mn	100		Recreation		100
	Hg	0.06		SMDS Protection		0.06
	Ni	11				11
	V	100		Livestock Water		100
	Zn	8		SMDS Protection		8
Major Ions and Nutrients	NO_2	1	mg/L	Recreation	-	1
	NO_3	1.7		SMDS Protection		1.7
	NH_4	0.01		Recreation		0.01
	TN	1.4		SCA (2012)		1.4
	TP	0.05		Irrigation		0.05
	SO_4	250		Drinking Water		250

Source: Modified after Groundwork Plus (2014) – Table 47

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

With respect to the impacts of new developments within the Sydney drinking water catchment (see **Figure 4.29**), *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* states:

> "*A consent authority must not grant consent to the carrying out of development under Part 4 of the Act on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on water quality*."

A neutral or beneficial effect on water quality is defined as one that:

- has no identifiable impact on water quality; or
- contains any water quality impact on the development site and prevents it from reaching any watercourse, water body or drainage depression on site; or
- transfers any water quality impact outside of the site where it is treated and disposed of, to standards approved by the consent authority.

4.5.6.2 Catchment Hydrology

Comparison of the catchment areas and peak runoff volumes (refer to **Tables 4.12** and **4.13**) indicates that there would be a small reduction in the undisturbed catchments flowing to the Coxs River (Catchments A2, B, E and F on **Figure 4.31**) of approximately 25ha. Of this, the 7.1ha associated with the extension of the overburden emplacement would still report to the Coxs River, albeit via SB3b.

This small reduction in annual runoff volume (7.5ML) would be effectively imperceptible as:

- there are no dams which collect this runoff;
- the runoff flows into the Coxs River which would have annual flows of several orders of magnitude greater than this flowing past the Stage 2 Site each year; and
- this reduction in discharge would almost certainly be replaced through the controlled discharges of water documented in Section 4.5.5.

The proposed change to catchment hydrology is therefore unlikely to have any adverse impact on the local catchments or other users of surface water generated by runoff from the catchments of the Stage 2 Site.

4.5.6.3 Erosion and Sediment Control

With the exception of SB1, the proposed erosion and sediment controls presented on *Figures 6 to 18* of Groundwork Plus (2014) have been prepared after consideration of and in compliance with Landcom (2004) and DECC (2008b). The implementation of the proposed stormwater and erosion and sediment control measures monitoring and maintenance program would ensure that these structures function as intended and are maintained for the life of the Proposal.

Assuming the preparation and implementation of an Erosion and Sediment Control Plan (ESCP), which would provide the final designs or drawings and construction requirements for each of the structures identified, monitoring regime and maintenance measures, it is assessed that erosion and sedimentation on the Stage 2 Site would be minimised as far as reasonable practical.

In the case of SB1, increasing the capacity of this structure to achieve a water settlement and sediment storage volume equivalent to that required for the 95th percentile 5-day rainfall event is constrained by geotechnical, as well as practical factors (refer to Section 4.5.4.1). As discussed in Section 4.5.5.4, the management proposed for this structure, involving the regular transfer of water to SD6, would prove more effective in limiting the number and volume of discharges than increasing the capacity of the basin. As such, the proposed and ongoing management is likely to provide for equivalent if not more effective erosion and sediment control management.

4.5.6.4 Discharge of Water / Receiving Waters

On the basis there would be no additional chemicals or reagents used on the Stage 2 Site, erosion and sediment controls would be upgraded to reduce the potential for discharge, and considering the consistency of the geology in which the extraction area is located, the water quality results obtained from on-site water storages and sediment basins is indicative of the water quality expected over the life of the Proposal. *Section 3* (and *Tables 9* to *14*) of Groundwork Plus (2014) review the water quality observed within the various catchments of the Stage 2 Site. On the basis of the observed water quality of the quarry water storages, Groundwork Plus (2014) analysed the potential impacts of discharges from the Stage 2 Site to the Coxs River and Yorkeys Creek against the LDWQOs presented in **Table 4.16**. Based on analysis of available data from the sediment basins and storage dams from which water would be discharged, **Table 4.17** identifies those parameters which may be discharged at concentrations exceeding the LDWQOs.

Table 4.17
Potential Exceedance of Locally Derived Water Quality Objectives

Guideline	SB1	SB2b	SB3b	SD2	SD6
SMDS Protection	Turbidity Al, Cd, Cu, Pb and Zn	Turbidity Al, Cd, Cu, Pb and Zn (total)	Turbidity Al , Zn & Cu (dissolved)	pH Turbidity Cu (dissolved	Turbidity TN, TP & NH_4 Cu (dissolved)
Recreation	Turbidity Mn	Turbidity Mn NH_4	Turbidity Mn NH_4	Turbidity	Turbidity Mn NH_4
Irrigation	TP	TP	TP		TP
Livestock watering	Al				Al
Drinking water	Turbidity Al	BOD Turbidity Al TN	TN	BOD	Turbidity BOD TN
Source: Modified after Groundwork Plus (2014) – Section 10.2.					

Groundwork Plus (2014) notes that the levels of EC (<770µS/cm) and pH (<8.7) of the water that would be discharged would pose no genuine risk to the Environmental Values of the receiving waters.

Groundwork Plus (2014) indicates that the likely concentrations of metals are reflective of the local geology and a comparison of total to dissolved metals concentration indicates that these are associated with the suspended sediment contained within the water, i.e. not from introduced sources. The suspended sediment levels would generally comply with the LDWQO (30mg/L), thereby limiting the total amount of these metals discharged. Furthermore, the required dilution to achieve compliance is low and provided almost immediately on release to the Coxs River.

Groundwork Plus (2014) considers the elevated nutrient levels (TN, TP and NH_4) likely to be associated with organic matter (e.g. manures, top-soil erosion) contained within the TSS component of discharge. While without sufficient dilution these could result in nuisance algal problems. The fact that TSS concentrations are likely to be complied with suggests the overall accumulation of these nutrients would remain low. Furthermore, discharge is most likely to occur during or following significant rainfall events and as such base flows in the Coxs River would quickly dilute the nutrient concentrations such that the noted algal bloom formation would not occur.

Turbidity could pose some risk to the receiving waters Environmental Values as aquatic ecosystems, recreational use and drinking water supply suitability. It is noted, however, that with flocculation of the water contained within the storages, the turbidity of the water is likely to be significantly reduced prior to controlled discharge. Under conditions of uncontrolled discharge, during or following a significant rainfall event, the flow within the receiving waters would be substantially higher, resulting in higher suspended sediment loads and therefore elevated turbidity.

In accordance with the recommendations of Groundwork Plus (2014), and until a reference background level for the receiving waters is established, the Applicant would undertake sampling and analysis of water upstream and downstream of the discharge point at the time of discharge to demonstrate minimal or no impact on receiving water quality (refer to Section 4.5.7).

4.5.6.5 Geomorphological and Hydrological Effects

The likely volume of water to be discharged to Yorkeys Creek and the Coxs River on each occasion is insignificant when considered against the total volume of water flowing past the Austen Quarry each day. Furthermore, both Yorkeys Creek and the Coxs River are subject to significant variations in flow due to seasonal variation and storm surges in the pre-extraction setting. Consequently, the relatively small and infrequent discharges from the Stage 2 Site would almost certainly have no effect on the geomorphology or hydrology of these watercourses.

4.5.6.6 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The following considers the potential impacts of the Proposal on receiving water as detrimental, neutral or beneficial.

- No uncontrolled releases of water would occur from the extraction area: Neutral Impact.
- While uncontrolled discharges are predicted from the Stage 2 Site potentially impacting on the Environmental Values of the receiving waters, the proposed modifications and additions to the water management system would reduce the predicted frequency and volume of these (compared against that currently expected): Beneficial Impact.
- The Proposal provides for the separation of runoff from undisturbed catchments upslope of SD1, SD2 and SD6 from disturbed catchments. Beneficial Impact.
- The Proposal provides for the upgrading of sediment basins SB2b and SB3b to comply with recommendations of Landcom (2004) and DECC (2008b): Beneficial Impact.

As is discussed further in Section 4.6, the development of the extraction area below the groundwater table would not result in any discernible change to the flow of groundwater to surface water in the local setting, i.e. neutral impact.

A neutral or beneficial impact on the affected catchments is therefore demonstrated and therefore the Proposal achieves the objectives of the SEPP.

4.5.7 Monitoring and Corrective Actions

4.5.7.1 Introduction

In addition to the monitoring and maintenance of stormwater and erosion and sediment control infrastructure presented in **Table 4.15**, the following monitoring of discharged water would be undertaken in accordance with the recommendations of Groundwork Plus (2014).

4.5.7.2 Parameters

Table 4.18 identifies the parameters to be monitored together with the sample type.

Table 4.18
Water Quality Monitoring Parameters

Parameter	Unit	Sample Type
pH	pH units	Grab Sample or In-situ
Turbidity	NTU	Grab Sample or In-situ
Total Suspended Solid	mg/L	Grab Sample
BOD_5	mg/L	Grab Sample
Total Al and Mn	µg/L	Grab Sample
Dissolved Cu	µg/L	Grab Sample
Ammonia	mg/L	Grab Sample
Total Nitrogen	mg/L	Grab Sample
Total Phosphorus	mg/L	Grab Sample
Visual Oil & Grease/Litter	Present/Absent	Visual observation
Source: Modified after Groundwork Plus (2014) – Table 48.		

The list of parameters would be regularly reviewed (i.e. annually) and revised as necessary based on water quality data collected.

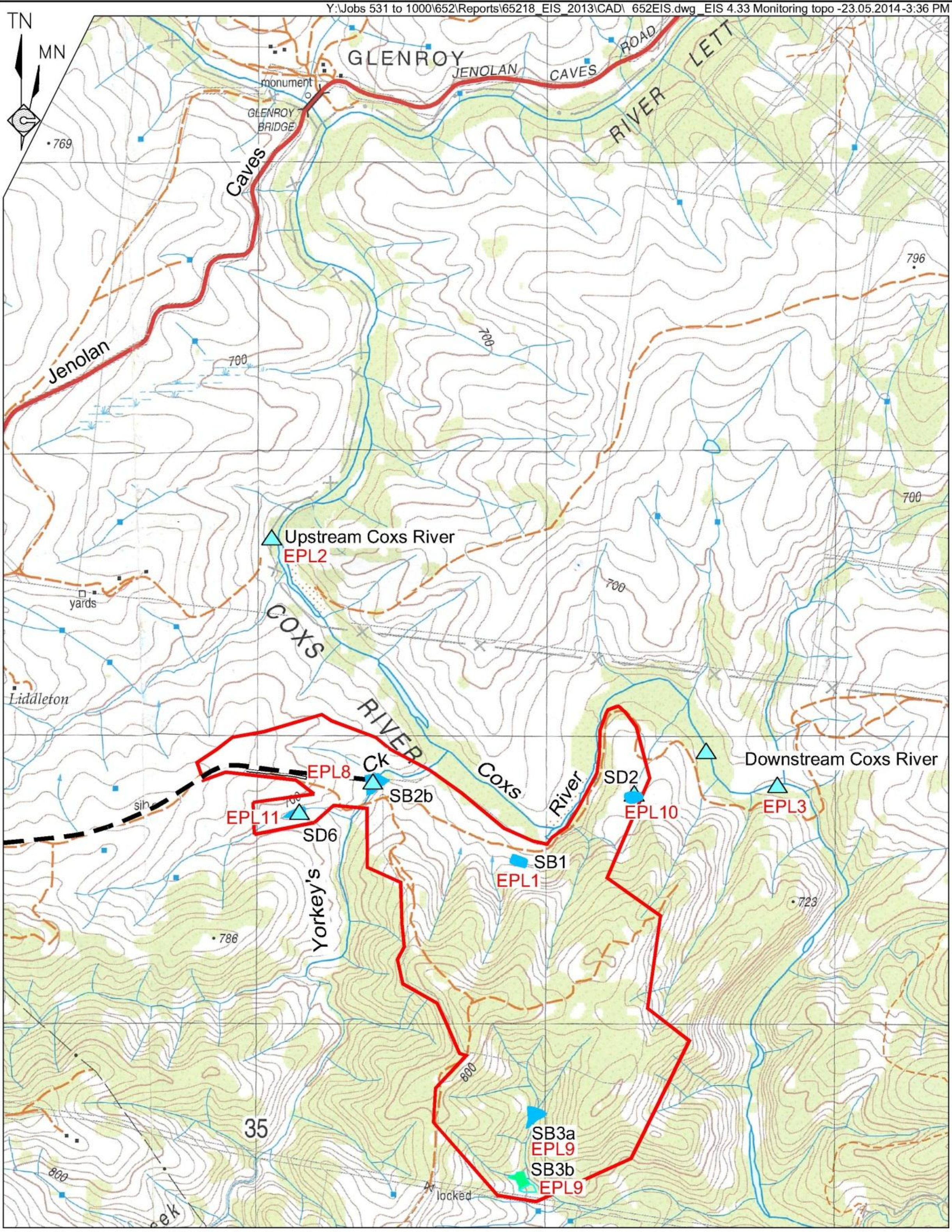
4.5.7.3 Locations and Frequency

The proposed monitoring locations and frequency are presented in **Table 4.19** and **Figure 4.33**.

Table 4.19
Water Quality Monitoring Frequency and Points

Monitoring Point[1]	Description	Frequency
EPL Point 1	Release point from SB1	Prior to a controlled discharge and within 24 hours then weekly during uncontrolled discharge events
EPL Point 8	Release point from SB2b	
EPL Point 9	Release point from SB3(a/b)	
EPL Point 10	Release point from SD2	
EPL Point 11	Release point from SD6	
EPL Point 2	Upstream Coxs River	At commencement of, then weekly during site discharge events
EPL Point 3	Downstream Coxs River	
Note 1: see **Figure 4.33.**		
Source: Modified after Groundwork Plus (2014) – Table 49.		

