Surface and Groundwater Assessment

Eulonga Quarry Proposed Extraction Area

Eulonga Quarries Pty Limited

Eulonga Quarries "Eulonga", Coolac NSW 2727

Prepared by:

SLR Consulting Australia

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Basis of Report

This report has been prepared by SLR Consulting Australia Pty Ltd. (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Client Name (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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Executive Summary

Proposal overview

Eulonga Quarries propose to establish a new extraction area (the ‘proposal’) to the south west of the existing quarry operation, at 809 Gobarralong Road, Coolac on land being described as Lot 158 DP750984 and Lot 4 DP1096529. The approval pathway of the proposed development is outlined in the Environmental Impact Statement, which outlines that an Environmental Protection License (‘EPL’) from the NSW Environmental Protection Authority (‘EPA’) is required.

The proposed extraction area is approximately 13.91 hectares and the extraction of material would occur in the same way as the current site and to the depth of 4 metres. All extracted material will be transported to the current Quarry site for processing, stockpiling and transport to market by the approved haulage routes. The proposed area is approximately 800 meters south west of the current site. The proposal site is located adjacent to the Murrumbidgee River approximately 90 kilometres downstream of Burrinjuck Dam and approximately 25 kilometres upstream from the township of Gundagai. The proposed extraction area has previously been disturbed by historical farming activities. No significant impacts to native vegetation are proposed.

Approach to surface water and groundwater assessment

This report presents an assessment of the potential impacts on surface water and groundwater of operating the proposed Quarry.

A flood impact assessment has been prepared to assess the impacts of the proposed Quarry on flooding within the Murrumbidgee River. Gauged flood flow rates have been used to map existing and proposed flood characteristics, which includes an assessment of the proposed Quarry on flood behaviour.

An assessment of site water management system, including a detailed site water balance modelling investigation has been undertaken to assess off site impacts. A qualitative assessment has been undertaken of the pollutants that could be introduced during construction and operation of the proposal to determine the potential resulting impacts on surface water quality of the receiving environment, i.e. the Murrumbidgee River. The assessment identified existing and future predicted pollutant loads and water quality controls needed to achieve the pollutant reduction targets for the proposal during operation.

The groundwater assessment includes a review and analysis of site-specific publicly available data and sampling completed during field investigations to characterise the existing environment and identify potential groundwater risks as well as potential impacts of the proposal on groundwater levels and quality.

An engineering geomorphological assessment has been undertaken to investigate the existing environment and assess potential impacts of the proposed new extraction area.

Conclusion

The assessment found that that the proposal is unlikely to result in any measurable changes in flood behaviour or the quality of the downstream receiving environment surface or groundwaters. The water balance modelling indicated that there will be no off-site discharges from the proposed Quarry. It is considered that, with the implementation of the mitigation measures recommended in this report, and the installation of the proposed water management system, potential impacts on surface water and groundwater resulting from the operation of the proposal would be minor and manageable.

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Acronyms and Abbreviations

AEP	annual exceedance probability
ARI	annual recurrence interval
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
ANZG	Australian and New Zealand Governments
ARR	*Australian Rainfall and Runoff*
BOM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECCW	Department of Environment, Climate Change and Water
DEM	Digital Elevation Model
DPE	Department of Planning and Environment
DPIE	Department of Planning, Infrastructure and Environment
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPL	environment protection licence
FM Act	*Fisheries Management Act 1994*
GDE	groundwater dependant ecosystem
LDP	licensed discharge point
LiDAR	Light Detection and Ranging
NWQMS	National Water Quality Management Strategy
NTU	Nephelometric Turbidity Unit
POEO Act	*Protection of the Environment Operations Act 1997*
REM	Relative Elevation Model
SEARs	Secretary’s Environmental Assessment Requirements
TUFLOW	Two-dimensional Unsteady FLOW model
WBM	Water Balance Model
WM Act	*Water Management Act 2000*
WSP	Water Sharing Plan

1.0 Introduction

1.1 Project Overview

Eulonga Quarries Pty Limited ('Eulonga Quarries') operate the Eulonga Quarry, an established sand and river rock quarry located at 809 Gobarralong Road, Coolac, on land being described as Lot 158 DP750984 and Lot 4 DP1096529). Eulonga Quarries propose to establish a new extraction area (the 'proposal') to the south west of the existing approved quarry operation area, as depicted on Figure 1-1, with details provided in Table 1-1.

The proposed extraction area is to support long term operations of the existing Quarry without any changes to the approved annual extraction volume, truck movements, hours of operation or rehabilitation outcome or any other aspect of the existing Quarry operation within Lot 1 & 2 DP1096529. It is intended that the proposed extraction area would be operated under a separate development consent to the existing Quarry operation. The proposed extraction area is not intended to increase the overall annual production of the existing Quarry which would remain capped at the current approved rate of 172,000 tonnes per annum. The proposed extraction area is intended to feed into and provide improved security of the resource for the ongoing operation of the existing Quarry.

As shown on Figure 1-1, the proposed extraction area is approximately 13.91 hectares and the extraction of material would occur in the same way as the current site to a shallower depth, approximately 4 metres below ground level, rather than 8 metres. The proposed extraction area is approximately 800 meters south west (downstream) of the current site. Prior to commencing activities in the proposed extraction area, Eulonga Quarries would have a surveyor identify, peg and mark the boundaries of the area. The proposed extraction area has previously been disturbed by historical farming activities. No impacts to native vegetation are proposed.

The proposed extraction area is for extraction only. No processing of material would occur in the proposed extraction area. All extracted material will be transported to the existing Quarry for processing, stockpiling and transport to market by the approved haulage routes. It is anticipated that the only machinery required in the proposed extraction area is an excavator or front end loader to extract the sand and then load the off-road haul truck which will transport the material back to the existing Quarry for processing via an internal access road.

1.2 Purpose of this report

This report has been prepared by SLR Consulting Pty Ltd (SLR) on behalf of Eulonga Quarries as part of the Environmental Impact Statement for the proposed extraction area. The report has been prepared to assess the potential impacts of operating the proposal on flooding, site water management, surface water quality, groundwater and river geomorphology, in particular, the items listed in the Planning Secretary's Environmental Assessment Requirements (SEARs), dated 5 September 2024. The report:

- provides a summary of key legislation, policies and procedures relevant to surface water and groundwater
- describes the existing surface water and groundwater environment
- assesses the potential impacts of quarrying activities associated with the proposal on surface water and groundwater and relevant environmental values
- recommends measures to avoid, minimise, mitigate and manage the impacts identified.

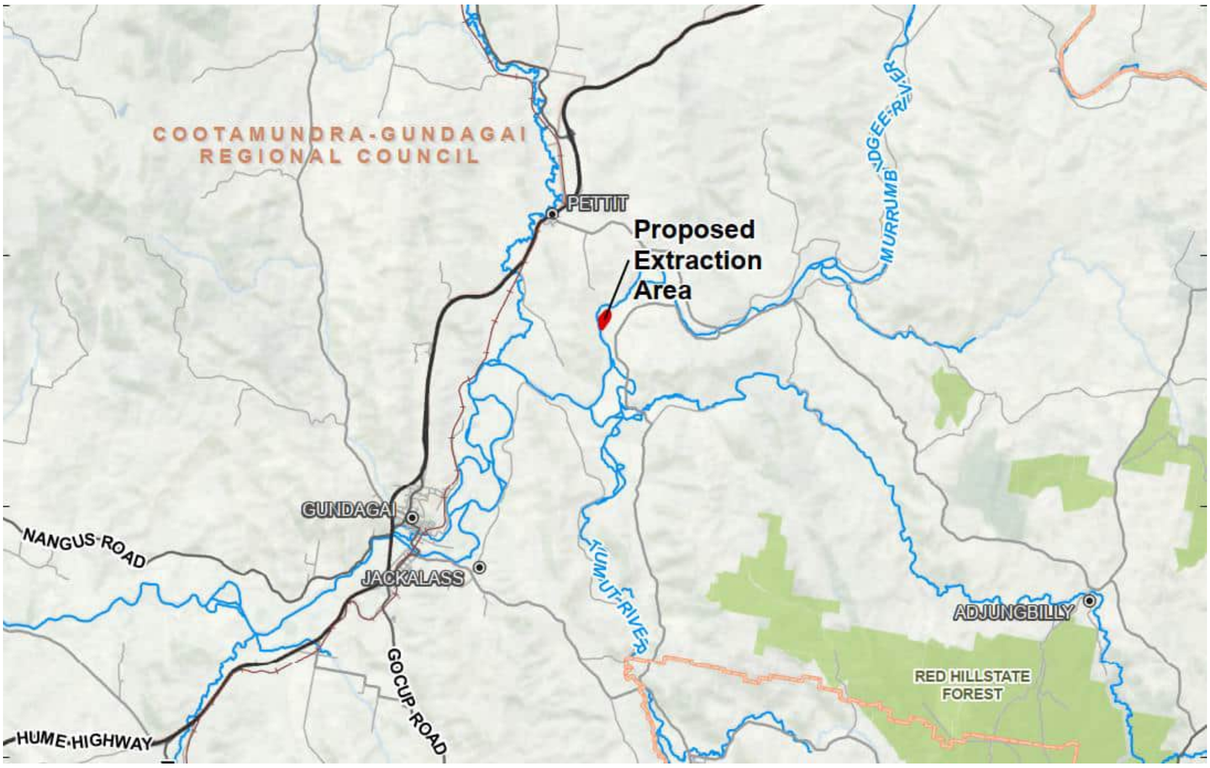


Figure 1-1 Proposed Extraction Area Location

Table 1-1 Proposed Development Overview

Parameter	Existing	Proposed
Material Extraction Maximum	172,000tpa	No Change
Extraction Area	Fine Sands: 8.5 ha Coarse Sands: 8.2 ha	13.91 ha
Extraction Depth	8 m	4 m
Hours of Operation	• 7:00 a.m. to 6:00 p.m. Monday to Saturday • No time on Sundays and Public Holidays.	No Change
Staff Number	3	No Change

2.0 Legislative and policy framework

This chapter provides a summary of the legislation that applies to the proposal and the policy framework that forms the basis of this assessment.

Further information about the legislative context for the proposal is provided in the Environmental Impact Statement (EIS).

2.1 Relevant legislation and planning instruments

2.1.1 Environmental Planning and Assessment Act 1979

An EIS is prepared to satisfy the requirements under Part 4 of the EP&A Act to ‘examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity’ in making decisions on the likely significance of any environmental impacts. This surface and groundwater assessment forms part of the EIS being prepared for the proposal and assesses the potential hydrology and flooding impacts of the proposal.

2.1.2 Water Act 1912, Water Management Act 2000 and Water Management (General) Regulation 2011

The *Water Act 1912* and the *Water Management Act 2000* (WM Act) are the two key pieces of legislation for the management of water in NSW and contain provisions for the licensing of water access and use. The *Water Act 1912* is being progressively phased out and replaced by the WM Act.

The aims of the WM Act are to provide for the sustainable and integrated management of the State's water sources for the benefit of both present and future generations. The WM Act implicitly recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water through the separation of water licences from land. The WM Act enables the State's water resources to be managed under water sharing plans, which establish the rules for the sharing of water in a particular water source between water users and the environment, and rules for the trading of water in a particular water source.

Under the WM Act the sharing of water must protect the water source and its dependent ecosystems and must protect basic landholder rights. Sharing or extracting water under any other right must not prejudice these rights. Therefore, water for licensed water users is effectively the next priority for water sharing. Water sharing plans provide a legal basis for sharing water between the environment and consumptive purposes.

The proposal is located within an area covered by the Water Sharing Plan for the Murrumbidgee Regulated River Water Sources 2016 for surface water. The proposal is also located within an area covered by the Water Sharing Plan for the Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources 2020.

In addition to water sharing plans and associated water access licences and water use approvals, section 91 of the WM Act identifies approval provisions relating to ‘controlled activities’ which includes (among other definitions) the carrying out of any activity on waterfront land. Of relevance to the proposal, waterfront land is defined as the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river. A river is defined as any watercourse, including any tributary, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved.

As described in Section 4.0 of this report, the proposed extraction area is adjacent to the Murrumbidgee River; therefore, there would be works undertaken on waterfront land (within 40 metres of a waterway). As such the proposal constitutes a 'controlled activity on waterfront land' and would require an 'activity' approval.

Generally, under the WM Act, taking water from a water source requires a water access licence and a works approval. Under the WM Act a licence is required for ongoing operational groundwater removal (take) whether passive or intentional. As noted in Scheduled 4 a water access licence is required where the ongoing operation groundwater take exceeds three mega litres per year. The need for a water access licence would need to be confirmed during detailed design. However, at this stage it is considered unlikely that groundwater interception during operation of the proposed extraction area would trigger the need for a water access licence.

2.1.3 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) aims to protect, restore and enhance the quality of the environment. It prescribes offences mainly regarding pollution of the environment and establishes a regime for the licensing of certain scheduled activities.

Section 120 prohibits the pollution of waters. Potential water quality impacts are discussed in Section 5.0. Eulonga Quarries are obliged to notify the EPA if a pollution incident occurs that causes or threatens material harm to the environment. Under Part 3.2 of the POEO Act an environment protection licence (EPL) is required for scheduled activities or scheduled development work. Activities requiring licences are defined in Part 3.2 and Schedule 1 of the Act.

In accordance with Schedule 1: clause 16, "crushing, grinding or separating", meaning the processing of materials (including sand, gravel, rock or minerals, but not including waste of any description) by crushing, grinding or separating them into different sizes; and clause 19 "extractive activities", meaning the extraction (by any method, including by excavation, dredging, blasting or tunnelling) or processing of extractive materials; are listed as an activity that may require licensing.

Based on the concept design and construction methodologies proposed, an EPL would be required as the proposal would involve extraction of more than 30,000 tonnes of material per year. It is anticipated that the EPA will assess the proposal, and if appropriate, issue general terms of approval, which could then been used to amend the existing EPL (EPL 12835) held by Eulonga Quarries, to incorporate the proposed extraction area, into the same EPL as the existing Quarry.

2.1.4 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) provides for the protection of threatened fish and marine vegetation. The FM Act aims to conserve, develop and share fishery resources and conserve marine species, habitats and diversity. One of the objectives of the FM act is to 'conserve key fish habitats'. Watercourses within the study area have been categorised with regard to NSW Fisheries key fish habitat mapping (DPI, 2007) and the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013). While the Murrumbidgee River is mapped as key fish habitat, there are no tributaries that cross the proposal site mapped as key fish habitat as watercourses present are highly degraded first and second order streams. Part 2 and Part 7 of the FM Act describe the requirements for permits for dredging and/or reclamation works, to obstruct fish passage and to harm marine vegetation. The anabranches/tributaries that cross the proposal site are highly degraded, ephemeral streams with no marine vegetation therefore the requirements of Part 2 and Part 7 of the FM Act do not apply.

2.1.5 Water Management Act 2000

The *Water Management Act 2000* (WM Act) provides a framework for the sustainable and integrated management of water sources across NSW. The WM Act primarily deals with the establishment of management plans for committees who manage water management areas, issue of access licenses for users to retrieve water from a designated area and approvals for the use of water from a particular location.

Under section 91 of the WM Act, approval is required for a 'controlled activity that is carried out on 'waterfront land'. Waterfront land is defined as the bed of any river, lake or estuary, and the land within 40 metres of the river banks, lake shore or estuary mean high-water mark. Waterfront land can be identified using *Natural Resources Access Regulator Waterfront land tool* (NSW Department of Planning, Industry and Environment). The proposal and the adjacent land are identified as waterfront land.

2.1.6 New South Wales Flood Prone Land Policy

The primary objective of the flood prone land policy is to reduce the impact of flooding and flood liability on communities and individual owners and occupiers of flood prone property. The policy adopts a merit-based approach for development decisions in the floodplain taking into account social, economic and ecological factors, as well as flooding considerations.

2.2 Guidelines and policies

2.2.1 Flood Risk Management Manual

The *Flood Risk Management Manual* (Department of Planning and Environment (DPE), 2023) (the Flood Risk Management Manual) supports the NSW Government's flood prone land policy. The policy sets the direction for flood risk management in New South Wales. The Flood Risk Management Manual and its toolkit support the implementation of the policy through the combined efforts of all levels of government.

2.2.2 Climate Risk Ready NSW Guide

The *Climate Risk Ready NSW Guide* (Department of Planning, Industry and Environment (DPIE), 2020) has been developed to help the NSW Government sector to lead, influence and enable their organisations to better understand their exposure to climate change risks and opportunities, and to develop plans to address them. The guide provides practical guidance to assess and manage climate change risks.

2.2.3 Australian Rainfall and Runoff: A Guide to Flood Estimation

Australian Rainfall and Runoff: A Guide to Flood Estimation Version 4.2 (Australian Government and Engineers Australia) (ARR) is used nationally as a guideline document, data and software suite, providing the information necessary for the estimation of design flood characteristics in Australia. The purpose of ARR is to provide a framework for reliable and robust estimates of flood characteristics to enable the assessment of flooding risk and design of infrastructure. ARR also provides procedures for climate change impact estimation.

The procedures and data provided in ARR have been adopted in the flood modelling of the study area and assessment of the proposal flooding impacts presented in this document.

2.2.4 Technical Flood Risk Management Guideline: Flood Hazard

The *Technical Flood Risk Management Guideline: Flood Hazard* (Australian Institute for Disaster Resilience, 2014) (Technical Flood Risk Management Guideline) provides a basis for quantifying the variations in flood hazard on a floodplain. The development of Technical Flood Risk Management Guideline was overseen by the National Flood Risk Advisory Group. The guideline provides methods to assess the vulnerability of people and/or the built environment to flood hazard using specific flood parameters for a select range of flood events that can be compared to thresholds. By using the guideline it is possible to describe the danger of the flooding to people, buildings and infrastructure in the community. The Technical Flood Risk Management Guideline has been used to assess the flood hazards associated with the proposal.

2.2.5 NSW Aquifer Interference Policy

The *NSW Aquifer Interference Policy* (DPI, 2012) (the Aquifer Interference Policy) was finalised in September 2012 and clarifies the water licensing and approval requirements for aquifer interference activities in NSW. Many aspects of this policy will be given legal effect in the future through an Aquifer Interference Regulation. Stage 1 of the Aquifer Interference Regulation started on 30 June 2011.

The *NSW Aquifer Interference Policy* requires that potential impacts on groundwater sources, including their users and groundwater dependant ecosystems, be assessed against the minimal impact considerations outlined in the policy. If the predicted impacts of the proposal are less than the minimal impact considerations, then the potential groundwater impacts of the proposal are acceptable.

The policy outlines the water licensing requirements under the Water Act 1912 and WM Act. A water access licence is required whether water is taken for consumptive use or whether it is taken incidentally by the aquifer interference activity (such as groundwater filling a void) even where that water is not being used consumptively as part of the activity's operation. Sufficient access licences must be held to account for all water taken from a groundwater or surface water source as a result of an aquifer interference activity, both for the life of the activity and after the activity has ceased. This take of water continues until an aquifer system reaches equilibrium and must be licensed.

The *NSW Aquifer Interference Policy* requires that potential impacts on groundwater sources, including their users and groundwater dependant ecosystems, be assessed against the minimal impact considerations outlined in the policy. Potential impacts of the proposal on groundwater are considered acceptable if they are less than the minimal impact considerations. The proposal has been assessed against the requirements of the *NSW Aquifer Interference Policy*.

2.2.6 NSW Groundwater Strategy

The objective of the *NSW Groundwater Strategy* (Department of Planning and Environment (DPE), 2022) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The N*SW Groundwater Strategy* has three strategic priorities:

– protect groundwater resources and the ecosystems that depend on them
– build community and industry resilience through sustainable groundwater use
– improve groundwater information and knowledge.

The groundwater impact assessment described in Section Groundwater has had regard to the *NSW Groundwater Strategy*.

2.2.7 Managing Urban Stormwater – Soils and Construction

The principles for the management of stormwater during construction are documented in *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom 2004) and *Volume 2E – Mines and quarries* (DECC 2008). These guidelines are commonly referred to in the construction industry as 'the Blue Book'. The Blue Book provides guidelines to help mitigate the impacts of land disturbance activities on soils, landforms and receiving waters by focussing on erosion and sediment control. Implementation of management measures listed in the Blue Book Volume 2e would be defined by the Soil and Water Management Plan (SWMP) developed as part of the Environmental Management Plan (EMP) for the proposal.

2.2.8 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) aims to protect the nation's water resources, by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development.

The NWQMS contains guidelines for setting water quality objectives to sustain current or likely future environmental values for water resources. The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Governments (ANZG), 2018) (the ANZG Water Quality Guidelines) are part of the NWQMS and are relevant to the proposal as discussed in Section Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality.

2.2.9 Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Environment and Conservation Council (ANZECC/ARMCANZ) published Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) to provide benchmarks against which to assess the existing water quality of watercourses. The guidelines were updated in 2018 to incorporate new science and knowledge developed over the past 20 years (ANZG, 2018).

The ANZG Water Quality Guidelines have been applied to understand the current health of the watercourses in the study area and the ability to support nominated water quality objectives, particularly the protection of aquatic ecosystems. The ANZG Water Quality Guidelines provide default guideline values which have been considered when describing the existing water quality and key indicators of concern. However, many of the guideline values are still in a draft form. Currently, physical and chemical stressors for aquatic ecosystems for the Murray Darling region (the geographic region relevant to this proposal) have not yet been completely updated.

The ANZG Water Quality Guidelines are not intended to directly apply to contaminant concentrations in industrial discharges or stormwater quality (unless stormwater systems are regarded as having relevant community value). They have been applied to the ambient waters that receive effluent or stormwater discharges and protect the water quality objectives they support.

2.2.10 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (DECCW, 2006) (NSW Water Quality Objectives) are the agreed environmental values and long-term goals for NSW's surface waters. They set out the community's values and uses for our rivers, creeks, estuaries and lakes (i.e. healthy aquatic life, water suitable for recreational activities like swimming and boating, and drinking water).

The water quality objectives identify environmental values for NSW waters and the ANZG Water Quality Guidelines provide the technical guidance to assess the water quality needed to protect these values.

Water quality objectives for the Murrumbidgee River and Lake George system were developed and agreed to by the NSW Government in 1998 and environmental values outlined align with environmental values set out by the DECCW Water Quality Objectives (DECCW, 2006).

The ANZG Water Quality Guidelines default trigger values for water quality take precedence for assessment of the existing water quality of the receiving environments as they supersede the values recommended in the HRC Inquiry (HRC, 1998). Environmental values and related numerical criteria which have been nominated for each environmental value using the ANZG Water Quality Guidelines are provided in Section Australian and New Zealand Water Quality Guidelines for Fresh and Marine Water Quality.

3.0 Methodology

This chapter provides a detailed summary of the methodology undertaken to assess the proposal.

3.1 Study area

For the purposes of this assessment, the study area comprises the proposed extraction area and a buffer of about two kilometres around it to incorporate surface water and groundwater receptors with the potential to be directly or indirectly impacted. The study area is shown on Figure 3-1.

3.2 Assessment methodology

3.2.1 Flood impact assessment

The flood impact assessment undertaken for the proposal has been based on flows in the Murrumbidgee River as there are no local creeks or overland flowpaths through the proposed Quarry site, i.e. local flows have not been modelled.

The study area hydraulics were simulated using TUFLOW flood modelling software. TUFLOW is a two-dimensional hydraulic modelling software which is used to model the flooding behaviour of flood water through the Murrumbidgee River and floodplain.

The TUFLOW model inputs included:

- Flood modelling for the proposal has been undertaken for existing and operational scenarios. terrain surface levels from LiDAR survey, ground survey and the operation and post closure surface levels
- surface roughness parameters determined from aerial photography, in Appendix A
- inflow rates obtained from the Log Pearson III flood frequency analysis of the Water NSW gauge, Murrumbidgee River at Upstream Gobarralong Bridge (No. 410195), located 8.5 kilometres upstream of the Proposal.
- downstream boundary conditions determined from the downstream watercourse dimensions and slopes.

All data used in this investigation has been provided in the Model Summary Sheet provided in Appendix A of this report.

Flood behaviour was simulated for the following events as a steady-state inflow from the Murrumbidgee River at Upstream Gobarralong Bridge (No. 410195) for existing and proposed operation conditions:

- 63.2 per cent annual exceedance probability (AEP), also referred to as the 1 Exceedance per year event – flow of 108.88 m^3/s
- 50 per cent AEP event, also referred as the 1 in 2 annual recurrence interval (ARI) event – flow of 139.86 m^3/s
- 18.13 per cent AEP, also referred as the 1 in 5 ARI event – flow of 510.45 m^3/s
- 10 per cent AEP event, also referred as the 1 in 10 ARI event – flow of 929.58 m^3/s
- 5 per cent AEP event, also referred as the 1 in 20 ARI event – flow of 1,769.75 m^3/s
- 2 per cent AEP event, also referred as the 1 in 50 ARI event – flow of 4,074.5 m^3/s
- 1 per cent AEP event, also referred as the 1 in 100 ARI event. – flow of 7,218 m^3/s

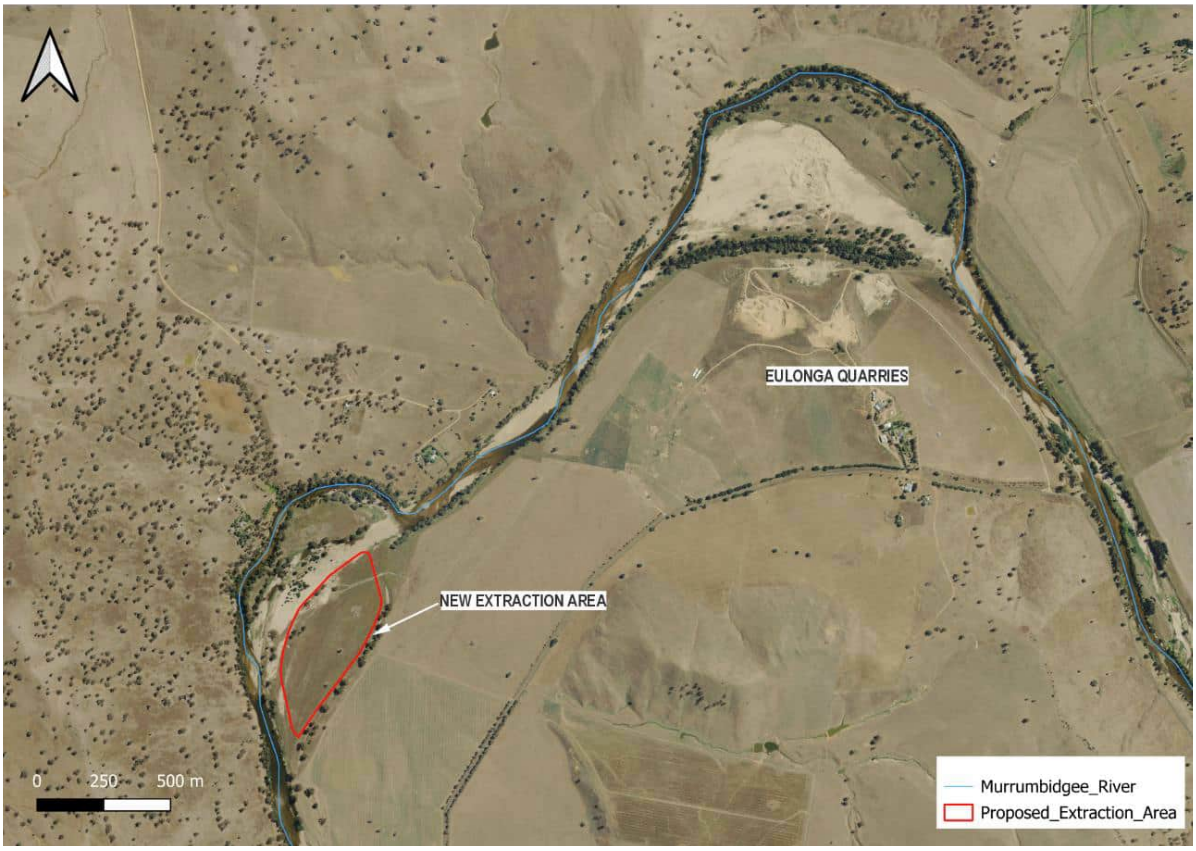


Figure 3-1 Proposed Extraction Area

The TUFLOW model has been used to develop maps of calculated flood levels, depths and velocities and bed shear stress (a measure of the potential for erosion and scour) for existing and proposed conditions. Mapping of flood impacts has been prepared, showing differences between flood elevation, peak velocity and peak shear stress for existing and proposed conditions.

3.2.2 Site water balance and water management system

The SEARs require an assessment of site water management system, including a detailed site water balance and an assessment of licencing requirements, sources and discharges.

