Soil and Water Management Plan

Menangle Sand and Soil Quarry

Prepared for Menangle Sand and Soil Pty Ltd
March 2021

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Menangle Sand and Soil Quarry

Soil and Water Management Plan

Report Number

J190166 RP27

Client

Menangle Sand and Soil Pty Ltd

Date

24 March 2020

Version history

Version	Date	Prepared by	Approved by	Comments
v1	24 March 2021	M. Frankcombe J. O'Brien	P. Towler	Draft

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1 Introduction

1.1 Background

Menangle Sand and Soil Pty Ltd (Menangle Sand and Soil) operates the Menangle Sand and Soil Quarry (the quarry) at 15 Menangle Road, Menangle (Figure 1.1). Quarrying has been undertaken in the location for over 40 years by a number of operators and at varying rates of production. Extraction, processing and rehabilitation activities have been undertaken by Menangle Sand and Soil since 1978.

The quarry, located in the Wollondilly local government area (LGA), extracts sand and soil along the Nepean River as approved by Development Consent 85/2865, granted by the Minister for Planning on 15 November 1989.

To date, sand and soil has been extracted from Stages 1 to 2 and 4 to 7 (Figure 1.2). While previously approved, sand and soil will not be extracted from Stage 3.

On 10 September 2020, the NSW Land and Environment Court (LEC) approved the Menangle Quarry Extension – Modification 1 (MOD1) to Development Consent 85/2865. Approval conditions are provided in the Notice of Orders for LEC 2018/342158 (the Approval).

The Approval allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 ha, and extends about 2 kilometres (km) along the Nepean River south of the Stage 7 area. The quarry is approved to extract sand and soil from the Stage 8 area at a rate of up to 150,000 tpa. The extracted material will be transported to the existing processing area where it will be stockpiled, processed and blended with materials imported to the site, prior to being dispatched from the quarry. The Approval to extract sand and soil from the Stage 8 area is subject to forgoing the extraction material from the Stage 3 area as originally approved.

This Surface Water Management Plan (SWMP) has been prepared to address the requirements of the Approval.

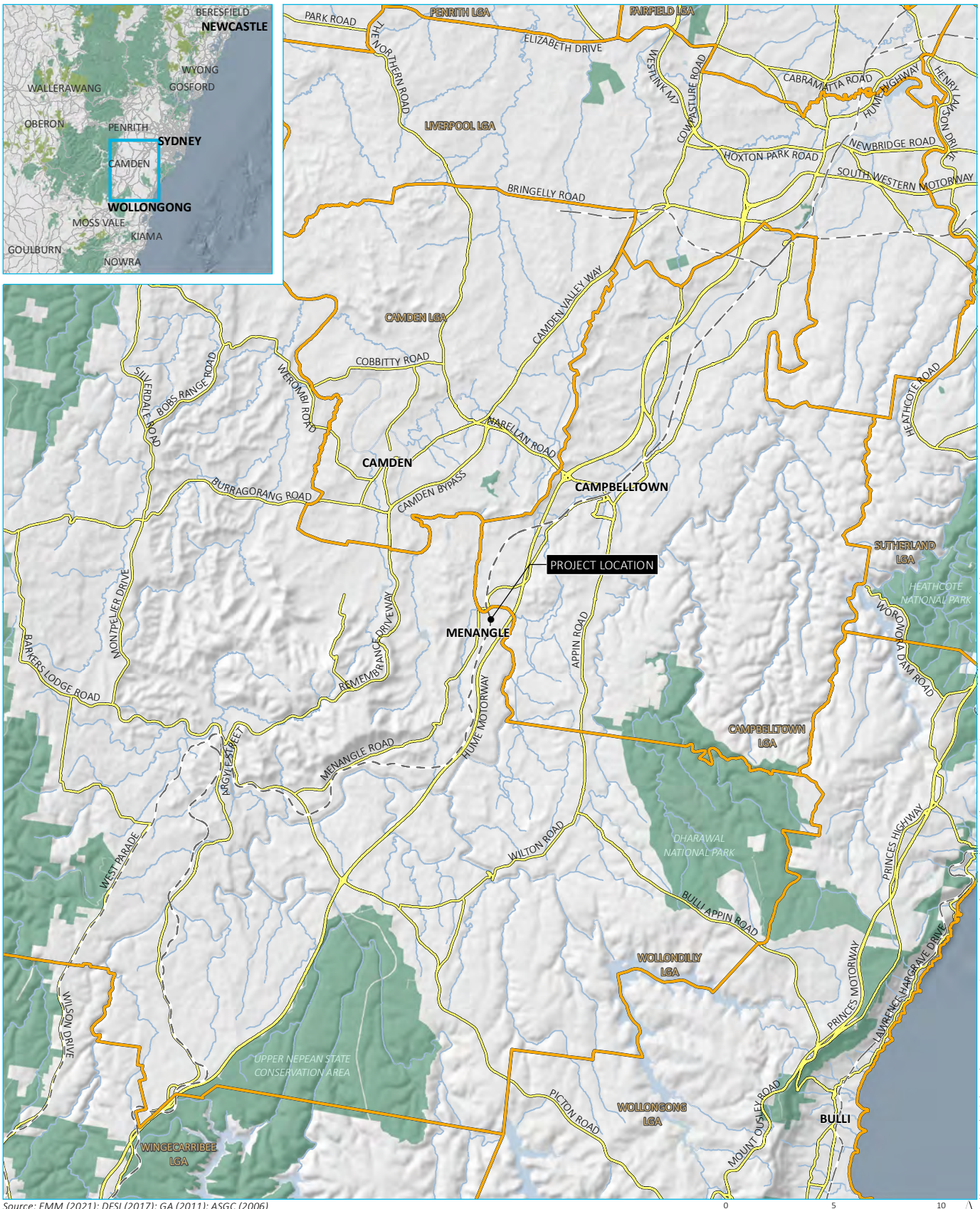
1.2 Project overview

The Approval increases the quarry life by 15 years (to 2035) by extracting the sand and soil resource in the Stage 8 area. Stage 8 has been split up into 15 sub-stages (Figure 1.3) which have been further categorised into seven extraction phases (Table 1.1).

Table 1.1 Stage 8 phases

Phase	Substage
1	8A–8B
2	8C
3	8D–8E
4	8F–8G
5	8H–8I
6	8J–8K
7	8L–8M

Operations (but not extraction) will continue in the Stage 6 and Stage 7 areas.



Source: EMM (2021); DFSI (2017); GA (2011); ASGC (2006)

0 5 10 km

GDA 1994 MGA Zone 56

N

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KEY

- Rail line
- Major road
- Named watercourse
- Named waterbody
- Local government area
- NPWS reserve

INSET KEY

- Main road
- State forest

Project location

Menangle Quarry
Figure 1.1

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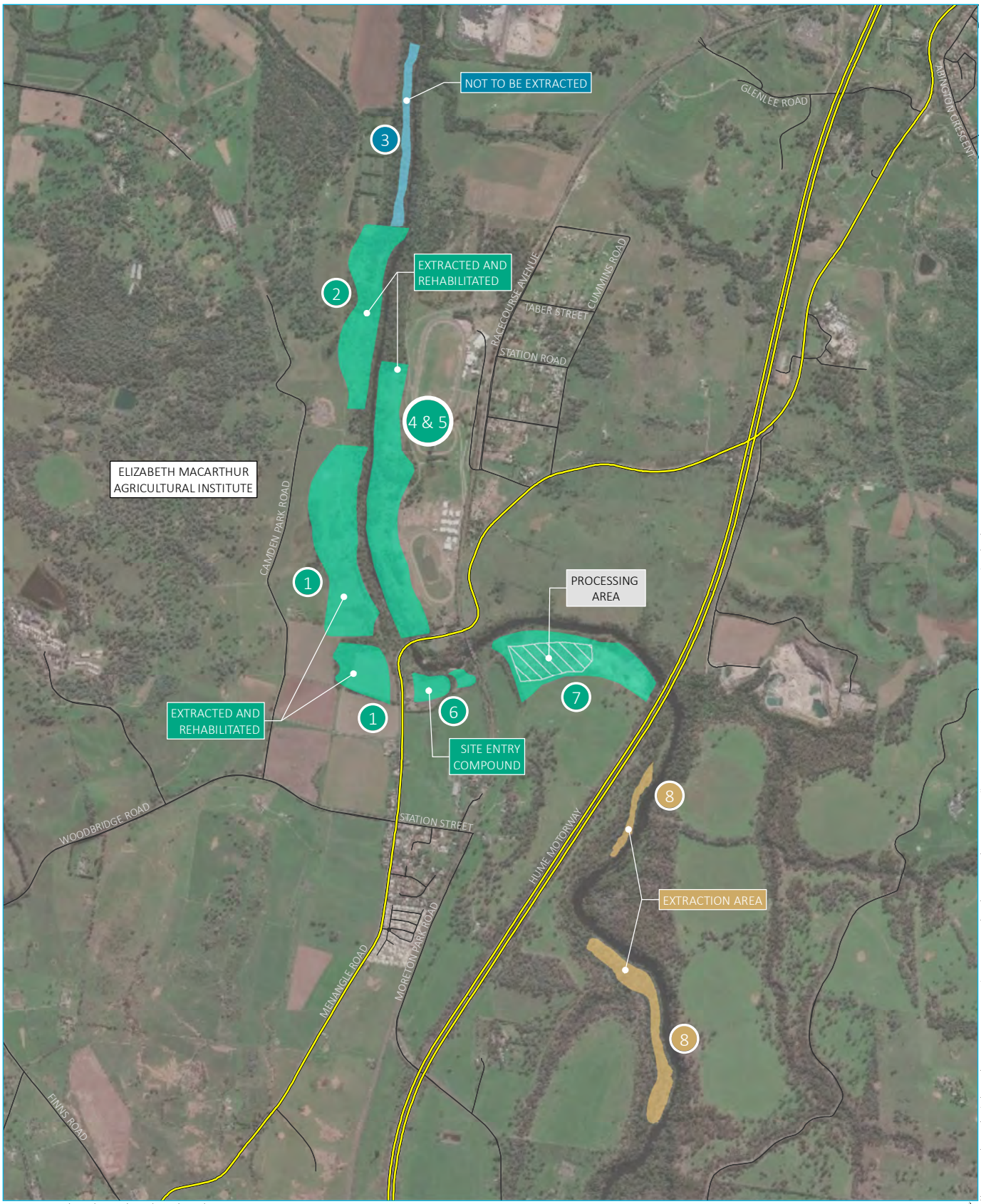

Source: EMM (2021); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Main road
- Local road
- Processing area
- Stages 1-2 and 4-7
- Stage 3 (not to be extracted)
- Stage 8 - extraction/rehabilitation area

Menangle Quarry Stages 1 to 8

Menangle Quarry
Figure 1.2

EMM creating opportunities

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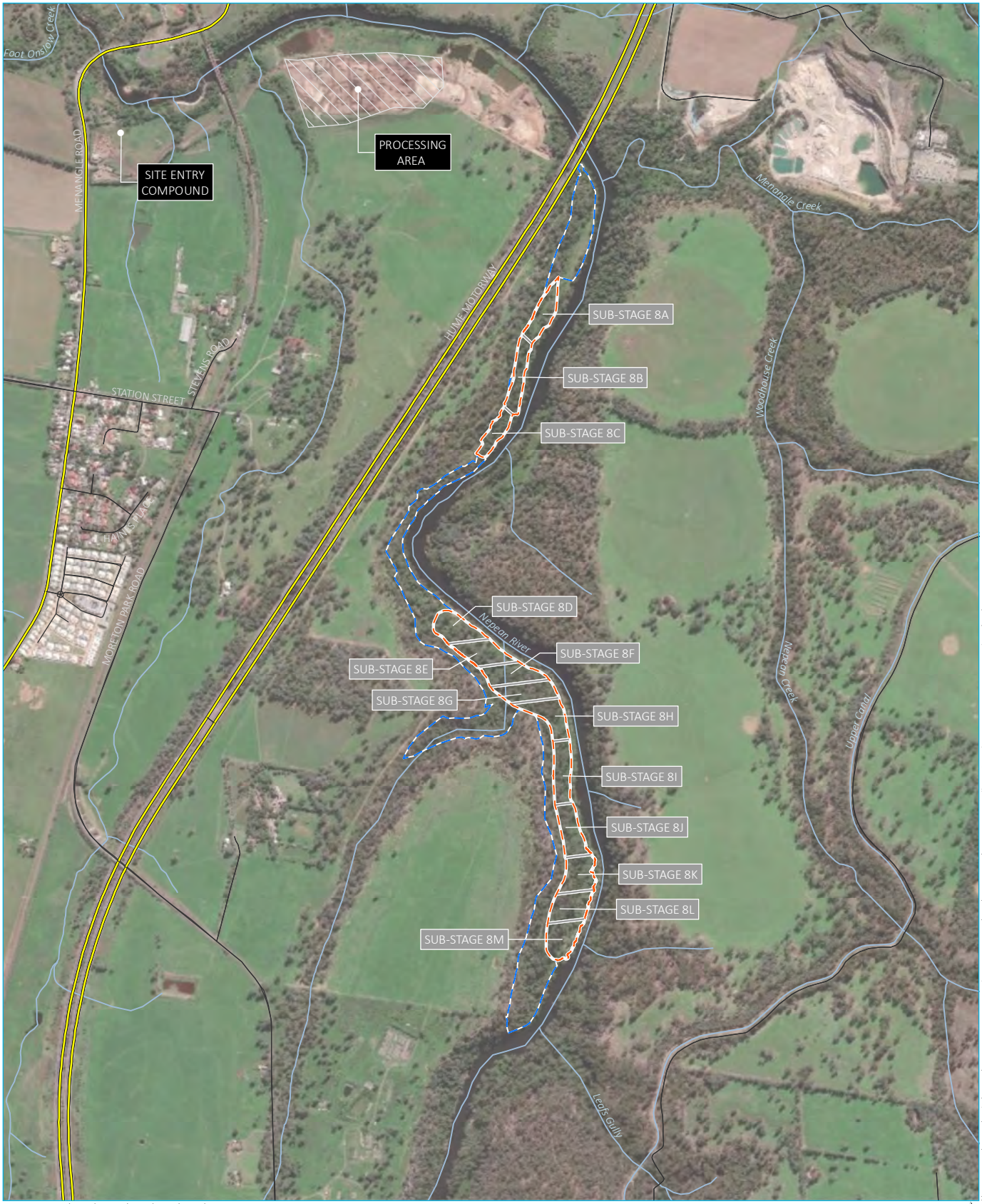

Source: EMM (2021); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 56

N

KEY

- Processing area (to be retained)
- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction)
- Main road
- Local road
- Watercourse/drainage line
- Substage boundary

Phase 1 Sub-stages 8A - 8B
Phase 2 Sub-stage 8C
Phase 3 Sub-stages 8D - 8E
Phase 4 Sub-stages 8F - 8G
Phase 5 Sub-stages 8H - 8I
Phase 6 Sub-stages 8J - 8K
Phase 7 Sub-stages 8L - 8M

Stage 8 area

Menangle Quarry
Figure 1.3

EMM creating opportunities

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As well as the extraction areas, key components of the quarry include:

- a wheel wash and weighbridge;
- a site office and amenity building;
- a workshop west of the site office;
- fuel supply tanks north of the storage shed;
- sand and soils storage and processing area; and
- other minor infrastructure.

These components will be used to support activities in the Stage 8 area which include:

- extraction in the Stage 8 extraction area followed by rehabilitation;
- restoration of areas adjacent to the extraction areas;
- a conveyor (if required); and
- internal haul roads utilising existing tracks.

1.3 Operations

1.3.1 Activities

Operations at the quarry comprises the following activities:

- vegetation management and clearance;
- sand and soil excavation;
- material transport by off-road haul truck and/or conveyor (see below);
- sorting and screening of excavated material;
- processing of excavated material;
- blending of excavated material with imported materials (permitted by the Approval and EPL 3991);
- stockpiling;
- loading of product into trucks; and
- product dispatch via trucks.

Menangle Sand and Soil propose to use the off-road haul truck to transport material between the extraction area and the processing area, removing the need for the conveyor with attendant additional environmental benefits. Menangle Sand and Soil have commenced the application process to modify the Approval accordingly (Modification 2). This SWMP provides measures applicable to the transport of material by a haul truck using existing tracks within the Stage 7 and Stage 8 areas.

1.3.2 Plant and equipment

Approval Condition A33 states:

> All plant and equipment used on site, or to monitor the performance of the development must be:
>
> (a) maintained in a proper and efficient condition; and
>
> (b) operated in a proper and efficient manner.

Regular maintenance of all plant and equipment will be logged and records stored on site available for review at any time.

1.4 Quarry life

The approved quarry life is for 15 years to 2035.

1.5 Operating hours

The quarry will operate during the approved hours in accordance with Approval Condition A26 Table 1 (see Table 1.2 below).

Table 1.2 Operating hours

Activity	Permissible hours
Construction work	• 7 am to 5 pm Monday to Friday • 7 am to 1 pm Saturday • At no time on Sundays or public holidays
Quarrying operations including loading and dispatch of laden trucks	• 6 am to 5 pm Monday to Friday • 6 am to 12 noon Saturday • At no time on Sundays or public holidays
Maintenance, security, office work, cleaning, etc	• May be conducted at any time, provided that these activities are not audible at any residence on privately-owned land

Approval Condition A27 states that where police or other public authorities request that deliveries or dispatching of materials are to be carried out outside operating hours and emergency work to avoid the loss of lives, property or to prevent environmental harm is required, then these activities are permitted outside the normal operating hours. In such circumstances, the Applicant must notify the Department and affected residents prior to undertaking the activities, or as soon as is practical thereafter.

1.6 Utilities

1.6.1 Potable water

Potable water from the mains supply is used for amenities in the site entry compound is used to top up the wheel wash. No mains water is used for processing or dust suppression.

Menangle Sand and Soil will implement water saving measures such as water efficient toilets, flow reducers and ensuring that taps are not dripping.

1.6.2 Sewage

The site currently uses a septic system (as does the nearby Menangle Village) to manage sewage generated from the facilities in the site offices as there is currently no sewerage mains available. The site amenities are currently being relocated and the relocated facilities will be connected to Bio-Cycle treatment system.

1.7 Access

1.7.1 Site access

The main access to the site is from Menangle Road. Menangle Road is an arterial road which provides sub-regional access.

1.7.2 Access to the Stage 8 area

Light vehicles accessing to the Stage 8 area will use the existing access under the Hume Motorway. The existing access was retained when the Road Transport Authority (now Transport for NSW, TfNSW) bisected the lands when acquiring the corridor for the original Hume Highway in 1969. The existing access road under the bridge will be improved by sealing and will comply with TfNSW drainage and pavements standards.

Material will be transported beneath the Hume Motorway Menangle Bridge by conveyor or by haul truck. The latter has in principle support from TfNSW (see Appendix A) and will be subject to a modification application currently being prepared.

The earthmoving equipment, off-road haul truck and other plant to service the Stage 8 area may also access the area via Moreton Park Road. However, no customer trucks will use this access point.

1.7.3 Product dispatch

Truck movements at the site (ie combined inbound and outbound movements) will not exceed an average of:

- 147 per day on Monday to Friday; and
- 80 per day on Saturday.

1.8 Consultation

As required by Approval condition B36(b), this SWMP has been prepared in consultation with:

- Environment Protection Authority (EPA); and
- Department of Planning, Industry and Environment – Water (DPIE-Water).

These regulators were contacted via email on 12 October 2020 (8.3) and invited to provide input to the SWMP preparation.

The EPA responded via a letter on 26 November that the EPA supports the development of Environmental Management Plans (EMPs) as part of good environmental management but does not generally approve specific EMPs for industry operations. The letter is provided in Appendix A.

This draft plan is provided to DPIE-Water for their comment.

[Details of comments received and responses to be provided here].

The SWMP will be reviewed periodically and any material updates submitted to DPIE, NSW EPA and DPIE-Water.

1.9 Purpose and scope

This Soil and Water Management Plan (SWMP) presents the framework for the management of soil (primarily erosion and sediment control), surface water and groundwater at the quarry. It has been prepared to address the requirements of the Notice of Orders made from the LEC 2018/342158 Court Appeal (the Approval).

This SWMP provides a structured approach to soil and water across the quarry, including:

- a site water balance, including:
  - water sources and supply security;
  - water use;
  - reporting procedures, including annual site water balances;
  - outputs of the groundwater model; and
  - measures to minimise potable water use.
- a surface water management plan, including:
  - baseline flow and water quality data;
  - impact assessment criteria and trigger values;
  - a description of the quarry's surface water management system;
  - a surface water monitoring program; and
  - a protocol for identifying and reporting any exceedances of impact assessment criteria.
- a groundwater management plan, including:
  - baseline flow and water quality data;
  - impact assessment criteria and trigger values;
  - a protocol for ensuring that the quarry does not exceed the prescribed depth limits;
  - measures to protect the integrity of the groundwater monitoring network;
  - a groundwater monitoring program; and
  - a protocol for identifying and reporting any exceedances of impact assessment criteria.

The SWMP's appendices include:

- consultation records;

- the Menangle Quarry Groundwater Model Report, including groundwater hydrographs; and
- technical notes for drainage, erosion and sediment control measures.

This SWMP provides specific management measures for:

- the previously extracted Stage 6 and 7 areas including the infrastructure and processing areas;
- the Stage 8A–8C areas; and
- the tracks adjacent to the Stage 8 area that may be used by the haul truck.

An Ephemeral Creek Management Plan identifying measures to manage and control soil erosion and bank stabilisation for the ephemeral creek within substages 8E–8G has not been prepared at this stage but will be incorporated into the BRMP prior to extraction within Substage 8E as required by Approval conditions B40 and B41.

Menangle Sand and Soil will not commence quarrying operations in the Stage 8 area until this SWMP is approved by the Planning Secretary.

Menangle Sand and Soil will implement this SWMPP as approved by the Planning Secretary.

1.10 Report preparation

This SWMP has been prepared by Michael Frankcombe, Jason O'Brien, Nick Bartho and Dr Philip Towler.

Michael holds a Bachelor of Environmental Science and is a Certified Professional in Erosion and Sediment Control. Michael has over 30 years' practical experience in the civil construction, mining, and pipeline industries, specialising in erosion and sediment control, mining landform design, rehabilitation, revegetation, natural channel design and water treatment.

Nick holds a Bachelor of Engineering (Civil and Environmental) (Hons) and is EMM's Surface Water Team Leader. Nick has 19 years' experience as a water resources engineer, specialising in hydrologic and hydraulic modelling, flood impact assessment and flood risk management, including flood emergency and response planning.

Jason holds a Bachelor of Engineering (Environmental) (Hons). Jason has over five years' experience working as an environmental and water resources engineer, specialising in surface water assessments, water management plans, flood impact assessment, hydrologic and hydraulic modelling, water balance modelling, water quality investigation and data management, stormwater drainage, water and sewerage design, and GIS analysis.

Philip holds a Bachelor of Science and a PhD in environmental chemistry. Philip has extensive experience preparing environmental and social impact assessments and environmental management plans around Australia and internationally, and has led a wide range of geochemistry, water and sediment assessment projects.

2 Environmental requirements

Menangle Sand and Soil will comply with all legislation; project approvals; permits and licences; and standards and guidelines, as listed below.

2.1 Legislation

Legislation relevant to soil and water management includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- Environmental Planning and Assessment Regulation 2000;
- *Protection of the Environment Operations Act 1997* (POEO Act);
- Protection of the Environment Operations (General) Regulation 2009;
- Protection of the Environment Operations (Waste) Regulation 2014;
- Protection of the Environment Operations (Waste) Regulation 2016;
- *Water Management Act 2000;*
- Water Management (General) Regulation 2018;
- *Work Health Safety Act 2011* (WHS Act);
- Work Health Safety Regulation 2017;
- *Contaminated Land Management Act 1997*;
- *Environmentally Hazardous Chemicals Act 1995;* and
- Environmentally Hazardous Chemicals Regulation 2008.

2.2 Approval conditions

The Approval conditions pertinent to this SWMP are listed in Table 2.1 below.

Table 2.1 Conditions relevant to the SWMP

Condition Number	Condition	Relevant report section
Evidence of consultation		
A28	Where conditions of this consent require consultation with an identified party, the Applicant must:	
	(a) consult with the relevant party prior to submitting the subject document; and	Section 1.8
	(b) provide details of the consultation undertaken including:	Section 1.8 Appendix A

Table 2.1 Conditions relevant to the SWMP

Condition Number	Condition	Relevant report section
	(i) the outcome of that consultation, matters resolved and unresolved; and	Section 1.8
	(ii) details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.	[TBD]
Staging, Combining and Updating Strategies, Plans or Programs		
A29	The Applicant may prepare and submit the Soil and Water Management Plan and/or Biodiversity and Rehabilitation Management Plan required under conditions B36 and B73 of Schedule 2 on a staged basis, prior to the commencement of Quarrying Operations in each of Phases 1 to 7. Quarrying Operations must not commence in any phase until a management plan has been approved by the Planning Secretary for that phase.	Section 1.9
Part B Specific Environmental Conditions – Soil and Water		
B18	The Applicant must ensure that diesel spills and the like are cleaned up immediately so as not present a risk to water quality if the relevant Substage is inundated by floodwaters.	Section 5.2.5
Groundwater Monitoring and Management		
B19	The Applicant must monitor groundwater levels at Groundwater Bores BH01_S, BH01_D, BH02, BH03 and BH04 as shown in Figure 7 in Appendix 5, using continuous data loggers, for the duration of Quarrying Operations in the Stage 8 Area.	Section 6.1
B20	The Applicant must ensure that Quarrying Operations do not compromise the integrity of the monitoring bores identified in condition B19 of Schedule 2.	Section 6.1
B21	The Applicant must:	
	(a) collect groundwater quality samples at each of the monitoring locations identified in condition B19; and	Section 6.4.2
	(b) analyse collected groundwater quality samples for all major anions and cations and field parameters;	Section 6.4.2
	on an annual basis for the duration of Quarrying Operations in the Stage 8 Area.	Section 6.4.2
B22	The Applicant must ensure that:	-
	(a) temporary bores are drilled or augered progressively in each Substage to determine the local water table position immediately prior to commencing extraction in each Substage; and	Section 6.4.1
	(b) the pit floor in each Substage remains at least 1 metre above the measured water table level averaged over a seven-day period following the date of drilling or augering.	Section 6.6
Water Supply and Licensing		
B23	The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of the development to match its available water supply.	Section 5.3.1
B24	The Applicant must develop a groundwater model using a variant of Modflow standard software, or equivalent software, to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 Area.	Section 6.2 Appendix B
B25	The Applicant must:	
	(a) initially construct the groundwater model required under condition B24 of Schedule 2 using the first three months of groundwater monitoring data collected from 17 June 2020 to 16 September 2020;	Section 6.2 Appendix B
	(b) update the groundwater model following collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021; and	Section 6.2

Table 2.1 Conditions relevant to the SWMP

Condition Number	Condition	Relevant report section
	(c) incorporate the outputs of the groundwater model into the Site Water Balance as required under condition B36(c)(i) of Schedule 2.	Section 5.3
B26	If a potential flood event (equivalent to a level of 64 m AHD at Menangle Weir, which represents the approximate height of overtopping of the Nepean River bank) does not occur between 17 June 2020 to 16 June 2021, then the Applicant must update the groundwater model required under condition B24 of Schedule 2 following the first flood event equivalent to or greater than this level when it occurs.	Section 6.2
B27	The Applicant must obtain any necessary Water Access Licences for the development under the *Water Act 1912* and/or the *Water Management Act 2000.*	Section 2.3.2
B28	When making an application for any necessary Water Access Licence, the Applicant must specify the annual take of water from each affected water source, as estimated by the groundwater model required under condition B24 of Schedule 2.	Section 2.3.2
B29	Should the maximum annual water take as calculated by the groundwater model increase due to subsequent revisions of the groundwater model, as required under conditions B25 and B26 of Schedule 2, the Applicant must acquire the necessary additional licence shares to account for the maximum predicted annual volume.	Section 2.3.2
B30	The Applicant must report on any water captured, intercepted or extracted from the site each year (directly and indirectly) in the Annual Review, including water taken under each Water Access Licence as applicable.	Section 5.8 Section 6.8
Soil Erosion		
B31	The Applicant must install and maintain suitable erosion and sediment control measures in the Stage 8 Area. These measures must be designed and implemented having regard to the guidance series *Managing Urban Stormwater: Soils and Construction*, and be detailed in the Soil and Water Management Plan required under condition B36 of Schedule 2.	Section 7
Soil and Water Management Plan		
B36	The Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
	(a) be prepared by suitably qualified and experienced person/s;	Section 1.10
	(b) be prepared in consultation with EPA and DPIE Water; and	Section 1.8
	(c) include a:	
	(i) **Site Water Balance** that:	Section 5.3
	• includes details of:	
	– sources and security of water supply;	Section 5.3.1
	– water use and management on the site;	Section 5.2
	– reporting procedures, including the annual preparation of a site water balance; and	Section 5.3.3 Section 5.8
	• minimises clean and potable water use on the site;	Section 5.3.1 Section 1.6
	• incorporates the outputs of the groundwater water model required under condition B24 of Schedule 2;	Section 5.3

Table 2.1 Conditions relevant to the SWMP

Condition Number	Condition	Relevant report section
	(ii) **Surface Water Management Plan**, that includes:	
	• detailed baseline data on surface water flows and quality in watercourses and/or water bodies that could potentially be affected by the development;	Section 3.3 Section 5.1
	• surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts, and surface water management performance measures;	Section 5.5
	• a detailed description of the surface water management system on the site, including the:	
	– clean water diversion system;	Section 5.2.3
	– erosion and sediment controls (including the construction of bunds and swales within each Substage); and	Section 7.2
	– water storages (including a description of measures to maintain the storage capacity of sedimentation basins);	Section 7.2.5
	• a program to monitor and report on:	
	– any surface water discharges;	Section 5.4 Section 5.8
	– the effectiveness of the water management system;	Section 5.8
	– surface water quality in sedimentation basins; and	Section 5.4
	– water levels and quality in the Nepean River both upstream and downstream of the site; and	Section 5.4
	• a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events;	Section 5.6
	(iii) **Groundwater Management Plan** that includes:	
	• all available baseline data for the site;	Section 6.3 Appendix B
	• groundwater performance criteria, including trigger levels for investigating any potentially adverse groundwater impacts, particularly with respect to aquatic habitat and regional groundwater systems;	Section 6.5
	• a protocol to ensure that Quarrying Operations do not exceed the extraction depth limit specified in condition B22(b) of Schedule 2;	Section 6.6
	• measures to ensure that the integrity of the groundwater monitoring network is not compromised by Quarrying Operations;	Section 6.1
	• a clear description of the reporting processes and procedures to be adopted for the routine collation, analysis and provision of monitoring data as required under conditions B21 and B22 of Schedule 2; and	Section 6.8
	• a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events.	Section 6.6 Section 6.8
B37	Subject to condition A29, the Applicant must not commence Quarrying Operations in the Stage 8 Area until the Soil and Water Management Plan is approved by the Planning Secretary.	Section 1.9
B38	The Applicant must implement the Soil and Water Management Plan approved by the Planning Secretary.	Section 1.9
B39	The Applicant must ensure that all surface discharges from the site comply with the relevant provisions of the POEO Act.	Section 2.3.1

Table 2.1 Conditions relevant to the SWMP

Condition Number	Condition	Relevant report section
Waste		
B91	The Applicant must:	
	(a) manage on-site sewage treatment and disposal in accordance with the requirements of an applicable EPL, and to the satisfaction of EPA and Council;	Section 1.6.2

2.3 Permits and licences

2.3.1 Environment Protection Licence

The quarry operates under Environment Protection Licence 3991 (EPL 3991). The EPL contains a number of conditions related to the prevention of pollution of, or to, water. These conditions are provided in Table 2.2, which also identifies the section of this SWMP or EMS where each condition is addressed. The EPL will be varied prior to commencing operations in the Stage 8 area.

Table 2.2 Relevant conditions of EPL 3991 for prevention of pollution (water)

Condition	Requirement	Relevant report section
L1	**Pollution of waters**	
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the *Protection of the Environment Operations Act 1997*.	Sections 5.5 and 6.5
M2	**Recording of pollution complaints**	
M2.1	The licensee must keep a legible record of all complaints made to the licensee or any employee or agent of the licensee in relation to pollution arising from any activity to which this licence applies.	EMS Sections 5 and 7
M2.2	The record must include details of the following: a) the date and time of the complaint; b) the method by which the complaint was made; c) any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect; d) the nature of the complaint; e) the action taken by the licensee in relation to the complaint, including any follow-up contact with the complainant; and f) if no action was taken by the licensee, the reasons why no action was taken	EMS Section 5
M2.3	The record of a complaint must be kept for at least 4 years after the complaint was made.	EMS Section 5
M2.4	The record must be produced to any authorised officer of the EPA who asks to see them.	EMS Section 5
R2	**Notification of environmental harm**	
R2.1	Notifications must be made by telephoning the Environment Line service on 131 555. Note: The licensee or its employees must notify all relevant authorities of incidents causing or threatening material harm to the environment immediately after the person becomes aware of the incident in accordance with the requirements of Part 5.7 of the Act.	EMS Section 7

Table 2.2 Relevant conditions of EPL 3991 for prevention of pollution (water)

Condition	Requirement	Relevant report section
R2.2	The licensee must provide written details of the notification to the EPA within 7 days of the date on which the incident occurred.	EMS Section 7

2.3.2 Water licensing

Menangle Sand and Soil hold existing water access licences (WAL) and approvals to extract surface water from the Hawksbury and Lower Nepean Rivers Water Source covered under the Water Sharing Plan (WSP) for the Greater Metropolitan Region Unregulated River Water Sources (see Section 5.3.1).

In accordance with Approval Condition B27 and the *Water Management Act 2000*, Menangle Sand and Soil is currently in the process of obtaining a 0.7-unit share WAL within the Sydney Basin Nepean Groundwater Source (Management Zone 2) to account for the estimated maximum groundwater ingress to the excavations in a Water Year (July–June) (see Section 6.2). Menangle Sand and Soil will specify the annual take of water from each affected water source, as estimated by the groundwater model.

Should the maximum annual water take as calculated by the groundwater model increase due to subsequent revisions of the groundwater model, Menangle Sand and Soil will acquire the necessary additional licence shares to account for the maximum predicted annual volume.

2.4 Guidelines

This SWMP has been developed consistent with the principles discussed in the following publications and documents:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC & ARMCANZ 2000) (ANZG 2018);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (EPA 2004);
- *Best Practice Erosion and Sediment Control* (IECA 2008);
- *Managing Urban Stormwater: Soils and Construction (4th Edition) Volume 1* (Landcom 2004) (the "blue book"); and
- *Managing Urban Stormwater: Soils and Construction – Volume 2E – Mines and Quarries* (DECC 2008).

3 Existing environment

3.1 Climate

The nearest active rainfall gauge to the quarry is the Bureau of Meteorology (BoM) operated gauge Menangle Bridge (Nepean River) (station number 68216). The Menangle Bridge rainfall gauge is located adjacent to the existing processing area and has a data record from 2000 to present day. While the Menangle Bridge gauge provides the most representative rainfall conditions at the site, the relatively short available data record means that rainfall statistics for the gauge are skewed by the generally drier conditions observed post 2000.

To characterise the long-term climate of the site, daily rainfall and evaporation totals were obtained as SILO (Scientific Information for Land Owners) Point Data from the Queensland Climate Change Centre of Excellence. SILO Point Data consist of interpolated estimates based on historically observed data from the BoM weather stations. SILO data was obtained for the nearest grid point (34.10 °S, 150.75 °S) located approximately 2 km north of the site. The average annual rainfall total at the site is 722 mm/year based on the SILO Point Data between 1900 and 2020.

Monthly rainfall and evaporation statistics calculated from the SILO Point Data between 1900 and 2020 are shown in Figure 3.1. Monthly rainfall totals are shown to be variable across all months but are generally higher in summer and lower during winter and early spring. Monthly evaporation totals are shown to typically exceed monthly rainfall totals throughout the year.

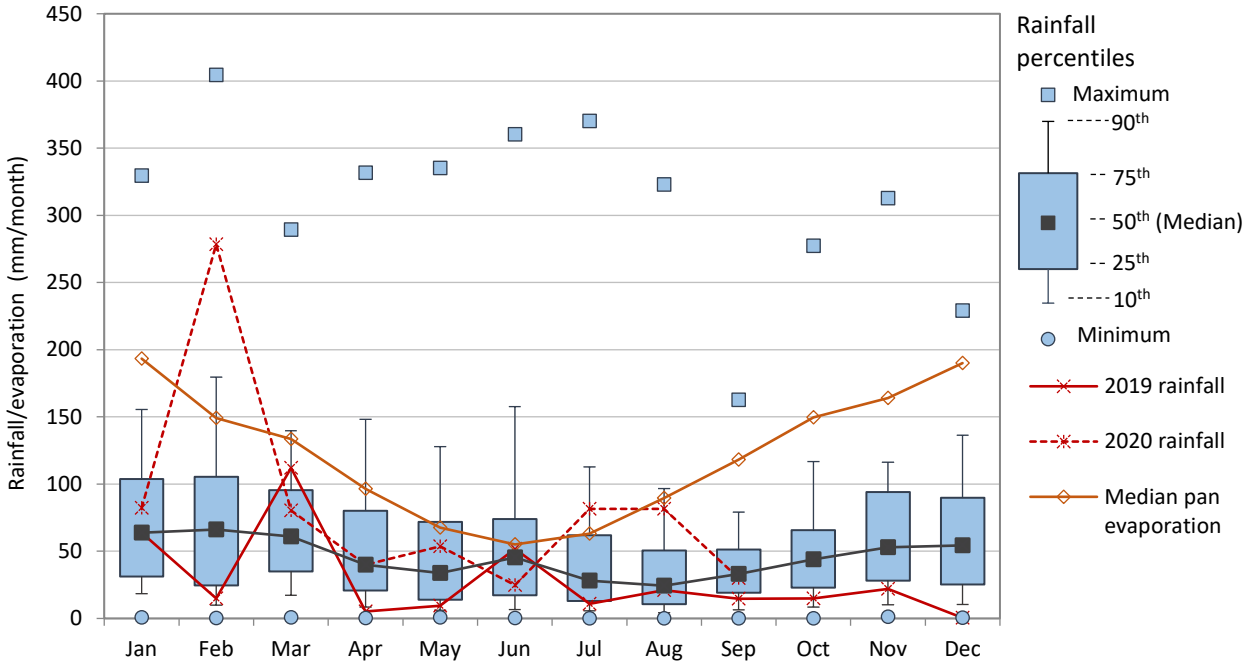


Figure 3.1 Monthly rainfall and evaporation statistics

The erosion potential of rainfall (rainfall erosivity (R-factor)) is a function of the rainfall amount and peak rainfall intensity measures in units of $MJ.mm.ha^{-1}.year^{-1}$. It is a multi-annual average index that measures rainfall's kinetic energy and intensity to describe the effect of rainfall on sheet and rill erosion and is calculated using the formula (Rosewell 1992):

$$R = 164.74\ (1.1177)^{S}\ S^{0.6444}$$

where, S is the 2-year annual recurrence interval (ARI), 6-hour rainfall event (0.5 exceedances per year, 6-hour event).

S equals 8.43 mm/h.

The calculated R-factor for the quarry site is 1,663 MJ.mm.ha^{-1}.year^{-1} The R-factor is used to determine erosion hazard for the quarry site in Section 7.1.

3.2 Land use and topography

The quarry is located in a semi-rural environment in the southwest of the Greater Sydney Metropolitan Region (see Figure 1.1). The surrounding land use includes scattered rural residential properties, agriculture and other extractive industry. The town of Menangle is located about 1 km to the south of the quarry's processing area. The area has a number of proposed housing developments currently in different stages of approval.

The quarry entry compound and processing area is located on the southern bank of the Nepean River, to the east and downstream of the Hume Motorway bridge. The ground surface elevation of these areas increases from approximately 61 m Australian Height Datum (AHD) at the Nepean River to approximately 70 m AHD at the southern boundary of the processing area. The terrain is terraced with lower elevations adjacent to the Nepean River and higher elevations forming the stockpiling and processing plant area.

Sand and soil will be quarried from the Stage 8 extraction area which is located along the western side of the Nepean River to the south of the processing area, upstream of the Hume Motorway bridge. The topography of the Stage 8 extraction area is steeper than the processing area, with a pronounced slope from the Nepean River to the agricultural land east of the Hume Motorway. The slope is generally gentler at the northern end of the Stage 8 area, increasing in steepness to the south. Terrain slopes within the Stage 8 area are described in Section 7.1.2.

3.3 Surface water

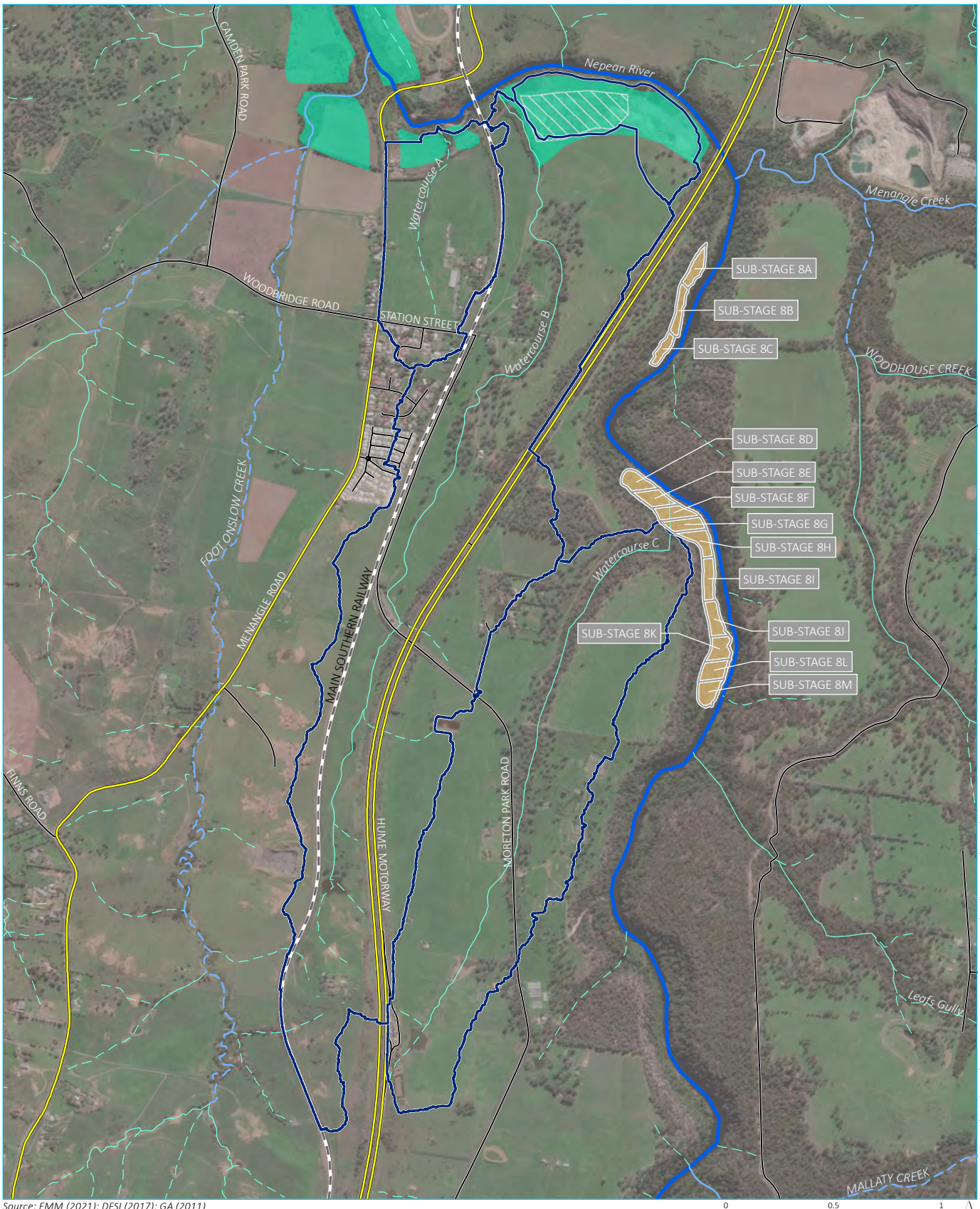
The quarry is located on the floodplain of the Nepean River which forms the northern boundary of the existing processing area and eastern boundary of the Stage 8 area. The Nepean River is a major perennial watercourse and forms part of the greater Hawkesbury-Nepean system. Adjacent to the quarry, the Nepean River is classified as a seventh order watercourse (Strahler 1952) and has a contributing catchment area of 1,280 km^2 (WorleyParsons 2015). A baseline characterisation of Nepean River flow regimes and water quality in the vicinity of the quarry is provided in Section 5.1.

There are several minor unnamed tributaries of the Nepean River close to, or within, the site entry compound, processing area and the Stage 8 extraction area (see Figure 3.2). All of these unnamed watercourses have an ephemeral flow regime and are identified as:

- Watercourse A – is a first order stream that flows north adjacent to the site entry compound and has a catchment of about 51 ha. The contributing catchment is comprised of rural grassland and a small area of residential development on the northern fringe of Menangle.

- Watercourse B – is a second order stream that flows north adjacent to the processing area. Watercourse B rises approximately 4 km south of the processing area and has a catchment of about 294 ha. The catchment is comprised of rural grassland with some scattered treed areas and includes parts of the Hume Motorway and Southern Rail Line corridors as well as a small area of existing residential development at Menangle.

- Watercourse C – is a second order stream that flows north and intersects the substage 8E, 8F and 8G extraction area. Watercourse C rises approximately 3 km south of the Stage 8 extraction area and has a catchment area of about 166 ha. The catchment is primarily comprised of rural grassland with some scattered treed areas.



Source: EMM (2021); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps_FMP\FMP001_WatercoursesCatchments_20201201_02.mxd 28/01/2021

KEY

- Existing processing area (to be retained)
- Substage boundary
- Stage 8 - extraction/rehabilitation area
- Extractive operations (approved)
- Rail line
- Main road
- Local road
- Local catchment

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

Local watercourses and catchment

Menangle Quarry Extension
Soil and water management plan
Figure 3.2

EMM creating opportunities

An Ephemeral Creek Management Plan will be developed specifically for Watercourse C prior to commencement of quarrying in Stages 8E, 8F and 8G in accordance with Approval Condition B40.

3.4 Geology

The quarry is within the south-central portion of the Permo-Triassic Sydney Basin (Helby 1980). The Sydney Basin covers approximately 36,000 km^2 along the eastern coast of Australia, centred around Sydney, NSW (Geoscience Australia 2020). Geology within the Sydney Basin typically comprises sedimentary sandstones and mudstones, Permian coal measures and marine shales (Helby 1980).

The quarry is predominantly underlain by Triassic Hawkesbury Sandstone (Colquhoun 2019). The Hawkesbury Sandstone occurs across approximately 20,000 km^2 of the Sydney Basin and can be up to a 250 m thick, typically comprising flat-lying, quartzose sandstone with occasional interbeds/interlaminates of shale. Deposition of the Hawkesbury Sandstone varies from shallow marine, littoral, estuarine, fluvial lacustrine and aeolian environments (Helby 1980).

The quarry extracts the Quaternary alluvial deposits along the Nepean River. Although not mapped in the regional surface geology (Colquhoun 2019), the alluvial deposit extends further south, localised to the Nepean River valley. The alluvial deposits comprise a mixture of sand, silt, gravel and clay (Colquhoun 2019).

An outcrop of Triassic Ashfield Shale of the Wianamatta Group is inferred approximately 500 m west of the quarry (Colquhoun 2019) and conformably overlying the Hawkesbury Sandstone. In some areas adjacent to the Nepean River the unit has been completely eroded, resulting in the underlying Hawkesbury Sandstone being in direct contact with the overlying alluvium (Ross 2014).

3.5 Soils

The processing area is mapped as being located within the Blacktown soil landscape. The Blacktown soil landscape occurs on gently undulating rises on Wianamatta Group shales and generally features shallow to moderately deep soils (<0.1 m) (Hazelton 1990).

The Stage 8 area is mapped as the Hawkesbury soil landscape and borders on the Blacktown soil landscape. The Hawkesbury soil landscape is situated along major rivers, such as the Nepean River. It is characterised by sandstone escarpments with moderate to steep slopes (>25%) and deeply incised valleys. Rock outcrops are a significant feature. This soil landscape is comprised of sandstone-quartz, sandstone-lithic, sand and shale overlaid with shallow, sandy soil.

The soil and landscape characteristics of the Hawkesbury and Blacktown soil landscapes are summarised in Table 3.1.

Table 3.1 Summary of soil landscapes

Soil landscape	Description	Vegetation and land use	Landscape integrity
Blacktown	Gently undulating rises on Wianamatta Group shales. Shallow to moderately deep (<0.1 m) hard setting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines.	Near completely cleared open-forest and open-woodland (dry sclerophyll forest).	No appreciable erosion occurs. Minor sheet and gully erosion may be found where surface vegetation is not maintained.

Table 3.1 Summary of soil landscapes

Soil landscape	Description	Vegetation and land use	Landscape integrity
Hawkesbury	Rugged, rolling to very steep hills on Hawkesbury Sandstone. Shallow (>0.5 m), discontinuous Lithosols/Siliceous Sands associated with rock outcrop; Earthy Sands, Yellow, Earths, and some Yellow Podzolic Soils on inside of benches and along joints and fractures; localised Yellow and Red Podzolic Soils associated with shale lenses; Siliceous Sands and secondary Yellow Earths along drainage lines.	Mostly uncleared open-woodland (dry sclerophyll) with pockets of tall open-forest (wet sclerophyll) and closed-forest (rainforest).	Severe sheet erosion often occurs during storms and after ground cover is destroyed by bushfire. Minor gully erosion occurs along unpaved tracks and fire trails.

Source: Hazelton and Tille (1990).

Importantly, field investigations have indicated that the Stage 8 area is not characteristic of the mapped soil landscapes but instead comprises alluvial deposits along a riparian corridor of the Nepean River. As such, the mapped soil landscapes are not indicative of the soils in the Stage 8 area. Drilling undertaking by Menangle Sand and Soil in 2014 indicates that the soils consist of deep fine to coarse sands ranging from 3 to 5.5 m deep with sandy loam soil with soil depth decreasing away from the river where bedrock is encountered.

3.6 Hydrogeology

The Hawkesbury Sandstone is a dual porosity aquifer unit, conducting groundwater flow primarily via interconnected fractures and partially via matrix pore spaces. Permeability of the unit is highly dependent on the degree, continuity and interconnectivity of fracturing. The unit is regionally semi-fully confined however, due to the inferred absence of the Wianamatta Group within the quarry the unit is assumed to be unconfined and hydraulically connected with overlying alluvial aquifers (where present) (Parsons Brinckerhoff 2009).

Groundwater within the upper section of the Hawkesbury Sandstone is typically slightly acidic-slightly alkaline (pH 5.3–7.3) (McLean 2009) and salinity of 1,000–3,000 milligrams per litre (mg/L) within the quarry (Russel 2009).

The localised alluvial aquifers within the quarry are likely highly permeable, unconfined aquifers. Water levels and quality are likely to be controlled by the Nepean River and rainfall with some potential influence from the underlying Hawkesbury Sandstone aquifer.

The Ashfield Shale typically has a very low permeability and contains saline groundwater. It is not considered an aquifer and, depending on the local underlying geological sequence, may be considered an aquitard or aquiclude. It may influence groundwater chemistry (particularly salinity) within the quarry (McLean 2009).

Further details of the baseline groundwater conditions are provided in Section 6.2 and in the Menangle Quarry Groundwater Model Report (provided in Appendix B).

4 Environmental aspects and impacts

4.1 Potential impacts

Key aspects of the quarry operation that could result in adverse impacts to soils and water include:

- vegetation clearing, including riparian vegetation, and topsoil stripping;
- earthworks, including resource extraction;
- transportation of extracted material;
- drainage works;
- material stockpiles;
- water use/extraction;
- landscaping and revegetation;
- operations including fuel and chemical storage, refuelling and chemical handling; and
- weed treatment, including herbicide spraying.

4.2 Impact summary

Potential impacts on soil and water depend on the nature, extent and magnitude of quarry activities and their interaction with the natural environment. The potential soil and water impacts associated with operations of the quarry are:

- erosion of land and soils within operational areas;
- mobilisation and transport of sediment into nearby surface water systems;
- contamination of surface water systems from activities associated with the quarry; and
- contamination of groundwater systems from activities associated with the quarry.

The potential soil and water impacts and associated risks are described in Table 4.1.

Table 4.1 Potential soil and water impacts and associated risk rating

Issue	Potential impact	Source	Risk ranking	Management response
Soil and water	Erosion of land and soils	Areas that have been disturbed by quarrying activities or areas that are unvegetated may be subject to erosion of topsoil in wet weather events.	High for soils Very low to very high from slope and rainfall	Refer to Section 7.2
	Mobilisation and transport of sediment	Runoff may transport sediment offsite and/or into surface water systems.	Moderate	Refer to Section 7.2

Table 4.1 Potential soil and water impacts and associated risk rating

Issue	Potential impact	Source	Risk ranking	Management response
	Contamination of surface water system from operational activities	If not properly managed, conducting quarrying operations in the vicinity of surface water systems could lead to contamination from waste, sediments, chemicals or other pollutants.	Moderate	Refer to Section 5.2
	Contamination of groundwater system from operational activities	If not properly managed, conducting quarrying operations could lead to contamination of groundwater from waste, sediments, chemicals or other pollutants.	Low	Refer to Section 6.6

5 Surface Water Management Plan

5.1 Baseline surface water data

5.1.1 Surface water flow

Nepean River water level and streamflow are measured at the WaterNSW operated Nepean River at Menangle Weir (212238) stream gauge. The Nepean River at Menangle Weir gauge is located approximately 250 m downstream of the processing area. The gauge provides a good representation of Nepean River flow characteristics adjacent to the site. Nepean River streamflow from 2015 to 2020 is shown in Figure 5.1.

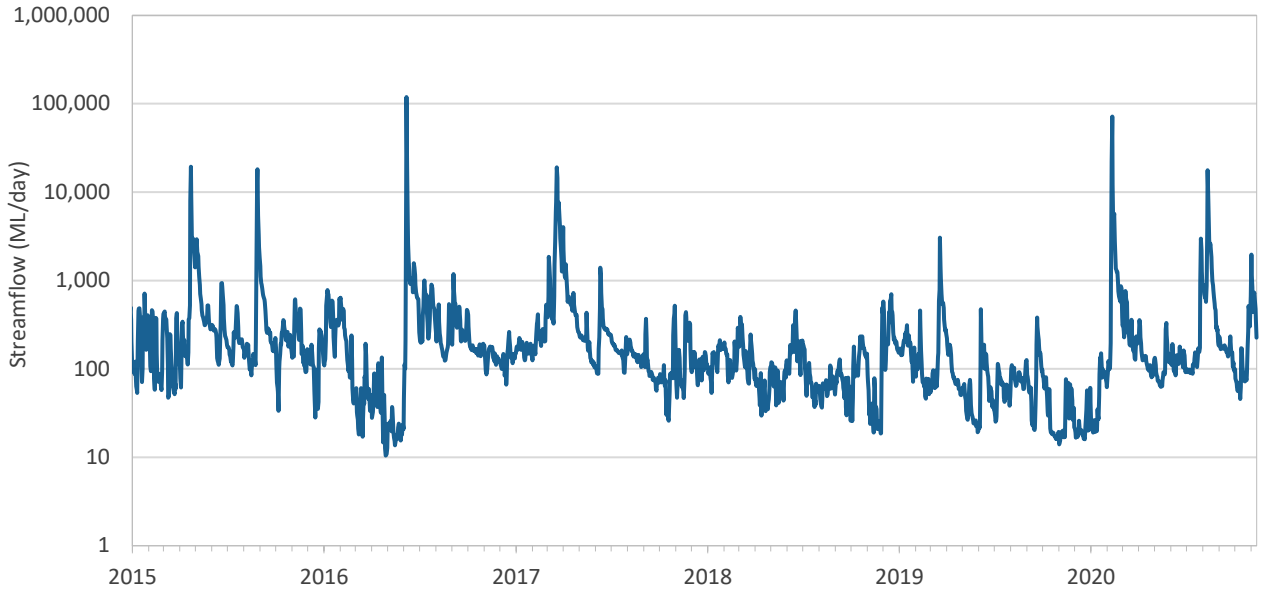


Figure 5.1 Nepean River at Menangle Weir streamflow from 2015 to 2020

The Nepean River experiences a broad range of daily streamflow totals with observed values ranging between about 10 ML/day and 100,000 ML/day (Figure 5.1). Streamflow at Menangle Weir typically ranges from 20 ML/day to 150 ML/day.

Water levels at Menangle Weir from 1990 to 2020 are shown in Figure 5.2. The Stage 8 horizontal setback contour (64 m AHD) and 20% and 50% annual exceedance probably (AEP) flood levels are shown for context. The Stage 8 extraction area is expected to be inundated by flooding. Flood conditions at the quarry are described in the Flood Management Plan (EMM 2020a).

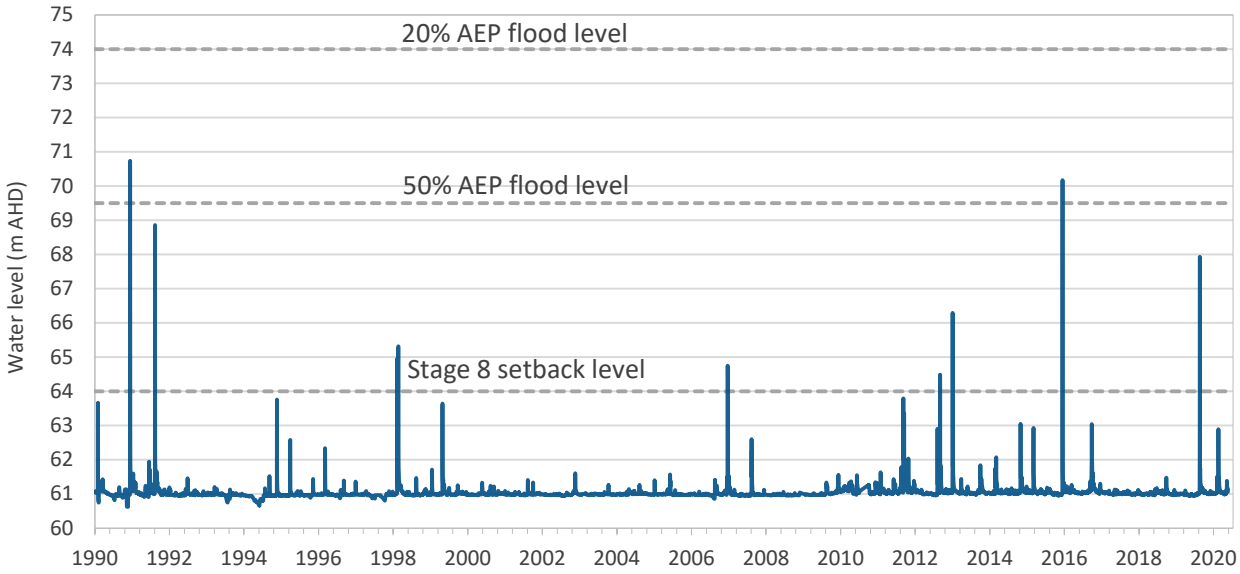


Figure 5.2 Menangle weir water level from 1990 and 2020

5.1.2 Surface water quality

Water temperature and electrical conductivity are measured at the Nepean River at Menangle Weir (212238) stream gauge by WaterNSW. Temperature data are available from 1990 while electrical conductivity data are available from 2019.

