Appendix 6

Surface Water Assessment

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THE AUSTRAL BRICK COMPANY PTY LIMITED

ABN: 52 000 005 550

New Berrima Clay/Shale Quarry

Revised Surface Water Assessment

Prepared by

Strategic Environmental and Engineering Consulting (SEEC)

March 2015

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New Berrima Clay/Shale Quarry

Revised Surface Water Assessment

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EXECUTIVE SUMMARY

Austral Brick Company Pty Limited proposes to lodge an application to modify its existing approval PA-08-0212 to quarry clay and shale from the New Berrima Quarry, located in the NSW Southern Highlands. The modified Project ('the Proposal') would include the following components, principally within and surrounding the modified extraction area:

- Relocation of the extraction area to a location within the clay/shale resource boundary with access to higher quality materials than the approved extraction area.
- Construction of appropriately located visibility barriers (constructed progressively).
- Relocation and replacement of water management / sediment dams and related water diversion structures.

SEEC undertook the Surface Water Assessment that accompanied the application for Project Approval in 2010 and has re-assessed the potential surface water impacts associated with the Proposal which includes an extraction area, surplus overburden stockpile, visibility barriers and associated infrastructure, with a total area of disturbance of approximately 16ha, with the revised extraction area disturbing 11.7ha in total.

The assessment requirements of both the original Director-General's Requirements (DGRs) (dated 21st November 2008) and the combined requirements of the new Government agencies Department of Planning and Environment (17/12/2014), (Environment Protection Authority (13/01/2015), Department of Primary Industries Office of Water (21/01/2015), Office of Environment and Heritage (06/01/2015) and Water NSW (07/01/2015)) have been taken into account. It is noted that no new requirements were identified by the government agencies.

The primary issue that has the potential to affect surface water as a result of the Proposal is suspended sediment eroded from areas of exposed soil and clay/shale discharging to the surrounding areas. A series of revised sediment basins is proposed to settle out suspended sediment prior to discharge (with the aid of flocculants, if necessary). Sediment basins have been designed in accordance with best-practice guidelines for NSW. Where possible, upslope clean water would be diverted away from work areas.

Water that collects in the sump within the extraction area would be pumped directly into a water truck or to a dedicated storage dam for use in dust suppression activities. Excess water in the extraction area would either infiltrate into the strata below, evaporate and/or be discharged to receiving waters (after flocculation, if necessary).

Water demand for the Quarry is low and is limited to that required for dust suppression and washdown, if necessary. Potable water supply for the workers and their ablutions would be sourced from imported water stored in a potable water tank on site. Water balance modelling included in this assessment shows the water demand is easily met by the harvestable right; no licences are required.

The Proposal is unlikely to have a negative impact on the quantity of water discharged to the receiving waters as all water demands for the Quarry can be achieved within the harvestable right volumes available. In fact, the total volume of water leaving the Project Site would increase marginally due to local increases in the volumetric coefficient of runoff.

Although the Project Site is in relatively close proximity to the Wingecarribee River, it is unlikely to have a significant impact on water quality. All disturbed lands that might generate sediment-laden runoff would ultimately drain to a series of sediment basins and a management and monitoring regime is proposed to ensure the quality of any discharge is within prescribed guidelines levels prior to discharge. Section 6 of this assessment includes a series of commitments designed to address and mitigate the identified risks to surface water.

1. INTRODUCTION

Austral Brick Company Pty Limited proposes to amend its existing approval PA-08-0212 to quarry clay and shale from the New Berrima Quarry, located in the NSW Southern Highlands (**Figure 1**). The modified Project ('the Proposal') would include the following components (as outlined on **Figure 2**), principally within and surrounding the modified extraction area:

- Relocation of the extraction area to a location within the clay/shale resource boundary with access to higher quality materials than the approved extraction area.
- Construction of appropriately located visibility barriers (constructed progressively).
- Relocation and replacement of water management / sedimentation dams and related water diversion structures.

SEEC (Strategic Environmental & Engineering Consulting (SEEC) Pty Ltd) have been commissioned by The Austral Brick Company Pty Limited to revise the surface water assessment submitted to support the original application for Project Approval (SEEC, 2010). This revised assessment serves to identify specific surface water-related constraints and opportunities that might affect the proposed project's design, establishment, operation and post-operative rehabilitation. An integrated water management strategy is also included. The assessment contains:

- a review of the existing surface water conditions on the Project Site and within its local environs;
- a field survey of the landforms on the Project Site and on the surrounding lands;
- an investigation into the existing hydrology and runoff/infiltration characteristics of the Project Site;
- the results of limited water quality testing in local watercourses to be used as a baseline for future water quality monitoring;
- an assessment of the potential impacts of the proposed development on the local surface water conditions, including downstream impacts; and
- a water balance for the Project Site that identifies the supply and demand for the quarry's operational phase.

A field investigation was conducted by SEEC staff during August 2008 to investigate the existing hydrology of the Project Site and to collect soil samples. Water sample collection occurred on 22 August 2008.