Key features of the proposed water management strategy during the operation of the proposed extraction area will include:

- diversion of runoff from undisturbed catchments away from disturbed areas and off site
- collection of all potentially sediment-laden runoff from disturbed areas of the site within the quarry pit
- use of captured runoff and water within pit for dust suppression of unsealed roads and disturbed areas by use of a single water cart applying water as required at a maximum rate of 12,000 litres per hour
- any potential for discharge of excess water from the site to Murrumbidgee River, which would require a licensed discharge point (LDP)
- Potable water and wastewater use for the proposal will utilise the facilities at the existing quarry for amenities and drinking water

3.2.3 Surface water quality

The surface water assessment involves:

- reviewing existing environmental conditions and water quality data in the study area including:
  - information from the Murrumbidgee valley annual surface water quality report, from the NSW Department of Climate Change, Energy, the Environment and Water
  - Water quality technical report for the Murrumbidgee surface water resource plan area (SW9) from the NSW Department of Planning, Industry and Environment
- identifying assessment criteria for the proposal based on:
  - *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC/ARMCANZ, 2000) (the ANZECC guidelines) which are the same as those adopted by the ANZG Water Quality Guidelines
  - NSW Water Quality Objectives for the Murrumbidgee River and Lake George (https://www.environment.nsw.gov.au/ieo/murrumbidgee/report-03.htm)
- identifying activities that could affect surface water hydrology and quality during operation
- assessing potential impacts during the quarrying period based on a qualitative desktop assessment
- assessing potential impacts on hydrology and water quality during operation, including:
  - identifying existing and future predicted pollutant loads
  - assessing future predicted pollutant loads against pollutant load reduction targets
  - assessing potential changes to surface water flow by water balance modelling for the site to assess site discharges
- recommending safeguards and management measures, including proposed treatment measures and water quality monitoring for identified impacts.

3.2.3.1 Water quality assessment criteria

Environmental values associated with water quality

As described in Section 2.2.10 NSW Water Quality and River Flow Objectives the NSW Water Quality Objectives provide the agreed environmental values and long-term goals for NSW's surface waters. The objectives are consistent with the national framework for assessing water quality set out in the ANZG Water Quality Guidelines. The water quality objectives provide environmental values for NSW waters and the Water Quality Guidelines provide the technical guidance to assess the water quality needed to protect those values.

Establishing ambient water quality in receiving waters

The Water Quality Guidelines recommend default trigger values associated with the identified environmental values for various physical, biological and chemical pollutants that could be present in water. Trigger values are the criteria used for concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' the need for a management response.

Relevant environmental values

The proposed extraction area is located within the Murrumbidgee River and Lake George which has been categorised as 'Major Regulated Rivers'. As such, the watercourses within the study area have been nominated for protection of the following values, outlined in the NSW Water Quality Objectives:

- Aquatic ecosystems
- Visual amenity
- Primary and Secondary contact recreation
- contact recreation
- Livestock water supply
- Irrigation water supply
- Homestead water supply
- Drinking water at point of supply-Disinfection only
- Drinking water at point of supply-Clarification and disinfection
- Drinking water at point of supply-Groundwater
- Aquatic foods (cooked)

The long-term goal of the NSW Water Quality Objectives is to return the sub-catchments to a condition where the watercourses are suitable for primary contact activities and aquatic food. As the watercourses are highly degraded, and primary contact activities and aquatic food are either not recommended or prohibited. While the above values apply, the majority of them have less relevance given the characteristics of the watercourses that drain to the proposal site (ephemeral).

For the purposes of managing the potential short-term impacts of the proposal, the primary environmental value is considered to be 'aquatic ecosystems' and the water quality objective for aquatic ecosystems is to 'maintain or improve the ecological condition of waterbodies and their riparian zones over the long term', which is relevant in all watercourses.

The indicators and criteria (trigger values) for this objective are listed below for lowland rivers, as drawn from the ANZG Water Quality Guidelines (Tables 3.3.2 and 3.3.3):

- Total phosphorus – 20 µg/L
- Total nitrogen – 500 µg/L
- Chlorophyll-a – 5 µg/L
- Turbidity – 6–50 Nephelometric Turbidity Unit (NTU)
- Salinity (electrical conductivity) – 125–2200 µS/cm
- Dissolved oxygen – 85–110%
- pH – 6.5–8.5.

As noted above, trigger values are the numeric criteria that if exceeded indicate potential for harmful environmental effects to occur. If they are not exceeded, a very low risk of environmental damage can be assumed. If they are exceeded, further investigation is 'triggered' for the pollutant concerned.

Establishing appropriate discharge criteria

Some water may need to be discharged during the operation of the proposed extraction area, such as from sediment basins during high rainfall events. The quality of the water discharged would influence whether there are any impacts on water quality and aquatic ecosystems in the receiving waters.

ANZG promotes the use of local (site specific) data to determine baseline conditions, which is the preferred approach where site specific targets are not prescribed in the EPL. As described above, the available water quality data is not sufficient to establish baseline conditions. As such the default trigger values noted above would be used as discharge criteria during the operation of the proposed Quarry.

3.2.4 Groundwater

A qualitative groundwater assessment has been undertaken for the proposal, with regards to the *NSW Groundwater Strategy.* The assessment includes:

- the review of publicly available information including geological maps, groundwater monitoring data, groundwater allocations, registered groundwater monitoring bores, climate data, and any groundwater dependent ecosystem to characterise the existing environment
- A hydrogeological conceptualisation was developed to understand groundwater processes during the phases of operation of the proposal (i.e. before during and after) in particular in relation to potential environmental receptors.
- Identification of potential risk during the phased of operation of the Project and a qualitative assessment of their significance

3.2.5 Engineering geomorphology assessment

An engineering geomorphology assessment has been undertaken to investigate the existing environment and assess potential impacts of the proposed extraction area.

Historical aerial imagery and 2014 LiDAR was used to characterise and delineate geomorphic features of the existing environment. Results of SLR's Flood Impact Assessment were then used to identify risks and opportunities for the proposed extraction area under a range of flow scenarios.

This report identifies key impacts of the proposed extraction area and provides recommendations for design and rehabilitation measures.

4.0 Existing environment

This chapter outlines the existing environment of the proposed Quarry site.

The proposal site is located adjacent to the Murrumbidgee River approximately 90 kilometres downstream of Burrinjuck Dam and approximately 25 kilometres upstream from the township of Gundagai.

Topography

The Murrumbidgee River is a single thread meandering river at the location of the proposal site and can be characterised within this reach as a partly confined, margin-controlled continuous floodplain sandy bed river.

The proposed extraction area is located on a broad alluvial floodplain on the inside meander bend and true left bank of the river, shown on Figure 4-1.

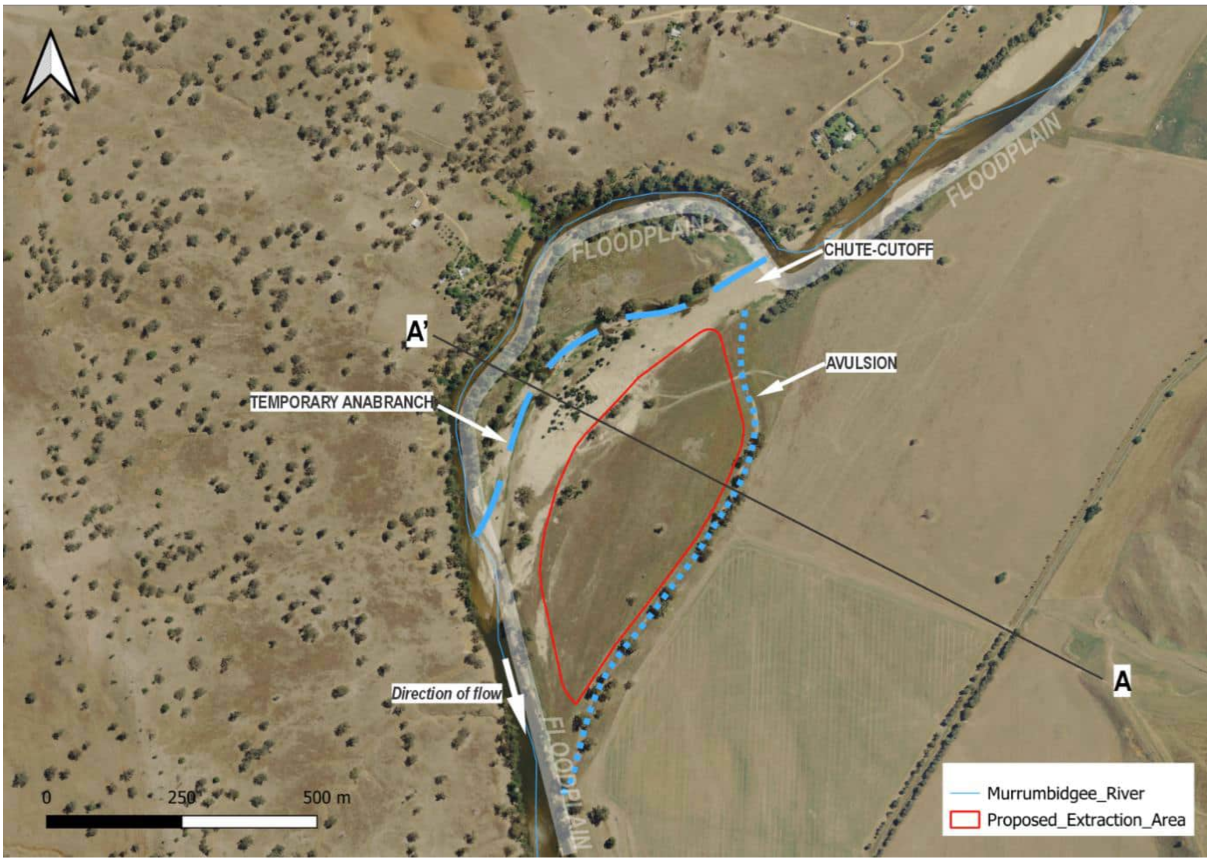


Figure 4-1 – Features of the existing environment and proposed extraction area

The floodplain is intersected by an unnamed anabranch that is periodically dry and forms in response to high flow events. Anabranches are typically formed in high energy flow conditions where the channel avulses to another position in the valley, whilst maintaining the original channel pathway.

Watercourses and surface water catchments

The Murrumbidgee River is perennial at the location of the proposed extraction area. The proposed extraction area is adjacent to the river and is not inundated during period of normal flow, with flow from the river above levels of the proposed extraction area during high flow events, discussed in Section Flooding. Runoff from the proposal site drains overland to the river, with no overland flow entering the site from watercourses and tributaries

The Murrumbidgee River is a 9th order Strahler stream at the location of the proposal. Several smaller streams are located within a floodplain to the east of the proposal with some intersecting 3rd and 1st order Strahler streams. These streams do not flow through the proposed Quarry site.

The Murrumbidgee River recorded a mean total annual flow 1.18 million megalitres (ML) (median of 0.77 ML) at the Water NSW gauge, Murrumbidgee River at Upstream Gobarralong Bridge (No. 410195), located 8.5 kilometres upstream of the proposal. The recorded range is 0.14 megalitres to 5.1 megalitres over a 20 year history of records.

Land use

The proposed extraction area is zoned RU1 Primary Production under the Gundagai Local Environmental Plan 2011.The site forms part of a larger rural area largely consisting of agricultural activities, primarily grazing, with a small number of associated dwellings.

The vegetation within the proposed Quarry site is a mixture of exotic and native groundcover. Trees visible on aerial photography and drone imagery are remnant native trees, comprising mostly of Eucalyptus and Casuarina species.

There are no notable modifications to the land or infrastructure built within the proposed extraction area on any of the parish maps for the site that have been published in 1893. The land has historically operated for cropping and as a dairy farm and cattle grazing, with impacts from cattle compacting the ground surface, along with minor light vehicle compaction through the proposed extraction area and surrounding area. This land use is likely to have contributed to erosion of the ground surface, exacerbated by the impacts of tree clearing within the surrounding floodplain and river banks.

Climate

Long term climate data collected from the Bureau of Meteorology Stations Gundagai - Nangus Road (Station 073141) for the period 1995-2024 and Gundagai - Ridge Street (Station 073128) for the period 1976-1995 indicated that:

- annual mean maximum and minimum temperatures are 22.3-22.7 degrees Celsius (°C) and 8.5-9.1°C respectively
- January experiences the hottest temperatures recording a mean maximum and minimum temperature of 32.7-31.6°C and 16.9-15.0°C respectively, while the coolest temperatures are experienced in July recording a mean maximum and minimum temperature of 13.1-12.8°C and 2.6-2.0°C respectively
- the area receives an annual mean rainfall of 624.1-713.2 millimetres per year
- the wettest months are between July and November receiving 66.3-78.6 millimetres of rain, while February to April are the driest months receiving 32.1-41.1 millimetres of rainfall.

4.1 Flooding

Existing flooding behaviour upstream and downstream of the proposed extraction area has been modelled using TUFLOW software. Flood mapping for the range of events modelled, using data from the upstream gauge (Murrumbidgee River at Upstream Gobarralong Bridge (No. 410195)) is provided in Appendix B .

4.1.1 Flood depths and elevations

As shown in the TUFLOW modelling results provided in Appendix B the proposed extraction area is not expected to be significantly inundated during frequent rainfall events, including the 1 Exceedance per year (EY) (63% AEP) flood event and 50% AEP event. In the 20% AEP event, the site is expected to be surrounded by flooding on all sides, with inundation of the anabranch located to the east of the site.

The proposed extraction area is modelled as partially inundated during the 10% AEP event, with flooding in the upstream (northern) end of the quarry boundary. The site has been modelled as totally inundated during the 5% AEP event, with depths between 0.25 and 1.0 metres deep.

Flood depths across the proposed extraction area have been estimated to be up to 4.0 metres in the 1% AEP event, with peak flood elevation of 230.5 metres AHD.

The existing Quary is inundated in the 10% AEP flood and less frequent events, with the processing area remaining flood free in the 1% AEP event.

Flood bed shear stress outputs for the site are discussed in greater detail within Section 4.5.2.

4.2 Site water management

There is currently no water management infrastructure, either permanent or temporary at the proposed extraction area. There are no means of water extraction storage or discharge to the Murrumbidgee River.

4.3 Surface water quality

There is no existing stormwater or drainage system on the site or natural overland flow features. There are currently no measures for stormwater runoff quality improvement within the proposed extraction area.

The quality of surface water entering local watercourses would largely be a function of grazing on the site. Typical surface pollutants from the pre-developed proposal site could include:

- Sediment from surface runoff
- Nutrients, including nitrogen and phosphorous, primarily from cattle grazing and pasture management practices
- Gross pollutants including vegetation and debris

4.3.1 Annual Surface Water Quality Report for Murrumbidgee Valley

The Annual Surface Water Quality Report for Murrumbidgee Valley has been assessed for the purposes of determining water quality within the Murrumbidgee River in the location of the proposed extraction area. The annual reporting publishes information at Gauge 410004 – Murrumbidgee River at Gundagai 24 kilometres downstream of the proposed Quarry site, noting that this is downstream of confluence with Tumut River. The overall water quality score in the 2022-23 report was 75 (moderate), which shows that water quality has declined relative to the 2021-2022 score 86 (good).

The published water quality data shows clear correlations between total nitrogen, total phosphorus and turbidity, with all three parameters positively correlated to flow. This suggests nutrients attached onto soil particles is the most likely transport mechanism at the site. Electrical conductivity does not show a correlation to flow.

The annual median total nitrogen, total phosphorus and turbidity results are all below the respective Basin Plan targets, except for 2010/2011. Median dissolved oxygen and pH is within the upper and lower limits.

Electrical conductivity fluctuates through time. As Gundagai is located downstream of the confluence of the Tumut and Murrumbidgee Rivers, the electrical conductivity would more likely be determined by the origin of the water (Blowering Dam, Burrunjuck Dam or tributary inflow) rather than local environmental factors.

4.3.2 Fisheries NSW Spatial Data Portal

The Murrumbidgee River is perennial at the location of the proposed extraction area. The river within the reach is a partly confined, margin-controlled continuous floodplain sandy bed river. The Murrumbidgee River is mapped as key fish habitat within the Murray Darling Basin South, and rated as Poor and Very Poor Freshwater Fish Community Status on the Fisheries NSW Spatial Data Portal. Freshwater Threatened Species were mapped on Fisheries NSW Spatial Data Portal as occurring within the Murrumbidgee River at the location of the proposal include, Flathead Galaxias, Murray Crayfish, Silver Perch and Trout Cod.

4.4 Groundwater

4.4.1 Groundwater Occurrence, recharge and flow

4.4.1.1 Hydrostratigraphic Units

The proposed extraction area is located within the fluvial zone of the Murrumbidgee River in the Gundagai/Coolac region, characterised by deep deposits of river sands and gravels on top of fractured rocks of the eastern part of the Lachlan Fold Belt, shown on Figure 4-2. The site is located on a broad alluvial floodplain of the Murrumbidgee River on the inside meander bend and left bank of the river. The Murrumbidgee Alluvium is a continuous sequence of unconsolidated sediments which were deposited as valley fill in the upper areas of the catchment and grades into broader valley and floodplain sediments in the mid catchment and the lower catchment (DPIE 2019).

The hydrogeological regime relevant to the proposed site comprises the following hydrogeological units, consistent with the geological setting and the Water Sharing Plan (WSP) for the Murrumbidgee Alluvial Groundwater Sources 2020:

- Alluvial aquifer: an unconsolidated aquifer consisting of river sands and gravels. In the area of the proposed quarry the thickness of the alluvial sediments was observed to reach 20 metres at registered bore GW400058 and 30 metres at registered bore GW018038 (Figure 4-2).
- Bedrock: a typically less permeable aquifer, limiting deeper groundwater flow and focusing it within the alluvial deposits. The bedrock underlying the alluvial sediments consists of early Ordovician rocks of the Lachlan Fold Belt.

The river sands and gravel alluvium are the primary aquifer at the proposed site, the dry sand is also the target quarry material.

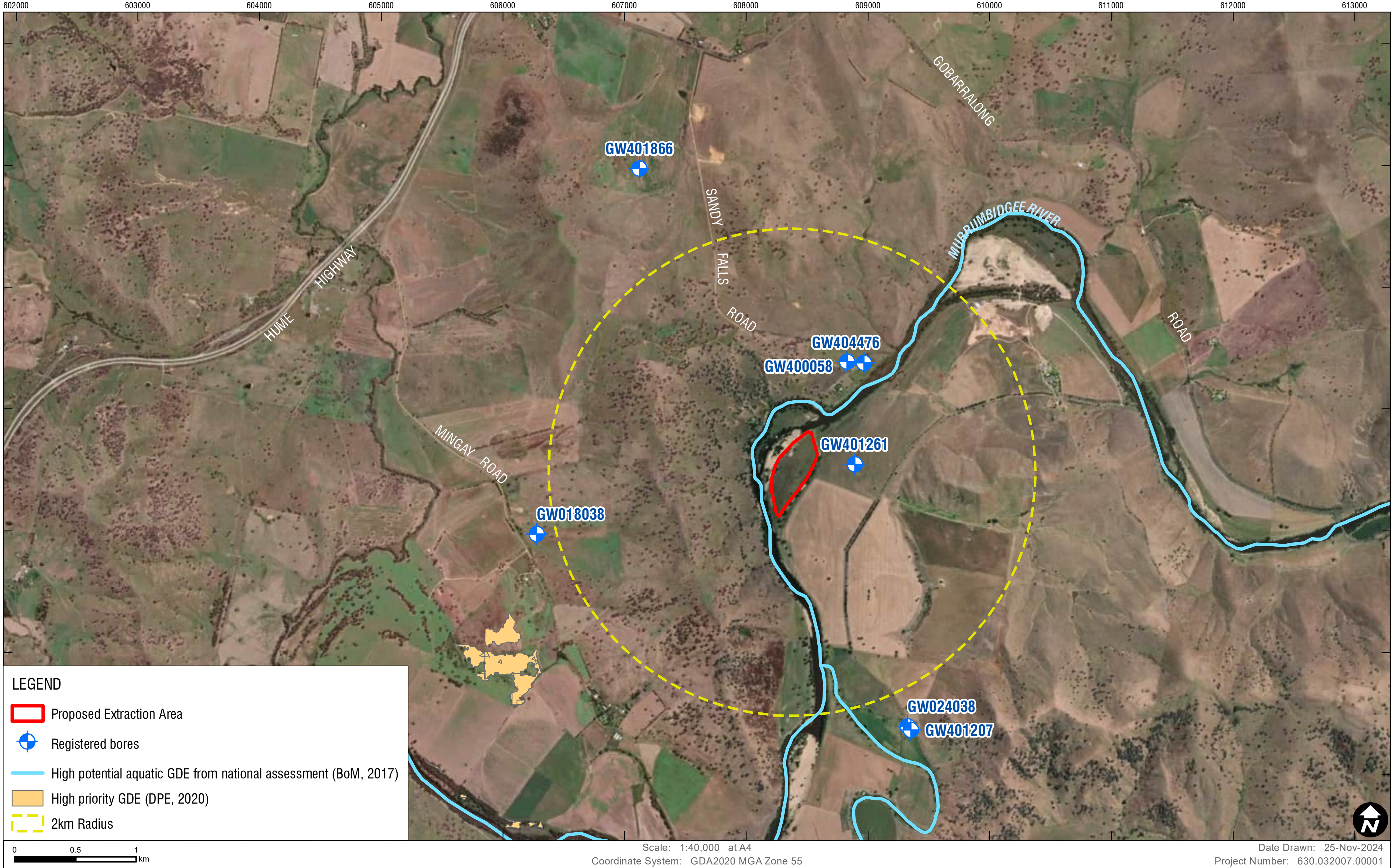
4.4.1.2 Groundwater level, flow and recharge/discharge mechanisms

The alluvial aquifer in the extraction area is likely unconfined and in hydraulic connection with the Murrumbidgee River. This was confirmed by test pits done in the existing quarry located within an anabranch of Murrumbidgee River 2 kilometres upstream from the proposed extraction area, where groundwater was found at the same elevation as the river. Groundwater in the alluvial aquifer is expected to be a subdued reflection of topography and the groundwater level at the extraction area is expected to be identical to the groundwater level in the river.

Recharge to the alluvial sediments is through rainfall recharge, estimated to range between 5% and 10% of annual rainfall.

Discharge occurs through evapotranspiration where the groundwater level is close to the ground level. Groundwater in the alluvial aquifer is also interpreted to discharge to the Murrumbidgee River (CSIRO 2008), i.e. at this location the Murrumbidgee River is a gaining stream.

The permeability of the underlying fractured and porous rocks is many orders of magnitude lower than that of the alluvium. Groundwater exchange between the alluvium and the underlying rock is expected to be insignificant in the context of the groundwater resources of the alluvium.



Scale: 1:40,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 25-Nov-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

REGISTERED BORES AND GROUNDWATER DEPENDENT ECOSYSTEMS

FIGURE 4-2

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\SLR630.032007_F2_RegBores_GDE_01.mxd

4.4.2 Groundwater quality

Based on the Murrumbidgee Alluvium Water Quality Management Plan (DPE, 2022), salinity levels in the shallow aquifer, as measured by electrical conductivity in groundwater monitoring bores at the time of construction, generally ranged from 150 to 1,660 µS/cm and is fresh (<500 µS/cm) adjacent to the Murrumbidgee River.

4.4.3 Hydraulic properties

There are no site-specific estimates of hydraulic property however based on the lithological description of the alluvial sediments encountered at the existing Quarry, a literature review aimed at identifying the potential range of hydraulic parameters for the alluvial sediments of the Murrumbidgee River was carried out and is summarised in Table 4-1**.**

Table 4-1 Literature Hydraulic parameters for the alluvial deposits

Lithology	Hydraulic conductivity (m/d)		Specific Yield (%)
	Freeze and Cherry, 1979	Bouwer, 1978 from Kruseman and de Ridder 1992	Morris and Johnson 1967 (form Aqtesolv)
Silty sand	0.0086 – 86.40	1 - 5	20 (silt) – 33 (fine sand)
Clean Sand	4.32 – 86.40	5 - 100	30-33%
Gravel	86.40 - 86400	100 - 1000	21-28%

4.4.4 Groundwater Users

4.4.4.1 Registered groundwater bores

A search of WaterNSW's real-time data water database on 18 October 2024 identified three registered groundwater bores within a two-kilometre radius of the proposed quarry. Two bores are installed in rock, described as shale 900 metres north of the proposed extraction area and granite 450 metres east of the proposed extraction area. One bore located 900 metres north of the proposed extraction area on the northern side of the Murrumbidgee River is installed in alluvium. The two bores located 900 metres north of the proposed extraction area are registered as water supply and the bore located 450 metres east of proposed extraction area is registered as Stock and Domestic. The summary of the information for each bore is presented in Table 4-2. The bore location is shown on Figure 4-2.

Table 4-2 Registered groundwater bore details

Registered number (RN)	Bore type	Easting (MGA55)	Northing (MGA55)	Drilled Date	Drilled depth (m)	Screen interval	Screened lithology
GW404476	Water Supply	608968	6128380	14-08-2004	68	43-56[1] 46-50[1]	Fractured rock (shale)
GW400058	Water Supply	608829	6128390	17-04-1996	19.81	0-19.81	Alluvium
GW401261	Stock and Domestic	608891	6127545	01-10-1993	61	36.6-61.0	Fractured rock (granite)

1: as presented in Water NSW's Realtime data website

4.4.5 Groundwater Dependent Ecosystem

A groundwater dependant ecosystem (GDE) is a natural ecosystem that requires "access to groundwater to meet all or some of their water requirements on a permanent or intermittent basis, so as to maintain their communities of plants and animals, ecosystem processes and ecosystem services" (Richardson, S., et al., 2011). GDEs can require access to groundwater on a permanent or intermittent basis to meet all or some of their water requirements so as to maintain their communities of plants and animals, ecological processes and ecosystem services (Doody et al., 2019).

The GDE Atlas map from Bureau of Meteorology (BOM, 2017) classifies GDEs as either:

- Aquatic GDEs (i.e. ecosystems dependent on the surface expression of groundwater, such as aquatic species that inhabit groundwater-fed surface pools).
- Terrestrial GDEs (i.e. ecosystems dependent on the sub-surface presence of groundwater, including some riparian vegetation communities with rooting depths that intersect the groundwater table).
- Subterranean GDEs (aquifer and cave ecosystems, such as stygofauna that can live within aquifer systems).

A review of the GDE Atlas map from Bureau of Meteorology (BOM, 2017) found the Murrumbidgee River as a high potential aquatic GDE from national assessment, and no terrestrial or subterranean GDEs have been identified within one kilometre of the proposed quarry.

The Water Sharing Plan (WSP) for the Murrumbidgee Alluvial Groundwater Sources 2020 (DPE, 2020) identified a group of high priority GDEs approximately 2.6 kilometres southwest of the proposed quarry, described as "*River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion.*"

The location of the GDEs is shown in Figure 4-2.

4.4.6 Hydrogeological Conceptual Model

Based on the hydrogeological setting and groundwater occurrence within the alluvium, a conceptual groundwater model is shown in Figure 4-3.

The project will directly intersect the alluvial sediments of the Murrumbidgee River. Recharge to this aquifer is predominantly through rainfall recharge with discharge to the Murrumbidgee River and through evapotranspiration where the groundwater level is close to the ground level. The aquifer is unconfined and in hydraulic connection with the Murrumbidgee River. Groundwater levels in the alluvial aquifer are expected to flow towards the Murrumbidgee River and are a subdued reflection of topography.

During operation of the quarry material will be extracted. It is anticipated that groundwater will not be intercepted. However, if required, groundwater may be extracted (up to 2 ML/year) from the lowest part of the proposed extraction area using pumps and water and used for dust suppression of the unsealed road.