Y:\Jobs 531 to 1000\652\Reports\65218_EIS_2013\CAD\ 652EIS.dwg _EIS 4.33 Monitoring topo -23.05.2014-3:36 PM



Note: The optimum design of SB3b remains to be confirmed and will follow additional review of local conditions by the Applicant and their hydrological consultants

REFERENCE
- Site Boundary
- Quarry Access Road
- Open Forest (50-80% crown cover)
- Surface Water Monitoring Location
- EPL1 Reference (EPL12323)

SCALE 1:20 000

200 0 200 400 600 800 1000 m

Base Map Source: Hartley 1:25 000 Topographic Map (2002)

Figure 4.33
SURFACE WATER MONITORING LOCATIONS

4.5.7.4 Corrective Action

Should the concentration of any parameter either exceed the LDWQOs of **Table 4.16** or exceed the reference concentration taken at the time of discharge (whichever is greater), the Applicant would implement the corrective actions presented in **Table 4.20**.

Table 4.20
Potential Exceedance of Locally Derived Water Quality Objectives

Water Quality	Corrective Action(s)
Less than or equal to LDWQO, release limit prescribed by EPL or <10% above background, whichever is greater	Nil.
Greater than LDWQO, release limit prescribed by EPL or >10% above background, whichever is greater	Cease discharge if practicable, advise EPA, investigate cause, implement immediate action to rectify (i.e. re-treat/retest to confirm compliance or implementation of additional stormwater or erosion and sediment control(s) prior to recommencing control discharge.
Presence of visual oil and grease	Cease discharge if practicable, test for Oil and Grease and if >10mg/L advise EPA, investigate and implement immediate action to rectify and prevent reoccurrence. Engage contractor to remove visual contamination and appropriately dispose/recycle contaminated water off site at an appropriately licensed facility.
Source: Modified after Groundwork Plus (2014) – Table 51	

4.6 GROUNDWATER

4.6.1 Introduction

The DGRs issued for the Proposal identified "*Soil and **Water***" as a key issue for assessment within the EIS. With respect to groundwater, the DGRs require that the "*EIS include:*

- *a detailed assessment of potential impacts on the quality and quantity of existing surface and ground water resources, including:*
  - *detailed modelling of potential groundwater impacts;*
  - *impacts on riparian, ecological, geomorphological and hydrological values of watercourses, including environmental flows, in particular Coxs River;*
  - *whether the development can operate to achieve a neutral or beneficial effect on water quality in the drinking water catchment, consistent with the provisions of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011;*
- *a detailed assessment of the potential impacts of the development on:*
  - *the quantity and quality of regional water supplies;*
  - *regional water supply infrastructure; and*
  - *affected licensed water users and basic landholder rights (including downstream water users);*

- *identification of any licensing requirements or other approvals under the Water Act 1912 and/or Water Management Act 2000; and*
- *demonstration that water for the construction and operation of the development can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP) or water source embargo;*
- *a detailed description of the proposed water management system …… and other measures to mitigate surface and groundwater impacts; ……"*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from the NSW Office of Water (NOW) which amongst several more general water impact and assessment related requests included a request for a predictive assessment of the impact of the Proposal on all groundwater sources that includes impacts on connectivity, yield of groundwater, water quality, groundwater dependent ecosystems and existing groundwater users. A consolidated list of the identified requirements and where each is addressed is presented in **Appendix 3**.

Based on the risk analysis undertaken for the Proposal (Section 3.3.1 and **Table 3.9**), the potential impacts relating to surface water and their risk rankings (in parenthesis) after the adoption of pre-existing or standard mitigation measures are as follows.

- Reduction in the volume of water contained within the local aquifer / availability resulting in reduced yields of groundwater bores (low risk).
- Reduction in base flows / spring flows leading to:
  - reduced discharge to gully colluvium ('springs') (low risk);
  - degradation of riparian or aquatic vegetation / ecosystems (low risk); or
  - reduced availability of water to downstream users (low risk).
- Reduced availability to local users as a result of contamination (low risk).
- Degradation of groundwater dependent ecosystems due to contamination of groundwater (low risk).
- Contamination of surface flows (from contaminated recharge) resulting in reduced availability of water to downstream users (low risk).

A review of the attributed risk levels, following the adoption of the recommended operational safeguards and controls, is provided in Section 6.2.1 and **Table 6.1**.

A groundwater impact assessment for the Proposal was undertaken by Mr James Morrow of Ground Doctor Pty Ltd. The assessment is presented as Part 3 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as "Ground Doctor (2014)". This subsection of the EIS provides a summary of Ground Doctor (2014), concentrating on those matters raised in the DGRs and related requirements provided by various government agencies. It is noted that Ground Doctor (2014) provides a qualitative assessment of the potential impacts to groundwater quality posed by the Proposal, rather than "*detailed modelling of potential groundwater impacts*" as nominated in the DGRs. This approach reflects the hydrogeological setting of the extraction area of the Stage 2 Site which is isolated from surrounding aquifers by topographic and surface drainage conditions (see Section 4.5.2).

4.6.2 Hydrogeological Setting

4.6.2.1 Local Hydrogeological Setting

This summary of the local hydrogeological setting considers:

- the NOW groundwater bore database within a 5km radius of the Stage 2 Site;
- an inspection of the Stage 2 Site conducted by Mr Morrow on 18 July 2013, including observations of open exploration drill holes; and
- discussions with Stage 2 Site personnel regarding observations of groundwater behaviour at the Stage 2 Site.

Water Sources and Standing Water Levels

Figure 4.34 displays the locations of 30 groundwater bores within a 5km radius of the Stage 2 Site. The majority of these bores are located between 4km and 5km of the Stage 2 Site and have recorded yields typically less than 0.5L/s. The recorded standing water levels (SWL) vary significantly (from 3.6m to 70m below ground surface) with the shallower SWLs where the water source is shallow alluvial or weathered rock (sedimentary sandstone, shale and siltstone) and deeper SWLs sourcing the fractured granite bed rock aquifers. Standing water levels correlate with changes in surface elevation.

Based on the observed water level (730m AHD) within an open vertical exploration drill hole (DD1) on the Stage 2 Site (see inset on **Figure 4.34**), the accumulation of water within a sump on the floor of the current extraction area (730m AHD) and observed seepage through fractures in the extraction area wall adjacent to the primary crusher (720m AHD), the SWL within the footprint of the Stage 1 extraction area has been established as being approximately 730m AHD.

Aquifer Properties

Notably, the SWL observed within the extraction area is significantly higher than the elevation of the Coxs River to the north and east, Yorkeys Creek to the west and an unnamed gully to the south. The presence of standing water at elevations above these ‘drains’, i.e. mounding, indicates that the groundwater occurring within the rhyolite is present as a direct result of infiltration of precipitation which falls on the elevated hilltops and ridges surrounding the extraction area. This mounding of groundwater has steep hydraulic gradients towards the surrounding rivers, creeks and gullies, approaching 15% to 20% towards the Coxs River, indicating that the water bearing factures within the rock have low permeability (Ground Doctor, 2014).

For the purpose of analysis of groundwater flow, Ground Doctor (2014) has assumed a low average permeability, equivalent to the yields of those registered bores identified within 5km of the Stage 2 Site, i.e. 0.5L/s. With respect to groundwater storage within the rhyolite hosted aquifer, a porosity of 0.4% is assigned to the rhyolite source rock and 0.7% of the overall rock volume (Ground Doctor, 2014).

Aquifer Boundaries

Based on the data obtained from the NOW groundwater bore database, the elevations of the Coxs River (630m to 660m AHD), Yorkeys Creek (700m AHD) and other local creeks, streams, valleys and gullies (typically less than 700m AHD) are lower than the observed SWL.

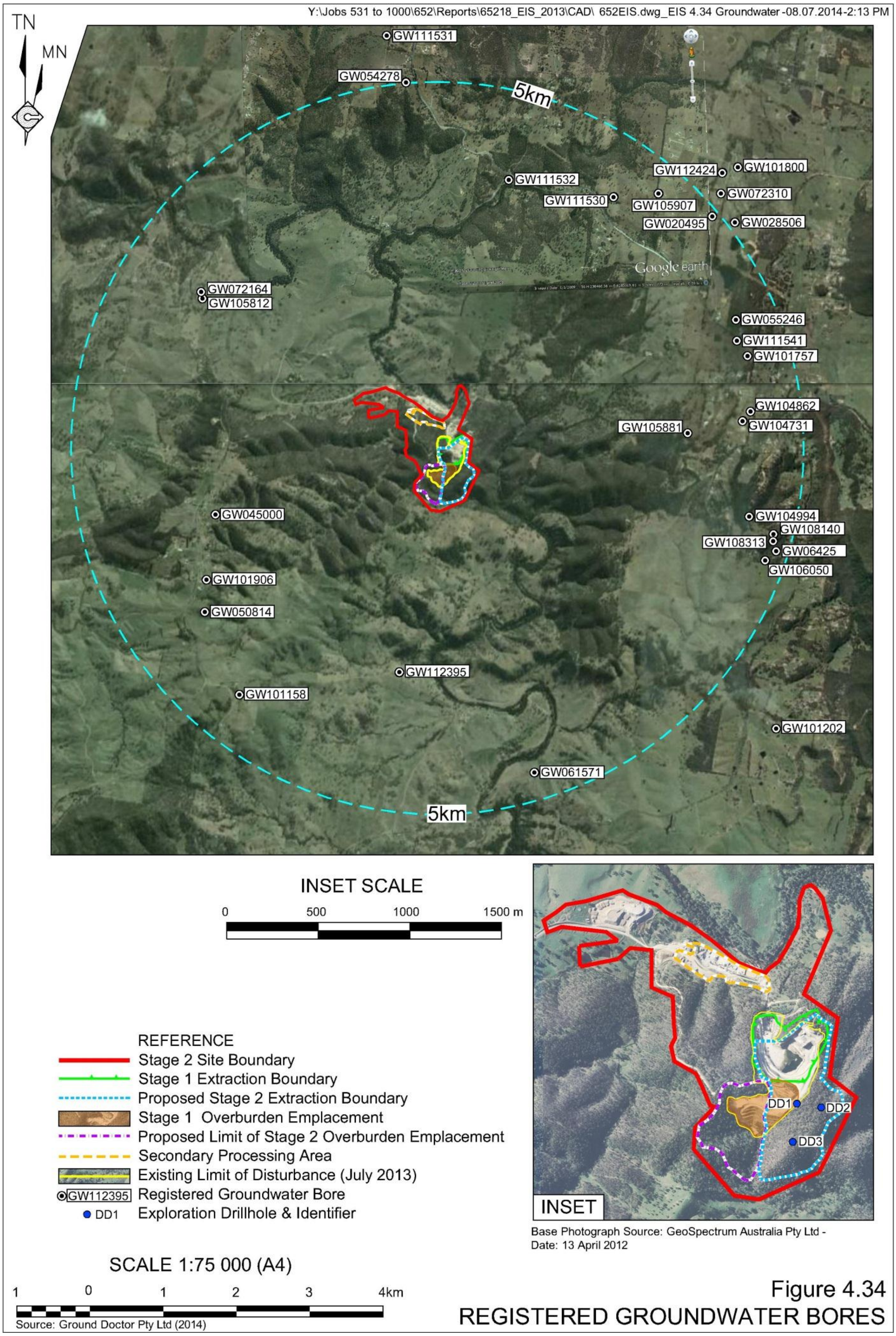


Figure 4.34
REGISTERED GROUNDWATER BORES

These would therefore function as groundwater discharge points and form a physical boundary limiting the lateral movement of groundwater between isolated fractured rock aquifers at elevations greater than the surrounding rivers, creeks and gullies. That is, the groundwater of the rhyolite hosted aquifer on the Stage 2 Site is isolated from adjacent aquifers due to the presence of gullies and low valleys in all directions from the Stage 2 Site.

Groundwater – Surface Water Interaction

The fractured rock aquifers within the local setting are recharged by a proportion of the rainfall on the elevated areas of and surrounding the Stage 2 Site. Ground Doctor (2014) estimates this proportion to be very small (<1%) due to the steep topography and shallow soils. The groundwater subsequently discharges to the surface on the lower slopes and watercourses. Groundwater is also likely to discharge into the adjacent Coxs River, which is the lowest point in the local landscape. Groundwater discharge to local drains equals groundwater recharge over the long term, however, groundwater levels will naturally fluctuate due to seasonal conditions. That is, during wet periods, increased recharge will result in higher standing water levels and increased discharge. During drier periods (reduced recharge), the standing water levels will fall leading to reduced discharge.

Water Quality

On the basis that the groundwater stored within the mounded aquifer is recently recharged rainfall as it flows towards the drains surrounding the Stage 2 Site, sampling has not been undertaken. Records of groundwater quality obtained from local bore logs provide descriptions of “good” or “fresh”, as is expected given the location within an elevated area of the Central Tablelands (an upland environment). Electrical conductivity (EC) is expected to be below 1 400µS/cm with water suitable for all potential beneficial uses (Ground Doctor, 2014). Extensive petrological studies have been conducted of the rhyolite and other rocks indicating these are comprised of geochemically inert materials. Nil to a trace amount of pyrite has been identified and as such there is no acid rock drainage risk.

Groundwater Dependent Ecosystems

No Groundwater Dependent Ecosystems (GDEs) listed under Schedule 4 of the *Water Sharing Plan for the Greater Metropolitan Area Groundwater Sources 2011* (the Water Sharing Plan) occur on or adjoin the Stage 2 Site. Section 4.8.3.2.3 provides a further review of the type and likelihood of GDEs occurring on or adjoining the Stage 2 Site.

Summary

The occurrence of groundwater within the local setting is largely controlled as follows.

- SWLs correlate with changes in surface elevation, i.e. they are higher in more elevated areas and lower in low points within the landscape.
- The fractured rock aquifers have relatively low average permeability which allows for relatively steep groundwater gradients. This appears as groundwater mounding beneath ridgelines with steep gradient to discharge points in the adjacent valleys.
- There is likely to be very limited lateral connectivity between fractured rock aquifers due to the physical boundary to movement provided by the incised valleys and gullies (which generally occur at elevations lower than the SWL of the water-bearing fractures and into which the groundwater discharges).