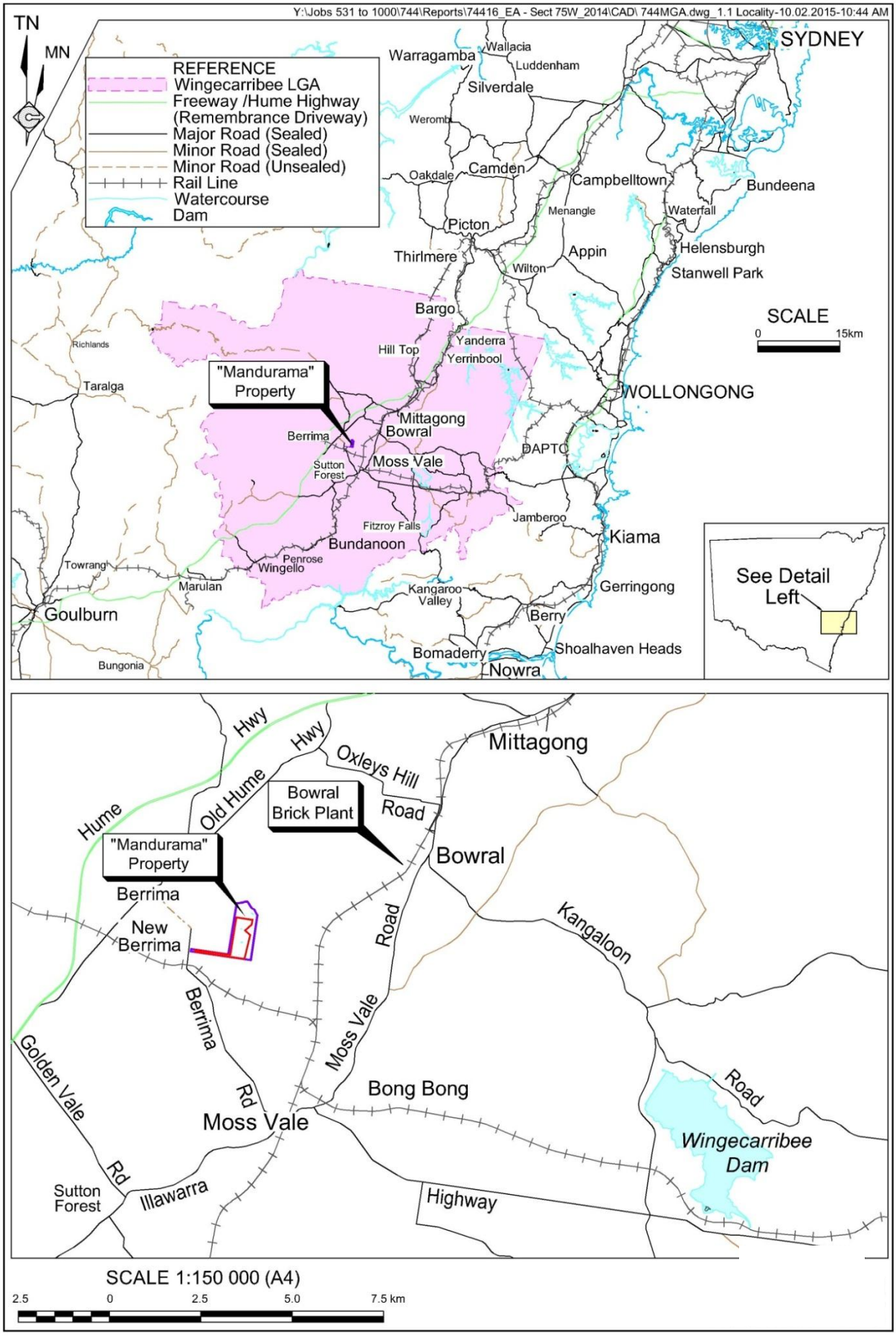

Figure 1 – Project Site Locality

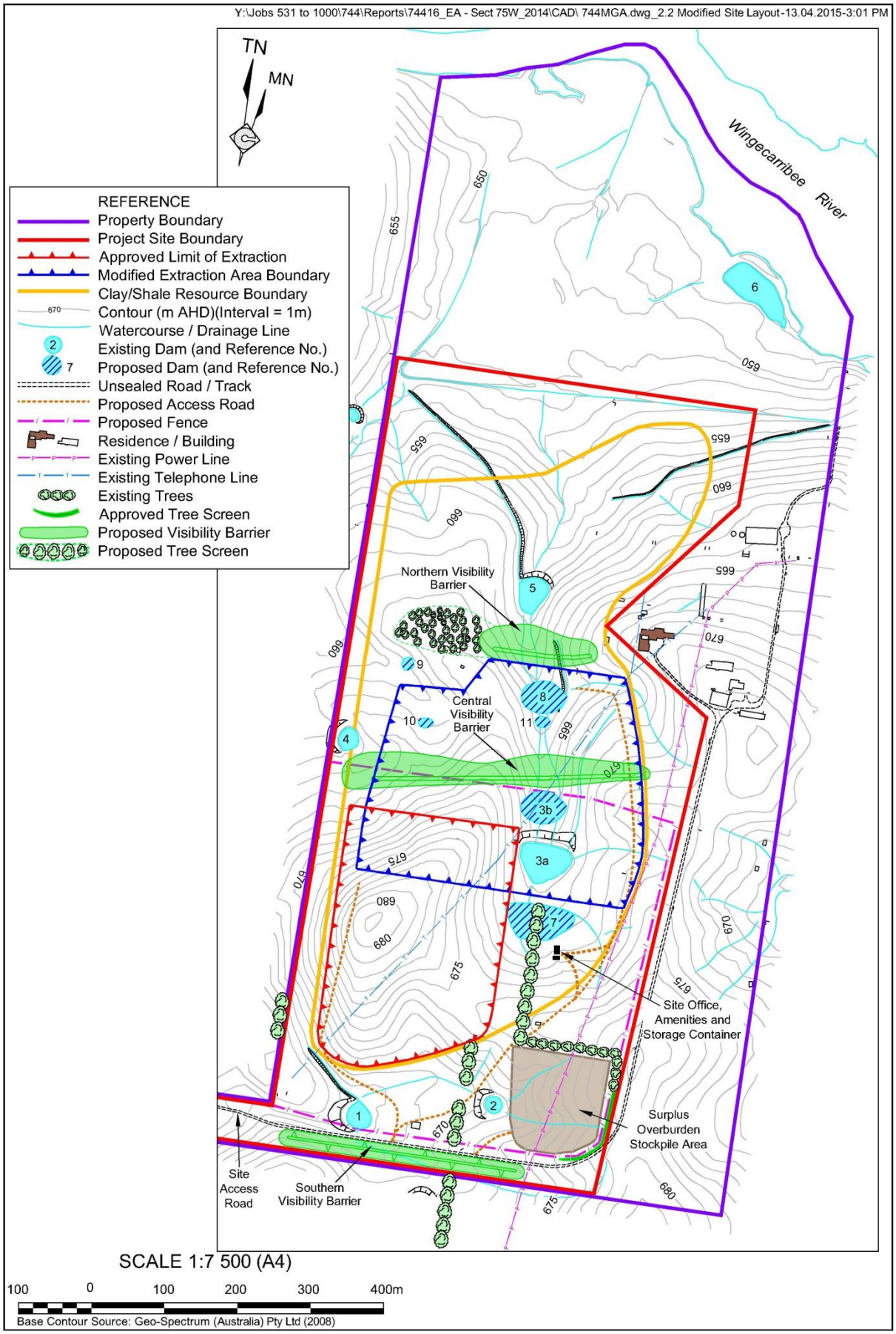

Figure 2 – Modified Site Layout

2. PROJECT OVERVIEW

2.1 PROJECT SITE

The Project Site is approximately 51ha in area and is wholly contained within the 100.2ha "Mandurama" property, namely Lot 1 DP 414246, 1 Berrima Road, New Berrima. The land is owned by The Austral Brick Company Pty Limited. The Project Site incorporates the optimum clay/shale resource area on the "Mandurama" property and the Site access road between the property entrance and the modified extraction area.

The entrance to the "Mandurama" property is located on Berrima Road approximately 300m north of the intersection of Taylors Road and Berrima Road, New Berrima. **Figure 1** provides a topographic map presenting the local setting around the subject property.

2.2 PROJECT DESCRIPTION

The Proponent seeks to extract shale, brick clay and some friable sandstone with an upper limit of 150 000tpa for a period of 30 years. The upper limit of 150 000tpa is sought to allow for fluctuations in the demand for product as determined by the production levels at the Bowral Brick Plant. The operation would employ approximately five part-time personnel for the duration of the project. The proposed project would involve a capital investment of approximately $1 million.

The extraction of the resource would be undertaken in two primary stages and, within them, a number of intermediate stages. This is principally to reduce the area of disturbance at any one time and to facilitate progressive rehabilitation of disturbed areas. Austral's principal raw material requirement at its Bowral Brick Plant is for the shale material within the defined extraction area. Whilst the overlaying weathered shale, clay and sandstone has uses in the manufacture of bricks, Austral anticipates that, at this time, only small quantities of the these materials would be extracted and transported to the Bowral Brick Plant, other Austral brick plants in the Sydney area or other sites requiring fill. For the purposes of this project, the materials transported from the extraction area are referred to as "product clay/shale".

The main features of the extraction operations would be:

- campaign stripping of topsoil and subsoil for use in the construction of visibility barriers and progressive Project Site rehabilitation;
- progressive construction of visibility barriers ;
- two or three extraction campaigns per year, each involving the excavation and stockpiling of the product clay/shale on the floor of the extraction area;
- a water management system to manage water collected in the extraction area and runoff from disturbed areas;
- full-time transportation of the product clay/shale to the Bowral Brick Plant.

3. STUDY AREA

The Surface Water Assessment Study Area is defined by the Project Site boundary as shown in **Figure 1** and is approximately 51ha**.** Included in this area is the modified extraction area and the Project Site access road. The Project Site access road comprises an 800m long access between the extraction area and Berrima Road. The Project Site itself includes:

- the extraction area (approximately 11.7ha total);
- visibility barriers;
- stockpiles of extracted product and surplus overburden material;
- water storage and sediment retention structures; and
- a storage area, workshop and lunchroom/amenities area.

The Study Area is located within the larger “Mandurama” property, owned by the Applicant and is approximately 110.2ha in size.

The transportation route between the Mandurama boundary and the Austral Brick Plant in Bowral is excluded from the Study Area. This aspect of the Proposal would not involve significant land disturbance and is, therefore, unlikely to significantly affect surface water.

Although the majority of this assessment focuses on the areas to be disturbed within the Project Site itself, comments are also included concerning the catchment conditions up and down stream of the quarry where water quality or flow might be affected. However, detailed assessments of external catchments are not included in this study. Catchment boundaries are discussed further in Section 4.4.

4. SITE CONDITIONS

4.1 TOPOGRAPHY

The Study Area comprises gently undulating rises and low hills with average slopes between 1:25 (V:H) and 1:10 (V:H). Elevation ranges from 651m AHD in the northwest corner of the Study Area to 681m AHD where the modified extraction area is located. The land slopes in a generally northerly direction towards the Wingecarribee River (**Figure 2**).

4.2 LAND USE

The entire Study Area has been disturbed previously and is presently used for grazing or fodder on improved pastures. The majority of the land is completely cleared with only a few scattered native trees and several rows of exotic species. There are five existing farm dams within the Study Area which are presently used for watering livestock.

4.3 SOILS

4.3.1 Soil Landscapes

The Project Site is dominated by well-structured clay soils of the Moss Vale Soil Landscape (SCA/DLWC, 2002). The Moss Vale Soil Landscape comprises low hills and rises on shale and is generally moderately well drained. Further details are outlined in the Soil and Land Capability Assessment by Geoff Cunningham, Natural Resource Consultants Pty Ltd (2010) and Section 4.8 of the Environmental Assessment.

4.3.2 Soil Testing

Soil tests were undertaken in 2008 on a representative subsoil sample collected in the location of the proposed quarry to determine soil characteristics for erodibility, sediment basin sizing and dispersion. In addition to field observations regarding soil structure and profile drainage, the following laboratory tests were conducted.

- PSA = Particle size analysis (both chemically dispersed and non-chemically dispersed)
- DP = Dispersion percentage
- EAT = Emerson aggregate test
- OC = Organic carbon percentage

Table 1 contains the results of laboratory testing. The results show the soils contain a significant proportion of highly-aggregated clay that does not readily disperse under natural conditions. The chemically-dispersed sample contained 33% clay, which was not identified in the non-dispersed sample. In the non-dispersed sample, the clay particles remained strongly aggregated.

Table 1 – Laboratory Test Results for a Representative Subsoil Sample

Sample	Particle Size Analysis						DP (%)	EAT	OC (%)
	Clay (%)	Silt (%)	Very fine sand (%)	Coarse-fine sand (%)	Coarse sand (%)	Gravel (%)			
Chemically-dispersed	33	18	21	12	6	10	0	6	0.37
Non-chemically dispersed	0	29	36	9	16	10			

Based on the results in **Table 1**, soils have a K-factor (soil erodibility factor) of 0.064, which is high (Rosewell and Edwards, 1988). Soils were not identified as being *significantly dispersible* as determined by the methodology in Landcom (2004) (The "Blue Book"). For the purposes of sediment basin design, soils are Type F (fine) – i.e. they require total storm capture structures for sediment retention prior to discharge (Landcom, 2004).

The strongly aggregating nature of the soils means that chemical dust suppressants are unlikely to be necessary as the risk of discrete soil particles becoming airborne is low.

4.3.3 Soil Loss and Erosion Hazard

The annual soil loss was calculated using SOILOSS 5.3 (Rosewell, 2005), which is based on the Revised Universal Soil Loss Equation (RUSLE). For the purposes of this analysis, the following inputs were used (Landcom, 2004).

- R-factor (rainfall factor): 2580 in Rainfall Zone 7.
- K-factor of 0.064.
- Average slope gradient of 6.5% (1:15 V:H) and a slope length of 80m.
- A rill:interill ratio of 3:1.
- P-factor (Conservation practice) of 1.3 (i.e. assuming no specific conservation practices).
- C-factor (Ground cover factor) of 1.0 (i.e. assuming bare soils).