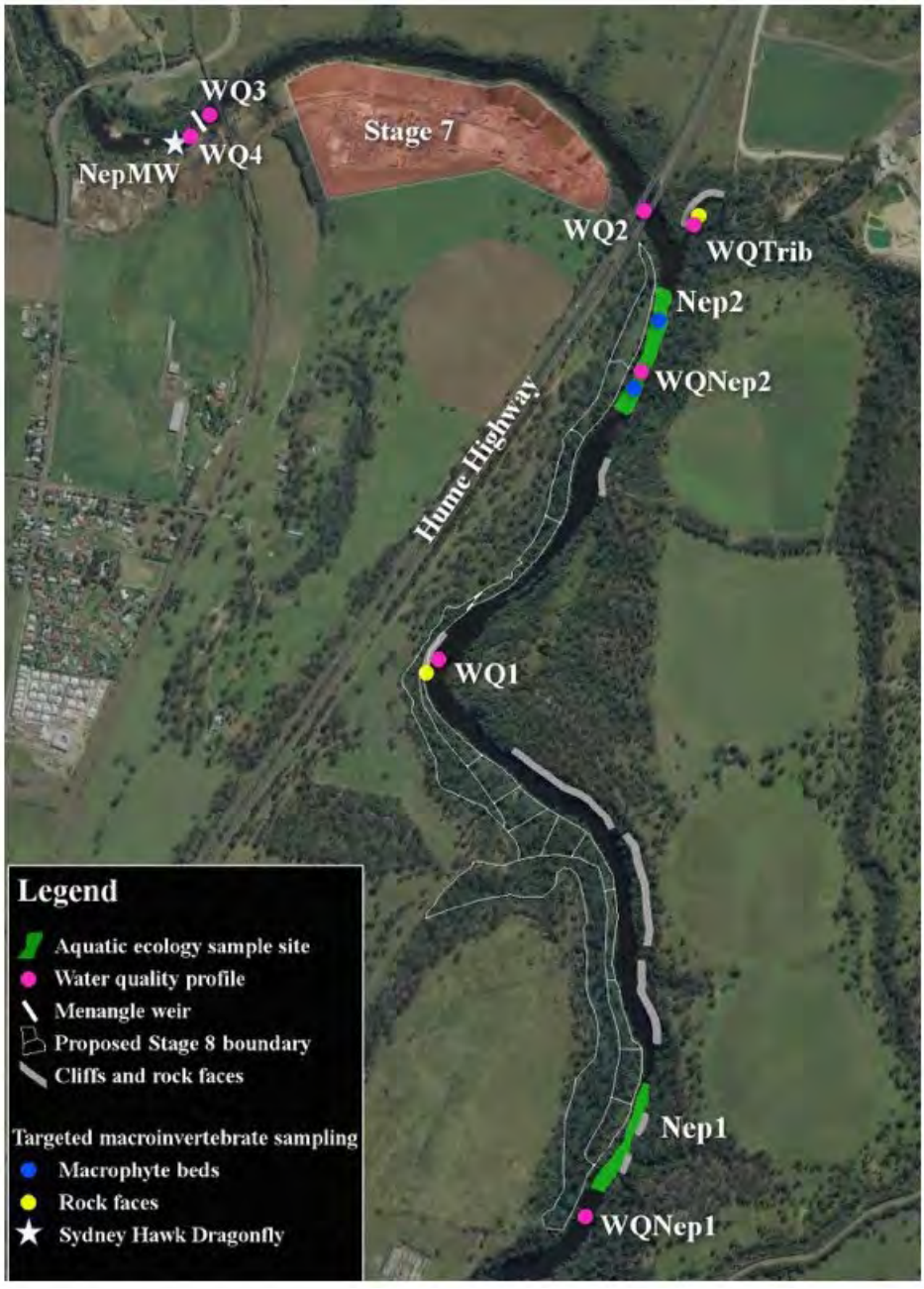
Monthly average water temperatures range from 9 °C in July to 27 °C in January. Electrical conductivity is fresh and typically ranges between 100 and 250 µS/cm. Lower electrical conductivities are generally observed during high flow conditions when rainfall runoff contributes a greater portion of streamflow.

Water quality in the Nepean River is summarised in the *Aquatic Ecology Assessment, Menangle Weir Pool Nepean River* (Marine Pollution Research 2019) as follows:

- There were generally no major differences between surface and bottom readings at sampling sites (see Figure 5.3), or of readings between sites, indicating that waters were generally well mixed, even at depth.
- Water temperatures were similar between river, tributary (WQTrib) and downstream of weir (WQ4) sites, ranging between 15.3°C and 16.8°C. Site NepMB waters [the Maldon Bridge, about 23.5 km upstream of Menangle Weir] (measured a week later) were slightly cooler, around 14.4°C.
- Conductivity levels were low for all Nepean River sites and showed a general decrease from upstream site Nep1 (mean ± standard deviation 203.4 ± 2.4 µS/cm) through to WQ3 (159.4 ± 0.7 µS/cm). Site NepMB (measured a week later) had a conductivity of 330.7 ± 0.6 µS/cm).
- Dissolved oxygen values were much lower (ranging from 48.6% to 63.5% saturation) for the sites upstream of the weir when compared to the range of values recorded at downstream of weir sites NepMW and WQ4 (89% to 100.9% saturation), as would be expected from sites located below sources of broken water.
- Water pH levels were alkaline at NepMB (pH 7.7), compared to downstream sites which were slightly acidic (pH range of 6.2 to 6.8).

- Turbidity values were low throughout all the Nepean River sites, ranging between 1.3 NTU and 8.1 NTU. Two elevated readings at WQ2 (20.1 and 24.1 NTU) were likely due to the probe coming in contact with bottom sediments.

- Field alkalinity (expressed in mg/L $CaCO_3$) for sampling sites Nep 1 and Nep2 was 36 mg/L at both sites and field alkalinity for NepMB (measured a week later) was 95 mg/L.



Source: Marine Pollution Research (2019).

Figure 5.3 Nepean River water quality sampling locations

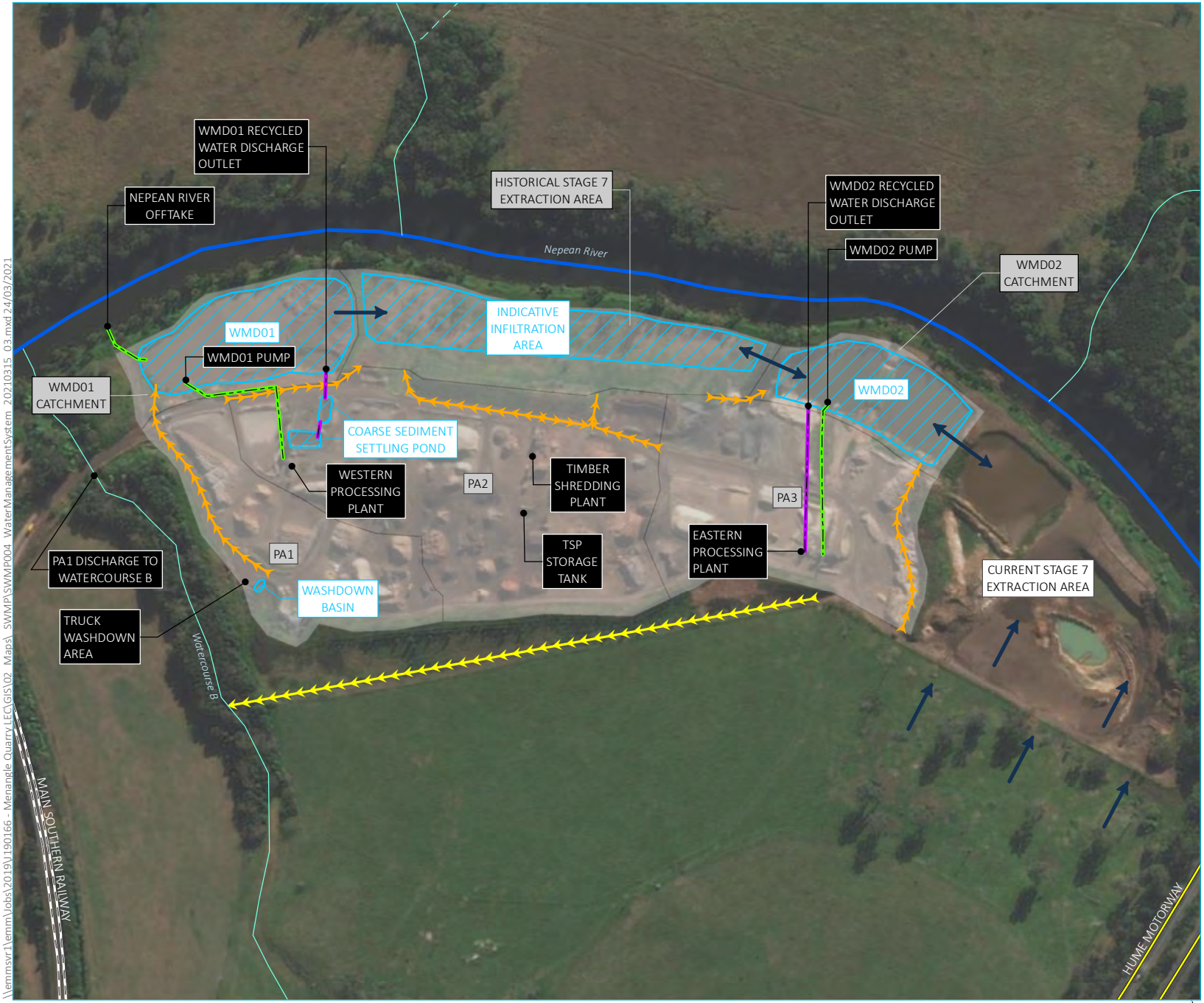
5.2 Surface water management

A surface water management system is in place for the existing processing area and Stage 7 extraction area. The existing processing area will be used to process, wash, blend and stockpile quarry material extracted from the Stage 8 area. Hence the existing surface water management system will be retained. Additional surface water management measures will be implemented for the Stage 8 extraction area. The surface water management system aims to:

- maximise the separation of clean and quarry affected water runoff;
- minimise discharges from the site by maximising the re-use and recycling of water onsite;
- minimise discharges of quarry affected water by capturing runoff from the existing processing area and active extraction area in water management storages prior to re-use or infiltration and evaporation; and
- minimise the potential for erosion and scour by implementing erosion and sediment control measures in accordance with *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004).

The quarry activities and water management controls in each catchment are described in Table 5.1. Controls in Stage 8 will be progressively relocated as the quarry advances.

Catchment areas and the key water management infrastructure in the processing area are shown in Figure 5.4. The Stage 7 extraction area has not been included in the description of the water management system as operations have ceased and the area will be rehabilitated as described in the Biodiversity and Rehabilitation Management Plan (EMM 2020b).



KEY

- Rail line
- Main road

Strahler stream order

- 1st order
- 2nd order
- 7th order

Indicative pipeline alignment

- Gravity pipeline
- Rising pipeline

Water diversion/drainage

- Clean water diversion bund/drain
- Quarry affected water drainage direction
- Water management storage area
- Water management catchment area
- Direction of surface flow

\\emmsvr1\emm\Jobs\2019\190166 - Menangle Quarry LEC\GIS\02 Maps\ SWMP\SWMP004 WaterManagementSystem 20210315 03.mxd 24/03/2021

Source: EMM (2021); DFSI (2017); GA (2011); ASGC (2006)

0 100 200 m

GDA 1994 MGA Zone 56

N

Water management system overview

Menangle Quarry Extension
Soil and water management plan
Figure 5.4

EMM creating opportunities

Table 5.1 Description of water management system

Catchment	Area (ha)	Catchment use	Surface water management
Site entry	0.8	• Parking • Site offices • Site access road • Truck wheel wash • Maintenance shed • Laydown area • Internal roads	• Runoff from the catchment drains onto the adjoining grassed area for infiltration. • Mains water is used to supply the site offices and truck wheel wash. • Water used in the truck wheel wash is recycled through a concrete sump pond resulting in a relatively small net water demand. • The internal roads are watered to minimise dust generation.
PA1	2.2	• Material stockpiling • Haul roads • Truck washdown	• Clean water diversion bund diverts runoff from upstream catchment into Watercourse B. • Runoff from the catchment drains to Watercourse B via culvert beneath haul road. • Water Management Dam (WMD) 01 is used to store water extracted from the Nepean River prior to use for dust suppression, truck washdown, and washing of material.
PA2	5.3	• Material processing and wash • Material stockpiling • Haul roads • Timber shredding plant (TSP) • Historical (Stage 7) extraction area	• Clean water diversion bund diverts runoff from upstream catchment into Watercourse B. • Runoff from the catchment drains to the historical Stage 7 extraction area for infiltration and evaporation. • Water used for material washing is recycled through two coarse-sediment settling ponds prior to discharging to WMD01 for re-use.
PA3	3.2	• Material processing and wash • Material stockpiling • Haul roads	• Clean water diversion bund diverts runoff from a portion of the upstream to Watercourse B. • Runoff from the catchment drains to WMD02 is used for material washing. • Water used for material washing is recycled through WMD02 for re-use.
Stage 8	0.33[1]	• Active extraction area • Haul roads	• Temporary sedimentation basin(s) will be constructed in extraction area to capture quarry affected water runoff prior to infiltration. No water will be extracted from the sedimentation basin.

Notes: 1. Advancing progressively.

5.2.1 Water storages

The quarry has two existing water management dams (WMD01 and WMD02) that are used for water supply and to capture quarry affected runoff from the existing processing area. The historical Stage 7 extraction area (WMD03) is also used to capture quarry affected runoff from the existing processing area prior to infiltration and evaporation. While the historical Stage 7 extraction area is not a formal water storage, a detention function is provided as a result of the embankment associated with the Stage 7 Nepean River setback contour.

A sedimentation basin(s) will be constructed to capture quarry affected runoff from the active Stage 8 extraction area. The location of the sedimentation basin will move as quarrying progresses. The Stage 8 sedimentation basin is described further in Section 7.2.5.

A description of each surface water storage including estimated storage volumes and overflow arrangement is provided in Table 5.2.

Table 5.2 Surface water storages

Storage ID	Description	Contributing catchment[1]	Estimated volume
WMD01	• Existing water management dam used to store water pumped from the Nepean River prior to use for dust suppression or in the western processing area. • Water used in the western processing area is recycled back into WMD01.	1.6 ha	6.1 ML[2]
WMD02	• Existing water management dam used to capture runoff from the PA3 catchment prior to use in the eastern processing area. • Water used in the eastern processing area is recycled back into WMD02. • Water exchange with the Nepean River may occur through the water management dam embankment but the exchange volume would be small compared to the pumped volume.	4.4 ha	27.5 ML[2]
Indicative infiltration area	• Historical extraction area that is used to capture and infiltrate runoff from PA2 catchment. • Receives overflows form WMD01 and WMD02.	7.7 ha	3.2 ML[2]
Stage 8 sedimentation basin	• Temporary sedimentation basin(s) to be constructed in the base of the Stage 8 extraction pit. • Captures runoff from the Stage 8 extraction area prior to infiltration into the underlying alluvium. • No water will be extracted from the sedimentation basin via a pump or other means.	1 ha[3]	0.3 ML

Notes: 1. Contributing catchment includes adjoining processing area catchment, water management storage surface area and catchment immediately adject to water management.
2. Storage volumes have been estimated from 2019 Lidar data sourced from ELVIS Spatial Data (ICSM 2020).
3. The Stage 8 contributing catchment and subsequently the required basin volume will vary as quarrying progresses.

5.2.2 Process water use

Typical process water requirements for the quarry have been provided by Menangle Sand and Soil (see Table 5.3). Operational water use is described further in the site water balance presented in Section 5.3.

Table 5.3 Water use description

Water use	Description	Water source	Annual water use
Dust suppression	• The site operates a 12-kL water cart 5.5 days per week. Typical application rate is estimated at 5 loads per day (0.33 ML/week). • An automatic sprinkler system provides dust suppression along the haul road between the processing area and the site entry area. Typical application rate estimated at 0.48 ML/week. • The Stage 8 access/haul roads and extraction area is expected to require dust suppression for up to an additional 2 ha. Typical application rate is estimated at 0.46 ML/week.	WMD01	66 ML/year

Table 5.3 Water use description

Water use	Description	Water source	Annual water use
Washing	• Water for the washing of materials is sourced from, and recycled to, the water management dams. • Gross process water demand is estimated at 62.4 ML/week most of which is recycled back to the water management dams. The net process water use is substantially less and is estimated at 0.63 ML/week. • Water lost in the quarry product is estimated to be a maximum of 8% (by weight) of total production (400,000 tpa) which is equivalent to the net process water use of 0.63 ML/week.	WMD01/02	32 ML/year[1]
Timber shredding plant (TSP)	• Water from WMD01 is transferred to a 23-kL water tank (TSP storage tank) to supply the TSP at an estimated rate of 0.18 ML/week.	WMD01	9 ML/year
Truck washdown	• A sprinkler system extracts water from WMD01 and transfers it to the truck washdown area at an estimated average rate of 0.04 ML/week. • Truck washdown water drains into the adjacent washdown basin for settlement and re-use.	WMD01	2 ML/year
Truck wheel wash	• Truck wheel wash water is sourced from and recycled to an adjacent concrete sump pond. • The sump pond is topped up with mains water approximately once every week and is expected to have negligible process water demand compared to the other water use processes described above.	Mains water	Negligible

Notes: 1. Net annual water use.

5.2.3 Clean water management

Clean water diversions are used at the quarry to intercept runoff from upstream catchments prior to it entering disturbed areas. There is a large vegetated clean water diversion bund on the southern side of the processing area which diverts upstream runoff to west and into Watercourse B (see Figure 5.4). Clean water diversions are also used to direct runoff around the existing site entrance compound and into Watercourse A.

There is limited opportunity to divert clean water away from the Stage 8 extraction areas due to topography and extent of native vegetation required to establish diversion drains. Further, unnecessary concentration of flow increases the erosion potential of runoff and may encourage the dispersal of weed seeds from the upstream catchments into rehabilitation and biodiversity restoration areas. As such, the sedimentation basin will be sized for both the contributing exposed and clean run-on water catchments.

The extraction area will be separated from the Nepean River by the combined Nepean River Buffer Zone (10 m to 17 m wide horizontally) and the lower riverbank that will remain in situ.

Due to the permeable nature of the soils being extracted in Stage 8, runoff is expected to be minimal with the majority of rainfall infiltrating into the underlying soil. As has been found to be the case during quarry operations over the last 30 years.

5.2.4 Quarry affected water management

Quarry affected runoff from most of the processing area is managed within the water management dams and the historical Stage 7 extraction area. Quarry affected runoff from catchment PA1 formerly drained to the Nepean River via Watercourse B. Water management system improvements now redirect quarry affected runoff from PA1 to WMD01.

The water management dams, and historical Stage 7 extraction area provide the primary erosion and sediment control function for the processing area. Quarry affected runoff that is captured in the water management dams is extracted for dust suppression and for use in the processing area. The runoff that drains to the historical Stage 7 extraction area is either evaporated or infiltrated into the underlying alluvium. The re-use and infiltration of quarry affected water minimises the potential for this water to discharge into the Nepean River.

Quarry affected runoff from the site entrance compound and access road drains to an adjacent vegetated buffer for infiltration. In higher runoff events, the vegetated buffer provides a treatment function prior to runoff entering the Nepean River.

Water management measures will be implemented within the proposed Stage 8 extraction area to capture and treat quarry affected runoff from the active pit area. An adaptive approach to erosion and sediment control will be implemented to account for the constantly progressing quarry footprint. The following water runoff and erosion and sediment control measures (or design principals) will be implemented:

- clean water diversions will be constructed (see Section 5.2.3) to minimise the volume of water that requires management within the quarry affected water system;
- a sedimentation basin (or basins), sized to trap and treat runoff from the Stage 8 area will be excavated within the extraction pit;
- sedimentation basins will be formed in the base of the pit and will be relocated as the extraction area progresses;
- runoff that is generated within the pit will drain to the sedimentation basin and infiltrate into the underlying alluvium via gravity or evaporate; and
- sedimentation basins will be desilted as required to maintain adequate storage capacity.

Site sediments are generally coarse, and low in clay, and as such the sediments are not expected to require treatment with coagulants or flocculants.

The optimal location for sedimentation basins and diversion bunds/swales will be determined as the active extraction area progresses. Erosion and sediment control measures will be regularly reviewed and maintained. A schematic of the Stage 8 quarrying method is shown in Figure 5.5.

Quarrying methods aimed at reducing the risk of erosion and sedimentation during a Nepean River flood event are described in the *Flood Management Plan* (EMM 2020a).

5.2.5 Spill management

Hydrocarbon spills (ie a burst hydraulic hose or spill during refuelling) may occur during quarry operations. Spills will be immediately cleaned up following the identification of an incident. The clean-up and treatment of spills will be managed under the quarry's *Pollution Incident Response Management Plan* (Menangle Sand and Soil 2020) and internal standards and procedures.

Stage 8 quarrying schematic

Menangle Quarry Extension

Figure 5.4

5.3 Site water balance

A site water balance has been developed for the quarry to quantify water use and transfers under existing and future operational conditions. The water balance model applies a continuous simulation methodology that simulates the response of the water management system under a range of climatic conditions (ie rainfall and evaporation). The water balance model has been created by representing each process of the water management system with pre-determined responses that reflect how the proposed water management system will operate. A schematic of the overall water management system is shown in Figure 5.6.

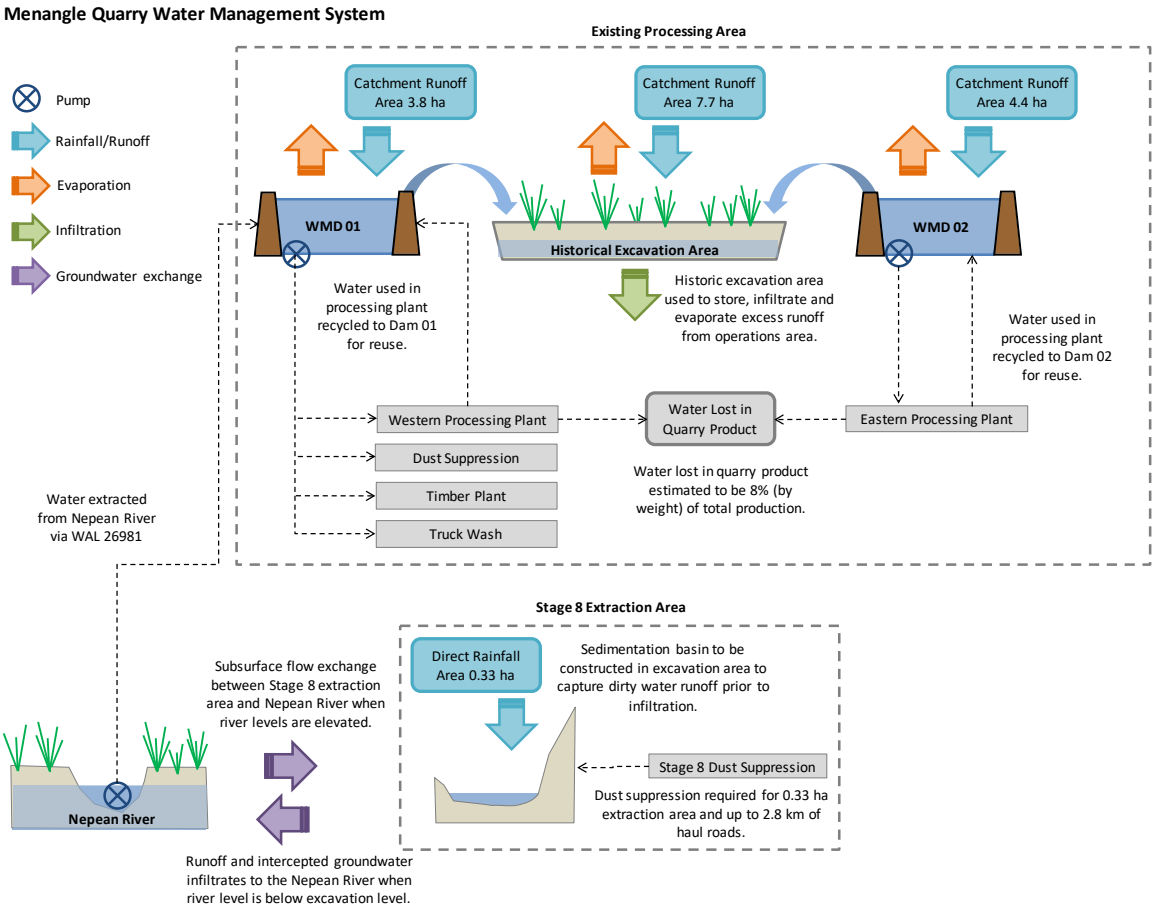


Figure 5.6 Water management system schematic

The model simulated the quarry water management system using 50 years of historical climate data and a daily time step. Daily rainfall and evaporation data for the period 1970 to 2020 was obtained as a SILO Point Data (see Section 3.1) and applied to the model. A summary of annual water management system inputs and outputs for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years is provided in Table 5.4.

Based on the preliminary groundwater modelling (see Section 6.2), a peak groundwater inflow volume of 0.4 ML/year is predicted. However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model, the inflow volumes may reach 0.7 ML/year. This higher value was used in the water balance, although it is noted that groundwater contribution is a small part (<0.5%) of the total water inputs.

Table 5.4 Summary of site water balance results

Water management component	Typical dry year (ML/year)	Median rainfall year (ML/year)	Typical wet year (ML/year)
Annual rainfall (mm/year)	443	730	916
Inputs			
Direct rainfall onto storages and catchment runoff	27	49	73
Nepean River water supply	116	90	82
Groundwater inflow to Stage 8 area	0.7	0.7	0.7
Total inputs	**144**	**140**	**156**
Outputs			
Evaporation	16	13	14
Infiltration (infiltration area, seepage from Stage 8 area)	10	19	28
Process water (dust suppression, timber plant, truck wash)	86	76	77
Water lost in product	33	33	33
Overflows from processing area	0	0	2
Total outputs	**145**	**141**	**154**
Change is storage	-1	-1	2
Balance (inputs – outputs – change in storage)	**0**	**0**	**0**

5.3.1 Water supply security

Water for site operational demands is sourced from the Nepean River and from harvested quarry affected runoff.

To minimise the requirement to source water from the Nepean River, process water used for material washing is recycled to WMD01 and WMD02 for re-use. The water balance model results in Table 5.4 show in a typical dry year (10^{th} percentile) the quarry requires 116 ML/year to be sourced from the Nepean River. Make-up water supply for quarry operations is primarily sourced from WAL 26981 (Water Supply Work Approval 10WA116673) for 640 units from the Hawksbury and Lower Nepean Rivers Water Source.

Given the significant difference between the water supply requirements and existing WAL entitlements, environmental and operational risks associated with water supply security are low. However, the rate of extraction will be reduced if water supplies are insufficient to meet operational requirements.

5.3.2 Overflow frequency

The water balance model results presented in Table 5.4 indicate overflows from the processing area water management system are predicted to occur during typical wet (90^{th} percentile) conditions. The model results show overflows are could theoretically occur due to high intensity rainfall events when runoff from the water management catchments exceed the storage and infiltration capacity of water management storages. However, this has not occurred in practice. Because of the large catchment upstream of the site and the precautionary releases from an upstream dam, floodwaters from the Nepean River are observed to inundate the site (and the water management dams) before they fill from local catchment runoff from the processing area. Hence, impacts due to water management system overflows are mainly associated with the mixing of quarry materials with

floodwaters. Control measures to reduce the risk of impacts during a Nepean River flood event are describe in the Flood Management Plan (EMM 2020a).

5.3.3 Preparation of annual site water balance

A site water balance will be prepared annually to document site water use and compliance with water licencing requirements. The water balance will include annual estimates of the following:

- runoff volume harvested by the water management dams using:
  - annual rainfall totals at BoM operated Menangle Bridge (Nepean River) rainfall gauge (or another appropriate gauge as necessary); and
  - appropriate hydrological assumptions for the contributing water management catchments.
- evaporation total based on nearest BoM operated evaporation gauge or Silo Patched Data for the site;
- net process water use including water lost in product; and
- water sourced from the Nepean River.

An estimate of annual groundwater inflows to the active Stage 8 extraction area will also be provided. The results of the annual site water balance will be reported in the Menangle Sand and Soil Quarry Annual Review.

5.4 Surface water monitoring program

The objective of the surface water monitoring program is to collect data to enable:

- the quality of surface water within the quarry's water management system and receiving waters to be progressively characterised;
- the site water balance to be progressively updated (as required); and
- assessment of compliance with the Approval and license conditions.

An overview of the surface water monitoring program is provided in Table 5.5. Monitoring locations are shown in Figure 5.7. Surface water quality monitoring will be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (EPA 2004). The proposed suite of analytes and monitoring methods are presented in Table 5.6.

Table 5.5 Surface water monitoring program overview

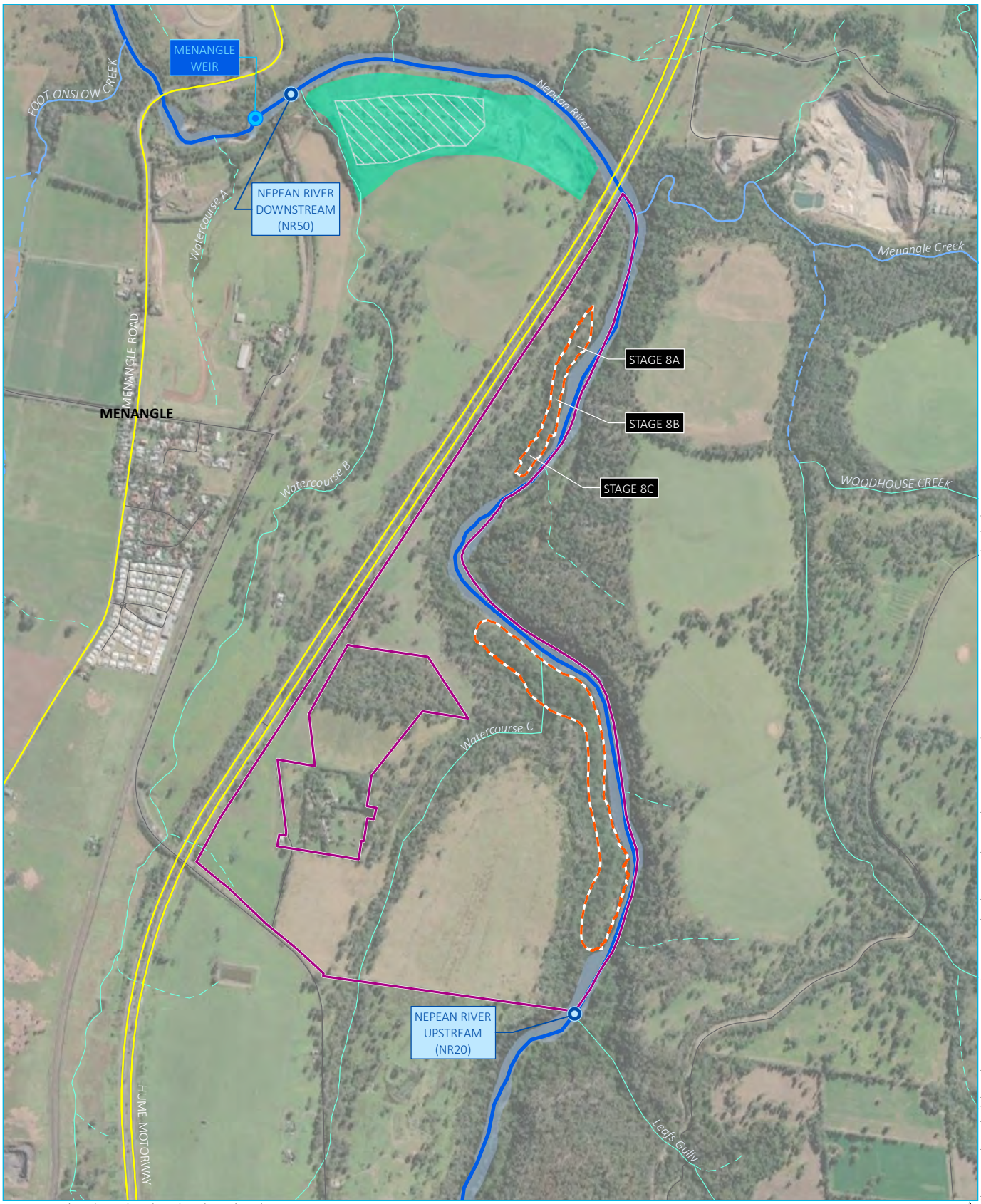
Monitoring aspect	Objective	Monitoring locations	Monitoring description
River level	To monitor water levels in the Nepean River adjacent to the site.	• Nepean River at Menangle Weir (212238)	River levels obtained from the Water NSW gauging station (212238).
Process water	Record process water volumes to inform the site water balance.	• Water cart use • Nepean River to WMD01	Monthly process water volumes will be recorded either by a cumulative flow meter or daily tanker load count.

Table 5.5 Surface water monitoring program overview

Monitoring aspect	Objective	Monitoring locations	Monitoring description
Discharges	To record the occurrence of site discharges.	• Processing area	The date and location of discharges (should they occur) will be recorded.
Water quality	To monitor the quality of water in the active extraction area sedimentation basins and in the Nepean River both upstream and downstream of the site.	• Active Stage 8 sedimentation basin • Nepean River (NR20 and NR50)	Monitoring is to be undertaken via grab samples at each location. Samples are to be collected on a monthly basis for the first 12 months and quarterly thereafter.

Table 5.6 Surface water quality analytical suite and method

Category	Analyte to be tested	Analysis method
General	• Temperature • pH • Electrical conductivity	To be measured using a portable water quality meter in the field.
	• Turbidity • Total suspended solids • Major ions • Total hardness as $CaCO_3$ • Oil and grease	Analysis to be undertaken by a NATA certified laboratory.
Nutrients	• Ammonia, oxidised nitrogen, organic nitrogen and total nitrogen • Reactive and total phosphorus	Analysis to be undertaken by a NATA certified laboratory.
Dissolved metals	• Al, As, B, Cd, Cr, Cu, Fe, Mn, Hg, Ni, Pb, Se, Ag and Zn	Analysis to be undertaken by a NATA certified laboratory.



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

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KEY

- Study area
- Existing processing area (to be retained)
- Menangle Quarry - stage 7
- Proposed extraction area - stage 8
- River level monitoring location
- Water quality monitoring location
- Main road
- Local road
- Named waterbody

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

Surface water monitoring locations

Menangle Quarry Extension
Soil and water management plan
Figure 5.7

EMM
creating opportunities

5.5 Surface water assessment criteria and trigger values

There are no prescribed surface water monitoring criteria in DA 85/2865 or EPL3991. Notwithstanding, the quarry must comply with Section 120 of the *Protection of the Environment Operations Act 1997*. The surface water monitoring would be undertaken to provide baseline Nepean River water quality and determine whether there are any contaminants in the sedimentation basins that could infiltrate to the underlying groundwater or Nepean River.

The baseline monitoring data (see Section 5.1.1) indicates the Nepean River is fresh with electrical conductivity and turbidity ranges which generally meet the ANZG (2018) default guideline values (DGVs) shown in Table 5.7. Water pH levels near the quarry were observed to be slightly acidic with some samples being lower than the DGV range.

Surface water assessment criteria have been developed using the default guideline values presented in ANZG (2018). The default trigger values provided in ANZECC & ARMCANZ (2000) are used where a parameter DGV is not yet defined in ANZG (2018). The surface water assessment criteria are provided in Table 5.7.

Table 5.7 Surface water assessment criteria and trigger values

Parameter	Units	Trigger value
General[1]		
Temperature	°C	-
pH	-	6.5–8.5
Electrical conductivity[3]	µS/cm	200–300
Turbidity	NTU	6–50
Total suspended solids	mg/L	-
Total hardness as CaCO3	mg/L	-
Oil and grease	mg/L	-
Nutrients[1]		
Ammonia	µg N/L	20
Oxidised nitrogen	µg N/L	40
Organic nitrogen	µg/L	-
Total nitrogen	µg N/L	500
Reactive phosphorus	µg P/L	20
Total phosphorus	µg P/L	50
Dissolved metals[2]		
Aluminium (Al)	µg/L	55
Arsenic (As)[4]	µg/L	13
Boron (B)	µg/L	370
Cadmium (Cd)	µg/L	0.2
Chromium (Cr)[5]	µg/L	1.0
Copper (Cu)	µg/L	1.4
Iron (Fe)	µg/L	-
Manganese (Mn)	µg/L	1,900

Table 5.7 Surface water assessment criteria and trigger values

Parameter	Units	Trigger value
Mercury (Hg)	µg/L	0.06
Nickel (Ni)	µg/L	11
Lead (Pb)	µg/L	3.4
Selenium (Se)	µg/L	5
Silver (Ag)	µg/L	0.05
Zinc (Zn)	µg/L	8.0

1. The trigger values for general parameters and nutrients refer to the DGVs for physical and chemical stressors in south-east Australia (lowland river) that are reported in Tables 3.3.2 and 3.3.3 of ANZECC & ARMCANZ (2000) as DGV is not yet defined in ANZG (2018).
2. Dissolved metal trigger values are for slightly to moderately disturbed ecosystems (ANZG 2018).
3. Table 3.3.3 of ANZECC & ARMCANZ (2000) specifies NSW coastal rivers typically have salinity values in the range of 200–300 µS/cm. The default trigger value for salinity in lowland rivers is 125–2,200 µS/cm as a DGV is not yet defined in ANZG (2018).
4. For AS (V).
5. For Cr (VI).

5.6 Surface water Trigger Action Response Plan

Surface water monitoring will be undertaken from within the water management system and the Nepean River (see Section 5.4). Exceedances will be identified and addressed as described in Table 5.8.

The Trigger Action Response Plan (TARP) provided in Table 5.8 establishes methods to identify the source of water quality exceedances and if necessary, establish actions to either improve water management or further investigate the exceedance.

Table 5.8 Surface water Trigger Action Response Plan

Trigger	Action required	Follow up actions
Discharges		
Unanticipated overflows from the water management system to the Nepean River.	Any unanticipated quarry affected water overflows that causes or threatens to cause material harm will be notified to DPIE and EPA immediately. All other unanticipated quarry affected water overflows to the Nepean River will be reported to DPIE and EPA within 7 days of the overflow occurring.	The notification and report will provide the information required by Approval conditions D7 and D8 as described in Section 8.2.2 of the *Environmental Management System* (EMS) (EMM 2020c). As well as the information required for all incidents (see EMS Section 8.2.2), the report will include the following information: 1. location of overflow event; 2. time at which overflow event commenced; 3. time at which overflow event ceased; 4. duration of the overflow event; and 5. estimated volume of overflow.

Table 5.8 Surface water Trigger Action Response Plan

Trigger	Action required	Follow up actions
Water quality		
Concentration of physical parameters within temporary sedimentation basin outside of trigger values provided in Table 5.7.	Investigate potential cause of exceedance and whether impacts to receiving environment are expected.	Document outcomes of investigation and any mitigation/management measures implemented in Annual Review.
Concentration of physical parameters at downstream Nepean River monitoring site (NR20) outside of trigger values provided in Table 5.7.	Identify if exceedance is naturally occurring or due to the quarrying operation by reviewing: 1. upstream sample location data to determine if exceedance naturally occurring; 2. baseline sampling data to determine if similar exceedances are known to occur; 3. sedimentation basin monitoring data to determine if similar exceedance occur.	If the source of exceedance is determined not to be associated with quarry operations, no other further action is required. If the source of exceedance is undetermined or identified as potentially due to quarry activities, the exceedance is to be noted in database for consideration in future monitoring rounds. If ongoing (2 out of 3 consecutive monitoring rounds) water quality anomalies are detected at downstream Nepean River monitoring site, advise DPIE and EPA.

The surface water TARP will be refined in future years as more site-specific surface water data are obtained.

5.7 Summary of surface water management actions

Specific surface water-related management measures and requirements to meet the objectives of this SWMP and to prevent impacts to surface water are outlined in Table 5.9. These will effectively manage potential surface water impacts that may arise due to the operation of the quarry. Erosion and sediment control management and mitigation measures are described in Section 7.

Table 5.9 Surface water management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
Hydrocarbons and other contaminant spills will be cleaned up immediately.	Throughout Stage 8A, 8B and 8C quarry operations	All quarry staff	Approval Condition B18
An annual water balance will be undertaken to describe water use and surface water licencing requirements.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Approval conditions B23 and B36(c)(i)
Surface water management measures such as clean water diversions, the capture of potentially quarry affected runoff and reuse of water onsite are to be implemented.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Approval Condition B36(c)(ii)
Surface water quality samples will be collected from within the Stage 8 sedimentation basin and upstream and downstream Nepean River locations.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Approval Condition B36(c)(ii)
Surface water assessment criteria will be used to identify potentially adverse impacts.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Approval Condition B36(c)(ii)

Table 5.9 Surface water management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
The TARP will be applied to investigate exceedances of surface water impact assessment criteria.	Throughout Stage 8A, 8B and 8C quarry operations	Quarry Manager	Approval Condition B36(c)(ii)

5.8 Data management and reporting

Menangle Sand and Soil will retain records of process water use, site discharges and surface water quality monitoring for a minimum period of the life of the quarry. Monitoring records will be made available to relevant government authorities upon request.

All data obtained as part of the surface water monitoring program (including any water captured, intercepted or extracted from the site each year (directly and indirectly), water taken under each Water Access Licence and any discharges) will be compiled and reported each year in the Annual Review. The data will be analysed against the established performance criteria triggers and for any trends that may be occurring. Triggers will be assessed for appropriateness against seasonal climatic variations and revised if necessary.

The Annual Review will report on the effective of the quarry's water management system based on an analysis of this monitoring data.

Any modifications to the surface water monitoring network will be reported in the Annual Review.

Details of regular reporting and incident reporting are provided in Section 7 and Section 8 of the EMS respectively.

6 Groundwater Management Plan

6.1 Groundwater monitoring network

The groundwater monitoring network comprises five bores (Table 6.1):

- two monitoring bores installed to assess groundwater within the alluvium; and
- three monitoring bores installed to assess groundwater within the Hawkesbury Sandstone.

One nested location (BH01_S/BH01_D) consists of adjacent bores installed within the alluvium and Hawkesbury Sandstone aquifers respectively. The location of the monitoring network is shown in Figure 6.1.

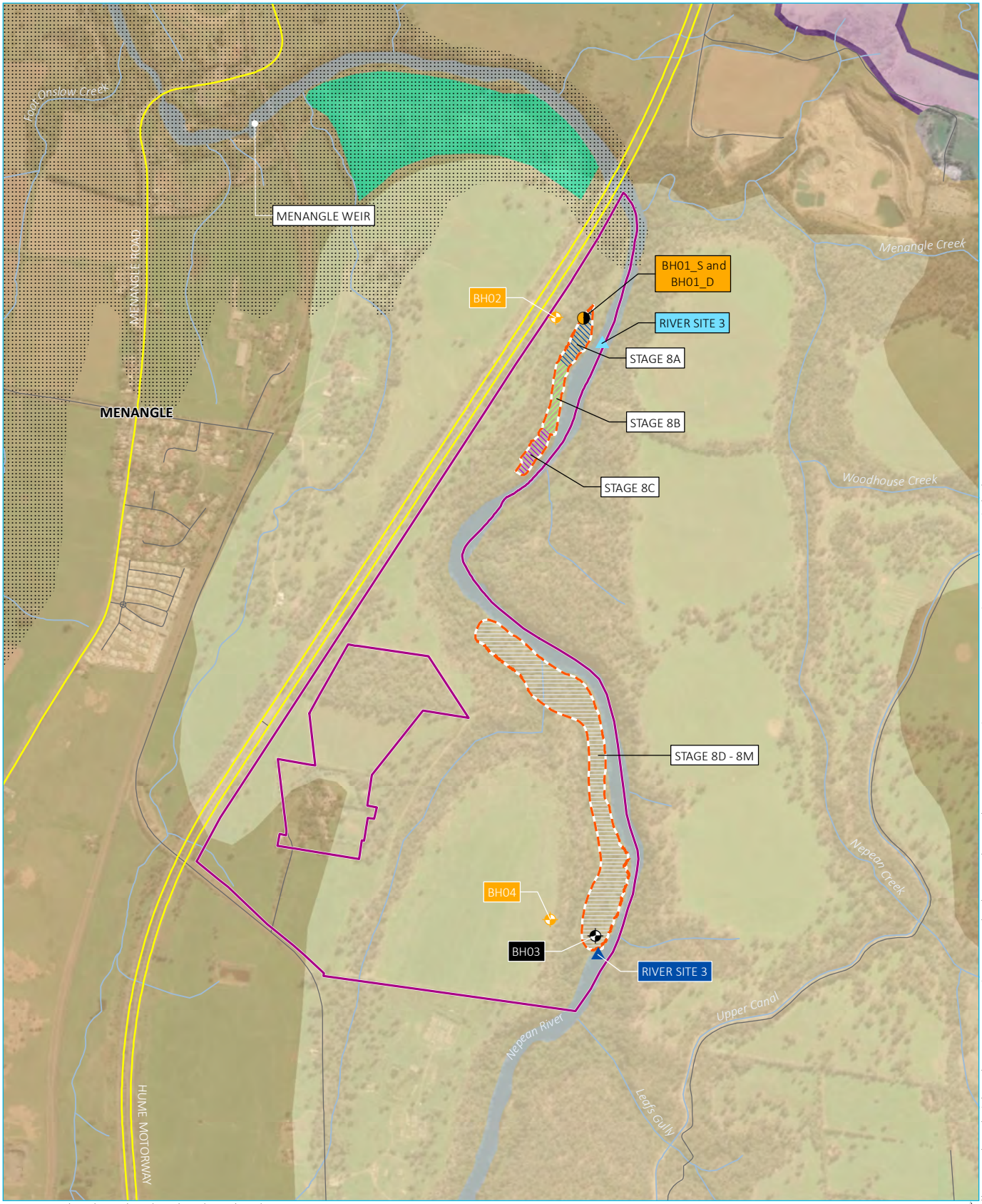
Table 6.1 Groundwater monitoring network summary

Location	Aquifer monitored	Co-ordinates[1]		Elevation	Screen depth	
		Easting mEast	Northing mNorth	Ground level[2] m AHD	Top[3] mbgl	Bottom mbgl
BH01_S	Alluvium	292937	6221762	66.73	4.4	7.4
BH01_D	Hawkesbury Sandstone	292934	6221758	67.04	8.5	11.5
BH02	Hawkesbury Sandstone	292844	6221762	87.62	33	39
BH03	Alluvium	292976	6219699	65.71	20	23
BH04	Hawkesbury Sandstone	292826	6219754	105.92	54	60

1. co-ordinates are projected in Map Grid of Australia (MGA), Zone 56;
2. metres above Australian Height Datum, ±20 mm; and
3. metres below ground level.

Following drilling and screen installation, all five groundwater monitoring bores were installed with Solinst Levellogger™ pressure transducer dataloggers, set to record groundwater level fluctuations every six hours. A barometric logger installed at the site (within the protective cover of BH01_D) measures and logs changes in atmospheric pressure, which are used to compensate water level readings recorded by the dataloggers.

The groundwater monitoring network will be maintained over the life of the quarry ensuring that quarrying operations do not compromise the integrity of the monitoring bores. A visual assessment for damage or blockage of the bores will be undertaken during each monitoring round (see Section 6.4) and repairs or modifications actioned where necessary.



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

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KEY

- Study area
- Menangle Quarry - stage 7
- Proposed extraction area - stage 8

Stage 8 - sub areas

- Stage 8A
- Stage 8B
- Stage 8C
- Stages 8D - 8M

Monitoring location

- Borehole - alluvium
- Borehole - sandstone
- Borehole - alluvium & sandstone
- Surface water quality
- Surface water quality and level

Surface geology

- Alluvium
- Ashfield shale
- Bringelly shale
- Hawkesbury sandstone
- Minchinbury sandstone

- Main road
- Local road
- Watercourse/drainage line
- Waterbody

Groundwater monitoring network

Menangle Quarry Extension
Soil and water management plan
Figure 6.1

EMM creating opportunities

6.2 Groundwater modelling

Preliminary groundwater modelling has been conducted, in accordance with Approval conditions B24, B25 and B28. This modelling quantifies the groundwater licence volume required from the Sydney Basin Nepean Groundwater Source (Management Zone 2) to allow for temporary interception of groundwater by quarrying in the Stage 8 area. The modelling was informed by approximately three months of groundwater monitoring data, proposed quarrying operations and expected conditions at the site (water levels in the Nepean River and adjacent groundwater system are largely controlled by the Menangle Weir with only short-duration rises above this long-term average level).

Based on preliminary Stage 1 modelling, the project will require an annual licence allocation to cover the peak predicted inflow volume of 410 kL/yr (0.4 ML/yr) for a high flow event (river level up to 64 mAHD). However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model (see below), the inflow volumes may reach 710 kL/yr (0.7 ML/yr). The outputs of the groundwater model have been incorporated into the site water balance (see Section 5.3) which will be updated annually.

The groundwater model will be updated following the collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021. If a potential flood event (equivalent to a level of 64 m AHD at Menangle Weir, which represents the approximate height of overtopping of the Nepean River bank) does not occur between 17 June 2020 to 16 June 2021, then the groundwater model will be updated following the first flood event equivalent to or greater than this level when it occurs.

6.3 Baseline groundwater data

6.3.1 Groundwater levels and flow

Groundwater levels in all five monitoring bores have been recorded by continuous dataloggers every six hours since 3 June 2020 at 12:00. The loggers were downloaded during three monitoring events in June and September 2020, and water levels verified by manual dips using an electronic dip meter. All available baseline groundwater level data is provided as hydrographs in Appendix A of the *Groundwater Model Report* (Appendix B). The hydrographs indicate that water levels in the Nepean River and the alluvial bores fluctuate in response to river flow and rainfall. A more muted response is observed in the bores targeting the Hawkesbury Sandstone aquifer.

Based on data collected from June to September 2020, groundwater within the Hawkesbury Sandstone typically flows east toward the Nepean River. However, during a flood event in August 2020 (see Appendix A of the Groundwater Model Report), data in bores BH01_S, BH01_D and BH02 indicates a reversal of the groundwater flow direction away from the Nepean River.

It is assumed that the alluvial aquifer is hydraulically connected to the Nepean River, based on the following:

- the alluvial aquifer comprises relatively high permeability sand deposits, directly adjacent to the Nepean River (see document J190166_RP20_v1, dated 22 June 2020); and
- groundwater levels in the alluvial aquifer bores (BH01_S and BH03) are consistent with the surface water level measured in the adjacent Nepean River (Appendix A of the Groundwater Model Report).

6.3.2 Groundwater quality

One round of water quality samples was obtained from each bore within the groundwater monitoring network (Table 6.1) and at two locations within the Nepean River, adjacent to the alluvium bores BH01_S and BH03 (Figure 6.1) on the 29 May 2020 and the 2 June 2020. A summary of water quality baseline physico-chemical parameters (temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), oxidation-reduction potential (ORP) and dissolved oxygen (DO)), and major cations and anions are provided in Table 6.2 and Table 6.3, respectively.

Table 6.2 Water quality baseline physico-chemical parameters

Water system	Monitoring bore	Temperature (°C)	pH		Electrical conductivity (µs/cm)		Total dissolved solids (mg/L)	Dissolved oxygen (% saturation)	Oxidation-reduction potential (mV)
		Field	Field	Laboratory[1]	Field	Laboratory	Laboratory	Field	Field
ANZECC (2000) guidelines[2]	N/A		6.5–8.0		125–2,200			85–110	
Alluvial aquifer	BH01_S	15.4	6.74	**6.45**	1,194	1,370	890	**128**	-5.4
	BH03	15.0	7.32	7.65	2,101	**2,640**	1,720	**127**	135.7
Hawkesbury Sandstone aquifer	BH01_D	13.5	7.53	6.85	**2,963**	**2,730**	1,770	**142**	99.7
	BH02	15.2	**8.38**	**8.04**	**8,732**	**9,840**	6,400	**157**	50.2
	BH04	14.3	**8.43**	**8.11**	**10,355**	**12,000**	7,800	**143**	94.5
Nepean River	Site 1	15.5	7.25	7.79	195.2	228	148	**112**	25.6
	Site 3	14.8	7.22	7.88	265	308	200	**128**	74.8

1. Laboratory pH was analysed outside of the typical holding time; EMM considers field pH more accurate

2. ANZECC (2000) Water Quality Guidelines: 95% protection levels (trigger values) for the protection of slightly disturbed freshwater ecosystems, South-East Australia, lowland river ecosystems. Values outside of the default trigger values are highlighted in bold.

'Field' indicates results have been obtained from in-situ measurements following well development.

'Laboratory' indicates results have been obtained from analysis at a NATA accredited laboratory.

Table 6.3 Water chemistry results - major cations/anions suite

Water system	Monitoring bore	Total Hardness as $CaCO_3$	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Alkalinity (as $CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (Fl)	Total anions	Total cations	Ionic balance
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%
ANZECC (2000) guidelines[1]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Alluvial aquifer	BH01_S	278	42	42	138	2	8	12	462	*ND*	13.4	11.6	7.33
	BH03	383	20	81	348	3	32	49	893	0.1	26.8	22.9	7.99
Hawkesbury Sandstone aquifer	BH01_D	260	43	37	450	5	228	215	732	*ND*	29.7	24.9	8.77
	BH02	1,180	142	201	1,650	15	318	770	2,880	0.8	104	95.8	3.93
	BH04	1,970	172	374	1,840	31	567	587	4,050	0.6	138	120	6.82
Nepean River	Site 1	26	4	4	34	3	52	6	35	*ND*	2.15	2.08	----
	Site 3	33	5	5	47	4	82	11	43	*ND*	3.08	2.81	----

1. ANZECC (2000) - Water Quality Guidelines: 95% protection levels (trigger values) for the protection of freshwater aquatic ecosystems. Values outside of the default trigger values are highlighted in bold.

Results have been obtained from analysis at a NATA accredited laboratory.

---- indicates limited cation/anion concentrations cannot be differentiated.

The default trigger values provided in ANZECC & ARMCANZ (2000) are used where a parameter DGV is not yet defined in ANZG (2018).

The alluvial aquifer contains brackish and slightly acidic to basic water within the ANZECC (2000) protection levels (Table 6.2).

6.4 Groundwater monitoring program

6.4.1 Groundwater levels

The dataloggers in BH01_S, BH01_D, BH02, BH03 and BH04 will continue to record groundwater level fluctuations every six-hours. Dataloggers will be downloaded quarterly (every three months; nominally in March, June, September and December) and manual water level measurements will be taken using an electronic dip meter to verify the water level.

The monitoring bores will be inspected during the quarterly download. Defective dataloggers will be replaced to ensure a continuous record of groundwater level is maintained.

Temporary bores will be drilled or augered progressively in the active extraction area to determine the local water table position immediately prior to commencing extraction in each substage. Water levels in the temporary bores will be recorded twice a day via an electronic dip meter for a period of seven days following the date of drilling or augering.

6.4.2 Groundwater quality

Groundwater quality monitoring will be undertaken once per year (nominally in June), in general accordance with the following:

- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC 2004); and
- AS/NZS 5667.11:1998 *Water Quality – Sampling – Part 11, Guidance on Sampling of Groundwaters*.

The groundwater quality sampling and analysis methodology will be as follows:

1. water quality physico-chemical field parameters (temperature, pH, EC, ORP and DO) will be measured using a calibrated water quality meter;
2. bores will be purged until three bore volumes have been removed or until physico-chemical field parameters have stabilised over three successive readings;
3. a representative groundwater sample will be collected in laboratory supplied bottles, appropriately preserved and submitted under chain-of-custody to a NATA accredited laboratory for analysis of the following analytical suites;
    a) physico-chemical parameters (pH, EC and TDS); and
    b) major cation/anions (including hardness).
4. all sampling equipment including but not limited to sampling pumps, the water quality meter and electronic dip meter will be decontaminated between sampling each bore.

6.5 Groundwater assessment criteria and trigger values

There are no prescribed groundwater monitoring criteria in DA 85/2865 or EPL3991. Rather, groundwater monitoring will be undertaken to prevent the unanticipated intersection of the local water table by extraction operations at the Quarry. Notwithstanding this, the Quarry must comply with Section 120 of the *Protection of the Environment Operations Act (*1997).

6.5.1 Groundwater levels

In the absence of prescribed criteria, a deviation of two metres from the long-term median groundwater level in the quarry monitoring bores would be considered a trigger for further action. Two metres was chosen as the deviation value as it aligns to the minimal impact considerations for aquifer interference activities stated in the NSW Aquifer Interference Policy (DPI 2012).

Initial water level assessment criteria and trigger values have been derived at all five quarry monitoring bores within the alluvium and Hawkesbury Sandstone, as shown in Table 6.4. These values will be reviewed annually, and ongoing collation of site-specific groundwater level data will be assessed against seasonal variations. The trigger values will be revised (where necessary).

Table 6.4 Water level assessment criteria and trigger values

Monitoring bore	Aquifer	Median groundwater level[1] (m AHD)	Trigger level (m AHD)
BH01_S	Alluvium	61.27	59.27
BH01_D	Hawkesbury Sandstone	61.29	59.29
BH02	Hawkesbury Sandstone	62.29	60.29
BH03	Alluvium	61.20	59.20
BH04	Hawkesbury Sandstone	62.70	60.70

Notes: 1. Based on groundwater levels recorded via continuous datalogger from 3 June 2020 to 23 September 2020.

The trigger levels in Table 6.4 provide an early indication of a change in groundwater level conditions. Should a change be observed a management response will be instigated in accordance with the Groundwater Trigger Action Response process detailed in Section 6.6.

6.5.2 Groundwater quality

The baseline monitoring data indicate that the alluvial aquifer contains brackish and slightly acidic to basic water, which generally meet the ANZECC (2000) default trigger ranges as shown in Table 6.2. However the Hawkesbury Sandstone aquifer contains water of a more basic and saline nature, with recorded values outside of the ANZECC (2000) default trigger ranges.

Site-specific water quality assessment criteria have been assigned to the quarry monitoring bores. Assessment criteria have been adopted for field EC and pH. Assessment criteria has been developed using site-specific data or the ANZECC (2000) guidelines. Although ANZECC (2000) guidelines are generally not considered suitable for assessing groundwater quality, these guidelines were adopted as interim assessment criteria where appropriate for field pH and EC as baseline data were insufficient for the development of site-specific assessment criteria.

Initial field pH and EC assessment criteria and trigger values have been derived at the monitoring bores, as shown in Table 6.5. The proposed ranges are suitable to identify a potentially adverse impact in the aquifers in the vicinity of the quarry.

Table 6.5 Field parameter assessment criteria and trigger values – alluvial bores

Monitoring bore	pH trigger levels		EC trigger levels (µS/cm)	
	Lower limit	Upper limit	Lower limit	Upper limit
BH01_S	6.5	8.0	125	2,500
BH01_D	6.5	8.0	125	3,000
BH02	6.5	8.5	125	10,000
BH03[1]	6.5	8.0	125	2,500
BH04	6.5	8.5	125	12,000

Assessment criteria are generally based on ANZECC (2000) guidelines – 95% protection levels (trigger values) for the protection of slightly disturbed freshwater ecosystems, South-East Australia, low lying river ecosystems, with the following exceptions to incorporate site-specific data:

- Alluvial aquifer bores (BH01_S and BH03) - slightly higher upper range for EC to accommodate naturally brackish water;
- Hawkesbury sandstone aquifer (BH02 and BH04) - slightly higher upper range for pH to accommodate naturally basic water; and
- Hawkesbury sandstone aquifer (BH01_D, BH02 and BH04) - higher upper range for EC to accommodate naturally saline water.

The assigned assessment criteria for EC and pH provide an early indication of a change in water quality conditions. Should a change be observed a management response will be instigated in accordance with the Groundwater Trigger Action Response process detailed in Section 6.6.

6.6 Groundwater Trigger Action Response Plan

As the Menangle Quarry will not intercept groundwater during its normal extraction operations it is considered highly unlikely that the quarry will alter groundwater levels or quality. Despite this, potential changes in groundwater conditions will be monitored during the undertaking of the groundwater monitoring program outlined in Section 6.4. If a change is detected that may be because of an unforeseen impact caused by the quarry operation, a Groundwater Trigger Action Response Plan (TARP) will be initiated. This TARP is detailed in Table 6.6.

Table 6.6 Groundwater Trigger Action Response Plan

Trigger value or level indicating potential impact	Action required	Any follow up actions
Water level		
Water levels in the groundwater monitoring bores decrease below the trigger levels provided in Table 6.4.	Continue to monitor and assess water level data, establish trends and correlate with quarrying activities and climatic data (rainfall). Apply statistical analysis to assess trends if required. Determine whether any decrease in water level may be due to impacts from the quarry. Calculate and assess any distance drawdown effects with respect to any neighbouring water users (bores).	If some, or all of the water level declines in the monitoring bore network are assessed to be due to impacts from quarrying at Menangle and distance drawdown calculations by the hydrogeological consultant (in consultation with the DPIE-Water) indicate a 'significant' impact on neighbouring water users (bores), access to the potentially affected bore/s should be requested in order to confirm and monitor any impact that may be solely or partly due to quarrying at Menangle. If a 'significant' impact on a neighbouring water user is scientifically demonstrated, make good arrangements may be implemented in consultation with the affected water user.
The water table measured in temporary bores installed within the extraction areas increases to within 1 m of the proposed pit floor level.	Quarry manager to review pit floor/ extraction levels to ensure a 1 m buffer is maintained.	Continue to monitor temporary bores to further assess fluctuations in the local water table.
Water quality		
Concentration of physical parameters increases outside the ranges of trigger levels as stated in Table 6.5.	Continue to monitor and assess groundwater quality data, establish trends and correlate with quarrying activities and climatic data to determine a causal link (if any) with Menangle quarrying operations.	If evolving geochemical anomalies are detected in groundwater sampled from the wider monitoring bore network and an impact from the proposed quarrying on the 'regional' sandstone aquifer system is demonstrated, advise DPIE-Water for further action.
Groundwater (not floodwater) inflow into the active extraction area		
Unanticipated groundwater inflow into the pit	All unanticipated groundwater inflow into the pit will be reported to DPIE-Water within 7 days of the commencement of inflow.	A report to DPIE-Water will be prepared that includes the following information: 1. time at which inflow event commenced; 2. time at which inflow event ceased; 3. duration of the inflow event; 4. volume of groundwater inflow; and 5. extraction area floor elevation at which the inflow event occurred
Groundwater inflow greater than the licenced volume (0.7 ML/year).	If water balance calculations indicate that net groundwater inflow into the pit exceeds 0.7 ML/year, a hydrogeological consultant will be commissioned to review and update the groundwater numerical model used to estimate groundwater inflow estimates.	It will be determined (in consultation with DPIE Water) if additional water access license share entitlements are needed to be obtained.

The groundwater TARP will be refined in future years as more groundwater data is obtained.

6.7 Summary of groundwater management measures

Specific groundwater-related measures and requirements to meet the objectives of this SWMP and to address potential impacts on groundwater are outlined in Table 6.7. Based on the mitigation and management measures it is considered that potential groundwater impacts that may arise due to the operation of the quarry can be effectively managed.