4.6.2.2 Hydrogeology of the Stage 2 Site (Conceptual Site Model)

Based on the description of the local hydrogeological setting provided by Section 4.6.2.1, Ground Doctor (2014) has generated a Conceptual Site Model (CSM) of Stage 2 Site hydrogeology (upper panel of **Figure 4.35**. As a result of infiltration through the elevated volcanic ridges, and the low permeability of fractures within the rock, local mounding of groundwater between elevated areas occurs with discharge along drainage gullies and valleys. The SWL of the mounded groundwater (currently 730m AHD) will vary depending on rainfall conditions of the time, however, a steep groundwater gradient is observed (of between 15% and 20% to the Coxs River). Perched groundwater units could be present where local accumulation of rainwater occur within fractures above, but not connected to the regional water table. These are considered unlikely within the proposed extraction area due to the homogeneity of the geology.

As described in Section 4.6.2.1, the CSM illustrates that the occurrence of groundwater below the Stage 2 Site is influenced by the volume of rainfall infiltration and groundwater discharge. Groundwater levels will be steady when the volume of groundwater recharge (occurring by infiltration of rainfall) equals the rate of groundwater discharge to surface water from the lower slopes. The small proportion of rainfall recharge (less than 1%) is likely to be offset by the volume of groundwater discharge occurring from the lower slopes (draining to the Coxs River) or into the extraction area. During periods of low rainfall and infiltration, the volume of groundwater in storage and the groundwater elevation would decrease. Conversely, during periods of higher rainfall and infiltration, the volume of groundwater in storage and the groundwater elevation would increase.

To the north and east of the Stage 2 Site, the Coxs River presents a local barrier to lateral connectivity between fractured rock aquifers (see **Figure 4.35**). **Figure 4.36** also identifies the aquifer barriers presented by the incised gullies of the local topography, such as the one occupied by Yorkeys Creek, to the west and south. As a consequence of this lack of lateral connectivity, any changes to the groundwater regime of the Stage 2 Site would not influence the hydrogeological conditions of aquifers beyond these aquifer barriers.

4.6.3 Potential Impacts of the Stage 2 Extension

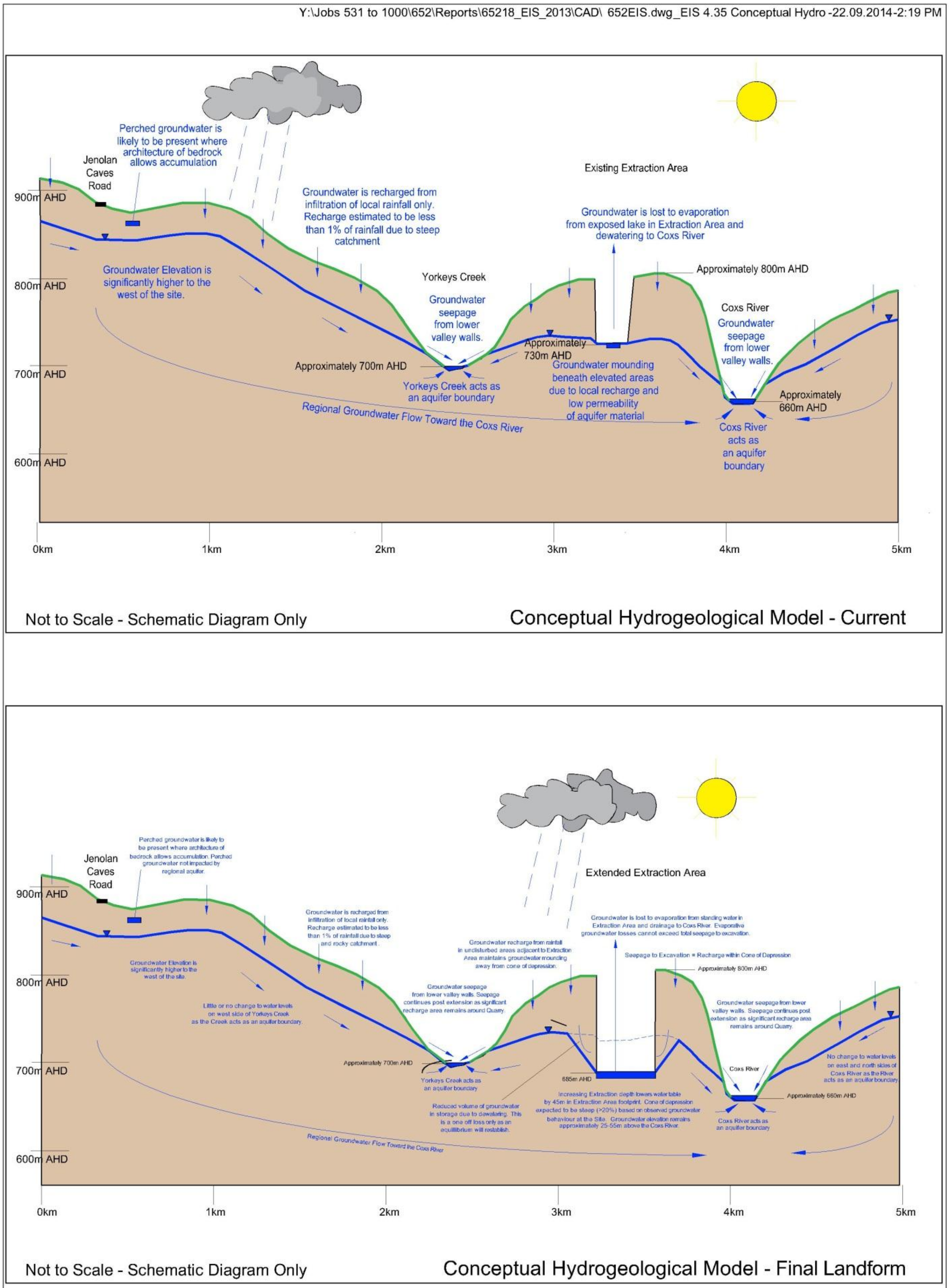
Impacts on groundwater could potentially constrain the Stage 2 Extension on the basis of the following three potential impacts.

Pollution of Groundwater

The removal of unsaturated rock from above the groundwater table increases the susceptibility of the aquifer to chemical contamination from surface spills. The potential sources of such spills and contamination include:

- fuel, oil or other hydrocarbon spills or leaks; and
- nitrates contained within explosives.

It is noted that the potential sources of contamination described above are a feature of current activities on the Stage 2 Site and therefore the proposed Stage 2 Extension poses no significant additional risk to groundwater quality. Furthermore, the risk of groundwater contamination through operational activities (including blasting and use of plant chemicals) is considered very low due to the low porosity characteristics of the rhyolite (0.4%) and its resistance to fracturing. This is likely to limit contamination due to blasting or spills from reaching the groundwater.



Source: Modified after Ground Doctor (2014) - Figures 6 & 7

Figure 4.35
CONCEPTUAL HYDROGEOLOGICAL MODEL FOR THE STAGE 2 SITE

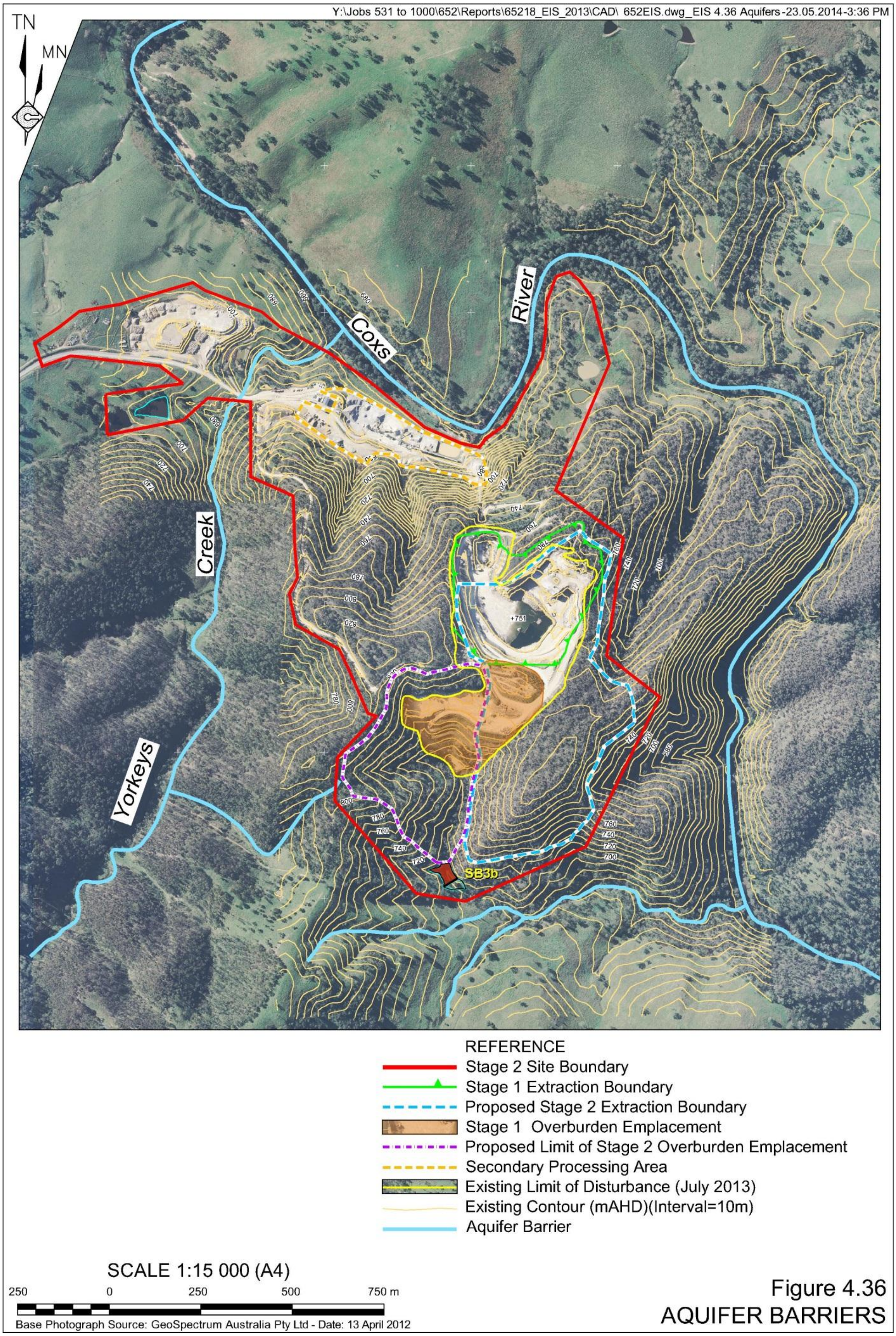


Figure 4.36
AQUIFER BARRIERS

Aquifer Interference and Groundwater Availability

The proposed increase in area and depth of the extraction area is likely to result in localised drawdown of the groundwater table. The Proposal is therefore considered an aquifer interference activity and requires assessment under the NSW *Aquifer Interference Policy* (DPI, 2012a).

Due to the lack of lateral connectivity between the groundwater source to be drawn down and those accessed by registered groundwater users surrounding the Stage 2 Site, no impact would occur to the availability of groundwater to these users.

As a result of the extraction being developed below the isolated groundwater table of the Stage 2 Site, there could be a minor reduction to the volume of water stored within the rhyolite hosted aquifer. A proportion of the groundwater retained in the rhyolite surrounding the extraction area, which previously may have flowed to the various drains surrounding the extraction area, e.g. Coxs River and local gullies, may seep into the extraction area. This seepage would be collected and either used for dust suppression or pumped to SD1 for entry into the Stage 2 Site water management system. A small proportion of the accumulated water would be lost via evaporation, however, on the basis that the water collected within SD1 would be periodically discharged to the Coxs River (see Section 4.5.5.3), combined with the increased runoff generated within the extraction area, there is unlikely to be any significant change to the overall water balance of the Coxs River.

Groundwater Licensing

As groundwater would be intercepted by the proposed extraction activities, this aquifer interfering activity requires approval. In accordance with Section 89J of the EP&A Act, which excludes the requirement for Water Management Works and Water Supply Approvals under the Sections 89 and 90 of the *Water Management Act 2000*, the development consent issued under Division 4.1 of Part 4 of the EPA&A Act would provide the necessary ‘aquifer interference approval’.

Groundwater removed as a result of the proposed activities, through in-flow to the extraction area, evaporation or removal with the extracted rock, requires a Water Access Licence (WAL) with an appropriate allocation to be obtained and maintained by the Applicant. As discussed in Section 2.10.4, the Applicant has made application for a zero allocation WAL and intends on applying for a controlled allocation from the Coxs River Fractured Rock groundwater management unit for 20 units (20MLpa) in accordance with Controlled Allocation Order (Various Groundwater Sources) (No 1) (NSW Government, 2014).

4.6.4 Controls and Management Measures

4.6.4.1 Aquifer Interference and Groundwater Availability

The Applicant would maintain a sump(s) on the active floor of the extraction area to collect any water which seeps into the void, as the depth of extraction is developed below the SWL of the surrounding groundwater, as well as rainfall runoff. As water accumulates within the sump, it would either be used for dust suppression or periodically discharged to SD1 for addition to the Stage 2 Site water management system. Based on the modelling of Groundwork Plus (2014), between 1.9ML and 65.5ML of water would be discharged back to the Coxs River from SD1 and SD2 annually (see Section 4.5.5.3).

Based on the isolated nature of the hydrogeological setting discussed in Section 4.6.2, it is highly unlikely that the proposed extraction area would impact on the availability of groundwater beyond the identified aquifer barriers (see **Figure 4.36**). This notwithstanding, the Applicant proposes to install piezometers between the extraction area and the Coxs River to the east, and Yorkeys Creek to the west. The SWL within the piezometers would be monitored regularly to confirm that the extent of groundwater drawdown remains equivalent to that predicted by Ground Doctor (2014) (refer to Section 4.6.5.3).