This produces a calculated soil loss of 225t/ha/yr within the Study Area, which is Soil Loss Class low (Landcom, 2004).

4.4 DRAINAGE

4.4.1 Drainage Lines and Catchments

The modified extraction area occupies the northern extent of the extraction area hillcrest position with radial drainage primarily towards the north and east. Although all surface runoff from the Project Site ultimately reaches the Wingecarribee River, three small catchments are present within the Project Site. These are shown in **Figure 3** and are labelled as Catchments A, B and C respectively.

Catchment A drains approximately 27ha within the Project Site boundary. Only a small area within Catchment A drains onto the Project Site from upslope; for the most part, the watershed of Catchment A is wholly within the Project Site. There are no defined channels within Catchment A, all drainage is via open grassy depressions.

Catchment A drains into a man-made lateral drain, the position of which is shown in **Figure 3**. It is assumed this was constructed in the past to reduce waterlogging of the low-lying, flat areas adjacent to the river and so to permit grazing. This drain diverts flow into Catchment B.

Catchment B drains approximately 11.4ha of the Project Site via a series of open grassy depressions. There is no run-on to the Project Site from external lands in Catchment B. Flows in Catchment A are diverted into Catchment B at the Project Site's northern boundary as shown in **Figure 3**.

Catchment C drains approximately 12.7ha of the Project Site via a series of open grassy depressions. These join Stony Creek before eventually entering the Wingecarribee River (**Figure 3**). Approximately 5.8ha upslope of the Project Site in Catchment C drains into Catchment A but this area would be diverted by the southern visibility barrier. The proposed Site access road connecting the extraction area with Berrima Road traverses Stony Creek as shown in **Figure 3**.

4.4.2 Existing Dams

There are five existing farm dams within the Project Site and one off-site but on the northern boundary of the property (Dam 6). All appear to be structurally sound and capable of holding water. None exhibited obvious signs of leakage through their walls. The existing farm dams are numbered on **Figure 2** and their estimated capacities are shown in **Table 2**. The combined capacity of these existing dams exceeds the Harvestable Right Capacity of 8.52ML. However, they were all built before 1999 (CMA, 1985) and have been used for stock purposes and so they have not required a licence. Nevertheless, these dams would be included in any assessment to build additional dams (Section 5.2).

Table 2 – Existing Dam Sizes

Structure Number	Approximate Surface Area (m^2)	Assumed Capacity (ML)
1	950	1.43
2	460	0.69
3	2,960	4.44
4	670	1.00
5	1,570	2.36
6	3,000	2.50
Total	9,610	12.42

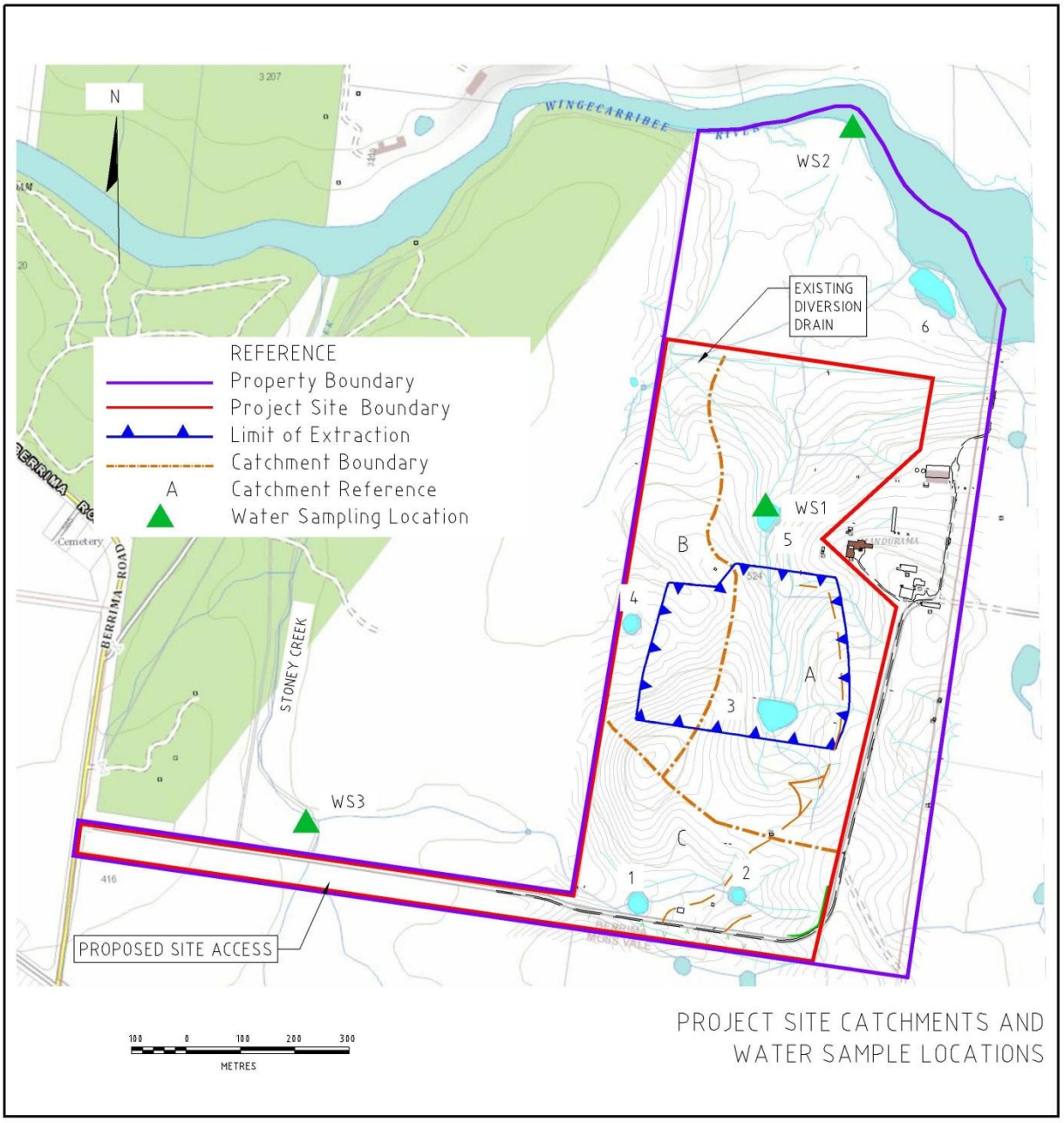

Figure 3 – Project Site Catchments and Water Sample Locations

4.5 EXISTING WATER QUALITY

Water samples were collected on 22 August 2008 at the three locations shown on **Figure 3**. They were tested for the following parameters.

- pH
- Electric Conductivity
- Total alkalinity
- Chloride
- Sulphate
- Ion Balance
- Total Nitrogen
- Total Phosphorus
- Iron
- Major Cations
- Total suspended solids

The results of laboratory testing are summarised in **Table 3.** These results would be used as part of the baseline water monitoring data during operation of the Quarry.

Table 3 – Results of Water Quality Testing

Parameter	Units	Sample Point 1	Sample Point 2 (the river)	Sample Point 3
pH in water	pH units	7.7	7.5	7.8
Electric Conductivity (EC)	uS/cm	393	102	396
Total alkalinity	mg/L	76	27	89
Chloride	mg/L	60	15	55
Sulphate	mg/L	2	<2	26
Ion Balance				
Anions total	me/L	3.0	0.9	3.6
Cation total	me/L	3.2	0.9	3.8
Percent Difference	%	6.5	-	5.4
Total Nitrogen	mg/L	7.3	0.2	<0.1
Total Phosphorus	mg/L	0.2	0.02	0.03
Iron	mg/L	7.92	0.82	0.45
Major Cations				
Calcium	mg/L	13.6	4.0	34.6
Magnesium	mg/L	7.9	2.9	6.8
Sodium	mg/L	26.9	10	29.5
Potassium	mg/L	27.1	1.2	8.4
Total suspended solids	mg/L	32	11	4

4.6 FLOODING

Flood modelling has not been done for the Study Area but geomorphic site conditions suggest overbank flows from the Wingecarribee River could inundate the low-lying plains immediately north of the Project Site. However, the modified extraction area, and all associated infrastructure, lie on gently undulating lands that appear to be well above the historic flood level.

4.7 VEGETATION

The majority of the Study Area is completely cleared with only a few scattered native trees and several rows of pine trees and other exotic trees. The remaining lands are under improved pasture and are used for grazing cattle.

4.8 CLIMATE

4.8.1 Rainfall

The Moss Vale (Hoskins Street) rainfall station (Bureau of Meteorology Station 68045) is the closest station geographically to the Project Site with a reliable and relatively complete rainfall record exceeding 100 years. 138 years of data were available, from 1870 to 2008, giving an annual average rainfall of 965.6mm/yr.

Data from the Moss Vale (Hoskins Street) rainfall station were selected to represent the typical climate conditions expected at this Project Site. An analysis of the monthly rainfall pattern is included in **Table 4** and **Figure 4**, showing that rainfall is fairly consistent throughout the year but with a slight trough in late winter and early spring. The period 1870 to 2008 includes significantly wet and dry periods, so can be considered a good representation of the long-term average for this Project Site.