Table 6.7 Groundwater management and mitigation measures

Measure/requirement	When to implement	Responsibility	Reference
Diesel and other contaminant spills will be cleaned up immediately. Appropriate action will be taken to notify the appropriate regulatory authorities and report the incident in accordance with the requirements of the quarry's EMS.	Throughout Stage 8A, 8B and 8C quarry operation	All quarry staff	Approval Condition B18
Groundwater levels at BH01_S, BH01_D, BH02, BH03 and BH04 will be monitored using continuous data loggers.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Approval Condition B19
Exclusion fencing and signage will be installed around at BH01_S, BH01_D and BH02.	Prior to commencement of operation at Stage 8A, 8B and 8C extraction areas.	Quarry manager	Approval conditions B20 and B36(c)(iii)
Groundwater quality samples will be collected annually from BH01_S, BH01_D, BH02, BH03 and BH04 and analysed for all major anions and cations and field parameters.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Approval Condition B21
Temporary bores will be drilled or augered progressively in Stage 8A, 8B and 8C extraction areas to determine the local water table position. Groundwater level will be measured twice-daily in the temporary bores using an electronic dip meter over a period of seven days.	Immediately prior to commencement of operation at each of Stage 8A, 8B and 8C extraction areas.	Quarry manager	Approval conditions B22 and B36(c)(iii)
The pit floor in Stage 8A, 8B and 8C will remain at least 1 metre above the measured water table level averaged over the seven-day monitoring period detailed in GWMM5.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Approval conditions B22 and B36(c)(iii)
A Modflow groundwater model will be developed and updated to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 Area in accordance with Approval conditions B24, B25 and B26.	Model prepared (see Section 6.2 and Appendix B).	Quarry manager	Approval conditions B24, B25 and B26.
All necessary Water Access Licences (WALs) and licence shares for the operation of the quarry under the *Water Act 1912* and/or the *Water Management Act 2000* will be obtained.	Prior to commencement of operation at Stage 8A, 8B and 8C extraction areas.	Quarry manager	Approval conditions B27 and B29
Report on any water captured, intercepted or extracted from the site each year (directly and indirectly) in the Annual Review, including water taken under each WAL as applicable.	Throughout Stage 8A, 8B and 8C quarry operation	Quarry manager	Approval Condition B30

6.8 Data management and reporting

Menangle Sand and Soil will retain records of water quality monitoring for a minimum period of the life of the quarry. Monitoring records will be made available to relevant government authorities upon request.

All data obtained as part of the groundwater monitoring program (including any water captured, intercepted or extracted from the site each year (directly and indirectly), including water taken under each Water Access Licence) will be compiled and reported each year in the Annual Review. The data will be analysed against the established performance criteria triggers and for any trends that may be occurring. Triggers will be assessed for appropriateness against seasonal climatic variations and revised if necessary.

Any modifications to the groundwater monitoring network will be reported in the Annual Review.

Details of regular reporting and incident reporting are provided in Section 7 and Section 8 of the EMS respectively.

7 Erosion and sediment control

7.1 Erosion hazard assessment

The overall water erosion hazard has been determined using the process described in Section 4.4.1 of Landcom (2004). If a low erosion hazard is determined, no further delineation of erosion hazard is required. If a high erosion hazard is determined, further assessment is required to determine the Soil Loss Class (SLC).

SLCs are determined by calculating the annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) with a nominal 80 m slope length and soil surface cover factor (C-factor). The RUSLE calculates the annual average erosion in tonnes per hectare (t/ha) from rill and inter-rill (sheet) erosion. It does not consider gully or tunnel erosion and does not calculate peak erosion.

Section 4.4.2(c) of Landcom (2004) nominates additional requirements for land of SLC 4 and higher.

7.1.1 Soil erosion hazard

The erosion potential of a soil is determined by its physical and chemical properties and is expressed as its K-factor (t.ha.h)/(ha.MJ.mm). Table 7.1 provides soil erodibility rankings for a range of K-factors as per Rosewell (1993).

Table 7.1 Rosewell (1993) soil erosion ranking

K-factor (t ha h $ha^{-1}MJ^{-1}mm^{-1}$)	Erosion potential
<0.02	Low
>0.02 to <0.04	Moderate
>0.04	High

The modelled K-factors for the mapped quarry area were determined from the eSpade 2.1 database (OEH 2019) (Figure 7.1). The modelled K-factors range from 0.04–0.06 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ which indicate that the quarry soils have a high erosion potential.

The default K-factors for well graded sands to silt sands range from 0.036 to 0.043 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ (Table E5, IECA 2008). Therefore, the modelled K-factors reflect the mapped soil landscapes and not the alluvially deposited site soils. A K-factor of 0.043 t ha h $ha^{-1}MJ^{-1}mm^{-1}$ that is appropriate for the alluvially deposited soils has therefore been adopted.

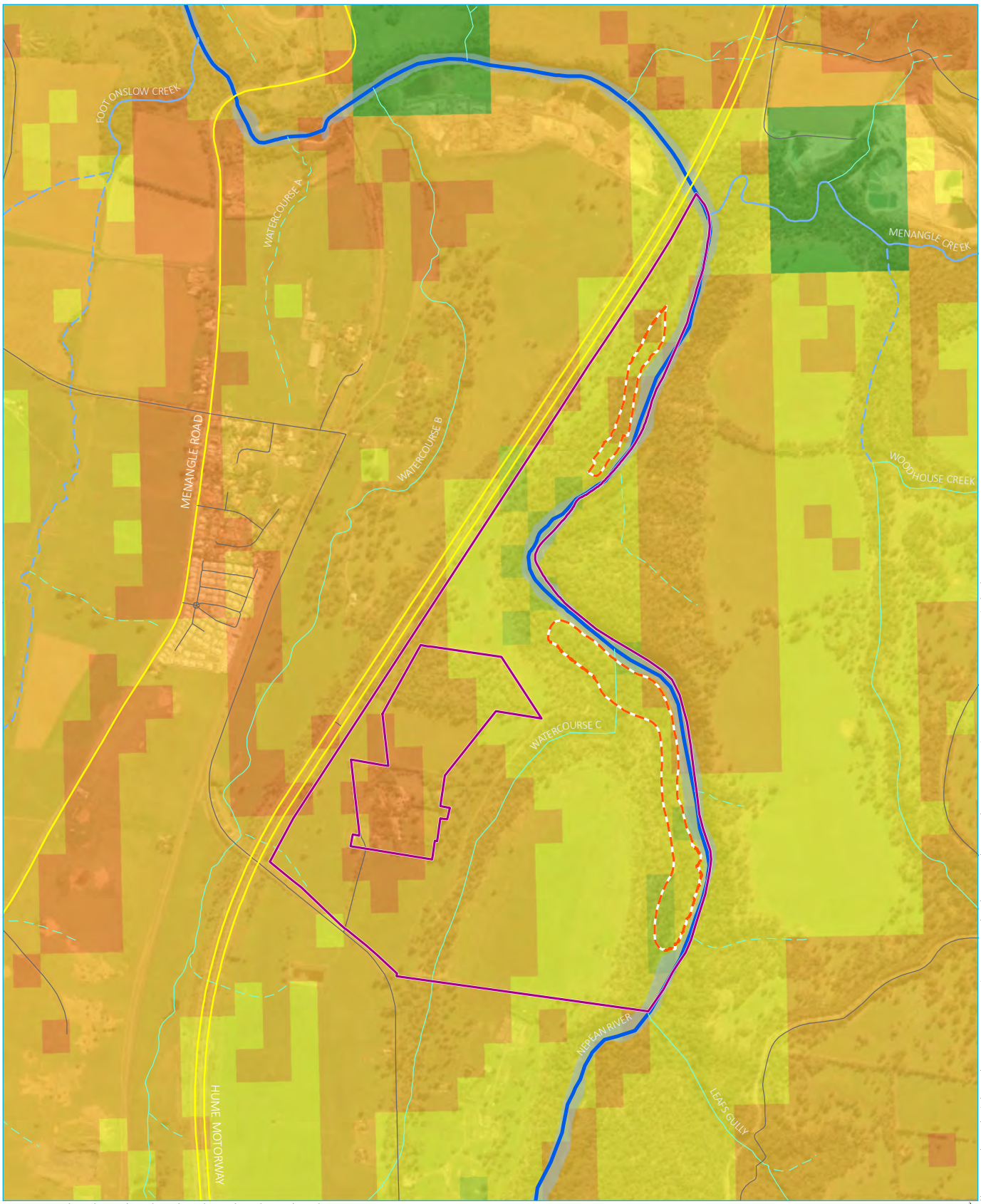
7.1.2 Slope and rainfall erosion hazard

The calculated R-factor for the quarry site is 1,663 $MJ.mm.ha^{-1}h^{-1}$ (see Section 3.1).

Slopes in the disturbance areas generally range from 0–180% (0 to 61°) (Figure 7.2).

Applying these parameters to the erosion hazard nomograph (Figure 7.3), indicates that there will be low to high erosion at the quarry due to slope and rainfall erosivity. On this basis, further analysis of SLCs is required.

A high erosion hazard requires further detailed assessment in accordance with Section 4.4.2 of Landcom (2004) to determine Soil Loss Classes (Table 7.2).



Source: EMM (2021); DFSI (2017); GA (2011); DPE (2015); OEH (2017)

0 250 500 m

GDA 1994 MGA Zone 56

N

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KEY

- Study area
- Proposed extraction area - stage 8
- Main
- Local road

Named Strahler stream order

- 1st
- 2nd
- 3rd
- 4th
- 7th

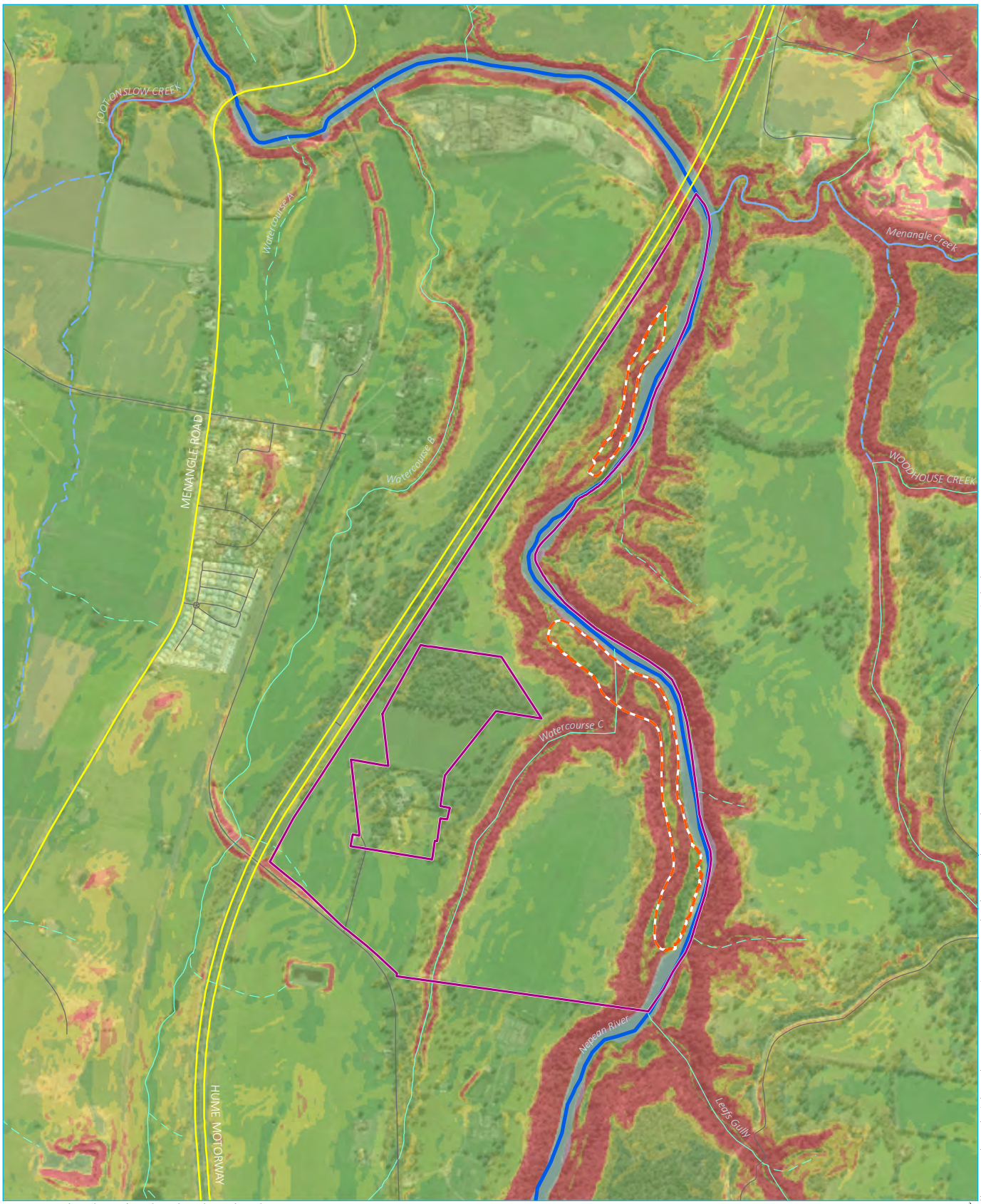
RUSLE K factor

- 0.01 -
- 0.03 -
- 0.04 -
- 0.05 -
- 0.06 -

Mapped soil K-factors

Menangle Quarry Extension
Soil and water management plan
Figure 7.1

EMM creating opportunities



Source: EMM (2021); DFSI (2017); GA (2011), DPE (2015)

0 250 500 m

GDA 1994 MGA Zone 56

N

\\Emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps_SWMP\SWMP006_SlopePercent_20210128_01.mxd 2/02/2021

KEY

- Study area
- Proposed extraction area - stage 8
- Named waterbody
- Main road
- Local road

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 7th order

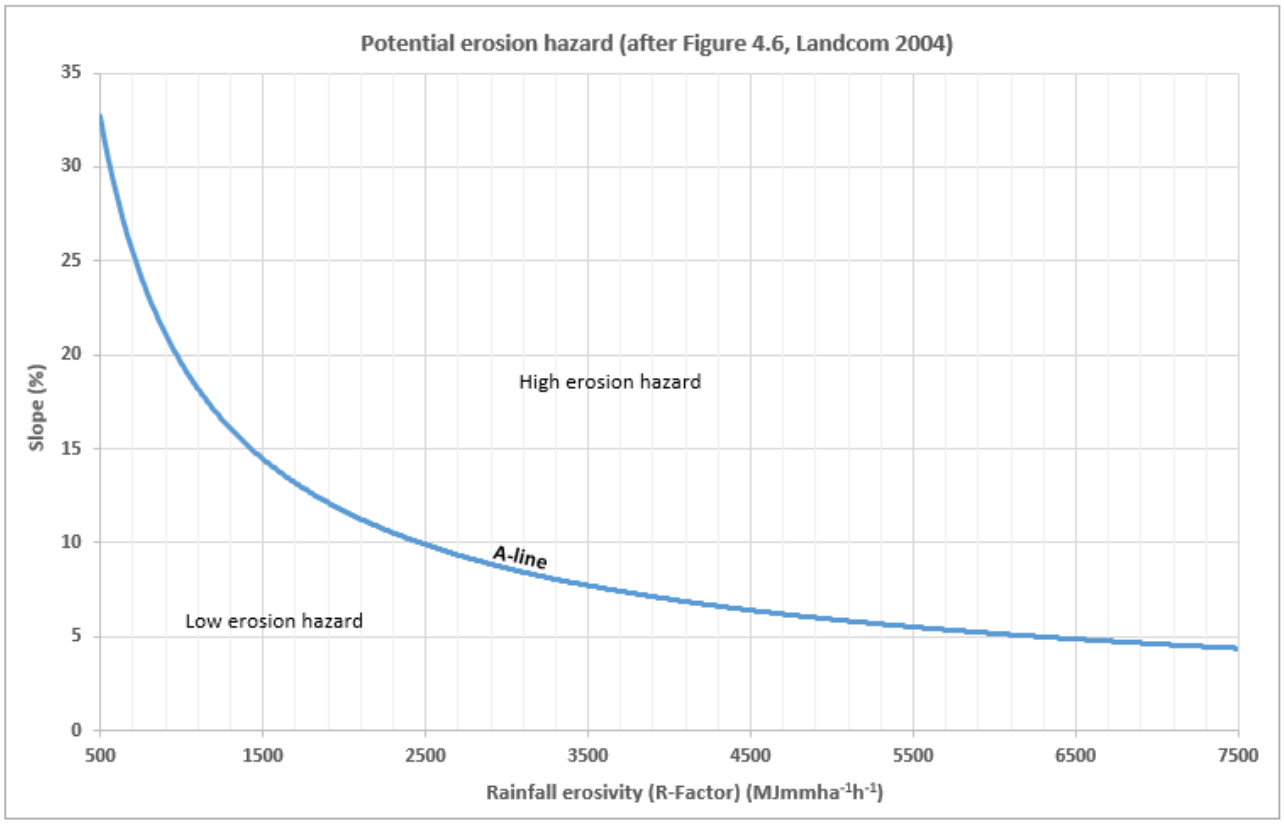
Slope percent

- < 5 %
- 5 - 10 %
- 10 - 15 %
- 15 - 20 %
- > 20 %

Project slope percentages

Menangle Quarry Extension
Soil and water management plan
Figure 7.2

EMM
creating opportunities



Source: Landcom (2004).

Figure 7.3 Assessment of potential erosion hazard

Table 7.2 Soil Loss Classes

Soil Loss Class (SLC)	Calculated soil loss (t/ha/yr)	Erosion hazard
1	0 to 150	Very low
2	151 to 225	Low
3	226 to 350	Low-moderate
4	351 to 500	Moderate
5	501 to 750	High
6	751 to 1,500	Very high
7	>1,500	Extremely high

Source: Adapted from Table 4.2 of Landcom (2004).

Soil Loss Classes for the quarry have been determined by calculating the annual average soil loss using the RUSLE with a nominal 80 m slope length, C-factor of 1 (100% bare soil) and a soil conservation factor (P-factor) of 1.3 (compacted and smooth soil).

Calculated indicative soil loss for slopes ranging from 1–30% are provided in Table 7.3.

Table 7.3 Annual average soil loss

Slope	1%	10%	14%	20%	25%	30%	40%
R (calculated)	1,663	1,663	1,663	1,663	1,663	1,663	1,663
K (OEH 2019)	0.043	0.043	0.043	0.043	0.043	0.043	0.043
LS (Table A1 Landcom 2004 and USDA 1997)	0.19	2.81	4.61	7.32	9.51	11.6	15.67
P (Table A2 Landcom 2004)	1.3	1.3	1.3	1.3	1.3	1.3	1.3
C (Figure A5 Landcom 2004)	1	1	1	1	1	1	1
Soil loss t/ha/year	**18**	**261**	**429**	**680**	**884**	**1,078**	**1,457**

Applying the calculated annual average soil loss to Table 7.2 results in a SLC ranging from 1 (very low) to 6 (very high).

Lands with SLCs greater than 4 trigger increased erosion and sediment control management requirements as stipulated in Section 4.4.2 of Landcom (2004).

The quarry is in rainfall zone 4 (Figure 7.4).

Landcom (2004) defines highly sensitive lands as:

1. always on SLC 7 lands; and
2. at certain times of the year:
    a) on SLC 5 or 6 lands in all rainfall zones; and
    b) on SLC 4 lands in rainfall zones 5 and 11.

Waterfront land, ie between a river and its highest bank, is regarded as SLC 6 lands (Landcom 2004).

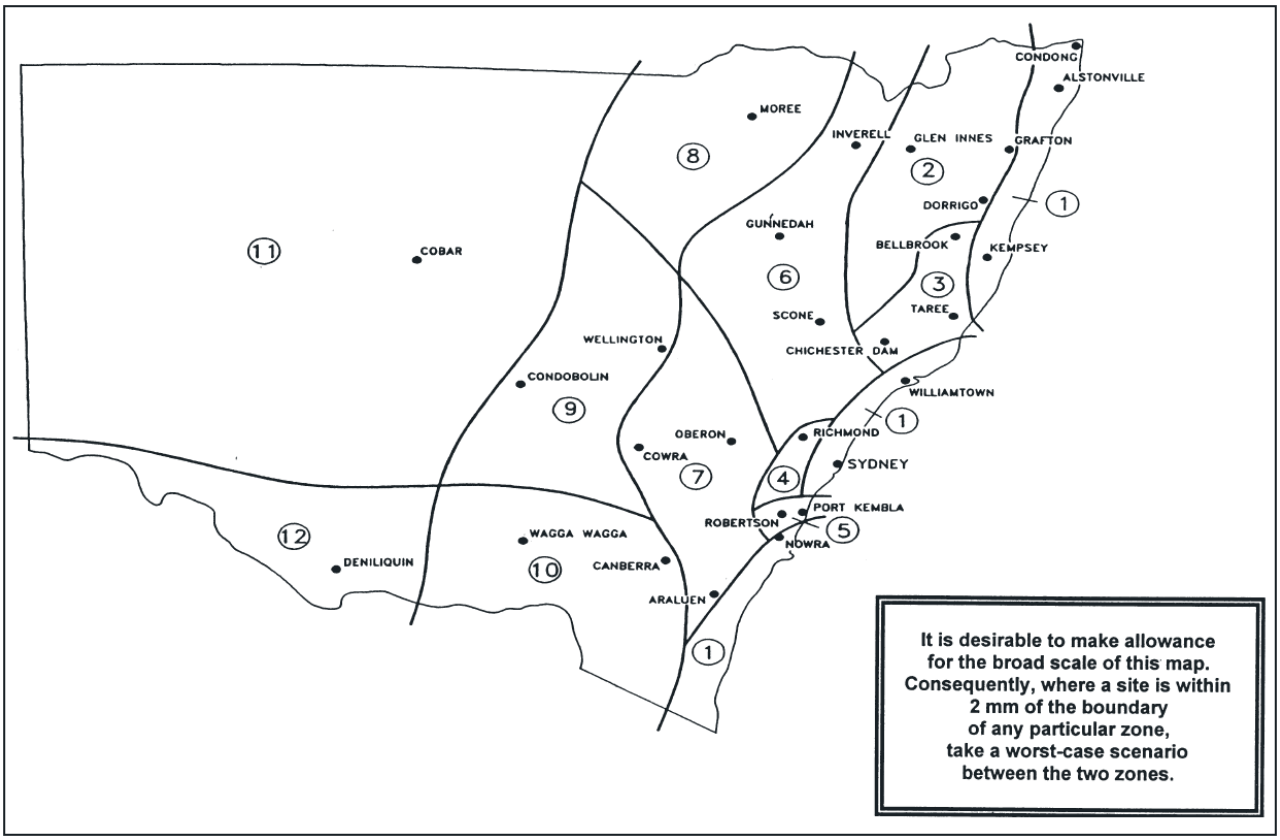


Figure 7.4 Rainfall zones (source: Landcom 2004)

Low and high rainfall erosivity periods for Zone 4 are provided in Table 7.4. Land disturbing works in highly sensitive areas should be scheduled for periods when rainfall erosivity is low.

Table 7.4 Zone 4 high and low rainfall erosivity periods

SLC	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
1-4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
5	L	L	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
6	H	H	H	H	H	H	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H
7	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

When it is not possible to schedule activities on highly sensitive land to periods when rainfall erosivity is low or is impractical, Menangle Sand and Soil will rapidly stabilise disturbed lands as far as practicable (see Section 7.2.5) to have a C-factor lower than 0.1 when the 3-day rainfall forecast suggests that rain is likely.

There is limited erosion associated with previous quarry extraction areas primarily due to the success in achieving soil surface cover via revegetation works.

However, in the absence of appropriate controls there would be a high to very high erosion risk for parts of the quarry. The erosion and sediment controls that will be implemented are described in Section 7.2.

7.1.3 Flood erosion hazard analysis

An assessment of flood erosion potential in the Stage 8 extraction area was undertaken by Fluvial Systems (2019) as part of the fluvial geomorphological assessment undertaken for the modification application. Fluvial Systems (2019) identified that during flood conditions, scattered patches of scour could occur within the Stage 8 area although these would be likely to infill, or partially infill with coarse sediment on the falling limbs of the flood hydrograph. Fluvial Systems (2019) stated that this is a natural and expected process that would occur regardless of extraction operations. They also stated that the risk of scour can be reduced by retaining as much vegetation as possible, revegetating disturbed land as quickly as possible and protecting with appropriate erosion resistant materials.

Table 5 in Fluvial Systems (2019) identifies there is a high risk of channel bench scour in exposed soils and well vegetated areas when shear stress exceeds 4 N/m^2 and 200 N/m^2 respectively. As described in Section 7.2.5, scouring during flooding will be minimised by rapidly stabilising disturbed areas (eg completed extraction areas) to cover and bind the soil, increasing the shear strength.

Management and mitigation of flood erosion risk is discussed further in the *Flood Management Plan* (EMM 2020a).

7.2 Application of the erosion risk assessment

The erosion risk assessment generally find that, without appropriate controls (as described in the SWMP) there will be a high to very high risk due to:

- the erodibility of soils;
- calculated soil loss;
- slope steepness; and
- rainfall erosivity in the wettest season (December to March).

Menangle Sand and Soil will adopt the following drainage, erosion and sediment control management measures to address this erosion risk.

Details of long-term quarry rehabilitation are provided in the *Biodiversity and Rehabilitation Management Plan* (EMM 2000b).

7.2.1 Full-time Rehabilitation Specialist

The quarry will employ a full-time Rehabilitation Specialist.

The Rehabilitation Specialist will be onsite every working day that the quarry is operating, implementing the erosion control, soil stabilisation and rehabilitation measures described in this SWMP. They will ensure that disturbed areas are stabilised as soon as possible, initially applying temporary measures if required, such as sowing a cover crop, and then applying permanent measures such as establishment of native vegetation.

As the Rehabilitation Specialist will be onsite every working day they will be able to implement the measures described in this SWMP progressively, targeting small area as soon as they are available rather than undertaking these works in larger areas on a less frequent 'campaign' basis.

The Rehabilitation Specialist will regularly inspect the success, or otherwise, of the measures implemented and will adjust the application of these measures accordingly.

7.2.2 Appropriately integrating quarry design with site constraints

As noted above, there is limited erosion associated with previous quarry extraction areas primarily due to the success in achieving soil surface cover via revegetation works.

The quarry has been designed, constructed and rehabilitated so that the landform generally blends with the surrounding topography to generally avoid significant modification to landforms. The exception is the noise/visual bund surrounding the processing area. Previously extracted areas have been recontoured so that they resemble the pre-disturbance landform. This practice will continue in the Stage 8 area.

The Stage 8 extraction area will generally result in an overall lowering of the alluvial benches to 64 m AHD with final batters 1(v):5(h) on the river side and up to 1(v):1(h) on the landward side (although natural sandstone faces may be steeper, up to vertical or overhanging).

The proposed extraction works will not result in the disturbance of electrochemically unstable soils.

7.2.3 Minimising the extent and duration of land disturbance

Menangle Sand and Soil will implement an internal Land Disturbance Permit process to ensure unnecessary land disturbance does not occur. Location-specific environmental, drainage and erosion and sediment controls will be planned and implemented as required.

Protected vegetation is identified in the quarry's Biodiversity and Rehabilitation Management Plan (BRMP) (EMM 2020b). Clearing limits will be clearly demarcated using barrier mesh, bunting or some other appropriate high visibility material.

Initial clearing and stripping works will be scheduled to avoid high rainfall erosivity periods, where practical, to minimise erosion. Where major land disturbing works need to occur in a high rainfall erosivity period, there will be an appropriate increase in the levels of control measures to compensate for the increased erosion risk.

Progressive stabilisation and rehabilitation of disturbed areas is fundamental to successful erosion and sediment control to prevent turbid runoff and subsequent sedimentation. Only two substages will only be active at any time. The active extraction area will be no greater than 0.33 ha.

Progressive stabilisation and rehabilitation will continue to be undertaken with a goal of achieving the C-factors and timing nominated in Table 7.5.

Table 7.5 Maximum C-factors during and post land disturbance

Feature/area	C-factor	Requirement
During land disturbance		
Waterways and land below the 2-year ARI flood levels including stockpiles	0.10	When working in waterways and flood prone lands a C-factor of ≤0.1 is to be achieved (eg by the application of timber debris or soil stabilising polymer) if the 3-day forecast indicates rain causing runoff is likely.
Land above 2-year ARI flood levels flood levels (including stockpiles)	0.15	A C-factor of ≤0.15 is to be achieved within 20 working days of inactivity, even though works might continue later.
Post- land disturbance		
Waterways and other areas subjected to concentrated flows	0.05	Applies after 10 working days from completion of formation and before they are allowed to carry any concentrated flows.

Table 7.5 Maximum C-factors during and post land disturbance

Feature/area	C-factor	Requirement
Stockpiles	0.10	Applies after 10 working days from completion of formation. Maximum C-Factor of 0.10 equals 60% ground cover.
All other land	0.15	In periods of expected 'low' rainfall erosivity during the rehabilitation period, achieve a C-Factor of less than 0.15. Maximum C-factor of 0.15 equals 50% ground cover.
	0.10	In periods of 'moderate' to 'high' rainfall erosivity during the rehabilitation period, achieve a C-Factor of less than 0.1. Implement a program to ensure C-Factor would reduce permanently to less than 0.05 within 60 days of the preliminary stabilisation activities described above.

Source: Adapted from Section 7.1.2, Table 7.1 and Table 9.3 in Landcom (2004).

7.2.4 Controlling water movement through the site

As identified in Section 3.3, the passage of clean water running on to previously extracted areas and the infrastructure areas is generally via ephemeral waterways. As discussed in Section 5.2.3, clean water is diverted around the processing area via a diversion bund (noise/visual bund). A trafficable inclined diversion bank will be installed on the eastern side of Watercourse B to ensure all potentially turbid runoff from this area is diverted away from Watercourse B to WMD01.

Pipe culverts are installed on all waterway crossings.

There is limited opportunity to divert clean water around the Stage 8 extraction area due to topography and existing native vegetation that is to be retained. Further, the diversion of clean water could potentially lead to the dispersal of weed seeds to rehabilitation and biodiversity restoration areas. Erosion hazard for non-cohesive sandy and silty soils will be reduced by maintaining sheet-flow conditions instead of concentrating flows in diversion drains.

Rainfall falling onto the roofs of offices and workshop facilities is considered to be clean water. Roof runoff is captured using gutters and stored in tanks for re-use and overflows directed away from active exposed areas.

Fuel storages are bunded.

7.2.5 Minimise soil erosion

Sediment and turbid water are only generated when erosion occurs. Therefore, the most effective form of sediment control is erosion control. Effective erosion control will be a fundamental component of Menangle Sand and Soil's drainage, erosion and sediment control strategy.

The types of erosion that can potentially are:

- raindrop splash erosion;
- sheet erosion;
- rill erosion;
- gully erosion; and
- creek bed and bank erosion.

Raindrop splash erosion is most effectively controlled by providing soil surface cover. This is achieved within the quarry area by:

- minimising the extent and duration of soil disturbance;
- retaining vegetation and other soil surface cover (eg timber debris) and respreading as part of rehabilitation and restoration works;
- progressively rehabilitating disturbed areas; and
- covering and binding exposed soils (see Section 7.2.6).

Rill erosion is effectively controlled by minimising slope length and gradient. This is achieved within the quarry area by:

- minimising disturbance of steeply grading areas where possible;
- reducing slope gradient and length;
- minimising concentration of flow; and
- progressively revegetating disturbed areas.

Gully erosion is effectively controlled by minimising the concentration of flow and slowing flow velocity. This is achieved within the quarry area by:

- maintaining sheet-flow where possible; and
- lining drains and installing grade control measures in waterways where flow velocities exceed the maximum permissible velocity of the soil (temporary and permanent).

Energy dissipaters will be used at the outlets of drains and spillways to reduce flow velocities to less than the maximum permissible velocity for the soil type.

7.2.6 Promptly stabilising disturbed areas

Progressive stabilisation and rehabilitation of disturbed areas will be undertaken to minimise erosion and the generation of sediment and turbid runoff with the goal of achieving the C-factors and timing nominated in Table 7.5.

Stabilisation methods will be selected based on variables including the specific location, the slope gradient and length, proximity to the Nepean River, time of year, surrounding vegetation (weed-infested versus self-sustaining native vegetation) and the final rehabilitation objectives as described in the *Biodiversity and Rehabilitation Management Plan* (EMM 2000b). Stabilisation methods are expected to include one or more of the following:

- sowing a cover crop along with seeding with the desired native tree and bush species;
- applying polymer soil stabiliser;
- slope reduction;
- spreading timber debris (in accordance with Approval Condition B78);
- permanent revegetation with native vegetation;

- applying straw based hydromulch/hydraulically applied growth medium (HGM); and/or
- rock mulching.

7.2.7 Maximise sediment retention

Irrespective of how well designed and implemented erosion control is on site, sediment and turbid water will always be generated during rainfall events.

As detailed in Section 5.2.4, sedimentation basins have been, and will continue to be constructed, to contain and treat sediment laden runoff from the disturbed areas, including the processing area and the Stage 8 area.

WMD01 and WMD02 are permanent water management dams that will remain until processing operations have been completed. These dams have been sized to contain the 95th percentile 5-day rainfall depth with the sediment storage zone 50% of the volume of the settlement zone in accordance with Table 6.1 of DECC (2008) for basins with a design life of greater than 3 years in a sensitive environment.

The first basin in the Stage 8 area will be constructed at the northern end of Stage 8A and will be progressively moved south as extraction progresses from the north to south.

Sedimentation basins in the Stage 8 area will be sized in accordance with Landcom (2004) for a Type D soil. The required sedimentation basin size will vary as quarrying progresses due to changes in the upstream clean water run-on catchment. The basins will be sized to contain the 85th percentile 5-day rainfall depth with the sediment storage zone 50% of the volume of the settlement zone in accordance with Table 6.1 of DECC (2008) for basins with a design life of 6 to 12 months in a sensitive environment. Indicative basin sizes for a typical Stage 8 area catchment as well as the maximum catchment expected to contribute to each substage area are provided in Table 7.6.

Table 7.6 Sedimentation basin sizing

Basin ID	Catchment area (ha)	Settling zone (m^3)	Sediment storage (m^3)	Total basin volume (m^3)	Total basin volume (m^3/ha)	Existing volume (m^3)
Stage 8 typical	0.8	164	82	246	307	-
Stage 8A max	1.3[1]	266	133	399	307	-
Stage 8B max	2.4[1]	492	246	738	307	-
Stage 8C max	2.1[1]	430	215	645	307	-
WMD01	3.8	1,990	995	2,985	786	6,100
WMD02	4.4	2,305	1,152	3,457	786	27,500

Notes: 1. Based on the estimated maximum catchment size including upstream run-on catchment and extraction area.

The sedimentations basins in the Stage 8 area will be in the base of the active extraction area. Should they fill, they will overflow into the base of the active extraction area. As the lower riverbank will be retained to a minimum height of 64 m AHD, there will be no overland flow-paths between the basins and the Nepean River, except when the river is flooding and the entire active extraction area is inundated.

The Quarry Manager will implement an onsite approval system to minimise the potential for accidental turbid water discharge during pumping and dewatering activities on site.

7.2.8 Maintain drainage, erosion and sediment control measures

Drainage, erosion and sediment control measures will be maintained at all times until their function is no longer required. Technical notes for drainage, erosion and sediment control measures are available from the International Erosion Control Association Australia's website: austieca.com.au/publications/book-4-design-fact-sheets and austieca.com.au/publications/book-6-standard-drawings. These technical notes include the construction and maintenance requirements for the control measures.

Controls will be inspected following rainfall that causes runoff or monthly during dry conditions.

Inspections will be undertaken by the Quarry Manager. The person undertaking the inspections will require the following knowledge:

- an understanding of site environmental values that could be impacted by the quarry's operations;
- an understanding of the requirements of the Approval and the EPL that are relevant to drainage, erosion and sediment control;
- a good working knowledge of drainage, erosion and sediment control fundamentals and their application; and
- the ability to provide advice and guidance on appropriate measures and procedures to maintain the site at all time in a condition representative of regionally specific best practice, and that is reasonably likely to achieve the required standards.

Menangle Sand and Soil will maintain control measures to maximum practicable extent so that they:

- will best achieve the required environmental protection including achieving the water quality criteria specified in the Approval and the EPL in the nominated design storm event (see Section 7.2.5);
- are in accordance with the specified operational standard for each drainage, erosion and sediment control measure; and
- prevent or minimise safety risks.

All natural debris and sediment removed from control measures will be transported to the processing area and incorporated into blended quarry products or will be placed into the base of a completed extraction area in a manner that will not create an erosion or pollution hazard. Any contaminated material will be removed from site for disposal at an appropriately-licenced facility.

7.2.9 Monitor and adjust drainage, erosion and sediment control practices to achieve the desired performance standard

If an inspection or environmental monitoring identifies a significant failure of the adopted drainage, erosion and sediment control measures, a critical evaluation of the failure will be undertaken to determine the cause and appropriate modifications made to the control measures on site and the SWMP amended if required.

7.2.10 Drainage, erosion and sediment control competence

Quarry personnel, including contractors, will have an appropriate level of drainage, erosion and sediment training. Two levels of competency training for personnel are recommended:

- Level 1 – basic awareness level training provided during the site induction.
- Level 2 – detailed training course where drainage, erosion and sediment control is a regular component of their daily activities and competence is required.

7.2.11 Erosion and sediment controls in each quarry area

A range of erosion and sediment control measures will be applied to each quarry area.

As described in Section 7.2.1, the quarry will employ a full-time Rehabilitation Specialist. The Rehabilitation Specialist will apply a combination (one or more) of the erosion and sediment controls provided in Tables 7.8 to 7.11 based on an assessment of the specific location within each quarry area:

- site entry compound: office, parking, workshop and laydown areas (Table 7.7);
- processing area (Table 7.8);
- Stage 8 extraction area (Table 7.9); and
- access track and haul road (Table 7.10).

Table 7.7 Drainage, erosion and sediment control options – site entry compound

Control measure	Purpose
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Guttering and down pipes	To convey clean roof-run-off
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Revegetation	To protect exposed embankments, stockpiles and borrow areas from raindrop splash erosion and surface flows.
Sediment control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment fence	To capture coarse sediment in sheet flow environments.
Permanent	
Wheel wash	To remove sediment from light vehicles and trucks to prevent mud tracking to public roads

Table 7.8 Drainage, erosion and sediment control options – processing area

Control measure	Purpose
Drainage control	
Lined drains	To convey run-off in a non-erosive manner.
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.
Revegetation	To protect exposed embankment and bunds from raindrop splash erosion and surface flows.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment fence	To capture coarse sediment in sheet-flow environments.
Sediment sumps	To capture coarse sediments.
Type F, high efficiency sediment basin	To capture and treat sediment and turbid runoff.

Table 7.9 Drainage, erosion and sediment control options – Stage 8 extraction area

Control measure	Purpose
Drainage control	
Trafficable cross banks	To divert quarry runoff from the access track to sediment controls.
Lined drains	To convey run-off in a non-erosive manner.
Mitre drains	To divert run-off to reduce the volume and velocity of drainage.
Earth bunds	To contain sediment and turbid run-off to the active quarrying area.
Erosion control	
Temporary	
Check dams	To reduce flow velocity in drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment until permanent vegetation germinates and grows.
Polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Slope reduction	To reduce flow velocities below the maximum permissible velocity for the soil.

Table 7.9 Drainage, erosion and sediment control options – Stage 8 extraction area

Control measure	Purpose
Timber debris	To provide soil surface cover, habitat, rill interruption and to discourage vehicle damage
Revegetation	To cover and stabilise exposed soil, including the completed extraction area and embankments from raindrop splash erosion and surface flows.
Straw based hydromulch/ Hydraulically applied growth medium (HGM)	To protect newly seeded areas from erosion and allow rapid vegetation establishment.
Rock mulching	To protect steep cut and fill batters from erosion.
Rock energy (stilling pond type)	To reduce flow velocities from drains and culvert outlets to below the maximum permissible velocity for the downstream soil.
Sediment Control	
Temporary	
Check dams	Capture small quantities of coarse sediment in drains.
Sediment Fence	To capture coarse sediment in sheet flow environments.
Mulch bunds	To capture medium and coarse sediment in sheet flow environments.
Type F sediment basin	To capture and treat sediment and turbid runoff.

Table 7.10 Drainage, erosion and sediment control options – access tracks and haul road

Control measure	Purpose
Drainage control	
Lined table drains	To convey track run-off in a non-erosive manner.
Mitre drains	To divert track run-off away from the track to reduce the volume and velocity of drainage.
Trafficable cross banks	To minimise track erosion, disperse water to reduce slope lengths and velocity.
Pipe culverts	To allow vehicle access over ephemeral creeks and to allow clean up-stream water to pass through the construction zone without contamination. Maintain natural drainage paths.
Erosion control	
Temporary	
Check dams	To reduce flow velocity in the access track table drains and mitre drains until permanent drain linings can be installed.
Cover crops	Rapid vegetation establishment along track/haul road edges until permanent vegetation germinates and grows.
Trafficable polymer soil stabiliser	To protect exposed soil from erosion and to control dust.
Permanent	
Revegetation	To protect along track/haul road edges from raindrop splash erosion and surface flows.
Straw based hydromulch	To protect newly seeded areas from erosion.

Table 7.10 Drainage, erosion and sediment control options – access tracks and haul road

Control measure	Purpose
Vegetation mulching	To protect exposed embankments from raindrop splash erosion and surface flows no steeper than 1(v):3(h).
Sediment control	
Check dams	Capture small quantities of coarse sediment in the table drains and mitre drains.
Sediment fence	To capture coarse sediment in sheet flow environments.

8 Inspection and maintenance

8.1 Incidents

All incidents will be reported and investigated, and corrective actions assigned to prevent future occurrences.

An incident may involve any action or activity deemed to be in non-compliance with this SWMP as well as actual or potential Material or Serious Environmental Harm.

All incident reporting will be undertaken in accordance with the procedures detailed in the EMS.

8.2 Inspections and monitoring

Inspections of drainage, erosion and sediment control measures will be undertaken:

- weekly during normal operations hours;
- daily during periods of rainfall; and
- within 12 hours of the cessation of a rainfall event (greater than 10 mm) causing runoff to occur on, or from, the quarry.

Inspections will be undertaken by the Quarry Manager.

8.3 Maintenance and remedial actions

As described in Section 7, a range of drainage, erosion and sediment control measures will be implemented within the quarry. A summary of the maintenance and remedial actions for these control measures is provided in Table 8.1.

Table 8.1 Maintenance and remedial actions

Control measure	Maintenance and remedial actions
Drainage control	
Lined clean water diversion drains and banks	Repair any damage to the liner (replace/re-anchor), repair any bunding or silt fence isolating the clean water catchment from the quarry affected water catchment.
Quarry affected water diversion drains and banks	Repair any erosion, re-line if necessary.
Temporary clean water culverts	Ensure water from disturbed areas cannot enter the pipe or channel. Monitor for erosion around the inlet and outlet headwalls and repair as necessary. Check the pipe outlet energy dissipater for erosion and repair and/or modify as necessary.

Table 8.1 Maintenance and remedial actions

Control measure	Maintenance and remedial actions
Culvert waterway crossing	Ensure the geofabric sediment retention is installed correctly and sediment cannot enter the waterway. Ensure the culvert pipe is not blocked. Ensure accumulated sediment is removed from the rock or rock is replaced as necessary. Inspect after flow events to ensure the crossing remains stable. Repair and/or modify as necessary.
Erosion control	
Temporary measures	
Polymer soil stabiliser	Re-apply following rainfall or heavy vehicle traffic as necessary.
Cover crops	Test the soil and apply ameliorants if necessary (see BRMP).
Permanent measures	
Lined channel, drains and batter chutes	Look for water flows under or beside the structure and repair and/or modify as necessary. Look for erosion around and downstream of the structure and repair and/or modify as necessary.
Revegetation	Inspect for evidence of rill, gully, and tunnel erosion, poor soil surface cover and nutrient deficiencies. Test the soil and apply ameliorants if necessary (see BRMP).
Sediment control	
Temporary measures	
Silt fences	Ensure silt fences pond water. If not, install additional panels. Check for blow-outs in the anchor trench. Re-anchor as necessary. Replace any ripped or damaged sediment fence.
Check dams	Check for erosion between check dams. Install additional check dams if necessary. Remove accumulated sediment.
Sedimentation basins	Remove accumulated sediment from WMD01 and WMD02 when it reaches the sediment storage zone marker. If required for sediment removal, dewater WMD01 and WMD02 when water quality is less than nominated water quality limits. Check basin inlets and outlets for erosion and repair as necessary. Check the basin wall for slumping or tunnel erosion. Repair as necessary. Sedimentation basins in the Stage 8 extraction area will be progressively built and then covered as the quarry advanced. Sediment will not need to be removed from these basins and therefore will not need to be dewatered.
Permanent measures	
Wheel wash	Clean out accumulated sediment, check sprays and repair as required.

8.4 Wet weather and site shutdown procedures

The Quarry Manager will monitor weather forecasts daily. Where the forecasts indicate that there is a greater than 60% chance of more than 10 mm of predicted rainfall, the Quarry Manager implement and the wet weather procedures.

The Quarry Manager will initiate erosion and sediment control wet weather preparedness at:

- the end of the working day; or
- in the event of imminent rainfall (greater than 60% chance of more than 10 mm of predicted rainfall).

Erosion and sediment control wet weather preparedness will include:

- ensuring clean water diversions are in place (where required);
- constructing temporary drains if required to ensure runoff from quarry affected catchments is diverted to sediment control measures;
- stabilise unprotected soil stockpiles and erosion prone embankments with soil stabilising polymers and ensure necessary sediment controls are in place;
- ensure sediment traps have been desilted, basins dewatered, and they are operating correctly; and
- implement any remaining controls.

Actions to be taken in the event of a flood warning are described in the *Flood Management Plan* (EMM 2020a).

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Appendix A

Agency consultation

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12 October 2020

Department of Planning, Industry & Environment: Water
Landuse.enquiries@dpi.nsw.gov.au

Re: Menangle Sand and Soil Quarry – Soil and Water Management Plan – Consultation with DPIE Water

To whom it may concern,

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry (the 'Quarry') at 15 Menangle Road Menangle. A modification to the Quarry's approval has recently been approved. The updated approval requires that the soil and Water Management Plan (SWMP) is prepared in consultation with the Environment Protection Authority (EPA) and DPIE Water.

This letter seeks the DPIE Water's input to these plans.

1 Quarry overview

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry at 15 Menangle Road Menangle. Quarrying has been undertaken in the location for over 40 years by a number of operators and at varying rates of production. Extraction, processing and rehabilitation activities have been undertaken by Menangle Sand and Soil since 1978.

Current extractive activities were approved in 1989 (DA 85/2865) and have involved the construction and operation of the quarry in seven stages. Sand and soil has been extracted from Stages 1 to 2 and 4 to 6 and is currently being extracted from Stage 7. While previously approved, sand and soil will not be extracted from Stage 3.

In September 2020, the NSW Land and Environment Court approved 'Menangle Quarry Extension – Modification 1' (MOD1). This allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 ha, and extends about 2 kilometres along the Nepean River south of the Stage 7 area. The extension will increase the life of the quarry by 15 years. The extracted material will be transported to the existing processing area where it will be stockpiled, processed and blended with materials imported to the site, prior to being dispatched from the quarry.

A description of the quarry, including MOD1, is provided in Appendix A. The Notice of Orders Made by the Land and Environment Court (the 'consent') is provided in Appendix B.

2 Previous assessments

The preparation of the environmental assessment for the modification application included the preparation of a *Flooding, Geomorphology and Onsite Water Management* report as part of the *Environmental Assessment* (EMM 2017). The assessment found that the proposed sediment extraction works and the

mitigation measures would ensure that there would be no significant adverse impacts on flooding, river geomorphology and river water quality. The extraction works would have no significant adverse impacts on flood behaviour or flood levels because it would provide more flood conveyance area.

Following the preparation of this assessment, a number of additional reports were prepared in response to DOI/DPI-Water requests, including:

- *DA 85/2865 MOD1, Response to DOI-Water comments of 21 February 2018* (EMM 2018);
- *Menangle Quarry Modification to Development Consent 85/2865, Review of Fluvial Geomorphology* (Fluvial Systems 2018); and
- *Menangle Quarry Extension, Flood Impact Assessment* (Advisan 2018).

The modification application was initially rejected by DPIE. During the Land and Environment Court (Case number 2018/00342158) appeal, additional assessments were prepared during the appeal process, including:

- *Menangle Quarry, Amended Extraction Area and Setback*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Groundwater Management*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Riverside Batter,* letter dated 23 August 2019 (EMM);
- *Fluvial Geomorphology Assessment for Menangle Quarry Modification to Development Consent 85/2865* dated 5 September 2019 (Fluvial Systems);
- *Menangle Quarry, Flood Mitigation*, letter dated 9 September 2019 (EMM);
- *Menangle Quarry Extension – Flood Impact Sensitivity Assessment*, dated September 2019 (Advisian); and
- *Additional Flood Impact Sensitivity Assessment*, dated 17 December 2019 (Advisian).

These reports are available on the Major Projects website:

- http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=8531

3 Management Plan

EMM Consulting Pty Limited (EMM) is now preparing a Soil and Water Management Plan (SWMP) in consultation with the EPA and DPIE Water in accordance with Part B, Condition B36 (b) of the consent.

The SWMP will address the matters raised in the Condition B34 of the consent and Menangle Sand and Soil's Summary of Commitments provided in Table 3.1 of Appendix A, including:

- a site water balance;
- erosion and sediment controls;
- surface water and groundwater baseline characterisation, monitoring and performance criteria;
- protocols for identifying and investigating any exceedances of performance criteria; and
- reporting requirements.

This letter seeks your input into the contents and preparation of the SWMP. We will also provide the draft SWMP to you for your review and comment. We would welcome the opportunity to meet, via teleconference, to discuss the plan.

It is requested that any comments you may have on the content or preparation the SWMP are provided by 26 October 2020 to allow them to be considered during preparation of the plan.

Should you wish to discuss anything specific please call me on the below number.

Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Jeremy Slattery
Associate, Environmental Management
Phone: 0421 827 231
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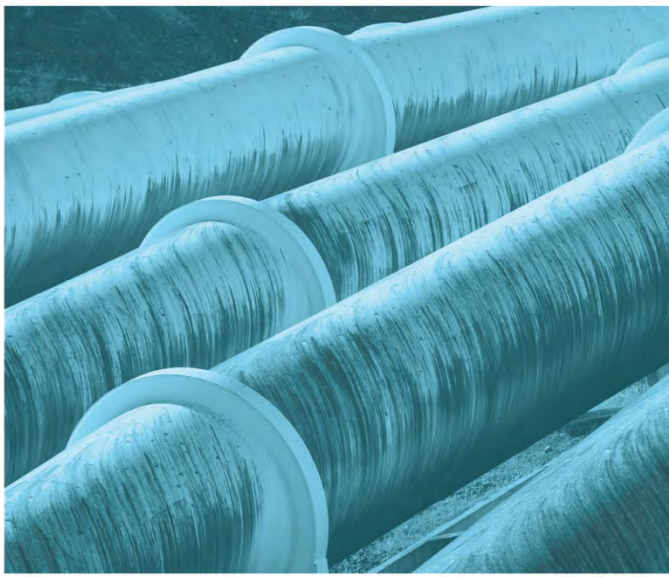
Appendix A

Project description


Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Menangle Sand & Soil Pty Limited v Minister for Planning
24 August 2020

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Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Prepared for Menangle Sand & Soil Pty Limited v Minister for Planning
24 August 2020

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Land and Environment Court Proceedings 342158 of 2018

Applicant's Description of Amended Project

Report Number

J190166 RP#4

Menangle Sand & Soil Pty Limited v Minister for Planning

Date

24 August 2020

Version

v7 Final

Approved by

Dr P. Towler
Associate Director
24 August 2020

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Appendices

Tables

Figures

1 Introduction

Menangle Sand and Soil Pty Ltd (Menangle Sand and Soil) seek a modification to Development Consent 85/2865 to extend the life of the quarry by 15 years while removing the need to re-establish quarrying activities, clear vegetation, and extract sand and soil from the approved Stage 3 area (the Menangle Sand and Soil Quarry Extension Project, the 'extension project'). It is proposed to forego approved land extraction (as well as dredging rights to another 200,000 tonnes) of 500,000 tonnes of sand and soil in the Stage 3 area and instead extend their current operations to extract sand and soil from an additional stage of the quarry (Stage 8). The Stage 8 area will extend approximately 2.8 km along the Nepean River on Company-controlled lands, within Lot 203//Deposited Plan 590247 on the eastern side of the Hume Highway. Approximately 760,000 tonnes of sand and soil will be extracted from the Stage 8 area land over about 15 years. Extraction will be in sequential substages so the active extraction area will be a small proportion of the total Stage 8 extraction area at any given time. No riverine extraction is proposed.

A modification application and accompanying environmental assessment (EA) report for the extension project was lodged in May 2017 and subsequently refused by the Department of Planning and Environment on 25 October 2018. The application is before the NSW Land and Environment Court (2018/342158).

An amended application was placed on public exhibition between 19 February 2020 and 4 March 2020. Amendments to the proposed modification are summarised in *NSW Land and Environment Court (2018/342158) Menangle Quarry - Project Amendments and Information Summary* (EMM [Towler] 2019a).

Given the application's history, the currently proposed modification is described in a range of documents.

This consolidated project description report provides a description of the currently approved quarry, based on Chapter 2 of the *Menangle Quarry Extension Environmental Assessment* (EA) (EMM 2017a), and the currently proposed modification (as amended) as described in Chapter 3 of the EA and subsequently amended in:

- *Supplementary Biodiversity Assessment* (EMM [Ward] 2019b);
- *Menangle Quarry - Amended Extraction Area and Setback* (EMM [Towler] 2019c);
- *Restoration Area Weed Strategy* (EMM [Grant] 2019d);
- *Groundwater Management* (EMM [Webb] 2019e); and
- *Flood Mitigation* (EMM [Towler] 2019f).

No modification amendments were proposed in the *Menangle Quarry Extension Response to Submissions* (RTS) (EMM 2017b).

The allotments subject to the development application modification, 'the site', are provided in Appendix A.

This consolidated project description report outlines the current proposal incorporating all of the changes to the project made since the Refusal and presents an updated statement of commitments.

2 Approved and proposed operations

2.1 Introduction

The extension project will increase the quarry life by 15 years (to 2035) by extracting the sand and soil resource in the Stage 8 area. The Stage 8 area extends approximately 2.8 km upstream of the currently active Stage 7 area. The project will require installation and operation of a conveyor between the existing processing area and the Stage 8 area. Menangle Sand and Soil will relinquish the approved extraction of resource (as well as its perpetual right to the resource located on the Elizabeth Macarthur Agricultural Institute land) from the approved Stage 3 area as part of the extension project.

The layout of the approved and proposed quarry is presented in Figure 2.1.

As well as the extraction areas, key components of the quarry include:

- an existing wheel wash and weighbridge;
- an existing site office and amenity building;
- an existing workshop west of the site office;
- existing fuel supply tanks north of the storage shed;
- existing sand and soils storage and processing area; and
- other existing minor infrastructure.

These components will be used to support activities in the Stage 8 area which will also include:

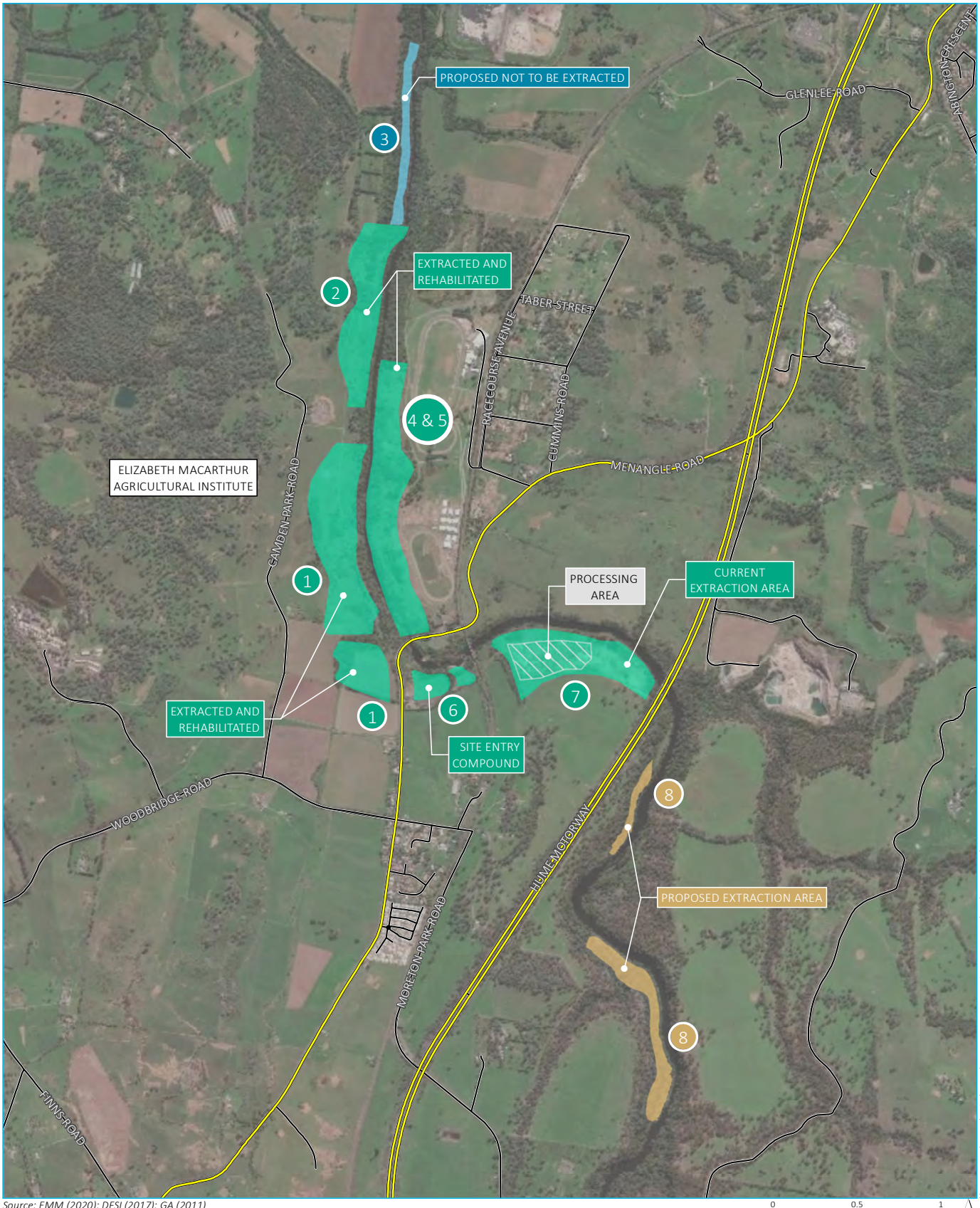
- extraction in the Stage 8 extraction area followed by rehabilitation;
- restoration of areas adjacent to the extraction areas;
- a conveyor; and
- a haul road.

These are described below.

2.2 Resource

The total resource in the 1989-approved quarry is approximately 7.7 million tonnes, made up of approximately 5.9 million tonnes of soil and 1.8 million tonnes of sand. The approved extraction area is approximately 123 ha. An extraction rate of up to 350,000–400,000 tonnes per annum (tpa) of soil and sand is approved. To date, the resource has been extracted in all but the Stage 3 (approximately 300,000 tonnes soil and 400,000 tonnes sand) and the remaining part of the of Stage 7 area.

It is proposed to extract 760,000 tonnes of sand and soil from the Stage 8 area at a rate of no more than 150,000 tpa.



Source: EMM (2020); DFSI (2017); GA (2011)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

KEY

- Main road
- Local road
- Existing processing area (to be retained)
- Extractive operations (approved)
- Extractive operations (approved but not extracted)
- Stage 8 - extraction/rehabilitation area

Menangle Quarry Stages 1 to 8

Menangle Quarry Extension
Figure 2.1

EMM creating opportunities

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It is proposed to extract sand and soil from the Stage 8 extraction area (Figure 2.2) which has a total area of 13.22 ha.

Given that the width of horizontal setback area (see Section 2.3.2i) is variable and to ensure that any biodiversity impacts are fully compensated for, the 'extraction area' is defined as including the horizontal setback area, although extraction will not occur within this setback. This also reflects the previous intent to grade parts of the horizontal setback area where there are no trees. However, it is now proposed to leave the entire horizontal setback area undisturbed, save for hand weeding of the extensive existing noxious weeds.

The 'active extraction area' is the area where the overlying vegetation will be cleared (removing extensive understory weeds and mature native trees) and the sand and soil resource extracted.