To ensure the annual 'take' of groundwater each year remains within that which the Applicant retains a licensed allocation, the Applicant would apply the following methodology to calculating the two components of groundwater take.

- In Situ Groundwater. The groundwater contained with the removed rock would be a simple multiplication of volume by porosity. Readings of SWL from the piezometers surrounding the extraction area would be used to delineate the extent and gradient of drawdown beyond the extraction area. The loss of groundwater from this cone of depression would also be calculated by multiplying the volume of lost storage by porosity.
- Seepage. The delineated cone of depression would also be used to estimate annual seepage losses. By multiplying the area at surface of the drawdown by annual rainfall by average recharge (1%), the volume of recharge removed from the aquifer would be calculated.

As is discussed in Section 4.6.5.3, these calculations are likely to overestimate the volume of water reporting to the extraction and 'taken' from the aquifer.

The above notwithstanding, the Applicant would respond to any claim of a reduction in availability of groundwater resources. Should it be determined that the reduction in groundwater can be attributed to the Proposal, replacement or compensatory measures would be developed.

4.6.4.2 Groundwater Contamination

As noted by Ground Doctor (2014) and discussed in Section 4.6.3, the risk of groundwater contamination through operational activities (including blasting and equipment operation) is considered very low due to the low porosity characteristics of the rhyolite (0.7%) and its resistance to fracturing. Therefore, the safeguards and controls relating to the prevention of surface water contamination nominated in Section 4.5.4.1 apply equally to the prevention of groundwater contamination.

The quality of water contained within SD1 and SD2 would be monitored to provide an indication of the accumulation of any contaminants within the water which is retained in the extraction area sumps. An elevation in any contaminant, e.g. hydrocarbon or nitrate, would lead to further sampling and assessment of the water of the extraction area sumps.

4.6.5 Assessment of Impacts

4.6.5.1 Aquifer Properties and Groundwater Availability

The impact of the Proposal would be to lower the groundwater table within the extraction area and immediate surrounds. A conceptual model of Stage 2 Site hydrogeology following the completion of the Proposal is provided by the lower panel of **Figure 4.35**.

The main changes to the groundwater regime at the Stage 2 Site would occur as a result of the following.

- The physical removal of groundwater contained within the extracted rock and cone of depression extending from the base of the extraction area ('in situ groundwater').

  The groundwater contained within the pore space of the quarried rock would be removed. As the extraction area is developed further below the existing groundwater SWL, a hydraulic gradient towards the extraction area void would be created with groundwater flowing towards and seeping into the void. Ground Doctor (2014) describes this as a permanent drainage of groundwater from the aquifer within the cone of depression as a new post-extraction SWL around the perimeter of the extraction area floor (eventually 685m AHD) is established (see lower panel of **Figure 4.35**).

- Ongoing seepage from surrounding fractured rock during excavation and from the post quarrying landscape.

  Once the drainage of in situ groundwater is complete, the water balance would return to pre-quarry conditions where the volume of rainfall infiltration is equal to the volume of groundwater discharge into the adjacent drains. A portion of this recharge which occurs over the cone of depression would drain to the extraction area (and is referred to hereafter as the 'seepage' component of groundwater loss). As a result, during periods of higher infiltration, e.g. periods of heavy or sustained rainfall, groundwater seepage into the void of the final extraction area would be higher (as it would in other drains surrounding the extraction area) than during periods of low rainfall.

As illustrated by the post-quarry CSM (see lower panel of **Figure 4.35**), the lateral spread of any drawdown impacts would be limited by the low average permeability of the aquifer, manifested as hydraulic gradients of 15% to 20%. That is, recharge to the more elevated areas around the periphery of the extraction area would still occur with some mounding of groundwater expected. In particular, groundwater would continue to flow toward Yorkeys Creek as a result of groundwater recharge occurring in the undisturbed area between the extraction area and Yorkeys Creek.

Furthermore, while lowering of the groundwater table within and surrounding the extraction area would occur, even in the worst case scenario drawdown would be limited (not progress beyond) the physical topographic aquifer barriers of Yorkeys Creek to the west , the Coxs River to the north and east, and an unnamed gully to the south of the Stage 2 Site.

4.6.5.2 Groundwater Drawdown and Loss

In the absence of measured aquifer properties, Ground Doctor (2014) has relied upon an analytical approach to estimating the two components of groundwater loss, in situ groundwater and seepage (see Section 4.6.5.2).

This analytical approach is based on the following assumptions which are likely to significantly overstate the loss of groundwater associated with the Stage 2 Extension.

- All water contained within the pore spaces of the quarried rock is accounted for. It is assumed that rhyolite contains 1.1% water on average.
- The base of the entire final extraction area at an elevation of 685m AHD with 45m of drawdown assumed.
- The base of the final extraction area has been approximated as a circle with a diameter of 350m.
- The existing SWL of 730m AHD is assumed to continue away from the extraction area indefinitely. That is, the mounded nature of the groundwater which would result in a reduction in the SWL with distance from the extraction area, is not incorporated.
- An average hydraulic gradient of 20% which, based on 45m drawdown, would create a cone of depression propagating 225m away from the outer walls of the extraction area. The hydraulic gradient has been assumed to be linear away from the extraction area.
- Average rainfall at the site is 859mm/yr and groundwater recharge is approximately 1% of total rainfall.

In Situ Groundwater Losses

The volume of rock within the cone of depression can be estimated by calculating the volume of a conical cylinder with base diameter of 350m, upper diameter of 800m (estimated width of the cone of depression) and depth of 45m. This equates to a volume of approximately 11 685 000m^3, of which 1.1%[4] (128,500m^3) is groundwater (128.5ML).

While annual loss would be dependent on annual removal of rhyolite and overburden, if averaged over the 35 year operating period of the Stage 2 Extension, this corresponds to an average annual take of 3.7ML/yr.

Seepage Losses

Following the removal of the in situ groundwater from the extraction area and cone of depression, groundwater would continue to be lost from the aquifer as a result of seepage into the open extraction area. As described in Section 4.6.5.2, the average annual loss due to seepage would be equivalent to the amount of recharge which occurs within the cone of depression surrounding the extraction area.

---

[4] Based on porosity of the rhyolite and other rock.

Based on an average hydraulic gradient of 20%, the cone of depression would extend approximately 225m from the outer walls of the excavation, i.e. an area of 503 000m^2 when applying the assumptions described above. Assuming an average rainfall of 859mm/yr, the total volume of rainfall would be, on average, approximately 432 000m^3. As recharge has been assumed as 1% of annual rainfall, the average volume taken from the cone of depression would be 4 300m^3 (4.3ML/yr)[5].

4.6.5.3 Groundwater Quality

Assuming the implementation of the management controls to reduce the potential for hydrocarbon or other spills and leaks, and measures to be implemented in the event of a spill or leak, the risk of groundwater contamination as a result of the Proposal is considered to be as low as reasonably possible. It is worthy of note that after over 10 years of operating at the Austen Quarry, there have been no incidents of contamination events or discharges as a result of hydrocarbon or other contaminant spills and leaks. However, even in the event of a spill or leak within the extraction area, the potential for contamination to enter the groundwater would be low, as drawdown in surrounding rock is expected to maintain an inward (i.e. towards the excavation) gradient (Ground Doctor, 2014).

The rhyolite displays nil to trace sulphur and therefore has very little potential to generate acid when it is exposed to oxygen.

Recent water quality monitoring identified that concentration of nitrate in the extraction area sumps was slightly elevated (refer to *Table 9* of Groundwork Plus, 2014), however, as a result of natural dilution, this concentration decreases within the interim storage dams (SD1 and SD2) prior to discharge (refer to *Table 12* of Groundwork Plus, 2014). Furthermore, these concentrations are equivalent and lower than those measured in other dams which receive runoff from local paddocks, e.g. SD6 (refer to *Table 13* of Groundwork Plus, 2014).

As discussed in Section 2.13.3.2, it is expected that water would accumulate within the final landform, with a small proportion of this provided by groundwater. On the basis that the majority of the water accumulating within the final void will be surface runoff, the potential for the accumulation of salt or other contaminants is considered very low.

4.6.5.4 Aquifer Interference and Licensing

Aquifer Interference

The NSW *Aquifer Interference Policy* characterises aquifers as highly or less productive on the basis of yield (being greater or less than 5L/s) and salinity (TDS being greater or less than 1 500mg/L). The groundwater source to be impacted by the Proposal is defined as a "less productive" aquifer on the basis that bores within 5km of the Stage 2 Site typically have reported yields well below 0.5L/s or 10% of the threshold for being a highly productive bore.

[5] Ground Doctor (2014) notes that the estimate of seepage is based on the inferred maximum extent of drawdown associated with the Stage 2 Extension. In reality the cone of depression would increase in size gradually proportional to increased depth of the extraction area.

Ground Doctor (2014) assessed the likely impacts of the Proposal against the "*Minimal Impact Considerations*" of the NSW *Aquifer Interference Policy*. **Table 4.21** reproduces the results of Ground Doctor's assessment.

On the basis that the minimal impact is demonstrated, the *NSW Aquifer Interference Policy* does not require any more detailed study or assessment.

Groundwater Licensing

Table 4.21 demonstrates that the Proposal would not exceed the minimal impact thresholds of the NSW *Aquifer Interference Policy* and therefore development consent may be issued approving this aquifer interfering activity.

Table 4.21
Minimal Impact Considerations

Impact	Assessment
Water Table and Water Pressure	
1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: a) high priority groundwater dependent ecosystem; or b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2m decline cumulatively at any water supply work then make good provisions should apply.	Aquifer barriers prevent lateral connectivity between the groundwater to be drawn down below the Stage 2 Site and that accessed by registered groundwater supply works. Furthermore, the significant distance between the extraction area and closest registered bore (2.8km) would limit any impact should there be any residual connectivity.
Water Quality	
1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If the above condition is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.	No change to groundwater quality is expected, i.e. the Proposal would not introduce contaminants or additional salt to the aquifer. In the event that water quality impacts did occur the potential for impacts to spread away from the extraction area would be low, as drawdown in surrounding rock is expected to maintain an inward (i.e. towards the excavation) gradient.
Source: Ground Doctor (2014) – Table 3.	

As noted in Section 2.10.4, the Applicant has lodged an application for a zero allocation WAL for groundwater within the Coxs River Fractured Rock Groundwater Source of the Water Sharing Plan. On receipt of this, an allocation for the annual volume of groundwater to be taken would be obtained in one of two ways.

1. An allocation would be obtained, either by purchase, lease or temporary transfer, from WALs held by third parties within the Coxs River Fractured Rock Aquifer Groundwater Source of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* (WSP, 2011). A search of publically available records has identified that there are only eight WALs for this Groundwater Source contained within allocations of between 0.5 and 21 units. The Applicant has made initial investigations as to the availability of the allocations attached to these WALs.
2. Through a controlled allocation of groundwater from the Minister for Natural Resources, Lands and Water (under delegation), it is noted that the NSW Government has issued a controlled allocation order for up to 327 units within the Coxs River Fractured Rock groundwater management unit (NSW Government, 2014). This represents approximately 5% of the LTAAEL for the Coxs River Fractured Rock management unit (6,806ML/yr) identified in the WSP (2011). The Applicant intends on applying for a portion of this controlled allocation by the deadline of 20 October 2014.

4.7 TERRESTRIAL ECOLOGY

4.7.1 Introduction

The DGRs issued for the Proposal identified "*Biodiversity*" as a key issue requiring that the "*EIS include:*

- *accurate estimates of proposed vegetation clearing and impacts on regionally significant remnant vegetation, or vegetation corridors;*
- *a detailed assessment of potential impacts of the development on any terrestrial or aquatic threatened species or populations and their habitats, endangered ecological communities and groundwater dependent ecosystems; and*
- *a detailed description of the measures taken to avoid, reduce or mitigate impacts on biodiversity including an appropriate biodiversity offset strategy."*

Additional matters for consideration in preparing the EIS were also provided in the correspondence attached to the DGRs from OEH which related to Biodiversity, Threatened Species, Flora and Fauna as follows.

- include an assessment of biodiversity impacts using the BioBanking Assessment Methodology or a detailed biodiversity assessment;
- identify vegetation communities and any threatened biota including an assessment of significance relative to all relevant legislation;

- include flora and fauna assessment reports; and
- document any requirements to refer the Proposal under the EPBC Act as a controlled action.

Also appended to the DGRs is correspondence from DTIRIS requesting an assessment of the ecological sustainability of the Proposal.

Based on the risk analysis undertaken for the Proposal (Section 3.3.1 and **Table 3.9**), the potential impacts relating to flora and fauna and their risk rankings (in parenthesis) after the adoption of pre-existing or standard mitigation measures are as follows.

- A reduction in remnant native vegetation resulting in a reduction in local biodiversity (high risk).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities through clearing activities (high risk).
- Local or regional reduction in distribution of threatened species, populations and endangered ecological communities through indirect impacts such as dust, noise and lighting from the Site (medium risk).

A review of the attributed risk levels, following the adoption of the recommended operational safeguards and controls, is provided in Section 6.2.1 and **Table 6.1**.

The Terrestrial Ecology Impact Assessment for the Proposal was undertaken by Mr Nathan Smith and Dr Rhidian Harrington of Niche Environment and Heritage (Niche) and comprised the following three primary components.

1. Background research, literature review and field survey to establish the environmental setting and issues of conservation significance that would or could be impacted by the Proposal.
2. Assessment of the impact (and relative significance) of the Proposal on the local ecological setting.
3. Development and assessment of a biodiversity offset strategy for the Proposal (to compensate for the unavoidable impacts on the local ecological setting and issues of conservation significance.

The resulting report is presented as Part 4 of the *Specialist Consultants Studies Compendium* and is referred to hereafter as “Niche (2014a)”. This subsection of the EIS provides a summary of the terrestrial ecology impact assessment, concentrating on those matters raised in the DGRs and related requirements provided by various government agencies. A consolidated list of the identified requirements and where each is addressed is presented in **Appendix 3**.