Table 4 – Monthly Average Rainfall Values for Moss Vale (Station 68045)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Rainfall (mm)	89.3	95.3	90.3	81.3	84.9	100.4	76.1	63.6	60.4	74.8	72.9	76.3	89.3

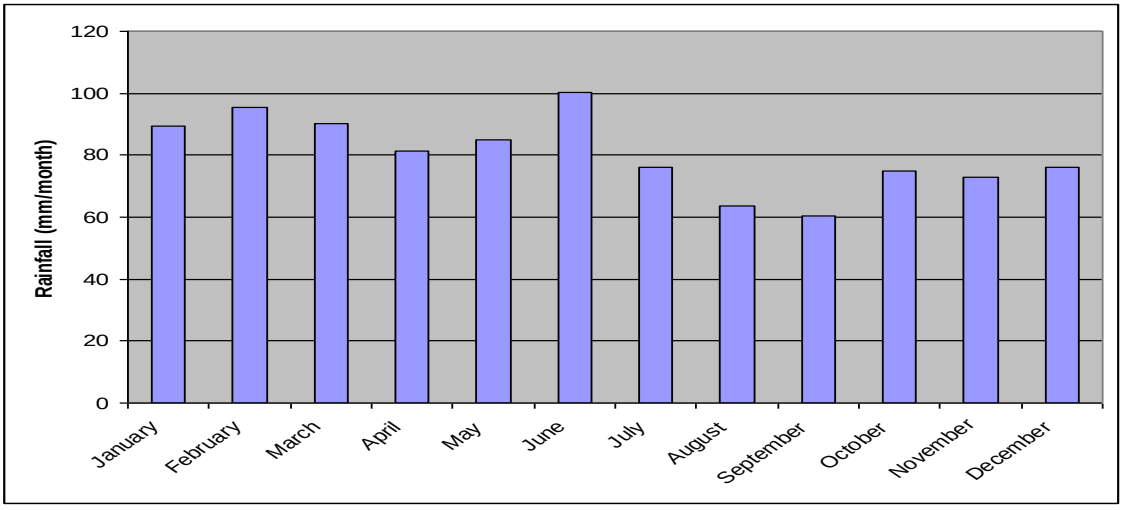

Figure 4 – Monthly Average Rainfall Values for Moss Vale (Station 68045)

4.8.2 Evaporation

The closest meteorological station collecting evaporation data is at Goulburn (Bureau of Meteorology Station 70263), approximately 65km to the west-south-west. **Table 5** and **Figure 5** show an analysis of the average daily evaporation occurring in each month. **Figure 5**

shows evaporation is significantly greater in the summer months. Although Goulburn has significantly different annual average rainfall to Moss Vale (640mm vs 968mm), potential evaporation is considered to be comparable because they are at similar elevations (Goulburn 670m AHD, Project Site 653 to 681m AHD) and they are only 65km apart.

Table 5 – Mean Monthly Evaporation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Evaporation (mm)	6.4	5.4	4.1	2.6	1.6	1.1	1.2	1.9	2.8	3.9	4.9	6.1	3.5

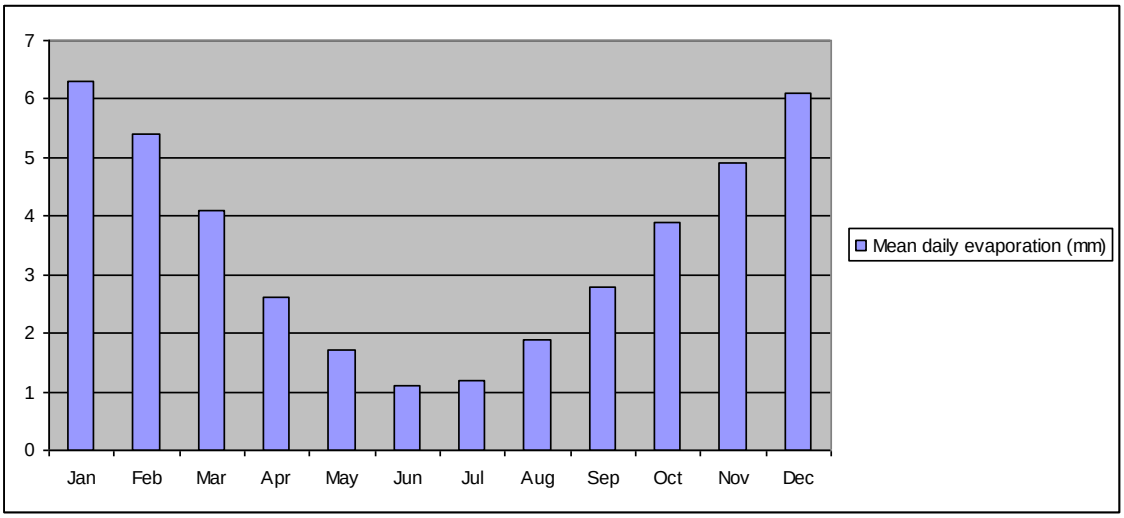

Figure 5 – Mean Daily Evaporation (mm/day) by month

5. SURFACE WATER IMPACT ASSESSMENT

5.1 CATCHMENT AREA CHANGES

The proposed quarry would affect the boundary between Catchments A and B but not Catchment C; **Figure 3** and **Table 6**.

Table 6 – Changes to Catchment Areas due to the Quarry Extraction Area

Catchment	Affected Catchment Area due to the Quarry Extraction Area (ha)
A	7.1
B	3.6
C	0

The existing dams would remain and be supplemented by a number of new dams and storages, some of which would be used for a short time only. In all, there would be 11 dams or storages used throughout the Project's life; these are discussed below and in more detail in Section 6.3.2.

5.2 HARVESTABLE RIGHT

NSW harvestable right legislation permits landholders to build a certain volume of dams without requiring a licence. The total volume is called the Harvestable Right (HR) and there are two factors that determine it for a parcel of land:

- The property's geographical location; and
- The size of the property.

The 100.2ha property was assessed using the harvestable right dam calculator at http://www.water.nsw.gov.au/Water-Licensing/Basic-water-rights/Harvesting-runoff/Calculator/default.aspx on 13th March 2015. The calculator shows the Property has a harvestable right of 8.52ML. This is already exceeded by the existing dams (Section 4.4.2) but:

- Dams 1 and 4 (combined capacity = 2.12ML) would, at some time during the life of the quarry, be sediment basins for the purpose of maintaining water quality. However, at other times they will remain for agricultural purposes so their volume is included in the HR calculation.

- Dam 2 would be enlarged and used for the purpose of maintaining water quality (i.e. it would be a sediment basin). Water detained in it would not re-used but would be released to downstream waters (after treatment if necessary). Therefore, it is exempt from the HR calculation.

- Dams 3 and (initially) Storage 3b would be used as sediment basins for the purpose of maintaining water quality. Water detained in them would not re-used but would be released to downstream waters (after treatment if necessary). Therefore, they are exempt from the HR calculation.

- Once the extraction area becomes internally-draining, Storages 3b and 8 would be sumps within the extraction area. These storages would be environmental storages to prevent dirty water entering receiving waters. Therefore, they would be exempt from the HR calculation. However, a portion (<17%) of this water would be pumped to Dam 7 for use as dust suppressant and washdown water. The remainder would remain in the extraction area and be infiltrated, evaporated or released to receiving waters (after flocculation if necessary).

- Dams 9, 10 and 11 would be constructed for the purposes of maintaining water quality (i.e. they would be sediment basins). Water detained in them would not re-used but would be released to downstream waters (after treatment if necessary). Therefore, they are exempt from the HR calculation.

- Dam 7 would be located south of the Extraction Area and be elevated above its southern perimeter. It would have two purposes:

    - To intercept run-on to prevent it entering the extraction area (for safety reasons); and
    - To store water for dust suppression.

    Dam 7's total volume would be 6.94ML of which 5.4ML of that would be available to collect the potential 24-hour/100 year storm event from its own catchment and 1.54ML would be used to store water for dust suppression. The 1.54ML would be part of the HR calculation. Water would be pumped to Dam 7 from storages 3b or 8 as necessary. However, to maintain a void of 5.4ML, water in Dam 7 would be released after most rainfall events (after treatment if necessary).

- Dam 5 would, for one short time in Stage 2, be a sediment basin but it would likely be used for agricultural purposes. Therefore, its volume (2.36ML) is part of the HR calculation.

- Dam 6 (off the Project Site but on the Property (Figure 3)) would be unaltered and used for agricultural purposes. Therefore, its volume (2.5ML) is part of the HR calculation.

In summary, the dams (and their capacities) that are included within the HR calculations are:

- Dams 1 and 4 (total 2.12ML)
- Dam 5 (2.36ML – likely agricultural purposes only)
- Dam 6 (2.50ML)
- Dam 7 (only 1.54ML).

In total, the combined capacity of the dams that would be used is 8.52ML, equalling the permissible harvestable rights volume. It is noted that any water not used for quarrying purposes would be allocated to other agricultural purposes within the Mandurama property.

How the dams and storages are used throughout the Project's life is discussed in more detail in Section 6.3.1.

5.3 POTENTIAL WATER QUALITY IMPACTS

5.3.1 Sedimentation

The Proposal involves disturbing a total of approximately 16ha to establish the extraction area, visibility barriers, quarry infrastructure and a surplus overburden stockpile. Of this 16ha, only 4ha of additional land would be disturbed as a direct result of the Proposal, accounting for the slighty larger footprint of the revised extraction area (11.7ha) to that approved within RWC (2010) (7.7ha). Although not all 16ha would be disturbed at once, without appropriate mitigation and management measures, the Proposal could impact water quality in the Wingecarribee River.

The principal potential pollutant that could be generated by the Proposal is suspended sediment eroded from exposed areas, particularly during site establishment entering the local waterways. Stripping soil and stockpiling it or using it to create the visibility barriers would result in significant areas of exposed soil. However, this would quickly reduce to just the extraction area as the visibility barriers would be vegetated as soon as practicable for long-term stability. Similarly, sediment loss could occur during the initial construction of the Site access road, although that too would be reduced once it was stabilised with compacted gravel.