2.3 Quarrying

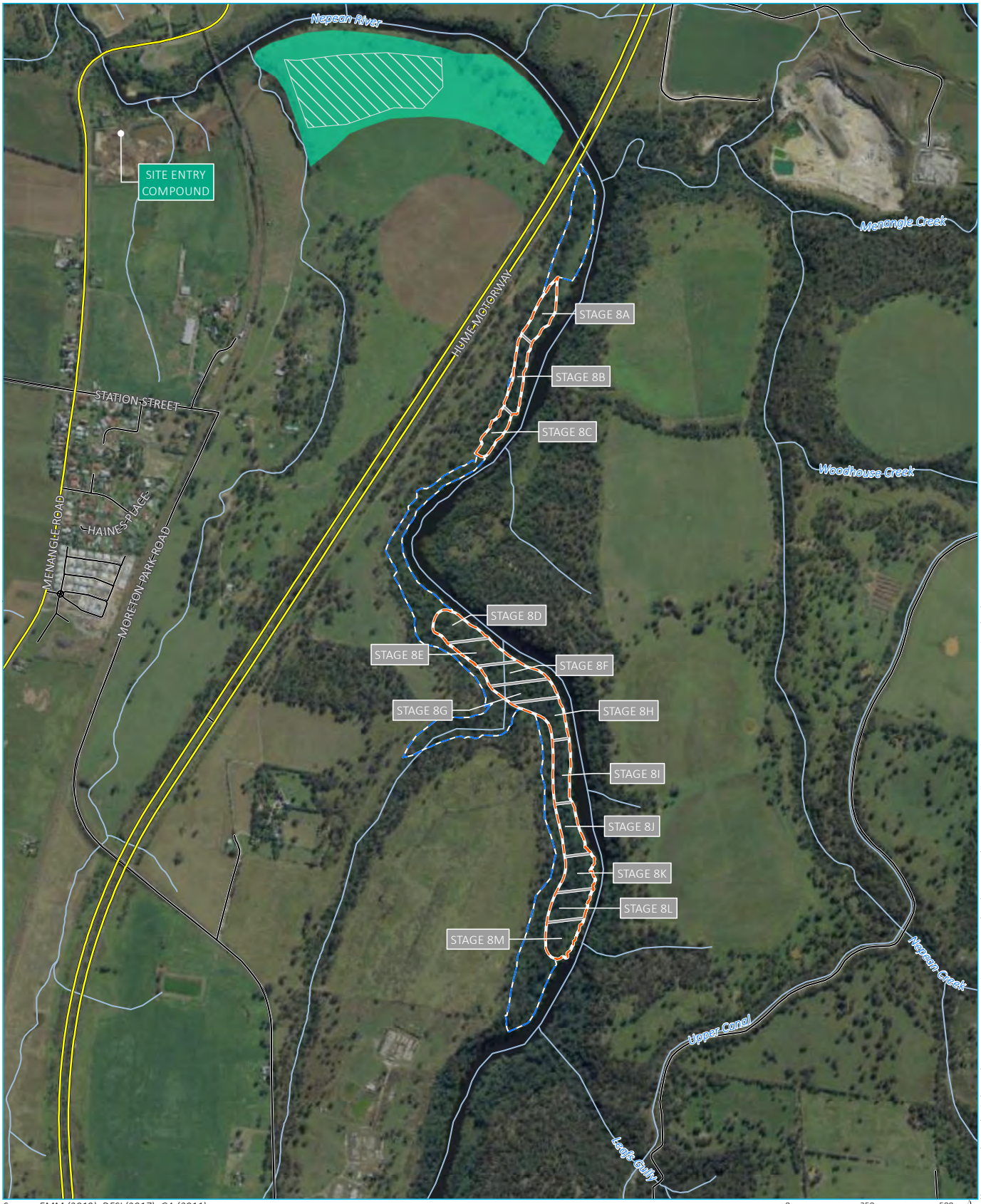
2.3.1 Quarry progression

Historically, quarrying has progressed from south to north (Stages 1–2) and from west to east (Stages 4–7). Quarrying activities in the Stage 7 area are progressing from west to east. Extraction in the Stage 8 area will occur in sub-stages such that only a small portion of the overall Stage 8 area will be the active excavation area at any one time. Extraction will progressively move upstream in thirteen sub-stages, with each sub-stage each covering about 1 ha (Figures 2.2 to 2.4). Each of these sub-stages will be a basic operating cell and will take approximately 1 year to complete, depending on demand for product. Each sub-stage will be progressively rehabilitated using similar methods to those as implemented in the Stage 1–2 and Stage 4–5 areas but with a more intensively managed native planting regime implemented.

The maximum area of each substage is provided in Table 2.1.

Table 2.1 Maximum area of each substage

Substage	Area (ha)
8a	0.93
8b	0.93
8c	0.69
8d	1.07
8e	1.07
8f	1.07
8g	1.07
8h	1.07
8i	1.07
8j	1.07
8k	1.07
8l	1.07
8m	1.07
Total	**13.25**



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Source: EMM (2019); DFSI (2017); GA (2011)

0 250 500 m

GDA 1994 MGA Zone 56

N

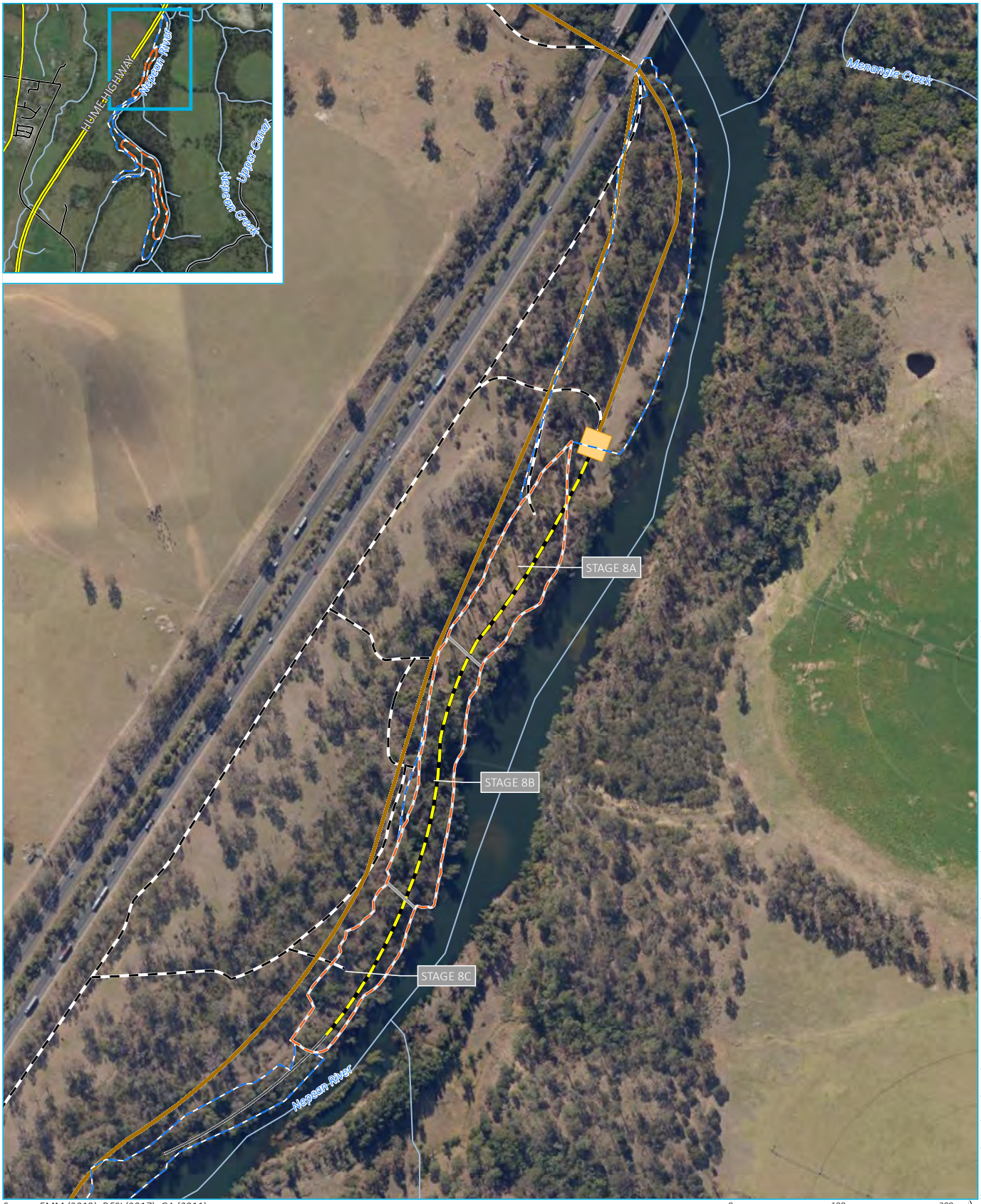
KEY

- Processing area (to be retained)
- Stage 7 - current extractive operations
- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction)
- Main road
- Local road
- Watercourse/drainage line

Overall staging plan

Menangle Quarry Extension
Figure 2.2

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

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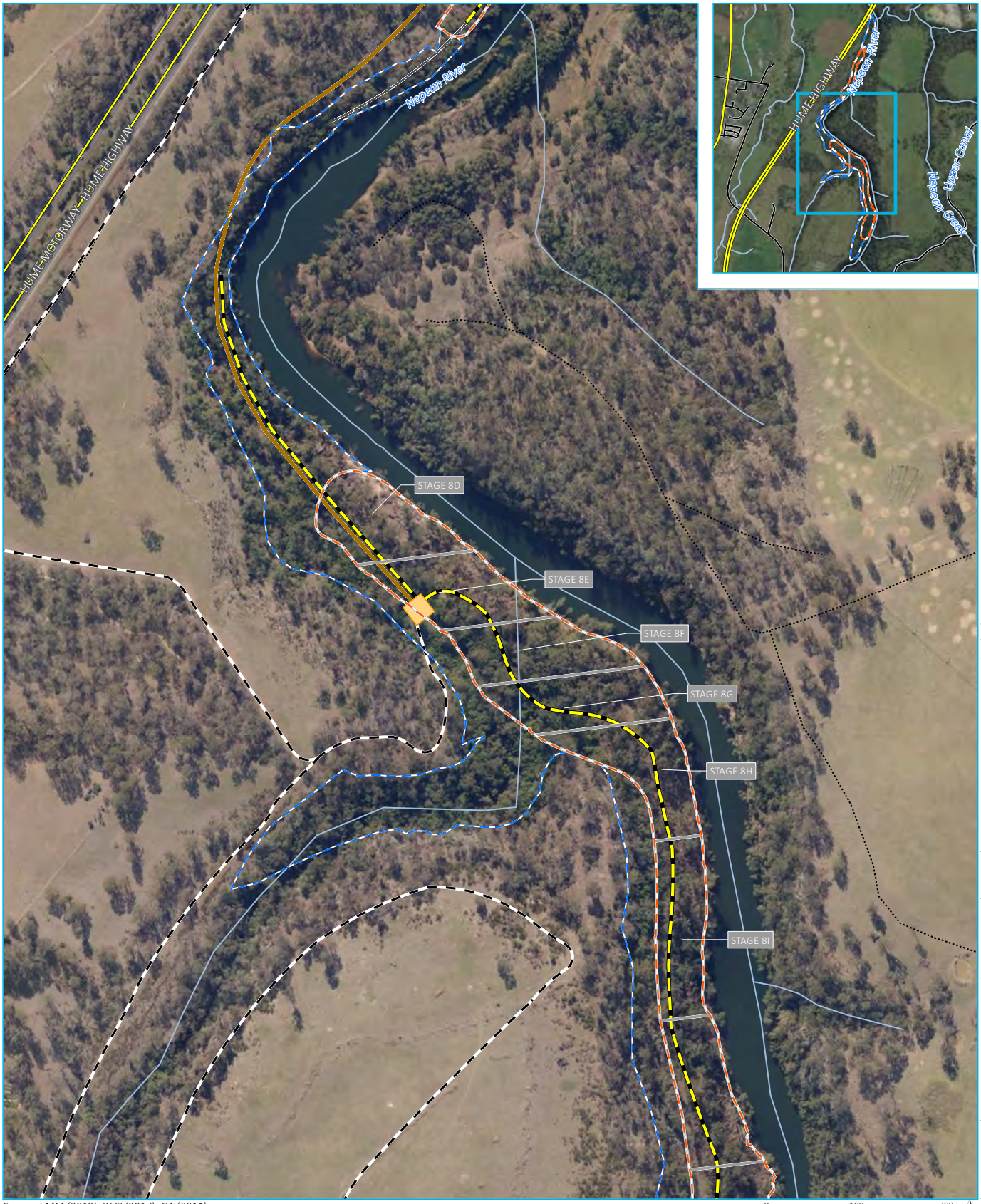
KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Conveyor head
- Indicative conveyor location
- Haul road
- Access road
- Existing access track
- Watercourse/drainage line

Stage 8 Extraction and restoration areas Stage 8A to 8C

Menangle Quarry Extension
Figure 2.3

EMM creating opportunities



Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

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KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Conveyor head
- Indicative conveyor location
- Haul road
- Access road
- Existing access track
- Main road
- Vehicular track
- Watercourse/drainage line

Stage 8 extraction and restoration areas – Stages 8D–8I

Menangle Quarry Extension
Figure 2.4

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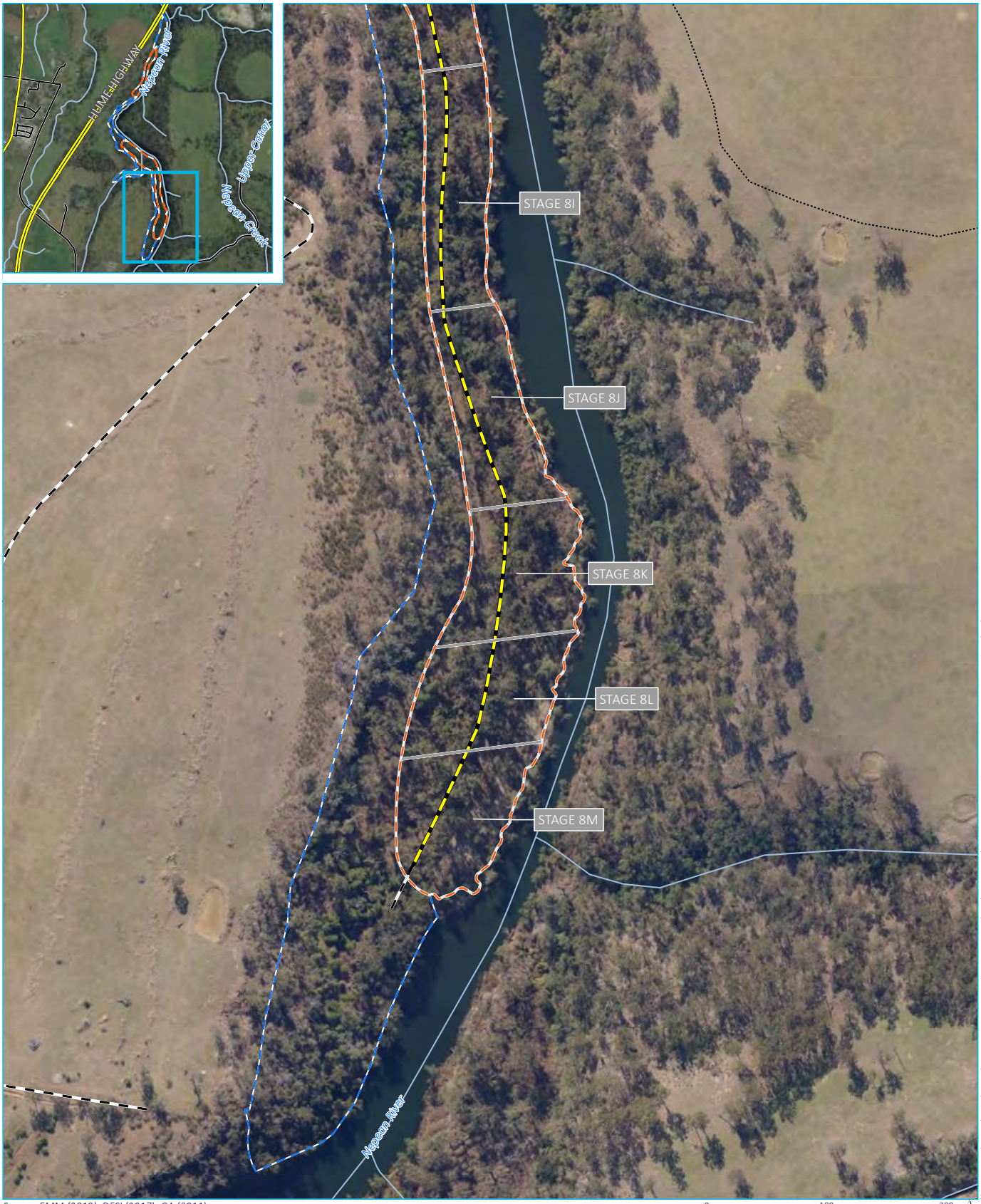

Source: EMM (2019); DFSI (2017); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

- Stage 8 - extraction/rehabilitation area
- Stage 8 - restoration area (no extraction) boundary
- Substage boundary
- Haul road
- Existing access track
- Local road
- Vehicular track
- Watercourse/drainage line

Stage 8 extraction and restoration areas – Stages 8I–8M

Menangle Quarry Extension
Figure 2.5

EMM creating opportunities

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2.3.2 Stage 8 area quarry design

The Stage 8 quarry design is presented in Chapter 3 of the EA. Subsequently, the design has been amended to incorporate changes made since the Refusal. The amened proposed quarry design is summarised below.

Schematics showing the quarry progression in plan-view and in cross-section are is presented in Figure 2.6 and Figure 2.7 respectively. An indicative cross-section perpendicular to the bank is presented in Figure 2.8 and Figure 2.9.

i Lower riverbank and horizontal setback retention

The level of the Nepean River adjacent to the Stage 8 area is controlled by the downstream Menangle Weir so as to be about 61 mAHD during normal low flow.

During extraction of the resource from the previous quarry stages, the lower riverbank was retained and a horizontal setback from a contour approximately 3 m above the normal river level was provided. For example, in the Stage 7 area, the lower riverbank (below 64 mAHD) was retained and a horizontal setback of 10 m from the 64 mAHD contour on the natural riverbank (ie 3 m above the normal level of the Nepean River) was provided.

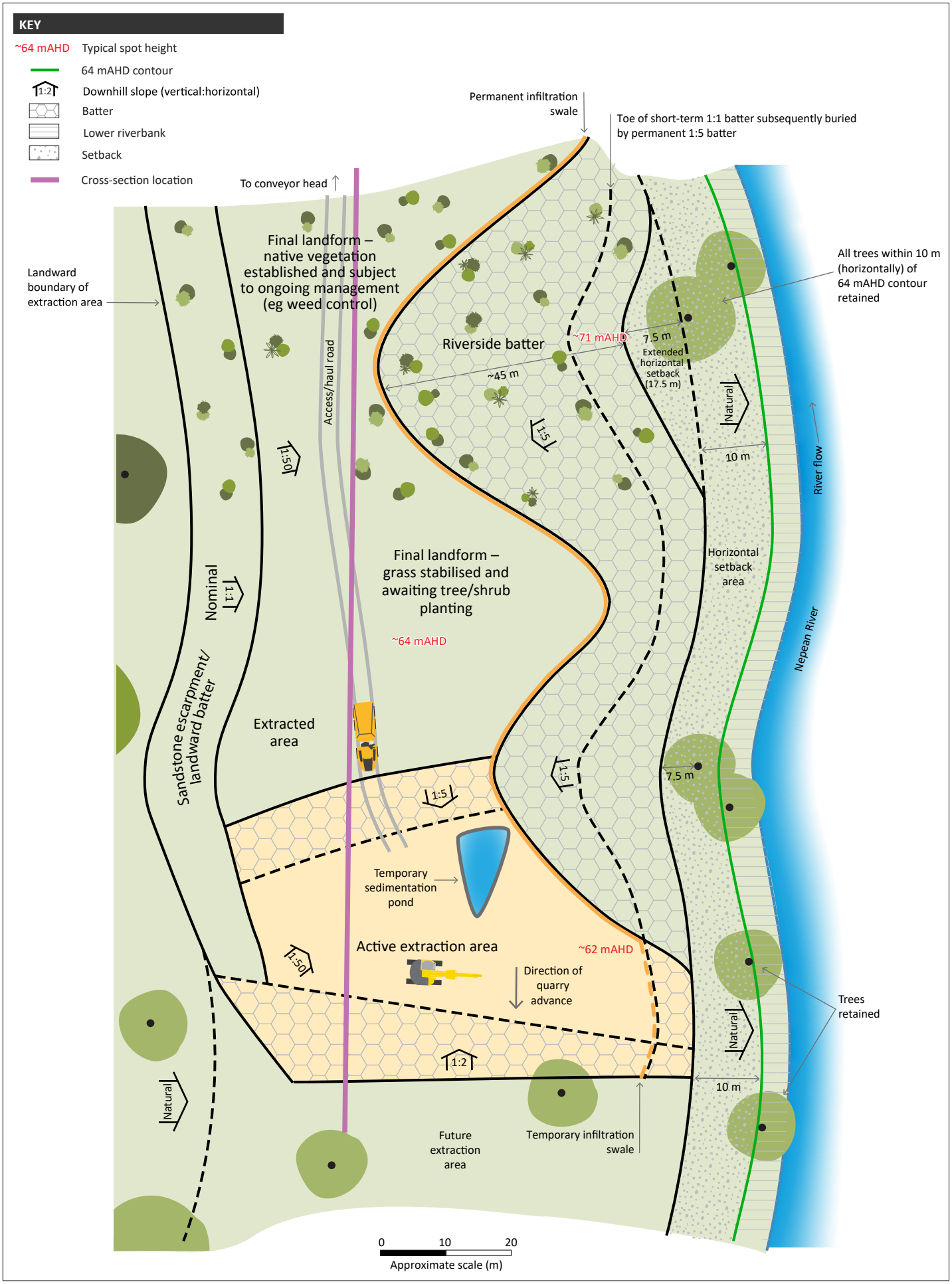
A similar setback was proposed for the Stage 8 area. However, the proposed setback method has since been amended to protect all native trees in the 10-m wide horizontal setback area as follows:

- The lower riverbank will be retained below the 64 mAHD contour and remain untouched (except for hand removal of weeds, felling of non-native trees leaving the roots in place, and very selective herbicide application).
- The riverbank will also be retained in a horizontal setback that extends at least 10 m (measured horizontally) inland from the 64 mAHD contour up the bank (referred to as the '10-m-wide horizontal setback area')[1].
- Where there are native trees[2] within the 10-m-wide horizontal setback area, the width of the setback will be increased so that edge of the setback area/start of extraction area is at least 7.5 m (measured horizontally) from the trunk of these trees.

Therefore, the active extraction area will be separated from the river by the lower riverbank (ie between 61 mAHD and 64 mAHD) and additionally by the horizontal setback that will be between 10 and 17.5 m wide. The undisturbed bank (ie the combined lower riverbank and horizontal setback) will vary in height but will be at least 3 m above the low-flow river level where the bank slope is shallow but will be higher where the bank slope is steeper.

[1] It was previously proposed to grade the horizontal setback to a slope of 1:50 where there are no native trees within the horizontal setback area. This is no longer proposed and the existing landform within the horizontal setback area will be retained, including where there are no trees.

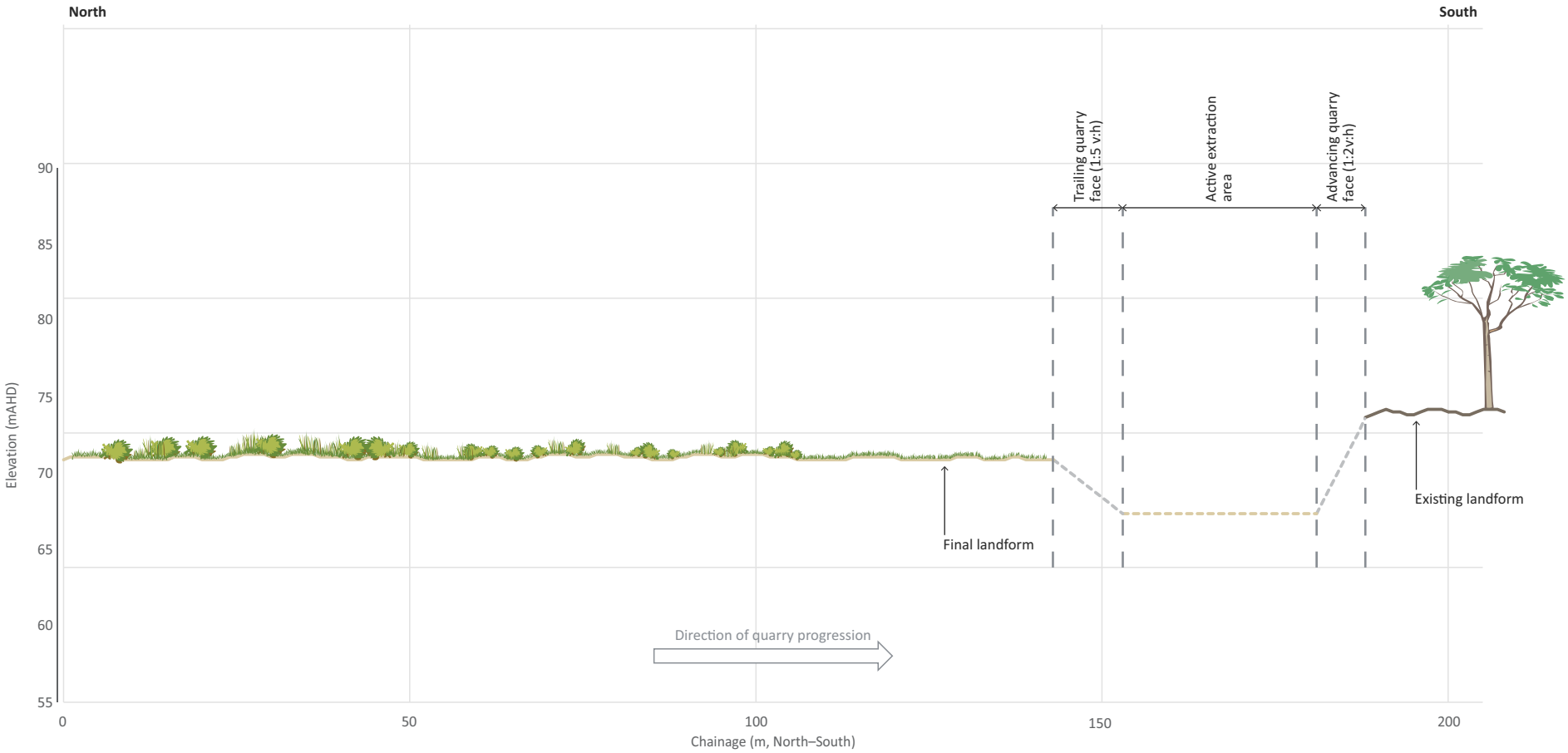
[2] Native trees with a trunk diameter of >0.1 m diameter at breast height (DBH).



Quarry progression schematic

Menangle Quarry Extension

Figure 2.6



Quarry progression cross-section

Menangle Quarry Extension

Figure 2.7

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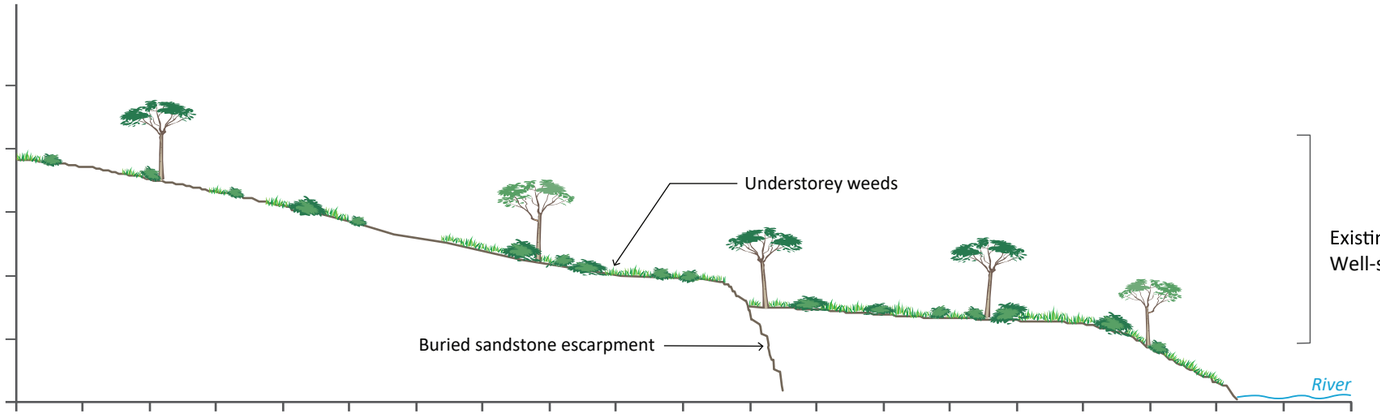
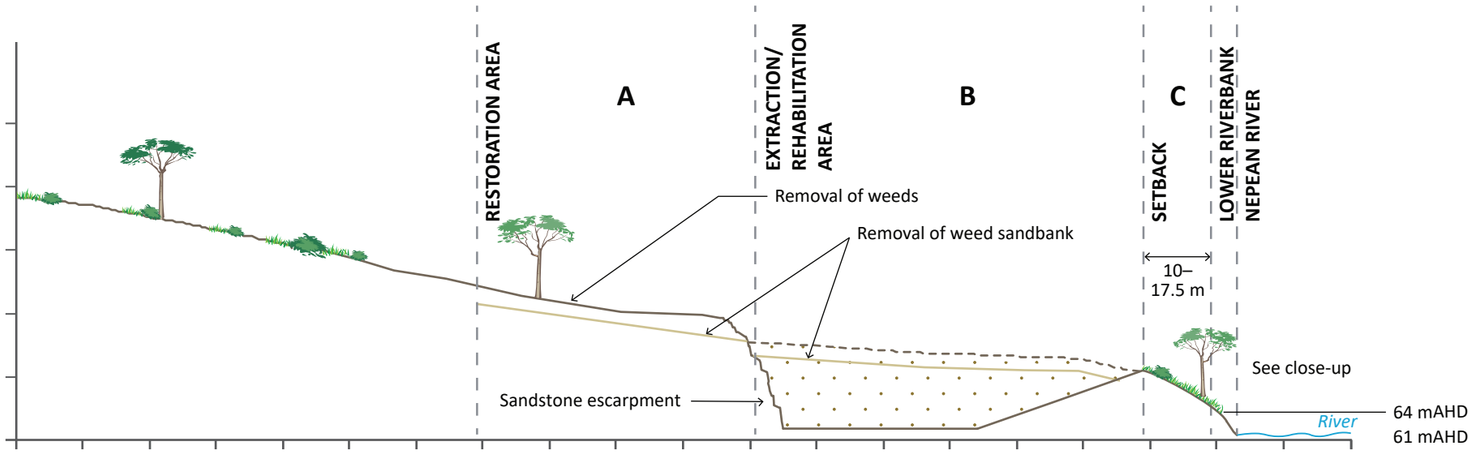
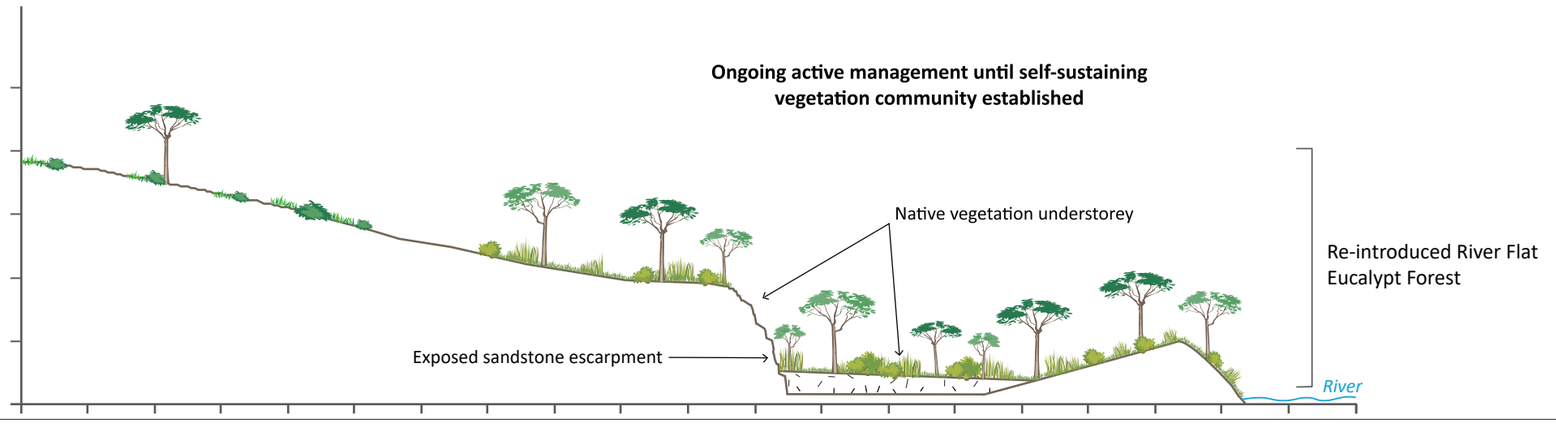
EXISITNG LANDFORM



EXTRACTION



FINAL LANDFORM



A. Restoration area

1. Understorey invasive weeds cleared
2. Large trees retained
3. Topsoil (containing weed seedbank) and weeds removed and buried in base of pit
4. Revegetation using species to form a high-quality vegetation community
5. Ongoing active management for years until self-sustaining vegetation community established

B. Extraction and rehabilitation

1. Clear vegetation
2. Topsoil (containing weed seedbank) removed and buried in base of pit
3. Extract sand and soil resource, remaining 1 m above water table
4. Place weed-infested soil in base of the pit followed by scalps to form final landform self-draining slope (≤1:50)
5. Revegetate final landform to form high-quality River Flat Eucalypt Forest
6. Ongoing active management until self-sustaining vegetation community established

C. Setback and lower river bank

1. Survey outer edge of buffer bank (64 m AHD contour)
2. Provide 10–17.5 m setback from 64 m AHD contour
3. Remove exotic trees and weeds from lower bank by hand
4. Ongoing active management for years until self-sustaining vegetation community established

KEY

Resource to be extracted including weed seed bed to be buried

Soil/scalps with weed infested soil placed at base of pit

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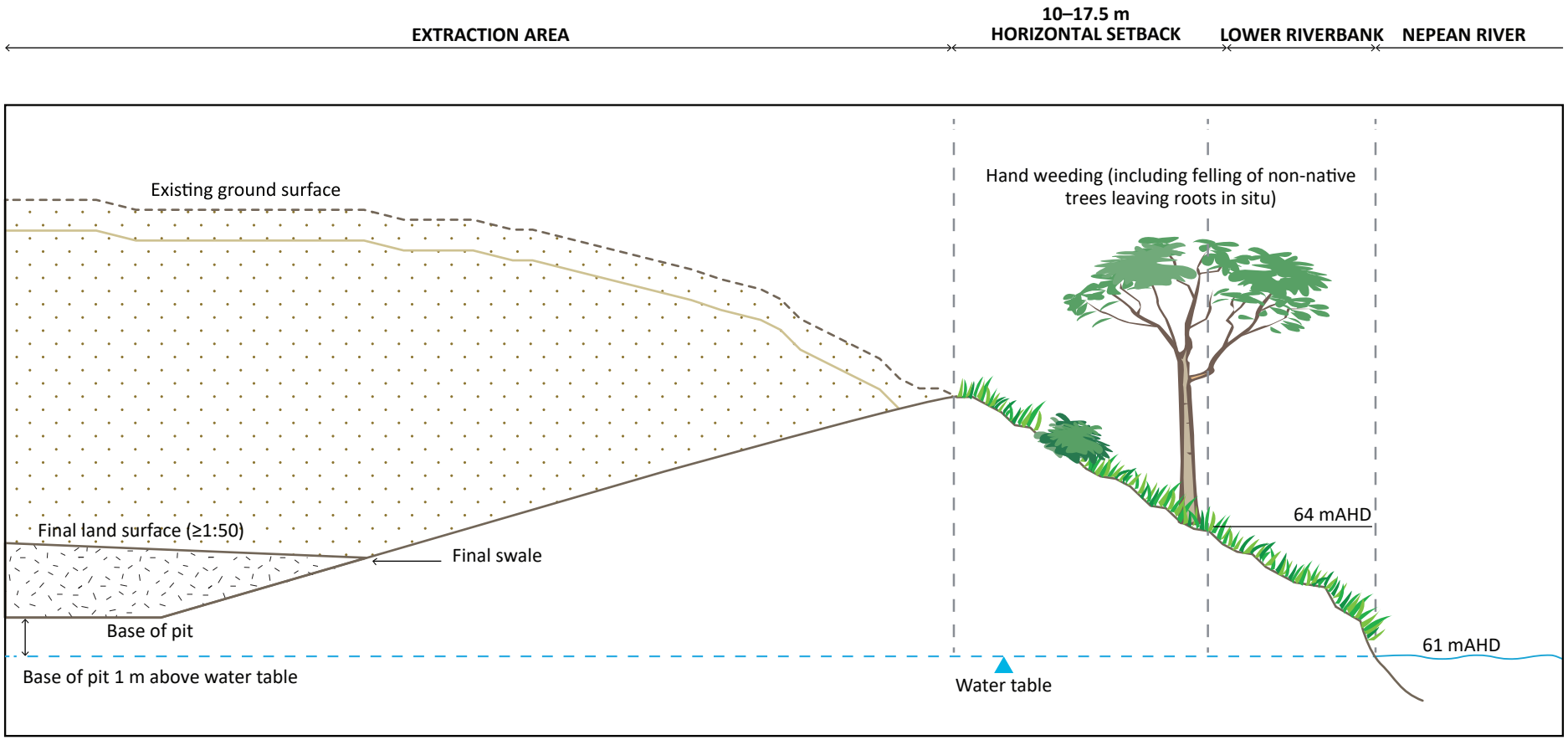
Indicative cross-section

Menangle Quarry Extension

Figure 2.8



Indicative cross-section – close-up

Menangle Quarry Extension

Figure 2.9

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ii Riverside batter

The riverside batter will be inland of the horizontal setback area (Figure 2.6).

It is proposed that:

- a temporary riverside batter with a maximum slope of 1:1 m (vertical: horizontal)[3], will be used during sand and soil extraction – this will allow the efficient extraction of the resource;
- following extraction of the resource above this batter, the batter will be then built up with suitable site material to give a permanent slope of 1:5 – this will provide additional assurance that the bank will be stable if the active extraction area is flooded during extraction;
- the maximum length of the riverside batter that has a slope between 1:1 and 1:5 will be restricted to 30-m long so that it can be returned to a 1:5 batter within 12 hours if flooding is predicted;
- regardless of the amount of material required, the maximum length of the riverside batter that has a slope between 1:1 and 1:5 will be restricted to 30 m, measured parallel along the river;
- in the final landform, the riverside batter will have a permanent slope of 1:5 – this will provide additional assurance that the bank will be stable in the long term; and
- if over the life of the quarry, activities temporarily cease in the extraction area such that the excavator is relocated from the Stage 8 area, the riverside batter will be always left as a 1:5 batter.

iii Advancing quarry face

The quarry will progressively advance upstream at an average rate of about 150 m/year. The advancing quarry face will face downstream.

During large floods, river water may overtop the lower riverbank and horizontal setback area and flow into the active extraction area or may overtop the riverbank upstream of the active extraction area and flow along the bank to enter the active extraction area over the advancing face. A maximum batter angle of 1:2 will be applied to the advancing face so as to minimise any scour occurring as the water initially flows down the batter, until the water level in the extraction area is at the same level as the river.

iv Trailing quarry face

The trailing quarry face, between the active extraction area and backfilled extracted area, will face upstream.

A maximum landward batter angle of 1:5 is proposed for this face as it will face upstream in a flood. As for the riverside batter, this will mitigate the scour risk.

v Landward batter

The landward, or inland, batter is on the side of the extraction area furthest from the river (Figure 2.6).

A maximum landward batter angle of 1:1 is proposed as it will be exposed to far lower flood current speeds and peak shear stress than the riverside batter. There may be a steeper angle on the landward side of the extraction area where it is formed by the natural sandstone rock escarpment, which in places, may be vertical.

[3] All slopes in this report are expressed as vertical:horizontal.

vi Base of the extraction area

Bores will be installed in the base of the active extraction area prior to the commencement of extraction in each successive substage and the water level will be recorded daily during active operations. The resource will be extracted in a manner that ensures that the base of the extraction area is always at least 1 m above alluvial water table resulting from the normal low flow water level in the Nepean River.

2.3.3 Pre-extraction surveys

Prior to any extraction occurring in each substage area, a qualified surveyor will:

- mark the boundary of the extraction area closest to the river as defined by the 64 m AHD contour;
- mark the extent of the 10-m-wide horizontal setback area;
- mark all living native trees with their trunk within the 10-m-wide horizontal setback area;
- place a peg 7.5 m horizontally landward of each tree within the 10-m-wide horizontal setback area – marking the extent to which the existing bank will be retained, ie forming the 10-m to 17.5-m-wide horizontal setback area;
- mark all other boundaries of the extraction area such that the area of each substage does not exceed the area in Table 2.1; and
- mark the boundaries of the adjacent restoration (no resource extraction) area.

2.3.4 Vegetation clearing

Vegetation will be cleared in campaigns ahead of sand and soil extraction. The area cleared at any one time will be minimised but will provide sufficient area to allow safe operations in the extraction area (allowing for the height of standing trees). The maximum extent of the cleared, but un-rehabilitated, extraction area will be 1 ha, but it is expected that a smaller portion will actually be cleared at any one time.

The timber will be stored onsite, prior to being periodically milled onsite using a portable mill. The milled timber will be used for fencing and other construction in the local area. Through a related entity, Menangle Sand and Soil control about 600 hectares in the local area where this milled timber will be used.

2.3.5 Topsoil removal

Topsoil will be stripped to a depth of approximately 0.2–0.3 m. Given that the topsoil in the Stage 8 area contains the seedbank for the noxious weeds infesting the area, this weed-infested material will be placed in the bottom of the preceding extraction area, following resource extraction, and will be covered by material returned as part of creating the final landform (see Section 2.8.1). It is important to bury these weed-infested soils deeply to prevent weed re-emergence.

2.3.6 Resource extraction

The sand and soil resource in the Stage 8 area will be extracted using an excavator and off-road haul truck. It will only be extracted to within 1 m above the water table (see Section 2.3.1). The excavator will load the haul truck, which will then transport the sand and soil to the conveyor head (see Section 2.4.1).

2.3.7 Dredging

Historically dredging has been used to extract sand from the Nepean River and is permitted in the existing Consent. Dredging is not proposed as part of the extension project (Stage 8).

2.4 Onsite material transport and processing

2.4.1 Stage 8 area material transport

Proposed Stage 8 works include the progressive construction of a haul road within the proposed Stage 8 area (see Figures 2.3 to 2.5). This haul road will follow existing cleared tracks.

An off-road haul truck will be used to transport excavated sand and soil from the active extraction area to the start of the conveyor, where it will be tipped.

At the conveyor head, sand and soil will be loaded into a self-powered screen which will remove the oversized material (>4 mm scalps). These scalps will be hauled back to the open excavation for use in rehabilitation. The screen will discharge sand and soil onto a conveyor.

The conveyor will be progressively extended south as the extraction moves south (see Figures 2.3 to 2.5). The conveyor will be a temporary structure (approximately 1.5-m high and 1-m wide) that will be removed upon completion of the project.

2.4.2 Processing

Mobile screens within the processing area are used to remove roots and coarse material (>4 mm) 'scalps'. The mobile stacker attached to the screen discharges screened soil into a stockpile for sale or blending. Some material is further screened to create specific blended soil products using mobile screening plants and a washing plant.

The wastes from the washing plant consist of organics such as pebbles, roots and fines (very fine sand, silt, and clay particles) in water. These wet fines are gravity fed to the settling pond in the processing area and are mostly recovered from the pond and blended into products. The remaining silts are used to rehabilitate the site.

No changes to material processing are proposed.

2.4.3 Blending

Environment Protection Licence (EPL) 3991 lists the type of wastes that can be accepted by the facility and the limits and conditions imposed on the acceptance and stockpiling of this waste. Extracted material is currently blended with these imported materials, where necessary.

No changes to material blending are proposed.

2.4.4 Stockpiling

Very little material is stockpiled in the extraction areas. Stockpiles are mainly kept in the processing area.

No changes to material stockpiling are proposed.

2.5 Access

2.5.1 Site access

The main access to the site is from Menangle Road. Menangle Road is an arterial road which provides sub-regional access. It is not proposed to change the site access for inbound materials or outbound materials.

2.5.2 Access to the Stage 8 area

Light vehicles accessing to the Stage 8 area will use the existing access under the Hume Motorway. The existing access was retained when the RMS bisected the lands when acquiring the corridor for the original Hume Highway in 1969. The existing access road under the bridge will be sealed and will comply with RMS drainage and pavements standards.

The earthmoving equipment, off-road haul truck and other plant to service the Stage 8 area will access the area via Moreton Park Road. Major plant is expected to remain onsite through-out the duration of the quarrying operations except for major servicing or replacement.

2.5.3 Product dispatch

No changes to product dispatch are proposed. Truck movements at the site (ie combined inbound and outbound movements) will not exceed an average of:

- 147 per day on Monday to Friday; and
- 80 per day on Saturday.

2.6 Quarry life

The proposed modification to the existing consent for the quarry would extend the approved life of the quarry for 15 years, from 2020 to 2035.

2.7 Biodiversity protection

A land 'swap' is proposed, surrendering the approval to extract sand and soil from the Stage 3 area (5.68 ha) for the same area (in hectares) of the Stage 8 extraction area on a 1:1 basis.

In addition, it is proposed to restore areas upstream, downstream and upslope of the extraction areas. These restoration areas are shown in Figures 2.3 to 2.5 and will form biodiversity offsets to compensate for the clearing of vegetation in the Stage 8 area that is not part of the land swap. Management of the restoration areas will include the removal of the extensive exotic vegetation in the restoration area, allowing restoration of the entire bank, back to a sustainable, high-quality, native ecosystem.

A Stage 8 area vegetation management plan will be prepared that:

- provides details of the conceptual final landform, soil stripping and vegetation clearing protocols, erosion and sediment control measures, rehabilitation of the extraction area and adjacent restoration activities;
- describes how the implementation of the biodiversity offset strategy will be integrated with the overall rehabilitation of the site; and
- details how connectivity will be managed during the rehabilitation program.

A full-time rehabilitation specialist will be employed as part of the Stage 8 area operations.

2.8 Rehabilitation and closure

2.8.1 Progressive rehabilitation of the Stage 8 area

Following completion of resource extraction, any weed-infested topsoil will be placed in the base of the extracted area followed by scalps and fines. These will used to build up the base of the extracted area to about 64 mAHD. Following construction of the final landform, the area will be immediately planted with grasses to stabilise the surface. Native vegetation will then be established through planting and seeding. There will be ongoing active management of the rehabilitated extraction area, including weed control.

2.8.2 Final landform

The extraction area design (see Section 2.3.2), as amended to incorporate changes made since the Refusal, will result in the following final landform:

- the lower riverbank (below 64 mAHD) landform will be unchanged;
- the landform in the 10-m to 17.5-m wide horizontal setback will be unchanged;
- the land will slope down at 1:5 from the landward edge of the horizontal setback to 64 mAHD (the riverside batter);
- the infiltration swale along the toe of the riverside batter will be retained to prevent runoff from the final landform flowing overland to the river;
- a nearly-level area at about 64 mAHD gently sloping (1:50) down to the infiltration swale at the toe of the riverside batter;
- a 1:1 slope, or the exposed sandstone escarpment, down to the western edge of the extracted area; and
- the landform in the restoration area and outside of the extraction area will be unchanged.

The rate and volume of extraction will be monitored to ensure that a final landform can meet these design parameters.

Conceptual final landforms are provided in Figures 2.10 to 2.13.

As described in Section 2.3.2i, the horizontal setback area will vary between 10-m and 17.5-m wide along the length of the extraction areas, depending on the exact locations of trees within the 10-m wide horizontal setback. Conceptual final landforms are presented for a 10-m wide horizontal setback and a 17.5-m wide horizontal setback. The actual final landform will be a mixture between these two conceptual final landforms.

The accuracy of the existing contours is limited by the digital elevation model accuracy. It is not currently possible to improve this accuracy through a detailed topographic survey of the entire Stage 8 area given the density of woody weeds in much of the area. These weeds need to be cleared prior to a detailed survey which would compromise the stability of the land surface if undertaken in a single campaign across the entire Stage 8 extraction area. A qualified surveyor will survey each substage area prior to any extraction occurring in the substage and a detailed final landform for the substage will be prepared.

The base of the ephemeral creek in the southern part of the extraction area will be left at its present elevation below 64 mAHD.

The inland batter of the extraction area will be a 1:1 (vertical:horizontal) sand and soil slope or the currently buried sandstone escarpment. The exact location and slope of the buried sandstone escarpment will vary along the extraction areas. A nominal, 1:1 (vertical:horizontal) has been assumed in the conceptual final landform. Some of this area may be low exposed sandstone cliffs as currently occur upslope of the extraction area.

Over the coming decades, ongoing sand and soil deposition from the river's floods will fill the low areas, eventually recreating the current terraced benches.

2.9 Site infrastructure and services

2.9.1 Site buildings

There is a compound containing the administrative offices and allied buildings immediately at the site entrance on Menangle Road. The compound comprises:

- an existing site office and amenities building, housing offices, kitchen amenities and soil laboratory;
- an existing wheel wash and weighbridge are located at the top of an elevated bank, level with the floor level of the main building;
- an existing large workshop housing equipment and machinery as well as a storage area for ancillary machinery; and
- existing fuel supply tanks.

No changes to site buildings and infrastructure are proposed.

2.9.2 Lighting

There will be no changes to lighting in the processing and site entry areas.

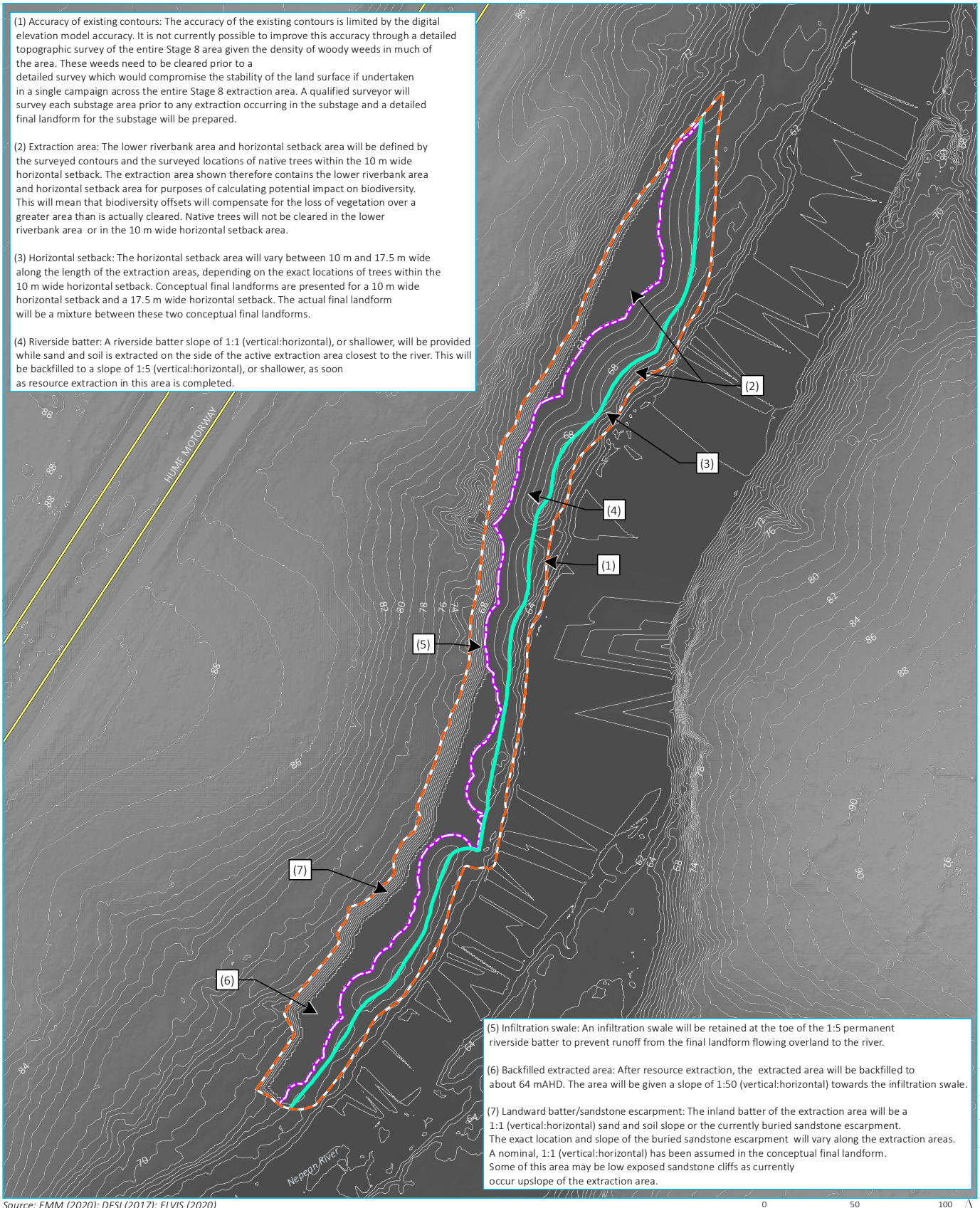
No fixed lighting will be required in the Stage 8 area as extraction will only occur in daylight hours.

2.10 Hours of operation

The existing development consent allows the quarry to operate over the following hours:

- 6 am to 5 pm Monday to Friday;
- 6 am to 12 pm Saturday; and
- with no operations on Sundays or public holidays.

No changes to the approved hours of operation are proposed.



(1) Accuracy of existing contours: The accuracy of the existing contours is limited by the digital elevation model accuracy. It is not currently possible to improve this accuracy through a detailed topographic survey of the entire Stage 8 area given the density of woody weeds in much of the area. These weeds need to be cleared prior to a detailed survey which would compromise the stability of the land surface if undertaken in a single campaign across the entire Stage 8 extraction area. A qualified surveyor will survey each substage area prior to any extraction occurring in the substage and a detailed final landform for the substage will be prepared.

(2) Extraction area: The lower riverbank area and horizontal setback area will be defined by the surveyed contours and the surveyed locations of native trees within the 10 m wide horizontal setback. The extraction area shown therefore contains the lower riverbank area and horizontal setback area for purposes of calculating potential impact on biodiversity. This will mean that biodiversity offsets will compensate for the loss of vegetation over a greater area than is actually cleared. Native trees will not be cleared in the lower riverbank area or in the 10 m wide horizontal setback area.

(3) Horizontal setback: The horizontal setback area will vary between 10 m and 17.5 m wide along the length of the extraction areas, depending on the exact locations of trees within the 10 m wide horizontal setback. Conceptual final landforms are presented for a 10 m wide horizontal setback and a 17.5 m wide horizontal setback. The actual final landform will be a mixture between these two conceptual final landforms.

(4) Riverside batter: A riverside batter slope of 1:1 (vertical:horizontal), or shallower, will be provided while sand and soil is extracted on the side of the active extraction area closest to the river. This will be backfilled to a slope of 1:5 (vertical:horizontal), or shallower, as soon as resource extraction in this area is completed.

(5) Infiltration swale: An infiltration swale will be retained at the toe of the 1:5 permanent riverside batter to prevent runoff from the final landform flowing overland to the river.

(6) Backfilled extracted area: After resource extraction, the extracted area will be backfilled to about 64 mAHD. The area will be given a slope of 1:50 (vertical:horizontal) towards the infiltration swale.

(7) Landward batter/sandstone escarpment: The inland batter of the extraction area will be a 1:1 (vertical:horizontal) sand and soil slope or the currently buried sandstone escarpment. The exact location and slope of the buried sandstone escarpment will vary along the extraction areas. A nominal, 1:1 (vertical:horizontal) has been assumed in the conceptual final landform. Some of this area may be low exposed sandstone cliffs as currently occur upslope of the extraction area.