4.7.2 Assessment Methodology

4.7.2.1 Background Research and Database Review

In order to obtain information on flora and fauna to be targeted for survey, and identify species likely to be present and affected by the Proposal, Niche (2014a) undertook a desktop review of previous ecological studies of the Austen Quarry and relevant threatened species databases, e.g. the Atlas of NSW Wildlife.

Available literature included the original Environmental Impact Statement for the quarry (SKM, 1994) and a subsequent ecological constraints assessment over the site of the proposed overburden emplacement extension completed by OzArk Environment & Heritage Management (2007), along with annual monitoring reports (prepared by Biosis Research between 2005 and 2008, and OnSite Environmental between 2008 and 2013). These assessments and monitoring reports have identified five threatened bird species on the Stage 2 Site (Gang-gang Cockatoo, Hooded Robin, Scarlet Robin, Flame Robin and Varied Sittella, as well as one threatened plant Silver-leafed Mountain Gum). Monitoring has not identified the ongoing quarry operations as having any significant adverse impact on local vegetation, bird or frog assemblages.

In December 2013, Niche (2014a) conducted searches of the following databases for records of, or potential habitat for threatened species within a 10km radius of the Stage 2 Site, to produce a list of potentially occurring threatened and migratory species.

- The Atlas of NSW Wildlife.
- The NSW Threatened Species Profiles Database.
- The Commonwealth Department of the Environment (DoE) Protected Matters Search Tool

4.7.2.2 Field Investigations

4.7.2.2.1 Introduction

Although the studies summarised in Section 4.7.2.1 provide a valuable database of threatened species records within the Stage 2 Site, additional field surveys were completed by Niche (2014a) in order to add to the knowledge of the locations of threatened species on the Stage 2 Site. Section 3 of Niche (2014a) provides a detailed description of the survey techniques undertaken with Sections 4.7.2.2.2 and 4.7.2.2.3 providing a general overview of the survey methods. **Figure 4.37** presents an illustration of the survey coverage over the Stage 2 Site.

4.7.2.2.2 Flora

Vegetation Mapping

Floristic plots and transects were established, and BioBanking Site attribute data collected, to allow for floristic analysis to be completed in accordance with the BioBanking Assessment Methodology (BBAM) (DECC, 2008c).

Rapid Data Point (RDP) survey was also undertaken to complement the full floristic plot information and allow for the mapping of vegetation communities to be refined (ground-truthed). RDPs provide summaries of floristic information at specific points in the field such as:

- dominant species, estimated cover and height for each layer of vegetation present usually including canopy, mid-storey, shrubs and ground-cover;
- vegetation condition, BBAM (moderate-good, low and cleared) and other habitat or notable features; and
- physical attributes of the site (vegetation structure, soil type, elevation, slope, aspect, physiographical position).

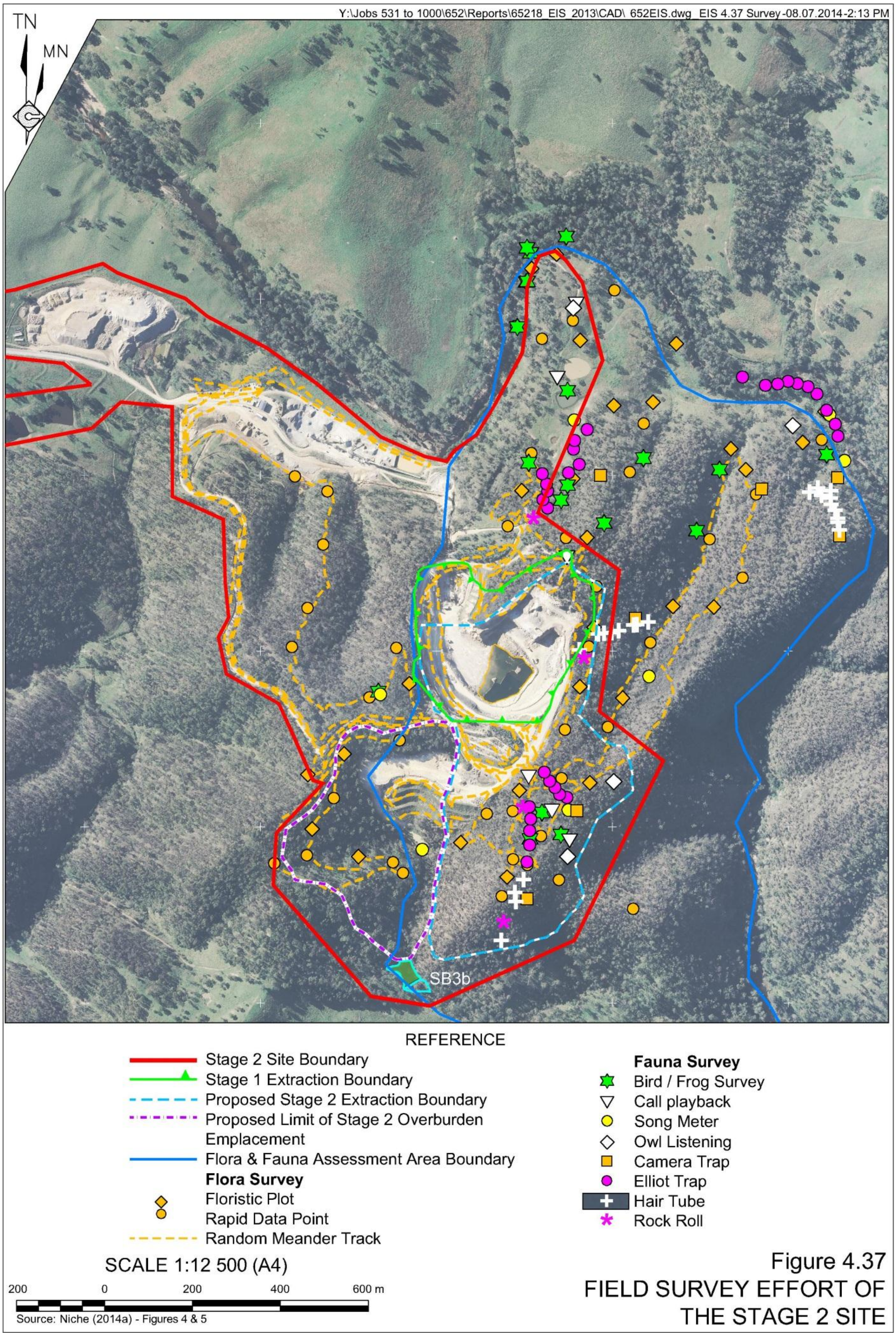


Figure 4.37
FIELD SURVEY EFFORT OF THE STAGE 2 SITE

The data collected was subject to full floristic analysis to define vegetation communities over the Stage 2 Site. These vegetation communities were subsequently aggregated and aligned to Revised Biometric Vegetation Types (RBVTs), Keith Formation and Keith Class.

Threatened Species Survey

Aerial photograph interpretation was undertaken to identify potential habitat for the threatened species identified through literature review and database searches as likely to occur within the Stage 2 Site.

Once on site, and targeting the areas of potential habitat, the Random Meander method was used to identify threatened plant species. On identification of threatened plants, these were marked by GPS and counted. Where the threatened plant population was too large for individuals to be marked and counted, the density of the population was estimated and a population estimate calculated by multiplying the density with the area of habitat.

Niche (2014a) notes that the field surveys were carried out in Summer, Autumn and Winter, outside of the peak flowering period for the threatened flora species likely to occur on the Stage 2 Site. Notably, the threatened species likely to occur are conspicuous and do not require flowers for identification. If present, these species were likely to have been identified (along with *Eucalyptus pulverulenta*) during the threatened flora survey carried out for previous assessments and monitoring programs (see Section 4.7.2.1).

4.7.2.2.3 Fauna

Habitat Assessment

Niche (2014a) recorded the following fauna habitat characteristics and parameters.

- Aspect and slope of the site.
- Dominant vegetation, floristic composition and structure (informed by the native vegetation survey).
- Composition of ground layer (bare earth, litter, fungi, moss, lichen etc.).
- Presence and relative abundance of key habitat features (e.g. tree hollows, large logs, exfoliating rock, flowering resources, aquatic features).
- Condition and disturbance factors.
- Vegetation age structure.

These characteristics were used to define the major (macro) habitat types within the Stage 2 Site, as well as provide information on micro habitats present which could influence the presence of native fauna.

Targeted fauna survey

Field fauna survey was targeted towards those species identified through background research and database review as likely to occur. Field surveys were undertaken on three occasions covering eight days and eight nights in February and March 2012. The field survey, designed and undertaken to meet the minimum survey requirements of OEH using a range of the most suitable techniques (DEC 2004), incorporated the following.

- Arboreal Elliot trapping targeting Squirrel glider and other arboreal mammals.
- Infra-red and white-light camera trap targeting Spotted-tailed quoll and other ground dwelling omnivores/scavengers.
- Hair tubes targeting ground dwelling and arboreal mammals.
- Ultrasonic call detection targeting microchiropteran bat species.
- Trip line surveys targeting microchiropteran bat species.
- Diurnal bird surveys.
- Spotlighting surveys targeting owls and arboreal mammals.
- Call playback targeting Powerful owl, Barking owl, Masked owl, Sooty owl.
- Rock rolling and herpetological searches targeting frogs and reptile species.
- Frog chorus survey and aquatic habitat (spotlight) surveys.
- Opportunistic observations.

Section 3.4.2 and *Appendix 4* of Niche (2014a) provide a more detailed summary of the fauna field survey undertaken.

4.7.2.3 Identification of Subject Species

After consideration of known records, habitat features, results of the field surveys and professional judgement of Niche, a 'likelihood of occurrence' rating was attributed to threatened species initially identified as potentially occurring on the Stage 2 Site (see **Table 4.22**).

Table 4.22
Likelihood of Occurrence Categories

Page 1 of 2

Likelihood	Threatened Flora/EEC Criteria	Threatened and Migratory Criteria
Known	The species/EEC has been observed on or immediately surrounding the Stage 2 Site.	The species has been observed on or immediately surrounding the Stage 2 Site.
High	It is likely that a species/EEC inhabits or utilises habitat within the Stage 2 Site for one or both of the following reasons. • Preferred habitat present and is in good condition. • There are a high number of records of the species within the locality.	It is likely that a species inhabits or utilises habitat within the Stage 2 Site for one or more of the following reasons. • Preferred habitat present and is in good condition. • Species is dependent on habitat within the study area on a permanent or seasonal basis. • There are a high number of records of the species within the locality.

Table 4.22 (Cont'd)
Likelihood of Occurrence Categories

Page 2 of 2

Likelihood	Threatened Flora/EEC Criteria	Threatened and Migratory Criteria
Moderate	It is possible that a species/EEC inhabits or utilises habitat within the Stage 2 Site for one or more of the following reasons: • Potential habitat for a species/EEC occurs on the site but is in a disturbed condition. • Records for the species occur within the locality. • Species is cryptic and was not seasonally targeted.	It is possible that a species inhabits or utilises habitat within the Stage 2 Site for one or more of the following reasons: • Potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. • Species unlikely to be wholly dependent on habitat present within the Stage 2 Site. • Species was not seasonally targeted or surveyed using optimal techniques for detection.
Low	It is unlikely that the species/EEC inhabits the Stage 2 Site for one or more of the following reasons: • species has a low number of previous records in the locality • non-cryptic species that was not recorded during targeted field surveys. • habitat for the species is not considered to be present within the Stage 2 Site.	It is unlikely that the species inhabits the Stage 2 Site for one or both of the following reasons: • If present, the species would likely be a transient visitor. • The Stage 2 Site contains only very common habitat for this species which the species does not rely on for its ongoing local existence.
None	The species/EEC is not considered to be present within the Stage 2 Site for one or more of the following reasons: • The habitat within the Stage 2 Site is unsuitable for the species/EEC. • The species has not been recorded previously within the Stage 2 Site or locality. • The Stage 2 Site is beyond the known limit of the species distribution.	The species is not considered to be present within the Stage 2 Site for one or more of the following reasons: • The habitat within the Stage 2 Site is Unsuitable for the Species/EEC. • The Species has not been recorded previously within the Stage 2 Site or locality. • The Stage 2 Site is beyond the known limit of the species distribution.
Source: Niche (2014a)		

Subject species were identified as having a moderate, high or known likelihood of occurrence, and for which known or potential habitat would be impacted. These species would require formal assessment of significance in accordance with the EP&A Act (Seven Part Test) for NSW listed species or EPBC Act (Significant Impact Criteria) for Commonwealth listed species.

4.7.3 Ecological Setting and Issues of Conservation Significance

4.7.3.1 Flora of the Stage 2 Site

4.7.3.1.1 Vegetation Communities

Following the methodology for vegetation mapping described in Section 4.7.2.2, Niche (2014a) described six vegetation communities (and two derived communities) within the Stage 2 Site (see **Table 4.23**).

Section 4.3.2 of Niche (2014a) provides a more detailed description of the structure and dominant species within each vegetation community, including a description of the two derived communities of C3, namely:

- C3a: Forest Red Gum native grassland; and
- C3b: Forest Red Gum exotic grassland.