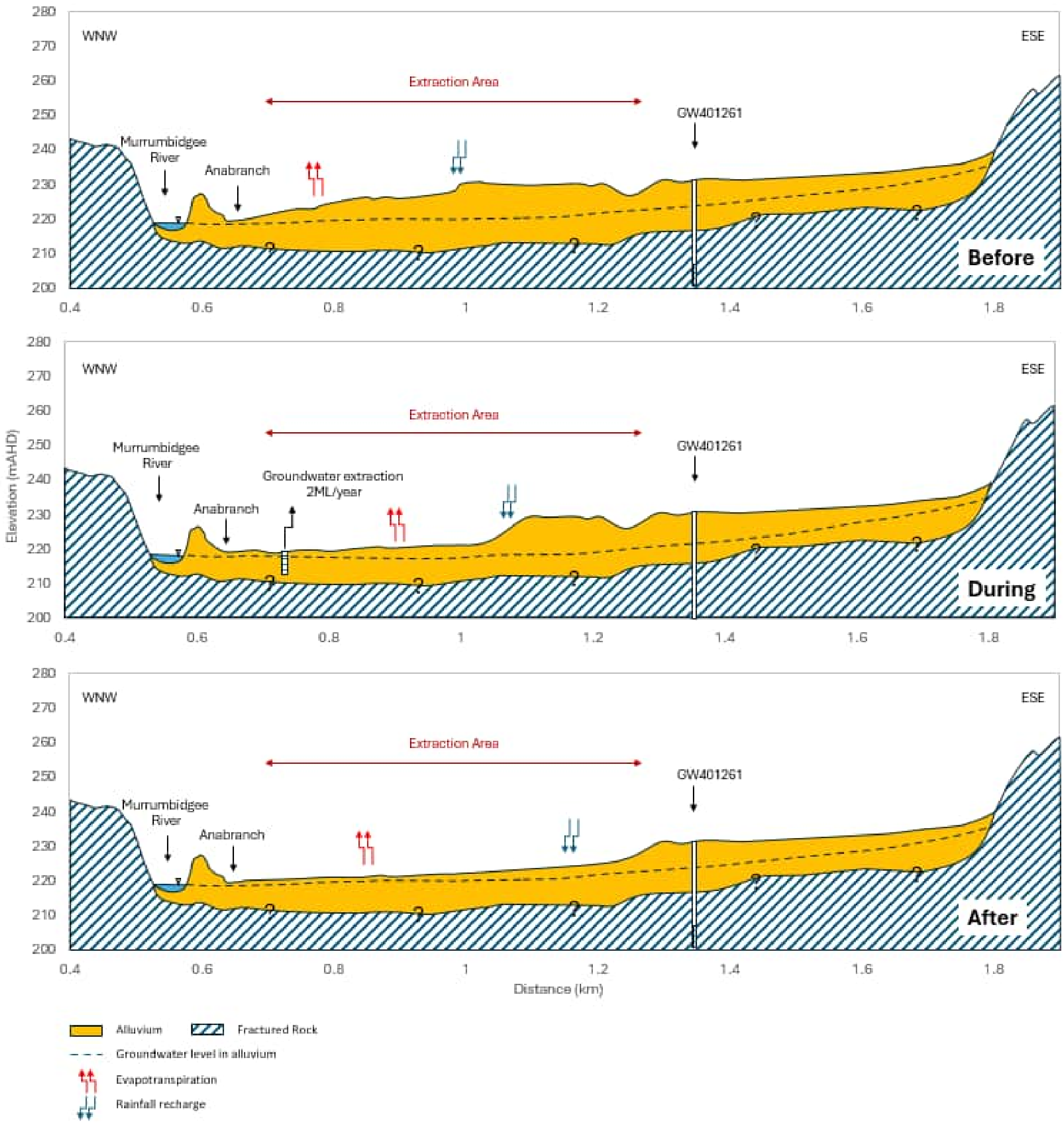


Figure 4-3 – Conceptual cross section (before, during and post quarrying)

4.5 Geomorphology

The Murrumbidgee River is a single thread meandering river and within this reach can be characterised by a partly confined margin-controlled continuous floodplain sandy bed river.

The site is located on a broad alluvial floodplain on the inside meander bend and true left bank of the river (Figure 4-1). The floodplain is intersected by an unnamed anabranch that is periodically dry and forms in response to high flow events. Anabranches are typically formed in high energy flow conditions where the channel avulses to another position in the valley, whilst maintaining the original channel pathway.

A Relative Elevation Model (REM) was created from 2014 LiDAR to investigate the geomorphic form of the reach and identify features of the existing environment. The floodplain appears to have been formed by point bar accretion with evidence of numerous palaeochannels and old meander pathways crossing the floodplain (Figure 4-6). Other floodplain features include the development of a chute-cutoff directly adjacent to and on the true left bank of the anabranch and an avulsion located along the eastern margin of the proposed extraction area.

The lower portion of the floodplain is grassed with mature riparian vegetation lining the channel and anabranch margins and an avulsed channel to the southeast of the anabranch.

Surface geology of the site obtained from NSW MinView[1] reveals the floodplain is categorised as Quaternary alluvial channel deposits and meander plain facies (Q_acm), characterised broadly by unconsolidated grey humic, clayey very fine-grained sand, typically overlying light brown clayey silt (Figure 4-5). It is understood that sands are to be mined from the proposed quarry.

A valley cross section (A-A’) reveals that the valley is approximately 1.3 kilometres wide at this location. The Murrumbidgee River is approximately 54 metres wide at this location and abuts the bedrock channel margins on the true right bank (Figure 4-4). An approximately 27 mere wide levee separates the Murrumbidgee River from the unnamed anabranch, which is approximately 86 metre wide at its downstream extent. The floodplain is approximately 1.1 kilometres wide at this location, with the quarry site located between 70 metres and 100 metres distance from the anabranch. An avulsed channel (avulsion) approximately 33 metre wide intersects the floodplain between the quarry site and the remaining floodplain.

[1] https://minview.geoscience.nsw.gov.au/#/?lon=148.5&lat=-32.5&z=7&l=

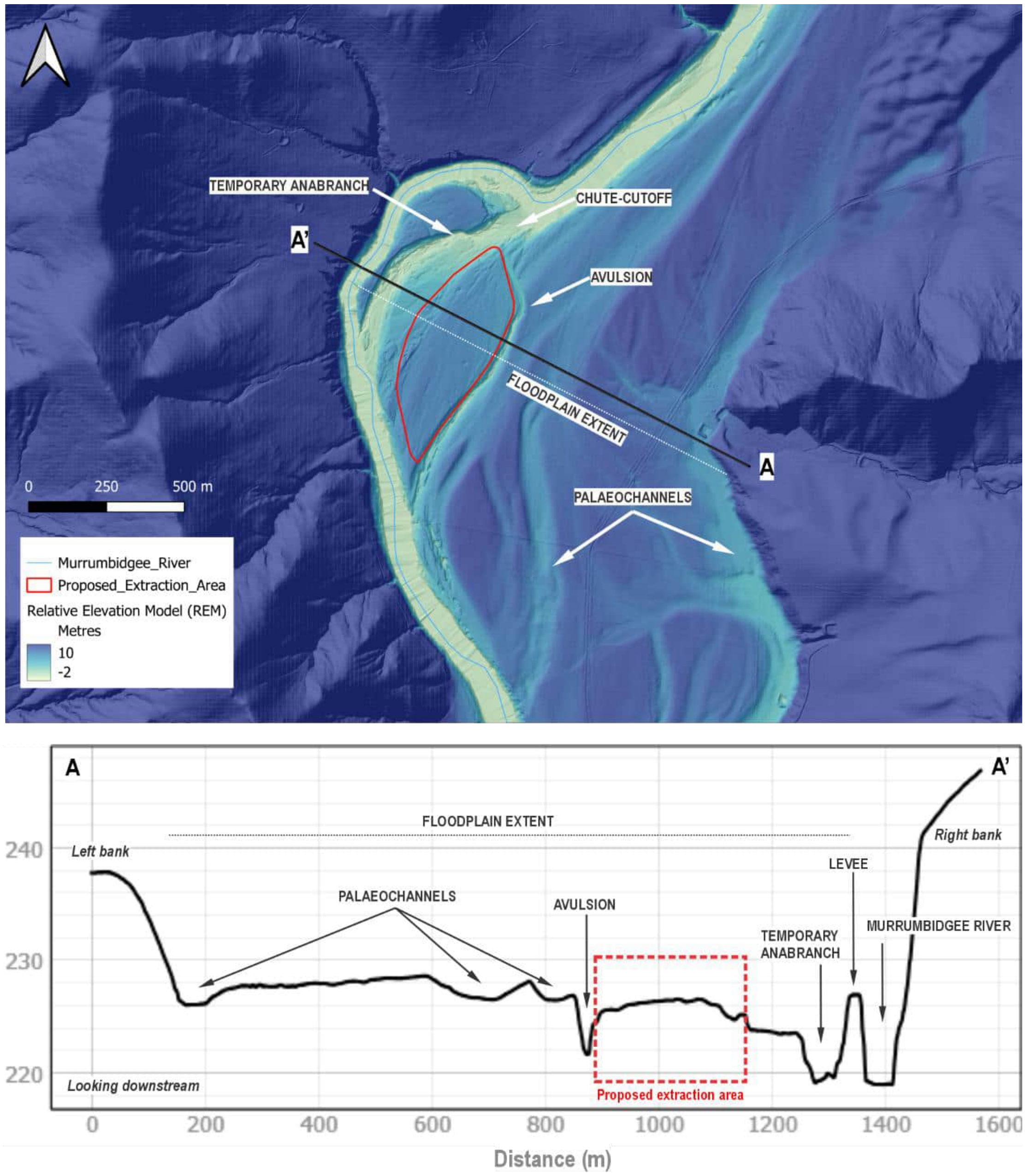


Figure 4-4 – REM and cross-section of the existing environment and proposed extraction area

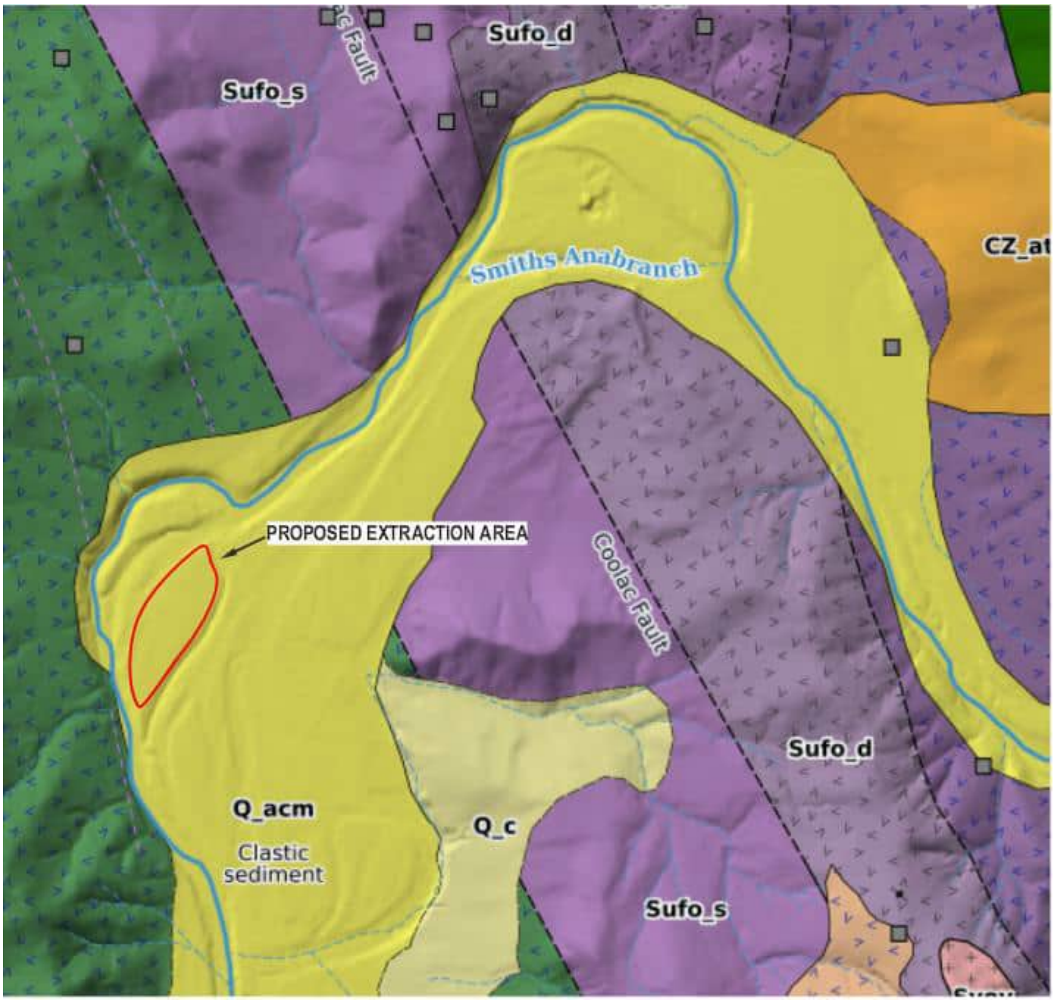


Figure 4-5 – Surface geology[2] of the existing environment and proposed extraction area (accessed 26/11/2024)

4.5.1 Historical Aerial Imagery

Analysis of historical aerial imagery from 1971 to present (approximately 50 years) reveals a progressive evolution of the floodplain, chute-cutoff and activation of the anabranch in response to inundation from high flow events (Figure 4-6).

Erosion and scour appear to occur along the chute-cutoff during high flow years (e.g. 2012 and 2022) and the anabranch forms an active and continuous channel connecting to the Murrumbidgee at its downstream extent. Sediment deposition can also be observed draped across the floodplain and proposed quarry site. The anabranch periodically transitions to a chain of pools and/or dry channel bed in response to low flow conditions and prolonged dry climate (e.g. 2019).

Aerial imagery also reveals a periodic downstream migration of sediment within the Murrumbidgee River, seemingly sourced from the upstream quarry site. It is likely this sediment acts to recharge downstream floodplains and represents an opportunity for recharge of the proposed extraction site, however the suspended sediment and bedload load carried by the Murrumbidgee River during flood within this reach is not well understood.

[2] https://minview.geoscience.nsw.gov.au/#/?lon=148.5&lat=-32.5&z=7&l=

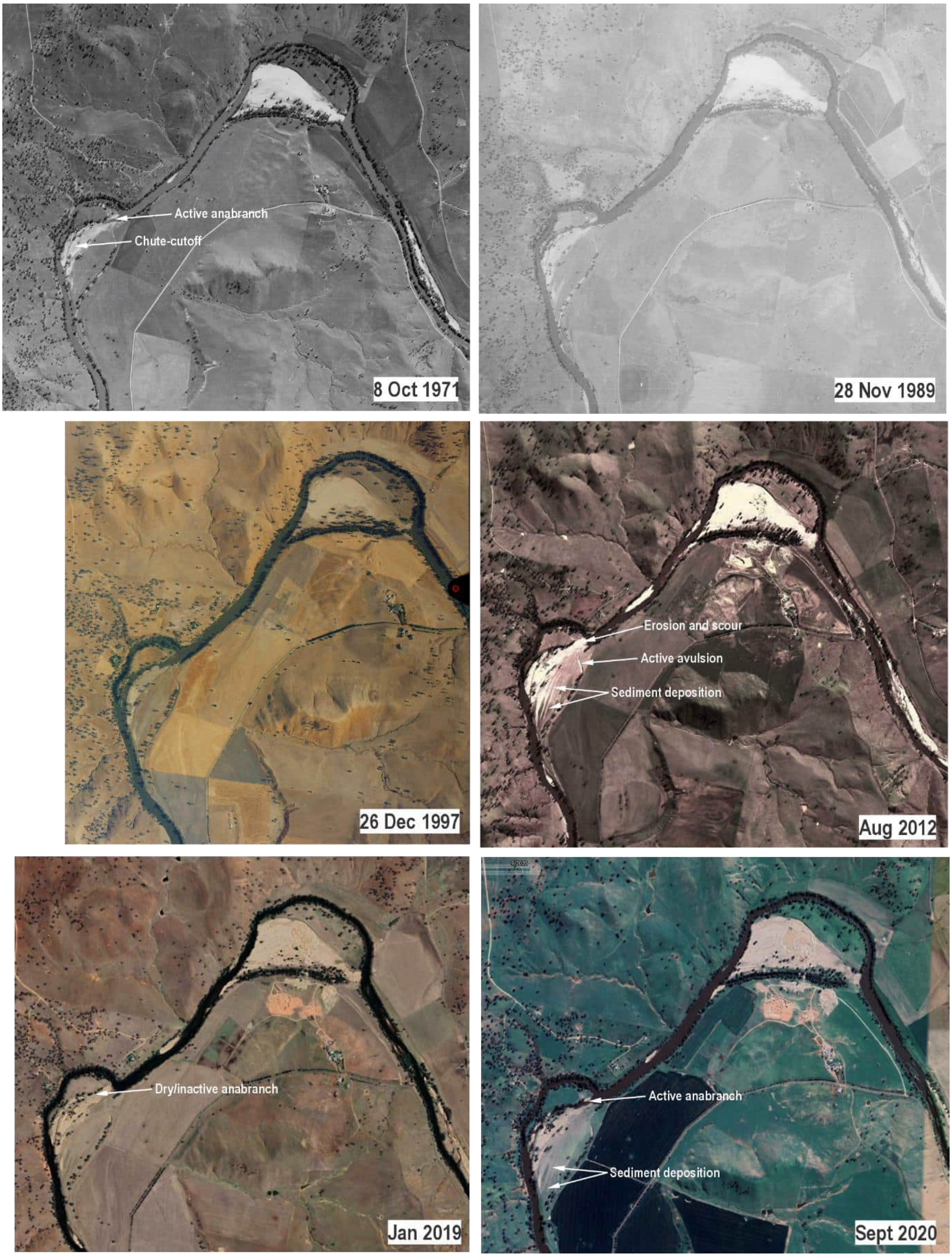


Figure 4-6 – Historical aerial imagery showing evolution of the existing environment

4.5.2 Existing Flow Scenario

Under the existing scenario, flows of a 50% AEP inundate and activate the temporary anabranch to a maximum depth of 3.3 metres and a maximum bed shear stress of approximately 95 N/m^2 (

Figure 4-7). Shear stress thresholds for various sediments and other boundary materials are depicted in Table 4-3, and reveal that flows of the 50% AEP are able to erode gravel sized (>150 mm) sediments and thus are capable of eroding material / sediments within the anabranch.

Under a 20% AEP, flows extend to inundate the chute-cutoff and activate the eastern avulsion, with flood depths up to approximately 3.8 metres and a max bed shear stress between 4 N/m^2 to 120 N/m^2 within the avulsion (

Figure 4-7). Under this scenario flood waters encroach upon the northern margin of the extraction site and are capable of eroding materials within the chute-cutoff and the avulsion channel.

Under a 5% AEP, flows inundate the proposed extraction area with depths between 1.0 to 3.5 metres. Bed shear stress values across the submerged quarry site range from 6 N/m^2 to 30 N/m^2, which exceeds the threshold for cohesive alluvial soils, sands and medium-grained gravels. Under this scenario flood waters are capable of eroding materials across the existing floodplain.

Table 4-3 Shear stress thresholds for various boundary layers using the Wentworth Grainsize Classification

Boundary layer	Shear stress threshold range (N/m^2)
Cohesive alluvial soil with occasional gravel	12 – 20
Coarse sand (1 mm)	1.44
Gravel (25 mm)	16
Gravel up to pebble (50 mm)	32
Gravel up to cobble (150 mm)	95
Jute mat (matting over soil)	22
Short native and bunch grass	34 – 45
Long native grasses	57 – 81
Coconut fibre with net	108
Mature trees, shrubs and grasses (structurally diverse vegetation)	80 – 120

4.5.2.1 Historical Floods

Flows modelled for the site under the existing scenario were compared against historical floods on the Murrumbidgee River in 1925, 1974, 2010, 2012 and 2022 to provide a historical context for inundation of the floodplain and proposed extraction site.

During the 1925 and 1974 flood events, flows (measured in ML/day) exceeded flows modelled for the 2% flood event at the site when compared to historical records from a downstream gauging station (410004) at Gundagai[3]. Although not a direct comparison to flows modelled for the quarry site, it can be inferred that the proposed quarry site would have been inundated during the 1925 and 1974 floods and likely experienced erosion of floodplain materials.

During the 2010, 2012 and 2022 flood events, flows (measured in ML/day) exceeded flows modelled for the 5% flood event at the site when compared to historical records from an upstream gauging station (410068) at Glendale[4]. Similarly, although not a direct comparison, it can be inferred that the proposed quarry site would have been partially inundated during the 2010, 2012 and 2022 floods, and likely experienced some erosion. Aerial imagery from 2012 and 2020 depicted in Figure 4-6 correlates this finding and reveals evidence of erosion and sediment deposition on the existing floodplain and proposed site.

[3] When compared to historical flows recorded downstream at Gundagai, gauging station 410004. It is noted that this gauging station includes flows from the Tumut River and is not a direct comparison to modelled flows from the gauging station (410195) directly upstream of the site.

[4] When compared to historical flows recorded upstream at Glendale, gauging station 4410068. It is noted that this gauging station records flows upstream in the catchment and is not a direct comparison to modelled flows from the gauging station (410195) directly upstream of the site.

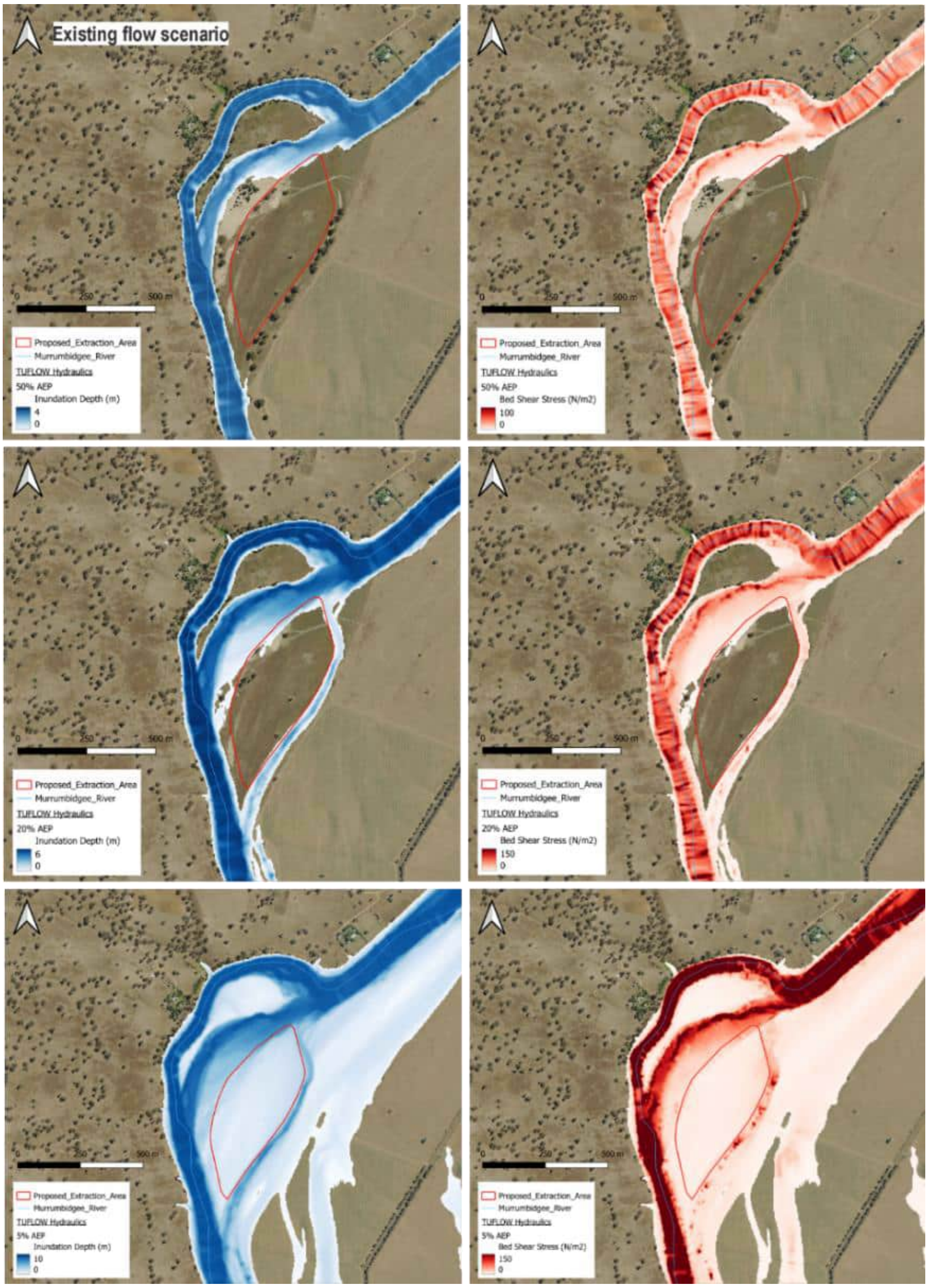


Figure 4-7 – TUFLOW outputs under the existing flow scenario for the 50%, 20% and 5% AEP flow events

5.0 Quarry operation impact assessment

This chapter provides an assessment of the operational impacts of the proposal.

5.1 Flooding

Flood behaviour upstream and downstream of the proposed extraction area during the operation period has been modelled using TUFLOW software. Flood mapping for the range of events modelled, using data from the upstream gauge (Murrumbidgee River at Upstream Gobarralong Bridge (No. 410195)), is provided in Appendix C, with flood difference mapping provided in Appendix D. Additional discussion on the results of the flood modelling are included in Section 5.5.

5.1.1 Flood depths and elevations

The mapping in Appendix C indicates that the proposed extraction area is modelled to be inundated in frequent events, including the 1 Exceedance per year (63% AEP) flood event to a depth of up to 0.25 metres and above 0.25 metres in the 50% AEP event. Differences in flood levels, velocity and shear stress are minimal for these events.

In the 10% and 20% AEP events, the proposed extraction area is modelled to be flood up to 4.0 metres deep, with the break out channel on the eastern side of the site coming into operation. Minor increase in flood level have been modelled on the upstream end of the proposed Quarry pit, with decreased in flood levels upstream to the approximate location of the existing Quary.

The site has been modelled as totally inundated during the 5% AEP event, with depths above 5.0 metres deep. Increases in flood levels have been modelled at the upstream end of the proposed extraction area, extending to the downstream end. Decreases in flood elevation have been modelled in the break out channel to the east of the pit, and upstream of the proposal a distance of 10 kilometres.

Flood depths across the proposed extraction area have been estimated to be above 5.0 metres in the 1% AEP event, with peak flood elevation of 230.5 metres AHD. Flood level impacts are of a lower range than the 5% AEP event.

5.2 Site water management

5.2.1 Operational water management

5.2.1.1 Site drainage

As outlined in Section 4.2, there are no existing overland flow paths or local water courses that drainage through the proposed extraction area. During operations, diversion of runoff from undisturbed catchments by use of small diversion drains and berms is required to maintain access to the extraction area. The layout will be developed with similar water management features to the example from Figure D1 from Managing urban stormwater: soils and construction – Volume 2e mines and quarries, presented in Figure 5-1.

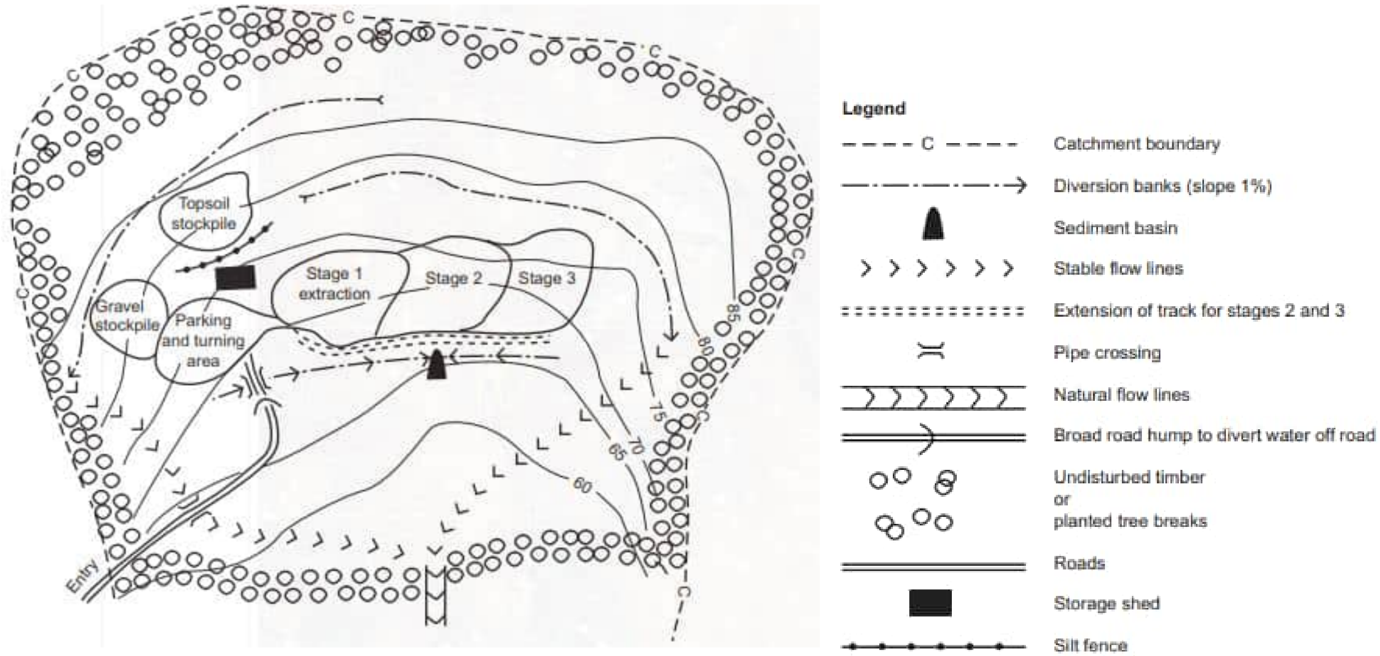


Figure 5-1 – Conceptual layout example quarry

This will also prevent flow from undisturbed areas and off site from entering quarrying operations. The site will be progressively rehabilitated (vegetation).