Source: EMM (2020); DFSI (2017); ELVIS (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

KEY

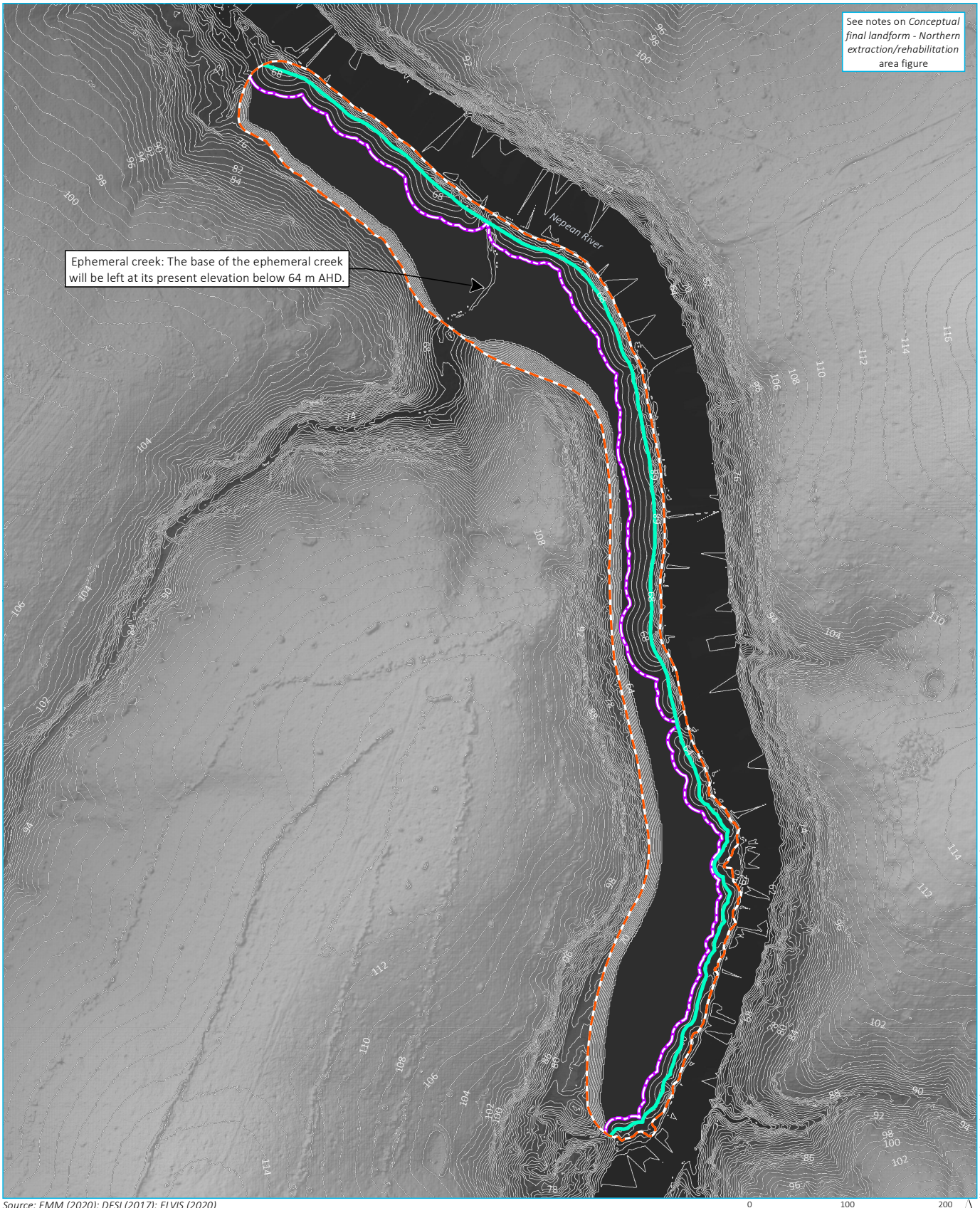
- Stage 8 - extraction/rehabilitation area
- Inland extent of horizontal setback (10 m)
- Infiltration swale/toe of riverside 1:5 permanent batter
- Contour (1 m)
- Major road

Conceptual final landform 10 m setback
Northern extraction/rehabilitation area

Menangle Quarry Extension
Figure 2.10

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G027_ConceptualFinalLandform_10mSetback_NE_20200515_03.mxd 15/05/2020

creating opportunities



Source: EMM (2020); DFSI (2017); ELVIS (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

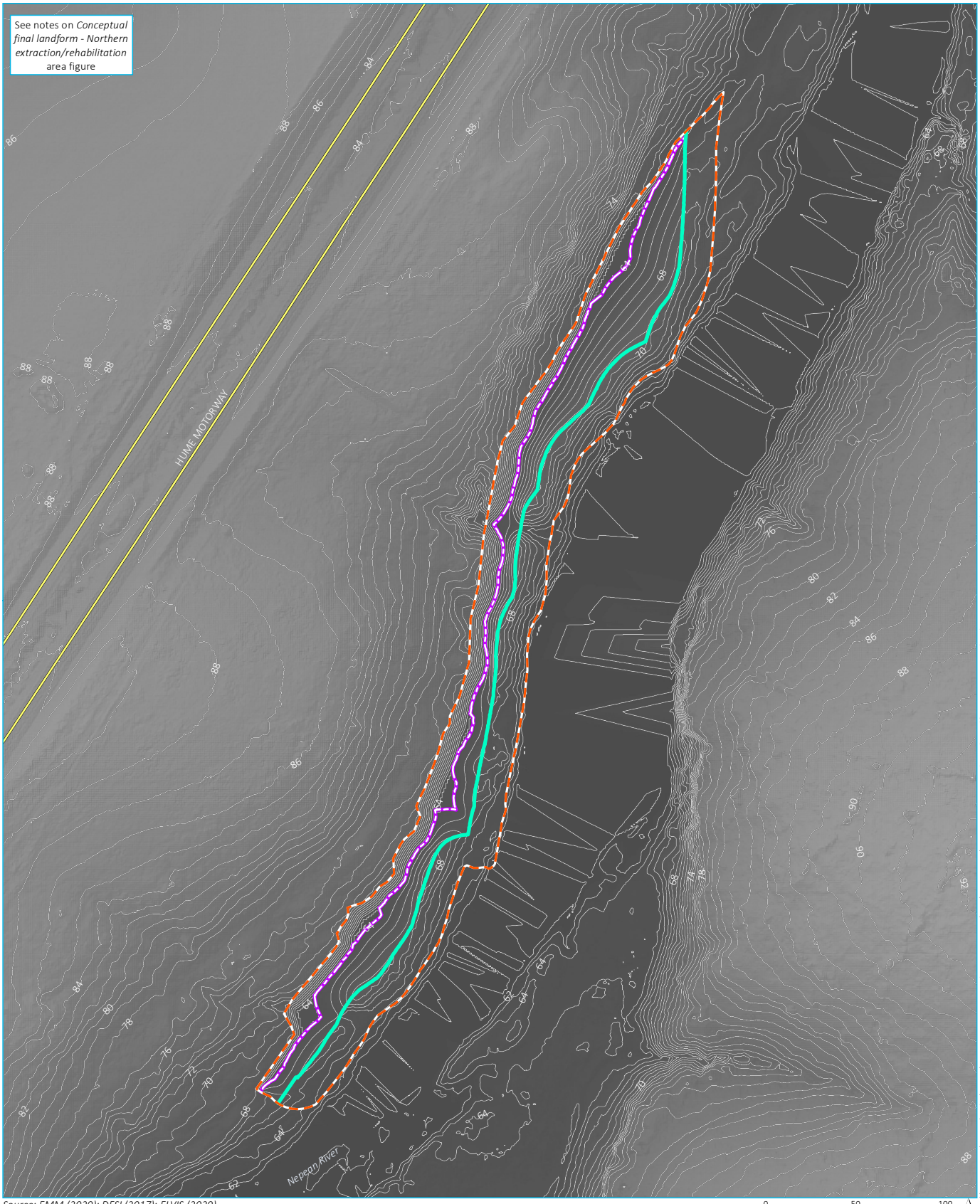
- Stage 8 - extraction/rehabilitation area
- Inland extent of horizontal setback (10 m)
- Infiltration swale/toe of riverside 1:5 permanent batter
- Contour (1 m)

Conceptual final landform 10 m setback Southern extraction/rehabilitation area

Menangle Quarry Extension
Figure 2.11

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G028_ConceptualFinalLandform_10mSetback_SE_20200515_02.mxd 15/05/2020

creating opportunities



Source: EMM (2020); DFSI (2017); ELVIS (2020)

0 50 100 m

GDA 1994 MGA Zone 56

N

KEY

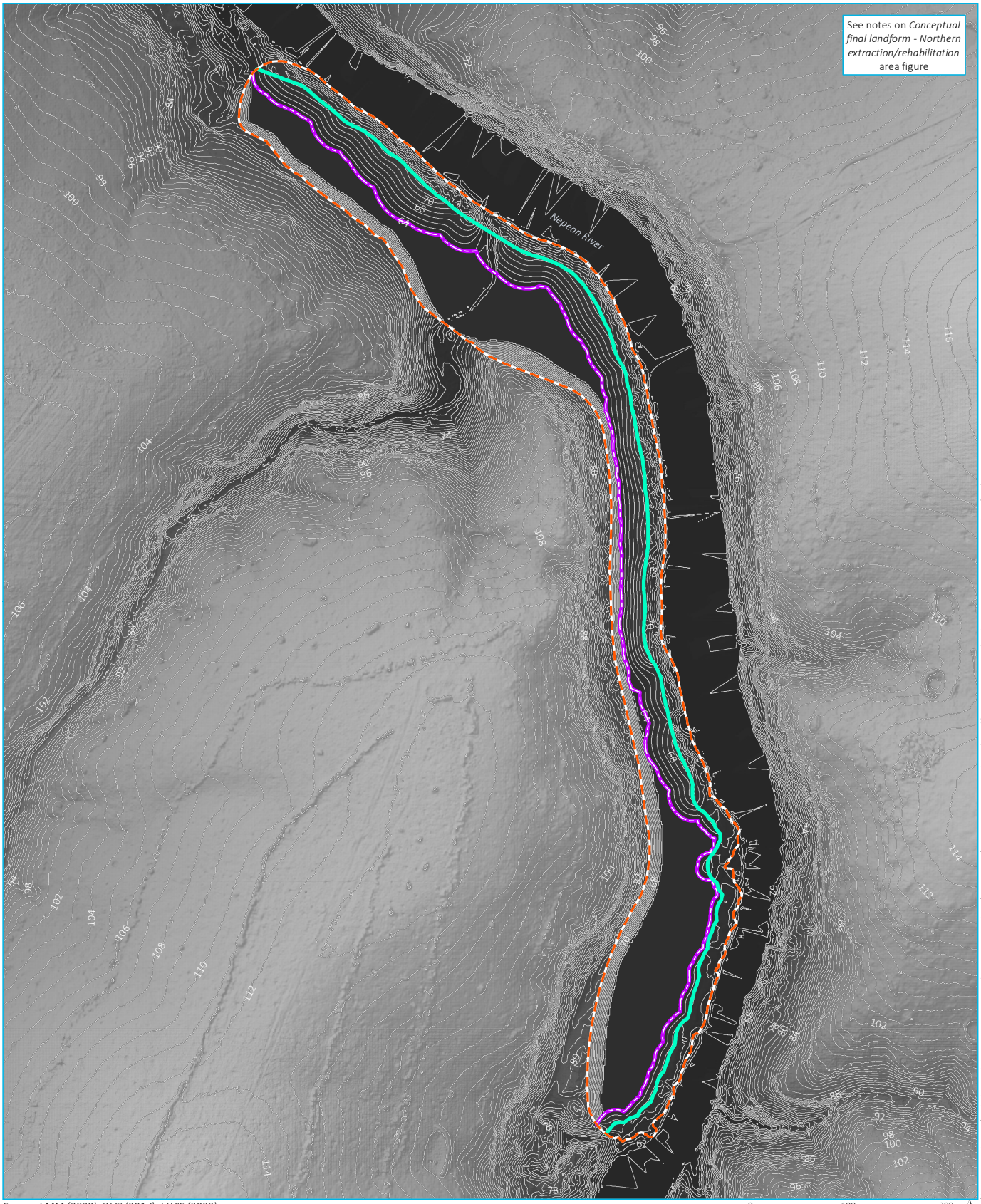
- Stage 8 - extraction/rehabilitation area
- Inland extent of horizontal setback (17.5 m)
- Infiltration swale/toe of riverside 1:5 permanent batter
- Contour (1 m)
- Major road

Conceptual final landform 17.5 m setback
Northern extraction/rehabilitation area

Menangle Quarry Extension
Figure 2.12

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G025_ConceptualFinalLandform_17_5mSetback_NE_20200515_03.mxd 15/05/2020

EMM creating opportunities



Source: EMM (2020); DFSI (2017); ELVIS (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

- Stage 8 - extraction/rehabilitation area
- Inland extent of horizontal setback (17.5 m)
- Infiltration swale/toe of riverside 1:5 permanent batter
- Contour (1 m)

Conceptual final landform 17.5 m setback
Southern extraction/rehabilitation area

Menangle Quarry Extension
Figure 2.13

\\emmsvr1\emm\Jobs\2019\J190166 - Menangle Quarry LEC\GIS\02_Maps\G026_ConceptualFinalLandform_17_5mSetback_SE_20200515_03.mxd 15/05/2020

EMM creating opportunities

2.11 Employment

The quarry employs 16 people, most of whom are employees of long standing. When there is an additional production demand, staff from other Benedict sites are brought to site to assist. In addition, Benedict and contracted truck drivers deliver materials to the site and products to customers.

In addition, a full-time rehabilitation specialist will be employed as part of the Stage 8 area operations.

3 Statement of commitments

3.1 Introduction

The commitments to manage potential environmental impacts from the extension project are described in Chapter 7 of the EA (EMM 2017b). This includes a summary of commitments in EA Table 7.1. An updated statement of commitments is provided in Chapter 6 of the RTS (EMM 2017b).

3.2 Summary of commitments

A summary of the environmental management and mitigation measures, as amended to incorporate the changes made since the Refusal, is provided in Table 3.1. Additional commitments made following submission of the RTS are highlighted in bold.

Table 3.1 Summary of commitments

Aspect	Commitment
Air quality	Management measures to suppress dust and emissions consistent with current operations will be continued: • level 2 water spraying for hauling on unpaved roads; • water spraying where screening occurs; and • water spraying at conveyor transfer points.
Noise and vibration	The current management measures to minimise noise emissions will continue to be implemented including: • regular reinforcement of the need to minimise noise; • regular identification of noisy activities and adoption of improvement techniques; • working in shielded areas when possible (ie below the top of the bank of the Nepean River); • avoiding the use of portable radios with external speakers, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents; • developing routes for the delivery of materials and parking of vehicles to minimise noise; • where possible, avoiding the use of equipment that generates impulsive noise; • minimising the need for vehicle reversing for example, by arranging for one-way site traffic routes; • minimising the movement of materials and plant and unnecessary metal-on-metal contact; and • scheduling respite periods for intensive works (such as timber milling). The following measures will be taken as part of the campaign use of the portable timber mill: • campaigns will be scheduled to avoid the winter period; • a noise measurement trial will be conducted during worst case meteorological conditions at the start of the first campaign and if noise levels are above the noise criteria, mobile noise barriers and/ or noise curtains will be installed.

Table 3.1 Summary of commitments

Aspect	Commitment
Aboriginal heritage	*Aboriginal sites* • A pre-clearance survey will be undertaken to ensure that any scarred trees in the Stage 8 area are identified and recorded. • Procedures will be implemented to ensure there is no inadvertent harm to buried rock shelters. • Procedures will be implemented if human skeletal remains are discovered. • Management measures will be implemented so that the quarry machinery avoids impacting buried sandstone features. • If new Aboriginal sites are discovered during soil extraction or revegetation of the Stage 8 area, they will be assessed by an archaeologist and any new sites will be recorded on Aboriginal Heritage Information Management System (AHIMS).
Biodiversity, restoration and rehabilitation	**A full-time rehabilitation specialist will be employed by the quarry.** Measures to minimise the project's biodiversity impacts will be: • Avoid - avoidance of direct impacts on critically endangered ecological communities, namely Shale/Sandstone Transition Forest in the Sydney Basin Bioregion and Cumberland Plain Woodland in the Sydney Basin Bioregion. It is proposed that the development consent for the Stage 3 area is modified so there is no quarrying in this area, avoiding the approved clearing of 5.68 ha of an endangered ecological community, River Flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions that would have otherwise occurred. • Minimise: – **each substage will be less than 1.07 ha and the active extraction area will be about 0.33 ha; and** – **once extraction in each part of the sub-stage is complete, the area will be progressively rehabilitated so about 33% of the sub-stage will be bare sand and soil and about 66% will be a combination of existing vegetation and the area being rehabilitated.** • Mitigate - measures have been proposed to mitigate the clearing of native vegetation, loss of hollow-bearing trees, fauna injury and mortality and erosion and sedimentation (Table 4.1 in EA Appendix I **and Section 6.5 in the Supplementary Biodiversity Assessment (EMM [Ward] 2019b**). • **Offset – biodiversity offsets will be provided in accordance with the Supplementary Biodiversity Assessment (EMM [Ward] 2019b).** **Extraction will be setback from the river as follows:** • **The lower riverbank will be retained below the 64 mAHD contour and remain untouched (except for hand removal of weeds, felling of non-native trees leaving the roots in place, and very selective herbicide application).** • **The riverbank will also be retained in a horizontal setback that extends at least 10 m (measured horizontally) inland from the 64 mAHD contour (the horizontal setback area).** • **Where there are trees within the 10-m wide setback, the width of the setback will be further increased so that edge of the setback area/start of extraction area is at least 7.5 m (measured horizontally) from the trunk of these trees.**

Table 3.1 Summary of commitments

Aspect	Commitment
	All native trees in the 10-m-wide horizontal setback will be retained. Restoration and rehabilitation will be undertaken in accordance with a post extractive rehabilitation and vegetation management plan similar to those contained in EA Appendix C. This plan will: • provide details of the conceptual final landform, soil stripping and vegetation clearing protocols, erosion and sediment control measures, rehabilitation of the extraction area and adjacent restoration activities; • describe how the implementation of the biodiversity offset strategy would be integrated with the overall rehabilitation of the site; and • detail how connectivity will be managed during the vegetation management plan works program. **Woody debris and logs from areas to be cleared will be retained and placed in the offset area, extraction area, and lower riverbank.** **A weed-control strategy will be prepared and implemented in the Stage 8 areas.** **Menangle Sand and Soil will ensure the vegetation maintenance in the Stage 8 area is fully funded.**
Groundwater	**The following groundwater monitoring and management measures will be implemented:** • **A conceptual locally-specific groundwater model will be prepared based on local site data.** • **A water monitoring and modelling plan will be prepared.** • **Install nested monitoring bores will be installed at four locations along the stage 8 area.** • **In-bore aquifer tests (slug tests) will be conducted.** • **Piezometers/loggers will be installed in each bore and water levels recorded.** • **The 'water take' in the pit predicted as a result of elevated groundwater levels during flooding will be calculated.** **Sufficient water access licences (WALs) will be purchased to account for the 'intercepted' groundwater, if required.** The existing groundwater management controls implemented on the site for the approved operations will be continued, including: • the base of the quarry pit will be no deeper than 62 mAHD, ie 1 m above the alluvial water table; and • if groundwater enters the pit, for example during extended high flow in the Nepean River, it will be allowed to infiltrate back into the alluvial groundwater system once the alluvial water table drops and extraction not recommenced until the water subsides.

Table 3.1 Summary of commitments

Aspect	Commitment
Surface water	The existing soil and surface water management controls implemented on the site for the approved operations will be continued. These measures include: • the extraction area will be setback from the river (see above); • flow diversions and check dams will be constructed to direct clean runoff around the extraction area; • a sedimentation basin (or basins), sized to trap and treat runoff, will be excavated within the pit; and • the erosion and sediment control measures will be regularly maintained. The sedimentation basin will be formed in the base of the pit and will be relocated as the extraction area progresses. Only commercially available non-toxic flocculants will be used at the site. Any water in the pit will not be dewatered using a pump. Rather, it will flow to a sedimentation basin or will be allowed to infiltrate to the water table under gravity. If the water level in the pit rises to a level where operations need to cease, operations will only recommence when the water level has dropped sufficiently to be safe (no operations within standing water are required). **The following actions will be taken when flooding of the Nepean River above 64 m AHD in the Stage 8 area is predicted:** • **any riverside batter that has a batter angle of less than 1:5 will be built up so that it has a maximum 1:5 slope;** • **exposed batters and the base of the pit will be flattened so that there are no isolated highpoints susceptible to scour;** • **all exposed sand and soil will be smoothed such that there are no rapid changes in slopes, particularly at the intersections of different batters; and** • **unattended earthmoving equipment will not be left within the Stage 8 area below the 1% annual exceedance probability flood level while a flood warning is current.** **These measures will be detailed in a flood preparedness plan that will be part of the site's operational environmental management plan.**
Traffic and transport	*Road upgrades* • No road upgrades will be required as a result of the extension. *Traffic management plan* • The existing traffic management plan will be monitored and reviewed. *Access beneath the Hume Highway/Menangle Bridges* • There will be no clearing of native vegetation, excavation or stockpiles placed within 50 m of the Hume Highway/Menangle Bridges or within 30 m of the edge of the boundary of the Hume Highway road corridor within the Stage 8 area. • Menangle Sand and Soil will continue to provide Transport for NSW (TfNSW)access to the Hume Highway/Menangle Bridges structure and associated facilities at all times, including for routine and emergency maintenance. • Access under the Hume Highway/Menangle Bridges will be restricted to light vehicles only. • Access under the Hume Highway/Menangle Bridges will be sealed and comply with RMS drainage and pavements standards. • The piers of the Hume Highway/Menangle Bridges, as well as any other part of the bridge structure and associated facilities, will be protected from any potential damage as a result of the construction or operations of the Menangle Sand and Soil Quarry.

Table 3.1 Summary of commitments

Aspect	Commitment
	• The conveyor and access under the bridges will be the subject of a license agreement drawn up by TfNSW's lawyers at no cost to TfNSW. This will be in place prior to starting any works under and adjacent to the Menangle Bridges and Hume Highway. • Any detritus associated with the construction and use of the access road under Hume Highway/Menangle Bridges will be removed by Menangle Sand and Soil. There will be no access to or from the Hume Highway road reserve area from the Menangle Sand and Soil Quarry site (specifically between Lot 202 and Lot 203 DP 590247) other than to travel beneath the Hume Highway/Menangle Bridges. A Drivers Code of Conduct will be prepared that applies to all employee and contractor drivers.
Social	Menangle Sand and Soil will continue to ensure that preference is given to local employees. As well, they will use local or regional contractors and suppliers where this presents a cost effective and feasible option.
Visual	Menangle Sand and Soil will continue to consult with surrounding landowners regarding the visual amenity of the quarry and will implement any reasonable additional controls to further reduce their visual impact, if necessary.
Historical heritage	Extraction in the northern-most part of the Stage 8 extraction area will avoid the storage container. The industrial equipment on the west bank of the Nepean River in the Stage 8 restoration area will not be disturbed.

References

EMM 2017a, *Menangle Quarry Extension Environmental Assessment*, prepared for Menangle Sand and Soil Pty Limited by EMM Consulting Pty Limited. 23 May 2017.

EMM 2017b, *Menangle Quarry Extension Response to Submissions*, prepared for Menangle Sand and Soil Pty Limited by EMM Consulting Pty Limited. 14 September 2017.

EMM [Towler] 2019a, NSW Land and Environment Court (2018/342158) *NSW Land and Environment Court (2018/342158) Menangle Quarry - Project Amendments and Information Summary*. Letter prepared by EMM Consulting Pty Limited for Minter Ellison. 20 December 2019.

EMM [Ward] 2019b, *Menangle Sand and Soil Pty Ltd v Minister for Planning, LEC 2018/342158 Supplementary Biodiversity Assessment*. Report prepared by EMM Consulting Pty Limited for Minter Ellison. Version 2. 6 September 2019.

EMM [Towler] 2019c, NSW Land and Environment Court (2018/342158) *Menangle Quarry - Amended Extraction Area and Setback*. Letter prepared by EMM Consulting Pty Limited for Minter Ellison. 16 August 2019.

EMM [Grant] 2019d, NSW Land and Environment Court (2018/342158) *Menangle Sand and Soil - Restoration Area Weed Strategy*. Letter prepared by EMM Consulting Pty Limited for Minter Ellison. 9 September 2019.

EMM [Webb] 2019e, NSW Land and Environment Court (2018/342158) *Menangle Sand and Soil - Groundwater Management*. Letter prepared by EMM Consulting Pty Limited for Minter Ellison. 16 August 2019.

EMM [Towler] 2019f, NSW Land and Environment Court (2018/342158) *Menangle Sand and Soil – Flood Mitigation*. Letter prepared by EMM Consulting Pty Limited for Minter Ellison. 9 September 2019.

Appendix A

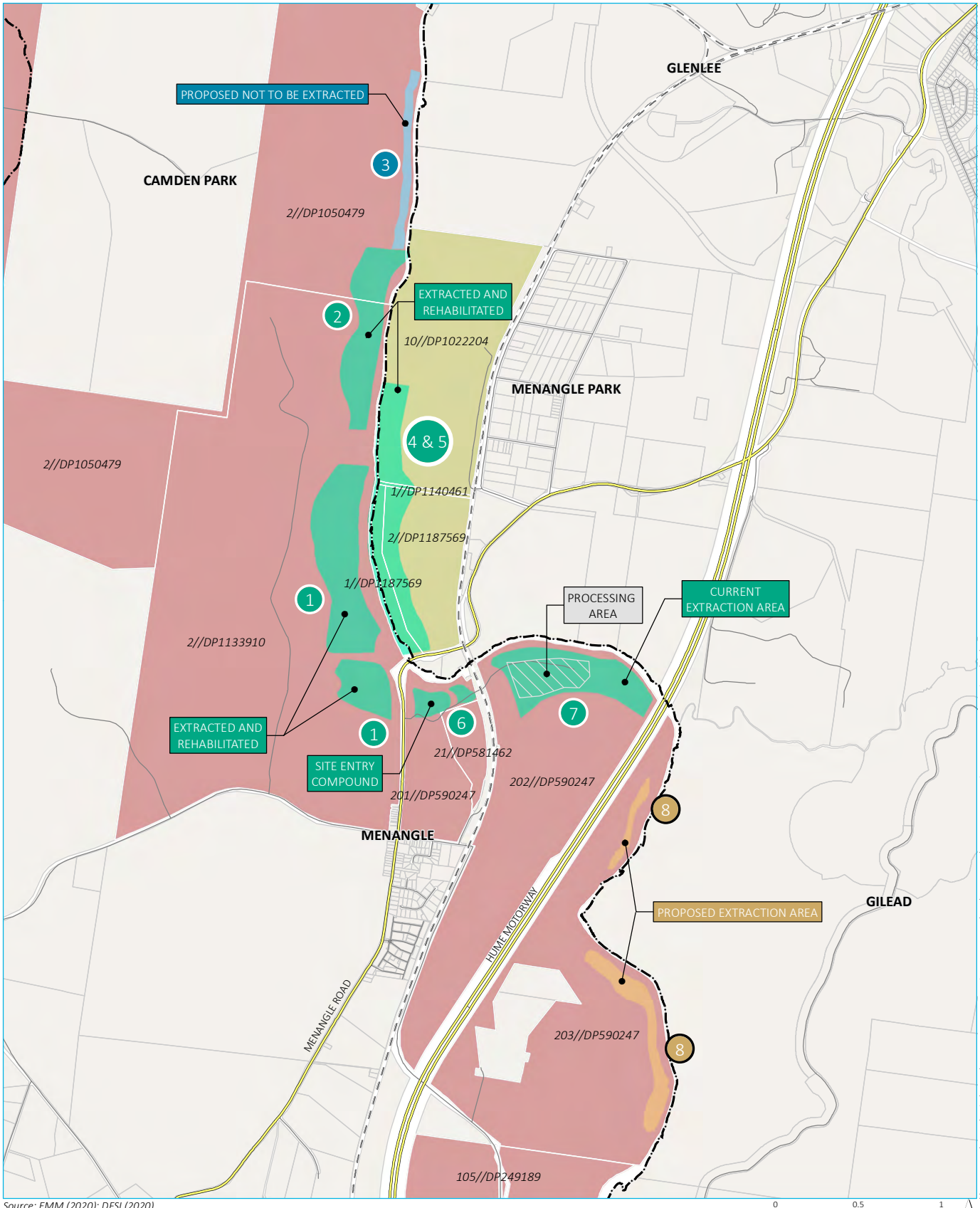
Development Application Land

A.1 Development Application Land

The allotments subject to the development application modification are listed in Table A.1 and shown in Figure A.1.

Table A.1 Development application land

Lot	Deposited plan
Lot 10	DP1022204
Lot 2	DP1050479
Lot 2	DP1133910
Lot 1	DP1140461
Lot 1	DP1187569
Lot 2	DP1187569
Lot 105	DP249189
Lot 21	DP581462
Lot 201	DP590247
Lot 202	DP590247
Lot 203	DP590247



Source: EMM (2020); DFSI (2020)

0 0.5 1 km

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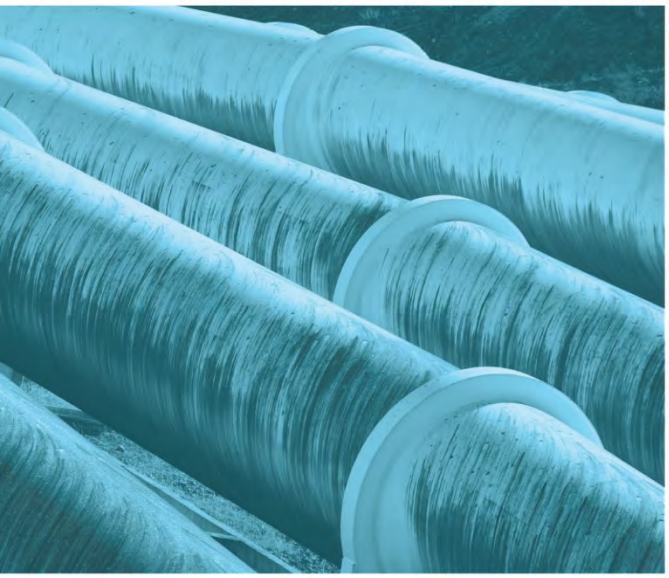
KEY

- Rail line
- Major road
- Minor road
- Cadastral boundary
- Local government area boundary
- Campbelltown impacted lots
- Wollondilly impacted lots
- Existing processing area (to be retained)
- Extractive operations (approved)
- Extractive operations (approved but not extracted)
- Stage 8 - extraction/rehabilitation area

Development Application Land

Menangle Quarry Extension
Figure A.1

EMM creating opportunities



Appendix B

Notice of Orders Made (LEC 2018/00342158)

Land and Environment Court
of New South Wales

Level 4 225 Macquarie Street SYDNEY NSW 2000
Level 4 GPO Box 3565 SYDNEY NSW 2001
DX 264, Sydney

Telephone: 02 9113 8200
Facsimile: 02 9113 8222
02 91138208

Email: lecourt@justice.nsw.gov.au
Website: http://www.lec.justice.nsw.gov.au

ABN: 52 659 114 436

Luke Anthony James Walker
luke.walker@minterellison.com

Your Ref:

D0001BMPSE

10 September 2020

NOTICE OF ORDERS MADE

Case number	2018/00342158
Case title	Menangle Sand and Soil Pty Limited v Minister for Planning

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On 10 September 2020 the following orders (and/or directions) were made:

The Court orders that:
(1) The appeal is upheld.
(2) Modification to development application DA 85/2865 "Menangle Quarry Extension – Modification 1" (MOD1) lodged by the Applicant on 22 May 2017 with the Minister for Planning, which includes (amongst other things) extending the life of the quarry by 15 years until 2035 by developing a new 13 ha, 2.8 kilometre (km) long southern extraction area (Stage 8) within Lot 203 DP 590247, is approved subject to the conditions set out in 'Annexure A' attached hereto.

For the Registrar

Annexure "A"

Modifications

*Note: Amendments to existing conditions of approval are shown in tracked changes (**bold and underlined** and where relevant ~~strikeout~~ font)*

1. **Amend the Schedule heading on page 2 as follows:**

Schedule **1**

2. **Delete condition 5 and 6.**

3. **Add additional condition 5A. as follows:**

The Applicant must not carry out any Quarrying Operations or extraction in Stage 3.

4. **Amend condition 14(a) as follows:**

a. ~~Stages 2-3~~ **Stage 2** (Western Bank)

5. **Amend condition 28 as follows:**

Breach of Consent

In the event of a breach of any of the conditions of consent by the applicant, the Campbelltown City and the Wollondilly Shire Council reserve the right to enter and rectify any such breach and recover the costs of such rectification from the amount of the guarantee **required under condition 25 of this Schedule**.

6. **Amend condition 30 as follows:**

Completion of Extraction

The applicant shall ensure that all extraction in Stage 1 and Stage 2 is completed by 30 June, 1995; and ~~all stages~~ **Stages 4 to 7** of the development by **31 December** 2020.

7. **Amend condition 31 as follows:**

Levy for Implementation of Management Plan

The applicant or its assigns shall pay the Director a levy on all sand and soil removed or carried from, the site from Stages ~~1, 2 and 3~~ **1 and 2**, within the Shire of Wollondilly, such levy being paid into a Trust Fund to be administered by the Director for the purpose of providing public facilities on the land subject to this consent in accordance with the requirements of the Camden Park Estate Management Plan which is to be prepared by the Department of Planning. The levy shall be paid at a rate of 8 cents per tonne of sand and soil and shall be adjusted annually on the Index Review Date in accordance with the formula contained in Condition 26.

8. **Insert Schedule 2 as follows:**

SCHEDULE 2

TABLE OF CONTENTS

DEFINITIONS

Aboriginal object	Has the same meaning as the definition of the term in section 5 of the NP&W Act
Aboriginal place	Has the same meaning as the definition of the term in section 5 of the NP&W Act
Active extraction area	The area of exposed sand or soil within each Substage which is not subject to rehabilitation
AHD	Australian Height Datum
AEP	Annual Exceedance Probability
Annual Review	The review required by condition D9
Applicant	Menangle Sand and Soil Pty Ltd, or any person carrying out any development under this consent
Approved disturbance area	The area identified as such on the development layout figures in Appendix 1, as amended by the conditions of this consent
Amended Project Summary	The amended project as described in: • correspondence prepared by EMM dated 20 December 2019, including: o Amended Extraction Area and Setback Letter dated 16 August 2019, prepared by EMM Consulting; o Groundwater Management Letter dated 16 August 2019, prepared by EMM Consulting; o Aquatic Ecology Assessment of Significance Letter regarding Sydney Hawk Dragonfly dated 2 September 2019, prepared by Marine Pollution Research Pty Ltd; o Fluvial Geomorphology Assessment for Menangle Quarry Modification to Development Consent 85/2865 dated 5 September 2019, prepared by Fluvial Systems Pty Ltd; o Stage 8 Area Weed Control Strategy Letter dated 9 September 2019, prepared EMM Consulting; o Flood Mitigation Letter dated 9 September 2019, prepared by EMM Consulting; o Supplementary Biodiversity Assessment Report dated 16 September 2019, prepared by EMM Consulting; o Menangle Quarry Extension – Flood Impact Sensitivity Assessment dated September 2019, prepared by Advisian; and o Additional Flood Impact Sensitivity Assessment dated 17 December 2019, prepared by Advisian; and • the Consolidated Project Description
BAM	Biodiversity Assessment Method
BC Act	*Biodiversity Conservation Act 2016*
BCD	Biodiversity and Conservation Division within the Department
BCT	NSW Biodiversity Conservation Trust
Calendar year	A period of 12 months from 1 January to 31 December
Conditions of this consent	Conditions contained in Schedules 2 and 3
Consolidated Project Description	The document titled *Applicant's Description of Amended Project for Case Management Conference 23 July 2020* prepared by EMM Consulting dated 24 August 2020
Construction	All physical works to enable Quarrying Operations to be carried out, including demolition and removal of buildings or works, and erection of buildings and other infrastructure permitted by this consent
Council	Wollondilly Shire Council

Day	The period from 7 am to 6 pm on Monday to Saturday, and 8 am to 6 pm on Sundays and Public Holidays
DBH	Diameter at breast height
Decommissioning	The deconstruction or demolition and removal of works installed as part of the development
Demolition	The deconstruction and removal of buildings, sheds and other structures on the site
Department	NSW Department of Planning, Industry and Environment
Development	The development described in the document/s listed in condition A7(c), as modified by the conditions of this consent
Development Layout	The figures in Appendix 1, as amended by the conditions of this consent
DPIE Water	Water Group within the Department
EA (Mod 1)	The EA titled *Environmental Assessment Menangle Quarry Extension*, prepared by EMM and dated 23 May 2017, the associated Response to Submissions titled *Response to Submissions Menangle Quarry Extension*, prepared by EMM and dated 14 September 2017, and additional information provided by the Applicant in support of the application including *Flood Impact Assessmen*t prepared by Advisian and dated May 2018, *Review of Fluvial Geomorphology* prepared by Fluvial Systems and dated May 2018, and correspondence prepared by EMM dated 27 August 2017 and 21 February 2018
Early Works	Means clearing for and construction of the linear infrastructure (being conveyors, access roads and haul roads) located between Stage 7 and Stage 8, but does not include Quarrying Operations within the Substage 8A.
EIS	The Environmental Impact Statement titled *Proposed Sand & Soil Extraction Nepean River & Environs Menangle NSW*, prepared by Planning Workshop and dated December 1987, submitted with the application for consent for the development.
Environment	Includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings
EPA	NSW Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	Environment Protection Licence under the POEO Act
Exclusion Areas	Means those areas with 1% AEP peak flow velocities greater than 4 metres/second as identified in the figures in Appendix 2 and the plan required under condition A15.
Feasible	Means what is possible and practical in the circumstances
Final determination	River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community final determination (as amended in 2011)
GPS	Global Positioning System
Heritage item	An Aboriginal object, an Aboriginal place, or a place, building, work, relic, moveable object, tree or precinct of heritage significance that is listed under any of the following: • the State Heritage Register under the *Heritage Act 1977*; • a state agency heritage and conservation register under section 170 of the *Heritage Act 1977;* • a Local Environmental Plan under the EP&A Act; • the World Heritage List; • the National Heritage List or Commonwealth Heritage List under the EPBC Act; or • anything identified as a heritage item under the conditions of this consent
Heritage NSW	Heritage NSW within the Department of Premier and Cabinet

Incident	An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance
Laden trucks	Trucks transporting quarry products from the site and/or trucks transporting waste and other blending material to the site
Land	Has the same meaning as the definition of the term in section 1.4 the EP&A Act, except for where the term is used in the noise and air quality conditions in PART B of Schedule 2 of this consent where it is defined to mean the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of determination of Modification 1
Material harm	Is harm that: • involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial; or • results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment) This definition excludes "harm" that is authorised under either this consent or any other statutory approval'
MEG	Mining, Exploration and Geoscience within Regional NSW
m	Metres
Minimise	Implement all reasonable and feasible mitigation measures to reduce the impacts of the development
Nepean River Buffer Zone	A horizontal setback area extending landward from the 64 m AHD contour of the western low bank of the Nepean River, as defined under condition A10 of Schedule 2
Non-compliance	An occurrence, set of circumstances or development that is a breach of this consent
Phase 1	Substages 8A – 8B as shown in the figures in Appendix 1
Phase 2	Substage 8C as shown in the figures in Appendix 1
Phase 3	Substages 8D – 8E as shown in the figures in Appendix 1
Phase 4	Substages 8F to 8G as shown in the figures in Appendix 1
Phase 5	Substages 8H to 8I as shown in the figures in Appendix 1
Phase 6	Substages 8J to 8K as shown in the figures in Appendix 1
Phase 7	Substages 8L to 8M as shown in the figures in Appendix 1
Planning Secretary	Planning Secretary under the EP&A Act, or nominee
POEO Act	*Protection of the Environment Operations Act 1997*
Processing Areas	Any areas used for processing (including blending with waste material), stockpiling and transportation of extractive materials during Stage 8 Operations, including any disturbed areas within Stages 6-7 required to facilitate Quarrying Operations in the Stage 8 Area
Protected Trees	Any native trees identified as such in a native vegetation identification report prepared in accordance with condition A10(b) of Schedule 2
Public infrastructure	Linear and related infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc
Quarrying Operations	The extraction, processing (including blending with waste material), stockpiling and transportation of extractive materials carried out on the site and the associated removal of vegetation, topsoil and overburden

Quarry products	Includes all saleable quarry products, but excludes tailings and other wastes and rehabilitation material
Reasonable	Means applying judgement in arriving at a decision, taking into account: mitigation benefits, costs of mitigation versus benefits provided, community views, and the nature and extent of potential improvements
Registered Aboriginal Parties	As described in the *National Parks and Wildlife Regulation 2009*
Rehabilitation	The restoration of land disturbed by the development to a good condition, to ensure it is safe, stable and non-polluting
Residence	Existing or approved dwelling at the date of determination of Modification 1
Restoration Area	The area shown as "Amended stage 8 – restoration area" in the figures in Appendix 1
RFS	NSW Rural Fire Service
River-Flat Eucalypt Forest EEC	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions endangered ecological community, as listed under the *Biodiversity Conservation Act 2016* and described in the Final Determination
TfNSW	Transport for New South Wales
Site	The land identified as: Lot 10 DP1022204 Lot 2 DP1050479 Lot 2 DP1133910 Lot 1 DP1140461 Lots 1-2 DP1187569 Lot 105 DP249189 Lot 21 DP581462 Lots 201-203 DP590247
Stage 3 Area	The area labelled Stage 3 and shown in blue in Figure 1 in Appendix 1
Stage 8 Area	The area labelled Stage 8 and shown in brown in Figure 1 in Appendix 1, comprising the 13 Substages labelled Stages 8A-8M and associated infrastructure including the conveyor and haul roads, shown in Figures 2-5 of Appendix 1
Stage 8 Operations	Quarrying Operations associated with extraction within the Stage 8 Area, including the operation of the Processing Areas identified in the figures in Appendix 1 and any private access roads or haul roads necessary for the carrying out of the development
Substage	Each of the 13 extraction areas labelled Stages 8A-8M and identified in the figures in Appendix 1, as amended by conditions of this consent
V:H	Vertical to horizontal
Waste	Has the same meaning as the definition of the term in the Dictionary to the POEO Act
Weed	Any weed specified by the Department of Primary Industries as being a weed on the website NSW WeedWise (or any successor websites or policies). For the avoidance of doubt, privet and lantana are weeds for the purposes of this definition.

PART A ADMINISTRATIVE CONDITIONS

APPLICATION OF THIS SCHEDULE

A1. The conditions in this Schedule have no effect until the Applicant provides notification of the commencement of construction activities associated with Stage 8 Operations, as required under condition A5(a) of this Schedule.

A2. The conditions in this Schedule do not apply retrospective requirements in relation to Quarrying Operations undertaken in Stages 1 to 7 of the development that have been completed prior to 31 December 2020 (inclusive).

A3. From the commencement date of construction activities associated with Stage 8 Operations, as notified under condition A5(a) of this Schedule, the obligations in Schedule 1 of this development consent will continue to apply in relation to Stages 1 to 7 of the development, except in so far as they are specifically amended by the conditions of this Schedule.

A4. In the event of an inconsistency, ambiguity or conflict between the conditions in Schedules 1 and 2 of this development consent, as they relate to the Stage 8 Operations, the conditions in Schedule 2 prevail to the extent of the inconsistency, ambiguity or conflict.

NOTIFICATION OF COMMENCEMENT (STAGE 8)

A5. The Applicant must notify the Department in writing of the date of commencement of any of the following phases of the development, at least two weeks before that date:

(a) construction activities associated with Stage 8 Operations;

(b) Quarrying Operations in each of Phases 1 to 7;

(c) cessation of Quarrying Operations (i.e. quarry closure); and

(d) any period of suspension of Quarrying Operations (i.e. care and maintenance).

OBLIGATION TO MINIMISE HARM TO THE ENVIRONMENT

A6. In addition to meeting the specific performance measures and criteria in this consent, all reasonable and feasible measures must be implemented to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the operation of the development, and any rehabilitation required under this Schedule.

TERMS OF CONSENT

A7. The development (as modified) may only be carried out:

(a) in compliance with the conditions of this consent;

(b) in accordance with all written directions of the Planning Secretary; and

(c) generally in accordance with the EIS, EA (Mod 1), Amended Project Summary and the Development Layout.

A8. Consistent with the requirements in this consent, the Planning Secretary may make written directions to the Applicant in relation to:

(a) the content of any strategy, study, system, plan, program, review, audit, notification, report or correspondence submitted under or otherwise made in relation to this consent, including those that are required to be, and have been, approved by the Planning Secretary; and

(b) the implementation of any actions or measures contained in any such document referred to in condition A8(a) of Schedule 2.

A9. The conditions of this consent and directions of the Planning Secretary prevail to the extent of any inconsistency, ambiguity or conflict between them and a document/s listed in condition A7(c) of Schedule 2. In the event of an inconsistency, ambiguity or conflict between any of the document/s listed in condition A7(c) of Schedule 2, the most recent document prevails to the extent of the inconsistency, ambiguity or conflict.

LIMITS OF CONSENT

Nepean River Buffer Zone

A10. The Applicant must establish and maintain a Nepean River Buffer Zone during Quarrying Operations in the Stage 8 Area. This buffer zone must:

(a) include a minimum horizontal setback of 10 m extending landward from the 64 m AHD contour on the western side of the Nepean River;

(b) be informed by a native vegetation identification report, which must:

(i) be prepared by a suitably qualified and experienced botanist or ecologist, whose appointment has been endorsed by the Planning Secretary;

(ii) include detailed site surveys to identify the DBH of all native trees that occur within the 10 m horizontal setback from the 64 m AHD contour referred to in sub-paragraph (a);

(iii) classify all native trees identified in subparagraph (b)(ii) with a DBH of greater than or equal to 0.1 m as Protected Trees and provide their GPS coordinates; and
(iv) include a map illustrating a 7.5 m setback (measured at the outside of the native tree trunk) around each of the identified Protected Trees;
(v) the map required under subparagraph (iv) must overlay high-resolution ortho-photographs, with supporting digital terrain data files provided in spatial format for GIS and as high-resolution JPEG files; and

(c) be amended to include the findings of the native vegetation identification report, such that it is widened to include areas where the Protected Tree setbacks extend beyond the minimum 10 m horizontal setback referred to in subparagraph (a).

A11. The Applicant must submit a copy of the native vegetation identification report and associated survey plans, GPS coordinates and data files required under condition A10(b) of Schedule 2 and associated final landform plans to the Planning Secretary for each of Phases 1 to 7 of the development prior to commencing any vegetation clearing or Quarrying Operations in the relevant phase.

A12. With the written agreement of the Planning Secretary, the Applicant may seek to reduce the minimum 7.5 m horizontal setback distance for Protected Trees to an appropriate distance recommended by a consulting arborist assessment. Any variation request must be supported by an expert report prepared by the consulting arborist and will be determined by the Planning Secretary on a case by case basis.

A13. The Applicant must retain and manage the minimum Nepean River Buffer Zone in accordance with the commitments in the documents listed in condition A7(c) of Schedule 2 (as may be amended by the conditions of this consent).

General Limits on Extraction and Processing

A14. Prior to undertaking Quarrying Operations in Substage 8G, the Applicant must update the TUFLOW hydrodynamic model used to generate the flood sensitivity analysis in the Additional Flood Impact Sensitivity Assessment dated 17 December 2019, prepared by Advisian in the Amended Project Summary, to include the post extraction topography for Substages 8G-M, using hydraulic roughness Scenario B, and simulate the 1% AEP flood.

A15. Prior to undertaking Quarrying Operations in Substage 8G, the Applicant must provide the Planning Secretary with a copy of the model required under condition A14 and a plan depicting any areas identified as having a post extraction 1% AEP peak flow velocity of 4 metres/second or greater.

A16. The Applicant must not carry out construction works or Quarrying Operations or locate any ancillary infrastructure within the Exclusion Areas.

A17. The Applicant must not:

(a) carry out Quarrying Operations or regrading; and/or

(b) remove vegetation, except where necessary for Weed control,

within the Nepean River Buffer Zone, without the prior written agreement of the Planning Secretary.

The written agreement of the Planning Secretary may be provided in circumstances where those activities are necessary for environmental management purposes.

A18. The Applicant must ensure that any Weed control activities undertaken within the Nepean River Buffer Zone:

(a) are limited to Weed removal techniques that use hand-held tools; and

(b) minimise ground disturbance to the greatest extent practicable.

A19. The Applicant must not undertake extraction within 7.5 m of any Protected Trees without the written agreement of the Planning Secretary under condition A12 of Schedule 2.

A20. The Applicant must maintain a minimum 7.5 m setback between Quarrying Operations and any native trees [a] located in the Restoration Area, except where a reduced setback is supported by an assessment by a suitably qualified and experienced arborist, and evidence of this assessment has been provided to the Planning Secretary.

[a] In this condition, the setback is to be measured from the outside of the tree trunk.

A21. The Applicant must not carry out any extraction:

(a) in Stages 1, 2, 4, 5, 6 or 7 after the date specified in condition 30 of Schedule 1; or

(b) in Stage 3 at any time.

Identification of Approved Disturbance Area

A22. Prior to the commencement of Quarrying Operations in each of Phases 1 to 7, the Applicant must:

a) engage a registered surveyor to mark out the boundaries of the approved limits of extraction for the relevant Substages in each phase (as set out conceptually in the Appendix 1 and as amended by the conditions of this consent);

b) submit a survey plan of these boundaries and their GPS coordinates to the Planning Secretary; and

c) ensure that these boundaries are clearly marked at all times during the life of the development in a manner that allows operating staff and inspecting officers to clearly identify those limits.

Quarrying Operations

A23. Stage 8 Operations may be carried out on the site until 31 December 2035.

Note: *Under this consent, the Applicant is required to decommission and rehabilitate the site and carry out other requirements in relation to Quarrying Operations. Consequently, this consent will continue to apply in all respects other than to permit the carrying out of Quarrying Operations until the rehabilitation of the site and other requirements have been carried out to the required standard.*

A24. A maximum of 150,000 tonnes of extractive material may be extracted from the site in any calendar year.

Quarry product transport

A25. Truck movements at the site (ie inbound combined with outbound movements) must not exceed:

(a) a maximum of 248 movements on any given weekday;

(b) an average of 148 movements per weekday, averaged on a weekly basis; and

(c) a maximum of 80 movements per day on Saturdays.

Hours of Operation

A26. The Applicant must comply with the operating hours set out in Table 1.

Table 1: Operating Hours

Activity	***Permissible Hours***
Construction work	• 7 am to 5 pm Monday to Friday • 7 am to 1 pm Saturday • At no time on Sundays or public holidays
Quarrying Operations including loading and dispatch of laden trucks	• 6 am to 5 pm Monday to Friday • 6 am to 12 noon Saturday • At no time on Sundays or public holidays
Maintenance, security, office work, cleaning, etc	• May be conducted at any time, provided that these activities are not audible at any residence on privately-owned land

A27. The following activities may be carried out outside the hours specified in Table 1.

(a) delivery or dispatch of materials as requested by Police or other public authorities; and

(b) emergency work to avoid the loss of lives, property or to prevent environmental harm.

In such circumstances, the Applicant must notify the Department and affected residents prior to undertaking the activities, or as soon as is practical thereafter.

EVIDENCE OF CONSULTATION

A28. Where conditions of this consent require consultation with an identified party, the Applicant must:

(a) consult with the relevant party prior to submitting the subject document; and

(b) provide details of the consultation undertaken including:

(i) the outcome of that consultation, matters resolved and unresolved; and

(ii) details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.

STAGING, COMBINING AND UPDATING STRATEGIES, PLANS OR PROGRAMS

A29. The Applicant may prepare and submit the Soil and Water Management Plan and/or Biodiversity and Rehabilitation Management Plan required under conditions B36 and B73 of Schedule 2 on a staged basis, prior to the commencement of Quarrying Operations in each of Phases 1 to 7. Quarrying Operations must not commence in any phase until a management plan has been approved by the Planning Secretary for that phase.

A30. With the approval of the Planning Secretary, the Applicant may:

(a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or

program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);

(b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined); and

(c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development).

A31. If the Planning Secretary agrees, a strategy, plan or program may be approved, staged or updated without consultation being undertaken with all parties required to be consulted in the relevant condition in this consent.

PROTECTION OF PUBLIC INFRASTRUCTURE

A32. Unless the Applicant and the applicable authority agree otherwise, the Applicant must:

(a) repair, or pay the full costs associated with repairing, any public infrastructure that is damaged by carrying out the development; and

(b) relocate, or pay the full costs associated with relocating, any public infrastructure that needs to be relocated as a result of the development.

Note: *This condition does not apply to any damage to roads caused as a result of general road usage or otherwise addressed by contributions required by condition 26 of Schedule 1.*

OPERATION OF PLANT AND EQUIPMENT

A33. All plant and equipment used on site, or to monitor the performance of the development must be:

(a) maintained in a proper and efficient condition; and

(b) operated in a proper and efficient manner.

COMPLIANCE

A34. The Applicant must ensure that all of its employees, contractors (and their sub-contractors) are made aware of, and are instructed to comply with, the conditions of this consent relevant to activities they carry out in respect of the development.

APPLICABILITY OF GUIDELINES

A35. References in the conditions of this consent to any guideline, protocol, Australian Standard or policy are to such guidelines, protocols, Standards or policies in the form they are in as at the date of this consent.

A36. However, consistent with the conditions of this consent and without altering any limits or criteria in this consent, the Planning Secretary may, when issuing directions under this consent in respect of ongoing monitoring and management obligations, require compliance with an updated or revised version of such a guideline, protocol, Standard or policy, or a replacement of them.

PRODUCTION DATA

A37. Each year, from the date of commencement of Quarrying Operations in the Stage 8 Area, the Applicant must provide calendar year quarry production data to MEG by no later than 30 January.

A38. The data must be provided using the relevant standard form and a copy of the data must be included in the Annual Review.

OTHER STATUTORY APPROVALS, LICENCES AND CONSENTS

A39. The Applicant must obtain all necessary approvals, licences and consents required for the carrying out of the development, including but not limited to, approvals under the *Roads Act 1993*, the *Water Management Act 2000* and the POEO Act.

PART B SPECIFIC ENVIRONMENTAL CONDITIONS

EARLY WORKS

B1. The Applicant may prepare an Early Works Construction Environmental Management Plan for the Early Works, to the satisfaction of the Planning Secretary. This plan must:

(a) describe measures to be implemented to minimise construction-related impacts on biodiversity, including:

(i) specific measures to minimise impacts on tree hollows, termite mounds and fauna; and

(ii) detailed procedures for pre-clearance surveys and supervision (by an appropriately qualified person) of the felling of habitat trees within disturbance areas associated with the Early Works;

(b) describe measures to be implemented to manage sediment and erosion risks, including:

(i) a detailed description of the surface water management measures to be implemented in relation to the Early Works; and

(ii) appropriate clean water diversion systems and construction of appropriate erosion and sediment controls for the management of disturbed areas associated with the Early Works;

(c) include a Trigger Action Response Plan which outlines actions to be undertaken to rectify impacts associated with erosion and sedimentation during the Early Works (to the extent that these actions are not addressed by other management plans required to be in place prior to the commencement of Early Works); and

(d) describe detailed procedures to be implemented to receive, record, handle and respond to complaints associated with the Early Works construction.

B2. If the Applicant opts to seek approval for Early Works, the Applicant must not commence Early Works until the Early Works Construction Environmental Management Plan is approved by the Planning Secretary.

B3. If the Planning Secretary approves an Early Works Construction Environmental Management Plan, the Applicant must implement that plan as approved by the Planning Secretary.

NOISE

Operational Noise Criteria

B4. The Applicant must ensure that the noise generated by the development does not exceed the criteria in Table 2 at any Residence on privately-owned land.

Table 2: Operational Noise Criteria dB(A)

Residences [a]	***Day***	***Shoulder Period*** *6.00 am to 7.00 am Monday to Saturday*	
	$L_{Aeq\ (15\ minute)}$	$L_{Aeq\ (15\ minute)}$	$L_{A(max)}$
2, 3, 5[b], 6, 7, 8, 9	45	45	55
4	54	52	62
10, 11	35	35	45
All other Residences	35	35	45

[a] *Residence locations are shown as "Assessment Locations" in Figure 6 in Appendix 3.*

[b] *Receiver location 5 is representative of Residences in Menangle Village as identified in the red polygon on Figure 6 in Appendix 3.*

Noise generated by the development must be measured in accordance with the relevant requirements and exemptions (including certain meteorological conditions) of the *NSW Industrial Noise Policy* (EPA, 2000). Appendix 4 sets out the meteorological conditions under which these criteria apply and the requirements for evaluating compliance with these criteria.

B5. The noise criteria in condition B4 do not apply if the Applicant has an agreement with the owner/s of the relevant residence or land to exceed the noise criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Noise Operating Conditions

B6. The Applicant must:

(a) take all reasonable steps to minimise all noise from operational activities, including low frequency noise and other audible characteristics, as well as road noise associated with the development;

(b) take all reasonable steps to minimise the noise impacts of the development during noise-enhancing meteorological conditions, particularly when the noise criteria in this consent do not apply (see Appendix 4);

(c) carry out regular attended noise monitoring (every three months unless otherwise agreed with the Planning Secretary) to determine whether the development is complying with the relevant conditions of Schedule 2; and

(d) regularly assess the noise monitoring data and modify or stop operations on the site to ensure compliance with the relevant conditions of Schedule 2.

Noise Management Plan

B7. The Applicant must prepare a Noise Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by a suitably qualified and experienced person/s;

(b) be prepared in consultation with the EPA;

(c) describe the measures to be implemented to ensure:

(i) compliance with the noise criteria and operating conditions in this consent;

(ii) best practice noise management is being employed; and

(iii) noise impacts of the development are minimised during noise-enhancing meteorological conditions; under which the noise criteria in this consent do not apply (see Appendix 4); and

(d) include a monitoring program that:

(i) is capable of evaluating the performance of the development against the noise criteria;

(ii) monitors noise at the nearest and/or most affected residences; and

(iii) includes a protocol for identifying any noise-related exceedance, incident or non-compliance and for notifying the Department and relevant stakeholders of these events.

B8. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Noise Management Plan is approved by the Planning Secretary.

B9. The Applicant must implement the Noise Management Plan as approved by the Planning Secretary.

AIR QUALITY

Odour

B10. The Applicant must ensure that no offensive odours (as defined under the POEO Act) are emitted by the development.

Air Quality Criteria

B11. The Applicant must ensure that particulate matter emissions generated by the development do not cause exceedances of the criteria in Table 3 at any residence on privately-owned land.

Table 3: Air Quality Criteria

Pollutant	***Averaging period***	***Criterion***	
Particulate matter < 10 µm (PM_{10})	Annual	[a, c] 25 µg/m^3	
	24 hour	[b] 50 µg/m^3	
Particulate matter < 2.5 µm ($PM_{2.5}$)	Annual	[a, c] 8 µg/m^3	
	24 hour	[b] 25 µg/m^3	
Total suspended particulate (TSP) matter	Annual	[a, c] 90 µg/m^3	
[d] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes:

[a] Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).

[b] Incremental impact (i.e. incremental increase in concentrations due to the development on its own).

[c] Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary.

[d] Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method

B12. The air quality criteria in Table 3 do not apply if the Applicant has an agreement with the owner/s of the relevant residence to exceed the air quality criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Air Quality Operating Conditions

B13. The Applicant must:

(a) take all reasonable steps to:

(i) minimise odour, fume, greenhouse gas and dust (including PM_{10} and $PM_{2.5}$) emissions of the development;

(ii) minimise any visible off-site air pollution generated by the development; and

(iii) minimise the extent of potential dust generating surfaces exposed in the Stage 8 Area at any given point in time;

(b) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Note c to Table 3 above);

(c) carry out regular air quality monitoring to determine whether the development is complying with the relevant conditions of Schedule 2; and

(d) regularly assess meteorological and air quality monitoring data and relocate, modify or stop operations on the site to ensure compliance with the relevant conditions of Schedule 2.

Air Quality Management Plan

B14. The Applicant must prepare an Air Quality Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by a suitably qualified and experienced person/s;

(b) be prepared in consultation with the EPA;

(c) describe the measures to be implemented to ensure:

(i) compliance with the air quality criteria and operating conditions in this Schedule;

(ii) best practice air quality management is being employed; and

(iii) air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events; and

(d) include an air quality monitoring program that:

(i) is capable of evaluating the performance of the development against the air quality criteria; and

(ii) includes a protocol for identifying any air quality-related exceedance, incident or non-compliance and for notifying the Department and relevant stakeholders of these events.

B15. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Air Quality Management Plan is approved by the Planning Secretary.

B16. The Applicant must implement the Air Quality Management Plan as approved by the Planning Secretary.

METEOROLOGICAL MONITORING

B17. Prior to the commencement of Quarrying Operations in the Stage 8 Area, and for the life of the development, the Applicant must ensure that there is a suitable meteorological station operating in close proximity to the site that:

(a) complies with the requirements in the *Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007); and

(b) is capable of measuring meteorological conditions in accordance with the *NSW Industrial Noise Policy* (EPA, 2000),

unless a suitable alternative is approved by the Planning Secretary following consultation with the EPA.

SOIL AND WATER

B18. The Applicant must ensure that diesel spills and the like are cleaned up immediately so as not present a risk to water quality if the relevant Substage is inundated by floodwaters.

Groundwater Monitoring and Management

B19. The Applicant must monitor groundwater levels at Groundwater Bores BH01_S, BH01_D, BH02, BH03 and BH04 as shown in Figure 7 in Appendix 5, using continuous data loggers, for the duration of Quarrying Operations in the Stage 8 Area.

B20. The Applicant must ensure that Quarrying Operations do not compromise the integrity of the monitoring bores identified in condition B19 of Schedule 2.

B21. The Applicant must:

(a) collect groundwater quality samples at each of the monitoring locations identified in condition B19; and

(b) analyse collected groundwater quality samples for all major anions and cations and field parameters;

on an annual basis for the duration of Quarrying Operations in the Stage 8 Area.

B22. The Applicant must ensure that:

(a) temporary bores are drilled or augered progressively in each Substage to determine the local water table position immediately prior to commencing extraction in each Substage; and

(b) the pit floor in each Substage remains at least 1 metre above the measured water table level averaged over a seven-day period following the date of drilling or augering.

Water Supply and Licensing

B23. The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of the development to match its available water supply.

B24. The Applicant must develop a groundwater model using a variant of Modflow standard software, or equivalent software, to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 Area.

B25. The Applicant must:

(a) initially construct the groundwater model required under condition B24 of Schedule 2 using the first three months of groundwater monitoring data collected from 17 June 2020 to 16 September 2020;

(b) update the groundwater model following collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021; and

(c) incorporate the outputs of the groundwater model into the Site Water Balance as required under condition B36(c)(i) of Schedule 2.

B26. If a potential flood event (equivalent to a level of 64 m AHD at Menangle Weir, which represents the approximate height of overtopping of the Nepean River bank) does not occur between 17 June 2020 to 16 June 2021, then the Applicant must update the groundwater model required under condition B24 of Schedule 2 following the first flood event equivalent to or greater than this level when it occurs.

B27. The Applicant must obtain any necessary Water Access Licences for the development under the *Water Act 1912* and/or the *Water Management Act 2000.*

B28. When making an application for any necessary Water Access Licence, the Applicant must specify the annual take of water from each affected water source, as estimated by the groundwater model required under condition B24 of Schedule 2.

B29. Should the maximum annual water take as calculated by the groundwater model increase due to subsequent revisions of the groundwater model, as required under conditions B25 and B26 of Schedule 2, the Applicant must acquire the necessary additional licence shares to account for the maximum predicted annual volume.

B30. The Applicant must report on any water captured, intercepted or extracted from the site each year (directly and indirectly) in the Annual Review, including water taken under each Water Access Licence as applicable.

Soil Erosion

B31. The Applicant must install and maintain suitable erosion and sediment control measures in the Stage 8 Area. These measures must be designed and implemented having regard to the guidance series *Managing Urban Stormwater: Soils and Construction*, and be detailed in the Soil and Water Management Plan required under condition B36 of Schedule 2.

Flood Management

B32. The Applicant must prepare a Flood Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s;

(b) identify measures to:

(i) proactively prepare for, and respond to, any flood event in which the active extraction area is likely to be inundated by floodwaters emanating from the Nepean River;

(ii) ensure the safety of site personnel;

(iii) minimise, to the greatest extent practicable, the areas of exposed ground on the site that would be susceptible to flood risks (including scour and erosion and potential transport of sediment to downstream waters);

(iv) ensure that the active extraction area in any Substage does not exceed 0.33 hectares at any one time;

(v) ensure that the batter adjacent to the Nepean River Buffer Zone does not exceed:

- a maximum slope of 1:1 at any time; and
- a maximum slope of 1:5 in preparation for flood events;

(vi) ensure that no more than a 30 metres length of the batter adjacent to the Nepean River Buffer Zone (measured in total) has a slope exceeding 1:5 at any one time; and

(vii) rectify any flood-related damage to areas undergoing rehabilitation; and

(c) include a Trigger Action Response Plan which outlines actions to be undertaken in preparation for, and immediately following, a flood event including detailed protocols and timeframes for:

(i) backfilling the active extraction area to achieve a maximum batter slope of 1:5 adjacent to the Nepean River Buffer Zone in preparation for flood events;

(ii) avoiding the downstream movement of debris from the site;

(iii) recommencing Quarrying Operations following a flood event; and

(iv) rectifying any damage to areas undergoing rehabilitation following a flood event.

B33. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Flood Management Plan is approved by the Planning Secretary.

B34. The Applicant must implement the Flood Management Plan as approved by the Planning Secretary.

B35. The Applicant must ensure that the flood storage capacity of the final rehabilitated landform is no less than the pre-existing flood storage capacity at all stages of the development, unless otherwise approved in writing by the Planning Secretary. Details of the available flood storage capacity must be reported in the Annual Review.

Soil and Water Management Plan

B36. The Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s;

(b) be prepared in consultation with EPA and DPIE Water; and

(c) include a:

(i) **Site Water Balance** that:

- includes details of:
  - sources and security of water supply;
  - water use and management on the site;
  - reporting procedures, including the annual preparation of a site water balance; and
- minimises clean and potable water use on the site;
- incorporates the outputs of the groundwater water model required under condition B24 of Schedule 2;

(ii) **Surface Water Management Plan**, that includes:

- detailed baseline data on surface water flows and quality in watercourses and/or water bodies that could potentially be affected by the development;
- surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts, and surface water management performance measures;
- a detailed description of the surface water management system on the site, including the:
  - clean water diversion system;
  - erosion and sediment controls (including the construction of bunds and swales within each Substage); and
  - water storages (including a description of measures to maintain the storage capacity of sediment basins);
- a program to monitor and report on:
  - any surface water discharges;
  - the effectiveness of the water management system;
  - surface water quality in sediment basins; and
  - water levels and quality in the Nepean River both upstream and downstream of the site; and
- a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events;

(iii) **Groundwater Management Plan** that includes:

- all available baseline data for the site;
- groundwater performance criteria, including trigger levels for investigating any potentially adverse groundwater impacts, particularly with respect to aquatic habitat and regional groundwater systems;
- a protocol to ensure that Quarrying Operations do not exceed the extraction depth limit specified in condition B22(b) of Schedule 2;

- measures to ensure that the integrity of the groundwater monitoring network is not compromised by Quarrying Operations;
- a clear description of the reporting processes and procedures to be adopted for the routine collation, analysis and provision of monitoring data as required under conditions B21 and B22 of Schedule 2; and
- a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events.

B37. Subject to condition A29, the Applicant must not commence Quarrying Operations in the Stage 8 Area until the Soil and Water Management Plan is approved by the Planning Secretary.

B38. The Applicant must implement the Soil and Water Management Plan approved by the Planning Secretary.