For the purpose of this report, two stages of the extraction area are considered separately. After the establishment of each stage, the only potential sources of sediment would be the extraction area, the surplus overburden stockpile and unsealed haul roads.

The Project Site has a number of existing dams that would be used as sediment basins with sufficient area to construct additional dams. The soil analyses in Section 4.3 indicate the soils are not significantly dispersible but if settlement of suspended solids could not be achieved by detention alone flocculation would be used to treat the water before discharge. Further details regarding the locations and management of sediment basins are contained in Section 6.3.1.

5.3.2 Onsite Effluent Management

The Project Site is not serviced by reticulated sewer. As a result, porta-loos would be provided for staff and visitors. These would be serviced regularly as required by a third-party contractor.

5.4 WATER BALANCE

5.4.1 On-site Water Demand

The Proposal has three demands for water:

- Staff requirements and ablutions.
- Dust suppression.
- Machinery washdown.

5.4.1.1 Amenities and Ablutions Supply

The site office and ablutions would be supplied by potable water imported by tanker or 20L bottles, i.e. no on-site water collected on-site would be used.

5.4.1.2 Dust Suppression

RW Corkery & Co. (2012) identified that 3,400 m^2 of haul roads would need dust suppression and that the daily water demand for that would be 17kL (used on dry days only). In reality trucks would not be operation all year round but, for the purpose of the calculations (Section 5.4.3), it is assumed they would.

5.4.1.3 Washdown

For the purpose of this assessment, the washdown water requirement would be minimal; however, if required, it is assumed that up to 2,000L/day would be required per day that the Quarry is operational, i.e. 90 days per year, for washdown and cleaning of machinery.

5.4.2 Water Supply

Water for dust suppression and washdown would be sourced from the permissible 1.54ML storage volume in Dam 7 which, in turn, would be topped-up from the sump in the active Extraction Area (Storages 3b or 8 depending on the stage of works).

5.4.3 Water Security

An assessment was made of the water supply confidence using an in-house water balance spreadsheet known as RATES. The spreadsheet was calibrated using 99.33 years of daily rainfall data from the Moss Vale rainfall station (Section 4.8)**.** The spreadsheet takes into account inherent system losses (e.g. surface wetting) and a volumetric runoff coefficient calibrated for a semi-impervious surface at the Project Site. The water demands are set according to the details in Sections 5.4.1.2 and 5.4.1.3.

For the purposes of modelling the following is assumed that water for both dust suppression and washdown would be sourced from 1.54ML in Dam 7[1]. This would be supplied from runoff collected in the semi-impervious active extraction area which has a volumetric runoff coefficient of 0.79 (Table F2, Landcom 2004) and an initial loss of 3mm per day.

RATES predicts (**Table 7**):

- The anticipated mean annual demand would be less than <17% of the mean annual runoff produced over 5.8ha of extraction area.
- The demand would be fully met; the Project would not need make-up water.

[1] The other 5.4 ML is ignored as it is a volume to be always available to trap the 24hour/100 year storm event from its own catchment for safety reasons.

Table 7 – RATES Results

		SEEC RATES IV Results		
		Site:	New Berrima	
		Rain station:	Moss Vale 68045	
Total years:	99.33	Avg annual rainfall (mm):	954.57	
Total days:	36278	Max daily rainfall (mm):	422	
Total no of days when rain fell:	11614	Longest dry spell (days):	57	
Avg days per year when rain fell:	116.9233867	Days when rain > S1 initial loss:	5661	
Avg wet day rainfall (mm):	8.16	Avg days/yr rain > S1 initial loss:	56.99185	

Input statistics:	**1.54ML Dam 7**		**XX**	
Capacity (L):	1540000		0	
Startup % full:	10		0	
Catchment area (sqm):	58000		0	
Initial loss per day (mm):	3		0	
Runoff percentage:	79		10	
Apply use A on wet days (Y/N):	Y		Y	
Apply use B on wet days (Y/N):	N		N	
Revert to mains at threshold (Y/N):	N		N	
Mains reversion threshold (% full):	0		0	
Overflows into Storage 2 (Y/N):	N		N/A	
USAGE stats (L/day):	**Storage 1**		**Storage 2**	
Usage type:	**A**	**B**	**A**	**B**
January	0	17000	0	0
February	0	17000	0	0
March	0	17000	0	0
April	2000	17000	0	0
May	0	17000	0	0
June	0	17000	0	0
July	0	17000	0	0
August	2000	17000	0	0
September	0	17000	0	0
October	0	17000	0	0
November	0	17000	0	0
December	2000	17000	0	0
Results:	**Storage 1**		**Storage 2**	
% of time demand met:	100			
% of demand supplied from mains:	0			
Avg Inflow	3.24E+07			
Longest time storage ran dry (days):	8			
Avg annual mains demand (L):	0			
Avg wet day overflow (L):	2.30E+05			
Avg no of overflow events annually:	NA			
Avg annual supply from rain in (L):	5.42E+06			
Max daily overflow (L):	1.91E+07			
Annual demand (L):	5.42E+06			
Demand/Inflow	17%			

6. WATER MANAGEMENT STRATEGY

6.1 INTRODUCTION

The following water management strategy aims to address surface water-related issues identified in Section 5 of this report. This strategy includes a series of commitments in Section 6.3 to minimise the potential impacts of the proposed operation on surface water and a program for ongoing monitoring in Section 6.4.

The following plan includes three key components.

- Construction and operation of various surface water management controls such as diversion structures and sediment basins.
- Ongoing monitoring of water quality in both release water from the various structures and in downstream areas.
- A maintenance and upgrade program to quickly repair any problems and to adapt the strategy as the operation progresses.

6.2 OBJECTIVES

The objectives of the water management strategy are to:

- Minimise changes to the hydrology of all catchments affected by the Proposal (**Figure 3**), so as to minimise potential impacts on surface water flows.
- Address the water quality requirements of key agencies such as NSW Office of Water and Water NSW.
- Minimise the demand for water as much as possible and ensure demand is met within the harvestable right for the Project Site.
- Maintain ecological conditions in downstream waters through adequate surface water management.
- Avoid artificial diversions of water between neighbouring catchments, (i.e. maintain run-on and runoff within the original, natural catchments).

6.3 COMMITMENTS

6.3.1 Rain Gauge

A rain gauge would be installed on the Project Site to measure and record daily rainfall.

6.3.2 Sediment Basins

Where and when applicable, all the existing dams would be used as sediment basins at least once. However, depending on the stage of works, they would be supplemented by a number of other temporary sediment basins. The following four primary stages of work are identified:

- Establishment of Stage 1 (Site access road, southern part of the Extraction Area and southern and central visibility barriers).

- Operation of Stage 1.
- Establishment of Stage 2 (northern part of the Extraction Area and northern visibility barrier).
- Operation of Stage 2.

Table 8 and Figures 6 to 9 identifies which dams and storages would be actively used as sediment basins during the four stages of works. When an existing dam is no longer required as a sediment basin it would remain but the other temporary basins (Dams 9, 10 and 11) would be removed. **Table 8** details the size of the dams during the various stages and indicates whether they would be considered clean water or dirty water dams.

In their submission of 23/09/08 the Sydney Catchment Authority (SCA) (now Water NSW) requested that sediment basins be designed to capture the 1 in 100 year 24 hour storm event but justification could be made if another design event is used.

The applicable Water NSW *Current Recommended Practice* is DECC (2008) which requires sediment basins to be designed for a 5-day rainfall depth which, if the design life of a basin is less than three years, is the 85th percentile value (36.2mm). However, this is increased to the 95th percentile (75.2mm) if the design life of the basin is more than three years. Rainfall events greater than these might cause the basins to overtop (unless the basins were larger than required). Such events would be considered *Unconditional Discharges* and water quality testing of them would not be required. Conformance with the design and management requirements of DECC (2008) would imply a Neutral or Beneficial Effect (NorBE) is met.

All sediment dams except Dams 2 and 7 are sized to capture the 5-day, 85th percentile rainfall depth (36.2 mm) (DECC, 2008 and Landcom, 2004). Dam 2 would be operational for more than three years and so it is sized to capture the 5-day, 95th percentile rainfall depth (75.2mm) (DECC, 2008 and Landcom, 2004). Dam 7 is sized to capture the 24hour/100 year storm event from its own catchment plus 1.54ML of storage to store water drawn, if required, from Storages 3b and 8. Once extraction begins, Storages 3b and 8 would be sumps in the extraction area and would not have a defined size.

Note: The total volume of a sediment basin comprises a sediment retention zone and a water (settling) zone, both sized in accordance with Landcom (2004) and DECC (2008).

All sediment basins would be subject to the following design, monitoring and maintenance requirements.

- The design of operational sediment basins would include an emergency spillway designed to safely convey the 100-year ARI flow (DECC, 2008).
- Sediment basins would be inspected fortnightly and immediately following any rain event exceeding 5mm to check their capacity and integrity.

Table 8 – Water Management Structures

Dam ID (+)	Establish Stage 1	Operation Stage 1	Establish Stage 2	Operation Stage 2	Capacity (ML)	Management	Re-use
1	Dirty	Clean	Clean	Clean	Existing (1.43ML)	Sediment Basin during Stage 1 establishment No management or re-use when clean	No re-use
2	Dirty	Dirty	Dirty	Dirty	Increased to (1.8ML)	Sediment basin for all stages	No re-use
3	Dirty	NA (removed)	NA (removed)	NA (removed)	Existing (4.45ML)	Sediment basin during Stage 1 establishment then decommissioned (moved to 3b)	
3b	Dirty	Dirty	Dirty	Dirty	(Min 0.6ML) during Stage 1 establishment Then not defined	Sediment basin during Stage 1 establishment Active Quarry Sump for Stage 2-4 <17% of trapped water pumped to Dam 7 (on average) Remainder infiltrated, evaporated or released (after flocculation if required).	