Table 4.23
Vegetation Communities of the Stage 2 Site

Vegetation Community	Revised Biometric Vegetation Type	Formation[1]	Class[1]	Regional Status (% cleared)[2]	Conservation Status
C1: Brittle Gum – Broad-leaved Peppermint open forest	HN570 – Red Stringybark - Brittle Gum - Brittle Gum dry open forest of the tablelands, South Eastern Highlands	Dry Sclerophyll Forests (Shrubby sub-formation)	Southern Tableland Dry Sclerophyll Forests	55% (not regionally significant)	Not an EEC
C2: Silver-leafed Mountain Gum mallee woodland					Contains *Eucalyptus pulverulenta* (not an EEC)
C3: Forest Red Gum grassy open forest	HN527 – Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin and South Eastern Highlands	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Central Gorge Dry Sclerophyll Forests	50% (not regionally significant)	Not an EEC
C4: Rough-barked Apple gully forest					Not an EEC
C5: Stringybark – Apple Box open forest	HN501 – Apple Box - Broad-leaved Peppermint dry open forest of the Abercrombie - Tarlo area, South Eastern Highlands	Grassy Woodlands	Tableland Grassy Woodlands	30% (not regionally significant)	Not an EEC
C6: River Oak riparian open forest	HN574 – River Oak open forest of major streams, Sydney Basin and South East Corner	Forested Wetlands	Eastern Riverine Forests	40% (not regionally significant)	Not an EEC

Note 1: after Keith (2004)
Note 2: Within Hawkesbury Nepean CMA Region
Source: Modified after Niche (2014a) – Section 4.3.1

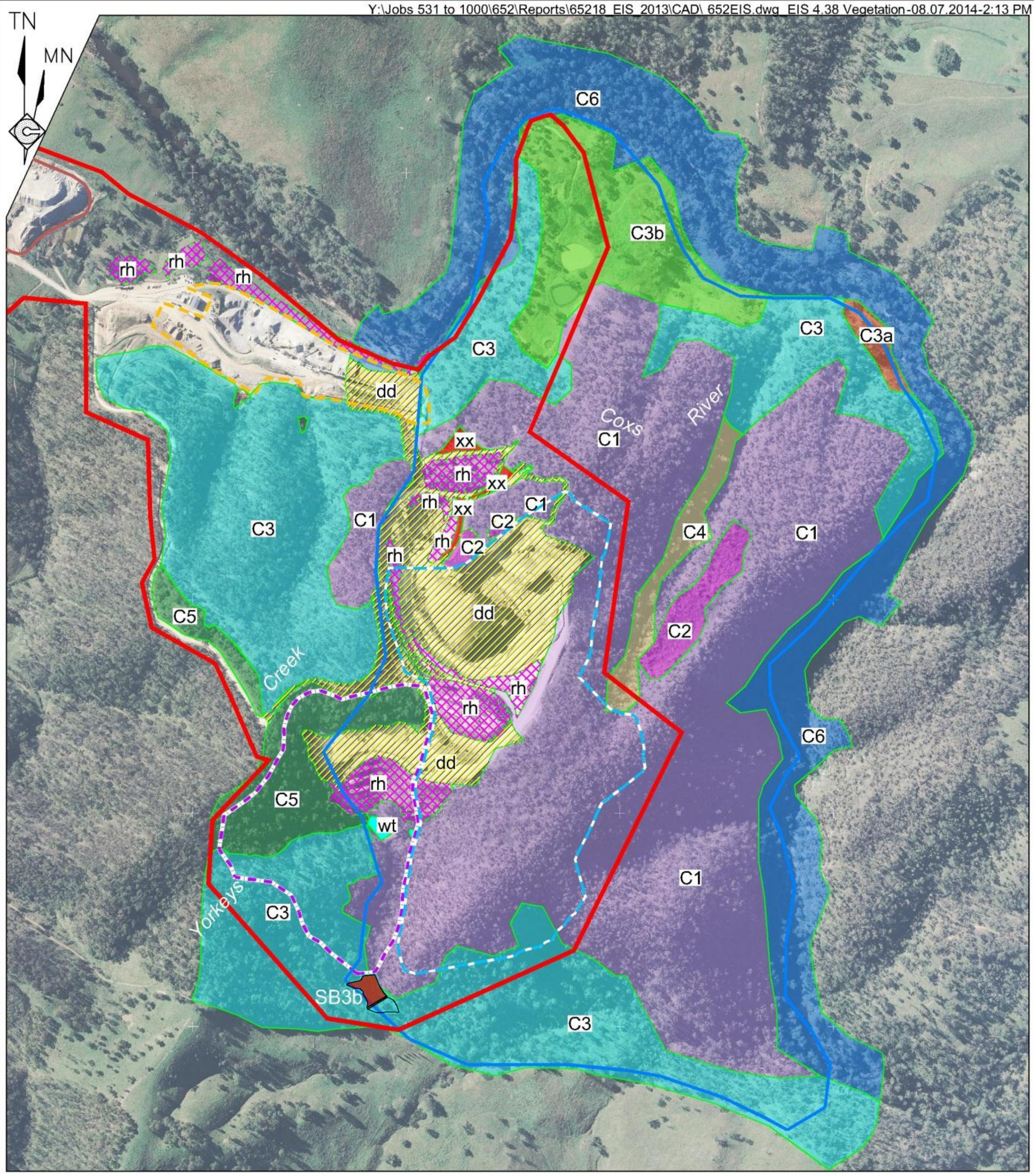
The distribution of these communities on the Stage 2 Site is displayed on **Figure 4.38** and **Table 4.24** identifies the area of each contained within the Stage 2 Site, the impact footprint of the Stage 2 Extension and the proposed biodiversity offset area.

Table 4.24
Distribution of Vegetation Communities of the Stage 2 Site

Vegetation Community	Survey Area (ha)	Impact Area		Proposed BOA (ha)
		direct (ha)	Indirect (ha)	
C1: Brittle Gum – Broad-leaved Peppermint open forest	64.9	17.3	1.3	46.3
C2: Silver-leafed Mountain Gum mallee woodland	1.9	-	-	1.9
C3: Forest Red Gum grassy open forest	28.0	4.4	0.8	22.8
C3a: Forest Red Gum native grassland	0.8	-	-	0.8
C3b: Forest Red Gum exotic grassland	9.7	-	-	9.7
C4: Rough-barked Apple gully forest	2.4	-	-	2.4
C5: Stringybark - Apple Box open forest	5.2	4.8	0.4	-
C6: River Oak riparian open forest	10.4	-	-	10.4
Total Native Vegetation	**123.3**	**26.5**	**2.5**	**94.3**

Source: Modified after Niche (2014a) – Tables 12 and 16

Y:\Jobs 531 to 1000\652\Reports\65218_EIS_2013\CAD\ 652EIS.dwg_EIS 4.38 Vegetation-08.07.2014-2:13 PM



Notes 1: Boundaries have been offset for clarity
2: The final site boundary is subject to modification following consultation with landowner (Hartley Pastoral Corporation Pty Limited)
3: The optimum design of SB3b (with a volume of 7ML) remains to be confirmed and will follow additional review of local conditions by the Applicant and their hydrological consultants

REFERENCE
- Stage 2 Site Boundary
- Proposed Stage 2 Extraction Boundary
- Proposed Limit of Stage 2 Overburden Emplacement
- Secondary Processing Area
- Yorkeys Creek Stockpile Area
- Flora & Fauna Assessment Area Boundary

VEGETATION COMMUNITIES *
- C1 Brittle Gum - Broad-leaved Peppermint open forest (HN570)
- C2 Silver-leaved Mountain Gum mallee woodland (HN570)
- C3 Yellow Box - Forest Red Gum grassy open forest (HN527)
- C3a Yellow Box - Forest Red Gum native grassland (HN527)
- C3b Yellow Box - Forest Red Gum exotic grassland (HN527)
- C4 Rough-barked Apple gully forest (HN527)
- C5 Stringybark - Apple Box open forest (HN501)
- C6 River Oak riparian open forest (HN574)
- dd Disturbed or Excavated
- rh Rehabilitation Area
- wt Pond
- xx Exotic Grassland

* Biometric Vegetation Type of Hawkesbury - Nepean Catchment

SCALE 1:12 000 (A4)

200 0 200 400 600 m

Source: Niche (2014a) - Figure 8

Figure 4.38
VEGETATION COMMUNITIES
OF THE STAGE 2 SITE

4.7.3.1.2 Flora Species

A total of 214 species were recorded, including 41 weeds (19%) and one threatened flora species, Silver-leafed Mountain Gum (*Eucalyptus pulverulenta*). This species, listed as vulnerable on both the TSC and EPBC Acts, was recorded as a common to dominant species during the field survey.

Contribution to the conservation of the Silver-leafed Mountain Gum forms a component of the current development consent (DA 103/94) for the Austen Quarry (see **Box 2.1**). While DA 103/94 does not require Silver-leafed Mountain Gum to be included in rehabilitation of the Austen Quarry, the Applicant has included the planting of this species in the revegetation of the overburden emplacement.

Figure 4.39 presents the distribution of this species on the Stage 2 Site, based on actual counts and calculations based on plant density within its core habitat. Considering the occurrence of the Silver-leafed Mountain Gum within rehabilitation areas of the quarry, the Stage 2 Site is estimated to contain 3 815 individuals occurring as follows.

- 2 283 within core areas of natural habitat (to remain undisturbed).
- 146 naturally occurring outside the core areas (90 to be removed).
- 1 386 planted within rehabilitation areas (631 to be removed).

Notably, this represents a more than doubling of the population of Silver-leafed Mountain Gum identified by Lembit (1994). The original local population was recorded as 1 680, having been estimated based on quadrat surveys completed over the original quarry site and surrounds.

4.7.3.1.3 Noxious Weeds

Seven Class 4 (of *the Noxious Weeds Act 1993*) noxious weeds were identified within the Stage 2 Site, namely:

- *Eragrostis curvula* (African lovegrass);
- Rubus fruticosus agg. spp. (Blackberry);
- *Nassella trichotoma* (Serrated tussock);
- Conium maculatum (Hemlock);
- *Onopordum spp.* (Scotch, Stemless, Illyrian and Taurian thistles);
- Hypericum perforatum (St. John's wort);
- *Rosa rubiginosa* (Sweet briar).

As Class 4 weeds, their growth must be managed in a manner that reduces their numbers, spread and incidence and continuously inhibits its reproduction.

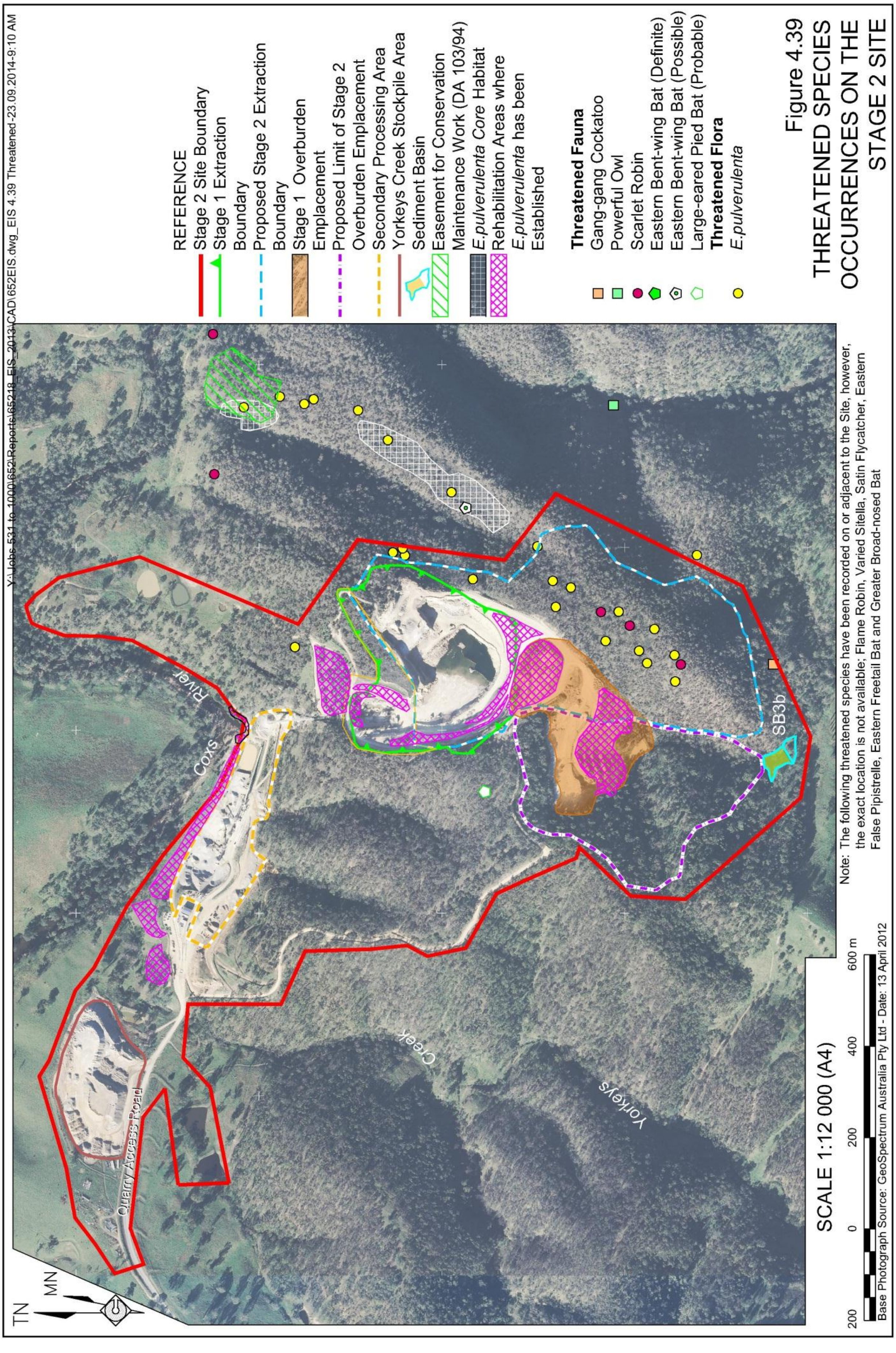


Figure 4.39
THREATENED SPECIES OCCURRENCES ON THE STAGE 2 SITE

4.7.3.2 Fauna of the Stage 2 Site

4.7.3.2.1 Fauna Habitat

Four dominant fauna habitat types were identified within the Stage 2 Site, generally aligned with the vegetation formations nominated in **Table 4.23**.

- Ridge Forest (Dry Sclerophyll Forest – shrubby sub-formation).