B39. The Applicant must ensure that all surface discharges from the site comply with the relevant provisions of the POEO Act.

Ephemeral Creek Management Plan

B40. The Applicant must prepare an Ephemeral Creek Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;

(b) describes the measures that would be implemented to manage and control soil erosion and bank stabilisation (if required) and limit the risk of impacts on downstream receiving environments;

(c) provide details of the methods and timing of extraction within Substages 8E, 8F or 8G that demonstrate the integrity of the ephemeral creek (shown conceptually in Figure 4 of Appendix 1) would be maintained for as long as practicable during operations;

(d) provide for construction and stabilisation of appropriate diversion channels to divert surface water flows around the disturbance area, unless otherwise approved by the Planning Secretary;

(e) provide final designs for the road crossing and realigned section of creek that are supported by hydrological modelling and meet the rehabilitation objectives in Table 4; and

(f) describe the methods and timing for rehabilitation of the final realigned section of creek channel.

B41. The Applicant must not undertake any construction activities or Quarrying Operations within Substages 8E, 8F or 8G until the Ephemeral Creek Management Plan is approved by the Planning Secretary.

B42. The Applicant must implement the Ephemeral Creek Management Plan approved by the Planning Secretary.

TRANSPORT

Works within Hume Highway Motorway Road Reserve

B43. Prior to commencing Quarrying Operations in the Stage 8 Area, the Applicant must make an application to TfNSW under Section 138 of the *Roads Act 1993* for any proposed works within the Hume Highway Motorway Road Reserve (including the area under the Menangle Bridges).

B44. The Applicant must enter into a legally binding agreement with TfNSW (eg a licence, not a lease or an easement), for the construction, operation and decommissioning of the conveyor within the Hume Highway Motorway Road Reserve (including under the Menangle Bridges). The legally binding agreement must be executed prior to any construction within the road reserve. All TfNSW legal costs associated with drafting and executing the legally binding agreement must be borne by the Applicant.

B45. The Applicant must:

(a) provide a sealed access under and adjacent to the Menangle Bridges and comply with TfNSW drainage and pavement standards;

(b) restrict vehicular access under Menangle Bridge to light vehicles only;

(c) provide unrestricted access to TfNSW to undertake maintenance on the Menangle Bridges and associated facilities at all times;

(d) remove any detritus associated the construction and use of the access road under and adjacent to the Menangle Bridges;

(e) protect the piers of the Menangle Bridges, as well as any other part of the bridge structure and associated facilities from any potential damage as a result of the development;

B46. In making the application to TfNSW required under condition B43, the Applicant must provide:

(a) details demonstrating how the requirements in condition B45 will be met during the early establishment phase of the development, including:

(i) sealing and drainage design details for the access road under and adjacent to the Menangle Bridges; and

(ii) anchoring details for any structure(s) associated with the development that may become floating debris during flood events; and

(b) details demonstrating how the compliance with the requirements in condition B45 will be maintained over the life of the development.

B47. The Applicant must ensure that works undertaken within the Hume Highway Motorway Road Reserve do not in any way destabilise the foundations of the Hume Highway, including the Menangle Bridges. Should rectification works be required as a result of the development, they must be undertaken by the Applicant in accordance with TfNSW requirements and standards, and at no expense to TfNSW.

B48. The Applicant must not undertake any works within the Hume Highway Motorway Road Reserve (including the area under the Menangle Bridges) without the consent of TfNSW under Section 138 of the *Roads Act 1993*.

Road Safety and Condition Audit

B49. Within 12 months of commencing Quarrying Operations in the Stage 8 Area, and every five years thereafter until the conclusion of Quarrying Operations, the Applicant must undertake a Road Safety and Condition Audit for the development, to the satisfaction of the Planning Secretary. This Audit must:

(a) be undertaken by a suitably qualified independent expert/s whose appointment has been endorsed by the Planning Secretary;

(b) be prepared in consultation with Council;

(c) assessment the safety, performance and condition of the site's vehicular access onto Menangle Road, including the associated acceleration and deceleration lanes;

(d) identify any road works that are required to ensure compliance with relevant Austroads standards or relevant Council requirements;

(e) be documented in a Road Safety and Condition Audit Report which must be submitted to Council and the Planning Secretary for approval within three months of commencing the Audit.

B50. Within 12 months of completing each Road Safety and Condition Audit required under condition B49 of this Schedule, unless otherwise agreed by the Planning Secretary, the Applicant must complete any road works recommended in the Audit, to the satisfaction of Council. If there is a dispute regarding the implementation of any recommendations contained in the Audit, the Applicant may refer the matter to the Planning Secretary for resolution.

Continuation of Rehabilitation Levy

B51. For the duration of the Stage 8 Operations, the Applicant must continue to pay Council a rehabilitation levy on all sand and soil removed from the Stage 8 Area in accordance with the existing rates, calculation methods and indexation required under condition 26 of Schedule 1. The first instalment of these payments is to be made based on the most recent Index Review Date under Schedule 1.

Monitoring of Product Transport

B52. The Applicant must keep accurate records of all truck movements to and from the site (including time of arrival and dispatch) and publish a summary of records on its website every 6 months.

Transport Operating Conditions

B53. No direct access to or from the development via the Hume Highway is permitted.

B54. The Applicant must:

(a) ensure that all laden trucks entering or exiting the site have their loads covered;

(b) ensure that all laden trucks exiting the site are cleaned of material that may fall from vehicles, before leaving the site;

(c) take all reasonable steps to minimise traffic safety issues and disruption to local road users; and

(d) take all reasonable steps to ensure that appropriate signage is displayed on all trucks used to transport quarry products from the development so they can be easily identified by other road users.

Traffic Management Plan

B55. The Applicant must prepare a Traffic Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;

(b) be prepared in consultation with TfNSW and Wollondilly Shire and Campbelltown Councils;

(c) include details of all transport routes and traffic types to be used for development-related traffic;

(d) describe the processes in place for the control of truck movements entering and exiting the site;

(e) include details of the measures to be implemented to minimise traffic safety issues and disruption to local road users;

(f) include a Drivers' Code of Conduct that includes procedures to ensure that drivers:

(i) adhere to posted speed limits or other required travelling speeds;

(ii) adhere to designated transport routes; and

(iii) implement safe and quiet driving practices;

(g) describe the measures to be put in place to ensure compliance with the Drivers' Code of Conduct; and

(h) describe measures to minimise the transmission of dust and tracking of material onto the surface of public roads from vehicles exiting the site.

B56. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Traffic Management Plan is approved by the Planning Secretary.

B57. The Applicant must implement the Traffic Management Plan as approved by the Planning Secretary.

HERITAGE

Heritage Operating Conditions

B58. The Applicant must ensure that the development does not cause any direct or indirect impact on any identified heritage item located outside the approved disturbance area.

B59. If suspected human remains are discovered on site, then all work surrounding the area must cease, and the area must be secured. The Applicant must immediately notify NSW Police and Heritage NSW, and work must not recommence in the area until authorised by NSW Police and Heritage NSW.

B60. If any previously unknown Aboriginal object or Aboriginal place is discovered in the Stage 8 Area:

(a) all work in the immediate vicinity of the object or place must cease immediately;

(b) a 10 metre buffer area around the object or place must be cordoned off; and

(c) Heritage NSW must be contacted immediately.

B61. Work in the immediate vicinity of an object or place subject to condition B60 may only recommence if:

(a) the potential Aboriginal object or Aboriginal place is confirmed by Heritage NSW upon consultation with the Registered Aboriginal Parties not to be an Aboriginal object or Aboriginal Place; or

(b) an Aboriginal Heritage Impact Permit is obtained under section 90 of the *National Parks and Wildlife Act 1974*, and the Aboriginal Cultural Heritage Management Plan is revised to include appropriate measures in respect the Aboriginal object or Aboriginal place, to the satisfaction of the Planning Secretary.

Aboriginal Cultural Heritage Management Plan

B62. The Applicant must prepare an Aboriginal Cultural Heritage Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;

(b) be prepared in consultation with Heritage NSW and Registered Aboriginal Parties;

(c) describe the measures to be implemented within the Stage 8 Area, Nepean River Buffer Zone and Restoration Area to:

(i) ensure all workers on the site receive suitable Aboriginal cultural heritage inductions prior to carrying out any activities which may cause impacts to Aboriginal objects or Aboriginal places, and that suitable records are kept of these inductions;

(ii) protect, monitor and manage Aboriginal objects and Aboriginal places;

(iii) protect Aboriginal objects and Aboriginal places located outside the approved disturbance area from impacts of the development;

(iv) manage any new Aboriginal objects or Aboriginal places discovered during the life of the development;

(v) maintain and manage reasonable access for relevant Aboriginal stakeholders to Aboriginal objects and Aboriginal places (outside of the approved disturbance area); and

(vi) facilitate ongoing consultation and involvement of Registered Aboriginal Parties in the conservation and management of Aboriginal cultural heritage on the site.

B63. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Aboriginal Cultural Heritage Management Plan is approved by the Planning Secretary.

B64. The Applicant must implement the Aboriginal Cultural Heritage Management Plan approved by the Planning Secretary.

BIODIVERSITY AND REHABILITATION

Construction of Linear Infrastructure

B65. Prior to commencing construction of any linear infrastructure required for the carrying out of the development (including conveyors, access roads and haul roads), the Applicant must:

(a) determine the final alignment of the linear infrastructure by survey;

(b) minimise the environmental impacts of the alignment of this infrastructure, where practicable;

(c) map the final vegetation clearance, excluding any vegetation within the approved disturbance area as identified under condition A22 of Schedule 2;

(d) submit a survey plan of the disturbance boundaries for linear infrastructure and their respective GPS coordinates to the Planning Secretary; and

(e) identify relevant ecosystem and species credits required to compensate for the clearance identified in subparagraph (c), to the satisfaction of BCD.

B66. The Applicant must retire the ecosystem and species credits identified under condition B65(e) in accordance with the Biodiversity Offsets Scheme of the BC Act, to the satisfaction of the BCT.

Biodiversity Offset Strategy

B67. Prior to commencing Quarrying Operations in the Stage 8 Area, or other timeframe agreed by the Planning Secretary, the Applicant must make suitable arrangements for the long-term protection of the Restoration Area as described in the documents listed in condition A7(c) of Schedule 2, to the satisfaction of the Planning Secretary.

B68. If the Restoration Area does not meet the listing criteria of the targeted communities or the completion criteria in Table 6 in Appendix 7, within the timeframes established in the Biodiversity and Rehabilitation Management Plan, then the Applicant must retire the relevant deficient biodiversity credits in accordance with the Biodiversity Offsets Scheme of the BC Act, to the satisfaction of the BCT.

B69. The Applicant may satisfy condition B67 of Schedule 2 by establishing a positive covenant on title under section 88E of the *NSW Conveyancing Act 1919*. If the Applicant seeks to establish a positive covenant on title:

(a) the positive covenant must stipulate that the Applicant will manage the Restoration Area and all rehabilitated Substages in accordance with the Biodiversity and Rehabilitation Management Plan required under condition B73 of Schedule 2; and

(b) the Applicant must establish a trust with sufficient funds (calculated in accordance with the total fund deposit requirements for a biodiversity stewardship site in accordance with BC Act) to provide for the ongoing management of the Restoration Area and all rehabilitated Substages in accordance with the Biodiversity and Rehabilitation Management Plan,

to the satisfaction of the Planning Secretary.

Rehabilitation Objectives

B70. The Applicant must rehabilitate all areas impacted by the Stage 8 Operations to the satisfaction of the Planning Secretary. This rehabilitation must be consistent with the final rehabilitation plans submitted to the Planning Secretary under condition A11 of Schedule 2 and must comply with the objectives in Table 4, to the satisfaction of the Planning Secretary.

Table 4: Rehabilitation objectives

Feature	Objective
Stage 8 Area	• Safe (both within the site and in relation to downstream environs, including under flood conditions) • Hydraulically, geotechnically and geomorphologically stable • Non-polluting • Fit for the intended post-Quarrying Operations land use(s) • Final landform integrated with surrounding natural landforms as far as is reasonable and feasible, and minimising visual impacts when viewed from surrounding land or the Hume Highway

Surface infrastructure	• Conveyor decommissioned and removed, unless otherwise agreed by TfNSW and the Planning Secretary • All other surface infrastructure decommissioned and removed, unless otherwise agreed by the Planning Secretary
Quarry Substages	• Pit floor partially backfilled with sufficient and appropriate material to promote establishment of River-Flat Eucalypt Forest EEC • Substages progressively landscaped and vegetated to meet the objectives, performance and completion criteria in Table 6 in Appendix 7 • Batters to be established to a maximum slope of 1:1 (V:H) along the landward edge of each Substage and 1:5 (V:H) adjacent to the Nepean River Buffer Zone
Final Landform	• No reduction in flood storage capacity, compared with pre-development conditions, unless otherwise agreed by the Planning Secretary • Designed to incorporate geomorphological features to allow for the free draining discharge of clean water from the site • Minimise sediment laden run-off into the Nepean River
Water Quality	• Water discharged from the site is suitable for receiving waters and capable of supporting existing aquatic ecology and riparian vegetation
Community	• Ensure public safety

Progressive Rehabilitation

B71. The Applicant must rehabilitate the Substages progressively, to the satisfaction of the Planning Secretary.

B72. Unless otherwise agreed by the Planning Secretary, the Applicant must ensure that:

(a) no more than two Substages are opened, excavated or worked at any one time without the written approval of the Planning Secretary;

(b) the active extraction area in all combined Substages does not exceed 0.33 hectares at any one time;

(c) the area of exposed ground at any one time is minimised as far as reasonable and feasible, for the life of the development;

(d) Quarrying Operations do not progress from one phase of the development to another unless the progressive rehabilitation performance criteria in the Biodiversity and Rehabilitation Management Plan have been met (with the exception of in the active extraction area) for the previous phase (see condition B73(d) of Schedule 2); and

(e) the post-extraction batter along the landward edge of each Substage does not exceed a maximum slope of 1:1 (V:H) or the natural underlying sandstone profile.

Biodiversity and Rehabilitation Management Plan

B73. The Applicant must prepare a Biodiversity and Rehabilitation Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

(a) be prepared by suitably qualified and experienced person/s;

(b) be prepared in consultation with BCD and Council;

(c) describe the short, medium, and long-term measures to be undertaken to:

(i) ensure compliance with the biodiversity objectives outlined in Table 6 in Appendix 7;

(ii) ensure compliance with the rehabilitation objectives outlined in Table 4 of Schedule 2; and

(iii) prevent impacts on aquatic biodiversity, including through the stabilisation of riverbanks and the prevention of sediment-laden runoff;

(d) include detailed progressive rehabilitation performance criteria that must be met for each phase of the development before extraction can progress into subsequent phases;

(e) include detailed performance and completion criteria for the Restoration Area and the final rehabilitation of the Stage 8 Area (including timeframes for the achievement of the listing criteria of the targeted communities) based on the performance and completion criteria in Table 6 in Appendix 7;

(f) include a program to monitor, independently audit and report on progress against the criteria in sub-paragraphs (d) and (e), including reporting in the Annual Review;

(g) include an evaluation of the performance of the Restoration Area and the progressive rehabilitation of the Stage 8 Area against the performance and completion criteria required under paragraph (d) above;

(h) include triggers for remedial action (including additional planting or seeding), where the performance or completion criteria required under (d) and (e) above are not met;

(i) describe management measures to ensure that Quarrying Operations do not encroach on the Nepean River Buffer Zone and Exclusion Areas;

(j) include a detailed description of the measures to be implemented to:

(i) demonstrate compliance with conditions B76 and B78;

(ii) manage the collection and propagation of seed;

(iii) trial methods of extraction of seed resources on site and implement the most effective method of seed recovery;

(iv) minimise impacts on tree hollows and termite mounds where reasonable and feasible;

(v) minimise impacts on fauna, including undertaking pre-clearance surveys and supervision (by an appropriately qualified person) of the felling of habitat trees;

(vi) protect native vegetation and fauna habitat outside the approved disturbance area, including in the Restoration Area;

(vii) implement the *Stage 8 Area Weed Control Strategy* in the Amended Project Summary, except where varied by condition A18 of Schedule 2;

(viii) control feral pests;

(ix) control erosion;

(x) control unrestricted access;

(xi) manage bushfire hazards;

(xii) rehabilitate any areas of the Nepean River that are materially harmed by the development (including indirect or incidental impacts); and

(xiii) progressively rehabilitate the site and reasonably and feasibly minimise disturbance areas; and

(xiv) ensure the successful rehabilitation and protection of Stages 6 and 7 until the completion of Quarrying Operations in the Stage 8 Area;

(k) include an annual program to monitor and report on:

(i) the effectiveness of the measures required under (j) above;

(ii) progress against the detailed performance and completion criteria required under (d) and (d) above;

(iii) any progressive improvements that could be implemented to improve biodiversity outcomes; and

(iv) any additional or remedial actions required over the next 12 months;

(l) identify the potential risks to the successful rehabilitation of the Stage 8 Area, particularly where rehabilitation is damaged or delayed by flooding, and include a detailed description of the contingency measures to be implemented to mitigate against these risks; and

(m) include details of who would be responsible for monitoring, reviewing, and implementing the plan.

B74. Subject to condition A29, the Applicant must not commence Quarrying Operations in the Stage 8 Area until the Biodiversity and Rehabilitation Management Plan is approved by the Planning Secretary.

B75. The Applicant must implement the Biodiversity and Rehabilitation Management Plan as approved by the Planning Secretary.

B76. The Applicant must place or create a minimum of 106 nest boxes or tree hollows within the Restoration Area within 12 months of commencing Quarrying Operations in the Stage 8 Area.

B77. The Applicant must, to the greatest extent practicable, maximise the salvage of resources within the Stage 8 Area, including retention of:

(a) nut and seed resources from native trees; and

(b) leaf and small branch material for mulching,

for beneficial reuse on the site, including in rehabilitated Substages and in the Restoration Area.

B78. Following the conclusion of extraction in each Substage, the Applicant must actively place logs and woody debris salvaged from the approved disturbance area within the completed Substage at the following ratios:

(a) logs and woody debris at least 10 cm in diameter and greater than 0.5 m in length are to be placed in a configuration that reflects natural systems, such that there is overall at least 400 m of this woody debris per hectare for all completed Substages; and

(b) large woody debris at least 50 cm in diameter and greater than 0.5 m in length, such that there is overall at least 100 m of this large woody debris per hectare for all completed Substages.

Disposal of Vegetation (Stage 8)

B79. The Applicant may undertake timber milling in Stage 8, provided this timber milling occurs outside of the Nepean River Buffer Zone and the Exclusion Areas, and that the Applicant can demonstrate ongoing compliance with condition B78 of this Schedule.

Additional Rehabilitation Requirements for Stages 6 and 7

B80. The Applicant must rehabilitate 1.22 ha within Stage 6 and 3.44 ha within Stage 7 of the development in accordance with the objectives and the performance and completion criteria in Table 6 in Appendix 6.

B81. By the end of December 2020, or other timing as agreed by the Planning Secretary, the Applicant must submit a Vegetation Management Plan for Stages 6 and 7 to the Planning Secretary for approval. This plan must:

(a) satisfy the relevant requirements of condition 13 of Schedule 1;

(b) clearly define the extent and scope of Stage 6 vegetated lands;

(c) clearly define the extent and scope of Stage 7 vegetated lands and identifies that the diversity of species established via retention of current species, tubestock planting or direct seeding is to be raised to deliver the native plant species diversity identified in Table 5 in Appendix 6;

(d) establish baseline data for the existing habitat in the Stage 6 and 7 areas;

(e) describe how the Stage 6 and 7 vegetated lands would be managed and how habitat would be established and retained; and

(f) include detailed biodiversity objectives and performance and completion criteria for Stages 6 and 7 of the development, based on the general objectives and performance and completion criteria in Table 5 in Appendix 6,

to the satisfaction of the Planning Secretary.

B82. The Applicant must implement the Vegetation Management Plan for Stages 6 and 7 to the satisfaction of the Planning Secretary.

Rehabilitation Bond

B83. Within 6 months of the approval of the Biodiversity and Rehabilitation Management Plan, the Applicant must lodge a Rehabilitation Bond with the Department to ensure that rehabilitation of the Stage 8 Area is implemented in accordance with the performance and completion criteria set out in the plan and the relevant conditions in Schedule 2 of this consent. The sum of the bond must be an amount agreed by the Planning Secretary and determined by:

(a) calculating the cost of rehabilitating all disturbed areas of the site at third party rates (other than land acquisition costs), taking into account the likely surface disturbance over the next 3 years of Quarrying Operations; and

(b) employing a suitably qualified, independent and experienced person to verify the calculated costs.

B84. The calculation of the Rehabilitation Bond must be submitted to the Department for approval at least 2 months prior to the lodgement of the bond.

B85. The Rehabilitation Bond must be reviewed and if required, an updated bond must be lodged with the Department within 3 months following:

(a) any update or revision to the Biodiversity and Rehabilitation Management Plan;

(b) the completion of an Independent Environmental Audit in which recommendations relating to the implementation of the Biodiversity and Rehabilitation Management Plan have been made; or

(c) in response to a request by the Planning Secretary.

B86. If rehabilitation is completed generally in accordance with the relevant performance and completion criteria, to the satisfaction of the Planning Secretary, the Planning Secretary will release the bond.

B87. If rehabilitation is not completed generally in accordance with the relevant performance and completion criteria, the Planning Secretary will call in all, or part of, the bond, and arrange for the completion of the relevant works.

B88. If the Applicant establishes a positive covenant on title under section 88E of the *NSW Conveyancing Act 1919* under condition B69, then the Planning Secretary may waive the requirement for all or part of the Rehabilitation Bond required under conditions B83 to B87.

Weed Management

B89. The Applicant must manage noxious weeds on the site in accordance with the Biodiversity and Rehabilitation Management Plan, and subject to the restrictions in condition A18 of this Schedule, to the satisfaction of the Planning Secretary.

VISUAL

B90. The Applicant must:

(a) take all reasonable steps to minimise the visual and off-site lighting impacts of the development, including potential lighting impacts on the Hume Highway;

(b) ensure that the visual appearance of all new structures, facilities or works (including paint colours and specifications) is aimed at blending as far as possible with the surrounding landscape; and

(c) take all reasonable steps to:

(i) shield views of Quarrying Operations and associated equipment from users of public roads and at privately-owned residences; and

(ii) direct any on-site lighting downwards to avoid lighting impacts on the Hume Highway.

WASTE

B91. The Applicant must:

(a) manage on-site sewage treatment and disposal in accordance with the requirements of an applicable EPL, and to the satisfaction of EPA and Council;

(b) minimise the waste generated by the development;

(c) ensure that the waste generated by the development is appropriately stored, handled, and disposed of; and

(d) report on waste minimisation and management in the Annual Review.

B92. Except as expressly permitted in an applicable EPL, specific resource recovery order or exemption under the *Protection of the Environment Operations (Waste) Regulation 2014*, the Applicant must not receive waste at the site for storage, treatment, processing, reprocessing or disposal.

LIQUID STORAGE

B93. The Applicant must ensure that all tanks and similar storage facilities (other than for water) are protected by appropriate bunding or other containment, in accordance with the relevant Australian Standards.

DANGEROUS GOODS

B94. The Applicant must ensure that the storage, handling, and transport of dangerous goods is done in accordance with the latest version of the Australian Standards, particularly *AS 1940-2004 The storage and handling of flammable and combustible liquids (*Standards Australia, 2004) and *AS/NZS 1596:2014 The storage and handling of LP Gas* (Standards Australia, 2014), and the *Australian Dangerous Goods Code*.

BUSHFIRE MANAGEMENT

B95. The Applicant must:

(a) ensure that the development:

(i) provides for asset protection in accordance with the relevant requirements in *the Planning for Bushfire Protection* (RFS, 2006) guideline; and

(ii) ensure that there is suitable equipment to respond to any fires on the site; and

(b) assist the RFS and emergency services to the extent practicable if there is a fire in the vicinity of the site.

PART C ADDITIONAL PROCEDURES

NOTIFICATION OF EXCEEDANCES

C1. As soon as practicable and no longer than 7 days after obtaining monitoring results showing an exceedance of any noise or air quality criterion in PART B of Schedule 2 following the date of commencement of Quarrying Operations in the Stage 8 Area, the Applicant must provide details of the exceedance to any affected landowners/tenants if the Applicant has not otherwise reached an agreement to exceed the relevant criteria with the affected landowner pursuant to condition B5 or B12. For any exceedance of any air quality criterion in PART B of this consent, the Applicant must also provide to any affected land owners and tenants a copy of the fact sheet entitled "*Mine Dust and You"* (NSW Health, 2017).

INDEPENDENT REVIEW

C2. If, at any time following the date of commencement of Quarrying Operations in the Stage 8 Area, a landowner considers the development to be exceeding any noise or air quality criterion in PART B of Schedule 2, they may ask the Planning Secretary in writing for an independent review of the impacts of the development on their land.

C3. If the Planning Secretary is not satisfied that an independent review is warranted, the Planning Secretary will notify the landowner in writing of that decision, and the reasons for that decision, within 21 days of the request for a review.

C4. If the Planning Secretary is satisfied that an independent review is warranted, then within 3 months of the Planning Secretary's decision, or as otherwise agreed by the Planning Secretary and the landowner, the Applicant must:

(a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:

(i) consult with the landowner to determine their concerns;

(ii) conduct monitoring to determine whether the development is complying with the relevant criteria in PART B of Schedule 2; and

(iii) if the development is not complying with that criteria, identify measures that could be implemented to ensure compliance with the relevant criteria; and

(b) give the Planning Secretary and landowner a copy of the independent review; and

(c) comply with any written requests made by the Planning Secretary to implement any findings of the review.

PART D ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

D1. An Environmental Management Strategy must be prepared for the development to the satisfaction of the Planning Secretary. This strategy must:

(a) provide the strategic framework for environmental management of the development;

(b) identify the statutory approvals that apply to the development;

(c) set out the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the development;

(d) set out the procedures to be implemented to:

(i) keep the local community and relevant agencies informed about the operation and environmental performance of the development;

(ii) receive record, handle and respond to complaints;

(iii) resolve any disputes that may arise during the course of the development;

(iv) respond to any non-compliance and any incident;

(v) respond to emergencies; and

(e) include:

(i) references to any strategies, plans and programs approved under the conditions of this consent; and

(ii) a clear plan depicting all the monitoring to be carried out under the conditions of this consent.

D2. The Applicant must not commence Quarrying Operations in the Stage 8 Area until the Environmental Management Strategy is approved by the Planning Secretary.

D3. The Applicant must implement the Environmental Management Strategy as approved by the Planning Secretary.

Management Plan Requirements

D4. Management plans required under this Schedule must be prepared in accordance with relevant guidelines, and include:

(a) a summary of relevant background or baseline data;

(b) details of:

(i) the relevant statutory requirements (including any relevant approval, licence or lease conditions);

(ii) any relevant limits or performance measures and criteria; and

(iii) the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;

(c) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;

(d) a program to monitor and report on the:

(i) impacts and environmental performance of the development; and

(ii) effectiveness of the management measures set out pursuant to condition D4(c);

(e) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;

(f) a program to investigate and implement ways to improve the environmental performance of the development over time;

(g) a protocol for managing and reporting any:

(i) incident, non-compliance or exceedance of the impact assessment criteria or performance criteria;

(ii) complaint; or

(iii) failure to comply with statutory requirements; and

(h) a protocol for periodic review of the plan.

Note: *The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.*

REVISION OF STRATEGIES, PLANS AND PROGRAMS

D5. Within three months of:

(a) the submission of an incident report under condition D7;

(b) the submission of an Annual Review under condition D9;

(c) the submission of an Independent Environmental Audit under condition D11;

(d) the approval of any modification to the conditions of this consent; or

(e) the issue of a direction of the Planning Secretary under condition A8 which requires a review,

the suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant.

D6. If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary and submitted to the Planning Secretary for approval within six weeks of the review.

Note: *This is to ensure strategies, plans and programs are updated on a regular basis and to incorporate any recommended measures to improve the environmental performance of the development.*

REPORTING AND AUDITING

Incident Notification

D7. The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing to compliance@planning.nsw.gov.au and must comply with the requirements specified in Appendix 8.

Non-Compliance Notification

D8. Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The notification must be in writing to compliance@planning.nsw.gov.au and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, the way in which it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

Note*: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.*

Annual Review

D9. By the end of March in each year after the commencement of Quarrying Operations in the Stage 8 Area, or other timeframe agreed by the Planning Secretary, a report must be submitted to the Department reviewing the environmental performance of the development, to the satisfaction of the Planning Secretary. This review must:

(a) describe the development (including any rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;

(b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, including a comparison of these results against the:

(i) relevant statutory requirements, limits or performance measures/criteria;

(ii) requirements of any plan or program required under this consent;

(iii) monitoring results of previous years; and

(iv) relevant predictions in the documents listed condition A7(c).

(c) identify any non-compliance or incident which occurred in the previous calendar year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;

(d) evaluate and report on:

(i) the effectiveness of the noise and air quality management systems; and

(ii) compliance with the performance measures, criteria and operating conditions in this consent, as they relate to the Stage 8 Area;

(e) identify any trends in the monitoring data over the life of the development;

(f) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and

(g) describe what measures will be implemented over the next calendar year to improve the environmental performance of the development.

D10. Copies of the Annual Review must be submitted to Council and made available to any interested person upon request.

Independent Environmental Audit

D11. Within one year of the commencement of Quarrying Operations in the Stage 8 Area, and every three years after, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development. The audit must:

(a) be led and conducted by a suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary;

(b) be carried out in consultation with the relevant agencies;

(c) assess the environmental performance of the development and whether it is complying with the relevant requirements in this consent, water licences and mining leases for the development (including any assessment, strategy, plan or program required under these approvals);

(d) review the adequacy of any approved strategy, plan or program required under the abovementioned approvals and this consent;

(e) recommend appropriate measures or actions to improve the environmental performance of the development and any assessment, strategy, plan or program required under the abovementioned approvals and this consent; and

(f) be conducted and reported to the satisfaction of the Planning Secretary.

D12. Within three months of commencing an Independent Environmental Audit, or within another timeframe agreed by the Planning Secretary, the Applicant must submit a copy of the audit report to the Planning Secretary, and any other NSW agency that requests it, together with its response to any recommendations contained in the audit report, and a timetable for the implementation of the recommendations. The recommendations must be implemented to the satisfaction of the Planning Secretary.

Note: *The audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Planning Secretary.*

Monitoring and Environmental Audits

D13. Any condition of this consent that requires the carrying out of monitoring or an environmental audit, whether directly or by way of a plan, strategy or program, is taken to be a condition requiring monitoring or an environmental audit under Division 9.4 of Part 9 of the EP&A Act. This includes conditions in respect of incident notification, reporting and response, non-compliance notification, compliance report and independent audit.

Note: *For the purposes of this condition, as set out in the EP&A Act, "monitoring" is monitoring of the development to provide data on compliance with the consent or on the environmental impact of the development, and an "environmental audit" is a periodic or particular documented evaluation of the development to provide information on compliance with the consent or the environmental management or impact of the development.*

D14. Noise and air quality monitoring under Part B of this Schedule is not required at all privately-owned residences and the use of representative monitoring locations can be used to demonstrate compliance with criteria.

ACCESS TO INFORMATION

D15. Prior to commencing Quarrying Operations in the Stage 8 Area, the Applicant must:

(a) make the following information and documents (as they are obtained, approved or as otherwise stipulated within the conditions of this consent) publicly available on its website:

(i) the document/s listed in condition A7(c);

(ii) all current statutory approvals for the development;

(iii) all approved strategies, plans and programs required under the conditions of this consent;

(iv) regular reporting on the environmental performance of the development in accordance with the reporting requirements in any plans or programs approved under the conditions of this consent;

(v) a comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs;

(vi) a summary of the current stage and progress of the development;

(vii) contact details to enquire about the development or to make a complaint;

(viii) a complaints register, updated monthly;

(ix) the Annual Reviews of the development;

(x) audit reports prepared as part of any Independent Environmental Audit of the development and the Applicant's response to the recommendations in any audit report;

(xi) any other matter required by the Planning Secretary; and

(b) keep such information up to date for the life of the development and to the satisfaction of the Planning Secretary.

Appendix 1 Development Layout

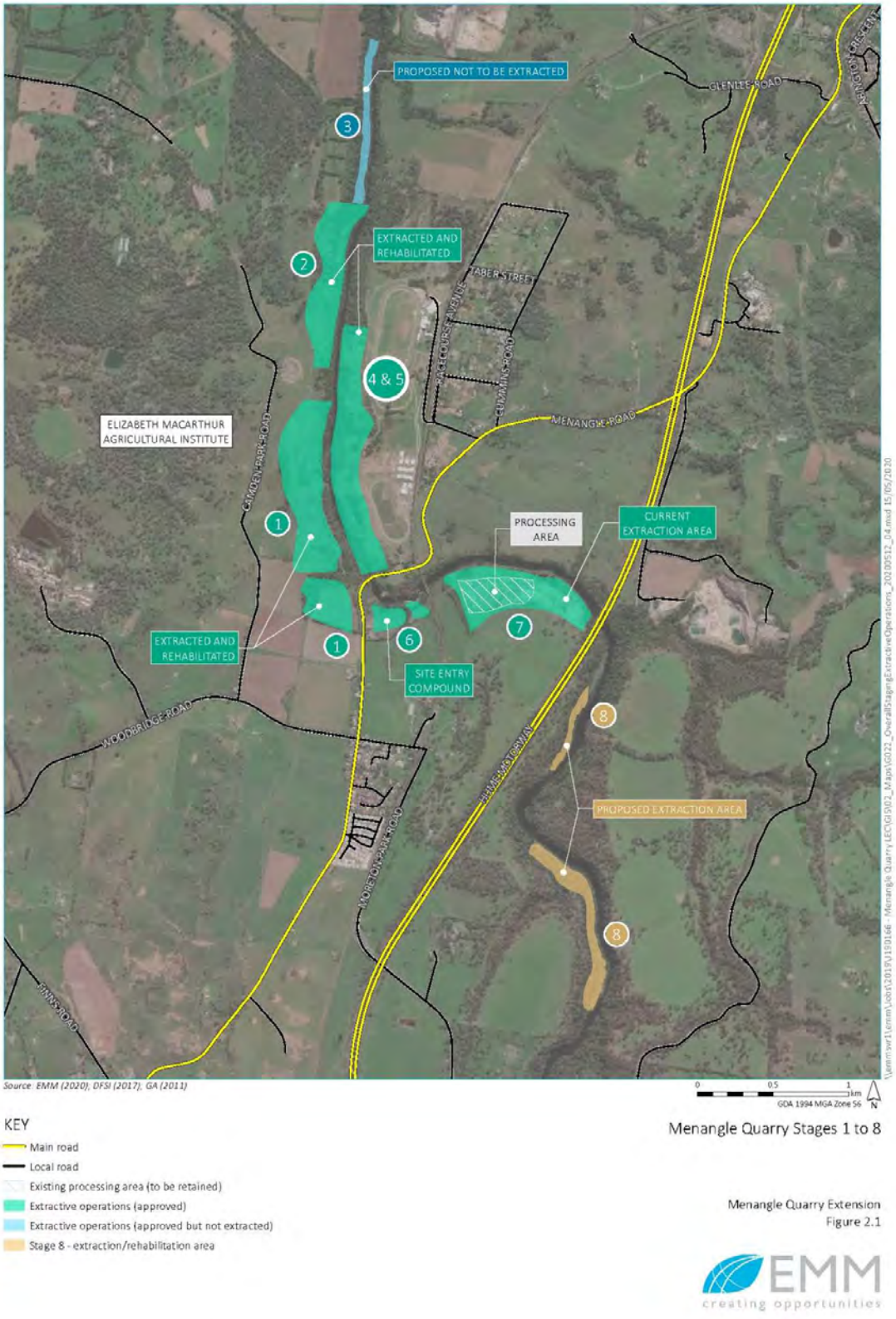

Figure 1 - Overall Development Layout Plan (Stages 1 to 8)

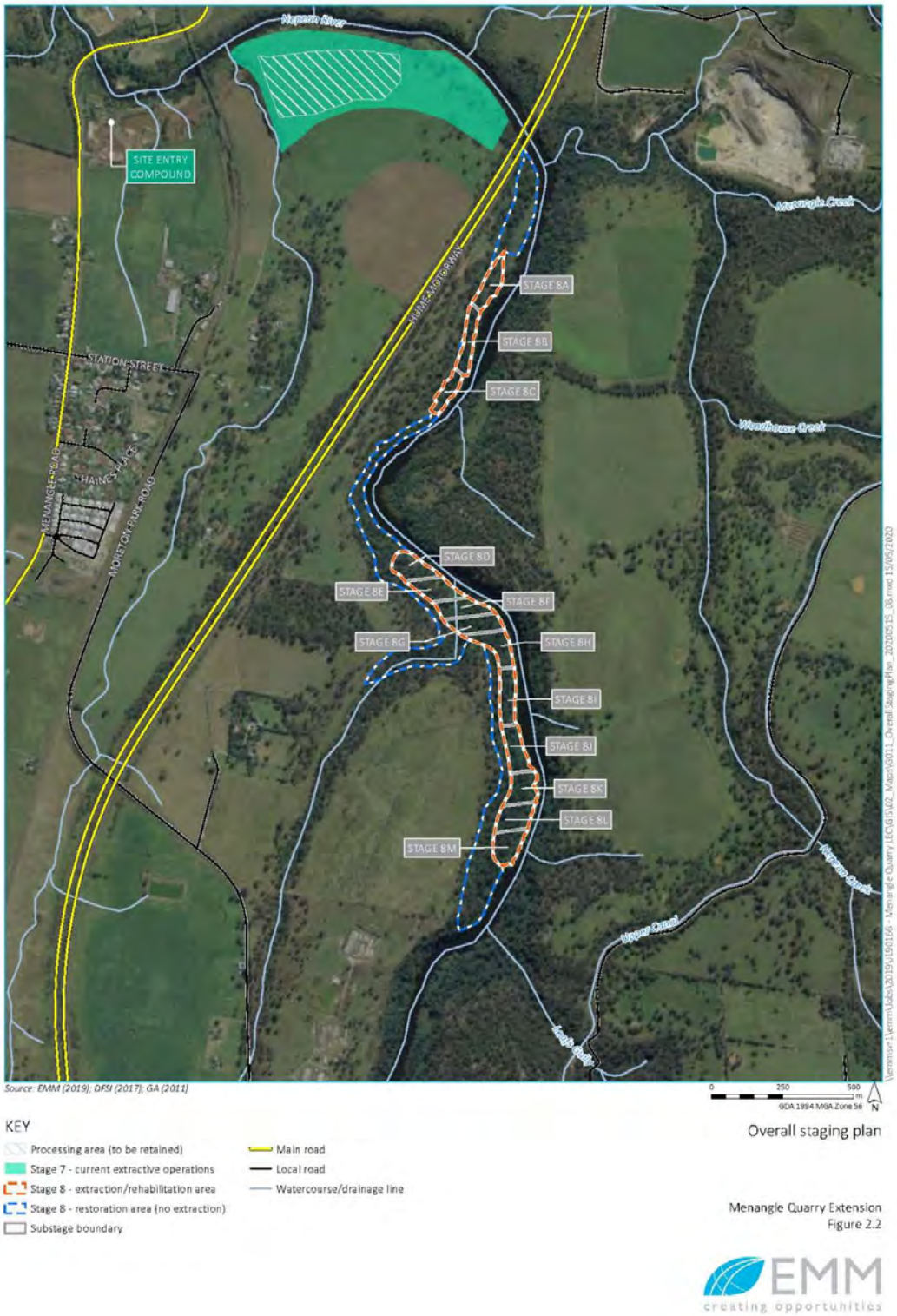

Figure 2 – Overall Staging Plan

Figure 3 - Substages 8A to 8C

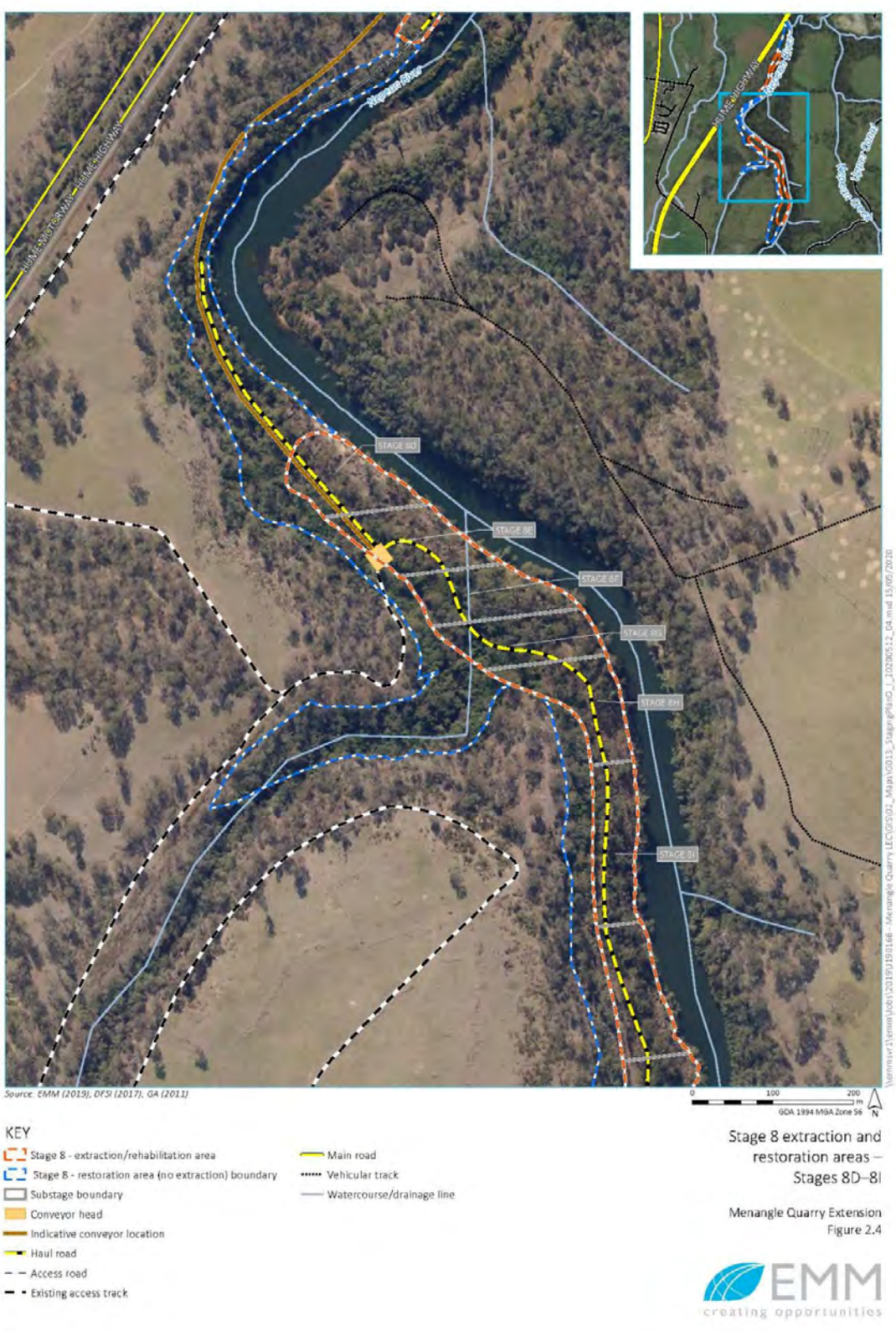

Figure 4 - Substages 8D to 8I

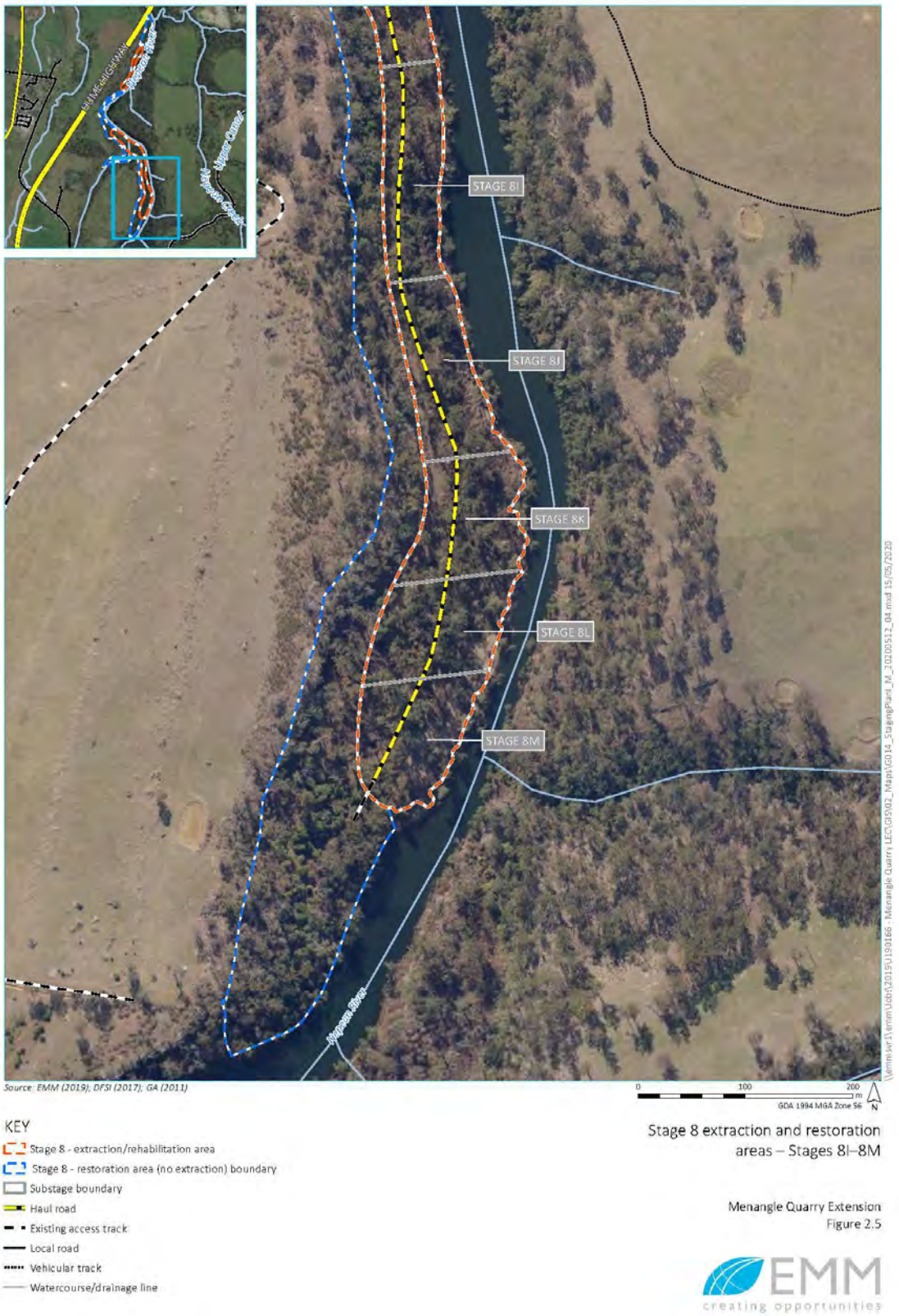

Figure 5 - Substages 8I to 8M

Appendix 2 Exclusion Areas

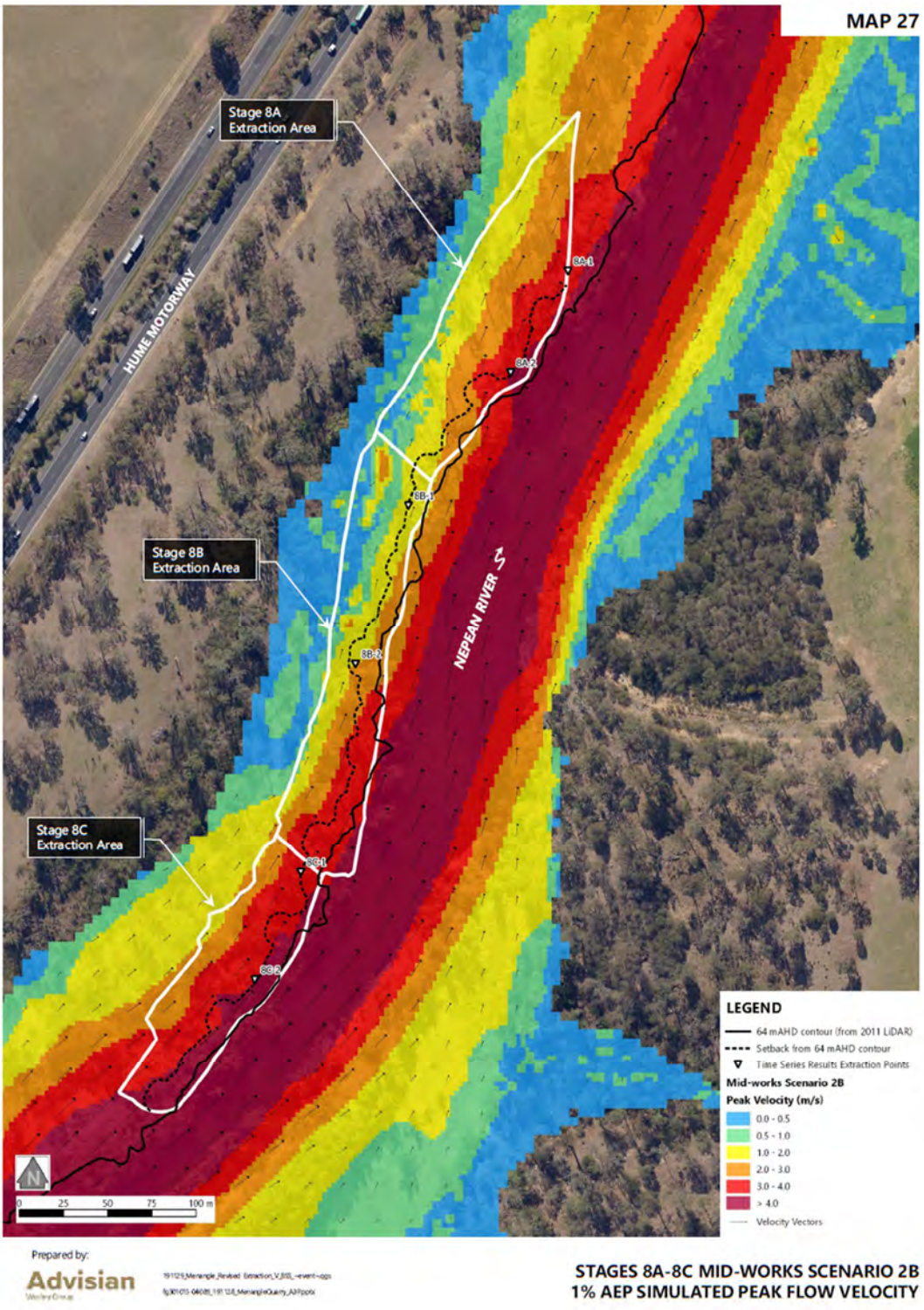

Figure 1 – Exclusion Areas Map Stages 8A-8C

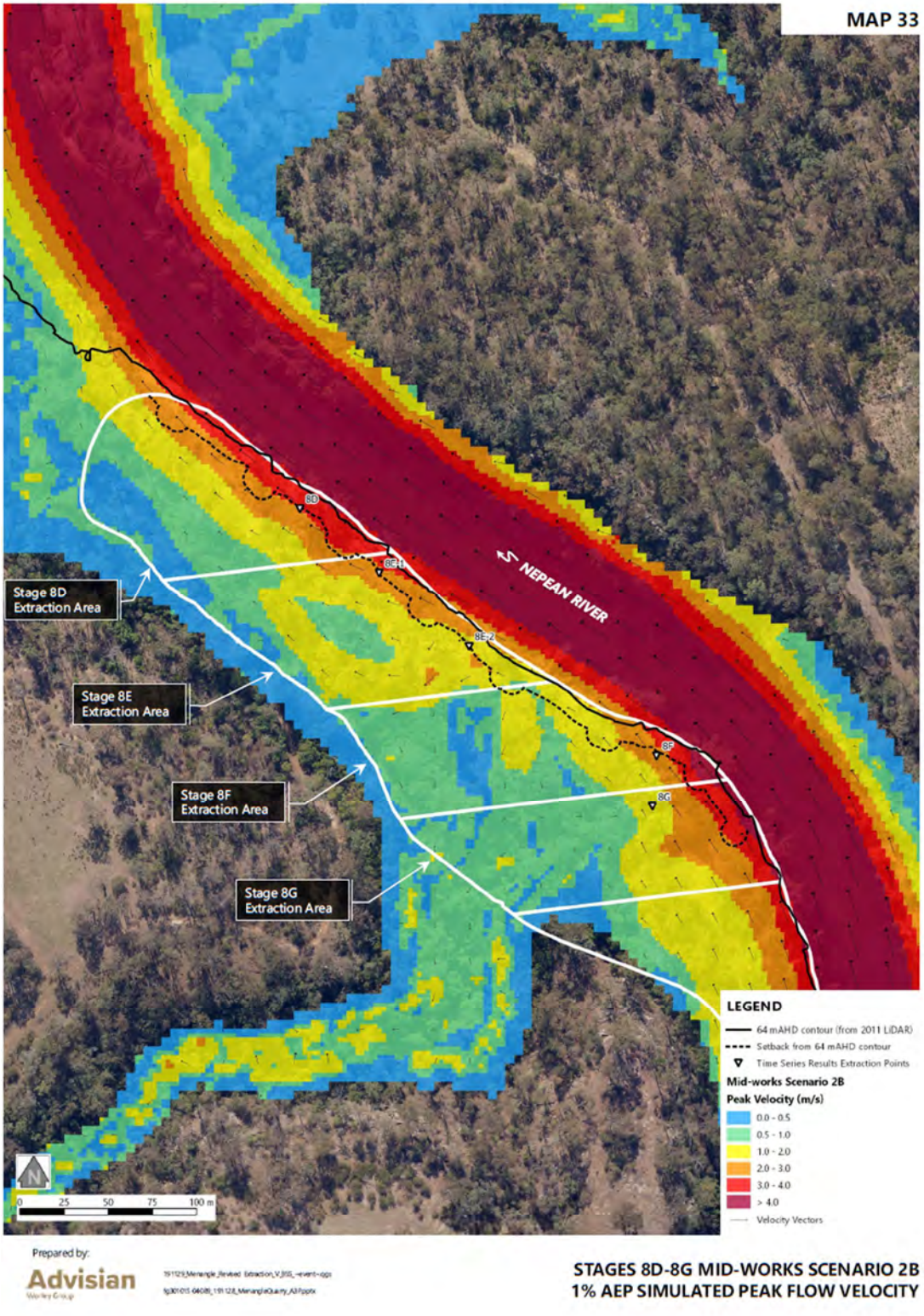

Figure 2 – Exclusion Areas Map Stages 8D-8F

Appendix 3 Receiver Locations

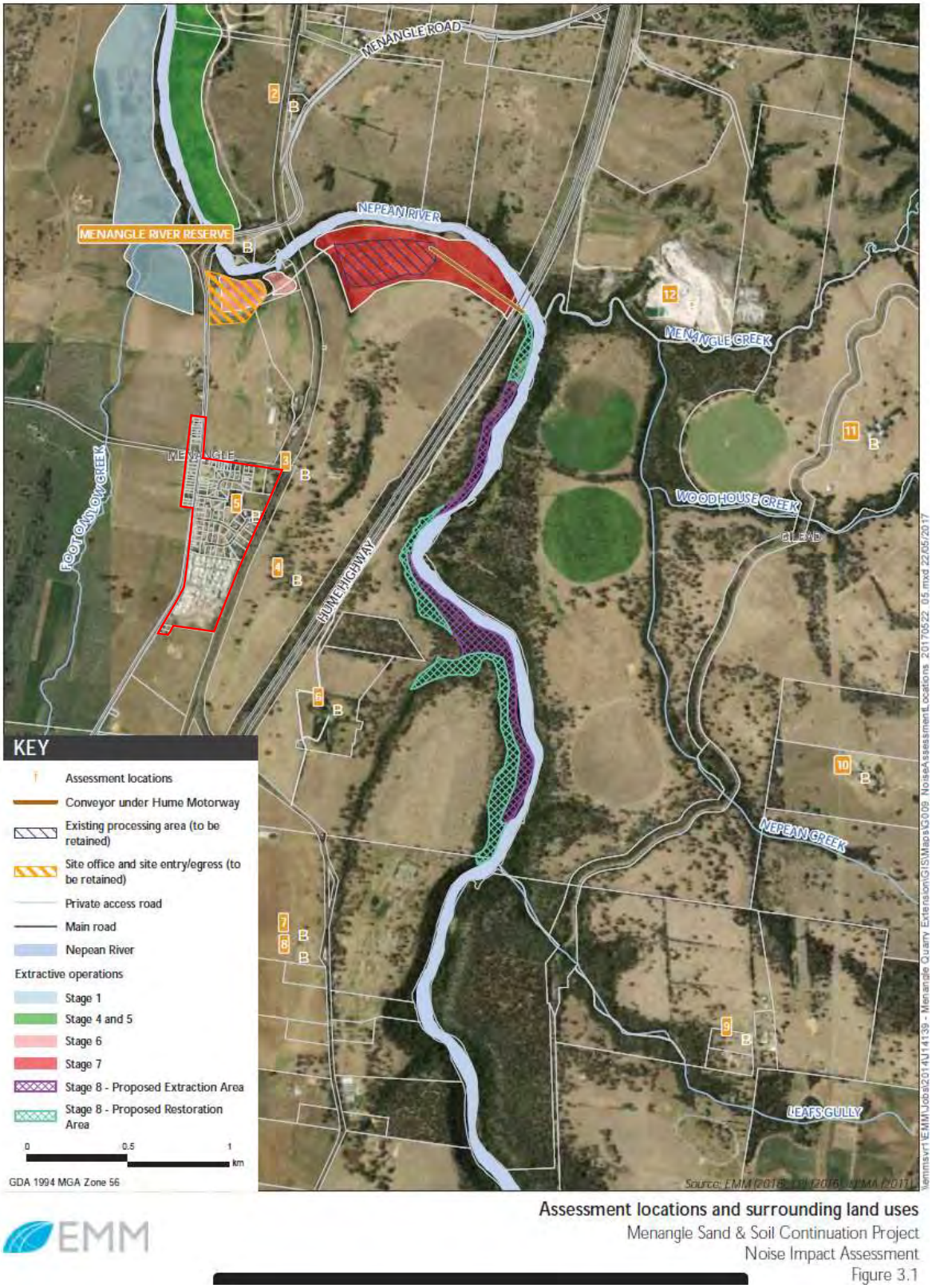

Figure 6 - Noise Receiver Locations

Appendix 4 Noise Compliance Assessment

Applicable Meteorological Conditions

1. The noise criteria in condition B4 of Schedule 2 are to apply under all meteorological conditions except the following:

   (a) where 3°C/100 metres (m) lapse rates have been assessed, then:

      (i) wind speeds greater than 3 metres/second (m/s) measured at 10m above ground level;

      (ii) temperature inversion conditions between 1.5°C and 3°C/100m and wind speeds greater than 2m/s measured at 10m above ground level; or

      (iii) temperature inversion conditions greater than 3°C/100m.

   (b) where Pasquill Stability Classes have been assessed, then:

      (i) wind speeds greater than 3m/s at 10m above ground level;

      (ii) stability category F temperature inversion conditions and wind speeds greater than 2m/s at 10m above ground level; or

      (iii) stability category G temperature inversion conditions.

Determination of Meteorological Conditions

2. Except for wind speed at microphone height, the data to be used for determining meteorological conditions shall be that recorded by the meteorological station required under condition B17 of Schedule 2.

Compliance Monitoring

3. A noise compliance assessment must be undertaken within two months of commencement of Quarrying Operations in the Stage 8 Area. The assessment must be conducted by a suitably qualified and experienced acoustical practitioner and must assess compliance with noise criteria in this consent. A report must be provided to EPA within 1 month of the assessment.

4. Unless otherwise agreed by the Planning Secretary, attended compliance monitoring must be carried out in accordance with the relevant requirements for reviewing performance set out in the *NSW Industrial Noise Policy* (EPA, 2000), in particular the requirements relating to:

   (a) monitoring locations for the collection of representative noise data;

   (b) meteorological conditions during which collection of noise data is not appropriate;

   (c) equipment used to collect noise data, and conformity with Australian Standards relevant to such equipment; and

   (d) modifications to noise data collected, including for the exclusion of extraneous noise and/or penalties for modifying factors apart from adjustments for duration,

   (e) modifying factors apart from adjustments for duration,

   with the exception of applying appropriate modifying factors for low frequency noise during compliance testing. This should be undertaken in accordance with Fact Sheet C of the *NSW Noise Policy for Industry* (EPA, 2017).