5.2.1.2 Proposed Extraction Area

Within the proposed extraction area, diversion measures such as berms and small drains will direct flow away disturbed areas and the extraction area to a low collection sump within the pit. This will maintain access to the proposed extraction area and divert all potentially sediment-laden runoff from disturbed areas of the site within the proposed extraction area to a sediment storage area.

5.2.1.3 Dust suppression

The proposed extraction area will use captured runoff and water for dust suppression of unsealed roads and disturbed areas. This dust suppression will be by use of a single water cart applying water as required at a maximum rate of 12,000 litres per hour. Dust suppression will occur on an as-needs basis and is discussed as part of the water balance modelling Section 5.2.2.

5.2.1.4 Licenced discharges

If discharge of excess water from the site is required as part of operations, this will occur via a licensed discharge point (LDP) to Murrumbidgee River.

5.2.1.5 Potable water usage

Potable water and wastewater use for the proposal will utilise the facilities at the existing quarry for amenities and drinking water.

5.2.2 Water balance modelling

A preliminary water balance model has been developed for the operation of the proposal. A detailed report is provided in Appendix E.

5.2.2.1 Methodology

The WBM was developed in the GoldSim modelling package (Version 14.0). GoldSim is a software program developed by the GoldSim Technology Group (GTG, 2004) that can analyse complex time-dependent systems and has the ability to assess stochastic systems resulting in probabilistic outcome ranges.

A conceptual model for the surface water management on site is represented in Figure 5-2, indicating the key site features and the water balance model boundary. The conceptual model includes the proposal including design depth, area, groundwater inflows, with water used for dust suppression of the road and quarry operational areas.

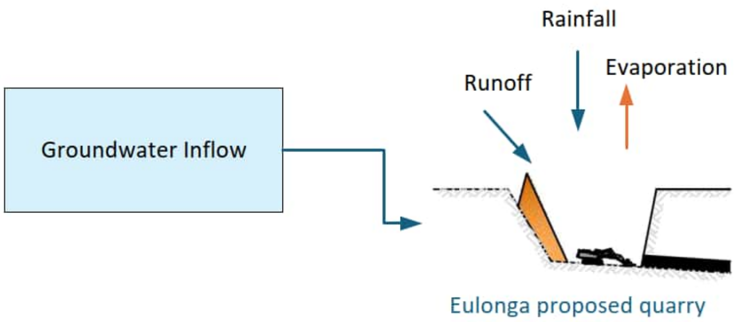


Figure 5-2 – Conceptual WBM of the proposed quarry

The water balance model has been simulated for a period of ten years of operation with a range of rainfall conditions, statistically equivalent to the historical records, to allow for the calculation of percentiles of key model outputs. These percentiles represent the results range due to the variability in the climate. The key assumptions and inputs of the model include:

- A total of volume of groundwater inflow cannot exceed the 2 ML/yr (WaterNSW 2020), as a conservative assumption this groundwater rate will be included as an average daily flow in the simulation.
- The WBM utilises the Australian Water Balance Model (AWBM) rainfall runoff module to calculate the rainfall and runoff inflows from the catchment.
- Seepage is considered negligible to zero.
- Initial water level for the start of the simulation corresponding to the minimum elevation of the DEM dated October 2024, 222 m AHD.
- Groundwater interaction and connection are excluded from this assessment.
- There is no external catchment runoff contributing to the proposed extraction area, as the pit functions as a self-contained turkey nest.
- Assumptions for operations: The proposed extraction area will operate ~5.5 days per week, ~48 weeks of the year ~264 operational days.
- The dust suppression target demand corresponds to NPI benchmark of 2.0 L/m2/h based on Air Quality Report (SLR, 2025). This target will be applied to the road area of 0.75 ha (5m wide and 1.5km length). However, in practice this may be reduced through the implementation of dust suppression additive.

- SLR will estimate the surplus water available in the pit, based on the conceptual WBM (Figure 5-2), to determine the volume of water that can be allocated to meet the road's dust suppression requirements. Additionally, the WBM will provide an average estimation of the number of dry days per year during which the pit will require dust suppression for the road.
- The stage-storage and surface area relationship curves were developed from the pit design.

5.2.2.2 Results and conclusion

The results of the water balance modelling indicate that:

- The proposed extraction area is expected to maintain low water levels throughout the 10-year simulation period, primarily driven by the interaction between inflows and, evaporation.
- The simulation results confirm that no water spills are anticipated from the quarry pit during the operation, even under wet climate conditions. This outcome is attributed to the high daily evaporation rates, which consistently exceed rainfall and runoff contributions, effectively preventing the accumulation of surplus water within the pit.
- The site requires approximately 7.5 ML/yr to reduce the impact of dust. However, this can be reduced to less than 2.0ML/yr through the implementation of additional water management measures.

Recommendations:

- Eulonga Quarry has advised SLR that Eulonga Station is a large land holding of more than 400ha and would have allowance of at least 28ML under the harvestable rights and therefore water for dust suppression if required will be sourced either from onsite supplies under the NSW 'Harvestable Rights' dam provisions or purchased from a licenced water supplier.
- Incorporate a dust suppressant additive to reduce the demand of water usage. For example, Vital Bon-Matt HR, a dust suppressant supplied by Vital Chemicals Pty Ltd, which has demonstrated reduction rates of up to 90% for haul road dust suppression.
- Additional operational management measure such as:
    - during dry conditions and when wind directions are not being blocked by the hills during dry conditions. Maintain awareness of where the dust plumes are going – if a dust plume is heading in the direction of a residence, stop operations until the wind direction shifts.
    - use of speed limits for various parts of the site including access roads to minimise wheel-generated dust emissions
    - dropping loads carefully into trucks e.g. minimising bucket drop heights
    - keeping a detailed record of dust complaints and addressing complaints properly.

Consideration of the model:

The accuracy of the model outcomes depends on the understanding of the conceptual model established at the outset. Given the significant number of assumptions incorporated in the model, it is imperative that these assumptions be revised and validated by the client.

The results obtained align with the assumptions and estimates based on the available data at the time of model development.

5.3 Surface water quality

The site is not inundated from river flooding during period of normal flow, with flow from the river entering the proposed extraction area during high flow events. Runoff from active areas drains to the proposed extraction area, with no overland flow entering the site from local upstream watercourses and tributaries.

Extraction activities could present a risk to water quality in receiving watercourses / waterbodies if mitigation and management measures are not effectively implemented. Potential sources of water quality impacts from the proposal include the following:

- Topsoil stripping.
- Increased sediment loads from exposed soil could be transported off site during rainfall events, and from the discharge of sediment-laden water. For the proposal, this could have the potential for soil erosion to discharge into the Murrumbidgee River and decrease water quality.
- Increased levels of nutrients, metals and other pollutants from extraction near watercourses and stormwater drains could be transported in sediments to downstream watercourses or via discharge of wastewater to nearby watercourses. The proposal could result in higher rates of export for the pollutants relative to existing conditions.
- Spills or leaks from quarrying machinery (including chemicals, oils, grease, and petroleum hydrocarbons), hazardous materials from chemical storage areas and gross pollutants such as litter could pollute downstream watercourses
- Tannins and other organic leachate from vegetation stockpiles could enter watercourses via runoff or discharge.

Without implementation of mitigation measures, the downstream effects on water quality impacts within the Murrumbidgee River could include:

- increased potential for bioaccumulation of heavy metals in aquatic species
- reduced dissolved oxygen levels that could impact aquatic species
- increased sedimentation smothering aquatic life and affecting aquatic ecosystems
- increased turbidity levels affecting aquatic species and the aesthetics of the water for recreational activities
- changes to water temperature due to reduced light penetration.

The likelihood and magnitude of potential impact would vary depending on the stage of extraction, the area of disturbance, and occurrence of high rainfall or wind weather events.

Potential impacts to water quality would be minimised or avoided by implementing the measures provided in Section 8 of this report. Measures and procedures, including those defined by the Blue Book, to minimise potential impacts to water quality during operation of the proposal. The Blue Book requires that treated runoff discharging from a construction site contain TSS concentrations of no greater than 50 mg/L and have a pH of between 6.5 and 8.5, which is in accordance with the water quality objectives provided in Section 3.2.3.1.

The proposal will result in ground disturbance, in particular close to drainage systems and on steeper slopes within the pit could result in water quality impacts through erosion and sedimentation. Stripping of topsoil should be undertaken during dry periods, with material stored away from flood prone land. Runoff from stockpiles has the potential to impact downstream water quality during rainfall if stockpiles are not managed appropriately. Sediments from the stockpiles have the potential to wash into watercourses, increasing levels of turbidity and resulting in transport of contaminants and impacts generally as described above.

Stockpiling cleared vegetation creates a risk of tannins leaching into watercourses, resulting in an increased organic load. Discharge of water high in tannins can increase the biological oxygen demand of the receiving environment, which can in turn result in a decrease in available dissolved oxygen. Once discharged to the environment, tannins can also reduce visibility, light penetration, and change the pH of receiving waters. The limited removal of trees and vegetation for the proposal, is unlikely to result in large volumes of tannins entering receiving waterbodies.

Sediment loads in watercourses can increase in the vicinity of hard surfaces (such as access roads) and compacted areas (within the quarry) due to increased surface runoff.

Gross pollutants (such as litter) and accidental spills or leaks (including chemicals, oils, grease, and petroleum hydrocarbons) could occur from the use, maintenance or re-fuelling of mobile equipment. These can affect general water quality including through accumulation of material in watercourses and changes in chemical composition of receiving waters. In addition, these pollutants can be ingested by aquatic fauna and result in dead or sick marine life.

5.4 Groundwater

The main risks to the groundwater environment from operation of the proposal may include:

- Reduction in groundwater to a receptor and direct drawdown to receptors due to groundwater dewatering.
- Contamination of groundwater from accidental spill, poor water management or other operational activities.

5.4.1 Impact of groundwater levels flow and connectivity

As described in Section Groundwater3.2.4, the proposal is unlikely to intercept the groundwater table. However, approximately 2 ML/year of groundwater may be extracted from bores or directly from the proposed extraction area for dust suppression.

The resulting potential reduction in groundwater discharge to Murrumbidgee River is expected to be negligible given that the water is being applied to the site for dust suppression. The annual groundwater extraction represents approximately 0.0002% of the annual flow of the Murrumbidgee River 8 km upstream from the extraction area and is expected to be offset by rainfall recharge.

Groundwater drawdown was estimated using the Cooper-Jacob (1946) solution for unconfined aquifer. Drawdown (s) can be estimated when groundwater inflow (Q), transmissivity (T), time (t), storage coefficient (S), and radius (r) are known

$$s = \frac{2.3Q}{4\pi T} log \frac{2.25Tt}{r^2 S}$$

Extracting 2 ML/year from the centre of the extraction area for 50 years, is expected to result in drawdown that will be locally constrained within the proposed extraction area.

5.4.2 Impacts on groundwater quality

There is potential for infiltration and contamination of groundwater as a result of accidental spills (e.g., chemical and/ or fuel), disturbance of sediment, and/ or stormwater mismanagement during the operational phase of the Project. Any accidental spill that interacts with the neighbouring groundwater environment could result in a degradation of groundwater quality.

The likelihood of occurrence of accidental spills is considered very low and where quality impacts exist, they are anticipated to be minor due to the short-term (temporary) nature of quality impacts in the water environment. The Murrumbidgee River downgradient receptors are vulnerable to adverse effects from any quality issues that may arise from the proposal. However, if any spills occur the contaminated sand would be immediately removed to minimise infiltration into groundwater.

5.5 Geomorphology

For the operational scenario, bed levels for the proposed extraction area are 4m lower than the existing floodplain elevation and sit at approximately the same bed level as the eastern avulsion (Figure 5-3). This assumption is based on the currently proposed design for the site.

Under the operational scenario, flows of a 50% AEP inundate the proposed extraction site by approximately 0.5 metres with a maximum bed shear stress of approximately 0.9 N/m^2 within the extraction area. These bed shear stress values are unlikely lead to erosion of sediment within the extraction area. Bed shear stress values increase to a maximum of 8 N/m^2 at the northern margin of the site and are capable of eroding sand-sized sediments (Figure 5-3). Analysis of the site cross section reveals the depth of inundation under the 50% AEP (Figure 5-3).

Under the 50% AEP it is likely that flood waters would pond within the extraction site and drain towards the north into the chute-cutoff and anabranch as river levels fell. As inundation is minimal flood waters can be expected to either recharge into groundwater through the permeable sediments or slowly recede.

Under a 20% AEP, flows extend to inundate the chute-cutoff, the proposed extraction site and the eastern avulsion, forming a near-continuous body of water across the floodplain. Analysis of the site cross section reveals the depth and extent of inundation site under the 20% AEP (Figure 5-3). Flood depths within the proposed extraction area are approximately 2.9 metres and bed shear stress values range from 2 N/m^2 to 15 N/m^2, capable of eroding cohesive alluvial soils, sands and fine-grained gravels. Bed shear stress values increase to a maximum of 120 N/m^2 at the northern margin of the site.

Under the 20% AEP the site captures a large portion of the Murrumbidgee flow and experiences significant inundation, connecting the chute-cutoff, extraction area and avulsion, with flood waters capable of eroding materials across the floodplain. This waterbody now has a greater hydraulic geometry and capacity than the Murrumbidgee River. As a result, the site will likely capture and transport the Murrumbidgee’s discharge and will result in an increased hydraulic gradient (water surface slope) through the proposed extraction area. This increased hydraulic gradient coupled with shear stress levels that exceed the threshold for erosion of alluvial soils, sands and fine-grained gravels are likely to trigger a large-scale avulsion and diversion of the Murrumbidgee River through the site.

This represents a high-risk scenario where there is a high risk that the site becomes the primary channel of the Murrumbidgee River, as discharge follows the new path of least resistance and the river forms a new shorter and straighter channel, bypassing the original channel pathway. Channel diversions are protected under the *Water Act 2000* and unplanned diversions of a major watercourse are cause for significant concern.

It is worth nothing that flood waters of the 1925, 1974, 2010, 2012 and 2022 historical floods all exceeded the modelled 50% and 20% AEP flows discussed here and would have led to significant inundation, erosion and scour at the proposed extraction site and likely triggered a large-scale diversion of the Murrumbidgee River. As discussed in Section 4.5.2.1 above, the 1925 and 1974 flood events are comparable to the 2% AEP and the 2010, 2012 and 2022 flood events comparable to the 5% AEP modelled for this project.

Table 5-1 Hydraulic results of quarry impact assessment

Quarry Impact Assessment	50% AEP Flow Scenario		20% AEP Flow Scenario	
	Inundation depth (m)	Bed shear stress (N/m^2)	Inundation depth (m)	Bed shear stress (N/m^2)
Operational Scenario	0.5	0.9 to 8	2.9	2 to 120

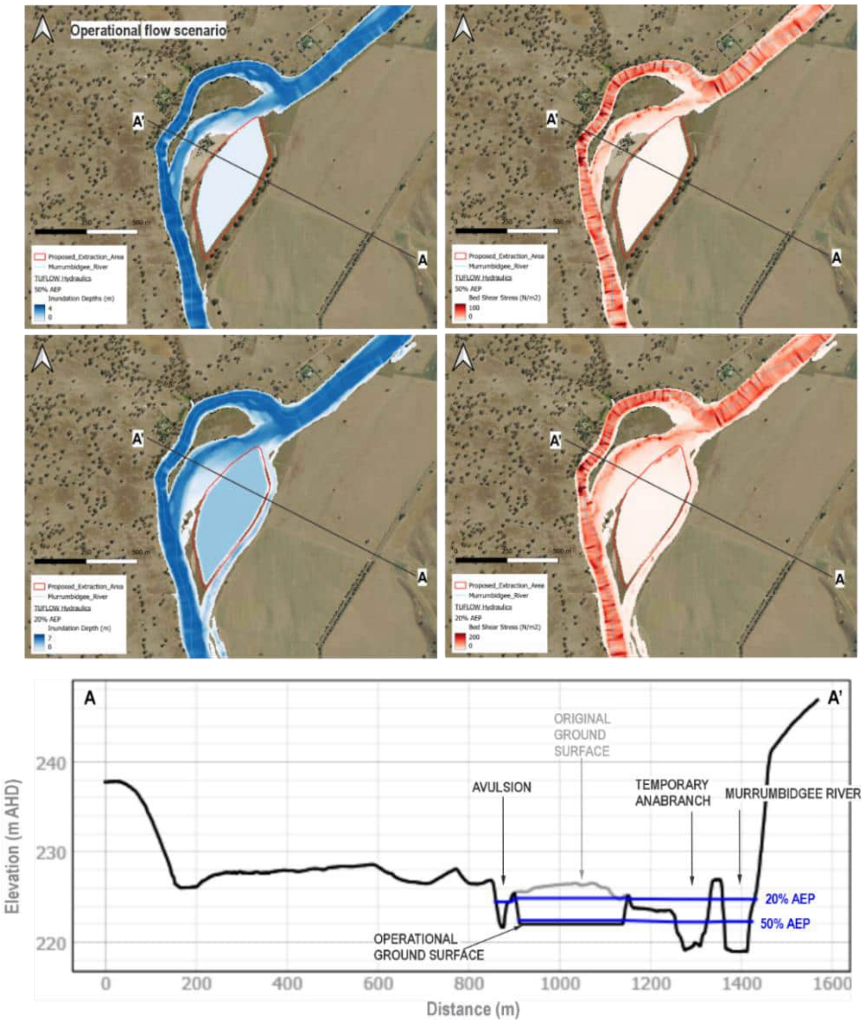


Figure 5-3 Operational landform scenario for the 50% and 20% AEP

5.5.1 Geomorphic assessment key findings

A summary of key findings of the geomorphic assessment addressing potential impacts and implications are presented below:

- Under the existing environment, floodwaters inundate the floodplain and proposed extraction area under a 5% AEP and are capable of eroding floodplain materials.
- Under the operational scenario where bed level depths are lowered by 4 metres, flows of the 20% AEP are likely to trigger a large-scale avulsion and diversion of the Murrumbidgee River through the site, representing a high-risk scenario.
- The 1925, 1974 historical floods (comparable to the 2% AEP) and the 2010, 2012 and 2022 historical floods (comparable to the 5% AEP) all exceeded the modelled 50% and 20% AEP flows discussed here and would have led to significant inundation, erosion and scour at the proposed extraction site and likely triggered a large-scale diversion of the Murrumbidgee River. It is not possible to directly compare potential impacts of the proposed extraction area with the existing Quarry upstream as the upstream site has a higher bed elevation.
- The geomorphic impact of the proposed extraction area under relatively modest flows are considered significant and high risk. Channel diversions are protected under the *Water Act 2000* and unplanned diversions of a major watercourse are cause for significant concern.

6.0 Cumulative impact assessment

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of a proposal when added to other existing, planned, and/or reasonably anticipated future projects.

The area surrounding the proposal is not currently the subject of significant development.

Cumulative stormwater impacts from proposed developments around the proposal would be managed in accordance with the NSW planning system which outlines objectives and controls which include:

- To manage the flow of the Murrumbidgee River and overland flows to replicate, as closely as possible, pre-development flows.
- To ensure an integrated approach to the management of water is considered to drive more sustainable water management outcomes.
- To ensure that water management measures for developments that incorporate key principles of water sensitive urban design to help protect, maintain or restore waterway health of identified high value waterways with a minimum requirement of maintaining current health, including:
  - protecting existing hydrological and ecological processes of these waterways including natural features and systems including watercourses, wetlands, lagoons and aquatic, riparian and groundwater dependant ecosystems
  - maintaining the natural hydrological behaviour of the catchment.

In accordance with the objectives and controls, future developments would include measures such as stormwater detention basins to mitigate increased stormwater flows.

7.0 Recommended safeguards and management measures

Design flood events have been assessed to understand the likelihood of potential flooding and geomorphologic impacts from the proposal to the surrounding tributaries and floodplain areas. The runoff management elements as they are currently proposed are predicted to cause minimal impacts on surrounding areas for events up to and including the one per cent AEP. The recommended operational safeguard to mitigate predicted impacts is shown in Table 7-1.

Additional potential operational impacts and recommended design considerations are shown in Table 7-1

Table 7-1 ***Potential operational impacts and recommended design considerations***

Risk	Potential impacts	Measures to avoid, mitigate or minimise impacts
Impact on surface flow in watercourse and flows in channels/drainage structures	Modified surface flow volume or rate downstream of the proposal	Design drainage elements within the proposal to minimise risk of localised surface water ponding.
	Changed surface flow paths across the proposal	Minimise regrading of terrain along the access road Install appropriately sized stormwater drainage pipes along the access road where applicable.
Impact of additional road hardstand	Increased runoff to watercourses	The impact of increased runoff to minor drainage lines should be managed by road design drainage mitigation measures.
Increased hazard from flooding	Impact to staff working on flood prone land.	Prepare high flow working and quarry flood risk management plans.
Impact of road construction and quarrying operations	Increased upstream flooding depths, extents and hazard Increased upstream flood durations	Velocity and depth modelling indicates that the proposal does not result in adverse hazard impacts to adjoining development.
Impacts to surface water quality	Decrease in water quality in receiving surface water environments (Murrumbidgee River)	A Soil and Water Management Plan (SWMP) will be prepared. The SWMP will identify reasonably foreseeable risks relating to soil erosion and surface and groundwater quality and describe how these risks will be addressed during construction. Site-specific Erosion and Sediment Control Plan/s will be prepared and

Risk	Potential impacts	Measures to avoid, mitigate or minimise impacts
		implemented as part of the SWMP. The plan/s will include: • arrangements for managing wet weather events, including monitoring of potential high-risk events (such as storms) and specific controls and follow-up measures to be applied in the event of wet weather • erosion and sediment controls appropriate for dispersive soils. Stabilisation measures will be installed to control discharge from stormwater outlets to manage erosion and scour. Where possible, the rehabilitation of disturbed areas will be undertaken progressively, as construction stages are completed, in accordance with the Appendix G (Rehabilitation recommendations) of *Managing Urban Stormwater – Soils and Construction – Volume 1* (Landcom, 2004)) and *Volume 2E – Mines and quarries* (DECC 2008). During any construction and maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction, Volume 1* (Landcom, 2004) and *Volume 2E – Mines and quarries* (DECC 2008).
Groundwater impacts	Decrease in water quality in receiving ground water environments	Impacts on groundwater during construction will be minimised as far as practicable by: • avoiding the need to extract groundwater • minimising groundwater inflows and volumes into excavations • managing any groundwater encountered during excavations

Risk	Potential impacts	Measures to avoid, mitigate or minimise impacts
Geomorphologic impacts on the Murrumbidgee River	large-scale avulsion and diversion of the Murrumbidgee River	Depth of the extraction area less than the depth of the temporary anabranch i.e. approximately 4 m below the 2014 LiDAR surface elevation. This acts to reduce the hydraulic geometry and therefore capacity during high flow events. As long as the proposed extraction area remains shallower than the temporary anabranch, inundation and high bed-shear stress is less likely to lead to large-scale incision at the site. The current operational landform depth of 4m below present ground level should meet these requirements, however a current LiDAR survey is recommended to refine this depth as the 2014 is significantly outdated. Undertake riparian planting along the northeastern boundary of the proposed extraction area. Development of mature native trees, shrubs and grasses (structurally diverse vegetation) are required to mitigate and reduce impacts from the 20% AEP, including a management plan for long-term maintenance and monitoring. The success of riparian planting should not be considered in isolation of the installation of timber pin rows.

8.0 Conclusion

This report has assessed and identified surface and groundwater impacts that could occur as a result of the operation of the proposed extraction area, located on the Murrumbidgee River.

The assessment indicated that the proposal is unlikely to result in serious adverse impacts to surface and groundwater, and the potential operation impacts discussed in this report are common on quarrying projects.

To understand the flooding risks and to identify relevant mitigation measures, flood modelling has been carried out to assess baseline flooding conditions and to predict the potential impact of the proposal on flooding regimes. No significant impacts have been identified in the flood modelling investigation. Flood risk management during operation of the quarry will be managed through the development of a site specific Flood Risk Management Plan.

Operation of the proposal is not predicted to intercept groundwater and therefore the proposal is not predicted to impact groundwater receptors, including groundwater dependent ecosystems and surrounding landholder bores.

Operational impacts on water quality would be mitigated by the site water management system. The proposal is modelled as unlikely to result in any off site discharges and as a result there would be no changes to the water quality of the downstream receiving environments of the Murrumbidgee River.

With the implementation of the safeguards and management measures provided in this report, and the installation of the proposed water quality treatment devices, potential impacts on soils, surface water and groundwater are considered minor and manageable.

9.0 References

ANZECC/ARMCANZ (2000). Australian Water Quality Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, October 2000

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Department of Planning and Environment (DPE), 2023, *Flood risk management manual – The policy and manual for the management of flood liable land*

Department of Planning, Industry and Environment (DPIE), 2020, *Climate Risk Ready NSW Guide – Practical guidance for the NSW Government sector to assess and manage climate change risks*

.   Appendix A

Model Summary Sheet

Eulonga Quary Proposed Extraction Area

Eulonga Quarries Pty Limited

SLR Project No.: 630.032007.00001

17 March 2025

Model Summary Sheet

SLR Project No.:	630.032007.00004	**Date:**	19 November 2024
Project:	Eulonga Quarry		
Prepared by:	Nigel Bosworth		
Distribution:	Eulonga Quarries Pty Ltd	James Graham	
	Nigel Bosworth, Chris Dzwinek		

Criteria/Parameter/Type	Value/Description	Source/Link	Comments/Departures
Models Used			
TUFLOW	2023-03-AE\TUFLOW_iSP_w64.exe	C:\TUFLOW\2023-03-AE\TUFLOW_iSP_w64.exe	
Topography			
1 metre LiDAR	Cootamundra201411 Tumut201411	download	Sourced from ELVIS TIF file
Operating quarry 1 metre LiDAR	DEM 1m Eulonga DES 4m Depth on existing surface	download	Sourced from Eulonga Quarries
Final quarry form 1 metre LiDAR	DEM 1m Eulonga DES 8m Depth on existing surface	download	Sourced from Eulonga Quarries
Flows/Gauged data			
Murrumbidgee River at Upstream Gobarralong Bridge	Station number 410195	http://www.bom.gov.au/waterdata/	Flows from LP III flood frequency analysis
ARR Data Hub Details			
N/A	N/A	N/A	N/A
Previous Models/Reports			
N/A	N/A	N/A	N/A
Recurrence Interval/Probability			
1 in 1.58 (1 EY)	108.88 m³/s	http://www.bom.gov.au/waterdata/	Flows from LP III flood frequency analysis
1 in 2 (50%)	139.86 m³/s		
1 in 5.52 (5 ARI)	510.45 m³/s		
1 in 10 (10%)	929.58 m³/s		
1 in 20 (5%)	1769.75 m³/s		
1 in 50 (2%)	4074.5 m³/s		
1 in 100 (1%)	7218 m³/s		

Criteria/Parameter/ Type	Value/Description	Source/Link	Comments/Departures
XXX year event	XXX m^3/s		
Storm durations modelled			
Steady State model	Values as above	http://www.bom.gov.au/waterdata/	Flows increased from 0 m^3/s to each listed AEP flows over 15 hours
Roughness			
Natural Channel	clean, regular section 0.03 some rocks and/or brushwood 0.07 very rocky or with standing timber 0.1	Table 6.2.1 from ARR	Mapped from aerial photography Normal roughness
Floodplains	short grass pasture 0.03 Brushwood 0.07 heavy timber or other obstacles 0.1	Table 6.2.1 from ARR	Normal roughness
Aerial photography			
NSW imagery from sixmaps	Added using AUSMap plugin in QGIS	AUSMap QGIS plugin	N/A
Building Obstructions			
Grid Size			
4 metre with Sub Grid Sampling (SGS) 2 metre	N/S aligned	TGC File	Based on LiDAR
Boundary Conditions			
Upstream boundary at location of gauge	8.5 km upstream of proposed site	Inflow boundary SA polygon	Steady state flow QT line and SA polygon
Downstream	3 km downstream of proposed site	Downstream boundary	Normal flow HQ line
Mapping outputs			
Water surface elevation Depth	h d	Water surface elevation Water depth	The model results have included

Criteria/Parameter/ Type	Value/Description	Source/Link	Comments/Departures
Velocity Shear Stress	V BSS	Velocity Shear Stress	surface water elevation in mAHD, water depth in metres, velocity in m/s and shear stress in Pounds Force per square foot (lbf/ft^2)
Coordinate System			
GDA94 MGA Zone 55	N/A	N/A	QGIS workspace and associated layers are all projected in GDA94 MGA Zone 55.