Table 8 – Water Management Structures (Cont'd)

Dam ID (+)	Establish Stage 1	Operation Stage 1	Establish Stage 2	Operation Stage 2	Size (ML)	Management	Re-use
4	Dirty	Clean	Dirty	Clean	Enlarged to 1.4ML	Sediment basin during both stages of establishment No management or re-use when clean	No re-use
5	Clean	Clean	Dirty	Clean	Existing (2.36ML)	Sediment basin when dirty No management or re-use when clean	Farm use
6	Clean	Clean	Clean	Clean	2.5	Not related to the Project Site operations	Farm use
7	Dirty	Dirty	Dirty	Dirty	6.94 (total)	No overflow Maintain 5.4ML volume for storm capture. 1.54ML additional volume used for dust suppression	Dust Suppression

Table 8 – Water Management Structures (Cont'd)

Dam ID (+)	Establish Stage 1	Operation Stage 1	Establish Stage 2	Operation Stage 2	Size (ML)	Management	Re-use
8	NA	NA	NA	Dirty	Sump - not defined	No overflow <17% of trapped water pumped to Dam 7 (on average) Remainder infiltrated, evaporated or released (after flocculation if required).	
9	NA	NA	Dirty	NA	0.64	Sediment basin during Stage 2 establishment then decommissioned	No re-use
10	Dirty	NA	NA	NA	0.23	Sediment basin during Stage 1 establishment then decommissioned.	No re-use
11	Dirty	NA	NA	NA	0.4	Sediment basin during Stage 1 establishment then decommissioned.	No re-use
(+) See Figure 7-9							