Appendix 5 Monitoring Locations

Figure 7 - Groundwater Monitoring Locations

Appendix 6 Additional Stage 6 and 7 Biodiversity and Rehabilitation Requirements

Table 5: Additional Biodiversity Objectives and Performance and Completion Criteria for Stage 6 and 7 Vegetated Areas

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
Composition Objective				
The vegetation composition of Stages 6 and 7 are recognisable as River-flat Eucalypt Forest EEC.	Native plant species are characteristic of River-flat Eucalypt Forest EEC as described in the Final Determination. *HN526 benchmark for native plant species richness is ≥24 species.* *It is noted that* Eucalyptus botryoides x saligna *is not listed in the River-flat Eucalypt Forest EEC Final Determination, but is to count as one species towards the benchmark value.*	Presence of a suitable number or proportion of species listed in the Final Determination. This is considered to be ≥24 species, across all monitoring plots, that are aligned with the species list in the Final Determination.	Use of standard 20 x 20 m floristic sampling plot(s) where all flora species present are recorded.	This criterion should be met early (i.e. at 5 years post-establishment), otherwise it is unlikely to be met in the long-term.
Structure Objectives				
The vegetation structure of Stages 6 and 7 are recognisable as, or is trending towards, the target BVT HN526, which provides a suitable surrogate for River-flat Eucalypt Forest EEC	Cover and abundance of plant growth forms are characteristic of, or are trending towards, the target BVT benchmarks, which are provided in the completion criteria.	Total foliage cover of species allocated to Tree (TG) growth form is trending towards the benchmark range of 27.5– 32.5	Use of BAM where all flora species present in a 20 x 20 m plot are recorded, with foliage cover and abundance of each species.	Foliage cover of Tree (TG) growth form is trending towards target value.
		Total foliage cover of species allocated to Shrub (SG) growth form is trending towards the benchmark range of 21-31		Foliage cover of Shrub (SG) growth form is trending towards target value.

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
		Total foliage cover of species allocated to Grass and Grass-like (GG) growth form is trending towards the benchmark range of 24.45-30.45		Foliage cover of Grass and Grass-like (GG) growth form is trending towards target value.
		Total foliage cover of species allocated to Forb (FG) growth form is trending towards the benchmark range of 24.45-30.45		Foliage cover of Forb (FG) growth form is trending towards target value.
Function Objectives				
Levels of ecosystem function have been established that demonstrate that Stages 6 and 7 are self-sustainable, or is trending towards self-sustainability	Evidence of plant reproduction and regeneration is present	The cover and species richness of the groundcover, including grasses and forbs, is stable or increasing, and is within the benchmark ranges	The ongoing persistence of groundcover species, which are relatively short lived and for which recruitment is not straightforward to measure, is regarded as evidence of reproduction and regeneration of these species	An initial decline in species richness and cover may occur, however a stabilisation in observed cover and richness should be observed by 5 to 10 years post-establishment.
		Second generation individuals of shrubs and trees are present	Presence of second-generation canopy species is evident within the rehabilitation domain (i.e. not limited to the plot, but present within rehabilitation of the same target community and age).	No performance guidance. The presence of second-generation trees and shrubs may not be evident for many years post-establishment.

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
	Cover of exotic species is low	Cover of 'high threat exotic' (HTE) and 'priority weeds' is no more than 2%.	Data collected in accordance with BAM. Sum foliage cover of species identified as 'high threat exotic' under the BAM and 'priority weeds' as identified by the Local Land Services (LLS) in the relevant strategic weed management plan for the region.	Cover of HTE and priority weed species are declining towards target value. Given the very high weed loads it is expected that it will take some time for weed growth to be brought under control and will require ongoing maintenance.
	Indicators of nutrient cycling are suitable for sustaining the target plant community type	Litter cover is within the benchmark range. There is no biometric benchmark, and thus the BAM benchmark of 40 for PCT835 is adopted	Data collected in accordance with BAM via five 1 m^2 subplots within the 20 m^2 floristic plot	Litter cover is increasing towards target value.

Notes:

Achieving biometric vegetation type (BVT) HN526 and/or plant community type (PCT) in the NSW Bionet Vegetation Information System (PCT835), can be used as a suitable surrogate for the EEC. BVT benchmarks are more specific (to vegetation type level, usually with lower and upper thresholds), whereas PCT benchmarks are to a broader vegetation class level (which is a grouping of similar vegetation types). For this reason, BVT benchmarks have generally been utilised in this table as being the best available.

The Completion Criteria column refers to the desired end goal, with the Performance Guidance column providing broad guidance on how the completion criteria should be interpreted in terms of producing future performance criteria in relevant Vegetation Management Plan(s). It is noted that the completion criteria and performance indicators in Table 5 will need to be resolved with more specific performance criteria relevant to different areas of the site.

It is also noted that stochastic events such as flood or fire might affect the achievement of performance standards and criteria, and whilst the intent will still be to achieve restoration and rehabilitation of the River-flat Eucalypt Forest EEC in the long-term, such events will need to be taken into account on a case by case basis for specific performance standards.

Appendix 7 Stage 8 Operations Biodiversity and Rehabilitation

Table 6: Biodiversity Objectives and Performance and Completion Criteria

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
Composition Objective				
The vegetation composition of the Restoration Area and rehabilitated substages are recognisable as River-flat Eucalypt Forest EEC.	Native plant species are characteristic of River-flat Eucalypt Forest EEC as described in the Final Determination. *HN526 benchmark for native plant species richness is ≥24 species.* *It is noted that* Eucalyptus botryoides x saligna *is not listed in the River-flat Eucalypt Forest EEC Final Determination, but is to count as one species towards the benchmark value.*	Presence of a suitable number or proportion of species listed in the Final Determination. This is considered to be ≥24 species, across all monitoring plots, that are aligned with the species list in the Final Determination.	Use of standard 20 x 20 m floristic sampling plot(s) where all flora species present are recorded.	This criterion should be met early (i.e. at 5 years post-establishment), otherwise it is unlikely to be met in the long-term.
Structure Objectives				
The vegetation structure of the Restoration Area and rehabilitated substages are recognisable as, or is trending towards, the target BVT HN526, which provides a suitable surrogate for River-flat Eucalypt Forest EEC	Cover and abundance of plant growth forms are characteristic of, or are trending towards, the target BVT benchmarks, which are provided in the completion criteria.	Total foliage cover of species allocated to Tree (TG) growth form is trending towards the benchmark range of 27.5– 32.5	Use of BAM where all flora species present in a 20 x 20 m plot are recorded, with foliage cover and abundance of each species.	Foliage cover of Tree (TG) growth form is trending towards target value.
		Total foliage cover of species allocated to Shrub (SG) growth form is trending towards the benchmark range of 21-31		Foliage cover of Shrub (SG) growth form is trending towards target value.

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
		Total foliage cover of species allocated to Grass and Grass-like (GG) growth form is trending towards the benchmark range of 24.45 - 30.45		Foliage cover of Grass and Grass-like (GG) growth form is trending towards target value.
		Total foliage cover of species allocated to Forb (FG) growth form is trending towards the benchmark range of 24.45 - 30.45		Foliage cover of Forb (FG) growth form is trending towards target value.
Function Objectives				
Levels of ecosystem function have been established that demonstrate the Restoration Area and rehabilitated substages are self-sustainable, or is trending towards self-sustainability	Evidence of plant reproduction and regeneration is present	The cover and species richness of the groundcover, including grasses and forbs, is stable or increasing, and is within the benchmark ranges	The ongoing persistence of groundcover species, which are relatively short lived and for which recruitment is not straightforward to measure, is regarded as evidence of reproduction and regeneration of these species	An initial decline in species richness and cover may occur, however a stabilisation in observed cover and richness should be observed by 5 to 10 years post-establishment.
		Second generation individuals of shrubs and trees are present	Presence of second-generation canopy species is evident within the rehabilitation domain (i.e. not limited to the plot, but present within rehabilitation of the same target community and age).	No performance guidance. The presence of second-generation trees and shrubs may not be evident for many years post-establishment.

Rehabilitation Objective	Performance Indicator	Completion Criteria	Example Justification/validation methods	Performance Guidance
	Cover of exotic species is low	Cover of 'high threat exotic' (HTE) and 'priority weeds' is no more than 2%.	Data collected in accordance with BAM. Sum foliage cover of species identified as 'high threat exotic' under the BAM and 'priority weeds' as identified by the Local Land Services (LLS) in the relevant strategic weed management plan for the region.	Cover of HTE and priority weed species are declining towards target value. Given the very high weed loads it is expected that it will take some time for weed growth to be brought under control and will require ongoing maintenance.
	Indicators of nutrient cycling are suitable for sustaining the target plant community type	Litter cover is within the benchmark range. There is no biometric benchmark, and thus the BAM benchmark of 40 for PCT835 is adopted	Data collected in accordance with BAM via five 1 m^2 subplots within the 20 m^2 floristic plot	Litter cover is increasing towards target value.

Notes:

Achieving biometric vegetation type (BVT) HN526 and/or plant community type (PCT) in the NSW Bionet Vegetation Information System (PCT835), can be used as a suitable surrogate for the EEC. BVT benchmarks are more specific (to vegetation type level, usually with lower and upper thresholds), whereas PCT benchmarks are to a broader vegetation class level (which is a grouping of similar vegetation types). For this reason, BVT benchmarks have generally been utilised in this table as being the best available.

The Completion Criteria column refers to the desired end goal, with the Performance Guidance column providing broad guidance on how the completion criteria should be interpreted in terms of producing future performance criteria within the Biodiversity and Rehabilitation Management Plan required under condition B73 of Schedule 2 of this consent. It is noted that the completion criteria and performance indicators in Table 6 will need to be resolved with more specific performance criteria relevant to different areas of the site. For example, the Amended restoration area will contain a tree overstorey and thus the performance standard should be higher compared to the Amended extraction area where some time will be required for the tree overstorey cover to become established. Refined performance criteria are to be included in the Biodiversity and Rehabilitation Management Plan.

It is also noted that stochastic events such as flood or fire might affect the achievement of performance standards and criteria, and whilst the intent will still be to achieve restoration and rehabilitation of the River-flat Eucalypt Forest EEC in the long-term, such events will need to be taken into account on a case by case basis for specific performance standards.

Appendix 8 INCIDENT NOTIFICATION AND REPORTING REQUIREMENTS

WRITTEN INCIDENT NOTIFICATION REQUIREMENTS

1. A written incident notification addressing the requirements set out below must be emailed to the Department at the following address: compliance@planning.nsw.gov.au within seven days after the Applicant becomes aware of an incident. Notification is required to be given under this condition even if the Applicant fails to give the notification required under condition D7 of Schedule 2 or, having given such notification, subsequently forms the view that an incident has not occurred.
2. Written notification of an incident must:
   a. identify the development and application number;
   b. provide details of the incident (date, time, location, a brief description of what occurred and why it is classified as an incident);
   c. identify how the incident was detected;
   d. identify when the applicant became aware of the incident;
   e. identify any actual or potential non-compliance with conditions of consent;
   f. describe what immediate steps were taken in relation to the incident;
   g. identify further action(s) that will be taken in relation to the incident; and
   h. identify a project contact for further communication regarding the incident.
3. Within 30 days of the date on which the incident occurred or as otherwise agreed to by the Planning Secretary, the Applicant must provide the Planning Secretary and any relevant public authorities (as determined by the Planning Secretary) with a detailed report on the incident addressing all requirements below, and such further reports as may be requested.
4. The Incident Report must include:
   a. a summary of the incident;
   b. outcomes of an incident investigation, including identification of the cause of the incident;
   c. details of the corrective and preventative actions that have been, or will be, implemented to address the incident and prevent recurrence; and

details of any communication with other stakeholders regarding the incident.

Ground floor, 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

T 02 9493 9500
E info@emmconsulting.com.au

www.emmconsulting.com.au

12 October 2020

Mr Chris Kelly
NSW Environment Protection Authority

planning.matters@epa.nsw.gov.au

Re: Menangle Sand and Soil Quarry – Soil and Water Management Plan – Consultation with EPA

Dear Chris,

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry (the 'Quarry') at 15 Menangle Road Menangle. A modification to the Quarry's approval has recently been approved. The updated approval requires that the soil and Water Management Plan (SWMP) is prepared in consultation with the Environment Protection Authority (EPA) and DPIE Water.

This letter seeks the EPA's input to these plans.

1 Quarry overview

Menangle Sand and Soil Pty Ltd operates the Menangle Sand and Soil Quarry at 15 Menangle Road Menangle. Quarrying has been undertaken in the location for over 40 years by a number of operators and at varying rates of production. Extraction, processing and rehabilitation activities have been undertaken by Menangle Sand and Soil since 1978.

Current extractive activities were approved in 1989 (DA 85/2865) and have involved the construction and operation of the quarry in seven stages. Sand and soil has been extracted from Stages 1 to 2 and 4 to 6 and is currently being extracted from Stage 7. While previously approved, sand and soil will not be extracted from Stage 3.

In September 2020, the NSW Land and Environment Court approved 'Menangle Quarry Extension – Modification 1' (MOD1). This allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 ha, and extends about 2 kilometres along the Nepean River south of the Stage 7 area. The extension will increase the life of the quarry by 15 years. The extracted material will be transported to the existing processing area where it will be stockpiled, processed and blended with materials imported to the site, prior to being dispatched from the quarry.

A description of the quarry, including MOD1, is provided in Appendix A. The Notice of Orders Made by the Land and Environment Court (the 'consent') is provided in Appendix B.

2 Previous assessments

The preparation of the environmental assessment for the modification application included the preparation of a *Flooding, Geomorphology and Onsite Water Management* report as part of the *Environmental Assessment* (EMM 2017). The assessment found that the proposed sediment extraction works and the mitigation measures would ensure that there would be no significant adverse impacts on flooding, river geomorphology and river water quality. The extraction works would have no significant adverse impacts on flood behaviour or flood levels because it would provide more flood conveyance area.

Following the preparation of this assessment, a number of additional reports were prepared in response to DOI/DPI-Water requests, including:

- *DA 85/2865 MOD1, Response to DOI-Water comments of 21 February 2018* (EMM 2018);
- *Menangle Quarry Modification to Development Consent 85/2865, Review of Fluvial Geomorphology* (Fluvial Systems 2018); and
- *Menangle Quarry Extension, Flood Impact Assessment* (Advisian 2018).

The modification application was initially rejected by DPIE. During the Land and Environment Court (Case number 2018/00342158) appeal, additional assessments were prepared during the appeal process, including:

- *Menangle Quarry, Amended Extraction Area and Setback*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Groundwater Management*, letter dated 16 August 2019 (EMM);
- *Menangle Quarry, Riverside Batter,* letter dated 23 August 2019 (EMM);
- *Fluvial Geomorphology Assessment for Menangle Quarry Modification to Development Consent 85/2865* dated 5 September 2019 (Fluvial Systems);
- *Menangle Quarry, Flood Mitigation*, letter dated 9 September 2019 (EMM);
- *Menangle Quarry Extension – Flood Impact Sensitivity Assessment*, dated September 2019 (Advisian); and
- *Additional Flood Impact Sensitivity Assessment*, dated 17 December 2019 (Advisian).

These reports are available on the Major Projects website:

- http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=8531

3 Management Plan

EMM Consulting Pty Limited (EMM) is now preparing a Soil and Water Management Plan (SWMP) in consultation with the EPA and DPIE Water in accordance with Part B, Condition B36 (b) of the consent.

The SWMP will address the matters raised in the Condition B34 of the consent and Menangle Sand and Soil's Summary of Commitments provided in Table 3.1 of Appendix A, including:

- a site water balance;
- erosion and sediment controls;

- surface water and groundwater baseline characterisation, monitoring and performance criteria;
- protocols for identifying and investigating any exceedances of performance criteria; and
- reporting requirements.

This letter seeks your input into the contents and preparation of the SWMP. We will also provide the draft SWMP to you for your review and comment. We would welcome the opportunity to meet, via teleconference, to discuss the plan.

It is requested that any comments you may have on the content or preparation the SWMP are provided by 26 October 2020 to allow them to be considered during preparation of the plan.

Should you wish to discuss anything specific please call me on the below number.

Please do not hesitate to contact me if you have any questions.

Yours sincerely,

Jeremy Slattery
Associate, Environmental Management
Phone: 0421 827 231
jslattery@emmconsulting.com.au

See Appendix A and B of letter to Department of Planning and Environment - Water, 12 October 2020

DOC20/987285

Mr Jeremy Slattery
EMM Consulting Pty Limited
PO Box 21
ST LEONARDS NSW 1590

Email: jslattery@emmconsulting.com.au

Dear Mr Slattery

Modification 1 - Update of Environmental Management Plans
Menangle Sand and Soil Quarry - Menangle Rd, Menangle

I am writing in response to the information submitted to the Environment Protection Authority (EPA) on 13 October 2020 regarding the recently approved (NSW Land and Environment Court) Modification 1 of the above Menangle Sand & Soil Pty Ltd (MSS) sand quarry operation. Your correspondence advises that the updated approval conditions require that the Soil and Water (SWMP), Air Quality (AQMP) and Noise Management Plans (NMP) are prepared in consultation with the EPA.

Following a review of the updated draft management plans, the EPA advises that the documents appear appropriate to manage the activities undertaken at the site. EMM Consulting Pty Limited should advise the proponent that they should review and update the management plans as necessary as the development progresses into the newly approved Stage 8.

The EPA supports the development of Environmental Management Plans (EMPs) as part of good environmental management but does not generally approve specific EMPs for industry operations. The preparation and implementation of any EMP for the above works is ultimately the responsibility of the proponent. MSS may wish to have the NMP, AQMP & SWMP audited to an industry standard or certified to the ISO 14001 Standard as part of an overall Environmental Management System.

If you have questions regarding the above, please phone Matt Fuller on (02) 4224 4100.

Yours sincerely

26/11/2020

GREG NEWMAN
Unit Head Regulation

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(from outside NSW)

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Our ref: STH05/01238/21
Contact: Andrew Lissenden 0418 962 703

18 December 2020

Ernest Dupere
Benedict Industries Pty/Ltd
BY EMAIL: ernest@benedict.com.au

MENANGLE SAND AND SOIL – REQUEST FOR IN PRINCIPLE AGREEMENT TO HOW MATERIAL IS TRANSPORTED WITHIN THE SITE.

Dear Ernest,

Transport for NSW (TfNSW, formerly Roads and Maritime Services) refers to your email dated 4 November 2020, and the subsequent phone discussion had regarding the above.

TfNSW notes that:

- You are looking at amending the currently approved Menangle Quarry development consent (DA85/2865). As such, you are seeking an 'in-principle agreement' with TfNSW so as to enable you to progress a proposed design with some confidence that it is open to the idea;
- The change you are proposing seeks to allow material on the eastern side of the Hume Highway to be transported by heavy vehicles, as opposed to a conveyor belt, to the processing area on the western side of the Hume Highway (i.e. under the Menangle Bridges);
- The Menangle Bridges are a TfNSW asset;
- You have had discussions with TfNSW Area Maintenance Manager (Vincent Boer) who has not objected to the concept subject to additional information being provided; and
- The current development consent will need to be amended (i.e. lodgement of a Section 4.55 application) to allow the proposed change from a conveyor belt system to the use of trucks/heavy vehicles.

Having regard for the above, TfNSW advises that it provides 'in-principle agreement' to the concept of using heavy vehicles to transport material under the Hume Highway/Menangle Bridges being further investigated. This being subject to the requirements outlined in **Attachment 1**.

If you have any questions, please contact Andrew Lissenden on 0418 962 703.

Yours faithfully

Andrew Lissenden
Development Assessment Officer
Community and Place I South Region

Cc: lauren.evans@planning.nsw.gov.au

1. Engineering designs that have been prepared by a suitably qualified person will need to be provided to TfNSW for its approval. These will need to have regard for issues including, but not limited to, the protection of piers and the bridge structure;
2. Further discussions be had with Vincent Boer (TfNSW Area Maintenance Manager) and Dony Castro (TfNSW Bridge Maintenance Planner) during the preparation of engineering designs;
3. The implementation and ongoing maintenance of any design approved by TfNSW will be at the quarry operator/owners own cost;
4. TfNSW will be licenced to use the enhanced access tracks; and
5. An application to amend the existing development consent will be lodged to enable the all relevant environmental and design factors to be considered.

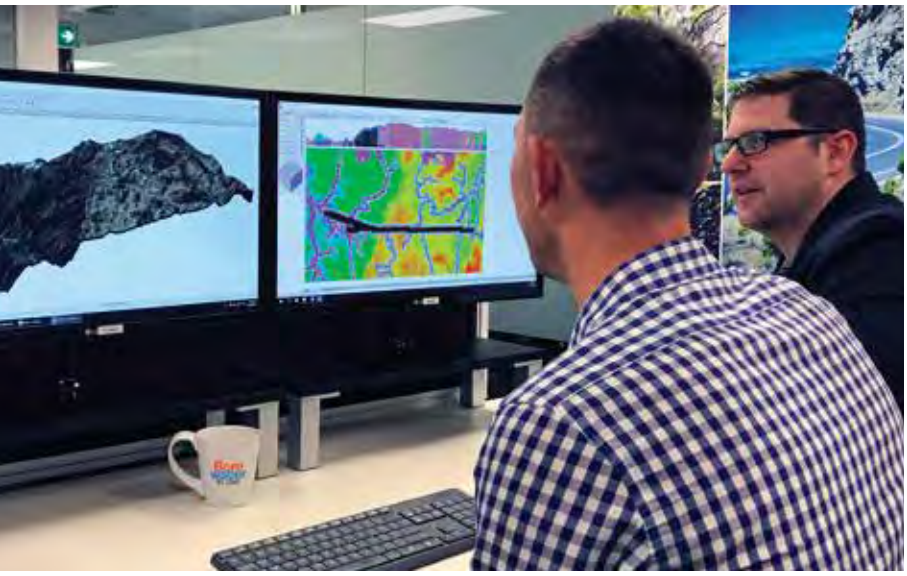
Appendix B

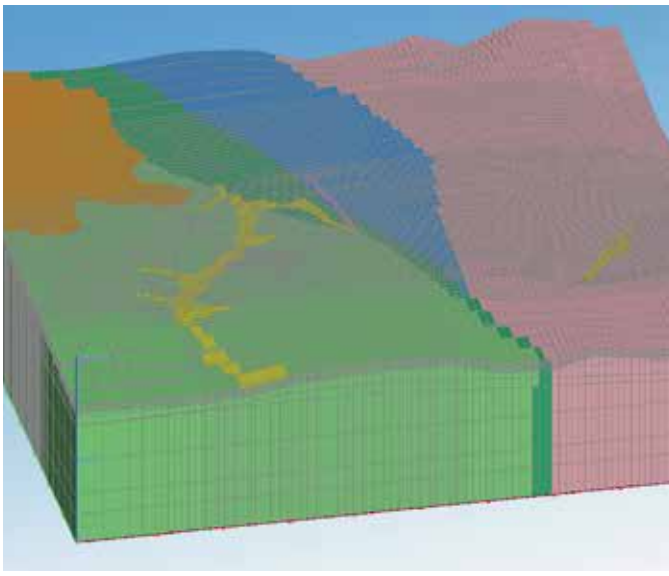
Menangle Quarry - Groundwater Model Report

Menangle Quarry

Groundwater model report

Prepared for Menangle Sand and Soil Pty Ltd
March 2021





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Menangle Quarry

Groundwater model report

Report Number

J190166 RP32

Client

Menangle Sand and Soil Pty Ltd

Date

4 March 2021

Version

v2 Final

Prepared by

Jeff Whitter
Associate Hydrogeologist / Modeller
4 March 2021

Approved by

Dr Doug Weatherill
Associate Groundwater Modeller
4 March 2021

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1 Introduction

Menangle Sand and Soil Pty Ltd (Menangle Sand and Soil) operates the Menangle Sand and Soil Quarry at 15 Menangle Road Menangle. In September 2020, the NSW Land and Environment Court (LEC) approved Menangle Quarry Extension – Modification 1 (MOD1). This allows the extraction of sand and soil in a new area, the Stage 8 area, that is about 13 hectares (ha) in area and extends about 2 kilometres (km) along the Nepean River.

Preliminary groundwater modelling has been conducted to quantify the groundwater licence volume required from the Sydney Basin Nepean Groundwater Source (Management Zone 2) to allow for temporary interception of groundwater by quarrying in the Stage 8 area. The modelling was informed by approximately three months of groundwater monitoring data, proposed quarrying operations and expected conditions at the site (water levels in the Nepean River and adjacent groundwater system are largely controlled by the Menangle Weir with only short duration rises above this long-term average level).

1.1 Background

The Menangle Quarry Extension – Modification 1 (MOD1) conditions of approval (CoA) require that:

- B24. The Applicant must develop a groundwater model using a variant of MODFLOW standard software, or equivalent software, to quantify the progressive takes from water sources during Quarrying Operations in the Stage 8 area.
- B25. The Applicant must:
  - (a) initially construct the groundwater model required under condition B24 of Schedule 2 using the first three months of groundwater monitoring data collected from 17 June 2020 to 16 September 2020;
  - (b) update the groundwater model following collection of the first 12 months of data collected from 17 June 2020 to 16 June 2021; and
  - (c) incorporate the outputs of the groundwater model into the Site Water Balance as required under condition B36(c)(i) of Schedule 2.
- B28. When making an application for any necessary Water Access Licence, the Applicant must specify the annual take of water from each affected water source, as estimated by the groundwater model required under condition B24 of Schedule 2.

This report describes the preliminary modelling results based on history matching to the first three months of groundwater monitoring data. As required under condition B25(b), once 12 months of monitoring data have been collected, the groundwater model will be updated utilising the extended groundwater monitoring record and the licence volume requirement updated in line with any changes to model predictions.

1.2 Water affecting activities

The quarry does not plan to excavate below the long-term average watertable elevation. However, during short-duration flooding in the Nepean River, the watertable in the adjacent alluvial water table is expected to rise. If the Nepean River water level increase is of sufficient magnitude and duration, the alluvial water table may rise above the base of the quarry and, hence, shallow alluvial groundwater will be intercepted. Quarrying ceases during such periods of inundation and intercepted groundwater will not be abstracted from the quarry area (eg by pumping) and water in the base will be allowed to infiltrate back into the base of the quarry. However, the NSW Aquifer Interference Policy (NSW AIP) requires intercepted water to be licensed.

1.3 Modelling objectives

The broad objective of the Menangle Sand and Soil Quarry groundwater modelling is to quantify the necessary groundwater volume to be licensed for the project. The modelling is being undertaken in two stages.

In Stage 1, a groundwater model has been built and undergone a ~3.5 month history-matching process using groundwater monitoring data from 3 June 2020 up to 23 September 2020. Initial predictions of groundwater interception will inform groundwater licensing.

The tasks in Stage 1 of the groundwater modelling are as follows:

- build a numerical groundwater flow model based on the conceptual model;
- calibrate/history-match the model using groundwater monitoring data from 3 June 2020 to 23 September 2020;
- simulate the proposed quarrying activities; and
- quantify groundwater potentially intercepted by the excavation voids (via indicative scenarios).

In Stage 2, the groundwater model will be reviewed and updated using a full year of groundwater monitoring data for history-matching. Predictive scenarios will be rerun and the required groundwater licence volume reassessed in line with the updated model.

1.4 Model confidence classification

The Australian Groundwater Modelling Guidelines (Barnett et al 2012) provide a framework from which to define a target “model confidence level”. Model class is closely linked to model history-matching, with reference to the historical stresses in comparison to the stresses (both magnitude and duration) in the predictions. The groundwater model is best described as a class 1 model at present. EMM expects that stage 2 of the modelling will be described as a class 1 model, with some class 2 attributes. Given the anticipated low groundwater risk of the project due to the expected relatively small groundwater interception, both in terms of duration and volume, a model of class 1 to class 2 categorisation is considered to be adequate.

2 Conceptual model

2.1 Geology and hydrostratigraphy

The following provides a summary of the site geology, taken from the joint expert report on groundwater (Merrick and Webb 2020). More detail is presented in monitoring bore installation and testing program report (EMM 2020a).

There are two geological units at the site:

- Thin alluvial Quaternary sand and alluvial deposits exist immediately adjacent to and underlying the Nepean River. Alluvial deposits contain discontinuous, unconfined local groundwater systems in direct connection with the Nepean River (Merrick and Webb 2020).

- The Hawkesbury Sandstone (HBSS) forms an extensive confined to semi-confined regional groundwater system within the Sydney Geological Basin with permeability from both the rock mass itself and fractures within the rock mass (ie dual permeability system) (Merrick and Webb 2020).

In the Stage 8 area, the HBSS is thick. At Bore GW105339, approximately 1.5 km south of the southern extent of Stage 8, the Bald Hill Claystone beneath the HBSS was intercepted at 238 m below ground level.

The alluvium deposit overlies HBSS, and the excavation will not intrude into the sandstone. The resource will be extracted so that the base of the quarry will be at least 1 m above the low flow water level in the Nepean River, as controlled by Menangle Weir downstream of the Stage 8 area. As the quarry will not excavate below the long-term average watertable elevation, and will not excavate into the HBSS, the project is considered to have very low potential to impact the regional HBSS aquifer.

The alluvial deposits and HBSS are two distinct hydrostratigraphic units (HSUs) at the quarry (Merrick and Webb 2020). These HSUs are managed as one groundwater source under the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The groundwater source is the Sydney Basin Nepean Groundwater Source (Management Zone 2).

HSUs of relevance to the project area are presented with additional details in Table 2.1.

Table 2.1 Hydrostratigraphy summary

HSU name	HSU type	HSU typical thickness	Description
Alluvial sediments (Sand)	Disconnected, unconfined aquifer	~9 m	Shallow, disconnected and often unsaturated alluvial sediments.
Ashfield Shale	Aquitard	Up to ~150 m	The presence of this unit is limited to the west of the model domain and is inferred to act as a confining unit, consistent with observations in the greater Sydney basin. It is not mapped at the project site.
Hawkesbury Sandstone	Aquifer	Up to 238# m	This unit forms a major regional aquifer in the Sydney basin and has been mapped and studied in the extensive detail. The Hawkesbury Sandstone is a sedimentary fractured rock aquifer with some primary porosity.

1. # value taken from Statement of Evidence by Dr. Noel Merrick (2020).

Surfaces for the top/bottom of the HSUs were developed using the regional hydrogeological understanding and drill hole data (sourced from Menangle Sand and Soil, WaterNSW and MinView drill hole databases). Figure 2.1 to Figure 2.3 show the locations of the data points used to generate HSU surfaces. The MinView database was used to download both exploration and groundwater drill hole databases. The orange points show the exploration drill hole database, while the red points are based on the groundwater drill hole database. The site-specific data (blue points) were included in the generation of the surfaces. In the figures, the quarry location is indicated as a pink area near the Nepean River. ELVIS topography data was used to define ground surface.

The joint expert report on groundwater (Merrick and Webb 2020) presented local-scale conceptual cross sections through the project area, aligned with the groundwater monitoring bores drilled for the project. These are reproduced as Figure 2.4 and Figure 2.5.

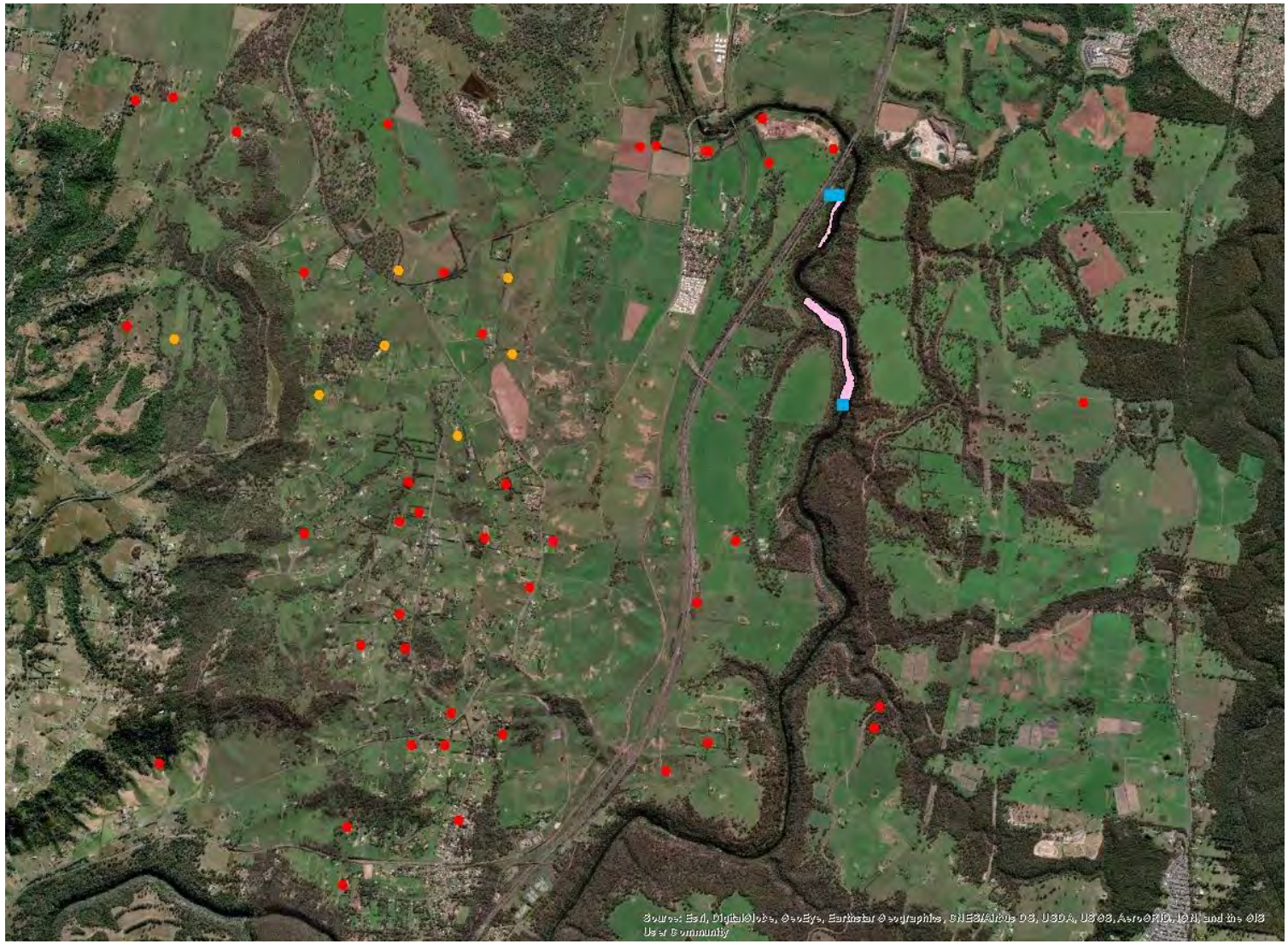


Figure 2.1 Alluvium data locations

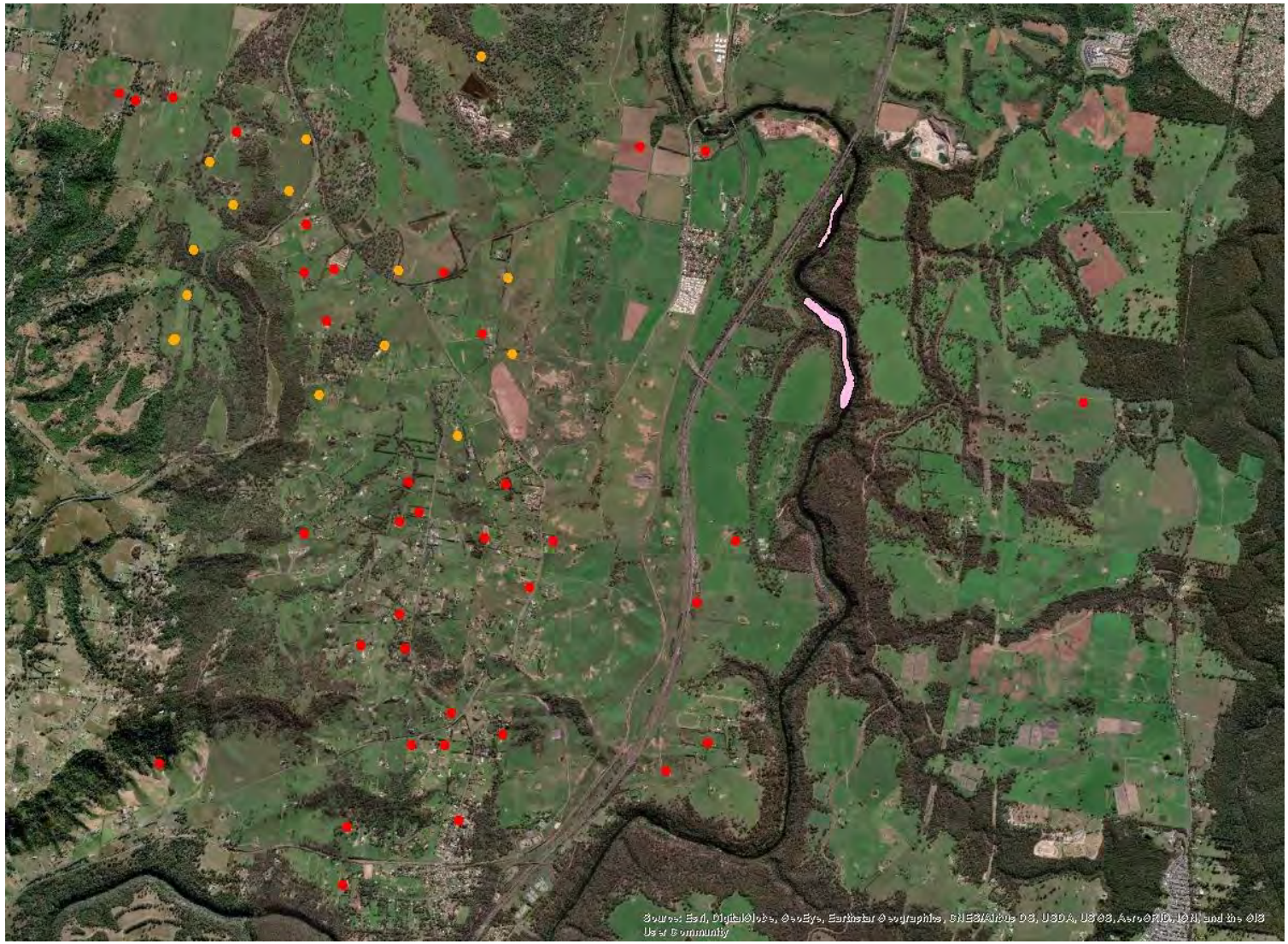


Figure 2.2 Ashfield Shale data locations

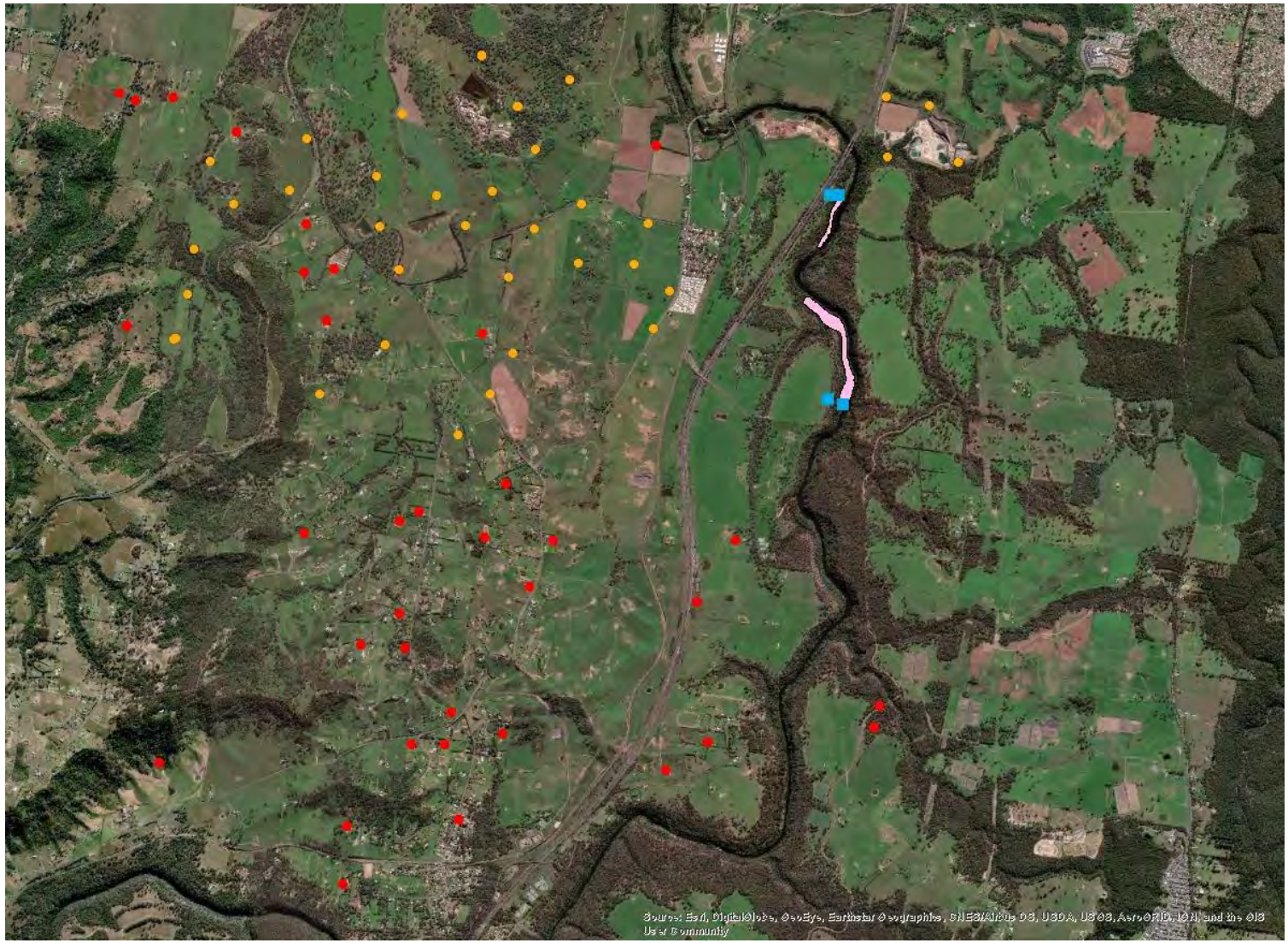
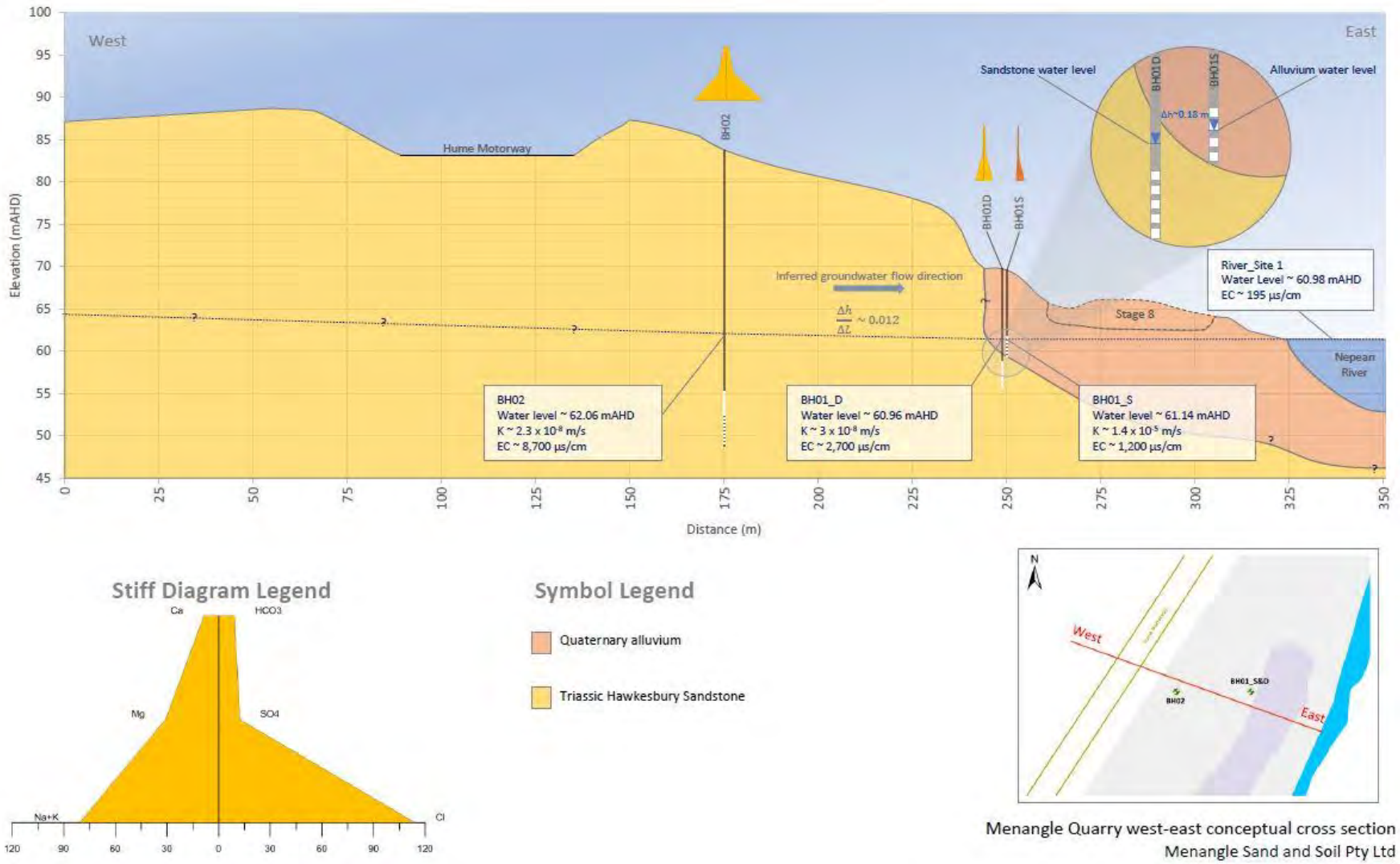


Figure 2.3 Hawkesbury Sandstone data locations



Menangle Quarry west-east conceptual cross section
Menangle Sand and Soil Pty Ltd

Figure 2.4 Conceptual cross section near BH01 and BH02

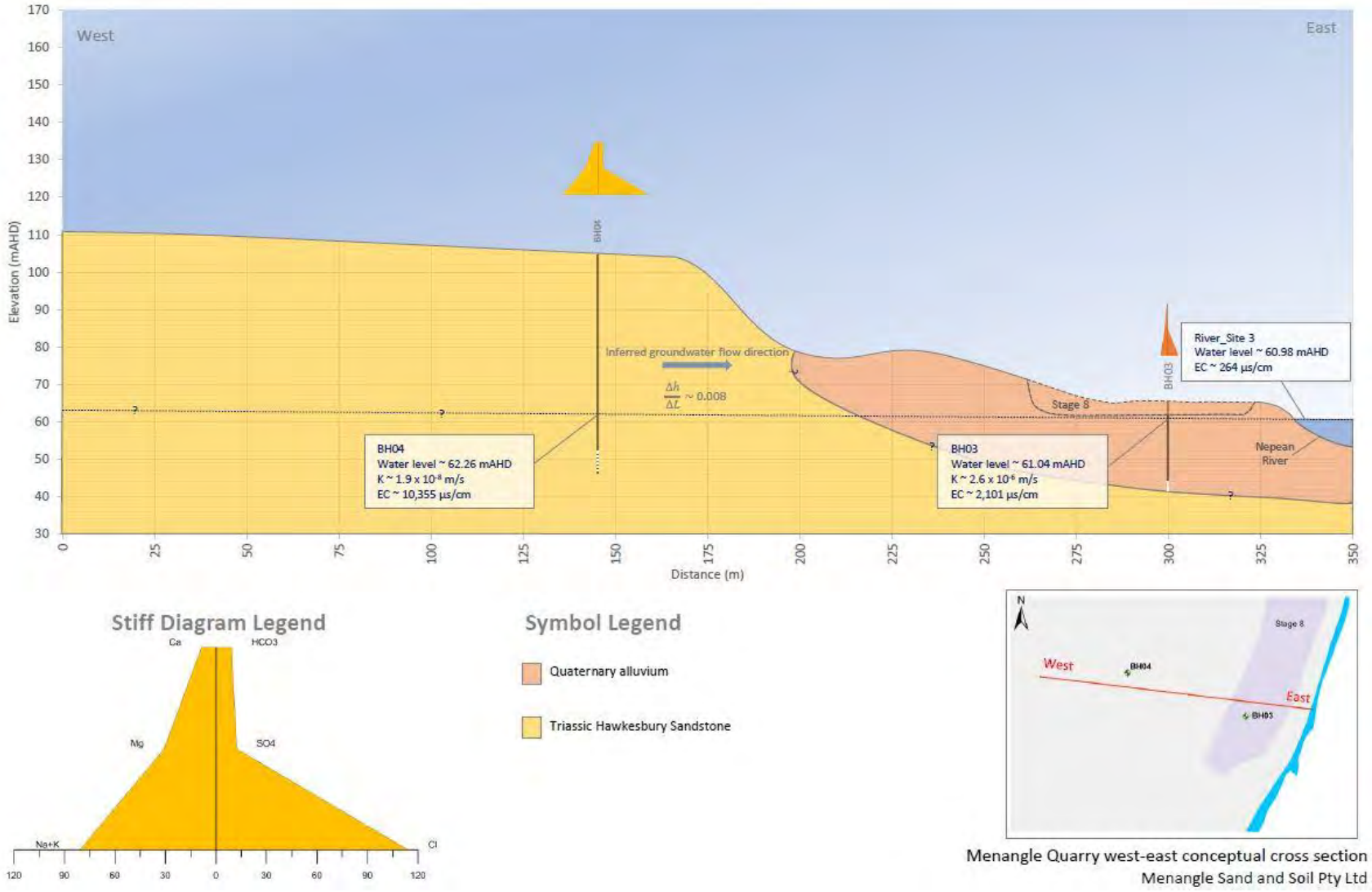


Figure 2.5 **Conceptual cross section near BH03 and BH04**

2.1.1 Groundwater levels and flow directions

Local-scale transient groundwater monitoring data are available for the groundwater monitoring bores installed for the project. Hydraulic heads are measured via pressure transducer every 6 hours at each of the 5 locations. Appendix A contains the data collected at the five monitoring locations until 23 September 2020. Of note from the joint experts report on groundwater (Merrick and Webb 2020) is that the alluvial groundwater level is observed by site operators to be controlled by the level in the Nepean River.

Two distinct groundwater behaviours are observed from the site hydrographs, bores BH01-S, BH01-D and BH03 can be grouped with similar behaviour, while bores BH02 and BH04 exhibit similar behaviour. The hydraulic head responses are associated with the bores being screened in either the alluvium or HBSS. The bore log for BH01-D suggests it is screened in the very top of the HBSS unit and monitoring data shows the characteristic changes associated with the alluvium watertable.

Monitoring data for the water table (ie alluvium bores) indicate that it is located at approximately 61 mAHD for the majority (>98%) of the time (based on river level data) (Merrick and Webb 2020). This level has been confirmed by the recent EMM bore installation and testing program (2020a) where the two alluvial bores having levels of 61.14 mAHD for BH01S, and 61.04 mAHD for BH03.

Available groundwater level data (Appendix A) show that the vertical hydraulic gradient in this area is upward from the regional HBSS aquifer towards the alluvium and the river. This supports the discussion in the joint experts report (Merrick and Webb 2020) that the head in the HBSS would generally be higher than that in the alluvium, from which groundwater discharges to the usually gaining Nepean River as baseflow.

The regional groundwater flow direction is from west to east on the western side of the Nepean River (refer Appendix A).

2.1.2 Nepean River

Hourly monitoring of Nepean River level is conducted by WaterNSW (Menangle weir station #212238). From the EMM joint experts report (Merrick and Webb 2020), it was agreed that the normal low flow level of the river in the Stage 8 area is approximately 61 mAHD. The river observation data are provided in Appendix A and show a strong correlation between river water level and alluvium groundwater levels at the local monitoring bores. It was agreed that 61 mAHD is the best estimate of the “average alluvial watertable level” (Merrick and Webb 2020).

Previous reporting (Merrick and Webb 2020) indicated the river level has exceeded 62 mAHD (the nominal base of quarry excavations) 1.0% of the time from 1990 to 2013, and 0.7% of the time from 1990 to 2020. The river level has also exceeded 64 mAHD, the height at which bank overtopping generally occurs, approximately 0.3% of the time, or 1.2 days per year, on average since ‘consent was granted’ (Merrick and Webb 2020).

The hydraulic gradient of the Nepean River is low, at approximately 1.9 cm/km, measured between Menangle Weir (60.84 mAHD) and Douglas Park Weir (61.10 mAHD) over a distance of approximately 14 km (Merrick and Webb 2020). Over the length of the Stage 8 corridor, the normal river levels are expected to range from 60.87 mAHD at the northern end to 60.92 mAHD at the southern end. Therefore, the adoption of 61 mAHD as the normal river level is appropriate.

The Nepean River is gaining the majority of the time in the project area, with gradient reversals during high flow events. In such events river water is expected to flow into the near-river alluvial aquifer, potentially being intercepted (but not extracted from) by quarry pits. When the river level declines this water is expected to flow back from the aquifer into the river, with the alluvium acting as a river bank storage. During overtopping events (ie when the river rises to 64 mAHD or higher) water will flow directly across the land surface and may flood pits from above, in addition to groundwater rising from the pit floor.

2.1.3 Rainfall

Daily rainfall in excess of 100 mm has occurred on only 0.06% of days since 1889 (31 days in 130 years), and the highest ever daily rainfall recorded in the location of the quarry was 235 mm (Merrick and Webb 2020). Therefore, rainfall is not considered a major contribution to the shallow groundwater system and is not considered an issue for site water management.

The joint experts report (Merrick and Webb 2020) agreed that the river flow is likely to be more affected by rainfall in the headwaters of the catchment, rather than rainfall at the project site due to the presence of significant weirs that would temper the variations in river levels. Hydrographs (Appendix A) show that site rainfall events have little to no influence on the groundwater levels and that the stage of the Nepean River has the greatest influence on the groundwater levels.

2.2 Aquifer properties

The permeability of the alluvial sediments associated with the Nepean River is known to be variable and dependent on the sediments, with sand and gravel deposits having high permeabilities, while clay lenses have a much lower permeability (Merrick and Webb 2020). The permeability of the HBSS rock mass itself (primary permeability) can be low relative to the overlying alluvium. However, the HBSS is a dual permeability system, and in areas of high density of interconnected fractures and faults the 'secondary permeability' can result in moderate to high permeabilities if intercepted (Merrick and Webb 2020).

Hydraulic testing (slug tests) of the recently installed site monitoring bores provided estimates of hydraulic conductivity. The results confirm that the hydraulic conductivity of the alluvium is approximately two orders of magnitude higher than the underlying HBSS. The hydraulic property ranges reported in the Drilling completion report (EMM 2020a) are reproduced in Table 2.2 for ease of reference.

Table 2.2 Summary of measured hydraulic conductivity

HSU	Area	Test type	Hydraulic conductivity (m/day)		
			Min	Max	Mean
Alluvium	Menangle Quarry	Rising head tests (2 tests)	0.2	1.2	0.7
HBSS	Menangle Quarry	Rising head tests (3 tests) and Development recovery (2 tests)	1.0×10^{-3}	3.5×10^{-3}	2.1×10^{-3}

The Sydney Basin bioregional assessment (Heron et al 2018) reports 370 packer tests conducted in the HBSS around the Sydney metropolitan area. The scaled geometric mean hydraulic conductivity of the HBSS ranges from 0.5 m/day at the surface to 0.01 m/day at 50 m depth (Heron et al 2018). The conceptual understanding that the hydraulic conductivity of the HBSS unit decreases with depth is commonly simulated. Hume Coal (EMM 2018) presented values of the HBSS ranging between 5×10^{-3} to 6×10^{-1} m/d.

In the Sydney Basin bioregional assessment (Heron et al 2018), the Ashfield shale unit is reported to vary between 3 and 10 m in thickness, with hydraulic conductivities between 0.01 and 0.08 m/day, and behave as an aquitard.

Based on EMM's experience in the Sydney Basin geological environment, and from other regional modelling work, values of hydraulic conductivity and storage properties were used to guide the values applied in the model (EMM 2020b, EMM 2020c).

Due to the method of the hydraulic testing (slug tests) in the bore installation and testing program, site specific storage properties could not be estimated. Rau et al (2018) specifies plausible ranges for specific storage as between 2.3×10^{-7} and 1.3×10^{-5} m^{-1}.

3 Numerical modelling

3.1 Model design

3.1.1 Software

A numerical groundwater flow model was developed using MODFLOW-USG (Panday et al 2013). This code contains additional capabilities over previous releases of MODFLOW. The formulation allows for the development of an unstructured, highly refined model mesh over areas of interest and larger, less computationally-demanding, model cells further away. In addition, MODFLOW-USG contains an optional Newton-Raphson formulation which improves model stability for processes involving the drying and rewetting of model cells.

The Groundwater Vistas 7 (ESI 2017) graphical user interface (GUI) was used to build and run the model, and to conduct some components of post-processing of the simulation results.

3.1.2 Equivalent porous medium

The model assumes an equivalent porous medium (EPM) approach for each HSU. This approach is commonly used in regional groundwater modelling of fractured rock hydrogeological environments. The EPM method assigns bulk hydraulic properties for a HSU and treats the rock (and pathways) as if it were a single porosity medium such as a granular aquifer (Anderson and Woessner 1991). This approach was adopted for the following reasons:

- in order to replicate regional hydraulic gradients, a simplified regional model was needed; and
- dual porosity models require significant detail on fracture/joint orientations, spacing and apertures. These details are not available for the geology in the model domain.

3.1.3 Model domain and spatial discretisation

The groundwater model domain was selected based on size of the quarry, publicly available groundwater level data, and the assumption that the Nepean River is a gaining river in the area of interest. The domain extends approximately 1.5 km to the west of the project. To the east, the model is bounded by the Nepean River. The model domain to the north and south uses the natural curves of the Nepean River and no flow boundaries perpendicular to the river, consistent with groundwater flow toward a gaining river. Groundwater monitoring data indicate that the Nepean River is lower than groundwater levels in the regional groundwater system on both sides of the river and, hence, groundwater converges at the river. Therefore, the river is typically gaining and groundwater beneath the river flows vertically upward, not across the river, making this an ideal model boundary. The model domain covers an area that is approximately 21.8 km^2. The domain is adequately large enough to:

- encompass all of the Stage 8 quarry areas;
- include the inferred hydrogeological boundary conditions influencing groundwater flow; and
- encompass changes to the groundwater system in relation to quarrying and site operation.

AlgoMesh, with default ‘high’ quality settings, was used to create a Voronoi polygon mesh incorporating relevant site features and locations. This discretisation method is numerically efficient and can handle complex geometries. The resultant mesh has approximately 32,000 cells per layer. Regional cells have a maximum size of approximately 250 m across, with cell sizes refined down to approximately 2 m to 3 m in areas of refinement, specifically between the Stage 8 quarry and the Nepean River. The model mesh has progressive refinement from large regional cells to small cells around the area of interest. The model domain and mesh are presented in Figure 3.1 to Figure 3.4.