. # Appendix B

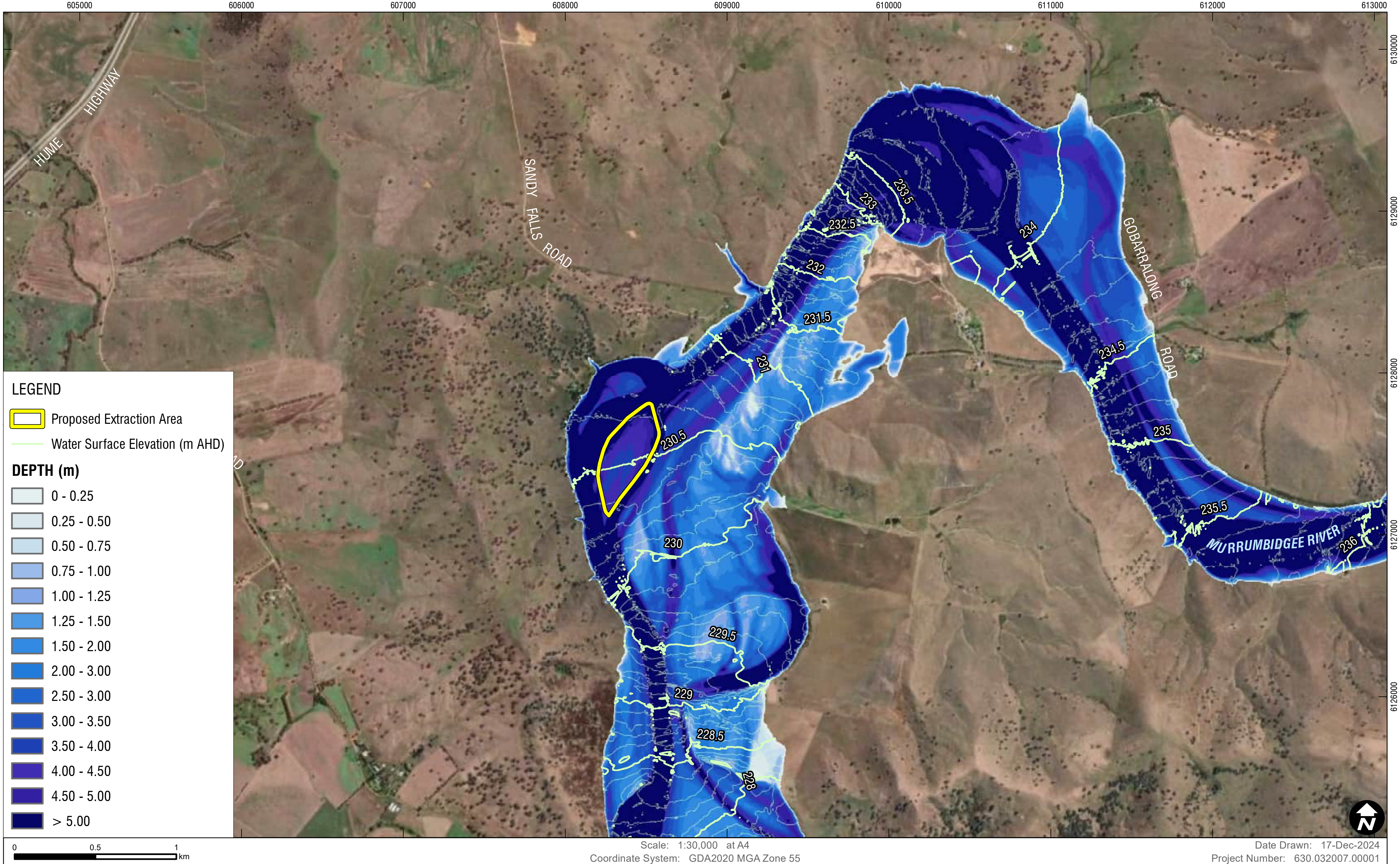
Existing flood mapping

Eulonga Quary Proposed Extraction Area

Eulonga Quarries Pty Limited

SLR Project No.: 630.032007.00001

17 March 2025



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

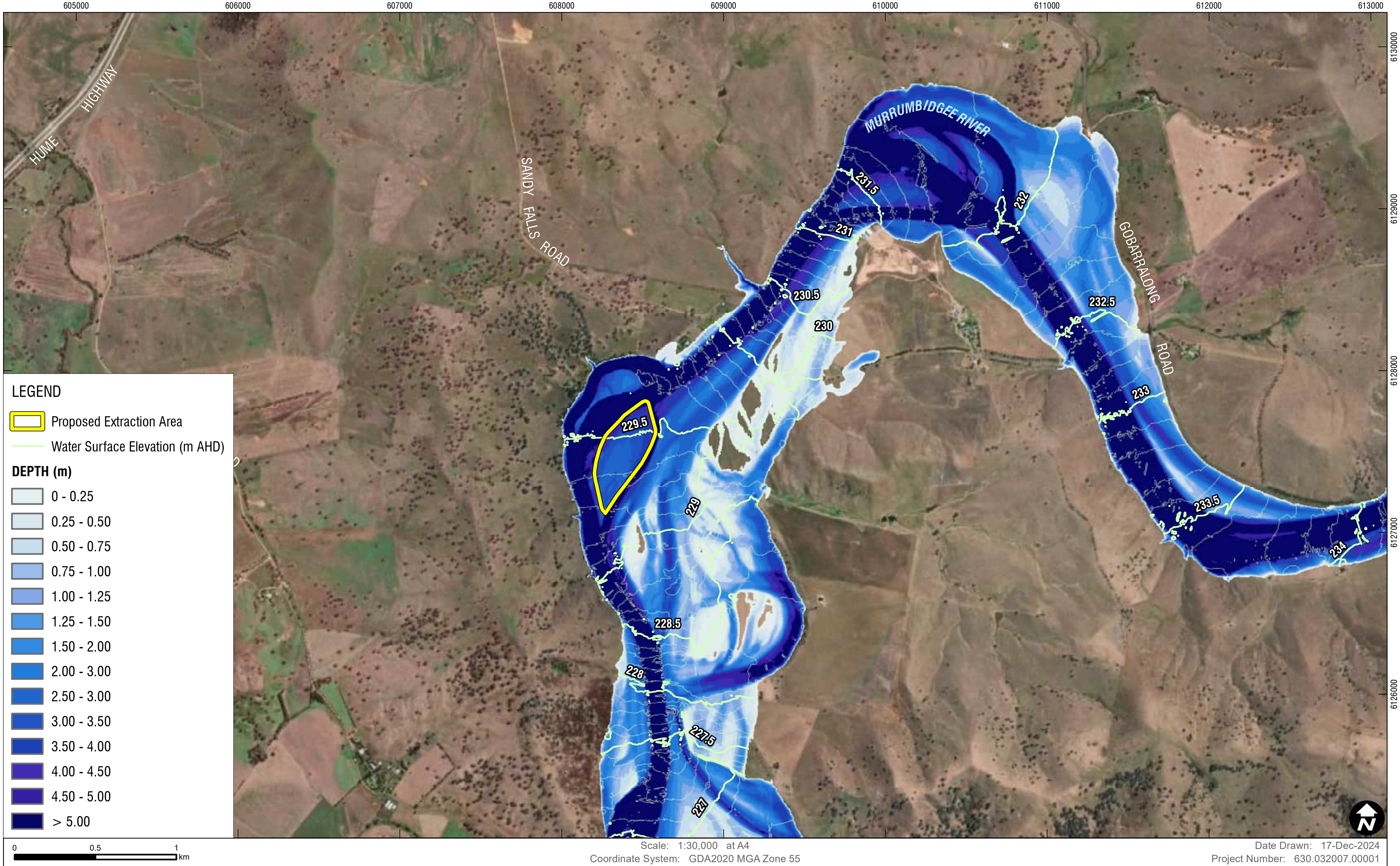
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD DEPTHS - 1% AEP

FIGURE B-1

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-1_E03_1pcAEP_DEPTH_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD DEPTHS - 2% AEP

FIGURE B-2

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-2_E03_2pcAEP_DEPTH_01.mxd

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

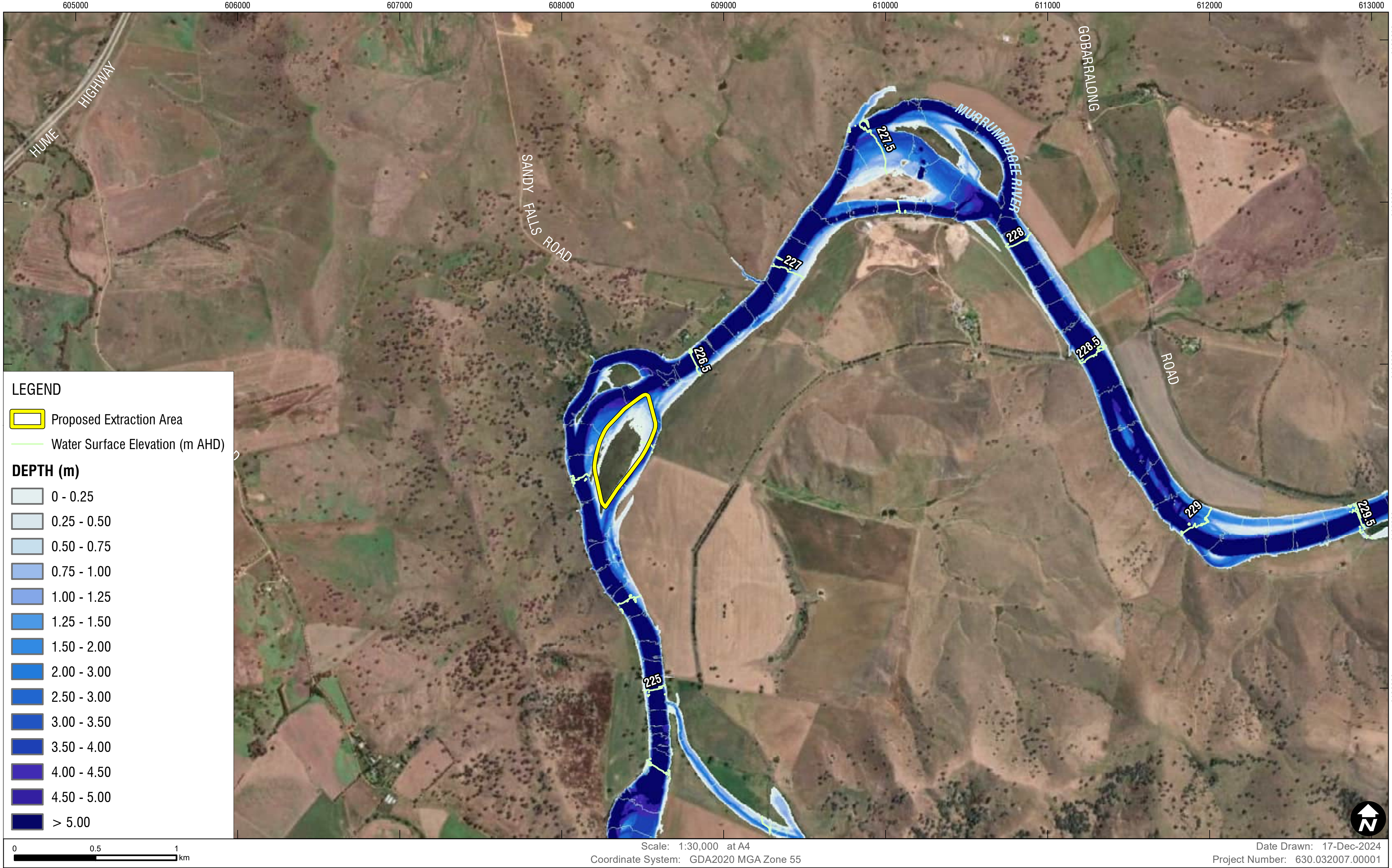
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD DEPTHS - 5% AEP

FIGURE B-3

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-3_E03_5pcAEP_DEPTH_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

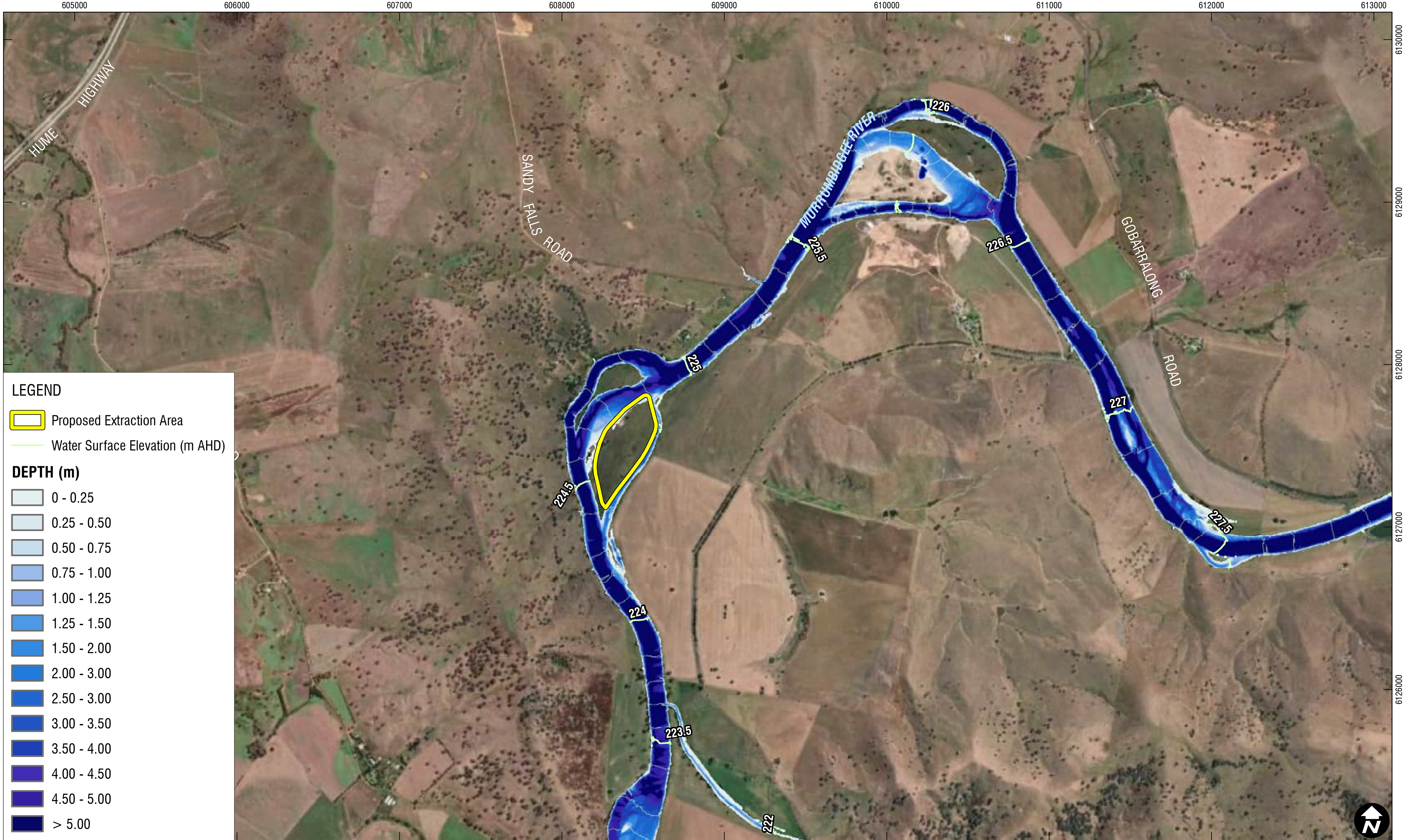
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD DEPTHS - 10% AEP

FIGURE B-4

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-4_E03_10pcAEP_DEPTH_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD DEPTHS - 20% AEP

FIGURE B-5

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO)
PEAK FLOOD DEPTHS - 50% AEP

FIGURE B-6

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-6_E03_50pcAEP_DEPTH_01.mxd

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

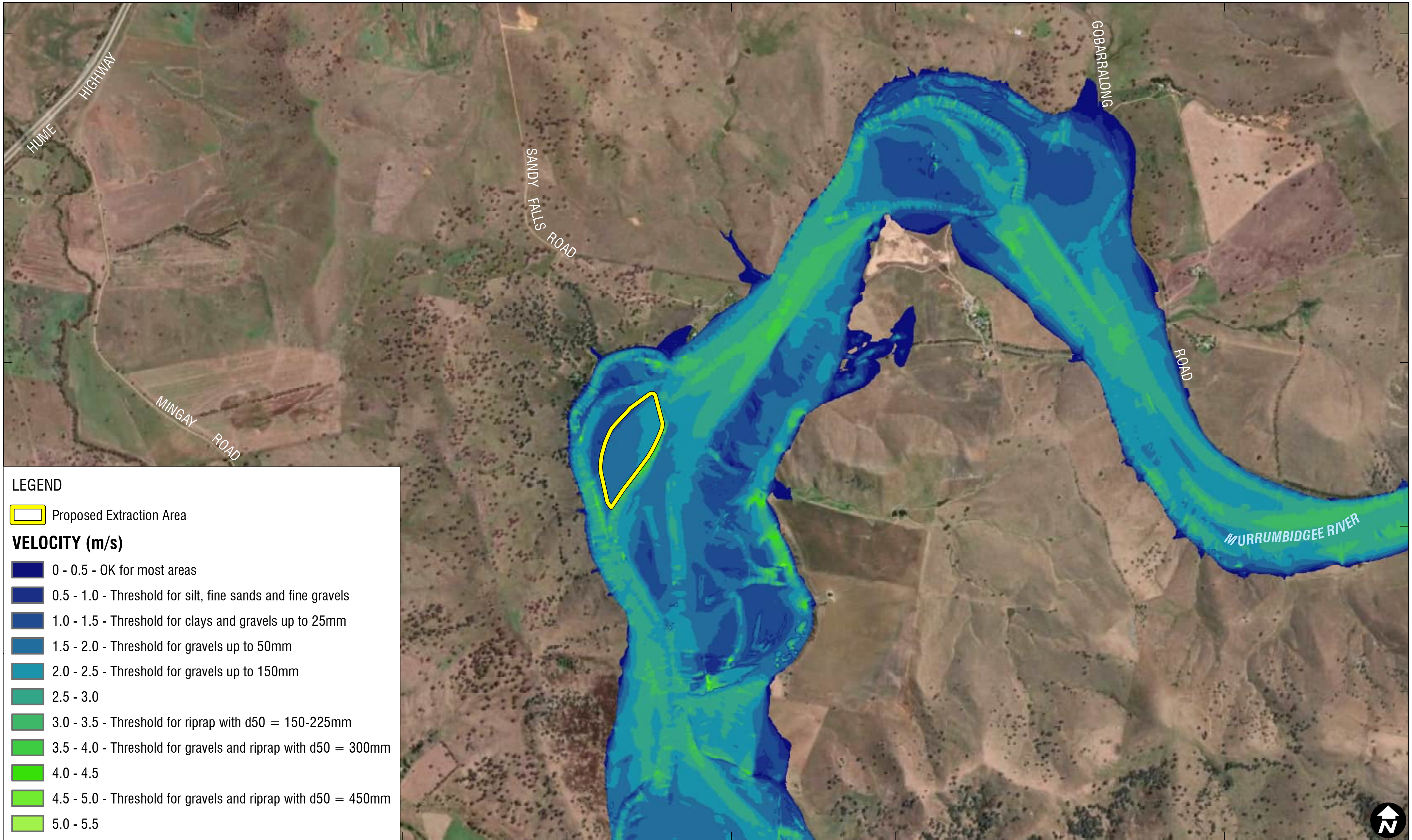
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO)
PEAK FLOOD DEPTHS - 63% AEP

FIGURE B-7

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-7_E03_63pcAEP_DEPTH_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

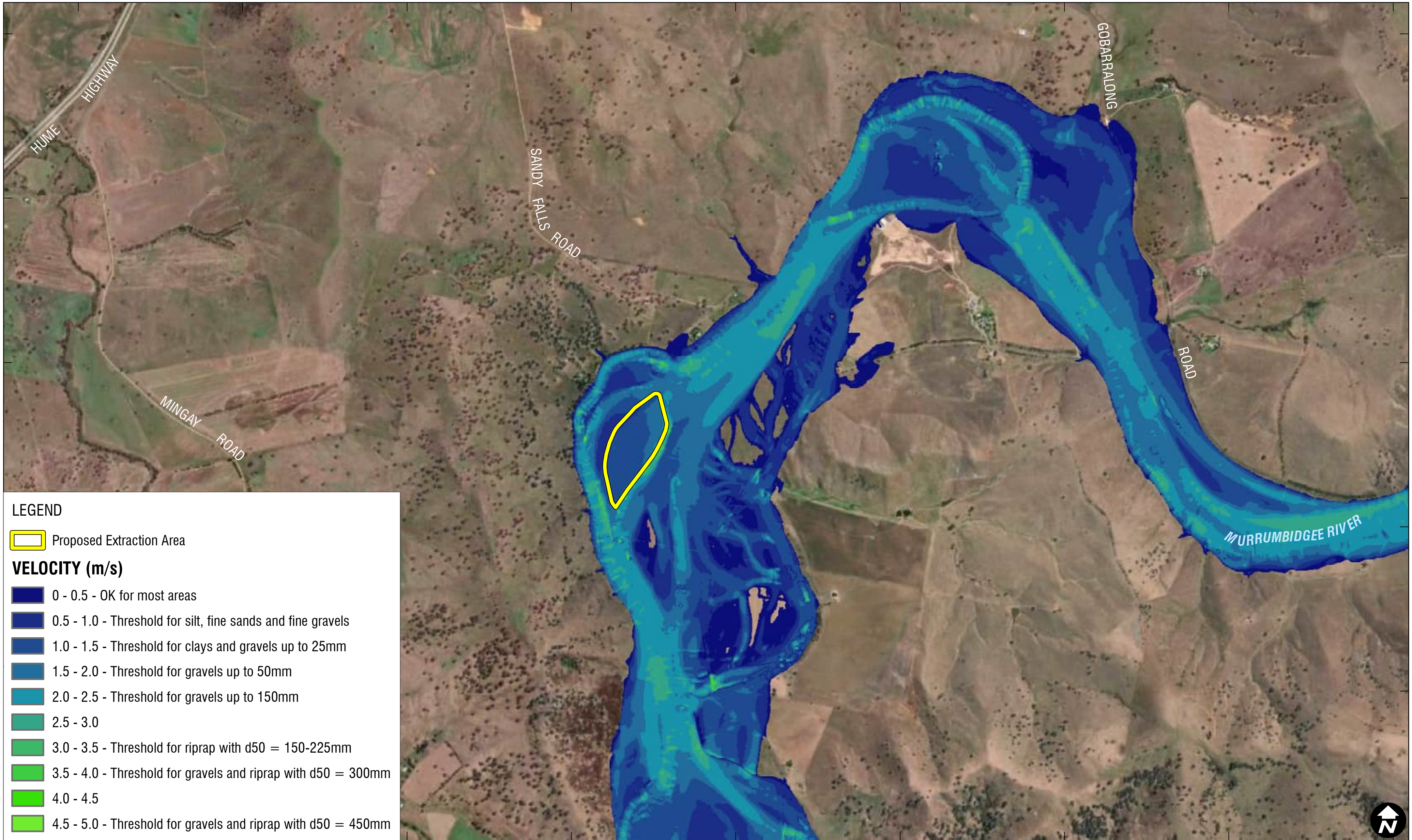
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 1% AEP

FIGURE B-8

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-8_E03_1pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

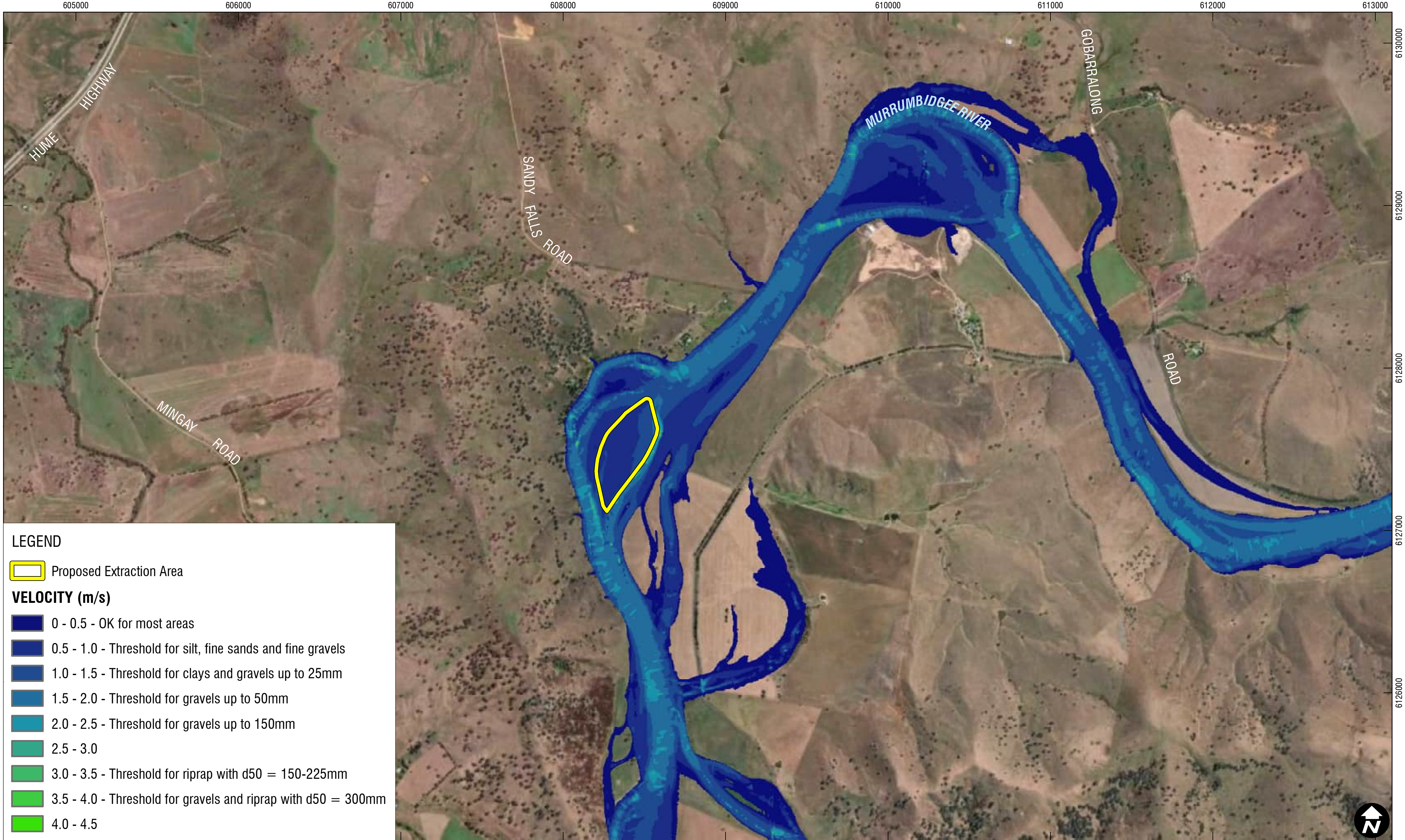
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 2% AEP

FIGURE B-9

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-9_E03_2pcAEP_V_01.mxd



LEGEND

Proposed Extraction Area

VELOCITY (m/s)

- 0 - 0.5 - OK for most areas
- 0.5 - 1.0 - Threshold for silt, fine sands and fine gravels
- 1.0 - 1.5 - Threshold for clays and gravels up to 25mm
- 1.5 - 2.0 - Threshold for gravels up to 50mm
- 2.0 - 2.5 - Threshold for gravels up to 150mm
- 2.5 - 3.0
- 3.0 - 3.5 - Threshold for riprap with d50 = 150-225mm
- 3.5 - 4.0 - Threshold for gravels and riprap with d50 = 300mm
- 4.0 - 4.5