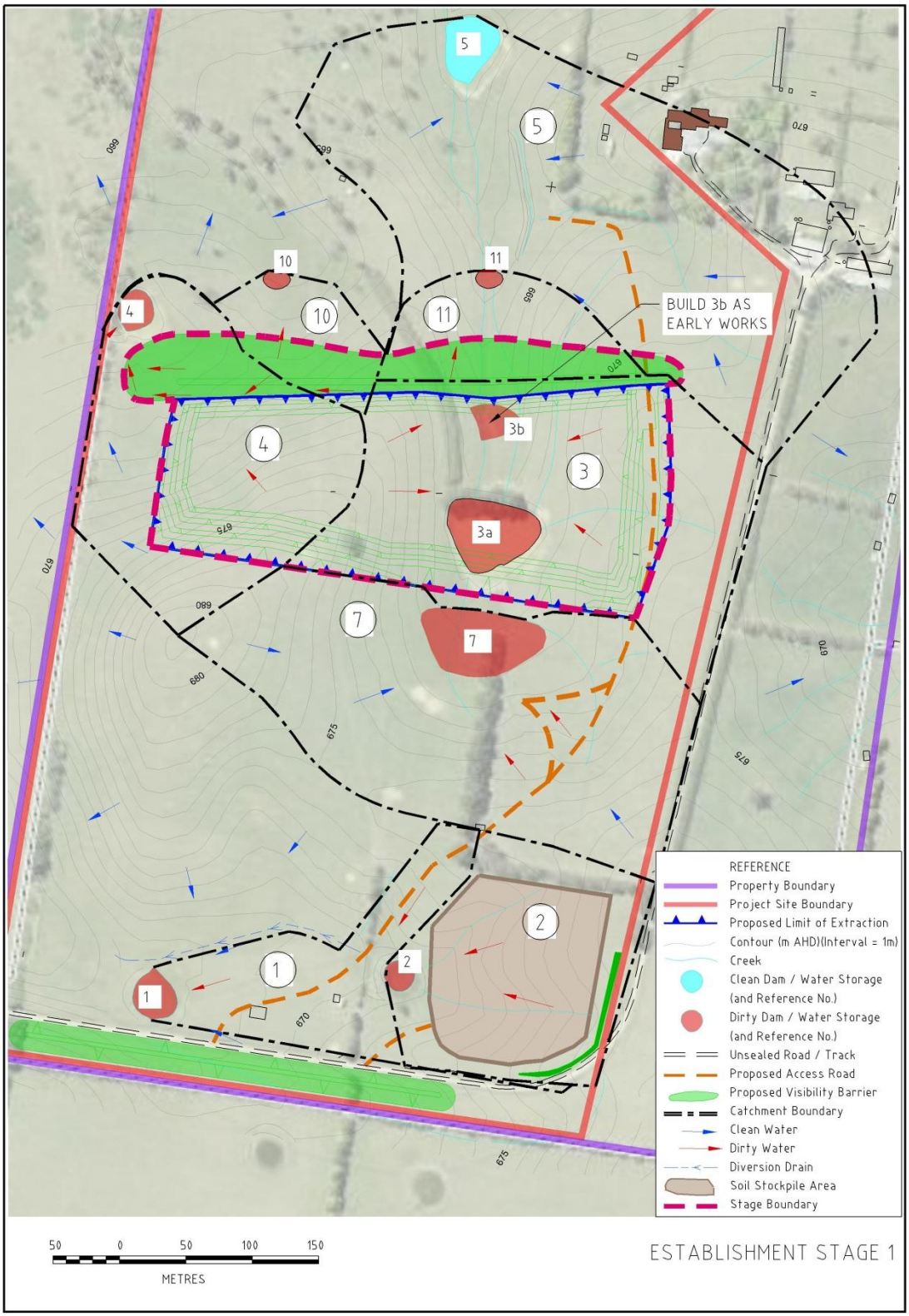

Figure 5 – Water Management: Stage 1 Establishment

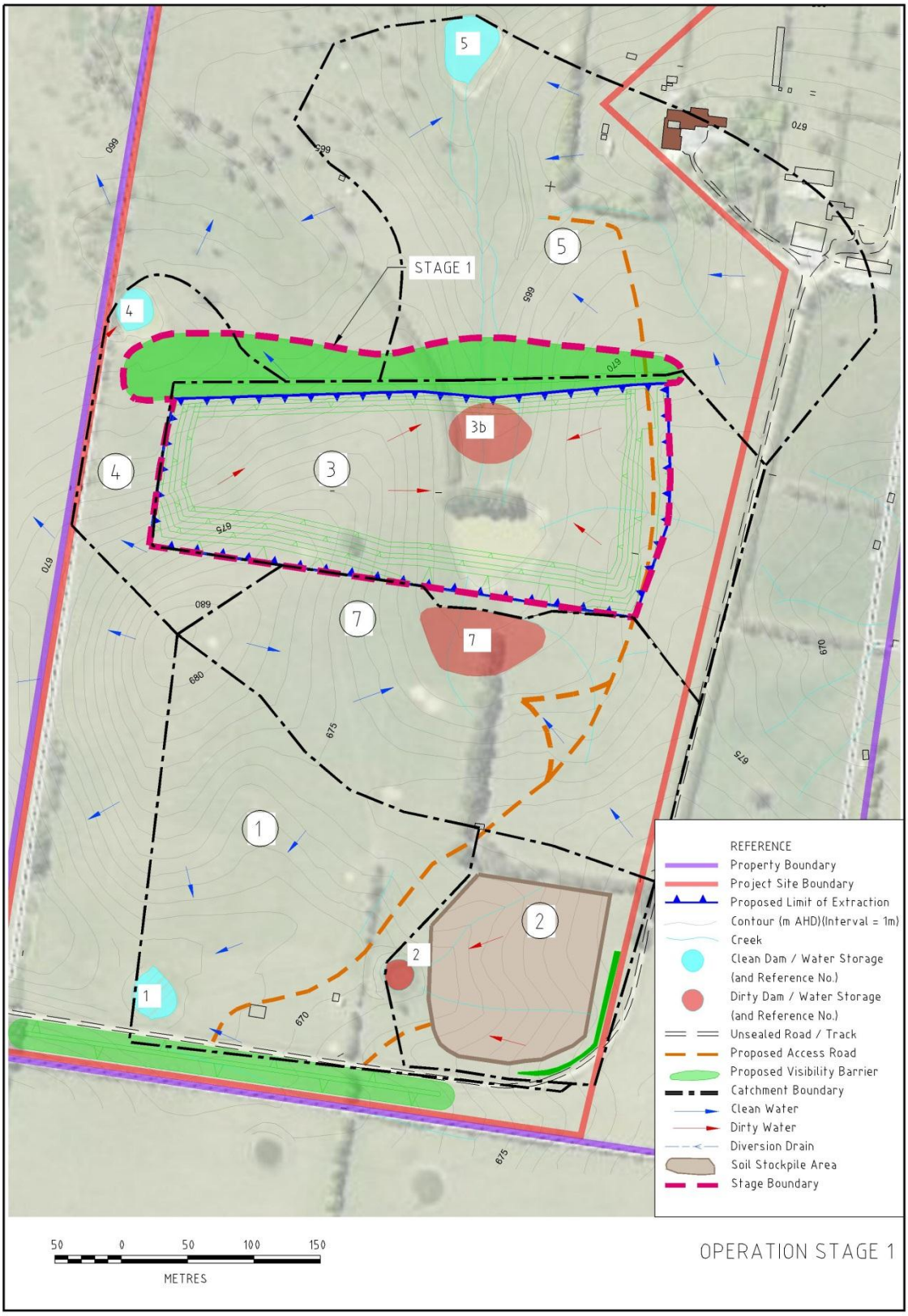

Figure 6 – Water Management: Stage 1 Operation

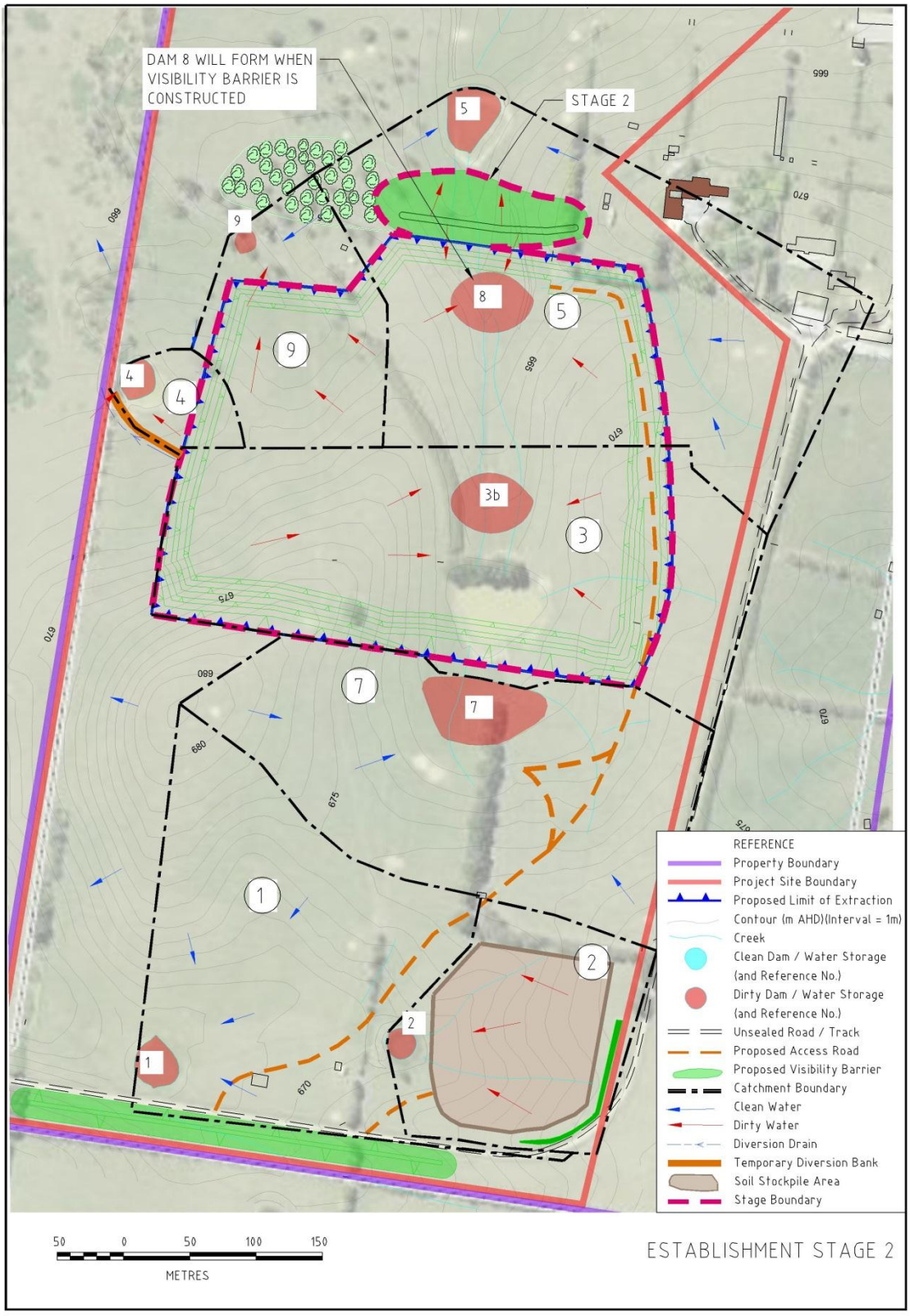

Figure 7 – Water Management: Stage 2 Establishment

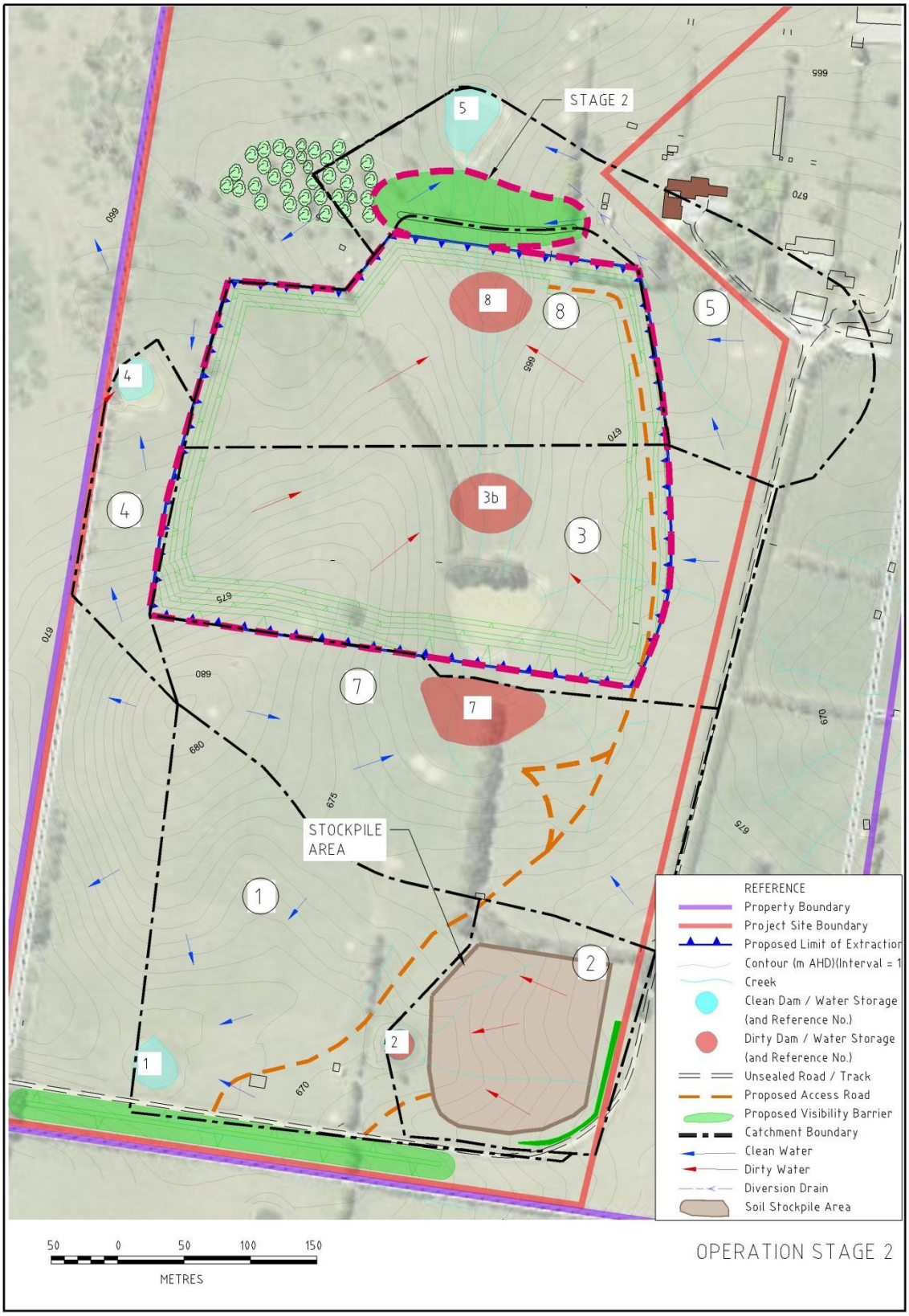

Figure 8 – Water Management: Stage 2 Operation

- Water would be flocculated (if required), settled and discharged within five days of the conclusion of a rain event which caused inflow into the basin. These would be considered *Conditional Discharges*.
- Conditional discharges released to receiving waters would have a concentration of suspended solids less than 50mg/L and a pH between 6.5 and 8. Soil investigations suggest sediment will naturally settle out but if this does not occur in practice, flocculation would be required.
- Rainfall events that exceed the design 5-day design values might cause overflow from the basins. These would be considered *Unconditional Discharges*. No water quality monitoring is required for these discharges
- A marker would be installed in each sediment basin showing the boundary between the Storage Zone (i.e. the lower zone) and the Settling Zone (i.e. the upper zone) in the basin.
- After discharging settled/treated water from a sediment basin, the level of retained sediment would be inspected. If retained sediment exceeded the marked level of the Storage Zone, sediment would be removed and added to an active stockpile.
- Any damaged components of a sediment basin would be repaired as soon as practicable.
- The management procedures for sediment basins would be regularly reviewed to ensure ongoing efficient operation and protection of downstream water quality.

6.3.3 Discharge Points

Discharge points would be located at all dams/storages except 3b and 8. With the exception of Dam 7, discharges could be either unconditional (above design) or conditional discharges (release of settled/flocculated water). Discharges from Dam 7 would be by pumping only (conditional discharges), with pumped water being released just downstream of Dam 1. If necessary, water in storages 3b or 8 would be released via Dam 7 (after treatment if required).

6.3.4 Surface Water Diversion

As shown on **Figure 6**, the southern visibility barrier would act as a diversion structure to direct natural flow around Dam 1 where it would re-enter the natural depression. Other diversion bunds or channels are required to:

- limit the catchment to Dam 4 during the establishment of Stage 2; and
- divert clean water away from the north east corner of the second extraction stage – with water diverted to Dam 5.