  Associated with Communities C1, and C2, this habitat occurs along the mid-upper slopes and ridges, the vegetation is predominantly in good condition with little evidence of significant past disturbance, except for some tracks and edge-effects due to adjacent extraction. While, there is a relatively low diversity of canopy and mid-storey species and the ground cover is patchy, a variety of habitat features for resident fauna are provided. Tree hollows and fallen logs are present, however, these are generally <30cm in diameter. Rock was prominent in some areas, however, exfoliating rock slabs were generally absent.

- Gully Forest (Dry Sclerophyll Forest – shrub/grass sub-formation).

  Associated with Communities C3, C4 and C5, this habitat occurs along the mid-lower slopes of the Site where there is a better developed soil profile and a higher moisture regime. The habitat values offered vary, generally with history of previous grazing which has decreased the diversity of the understorey and ground cover vegetation. Habitat features include occasional small and medium sized hollows and fallen logs and small patches of rocky areas on steeper sections (although mainly of rock embedded into the soil which limits the value as reptile habitat).

- Riparian Forest (Forested Wetlands)

  Associated with Community C6, this habitat includes large *Casuarina cunninghamiana* and *Eucalyptus viminalis* trees forming dense foliage in places. Casuarina offer important food resources for particular fauna species such as Glossy Black-cockatoos. Large logs within these riparian areas also offer important habitat to particular species and create in-stream woody debris. Occasional medium and small hollows were present.

- Cleared Areas

  These areas, primarily associated with ongoing operations at the quarry offer limited habitat value apart from occasional foraging.

4.7.3.2.2 Fauna Species

Niche (2014a) observed a total of 89 vertebrate fauna species (86 native and 3 introduced) within the Site including five threatened fauna species listed on the TSC and/or EPBC Acts, namely:

- Gang-gang Cockatoo;
- Powerful Owl;
- Scarlet Robin;
- Eastern Bentwing-bat; and
- Large-eared Pied Bat.

The locations of the threatened species identified on the Stage 2 Site are provided on **Figure 4.39**. It is noted that an additional seven species have been previously recorded on or adjacent to the Stage 2 Site during the previous surveys and monitoring described in Section 4.7.2.1. While the exact locations of these identifications are not available, the species recorded are as follows.

- Flame Robin.
- Hooded Robin.
- Varied Sittella.
- Satin Flycatcher (recorded within the riparian corridor of the Coxs River adjoining the Stage 2 Site).
- Eastern False Pipistrelle.
- Eastern Freetail-bat.
- Greater Broad-nosed Bat.

Niche (2014a – *Appendix 9*) provides a complete list of the fauna recorded who report that the low diversity and abundance of arboreal and small ground dwelling mammals recorded is attributable to the low density or seasonal variability of foraging resources. For ground dwelling mammals, it may also be due to a lack of ground and mid-storey vegetation cover and from a lack of ground habitat features (rock outcrops and logs).

4.7.3.3 Subject Species

Niche (2014a) identify the subject species for the Proposal as those either known to occur on the Stage 2 Site or considered as having a moderate or high likelihood of occurrence, i.e. those species that would potentially be impacted by the Proposal. Following consideration of the results of desktop and field surveys of the Stage 2 Site and surrounds, Niche (2014a) identified 24 subject species (no vegetation communities) with:

- 13 known to occur;
- 5 with a high likelihood of occurrence; and
- 6 with a moderate likelihood of occurrence.

Table 4.25 provides a list of the subject species identified for the Stage 2 Site, also identifying the additional assessment completed in accordance with the TSC Act and/or EPBC Act.

4.7.3.4 Groundwater Dependent Ecosystems

Section 4.8.3.2.3 considers the likelihood of occurrence of Groundwater Dependent Ecosystems (GDEs) of the Stage 2 Site and surrounds.

Table 4.25
Subject Species of the Stage 2 Site

Species	TSC Act	EPBC Act	Likelihood of Occurrence	NSW Seven Part Test required (Yes/No)	Commonwealth Significance Assessment required (Yes/No)
Woodland Birds					
Flame Robin – *Petroica phoenicea*	V	-	Known	Yes	No
Hooded Robin – *Melanodryas cucullata*	V	-	Known	Yes	No
Scarlet Robin – *Petroica boodang*	V	-	Known	Yes	No
Varied Sittella – *Daphoenositta chrysoptera*	V	-	Known	Yes	No
Psittacines (Parrots)					
Gang-gang Cockatoo – *Callocephalon fimbriatum*	V	-	Known	Yes	No
Little Lorikeet – *Glossopsitta pusilla*	V	-	High	Yes	No
Forest Owls					
Powerful Owl – *Ninox strenua*	V	-	Known	Yes	No
Migratory Birds (EPBC Act)					
Fork-tailed Swift – *Apus pacificus*	-	M	Moderate	No	Yes
Rainbow Bee-eater – *Merops ornatus*	-	M	High	No	Yes
Satin Flycatcher – *Myiagra cyanoleuca*	-	M	Known	No	Yes
White-throated Needletail –*Hirundapus caudacutus*	-	M	Moderate	No	Yes
Microbats					
Eastern Bentwing-bat – *Miniopterus schreibersii oceanensis*	V	-	Known	Yes	No
Eastern False Pipistrelle – *Falsistrellus tasmaniensis*	V	-	Known	Yes	No
Eastern Freetail-bat – *Mormopterus norfolkensis*	V	-	Known	Yes	No
Greater Broad-nosed Bat – *Scoteanax rueppellii*	V	-	Known	Yes	No
Large-eared Pied Bat – *Chalinolobus dwyeri*	V	V	Known	Yes	Yes
Southern Myotis – *Myotis macropus*	V	-	High	Yes	No
Yellow-bellied Sheathtail-bat – *Saccolaimus flaviventris*	V	-	High	Yes	No
Mammals (other than microbats)					
Grey-headed Flying-fox – *Pteropus poliocephalus*	V	V	Moderate	Yes	Yes
Koala – *Phascolarctos cinereus*	V	V	Moderate	Yes	Yes
Squirrel Glider – *Petaurus norfolcensis*	V	-	Moderate	Yes	No
Spotted-tailed Quoll – *Dasyurus maculatus*	V	E	High	Yes	Yes
Plants					
Eucalyptus aggregata – Black Gum	V	-	Moderate	Yes	No
Eucalyptus pulverulenta – Silver-leafed Mountain Gum	V	V	Known	Yes	Yes
V = Vulnerable E = Endangered M = Migratory					
Source: Modified after Niche (2014a) – Table 2					

4.7.4 Design and Operational Safeguards

4.7.4.1 Introduction

In line with Step 4 of the *Draft Guidelines for Threatened Species Assessment* (DEC/DPI, 2005), the Applicant has designed the Proposal to minimise impacts on threatened species by avoiding, then mitigating and finally offsetting impacts. The following subsections present the design features, operational controls and management measures proposed to avoid, then minimise and then offset impacts on local flora and fauna.

Given the proposed direct impacts on the Silver-leafed Mountain Gum, impact avoidance, mitigation and offset measures specific to this species are referenced.

4.7.4.2 Avoidance of Impacts

The following impact avoidance measures have been adopted by the Applicant in the design of the Proposal. It is noted that these reflect many of the impact avoidance measures currently implemented at the quarry, however, these have been included as they are considered relevant to the overall assessment of the Proposal.

- The primary crushing station is located within the impact footprint of the extraction area, thereby avoiding the necessity for additional clearing for a separate location.
- No further extension of the processing or stockpiling areas is proposed.
- The Stage 2 extraction area has been modified and designed to avoid the core habitat areas of the Silver-leafed Mountain Gum (see **Figure 4.41**). Where possible, impacts on non-core occurrences of this species have also been avoided.
- Two small patches of Community C2 (Silver-leafed Mountain Gum mallee woodland) which have to date been excluded from the extraction area to act as a visual screen are planned to remain undisturbed for the life of the Proposal.

4.7.4.3 Minimisation and Mitigation of Impacts

In addition to the impact avoidance measures noted in Section 4.7.4.2, the following impact minimisation and mitigation would be implemented by the Applicant.

- By continuing to operate a conveyor between the primary crushing station and secondary processing area, the number of internal truck movements would be significantly reduced on the extraction area Access Road. By reducing the number of movements, the potential for road kill of native fauna would be greatly reduced.
- By establishing a 10m wide buffer around the proposed areas of disturbance, the potential indirect impacts of the Proposal are accounted for and can be appropriately offset (refer to Section 4.7.4.4). The outer boundary of the 10m wide buffer would also identify the edge of an exclusion zone, which would be enforced to prevent access to surrounding vegetation and therefore unforeseen impacts.

The adequacy of the 10m buffer is justified by Niche (2014a) on basis that the only unmitigated edge effect would be minor weed invasion, as a result of the altered microclimate, within 2m to 3m of the disturbance edge. The nominated 10m buffer therefore likely overstates and compensates for potential indirect impacts.

- Following completion of clearing operations, fence, as appropriate, sections of the Site not required for ongoing operations to limit access by non-authorised personnel.
- Undertake vegetation clearing operations, where practicable, between April and September to limit adverse impacts on tree dependent avifauna and microchiropteran bats.
- Salvage tree trunks, major limbs and, if practicable, minor branches for use in rehabilitation. If these material are stockpiled, signs would be erected noting the significance and importance of this material for future rehabilitation and habitat creation.
- The revegetation of the final landform has been designed to provide for the re-establishment of native vegetation communities over the overburden emplacement area, extraction area and secondary processing area (see **Figure 2.9**). Furthermore, and in line with the rehabilitation undertaken to date, the revegetation of the final landform would include the Silver-leafed mountain gum.
- The blended topsoil/subsoil would be directly translocated onto rehabilitation areas as often as possible to maximise the opportunity for retention of the natural seed stock, and thereby maximise the revegetation of the final landform with endemic species.
- A program of weed control would be undertaken, firstly to remove/reduce weeds in soils prior to soil stripping activities and secondly following re-vegetation to ensure native plants are not overgrown during their early periods of growth.
- Install appropriate erosion and sediment control measures prior to vegetation clearing activities (to reduce the potential for pollution of downstream riparian and aquatic habitat).
- Limit vehicle speeds within the Stage 2 Site to limit the potential for vehicle trauma to wildlife.

4.7.4.4 Offsetting of Impacts

In accordance with Step 4 of DEC/DPI (2005), the Applicant has proposed a Biodiversity Offset Area (BOA) to offset impacts on vegetation, fauna habitat and the Silver-leafed Mountain Gum population where these cannot be avoided or mitigated. Details of the proposed BOA are set out in Section 2.14, **Figure 2.11** and **Table 2.9**. The objective when defining the area and composition of the BOA is to achieve an outcome compliant with OEH (2011) and the minimum 90% direct offset benchmark of the EPBC Act Offsets Policy.

4.7.5 Impact Assessment

4.7.5.1 Introduction

This subsection assesses the residual impacts of the Proposal on terrestrial ecology, and in particular considers the adequacy of the proposed BOA and residual impacts on threatened flora and fauna (in accordance with Step 3 of DEC/DPI, 2005). This step involves identifying not only the magnitude and duration of impacts, but also the significance of the impacts as related to the conservation importance of the habitat, individuals and populations likely to be affected.

4.7.5.2 Biodiversity Offset Strategy

4.7.5.2.1 NSW Offsets Policy (OEH, 2011)

Niche (2014a) has used the BioBanking Assessment Methodology (BBAM) (DECC, 2008c), in accordance with the *NSW OEH Interim Policy on Assessing and Offsetting Biodiversity Impacts of Part 3A, State Significant Development (SSD) and State Significant Infrastructure (SSI) Projects* (OEH, 2011) (“the OEH Interim Policy”), to quantify the nature and extent of offsets required for impacts within the Site (the BBAM ‘Development Site’) and provide within the proposed BOA.

Tables 2.8 and **2.9** of Section 2.14 provide the output generated by the BBAM credit calculator for the Development Site and BioBank Site.

The following reviews the matching of credits between the Development Site and proposed BOA considered against the Tier 1 (‘Improve or Maintain’), Tier 2 (’No Net Loss’) or Tier 3 (‘Mitigated Net Loss’) benchmarks.

Tier 1 ‘Improve or Maintain’ Standard

<u>Ecosystem Credits:</u>

The proposed BOA achieves the “Improve or Maintain” benchmark for the following Revised Biometric Vegetation Type (RBVT).

- HN527: Forest Red Gum - Yellow Box woodland of dry gorge slopes, southern Sydney Basin and South Eastern Highlands (Communities C3 and C4)

The 134 credits generated by the Development Site would be retired against 439 credits of the BOA (leaving a surplus of 305 credits).

Of the 620 ecosystem credits required for HN570: Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest, 461 are provided by the proposed BOA and would be retired (leaving a deficit of 159 ecosystem credits).

The proposed BOA does not provide for vegetation equivalent to HN501: Apple Box - Broad-leaved Peppermint dry open forest resulting in a deficit of 148 ecosystem credits.

The availability of ecosystem credits on the Biodiversity Credit Market and the acquisition of alternative offset sites as methods to offset the small deficit at a Tier 1 ‘Improve or Maintain’ was reviewed by Niche (2014a). This review identified that there are currently no ecosystem credits available for purchase for either HN570 or HN501 within the Bathurst CMA sub-region or the adjacent CMA sub-regions.

Two equivalent RBVTs, providing 310 ecosystem credits, were identified within the Oberon and Wollemi CMA subregions, however, Niche (2014a) considers the acquisition of these or alternate offset lands unnecessary for the following reasons.

- The Threatened Species Profile of the three RBVTs that require offsetting (HN501, HN527 and HN570) are very similar. Combined, these require a combined 902 ecosystem credits. The combined ecosystem credits of HN570 and HN527 within the proposed BOA is 900. Therefore, if considered in relation to the value provided by the proposed offset to the threatened fauna likely to inhabit the area to be disturbed, Niche (2014a) consider the proposed BOA would provide an improve or maintain outcome in relation to threatened fauna.
- There is greater value to local biodiversity by providing for the offset in the same locality as the disturbance. That is, locally occurring threatened fauna would be provided with a conserved area immediately adjacent to the impact site, as opposed to within another catchment entirely, e.g. Oberon or Wollemi.
- The vegetation proposed to offset the ecosystem credit deficits is provided for by vegetation which is more highly cleared in the catchment, hence considered to be of greater conservation significance.