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

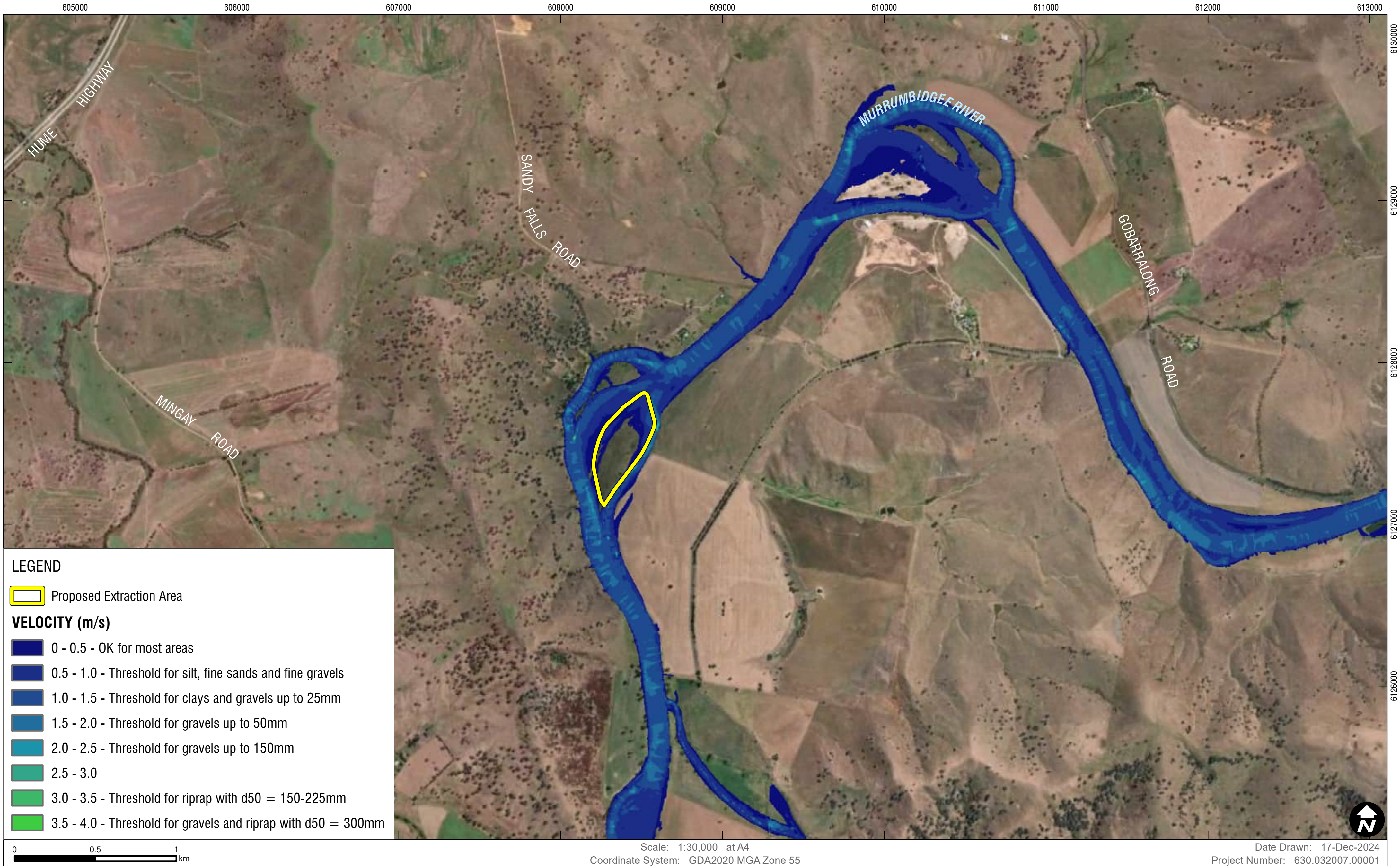
Data Source: Imagery ESRI Base Maps

SLR

**EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 5% AEP**

FIGURE B-10

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-10_E03_5pcAEP_V_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

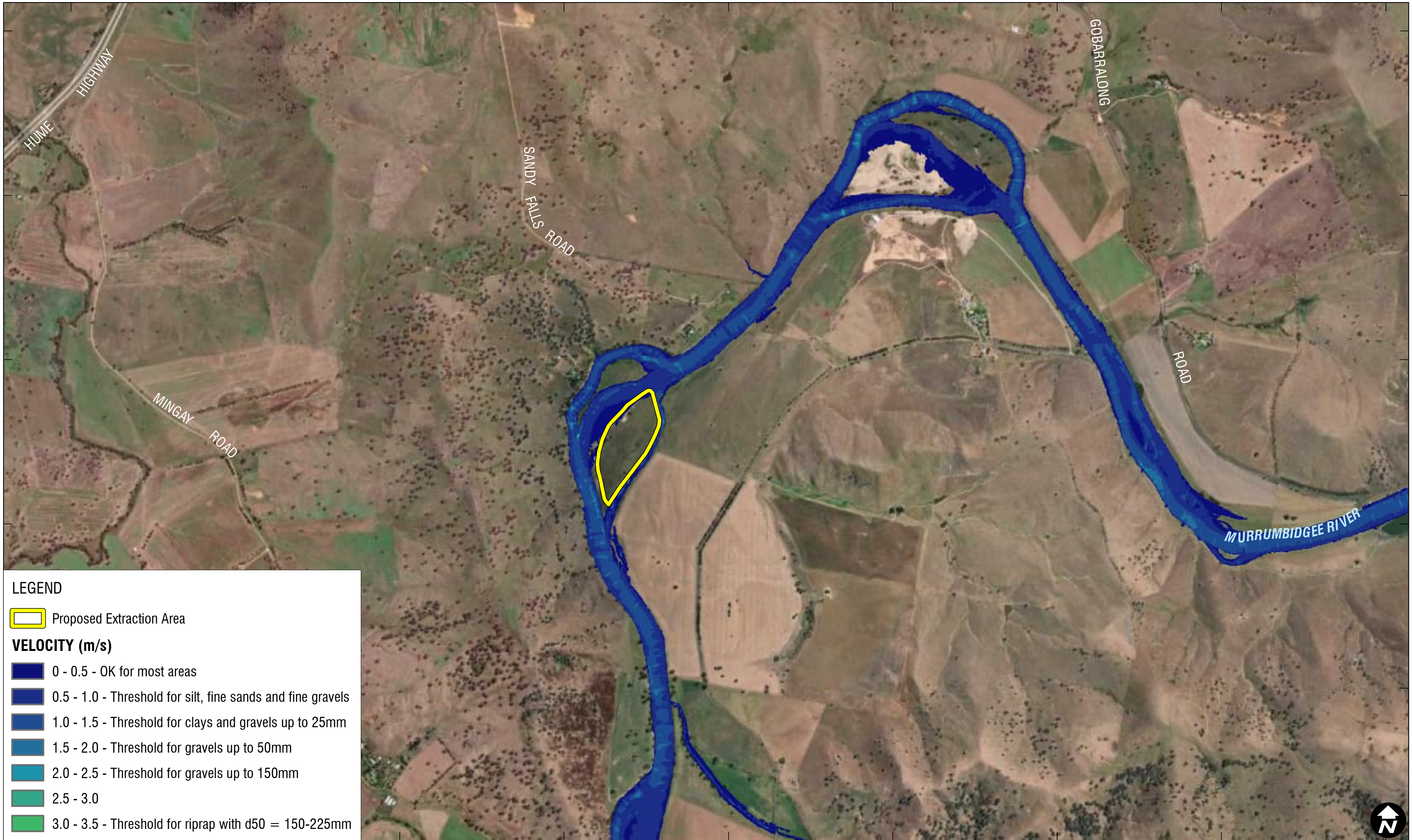
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 10% AEP

FIGURE B-11

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-11_E03_10pcAEP_V_01.mxd



LEGEND

Proposed Extraction Area

VELOCITY (m/s)

- 0 - 0.5 - OK for most areas
- 0.5 - 1.0 - Threshold for silt, fine sands and fine gravels
- 1.0 - 1.5 - Threshold for clays and gravels up to 25mm
- 1.5 - 2.0 - Threshold for gravels up to 50mm
- 2.0 - 2.5 - Threshold for gravels up to 150mm
- 2.5 - 3.0
- 3.0 - 3.5 - Threshold for riprap with d50 = 150-225mm

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

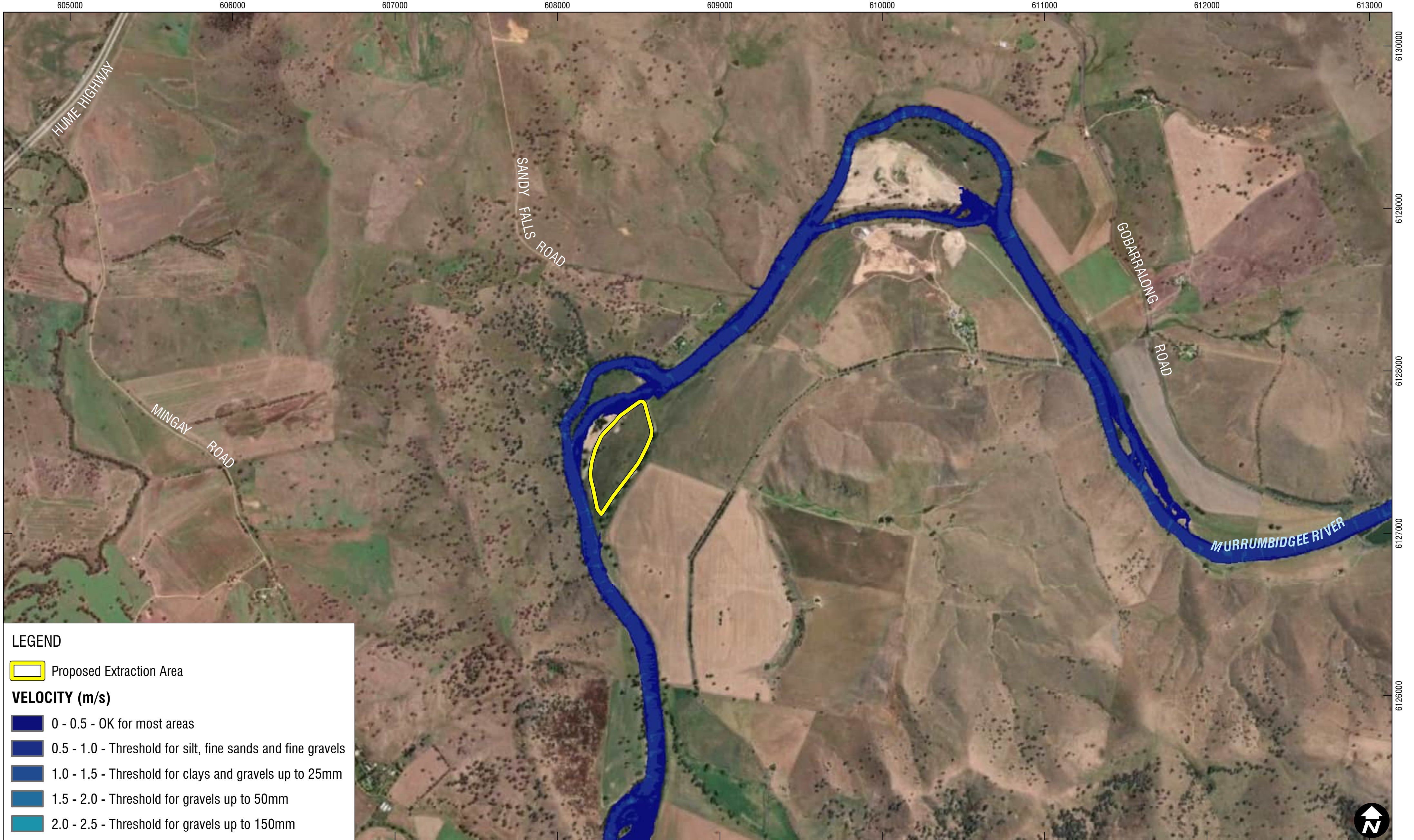
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 20% AEP

FIGURE B-12

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-12_E03_20pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

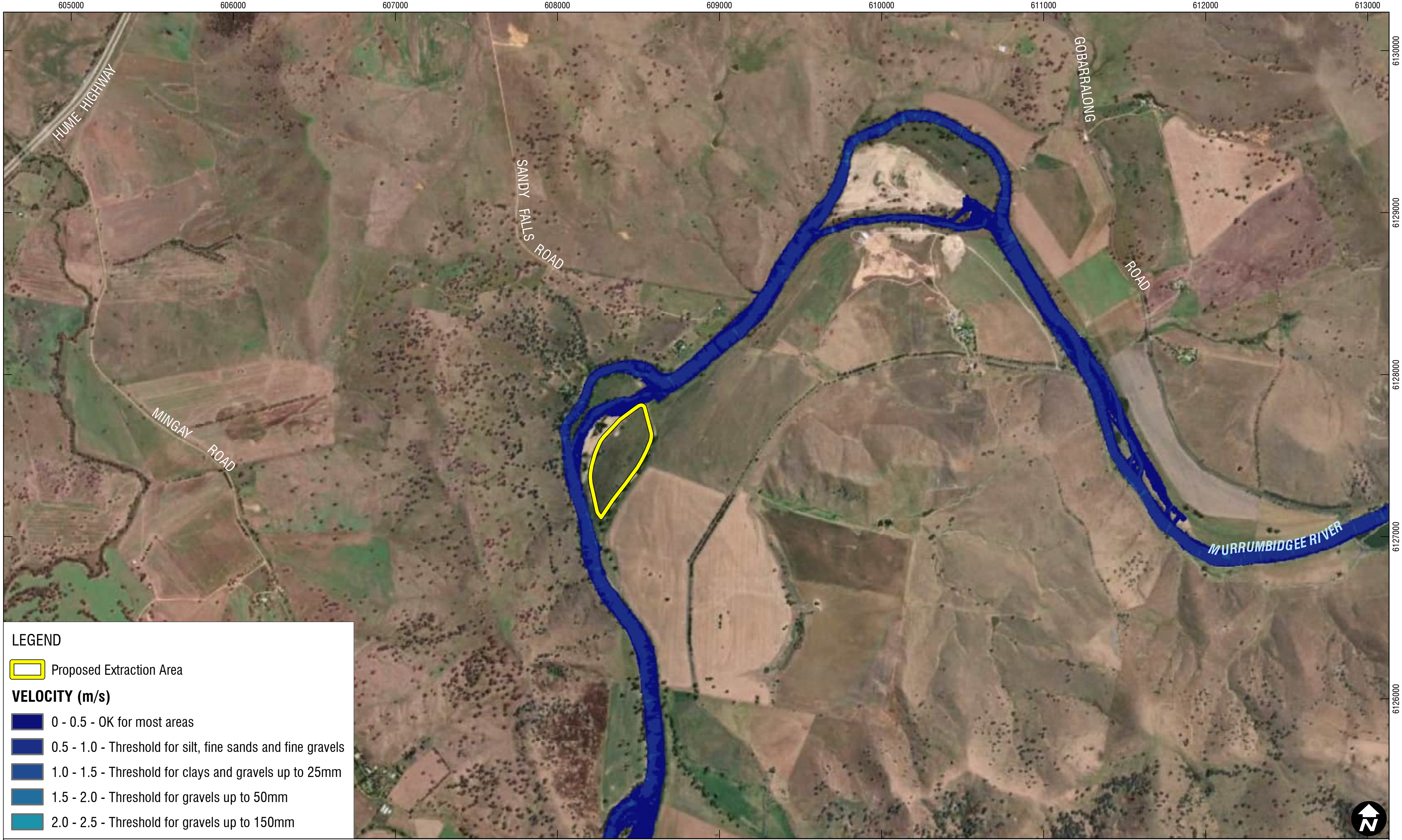
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 50% AEP

FIGURE B-13

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_B-13_E03_50pcAEP_V_01.mxd



LEGEND

Proposed Extraction Area

VELOCITY (m/s)

- 0 - 0.5 - OK for most areas
- 0.5 - 1.0 - Threshold for silt, fine sands and fine gravels
- 1.0 - 1.5 - Threshold for clays and gravels up to 25mm
- 1.5 - 2.0 - Threshold for gravels up to 50mm
- 2.0 - 2.5 - Threshold for gravels up to 150mm

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

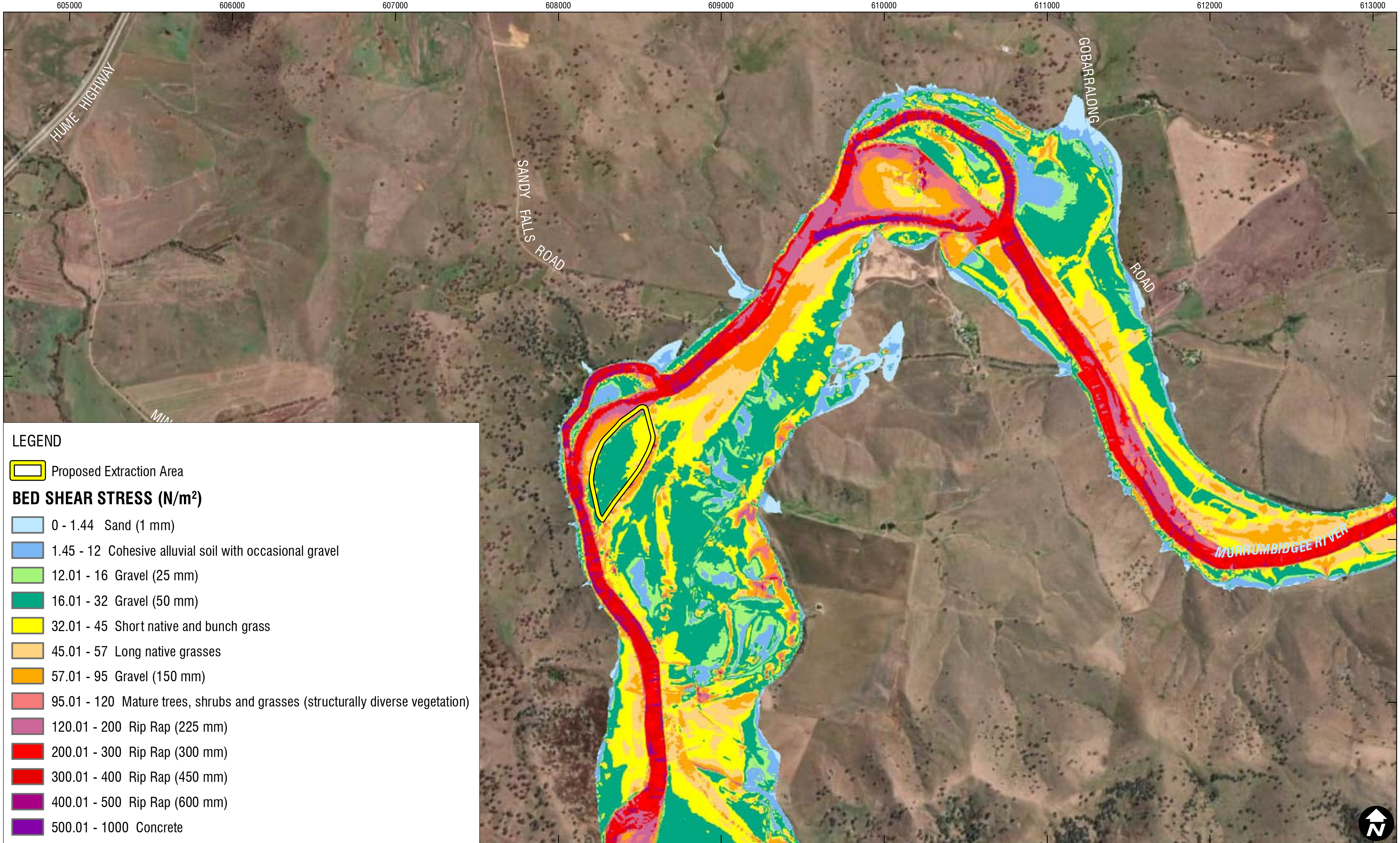
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
VELOCITIES - 63% AEP

FIGURE B-14

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPB-14_E03_63pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

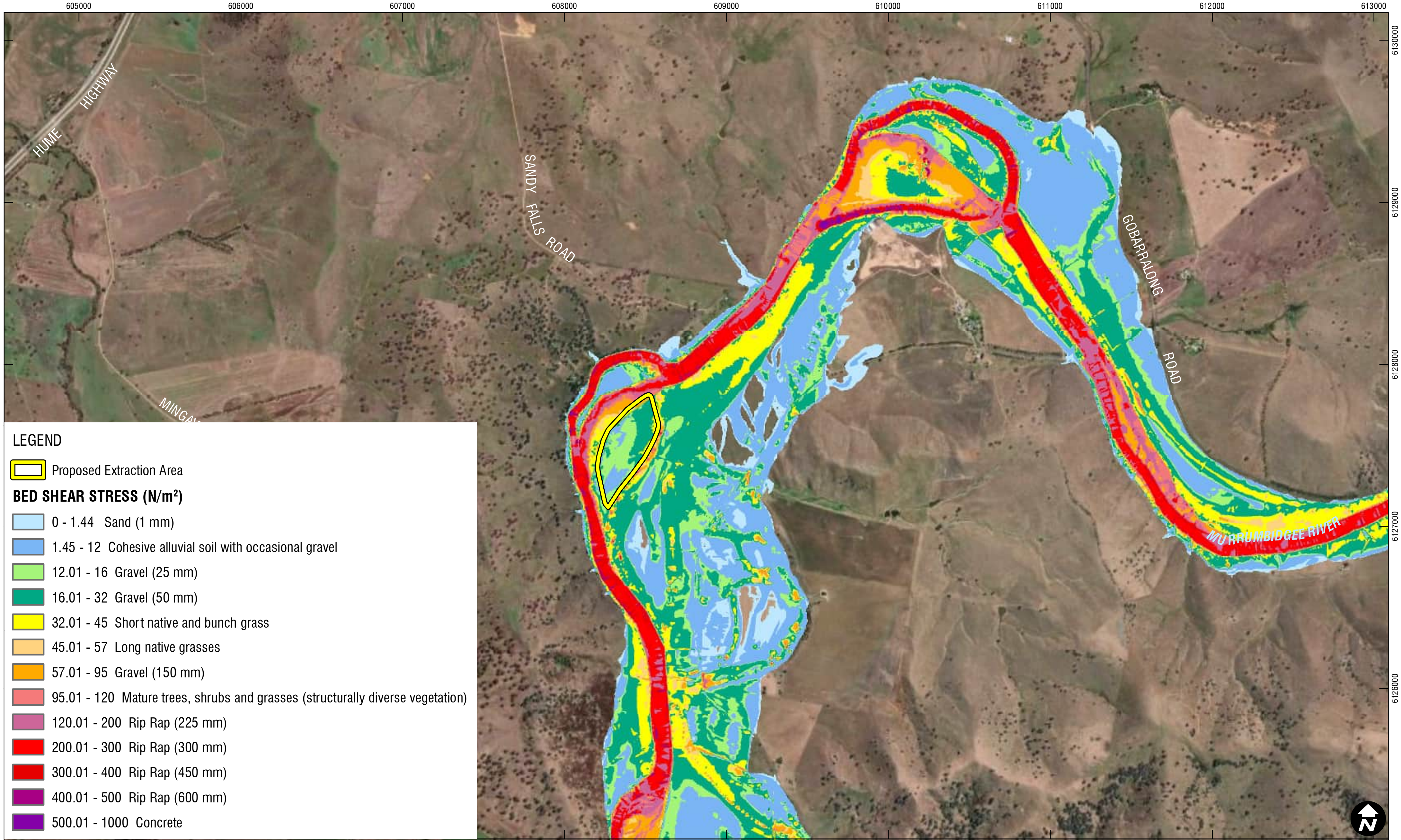
Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 1% AEP

FIGURE B-15



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

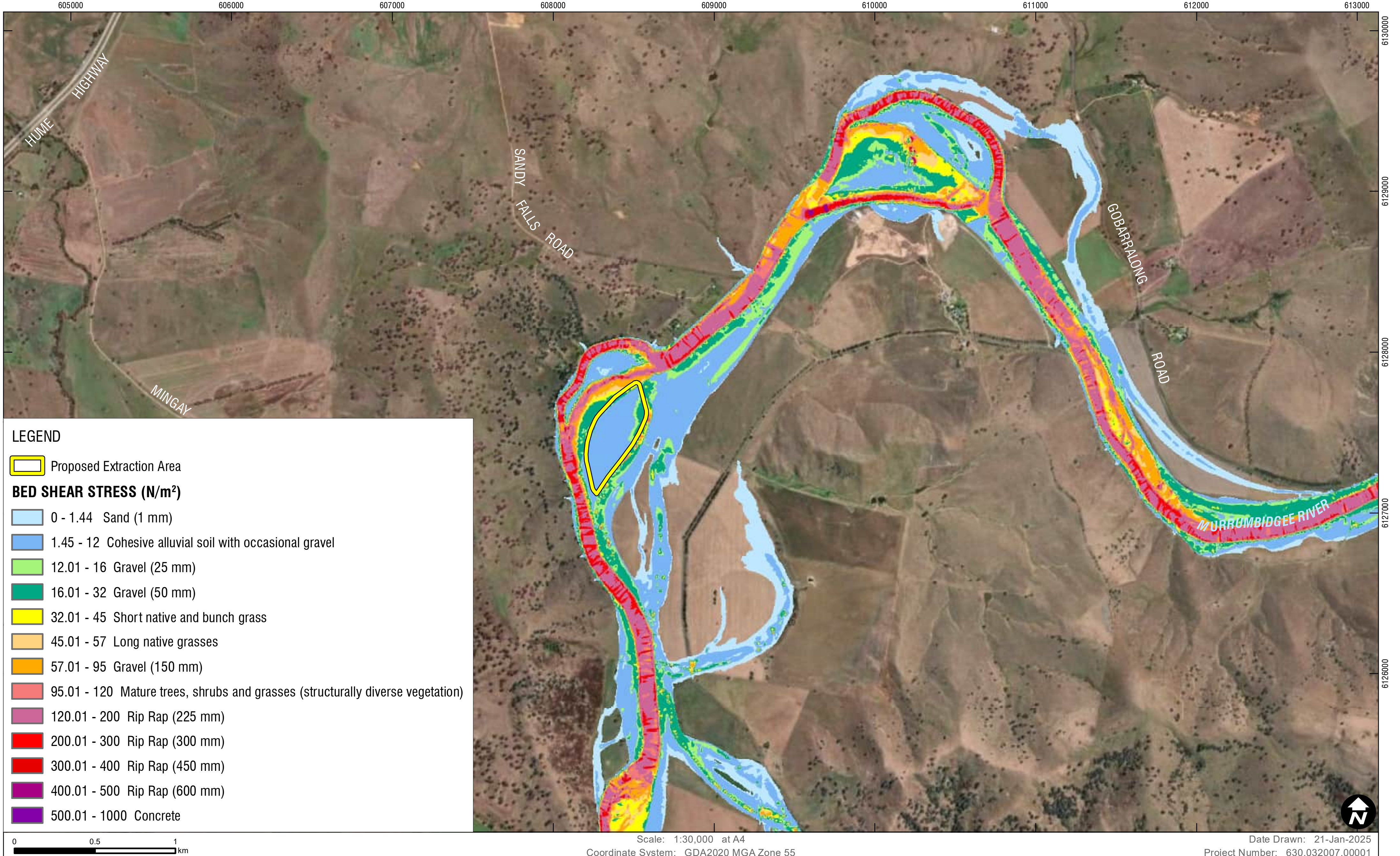
Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 2% AEP

FIGURE B-16



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

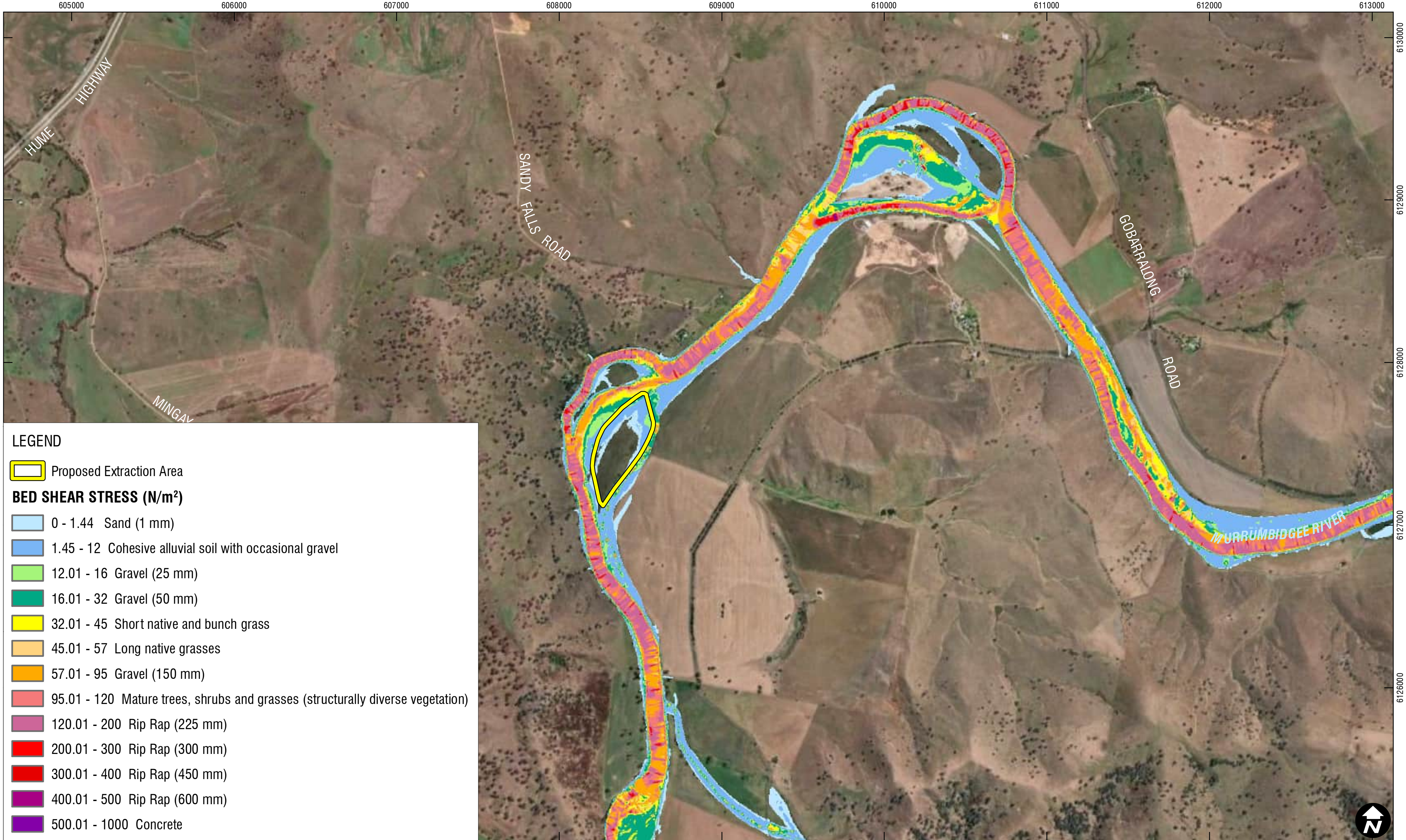
Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 5% AEP