Diversion bunds or channels would adhere to the following requirements and commitments.

- All structures would be stabilised using appropriate ground cover to achieve a C-factor of 0.05 (achievable with 70% grass cover or equivalent) or less (Landcom, 2004) prior to conveying water.

- All structures would be designed to fully convey the 20-year ARI time-of-concentration event, and would be stabilised using materials capable of safely managing that flow volume and velocity.
- Potential scour points (e.g. channel inlets/outlets and bends) would be armoured with rock.
- All structures would be inspected monthly and immediately following any rain event that generates flow in the drains to identify areas of erosion, scour, damage or blockage. Any problem areas would be repaired.

6.3.5 Erosion Control and Dust Suppression

6.3.5.1 Erosion Control

Rapid rehabilitation of disturbed areas is the most effective form of erosion control (Landcom, 2004). As such, the potential for erosion would be managed in the same measures as outlined within Section 5.9 of RWC (2010), in accordance with the recommendations of Geoff Cunningham Natural Resource Consultants (2010b) and as outlined in Section 2.6.5 of the *Environmental Assessment*.

Outside of the extraction area, stockpiles of soil, clay shale products awaiting transport would all be stored in the designated stockpile area in the southeast corner of the Project Site. This would ensure sediment-laden water would be collected within Dam 2.

6.3.5.2 Dust Suppression

Dust suppression would be undertaken on exposed active areas of the extraction area, un-vegetated stockpiles and the Site access road at the following rates when the Quarry is operating:

- 1L/m^2/day on non-rainy days during the months September to March inclusive; and
- 0.25L/m^2/day on non-rainy days during the months April to August inclusive.

Records would be kept of the location, time and volume of each application of water.

6.4 WATER QUALITY MONITORING

Water quality would be monitored at the WS1 and WS2 locations identified on **Figure 3** for the range of parameters listed on the Environment Protection Licence for the quarry. Samples would be collected annually or prior to a controlled discharge event and tested at a registered and accredited laboratory. Note WS3 is located at an intermittent watercourse (Stoney Creek) and would likely result in opportunistic sampling.

The results would be collated and summarised within the Quarry's Annual Review, with a copy also provided to Council, NSW Office of Water and any other relevant government agency if necessary. Results would be compared to existing baseline data and with previous years' data. Any decline in water quality would be investigated and, if required, appropriate remedial action would be taken.

6.5 WATER MANAGEMENT STRATEGY MONITORING AND AMENDMENT

The Water Management Strategy for the quarry would be independently audited every three years or as nominated in the Water Management Plan and upgrades or amendments made as required ensuring ongoing compliance with relevant environmental protection instruments.

7. REFERENCES

CMA (1985) Moss Vale 1:25,000 Topographic Map (8928-1-N). Second Edition. Central Mapping Authority, Bathurst.

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Geoff Cunningham Natural Resource Consultants Pty Ltd (2010). Part 7 of the New Berrima Quarry 2010 Environmental Assessment (RWC, 2010).

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Rosewell, C.J. and Edwards, K. (1988). Soiloss; A program to assist in the selection of management practices to reduce soil erosion. Soil Conservation Service of NSW Technical Handbook No 11.

RWC (2010) "*Environmental Assessment for the New Berrima Clay/Shale Quarry (Major Project No 08_0212)"*

RW Corkery & Co. (2012). Email transmission to David Mooney, Dept. Planning and Infrastructure. 7th June 2012. *RE: Water requirement for Berrima Clay/Shale Quarry.*

SCA/DLWC (2002). *Soil Landscapes of the Sydney Catchment Authority Hydrological Catchments.* Version 1. June 2002.

Appendix 1

Assessment Requirements from Relevant Government Agencies

Table 9 – Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008)

In red: New Government Departments

Paraphrased Requirement		Relevant Section
SOIL AND WATER		
A detailed description of the water management system for the Project Site including water quality management, storm water management, erosion and sediment control and monitoring programs.		Section 6 of the Surface Water Management Assessment
GENERAL		
Department of Water and Energy (02/10/08) NSW Office of Water (21/01/2015)	The EA is required to take into account the following NSW Government policies, as applicable: • NSW Groundwater Policy Framework Document - General; • NSW Groundwater Quantity Management Policy; • NSW Groundwater Quality Protection Policy; • NSW Groundwater Dependant Ecosystem Policy; • NSW State Rivers and Estuaries Policy; • NSW Wetlands Management Policy • NSW Farm Dams Policy	Refer to the EA
Department of Environment and Climate Change (03/10/08) EPA (19/01/2015)	Details are required on the location of the proposed development including the affected environment to place the proposal in its local and regional environmental context including surrounding land uses, planning zones, potential sensitive receptors, surface and sub-surface areas/features of conservation significance and environmental sensitivity. These should include areas containing natural and cultural heritage values.	Refer to the EA
	Describe mitigation and management options that will be used to prevent, control, abate or mitigate identified environmental impacts associated with the project and to reduce risks to human health and prevent the degradation of the environment.	Section 6 plus EA
SURFACE WATER		
Department of Water and Energy (02/10/08) NSW Office of Water (21/01/2015)	If a water supply is required, the source/availability of a sustainable water supply needs to be addressed in the EA.	Section 5.4
	The location and estimated capacity of every dam must be shown. Any capacity of the total of all dams on the property greater than the MHRDC may require a licence.	Sections 4.4.2 and 5.2
	The EA should provide details on:	EA
	• any existing surface water and groundwater licences under the Water Act 1912 on the subject property;	
	• the purpose of the existing licences;	EA
	• the water supply source(s) for the proposal;	Section 5.4
	• volumes of water to be used;	Section 5.4
	• The function and location of all existing and proposed storages/ponds on the Project Site; and	Section 5.2 and 6.3
	• The design layout, pumping and storage capacities, all associated earthworks and infrastructure works must be clearly shown and explained.	Section 5.2 and 6.3

Table 9 – Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008) (Cont'd)

In red: New Government Departments

Paraphrased Requirement		Relevant Section
SURFACE WATER (Cont'd)		
Department of Water and Energy (02/10/08) NSW Office of Water (21/01/2015)	If the proposal includes water management structures/dams, the EA needs to provide details on the following: • any existing structure(s) (date of construction, location, purpose, size and capacity, the legal status/approval for existing structure/s);	Section 4.4.2 and 6.3
	• any proposal to change the purpose of existing structure/s;	Section 5.2 and 6.3
	• if any remedial work is required to maintain the integrity of the existing structure/s;	Not applicable
	• size and storage capacity of the structure/s;	Section 5.2 and 6.3
	• calculation of the Maximum Harvestable Right Dam Capacity (MHRDC);	Section 5.2
	• if the structure/s is affected by flood flows;	Not applicable
	• any proposal for shared use, rights and entitlement of the structure/s; and	Not applicable
	• if the proposed development has the potential to bisect the structure/s.	Not applicable
Department of Environment and Climate Change (03/10/08) EPA (19/01/2015)	The goal of the project should ensure: • There is no pollution of waters (including surface and groundwater);	Section 6
	• Polluted water is captured on the Project Site and directed to reticulated sewer where available or else collected, treated and beneficially reused, where this is safe and practicable to do so;	Not applicable
	• There is consistency with any relevant Statement of Joint Intent established by the Healthy Rivers Commission; and	Not applicable
	• It contributes to the protection or achievement over time of River Flow Objectives and Water Quality Objectives.	Sections 5 and 6
	An assessment needs to be provided in the EA demonstrating how the above objectives will be achieved. The proponent should confirm in the EA the catchment that the development occurs in to determine the requirements that should apply. The EA should clearly identify any sensitive areas nearby and provide details on any potential impact this proposal may have on these areas including any associated mitigation measures.	Sections 5 and 6

Table 9 – Director-General's Requirements from Relevant Environmental Assessment Sections (Department of Planning – 21 November 2008) (Cont'd)

In red: New Government Departments

WATERCOURSES AND RIPARIAN LANDS		
Department of Water and Energy (02/10/08) NSW Office of Water (21/01/205)	The EA should identify any watercourses at the Project Site, or in the vicinity of the Project Site and their associated riparian corridors which may potentially be impacted by the proposal and address how the watercourses and riparian corridors at the Project Site will be protected and enhanced.	Section 4.4 and Section 5
	The riparian corridors should be protected and/or enhanced with native riparian vegetation.	Section 4.4
	The EA should provide on a scaled plan, details on the location of: a. the watercourses at the Project Site b. top of bank c. the riparian corridors, including the Core Riparian Zone (CRZ) and vegetated buffers d. any Asset Protection Zones e. the footprint of the proposed development and any other areas of disturbance f. any proposed revegetation of the riparian corridors g. land uses associated with the proposal which are proposed to be located adjacent to the riparian corridor (eg roads, basins and any other works adjacent to the riparian corridor)	Section 4.4
	The EA needs to provide details on any watercourses and riparian corridors that may be affected by the proposal and the rehabilitation of these watercourses to mimic natural systems and the rehabilitation of vegetated riparian corridors.	Section 4.4
Department of Lands (25/11/08)	The proposed extraction should have no adverse effect on the bed or bank of the Wingecarribee River and or the associated riparian lands and water quality within, both upstream and downstream of the Project Site.	Sections 5 and 6
WETLANDS		
Department of Water and Energy (02/10/08) NSW Office of Water (21/01/2015)	The EA should provide on a scaled plan, details on the location of: a. any wetlands on the subject property b. buffer setbacks around the wetlands c. any Asset Protection Zones d. the footprint of the proposed development and any other areas of disturbance	Not applicable at this Project Site