Further justification of this assessment based on the benefits of this local offset to threatened fauna, conservation levels in the proposed BOA and the classification of these RBVTs is provided in *Section 7.3.1* of Niche (2014a).

<u>Species Credits:</u>

The 11 100 species credits generated by the proposed BOA would achieve the Tier 1 benchmark with a surplus of 8 credits (11 100 – 11 092) (Niche, 2014a).

Tier 2 'No Net Loss' Standard

As none of the RBVTs are considered EECs, or over cleared within the Hawkesbury Nepean CMA region, they do not qualify as red flags and therefore Tier 2 does not apply.

Tier 3 'Mitigated Net Loss' Standards

<u>Ecosystem credits</u>

"Mitigated Net Loss" considers when the ecosystem credits generated by the Development Site are not provided for by the proposed BOA. Various assessment criteria are specified by OEH (2011) to enable determination as to whether the proposed BOA achieves the Tier 3 benchmark. The two RBVTs which do not meet a Tier 1 outcome (completely) are considered as follows.

- HN570: Red Stringybark - Brittle Gum - Inland Scribbly Gum dry open forest (deficit of 159 credits) (Communities C1 and C2).

  This deficit can be reconciled by retiring ecosystem credits against those surplus credits (305) of HN527 (which is of same Keith Formation and within the same IBRA bioregion - Criteria (a) of *Appendix B* of OEH 2011). The proposed BOA therefore provides for a mitigated net loss outcome for HN570.

- HN501: Apple Box - Broad-leaved Peppermint dry open forest (deficit of 148 credits).

  Niche (2014a) has calculated that the 148 ecosystem credit deficit for HN501 is equivalent to an area of 16ha (in accordance with the OEH Credit Converter applied in accordance with Criteria (d) or (e) of *Appendix B* of OEH (2011). HN527 and HN574 (for which surplus credits remain) generate 11.8 credits/ha (542 credits created over 46.1 hectares) requiring 189 ecosystem credits (16 x 11.8) from either to be retired. As 249 surplus ecosystem credits are available from HN527 and HN574 combined, the proposed BOA provides for a mitigated net loss outcome for HN501, with a surplus of 60 ecosystem credits.

On the basis of the above, the proposed BOA achieves the Tier 1 ‘improve or maintain’ benchmark for 66% and Tier 3 (mitigated net loss) for 34% of the native vegetation that would impacted by the Stage 2 Extension.

Evaluation against OEH Offset Principles

The following considers the adequacy of the proposed Biodiversity Offset Strategy against the seven principles nominated in the *Draft Biodiversity Offsets Policy for Major Projects* (OEH, 2014).

1. **Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.**

   Section 4.7.4.2 considers the impact avoidance measures incorporated into the design of the Proposal. In particular, the impact on the Silver-leafed Mountain Gum has been minimised through avoidance of core habitat areas. Section 4.7.4.3 nominates the measures that would be implemented to further minimise or mitigate the impact footprint of the Proposal.

   There are no other practically applicable measures available to the Applicant to further reduce the direct impact footprint or potential for indirect impacts. Notably, the offset accounts for the 2.5ha buffer area surrounding the direct impact footprint.

2. **Offset requirements should be based on a reliable and transparent assessment of losses and gains.**

   The development and assessment of the proposed BOA has been undertaken in accordance with BBAM, considered best practice by OEH (2014).

3. Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.

The proposed BOA meets the Tier 1 (Improve or Maintain) benchmark for the majority (66%) of the vegetation impacted and for disturbance to Silver-leafed Mountain Gum in its entirety. The remaining 34% of vegetation impacted would meet the Tier 3 (Mitigated Net Loss) benchmark in accordance with the various criteria of OEH, (2011). The Proposal therefore provides for:

– direct like-for-like offsetting for the majority of the vegetation impacted;

– equivalent vegetation formation for a proportion of the remaining area (HN570); and

– an appropriate quantum of vegetation for the remainder (HN501).

In the case of HN501, the vegetation assigned to retire the credit deficit (HN527 and HN574) are both more highly cleared (50% and 40%) than this RBVT (30%) and therefore of higher conservation value.

Justification for not obtaining available ‘like for like’ ecosystem credits more distant from the Stage 2 Site is provided in the discussion on Tier 1, 2 and 3 Standards.

4. Offsets must be additional to other legal requirements.

It is noted that the area of the proposed BOA is not held under any other agreement (conservation or otherwise) nor is it currently used for offsetting other disturbance. Notably, a conservation area previously established in accordance with the condition of DA 93/104 for the purpose of conserving Silver-leafed Mountain Gum (refer to **Box 2.1**) has been excised from the proposed BOA and not included in any credit calculations. The conservation value of this area would, however, be enhanced by the conservation of the surrounding vegetation by way of Voluntary Conservation Agreement (VCA), addition to OEH estate, BioBanking Site, covenant on title, or other means.

5. Offsets must be enduring, enforceable and auditable.

At this time, the mechanism for conserving the proposed BOA, e.g. through VCA, BioBanking Site, covenant on title, etc. has not been formalised. However, once an in-principle agreement for the BOA is obtained from the consent authority, the Applicant would implement an ‘in perpetuity’ conservation arrangement.

6. Supplementary measures can be used in lieu of offsets.

The calculations of Niche (2014a) confirm that the land-based offset would be sufficient and practical, and therefore supplementary measures are not required.

7. **Offsets can be discounted where significant social and economic benefits accrue to NSW as a consequence of the proposal.**

   The calculations of Niche (2014a) confirm that the land-based offset would be sufficient and practical, and therefore there is no necessity to discount the offset to account for social and economic benefits.

4.7.5.2.2 Commonwealth Environmental Offsets Policy

The *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (the 'EPBC Offset Policy') was applied to the Proposal as potential impacts on the Silver-leafed Mountain Gum were considered to be significant enough to warrant determination of the Proposal as a 'Controlled Action'. The EPBC Offsets Policy promoted by the Commonwealth Department of the Environment (DoE) was followed to address its five key aims.

- To ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act.
- To provide greater certainty and guidance on how the offset was developed.
- To deliver improved environmental outcomes.
- To outline the appropriate nature and scale of offsets and how it was determined.
- To provide guidance on acceptable delivery mechanisms for offsets.

Niche (2014a – *Section 8*) provides a detailed review of the various parameters and factors required to be considered and quantified in accordance with the DoE publication "*How to use the Offsets Assessment Guide*" (DSEWPaC, 2012). In summary, the proposed BOA would protect and manage in perpetuity for conservation 1 850 naturally occurring individual plants representing a 257% offset of the impact to 721 plants (the vast majority of which [631] have been planted as part of the rehabilitation of the Stage 1 overburden emplacement). The conservation value of the offset, which is located within intact remnant habitat, is therefore far higher than the majority of the disturbance (to Silver-leafed Mountain Gum), within recently established rehabilitation areas.

Evaluation against DoE Offset Principles

The Commonwealth Offsetting Policy (DSEWPaC, 2012) lists eight requirements that must be met in order to achieve a suitable offset for impacts on threatened biodiversity as listed within the EPBC Act. The eight requirements are considered below in relation to the provision of the proposed offset for *Eucalyptus pulverulenta*. These requirements reflect closely the OEH Offset Principles addressed in Section 4.7.5.2.1.

1. **Suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter.**

   The calculations of Niche (2014a) confirm that the land-based offset would provide well in excess of the 90% requirement of the Commonwealth Offsetting Policy.

2. **Suitable offsets must be built around direct offsets but may include other compensatory measures.**

   The calculations of Niche (2014a) confirm that the land-based offsets provide an 'improve or maintain' outcome for Silver-leafed Mountain Gum and therefore, other indirect measures are not required.

3. **Suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter.**

   The 1 850 Silver-leafed Mountain Gum individuals within the proposed BOA provides a direct like-for-like species offset for the 721 individuals that would be removed. Application of the Commonwealth Offsetting Policy Offsets Calculator confirms this achieves an offset value in excess of 250%.

4. **Suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter.**

   The scale of the offset, as compared to the impact, has been calculated by the EPBC Offsets Calculator at 257%, i.e. the proposed offset is 2.5 times larger in terms of the number of individuals required.

5. **Suitable offsets must effectively account for and manage the risks of the offset not succeeding.**

   The offset site will be subject to good governance arrangements to ensure it is managed and secured 'in perpetuity'. At this time, the mechanism for conserving the proposed BOA, e.g. through VCA, BioBanking Site, covenant on title, etc. has not been formalised. However, once acceptance of the BOA is obtained from the consent authority, the Applicant would implement an in perpetuity conservation arrangement.

6. **Suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs.**

   It is noted that the area of the proposed BOA is not held under any other agreement (conservation or otherwise) nor is it currently used for offsetting other disturbance. Notably, a conservation area previously established in accordance with the condition of DA 93/104 for the purpose of conserving Silver-leafed Mountain Gum has been excised from the proposed BOA and not included in any credit calculations. The conservation value of this area would, however, be enhanced by the conservation of the surrounding vegetation by way of Voluntary Conservation Agreement (VCA), addition to OEH estate, BioBanking Site, covenant on title, or other means which would guarantee the security and management of the BOA into perpetuity.

7. **Suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable.**

   The EPBC Act Offsets Assessment Guide was utilised in this assessment to assess the proposed offset to the impacts on Silver-leafed Mountain Gum. Furthermore, all survey effort met the draft survey guidelines as required by OEH (DEC, 2004) and all data collected during the assessment has been supplied. The assessment is therefore transparent, scientifically robust and reasonable.

8. **Suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.**

   The offset site will be subject to good governance arrangements to ensure it is managed and secured in perpetuity. Appropriate plans of management would be developed, including monitoring, and legal security would be guaranteed through a suitable planning mechanism such as a VCA, BioBanking Agreement, covenant on title, or other means.

   At this time, the mechanism for conserving the proposed BOA, however, once an in-principle agreement of the BOA is obtained from the consent authority, the Applicant would implement an in-perpetuity conservation arrangement.

4.7.5.3 Clearing of Native Vegetation

The clearing of approximately 26.5ha native vegetation is the main ecological impact that would result from the Proposal, as it would lead to a reduction in available habitat for a number of threatened species which currently utilise the Stage 2 Site.

Magnitude of Impact

Table 2.8 summarises the approximate areas of each vegetation community within the Stage 2 Site to be cleared. Notably, no EECs would be cleared, nor are any of the RBVTs to be disturbed over cleared (>70%) in the Hawkesbury Nepean CMA region.

Duration of Impact

The duration of the impacts is a consideration of the permanence and reversibility of impacts and considers both the resilience of the vegetation cleared and proposed mitigation measures proposed. Resilience is a measure of the capacity of an area to naturally regenerate.

The affected vegetation communities are moderately to highly resilient as they are composed of relatively intact and natural soil profiles and are therefore likely to contain diverse soil seed banks. Remnants of each of these communities remain in the local area, upon which genetic material would be drawn in the expansion of these communities within the final landform and conservation and amelioration areas. Whilst the resilience of the remnant bushland to be removed would be reduced, the proposed mitigation measures nominated in Section 4.7.4.3, which include soil translocation, revegetation using locally endemic species, management of weeds, and erosion and sediment control would aid to re-establish ecological structure and function. Tubestock of the threatened Silver-leafed Mountain Gum propagated from seed collected on site would continue to be a component of this rehabilitation work.

Significance of Impacts

The significance of impacts consider both aspects related to the vegetation communities themselves, i.e. relative distribution, importance as habitat to threatened species, regional and local representation, as well as the mitigation and offset measures proposed.

The vegetation to be cleared is typical of that on and surrounding the Stage 2 Site and within the local area and region. Notably, there would be no clearing of EECs or over cleared vegetation types with the residual impacts on vegetation offset by the proposed BOA to achieve a Tier 1 (66%) improve or maintain and Tier 3 (34%) mitigated net loss outcome for biodiversity.

On the basis of the above, the impact is considered significant but appropriately mitigated and offset in regards to State and Commonwealth policies and guidelines.

4.7.5.4 Impacts on Habitat Corridors

The Stage 2 Site forms part of a larger east-west habitat corridor linking vegetation on and to the west of the Stage 2 Site with vegetation contained in OEH estate to the east (Blue Mountains National Park) and north (around Hartley). Notably, these corridors are threatened by residential and rural-residential development with the Little Hartley area.

The vegetated corridor of the Coxs River which adjoins to the Stage 2 Site to north is approximately 100m wide. This corridor contains some property infrastructure and roads, reducing the habitat connectivity, but would not be affected further by the Proposal. To the south of the extraction area and overburden emplacement is a more intact vegetated corridor of approximately 320m wide. The proposed extension of the extraction area and overburden emplacement would reduce this to approximately 110m, although reinstatement of the corridor would follow rehabilitation. Notably, the width of the corridor would remain within the 100m to 500m class, and the over-storey and mid-story/groundcover condition within the connected landscape would remain at benchmark levels, when considered using the BioBanking Assessment Methodology and Credit Calculator Operational Manual (DECC, 2009). Therefore, considered against the standards nominated by DECC (2009), the corridor remains within the same condition class.

The fact that the corridor remains within the same condition class notwithstanding, Niche (2014a) has further reviewed the effects of this corridor reduction on local fauna. Mobile fauna, such as large mammals, are unlikely to be affected, however, there may be some temporary reduction in the movement of small non-mobile animals and arboreal fauna. This impact is more than compensated for by the conservation provided for by the BOA, which includes the southern habitat corridor.

4.7.5.5 Key Threatening Processes

The Proposal is likely to exacerbate the following key threatening processes (KTPs) listed under the TSC Act and EPBC Acts:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.