FIGURE B-17



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

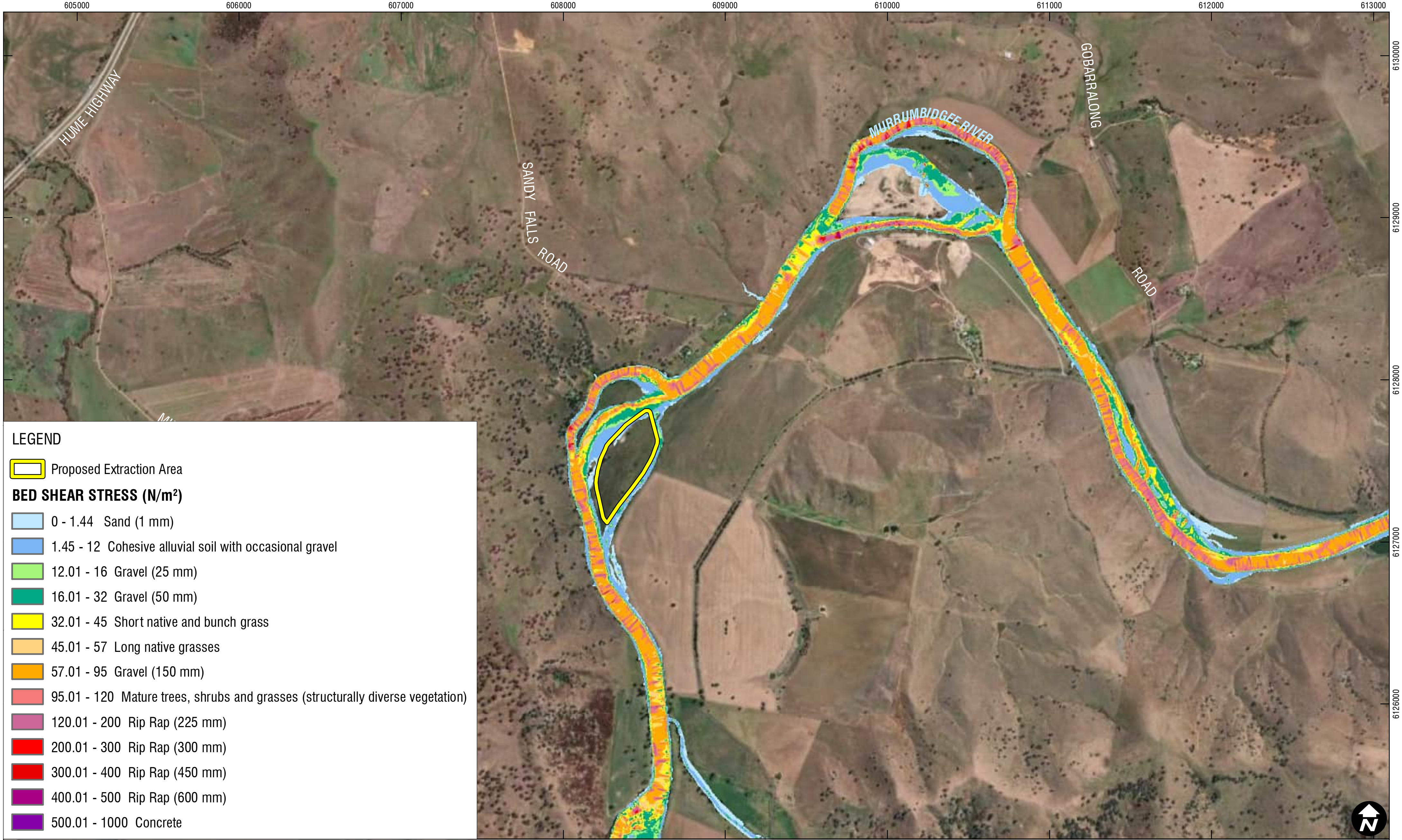
Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 10% AEP

FIGURE B-18



LEGEND

Proposed Extraction Area

BED SHEAR STRESS (N/m²)

- 0 - 1.44 Sand (1 mm)
- 1.45 - 12 Cohesive alluvial soil with occasional gravel
- 12.01 - 16 Gravel (25 mm)
- 16.01 - 32 Gravel (50 mm)
- 32.01 - 45 Short native and bunch grass
- 45.01 - 57 Long native grasses
- 57.01 - 95 Gravel (150 mm)
- 95.01 - 120 Mature trees, shrubs and grasses (structurally diverse vegetation)
- 120.01 - 200 Rip Rap (225 mm)
- 200.01 - 300 Rip Rap (300 mm)
- 300.01 - 400 Rip Rap (450 mm)
- 400.01 - 500 Rip Rap (600 mm)
- 500.01 - 1000 Concrete

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

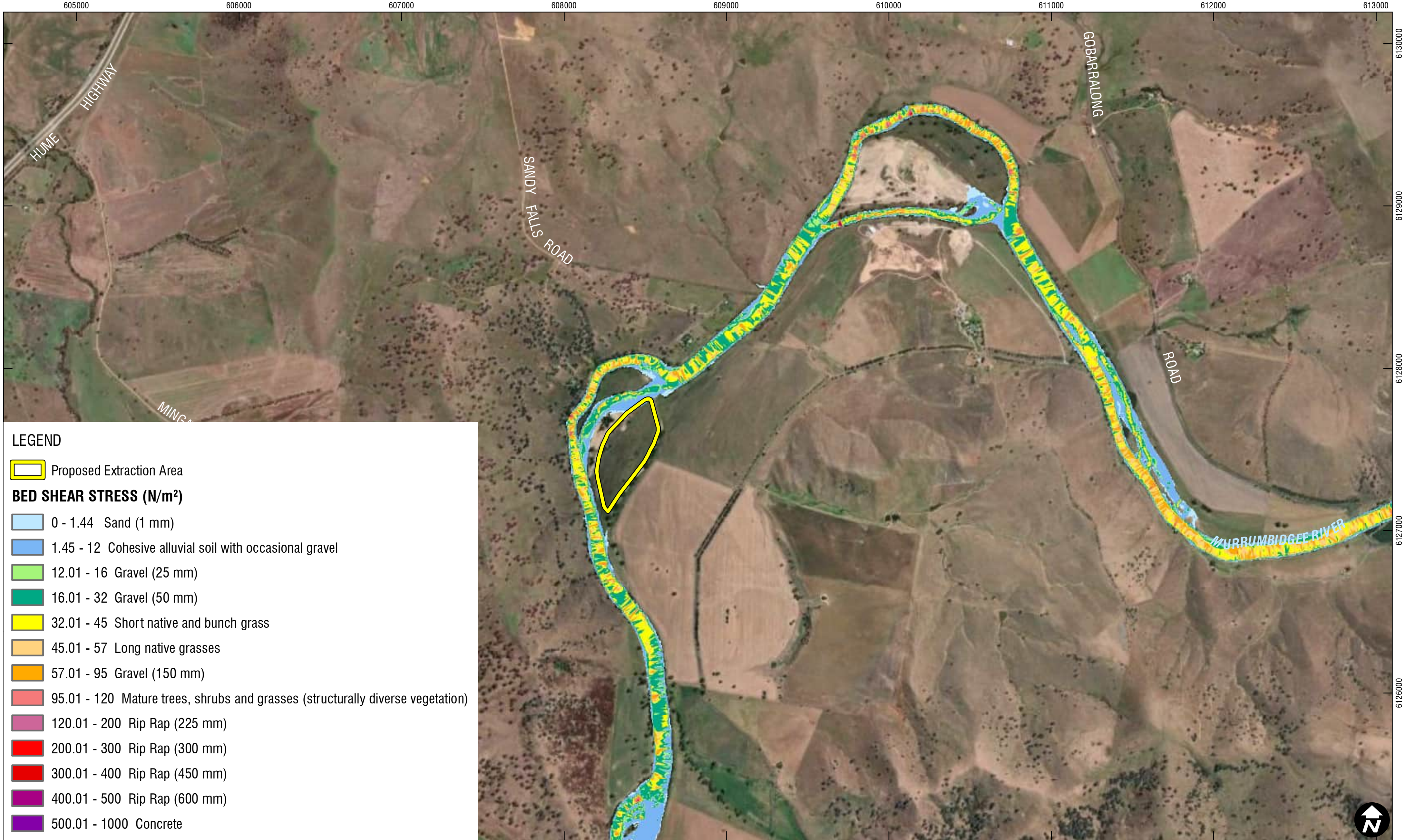
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 20% AEP

FIGURE B-19

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPB-19_E03_20pcAEP_BSS_01.mxd



LEGEND

Proposed Extraction Area

BED SHEAR STRESS (N/m²)

- 0 - 1.44 Sand (1 mm)
- 1.45 - 12 Cohesive alluvial soil with occasional gravel
- 12.01 - 16 Gravel (25 mm)
- 16.01 - 32 Gravel (50 mm)
- 32.01 - 45 Short native and bunch grass
- 45.01 - 57 Long native grasses
- 57.01 - 95 Gravel (150 mm)
- 95.01 - 120 Mature trees, shrubs and grasses (structurally diverse vegetation)
- 120.01 - 200 Rip Rap (225 mm)
- 200.01 - 300 Rip Rap (300 mm)
- 300.01 - 400 Rip Rap (450 mm)
- 400.01 - 500 Rip Rap (600 mm)
- 500.01 - 1000 Concrete

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

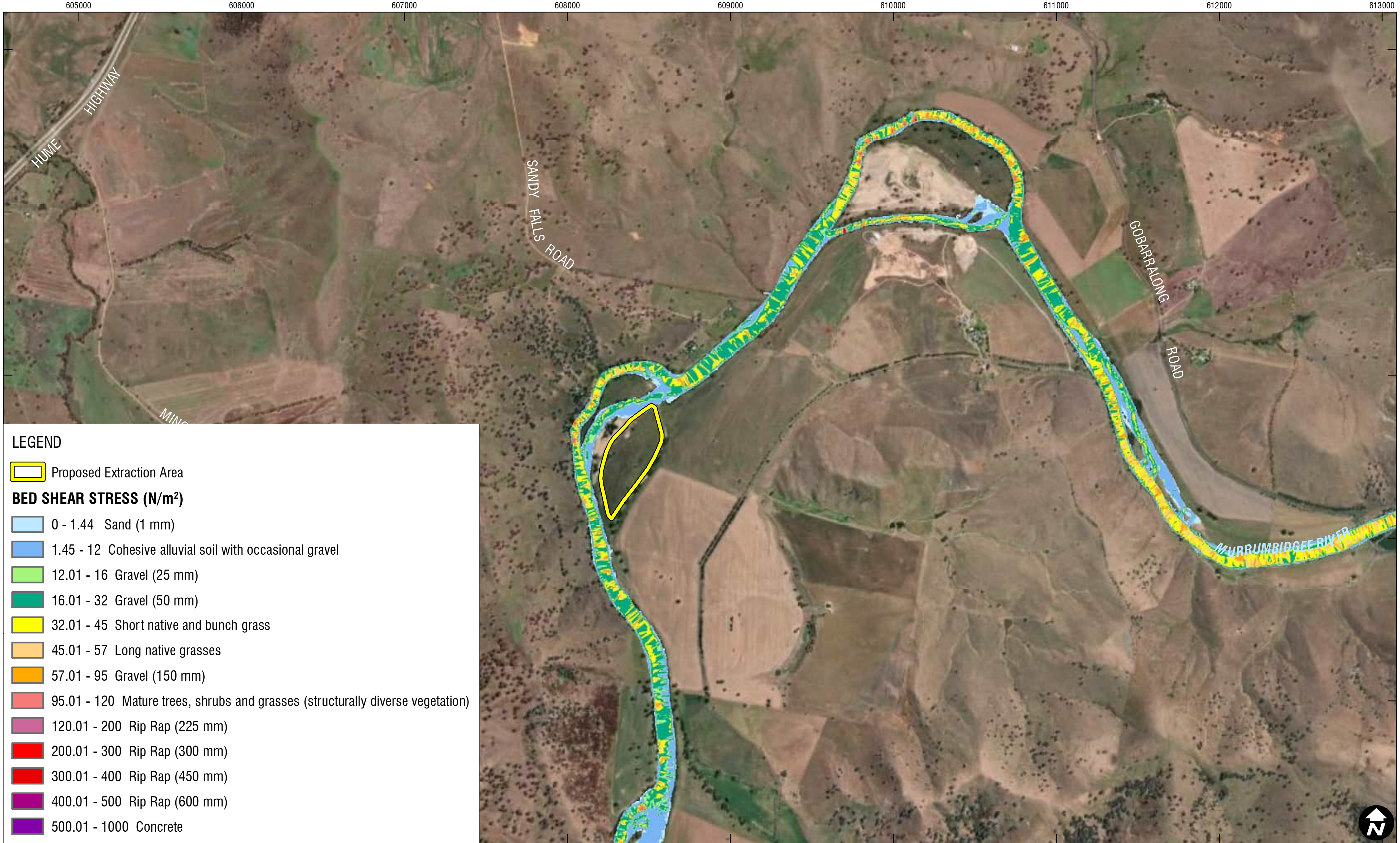
Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 50% AEP

FIGURE B-20

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPB-20_E03_50pcAEP_BSS_02.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

EXISTING SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 63% AEP

FIGURE B-21

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPB-21_E03_63pcAEP_BSS_02.mxd

. Appendix C

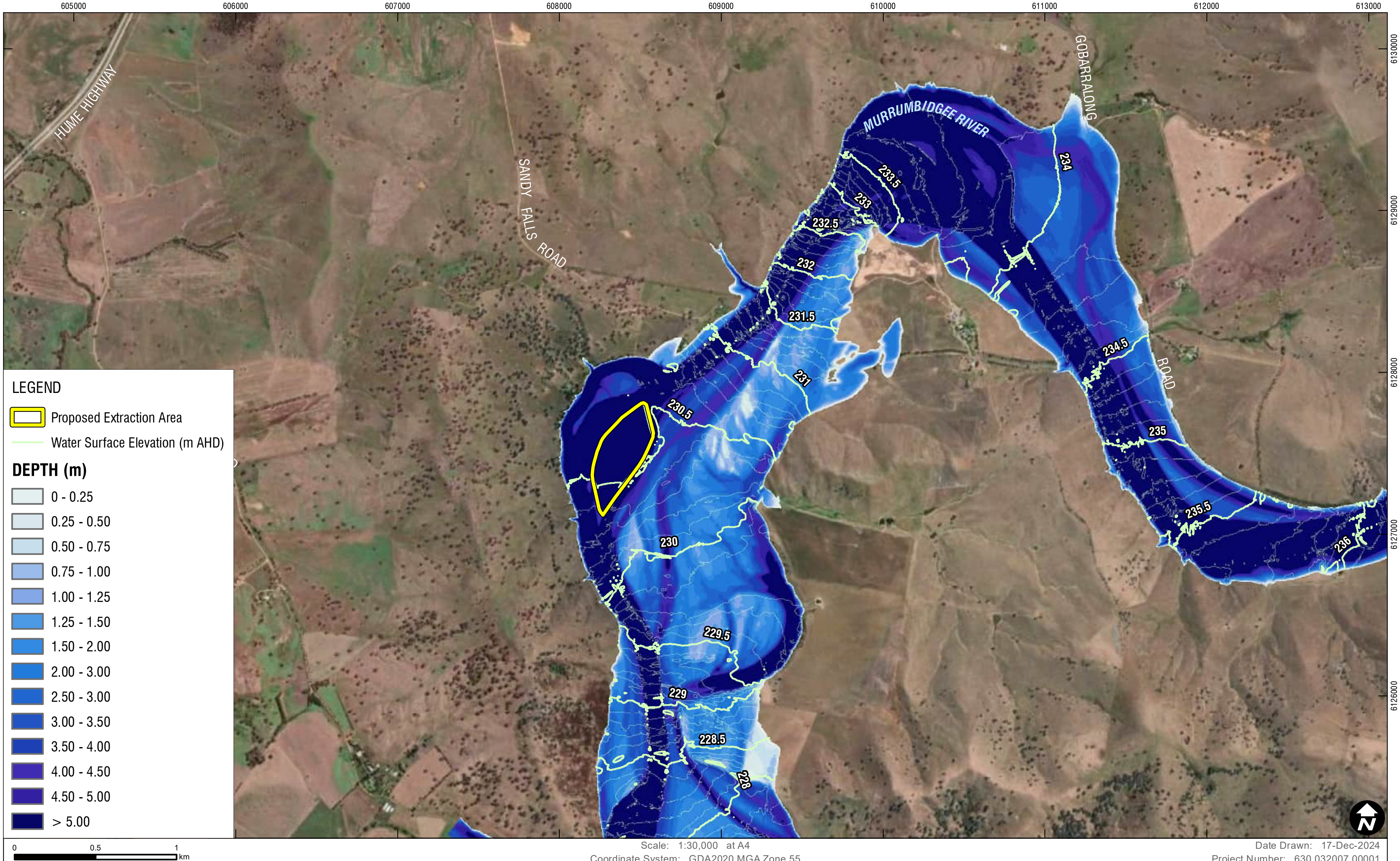
Proposed Quarry Flood Mapping

Eulonga Quary Proposed Extraction Area

Eulonga Quarries Pty Limited

SLR Project No.: 630.032007.00001

17 March 2025



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 1% AEP

FIGURE C-1

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-1_OpSc01_1pcAEP_DEPTH_01.mxd

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 2% AEP

FIGURE C-2

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-2_OpSc01_2pcAEP_DEPTH_01.mxd

LEGEND

Proposed Extraction Area

Water Surface Elevation (m AHD)

DEPTH (m)

- 0 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 3.00
- 2.50 - 3.00
- 3.00 - 3.50
- 3.50 - 4.00
- 4.00 - 4.50
- 4.50 - 5.00
- > 5.00

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

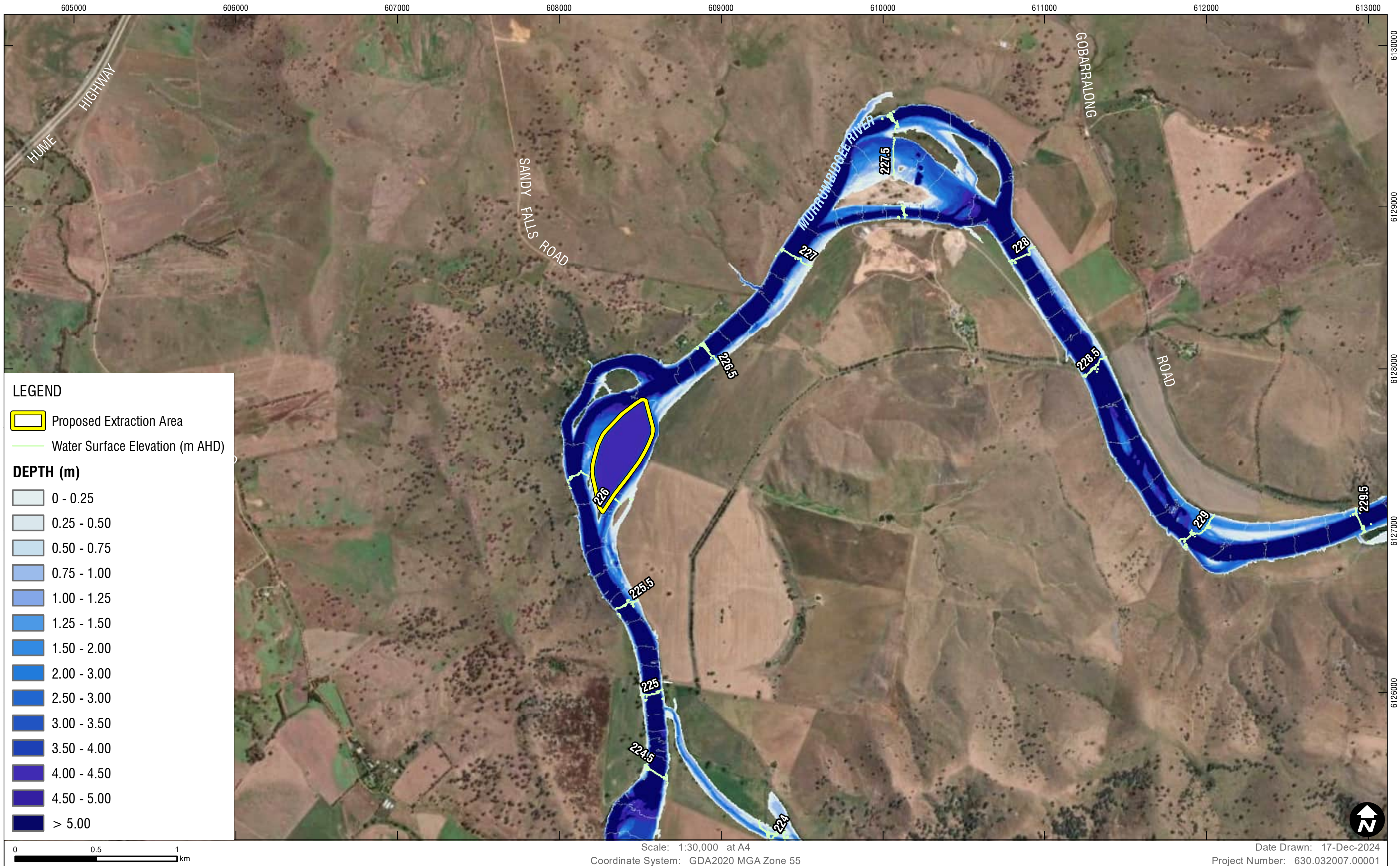
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 5% AEP

FIGURE C-3

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-3_OpSc01_5pcAEP_DEPTH_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

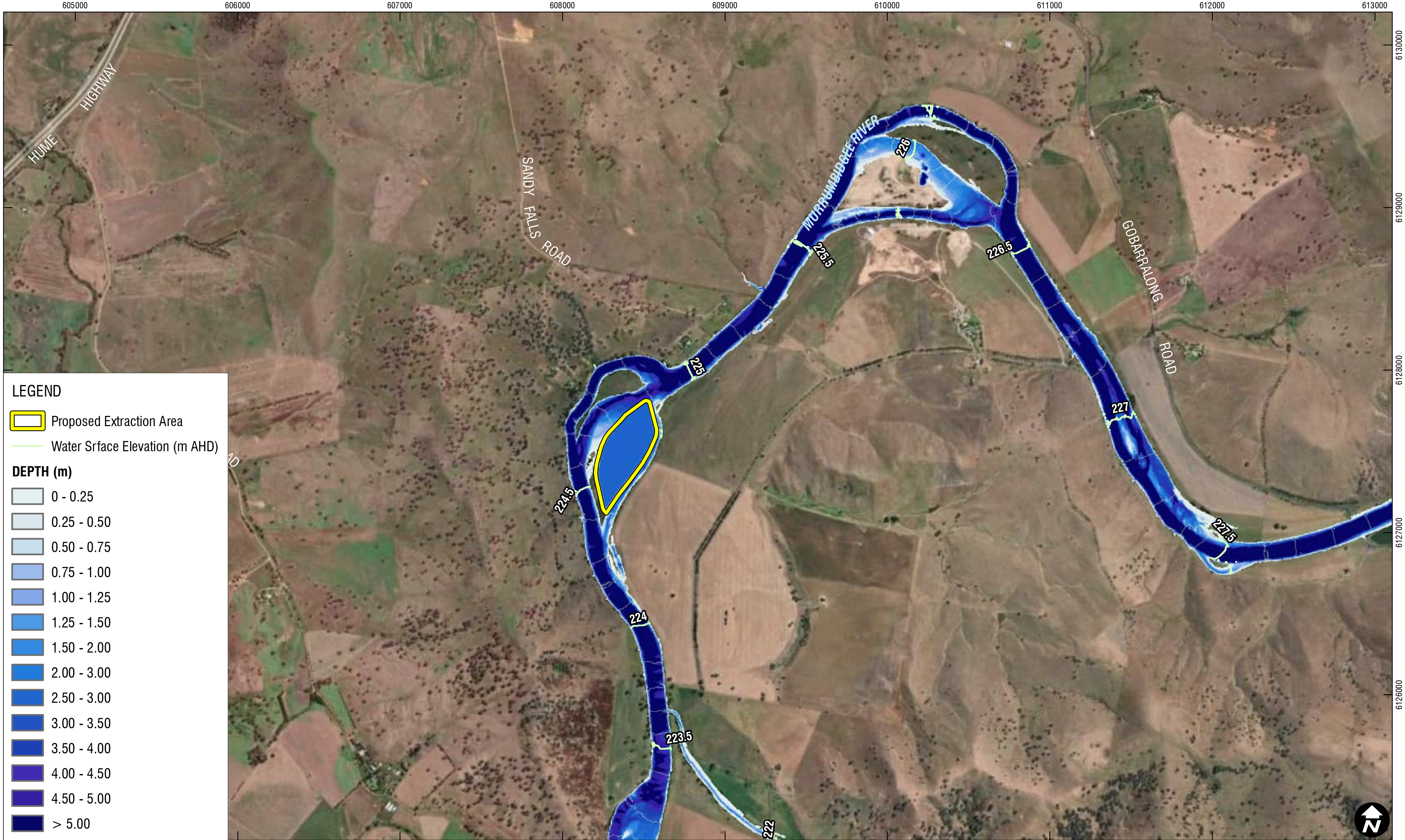
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 10% AEP

FIGURE C-4

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-4_OpSc01_10pcAEP_DEPTH_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 20% AEP

FIGURE C-5

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-5_OpSc01_20pcAEP_DEPTH_01.mxd

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

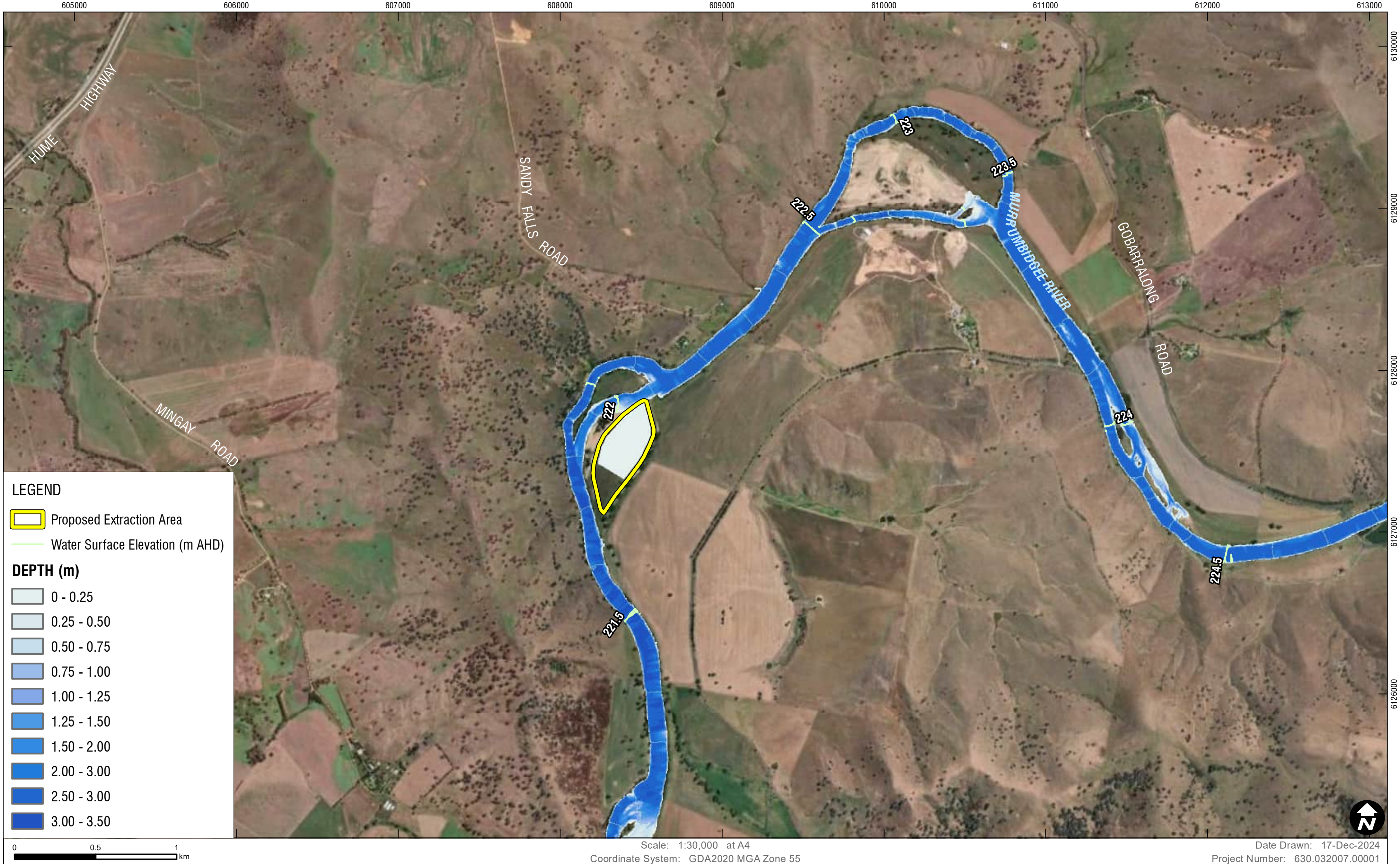
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 50% AEP