Figure 3.1 **Groundwater model domain with Voronoi cells**

Figure 3.2 **Stage 8 area with Voronoi cells (northern area)**

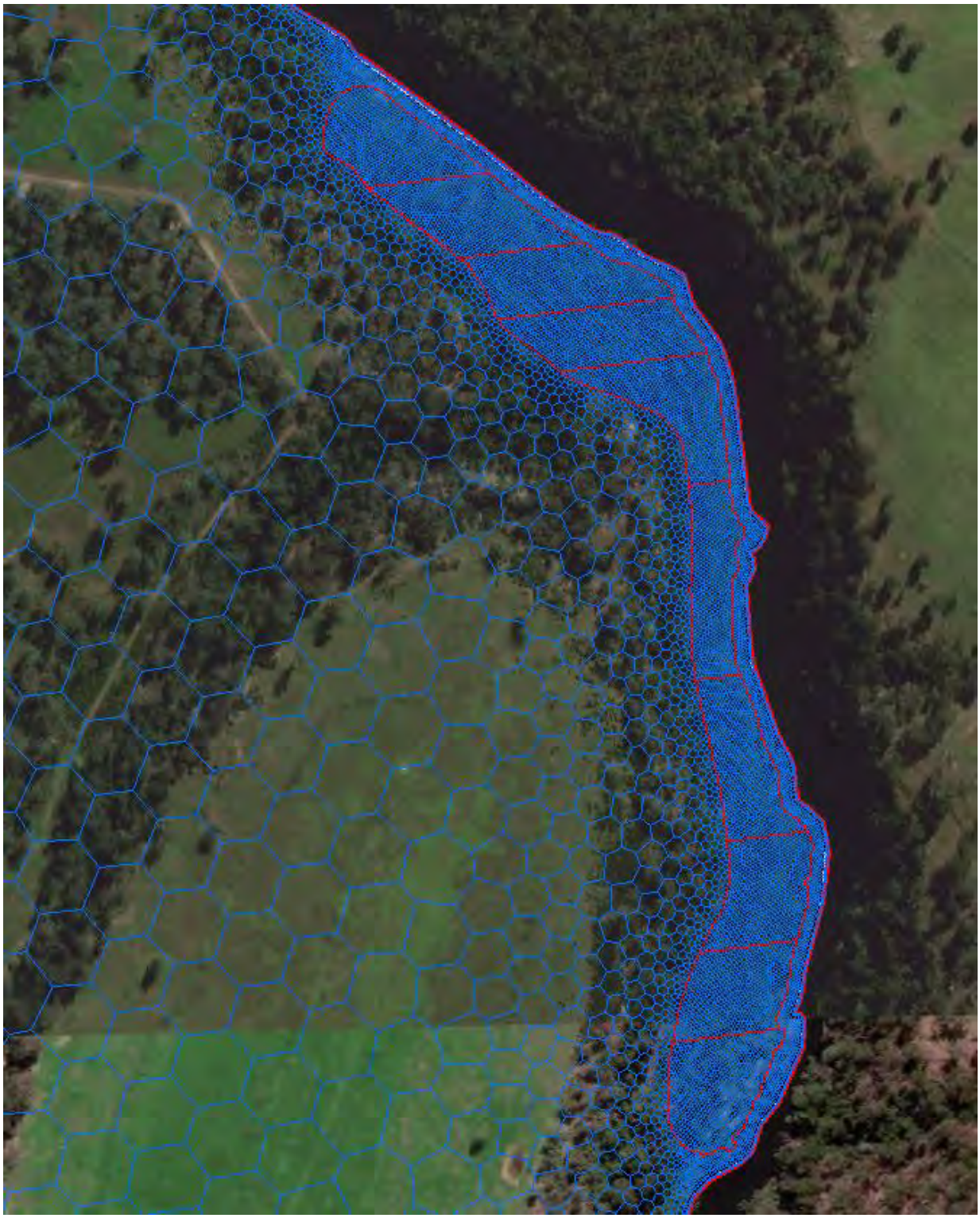


Figure 3.3 Stage 8 area with Voronoi cells (southern area)

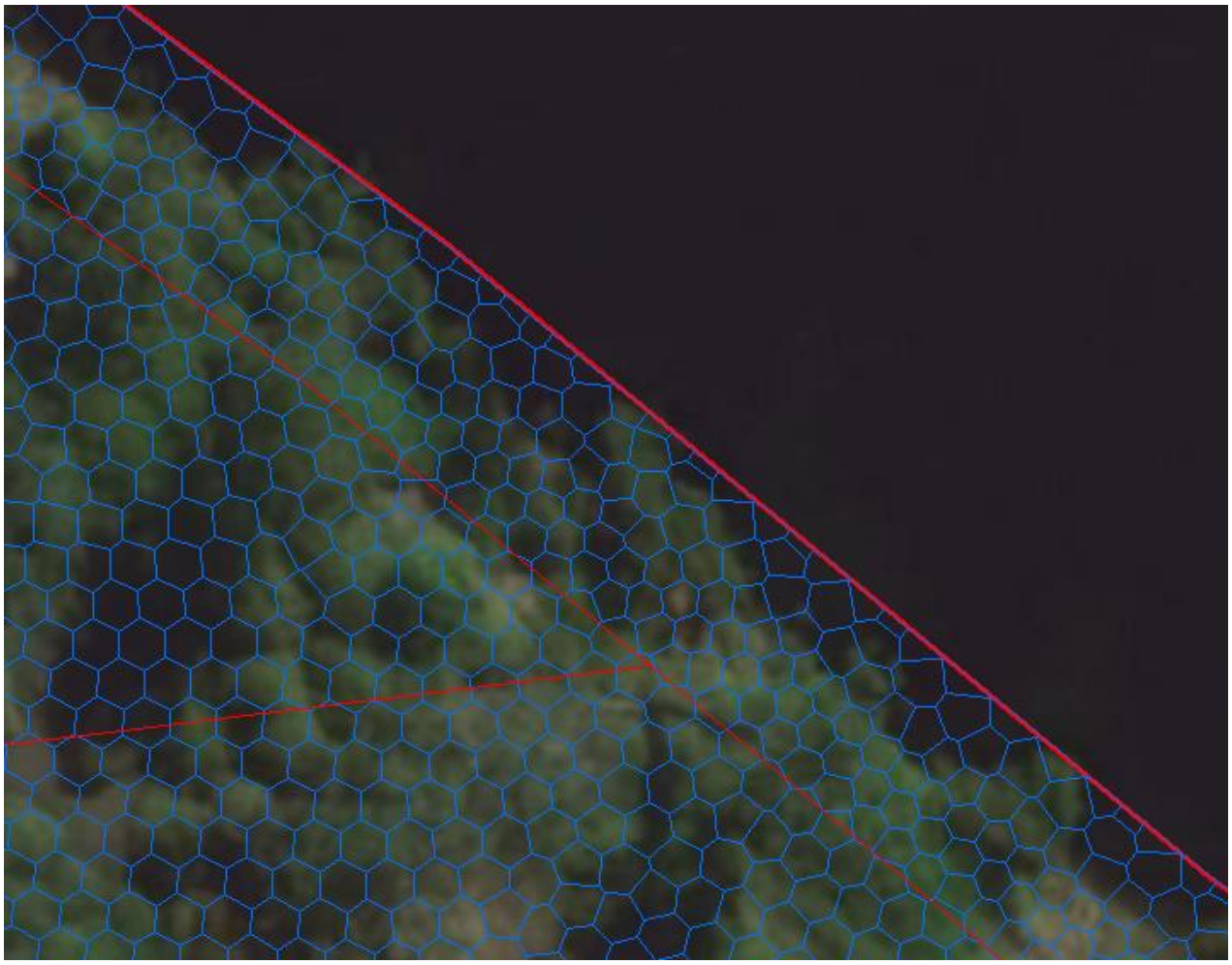


Figure 3.4 Voronoi cells between Nepean River and Quarry area

3.1.4 Model layers

Four model layers were employed to represent the HSUs and quarry operations (Table 3.1).

Table 3.1 HSUs and model layers

HSU Name	Groundwater model layer#	Comments	Quarry Infrastructure
Alluvium (above base of quarry)	Layer 1 – unconfined aquifer	As the area of interest is based on the removal of alluvium sediments, layer 1 of the groundwater model simulates quarry pits.	Present
Alluvium (below base of quarry)	Layer 2 – unconfined aquifer	Present over the entire model domain in various thicknesses- main conduit to water affecting activities.	Not included
Ashfield Shale	Layer 3 – aquitard	Present in the western area of the model domain.	Not included
Hawkesbury Sandstone	Layer 4 – aquifer	Regionally extensive.	Not included

# denotes model layer near Quarry area – groundwater model layers may be combined regionally based on HSUs and available information.

Model layer elevations were developed using drill hole data sourced from Menangle Sand and Soil and publicly available drill hole databases. The top of the model is set at topography using the ELVIS 1 second (~30 m) dataset from Geoscience Australia and the base of the model is set 150 m below the generated top of HBSS surface.

MODFLOW-USG allows model layers to pinch out and be deactivated. The alluvium is divided into two layers to represent the alluvium above the base of the quarry pits (62 mAHD) and the alluvium below the base of the pits. These layers pinch out a) where alluvium is not present and/or b) where the alluvium is not present below the proposed base of excavation. The Ashfield Shale layer pinches out towards the Nepean River, where it is mapped as not being present.

The base of the active extraction area is proposed as 62 mAHD and therefore 1 m above the long-term average watertable elevation in the alluvium (during the normal low flow level of the river). For most of the time (>98% of the time when normal river flow conditions occur), the excavations will be 1 m above the watertable and will not intercept groundwater.

3.1.5 Temporal discretisation

Stress periods used for history matching period are outlined in Table 3.2. The model employs an initial steady state stress period followed by a series of transient stress periods over which the Nepean River stage is varied in line with measured stage over the history matching period. River stage is the only time-varying stress in the history matching period and, hence, is the driver for design of stress periods. Figure 3.5 illustrates measured Nepean River level, the defined stress periods and modelled Nepean River boundary condition elevation.

Table 3.2 Model stress periods

Stress period	Duration	Description	Dates	River stage (mAHD)
1	Steady state (1 day)	Develops initial pre-project conditions in response to modelled hydraulic parameters and boundary conditions.	Prior to recording of any data	Constant at 61.009
2	53 days	History matching period, steady river levels	from 3 June 2020 to 26 July 2020 (12:00)	Use average river value of 61.009 over period
3-5	0.6667 days each	History matching period, increasing river levels	from 26 July 2020 (12:00) to 28 July 2020 (12:00)	Use average river value over stress period times (gradual increase 61.053, 61.194, 61.428)
6	12 hours total – 0.5 day	History matching period, steady river levels (peak)	from 28 July 2020 (12:00) to 28 July 2020 (24:00)	Use average river value over stress period times (steady value 61.538)
7-9	1 day each	History matching period, decreasing river levels	from 28 July 2020 (24:00) to 31 July 2020 (24:00)	Use average river value over stress period times (gradual decrease 61.405, 61.271, 61.185)
10	7.25 Days	History matching period, steady river levels	from 31 July 2020 (24:00) to 8 August 2020 (06:00)	Use average river value of 61.165 mAHD over period
11-13	0.708 day each	History matching period, increasing river levels	from 8 August 2020 (06:00) to 10 August 2020 (12:00)	Use average river value over stress period times (gradual increase 61.203, 61.4, 62.359)
14	0.1667 day	History matching period, steady river levels (peak)	from 10 August 2020 (12:00) to 10 August 2020 (14:00)	Use average river value over stress period times (steady value 63.118)
15-17	1.333 days each	History matching period, quickly decreasing river levels	from 10 August 2020 (14:00) to 14 August 2020 (14:00)	Use average river value over stress period times (gradual decrease 62.373, 61.614, 61.465)
18-19	7 days each	History matching period, gradually decreasing river levels	from 14 August 2020 (14:00) to 28 August 2020 (14:00)	Use average river value over stress period times (gradual decrease 61.318, 61.109)
20	26.25 days	History matching period, steady river levels	from 28 August 2020 (14:00) to 23 September 2020 (14:00)	Use average river value over stress period times (steady value 61.034)

The ATS package is used to adaptively adjust time step lengths within each stress period. An initial time step of 1 x 10^{-6} days was defined. The maximum timestep length was 2.5 days in stress period 20.

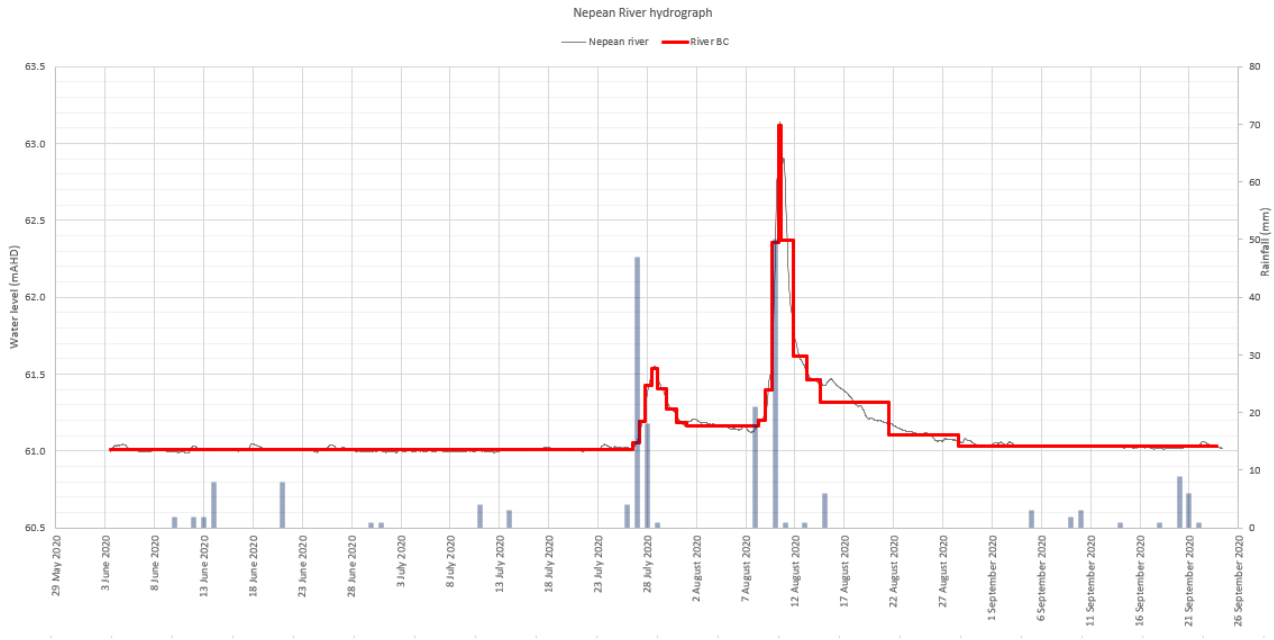


Figure 3.5 Measured and modelled Nepean River stage

3.1.6 Boundary conditions

a General head boundary condition

The General Head Boundary (GHB) package was employed to assigned boundary conditions to model cells along the western edge of the model domain in the HBSS layer to represent regional groundwater inflow to the model domain. Hydraulic head was set to 75 mAHD in line with measured groundwater elevations in the HBSS (see Figure 3.6). A sufficiently high conductance value was assigned such that it would not act as a limit to flow in and out of the model domain, effectively acting as a constant head boundary condition.

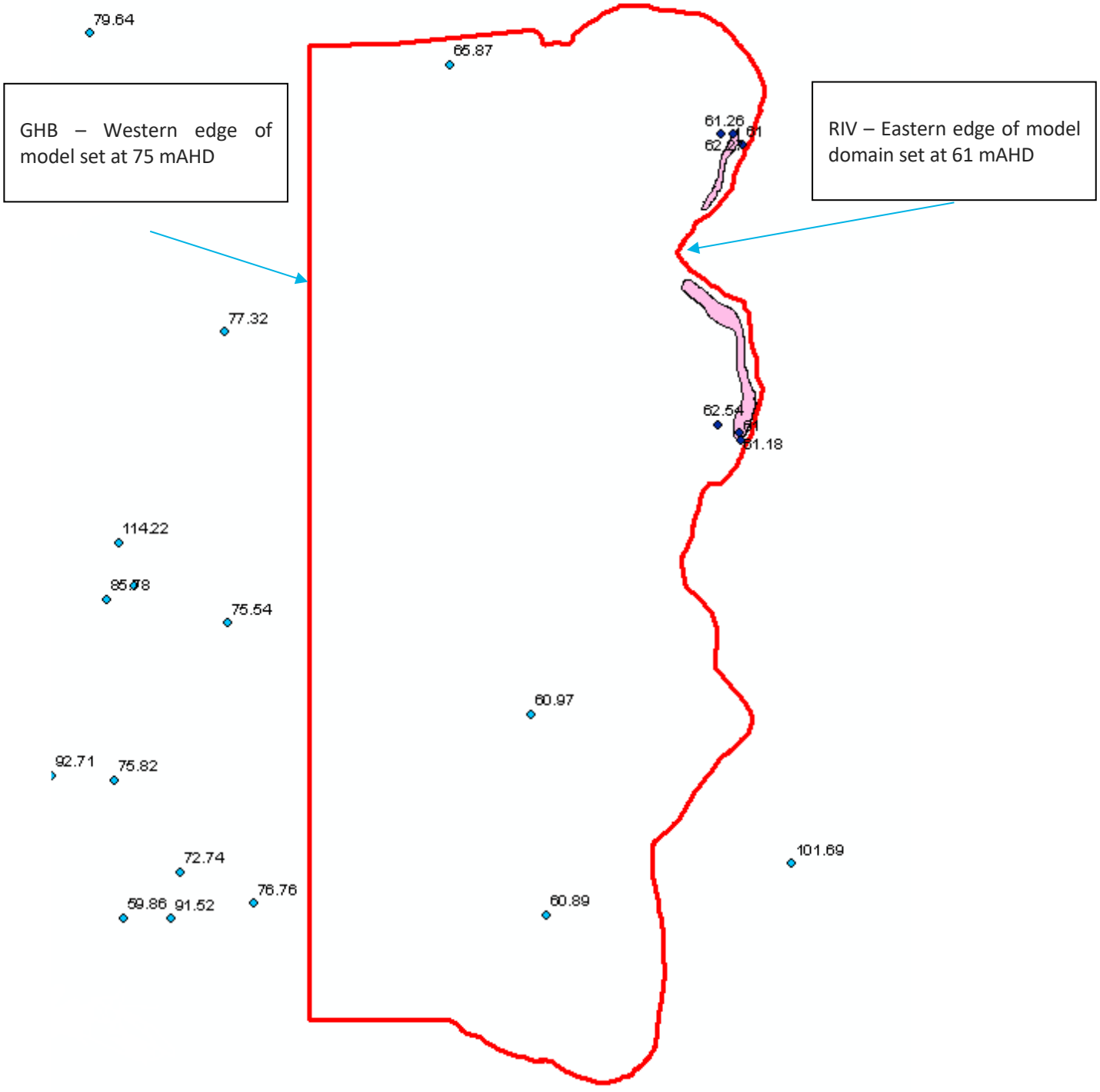


Figure 3.6 **Model boundary conditions and regional groundwater levels**

b River boundary condition

The River (RIV) package was used to simulate the Nepean River in model layers 1 and 2. The assigned river stage and timing are presented in Table 3.2. River conductance was assigned a value of 80 m^2/d, based on an approximate river width of 40 m, the average cell length parallel to the river of 2 m and riverbed thickness of 1 m and a vertical hydraulic conductivity of 1 m/d. Figure 3.5 shows the modelled river stage and the measured water levels of the Nepean River over the history-matching period.

c Evapotranspiration and recharge

As shown in site groundwater level hydrographs in Appendix A, periods of local rainfall do not significantly affect the groundwater levels at the site. Therefore, climate interaction via evapotranspiration and recharge from rainfall are not simulated.

4 History matching and sensitivity analysis

4.1 Approach

The numerical groundwater flow model was calibrated in two modes. The initial steady state stress period was used to calibrate the model to regional groundwater levels. A single indicative average unimpacted hydraulic head value for each observation location was used to quantify model performance. Following the initial steady state stress period, transient stress periods were used to calibrate the model to the key process of interest: the response of groundwater levels near the quarry to changes in Nepean River level. No measurements of groundwater fluxes to or from the Nepean River were available to inform calibration and, hence, history-matching was to hydraulic head data only.

4.2 Hydraulic properties

Hydraulic conductivity property ranges were guided by the ranges measured at the project site (refer Section 2.2) and from other projects in similar geological environments.

In the groundwater model, the hydraulic properties of the Ashfield Shale were not modified from a horizontal hydraulic conductivity of $1x10^{-4}$ m/d and $1x10^{-5}$ m/d for a vertical hydraulic conductivity. The adopted values are lower than reported in the bioregional assessment (Heron et al 2018), however the values are consistent with the conceptual understanding and with other reported (modelled) values in the region.

Site storage properties were not evaluated during the EMM drilling completion report, as these can only be calculated during aquifer pumping tests where data from observation bores are available. Representative values from literature were used. Specific storage values were constrained between the physical limits presented by Rau et al (2018) of 2.3×10^{-7} m^{-1} to 1.3×10^{-5} m^{-1}. A value of 5×10^{-6} m^{-1} was adopted. Specific yield values for assigned similarly, with sand typically around 20%; the Ashfield Shale is approximately 1%; and the HBSS is typically slightly lower at 0.5 to 0.8% (EMM 2018).

During the history-matching process, an additional model layer was added to aid the matching of the data observed at BH01-D. The HBSS was divided into an upper and lower system, where the upper layer was denoted as the upper 10 m of the HBSS unit.

During the automated history-matching process it was observed that some hydraulic parameters were trending towards values outside of their conceptual range. However, the parameters were constrained to plausible limits. The calibrated hydraulic parameter values are presented in Table 4.1.

Table 4.1 Calibrated hydraulic parameter values

Layer	Geological Unit	Hydraulic conductivity - horizontal	Hydraulic conductivity - vertical	Specific yield
1	Alluvium	5 m/d	0.1 m/d	0.05
2	Alluvium	5 m/d	0.1m/d	0.05
3	Ashfield Shale#	$1x10^{-4}$ m/d	$1x10^{-5}$ m/d	0.01
4	Upper Hawkesbury Sandstone	5 m/d	0.1 m/d	0.001
5	Lower Hawkesbury Sandstone	0.1 m/d	0.07 m/d	0.001

- denotes that parameters were not adjusted during history matching process.

4.3 History-matching performance

Calibration performance was evaluated in several ways. Modelled regional groundwater contours and scaled root mean square (SRMS) error were used to evaluate the history-matching performance, in addition to the mounding of the watertable observed at the site bores (in response to high river flow events).

Modelled and measured hydrographs at the selected monitoring bores were used to quantify the ability of the model to replicate responses to changes in Nepean River level. Given that change in groundwater level is the key aspect of transient calibration, SRMS error was quantified for hydraulic head relative to steady state modelled head at each of the bores. The transient response to the changes in river levels was evaluated at the five project monitoring bores.

The history-matching performance of the groundwater model was evaluated for the transient response to the measured Nepean River level at the Menangle weir over approximately 3 months of monitoring. Figure 4.1 shows modelled and measured hydraulic head at the site-specific monitoring bores (BH01 to BH04). Figure 4.2 shows modelled and measured mounding of groundwater levels relative to the pseudo steady state period over the first ~1.5 months of measurements.

The calculated hydraulic head SRMS for the history-matching model is 22.7%. Figure 4.3 shows a scatter plot of modelled versus measured hydraulic head. Modelled heads are typically below the measured heads. It is expected that an improved match to measured groundwater behaviour will be achieved when the model is updated when 12 months of monitoring data are available.

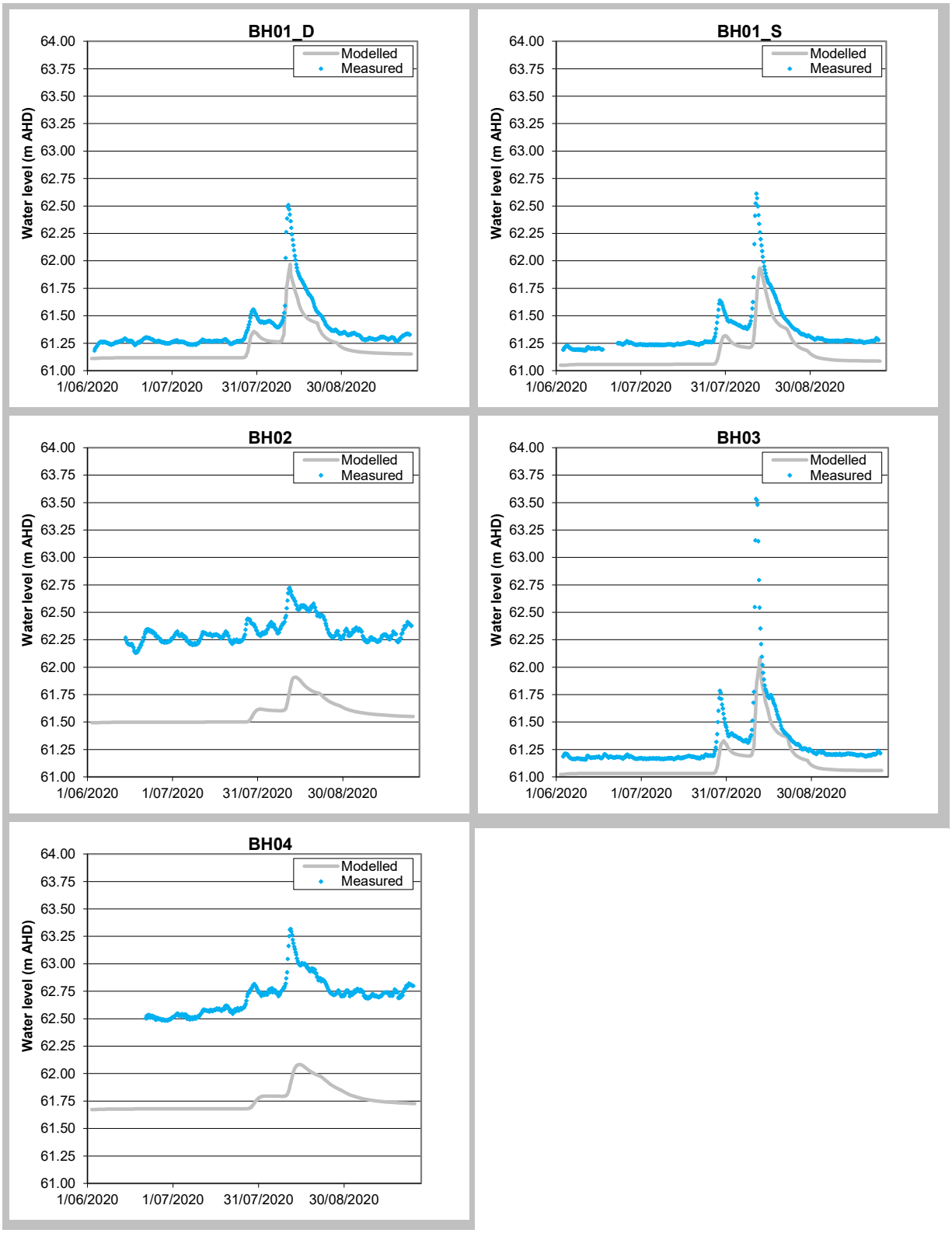


Figure 4.1 - Modelled and measured hydrographs (History Matching)

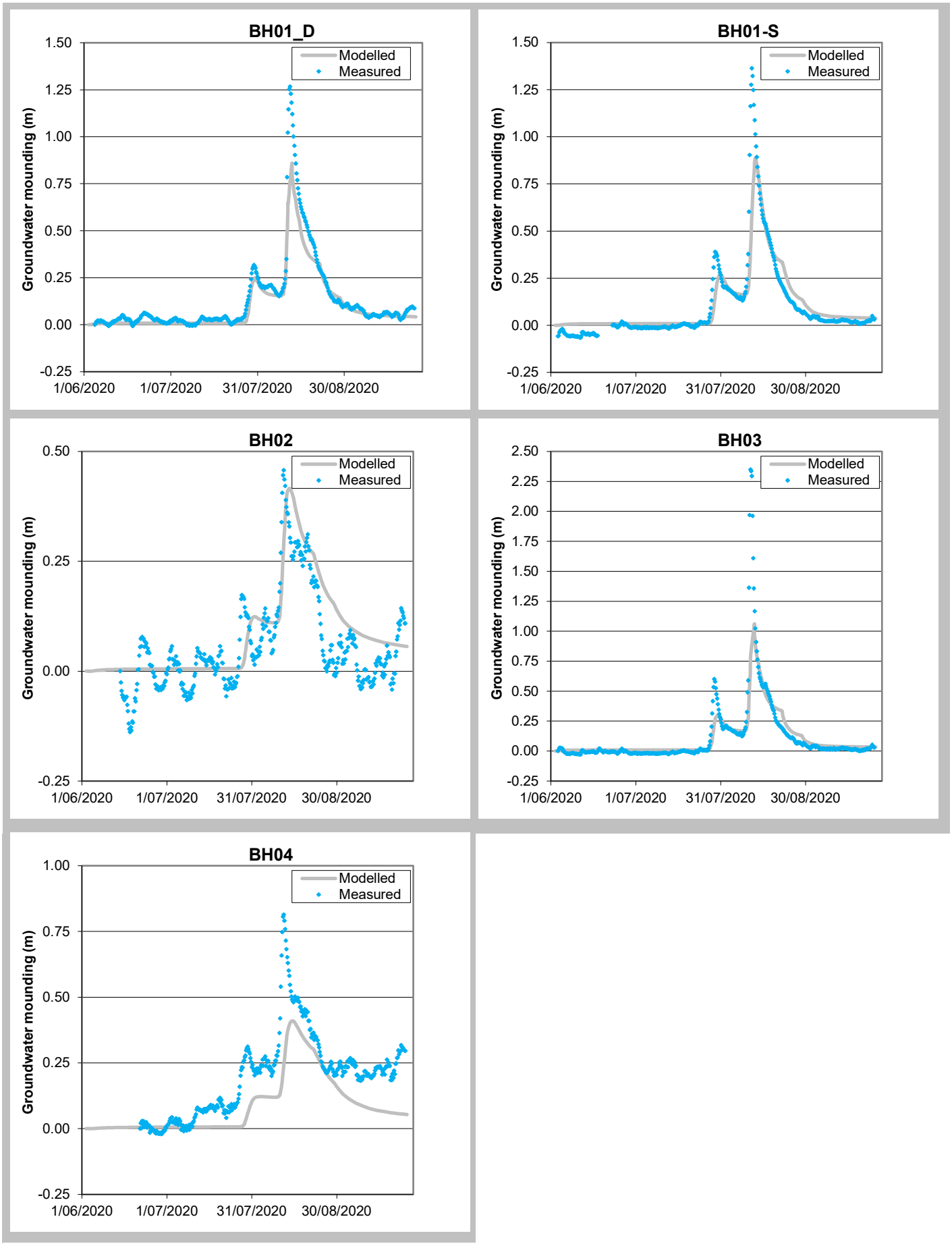


Figure 4.2 - Modelled and measured mounding hydrographs (History Matching)

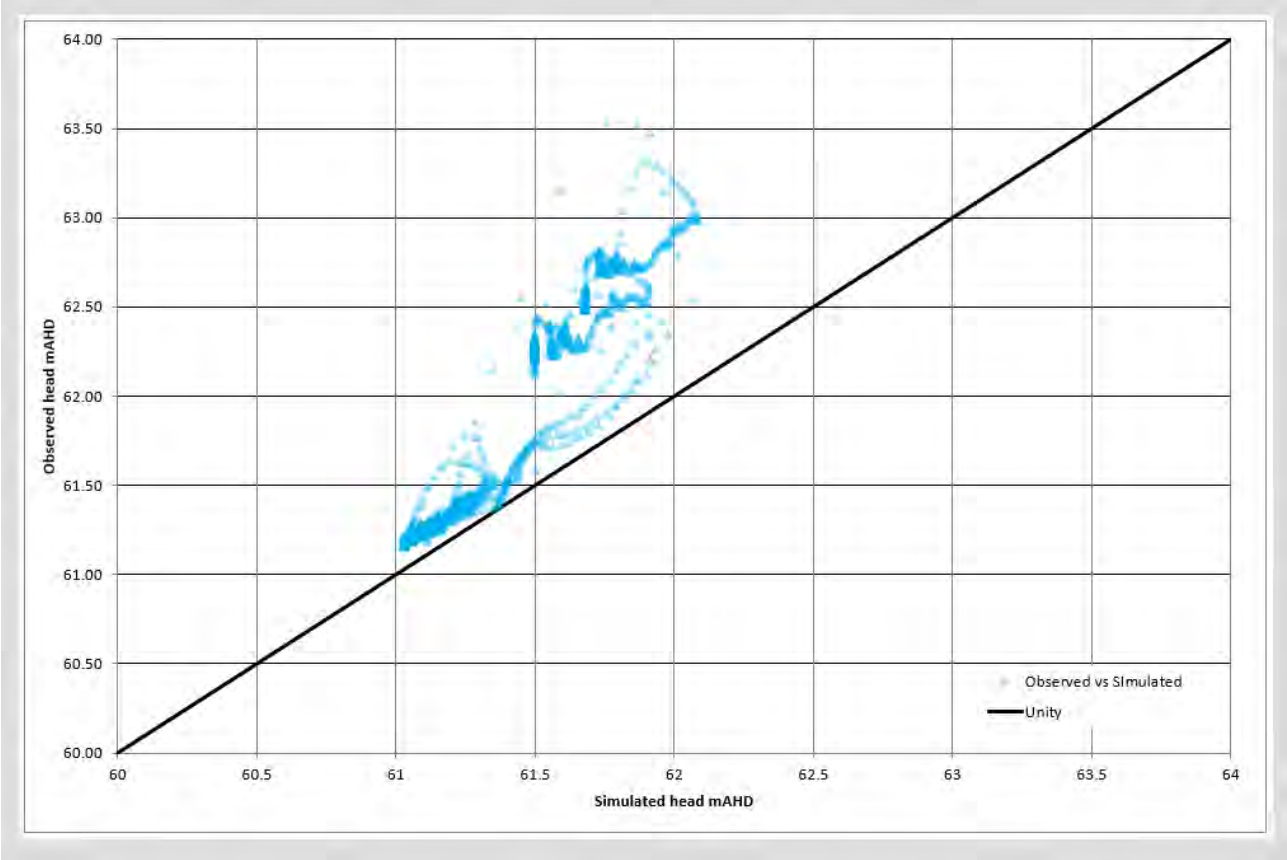


Figure 4.3 Scatter plot of modelled versus measured hydraulic head

4.4 Sensitivity analysis

A relative composite sensitivity analysis was performed on the calibrated model and the results show that the model is most sensitive to horizontal hydraulic conductivity (model layers 2, 4 and 5) and specific yield of layer 2 (alluvium). Figure 4.4 shows the relative values of the composite sensitivity. The sensitivity of the history-matched model is based on the hydraulic head targets at the site monitoring bores.

As there are no measurements in model layer 1, the sensitivity shows a low relative sensitivity to the parameters of layer 1.

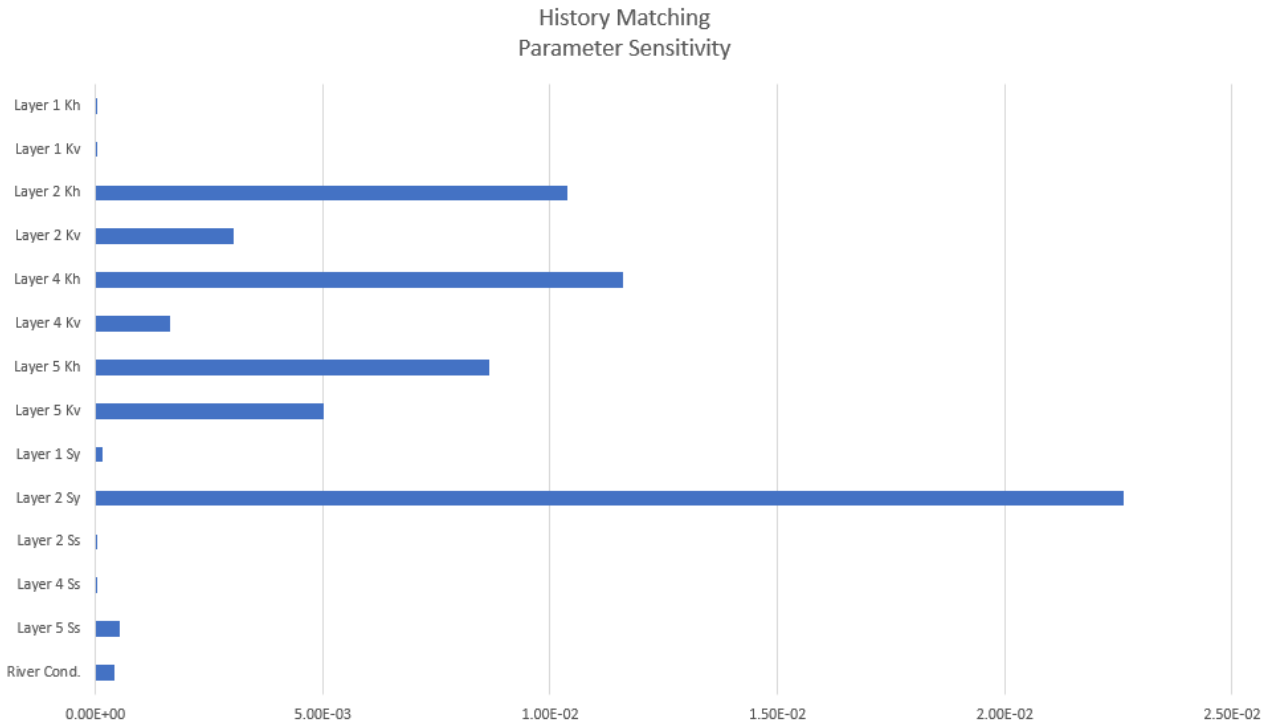


Figure 4.4 Relative composite sensitivity of the history-matched model

5 Predictive scenarios

5.1 Predictive modelling

a Quarry void material properties used in predictive modelling

For the predictive modelling of the proposed project, the following material properties were implemented:

- Hydraulic conductivity: a significant increase in the horizontal and vertical hydraulic conductivity was used to represent void space. A value of 1,000 m/d was assigned to layer 1 in the quarry void areas.
- Specific yield: specific yield was increased to 100% in quarry void areas of model layer 1.

b Boundary conditions

The Nepean River boundary condition simulated a synthetic high flow event, designed to represent the maximum driving head that can cause groundwater interception by the quarry. River level was raised over time to just below the overtopping level of the river banks, at an elevation of 64 mAHD. The base of the proposed quarry was set at an elevation of 62 mAHD, which is 1 m above the long-term average watertable. When river levels are above 64 mAHD, the river overtops the banks and any water captured by the quarry is considered surface water. Therefore, simulation of a river stage higher than modelled would not represent an event requiring licensing of groundwater.

A synthetic river flood event was constructed from a review of measured Nepean River historic high flow events. River level measurements since 1990 indicate that 13 high flow events occurred where the maximum river level was below 64 mAHD. A synthetic flood event was created where the rise and fall of the Nepean River was designed to be consistent with typical historical events, particularly the duration of river level above the base of the quarry floor (62 mAHD). Figure 5.1 shows measured river levels during high flow events, and the synthetic event assigned to the Nepean River boundary condition in the predictive modelling. It was observed that since the end of the Millennium drought (2010), 12 high flow events (with river levels above 62 mAHD but not greater than 64 mAHD) have occurred. Therefore, a high flow event occurred on average 1.2 times per year. As the predictive scenario only simulates one high flow event, rather than an annual duration, the model results have been multiplied by 1.2 to annualise them.

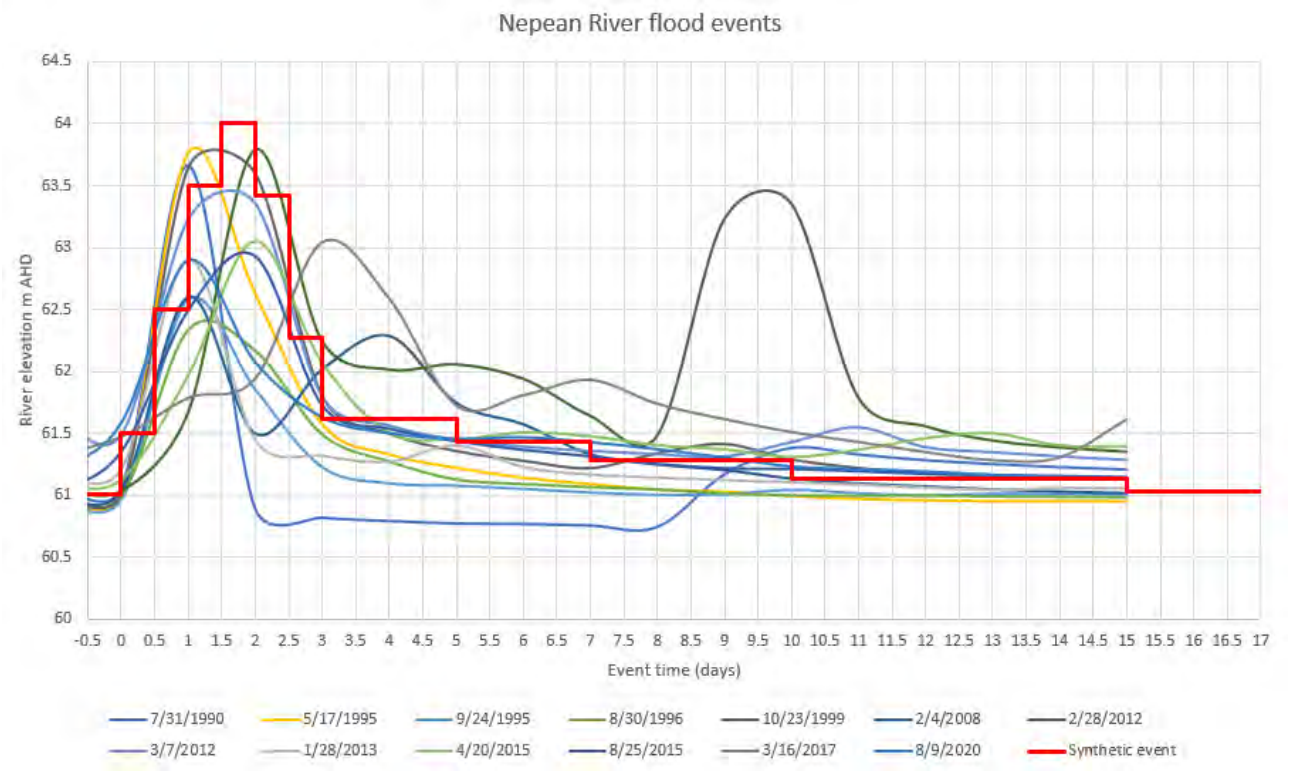


Figure 5.1 Nepean River high flow events since 1990 and the modelled synthetic scenario

c Predictive scenarios

The quarry plan will minimise the open quarry area and active face that is exposed at any one time with progressive backfill of the quarried areas. The project quarry areas (substages 8A to 8M) were subdivided into four sections (1, 2, 3 and 4) that represent areas of quarry that are active at any time and to represent the open area of the quarry consistent with the progressive backfilling approach. For example, area 8A is subdivided into A-1, A-2, A-3 and A-4. All simulated quarry areas have the same pit floor elevation (62 mAHD).

EMM initially selected four predictive scenarios to allow estimates of a range of inflows to the quarry based on active quarry area:

- Scenario 1: quarrying from the subdivision area longest parallel to the Nepean River (Area 8B-4, refer Figure 5.2);
- Scenario 2: quarrying from the largest of the subdivided areas (Area 8F-4, refer Figure 5.2);
- Scenario 3: quarrying from the smallest of the subdivided areas (Area 8C-4, refer Figure 5.2); and
- Scenario 4: quarrying from the subdivided area shortest parallel to the Nepean River (Area 8G-3, refer Figure 5.2).

Figure 5.2 shows the locations of the simulated quarry area for the various predictive modelling scenarios. While reviewing the total inflow data, it was observed that location 8C-4 (Scenario 3), the smallest of the subdivided area, showed the highest inflow volumes. The reason for this may relate to the location of the quarry area relative to the river, where the quarry allows a longer interaction length (eastern and southern faces of the quarry) between the quarry and river. As such, four additional scenarios were simulated as part of the predictive modelling:

- Scenario 5: the northern cell in the north section of the quarry (Area 8A-1, refer Figure 5.2);
- Scenario 6: the northern cell in the southern section of the quarry (Area 8D-1, refer Figure 5.2);
- Scenario 7: the southern cell in the southern section of the quarry (Area 8M-4, refer Figure 5.2); and
- Scenario 8: a quarry cell that is closest to the mean size of all subdivided areas (Area 8K-2, refer Figure 5.2).

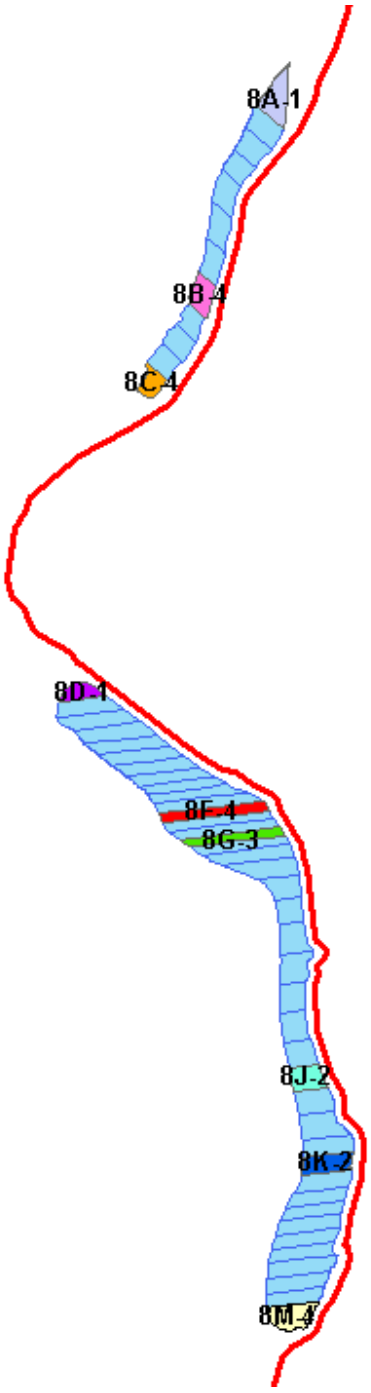


Figure 5.2 Quarry pit locations simulated in predictive modelling

5.2 Predictive uncertainty analysis

A single 'true' model cannot be constructed due to the inherent uncertainty that exists within hydrogeological systems, which is introduced by effects of error in field measurements, conceptual, spatial and temporal simplifications (Barnett et al 2012). To better understand how the prediction results may vary due to uncertainty within the system, a simple uncertainty analysis has been carried out. This is in the form of 'scenario analysis with subjective probability' as defined by the IESC explanatory note on Uncertainty Analysis (Middlemis and Peeters 2018). The main advantage of this kind of 'what-if' analysis is that it is straight forward to implement and communicate to stakeholders, and it is less computationally demanding compared to some other approaches. This approach is viewed as appropriate for this low-risk project.

The following uncertainty analysis was performed, which was guided by the relative composite sensitivity analysis that was performed on the history matching model (Section 4.4). The predictive uncertainty analysis was performed on the quarry cell that showed the highest predicted inflow during the simulated flood event.

Five predictive uncertainty models were generated based on the following changes to hydraulic parameters:

- Uncertainty 1 – increase the hydraulic conductivity in the alluvium by 25%;
- Uncertainty 2 – reduce the hydraulic conductivity in the alluvium by 25%;
- Uncertainty 3 – increase the specific yield to 10% (twice the history-matched value);
- Uncertainty 4 – reduce the specific yield to 2.5% (half the history-matched value); and
- Uncertainty 5 – a combination of #1 and #4 above.

6 Results

The model predicted inflow volumes are presented in Table 6.1. The modelled inflow volumes are calculated from the change in storage of Layer 1 (quarry layer) over the quarry area for each simulation. As the predictive model duration only covers one flood event, rather than an annual period, the model results have been multiplied by 1.2 to represent an indicative annual inflow amount, consistent with the requirement for licensing.

The scaled modelled inflow volumes range from 4 kL/yr to 408 kL/yr (up to 0.4 ML/yr).

Table 6.1 Model predicted inflow volumes

Scenario	Quarry area	Modelled inflow volumes (kL)	Scaled inflow volumes (kL/yr)
1	8B-4 – longest along Nepean River	97	116
2	8F-4 – largest area	55	66
3	8C-4 – smallest area and southern end of southern area	214	257
4	8G-3 – shortest along Nepean River	26	31
5	8A-1 – Northern end of northern area	38	46
6	8D-1 – Northern end of southern area	28	34
7	8M-4 – Southern end of southern area	340	408
8	8K-2 – average area	3	4

The predictive uncertainty analysis was conducted on Scenario 7 (Area 8M-4), as it has the highest predicted inflow during the simulated high flow event. Table 6.2 shows the results of the predictive uncertainty analysis.

Table 6.2 Predictive uncertainty analysis – Area 8M-4 predicted inflow volumes

Uncertainty run #	Model changes	Modelled results (kL)	Scaled volumes (kL/yr)
1	Increase alluvium hydraulic conductivity by 25%	460	552
2	Decrease alluvium hydraulic conductivity by 25%	220	264
3	Increase specific yield to 10%	191	229
4	Decrease specific yield to 2.5%	463	556
5	Alluvium K values up by 25% and Sy down to 2.5%	592	710

The model results show a large range in the predicted inflow volumes, with the predicted inflow volumes for Area 8M-4 ranging from 229 kL/yr to 710 kL/yr, compared to the base case (ie using history-matched parameter values) of 408 kL/yr. For example, a 25% increase in alluvium hydraulic conductivity results in a 35% increase in predicted inflows.

7 Summary

The groundwater model was constructed based on limited regional data, and was history matched on the 3 months of available hydraulic site data. The model will be updated following the collection of 12 months of monitoring data, in June 2021.

Based on preliminary Stage 1 modelling, the project will require an annual licence allocation to cover the peak predicted inflow volume of 410 kL/yr (0.4 ML/yr) for a high flow event (river level up to 64 mAHD). However, based on the uncertainty of the hydraulic conductivities in the area, and potential uncertainty in the geological surfaces used in the model (see below), the inflow volumes may reach 710 kL/yr (0.7 ML/yr).

8 Limitations

Numerical simulation of the hydrogeological regime at the Menangle Sand and Soil Quarry area has limitations that reflect the complexity of the groundwater systems, the influence of the adjacent Nepean River, the scope and timing of the project, data availability and the restrictions imposed by the software. The main limitations are as follows:

- Any faults, bedding planes and fracture/joint planes have not been represented as discrete features due to limitations of available detailed structural and/or hydraulic information related to these potential features. This simplification means that the influence of these heterogeneities (preferential pathways or secondary porosities) is not be captured, which may be locally important in controlling flux distribution.

- Any local mining operations (BHP, South32 and others) are not explicitly simulated. In reality, mine planning and associated dewatering and depressurisation may have changed, which could influence predictions for the Menangle Quarry area.

- The model layers represent the hydrostratigraphy in the area of the Menangle Quarry. These data were collected from the WaterNSW and MinView databases for water drill points and for mine drill data, respectively.

- Model history-matching included site-specific hydraulic head data at Menangle and publicly available data from WaterNSW for the Nepean River weir at Menangle. However, there are information gaps related to bore construction and screened lithological unit for some publicly available data, as such these data are not vetted in terms of accuracy of groundwater elevations.

- The model does not consider backfill operations, however it is planned that the pits will be backfilled to an elevation of 64 mAHD such that they will no longer intercept groundwater during times of high river levels.

- The groundwater model does not simulate the removal of water from the excavation of alluvium material.

- The groundwater model did not simulate all quarry areas, a representative sampling of quarry areas was used to generate a range of potential inflow volumes.

- Potential density-dependent flow is assumed to be negligible in the model. The salinity levels at the site do not warrant that their effects to be simulated.

- Contaminant fate and transport modelling are not part of the modelling scope.

- Simulation of quarry water management is limited to reporting of the amount of the groundwater intercepted from the rise of the Nepean River in active quarrying areas.

- Waste stockpiles and other stockpiles were not simulated.

- Quantification of baseflow or river leakage will not be included as part of history-matching or the modelling of the proposed project.

- Impacts of local climatic or weather variations were not modelled.

- Topography used in the groundwater model is based on a 1 second (~30 m) digital elevation model (DEM) dataset from Geoscience Australia based on Shuttle Radar Topography Mission (SRTM).

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2020c, Hume Coal Project and Berrima Rail Project – Response to Submissions Volume 2D Appendix F Revised groundwater modelling, June 2018.

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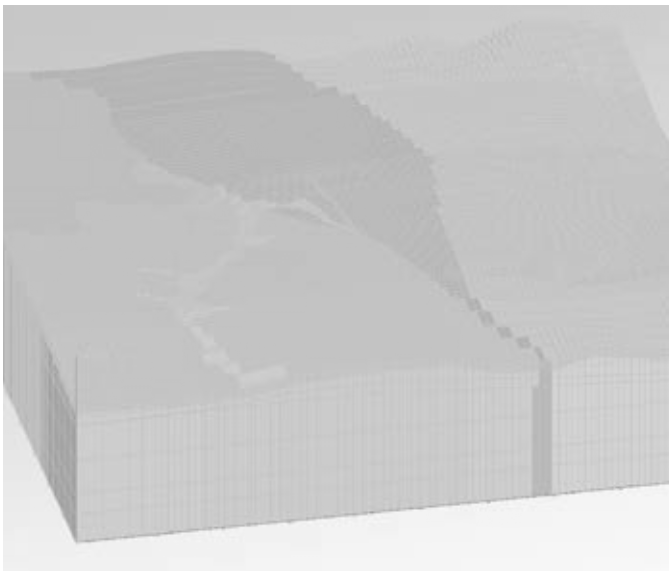
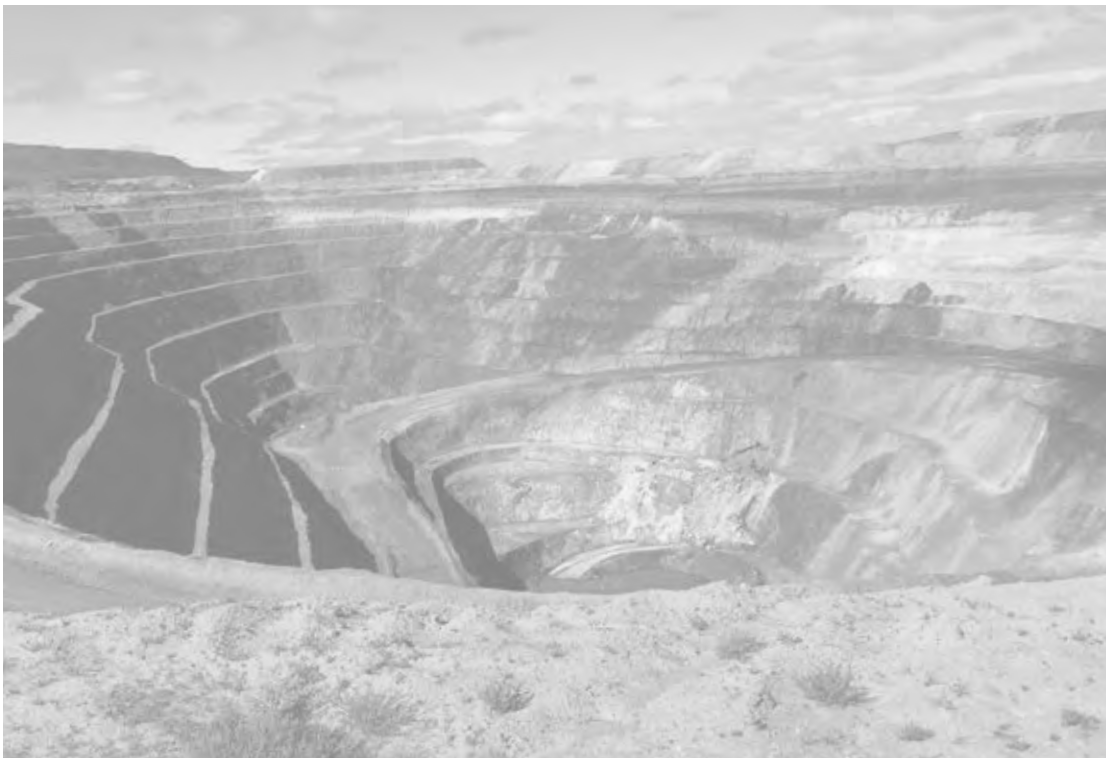
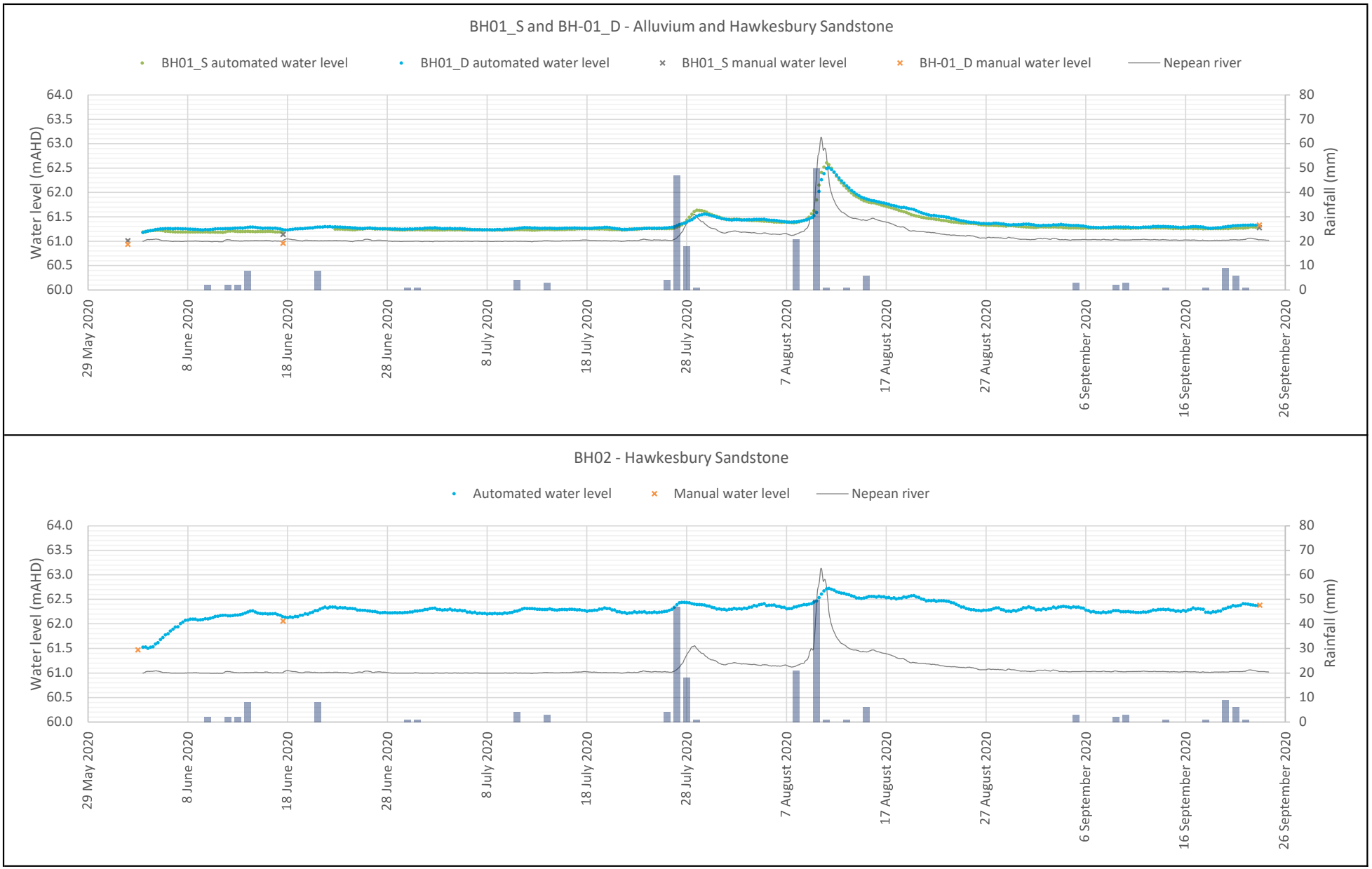
Appendix A

Hydrographs







Notes

Average hourly river height data accessed from Menangle Weir gauging station, WaterNSW station reference 212238 (https://realtimedata.waternsw.com.au/)

Daily rainfall data accessed from Menangle Bridge monitoring station, BoM reference 68216. (http://www.bom.gov.au/climate/data/)

Water level hydrographs - BH01_S, BH01_D and BH02

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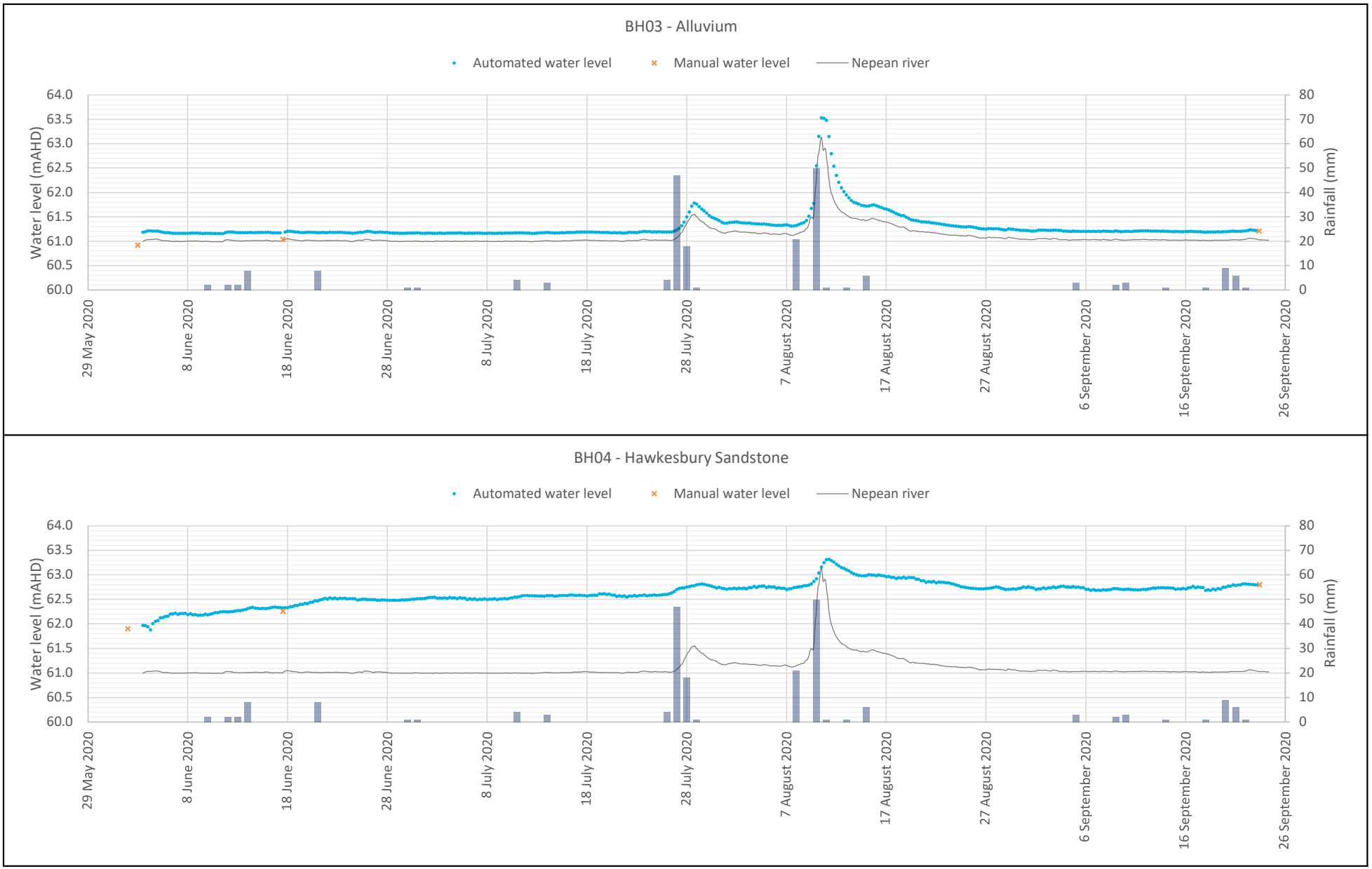
Figure A.1



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Daily rainfall data accessed from Menangle Bridge monitoring station, BoM reference 68216. (http://www.bom.gov.au/climate/data/)

Water level hydrographs - BH03 and BH04

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Figure A.2


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