FIGURE C-6

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-6_OpSc01_50pcAEP_DEPTH_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

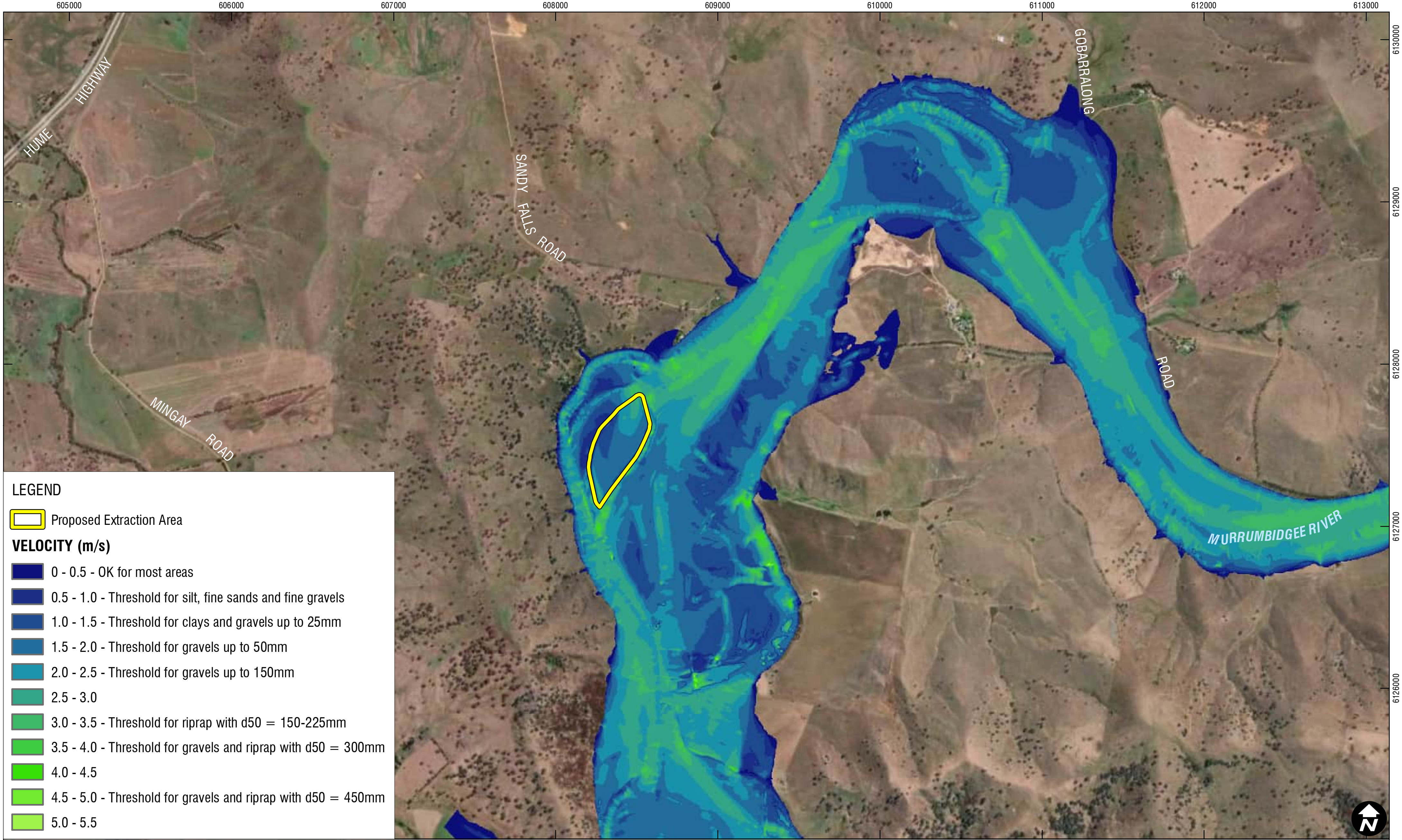
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD DEPTHS - 63% AEP

FIGURE C-7

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-7_OpSc01_63pcAEP_DEPTH_01.mxd



LEGEND

Proposed Extraction Area

VELOCITY (m/s)

- 0 - 0.5 - OK for most areas
- 0.5 - 1.0 - Threshold for silt, fine sands and fine gravels
- 1.0 - 1.5 - Threshold for clays and gravels up to 25mm
- 1.5 - 2.0 - Threshold for gravels up to 50mm
- 2.0 - 2.5 - Threshold for gravels up to 150mm
- 2.5 - 3.0
- 3.0 - 3.5 - Threshold for riprap with d50 = 150-225mm
- 3.5 - 4.0 - Threshold for gravels and riprap with d50 = 300mm
- 4.0 - 4.5
- 4.5 - 5.0 - Threshold for gravels and riprap with d50 = 450mm
- 5.0 - 5.5

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

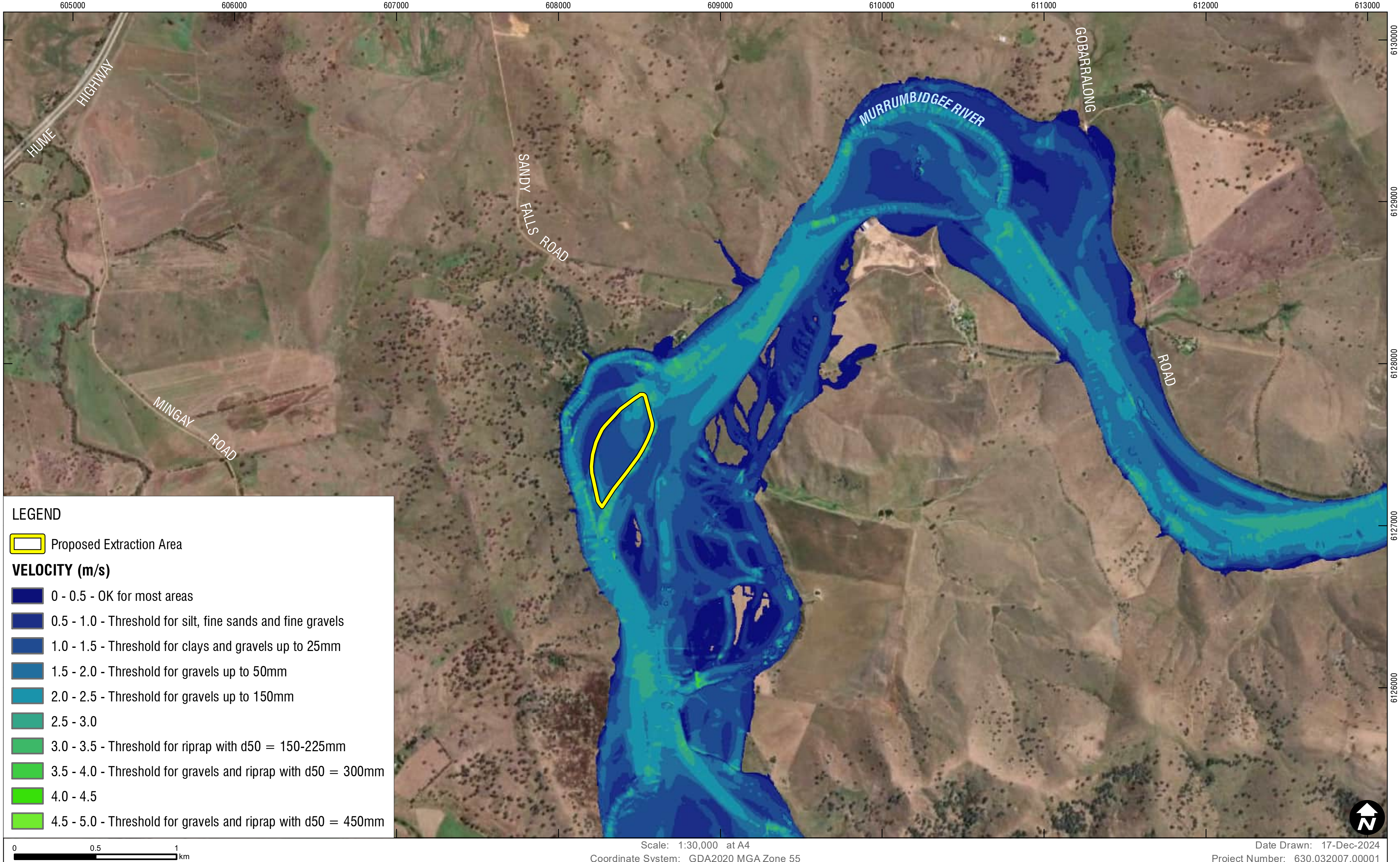
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO PEAK FLOOD VELOCITIES - 1% AEP

FIGURE C-8

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-8_OpSc01_1pcAEP_V_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

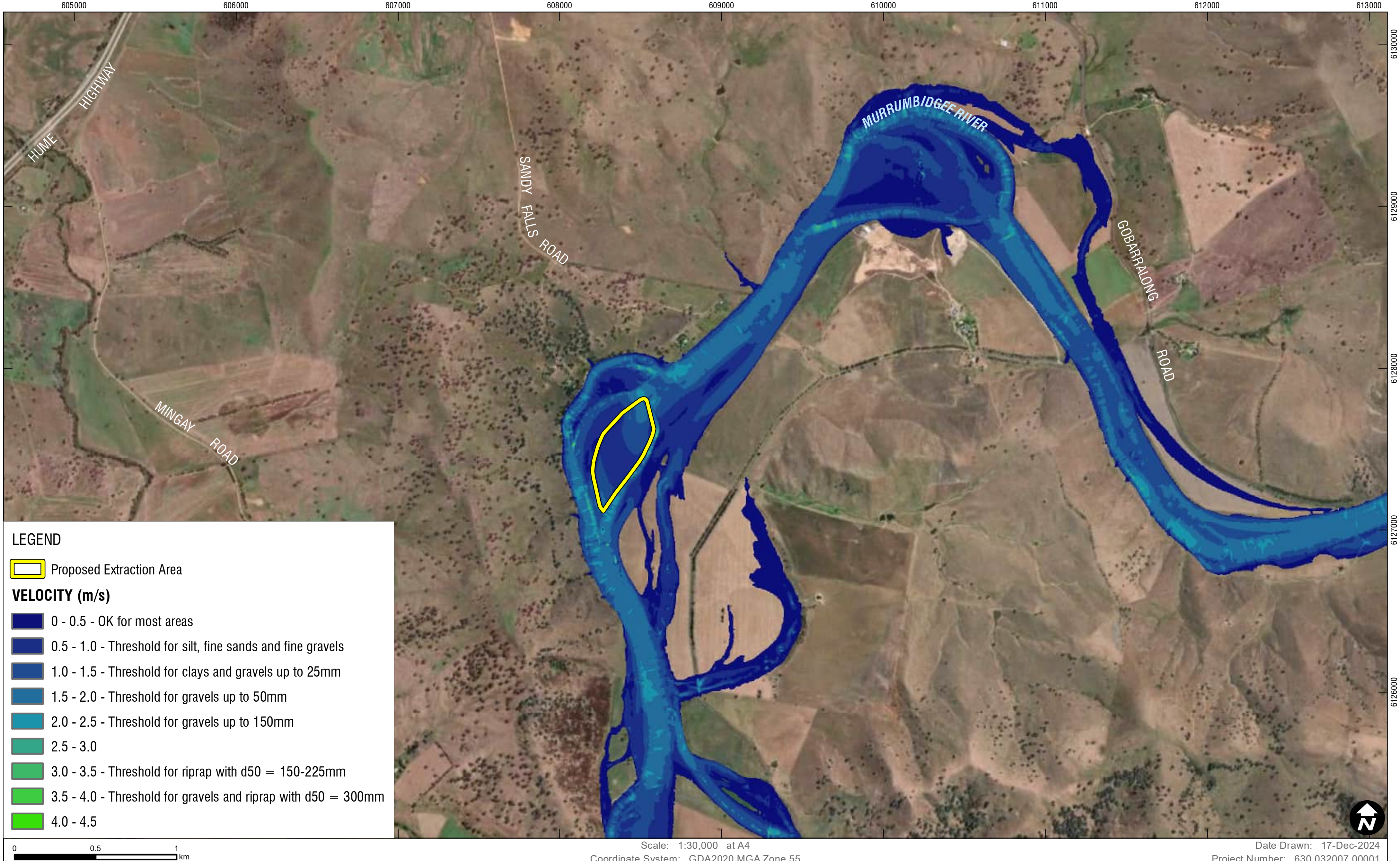
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO PEAK FLOOD VELOCITIES - 2% AEP

FIGURE C-9

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-9_OpSc01_2pcAEP_V_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

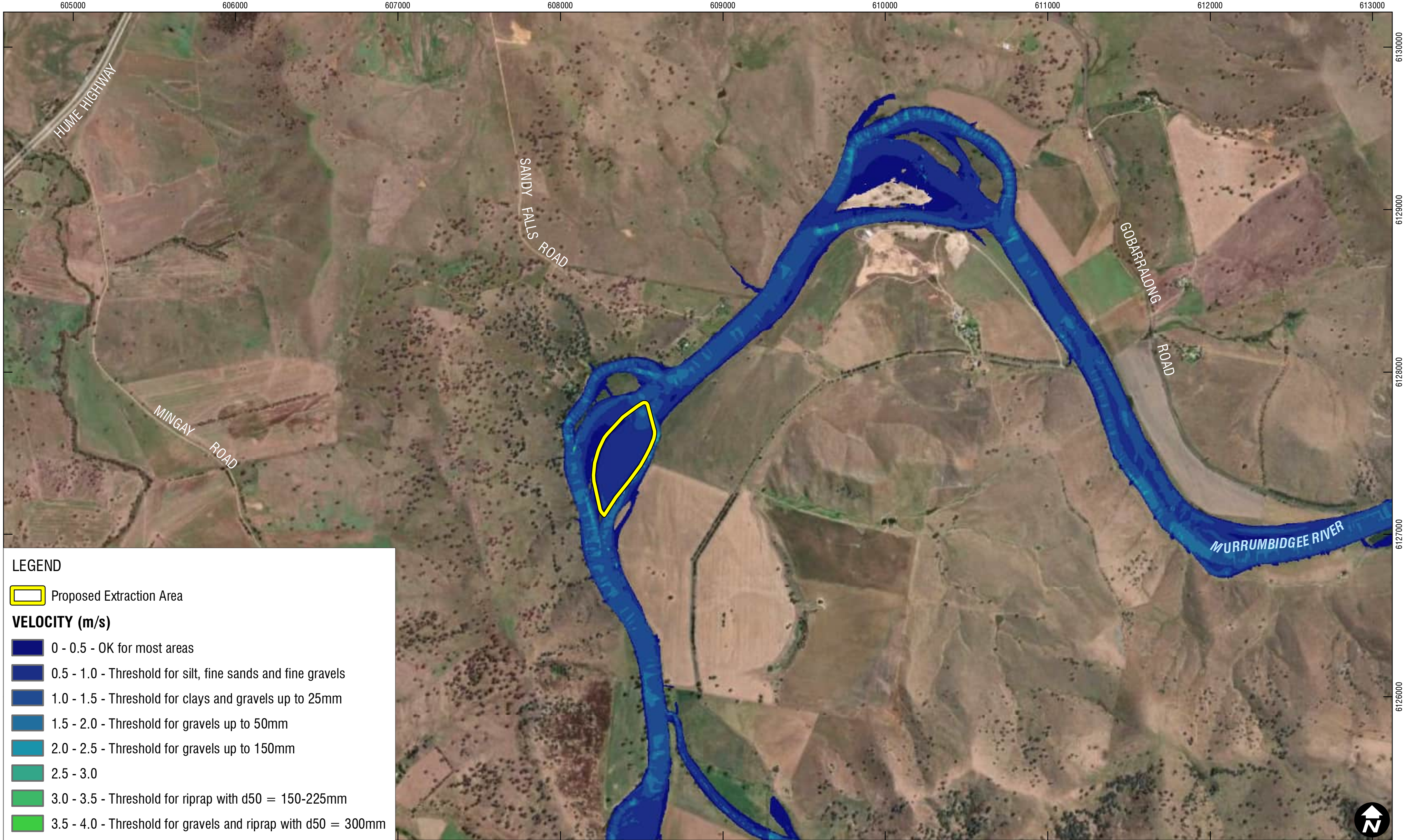
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO PEAK FLOOD VELOCITIES - 5% AEP

FIGURE C-10

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-10_OpSc01_5pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

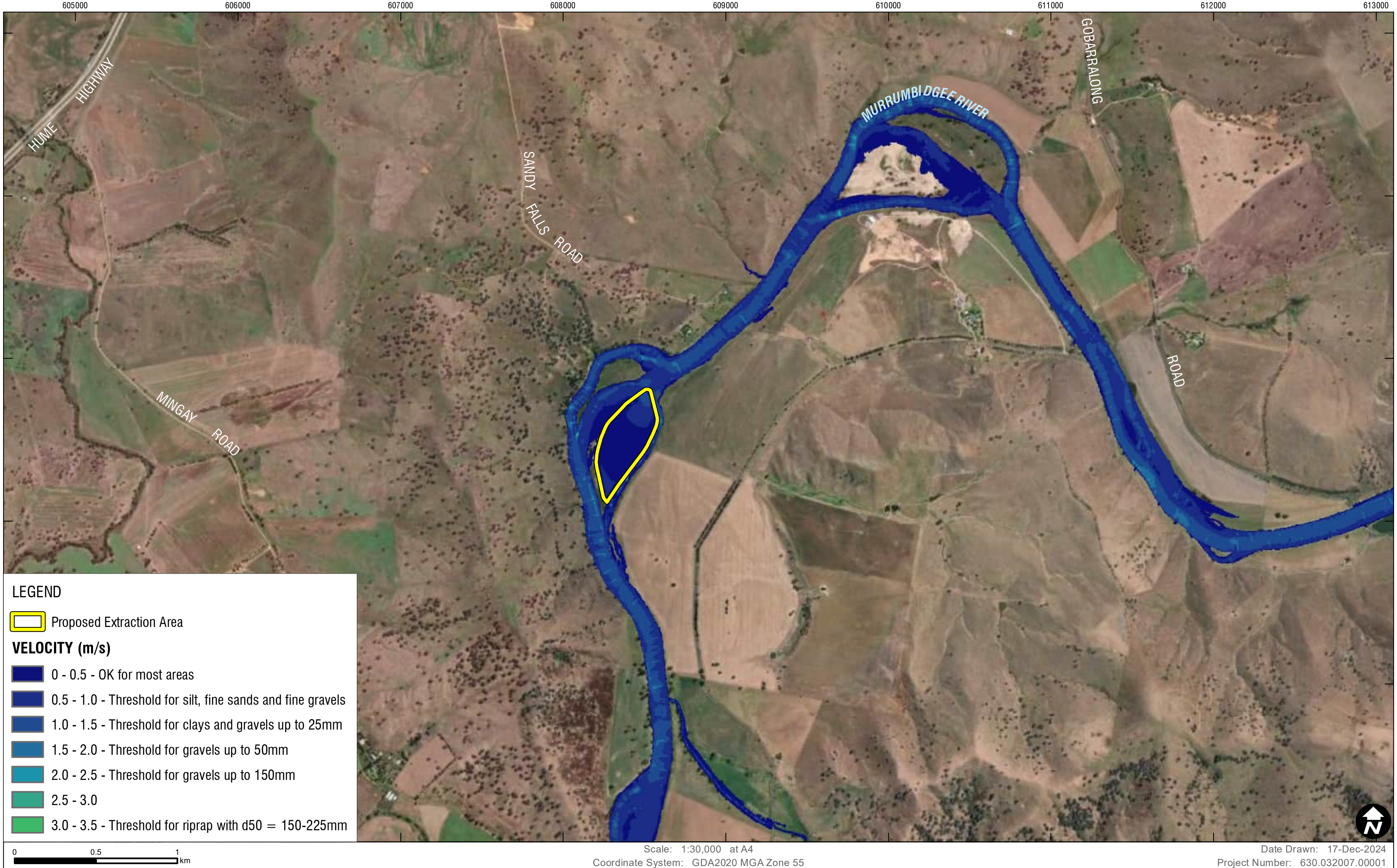
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
VELOCITIES - 10% AEP

FIGURE C-11

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_C-11_OpSc01_10pcAEP_V_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

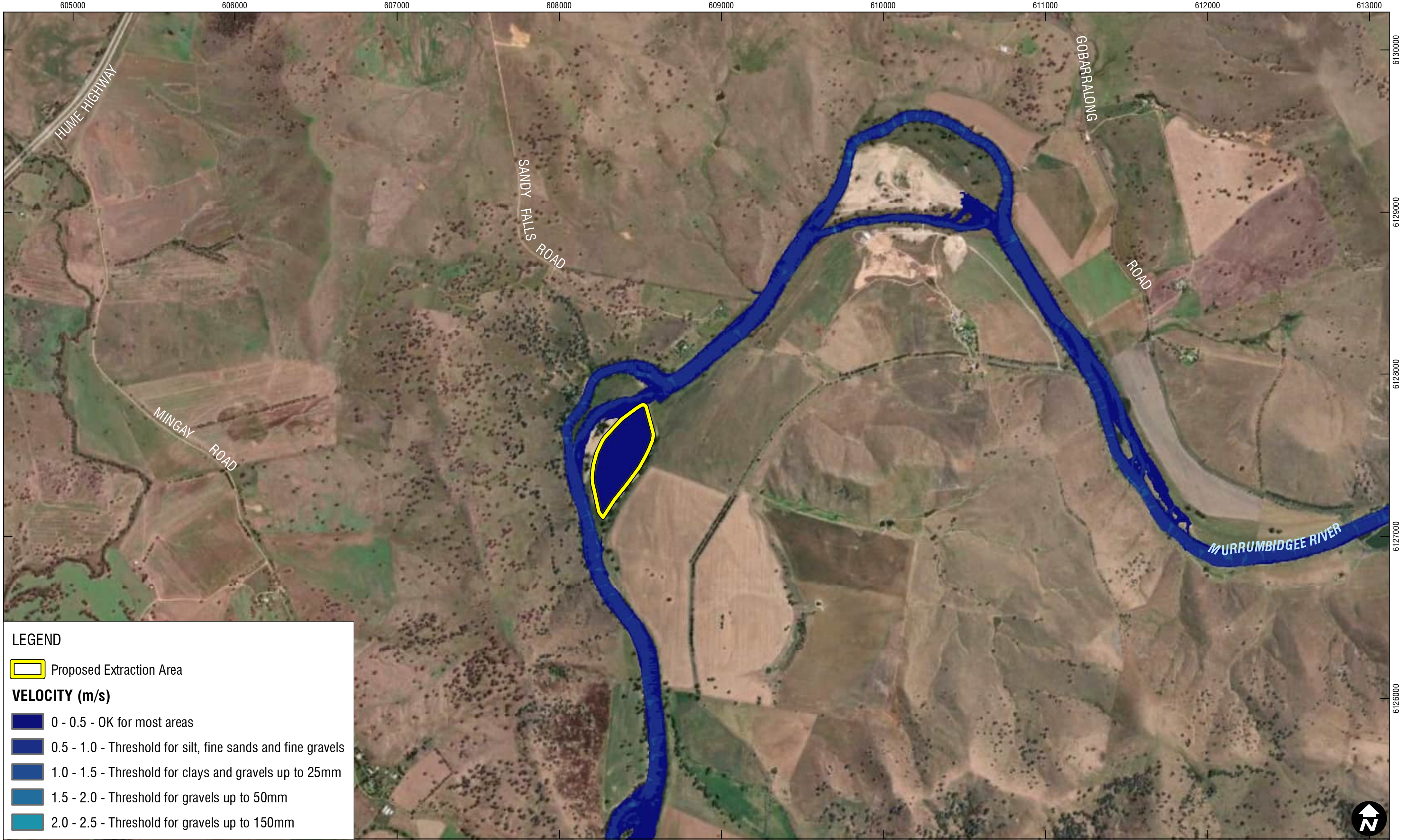
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
VELOCITIES - 20% AEP

FIGURE C-12

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-12_OpSc01_20pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

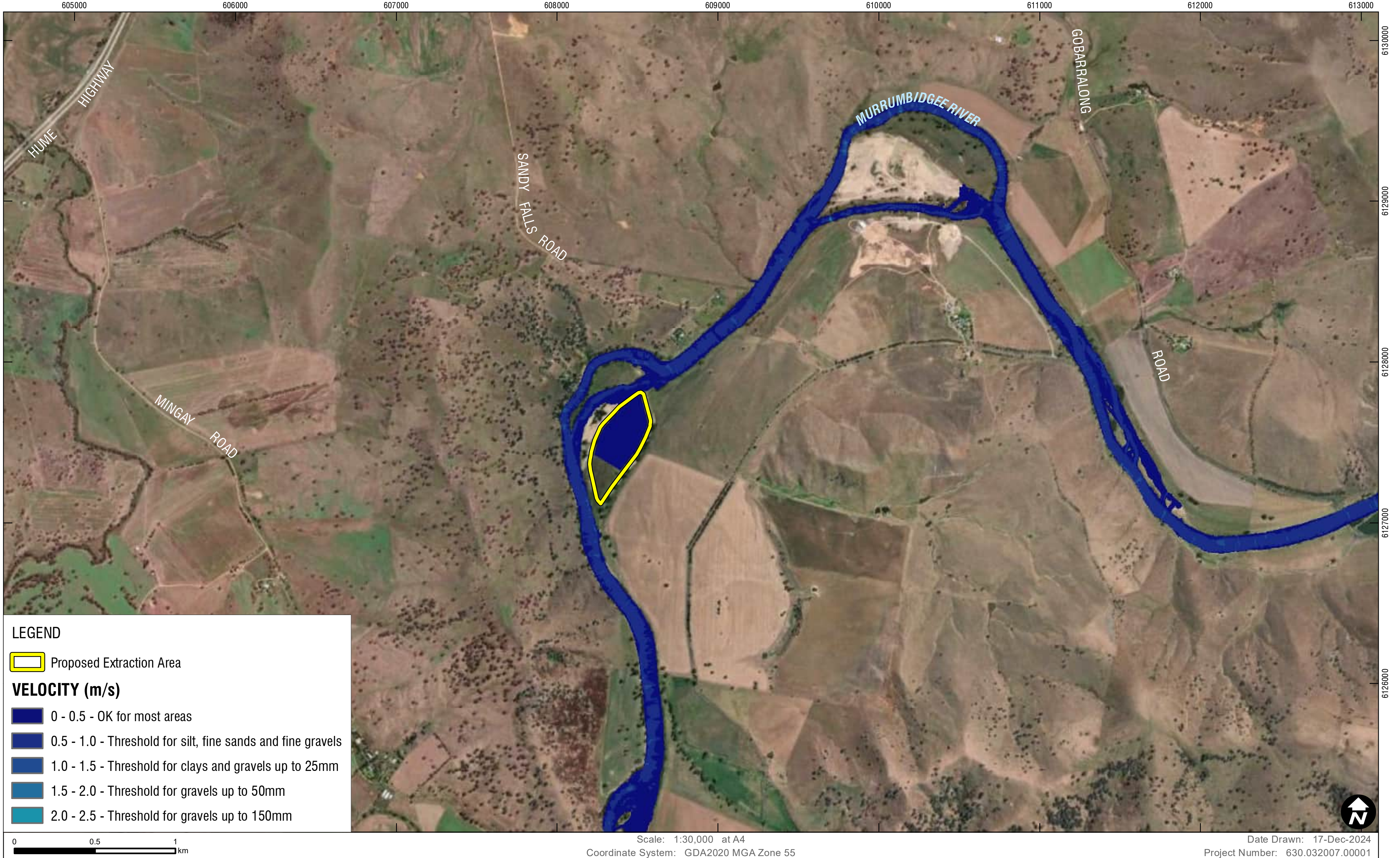
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO PEAK FLOOD VELOCITIES - 50% AEP

FIGURE C-13

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-13_OpSc01_50pcAEP_V_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

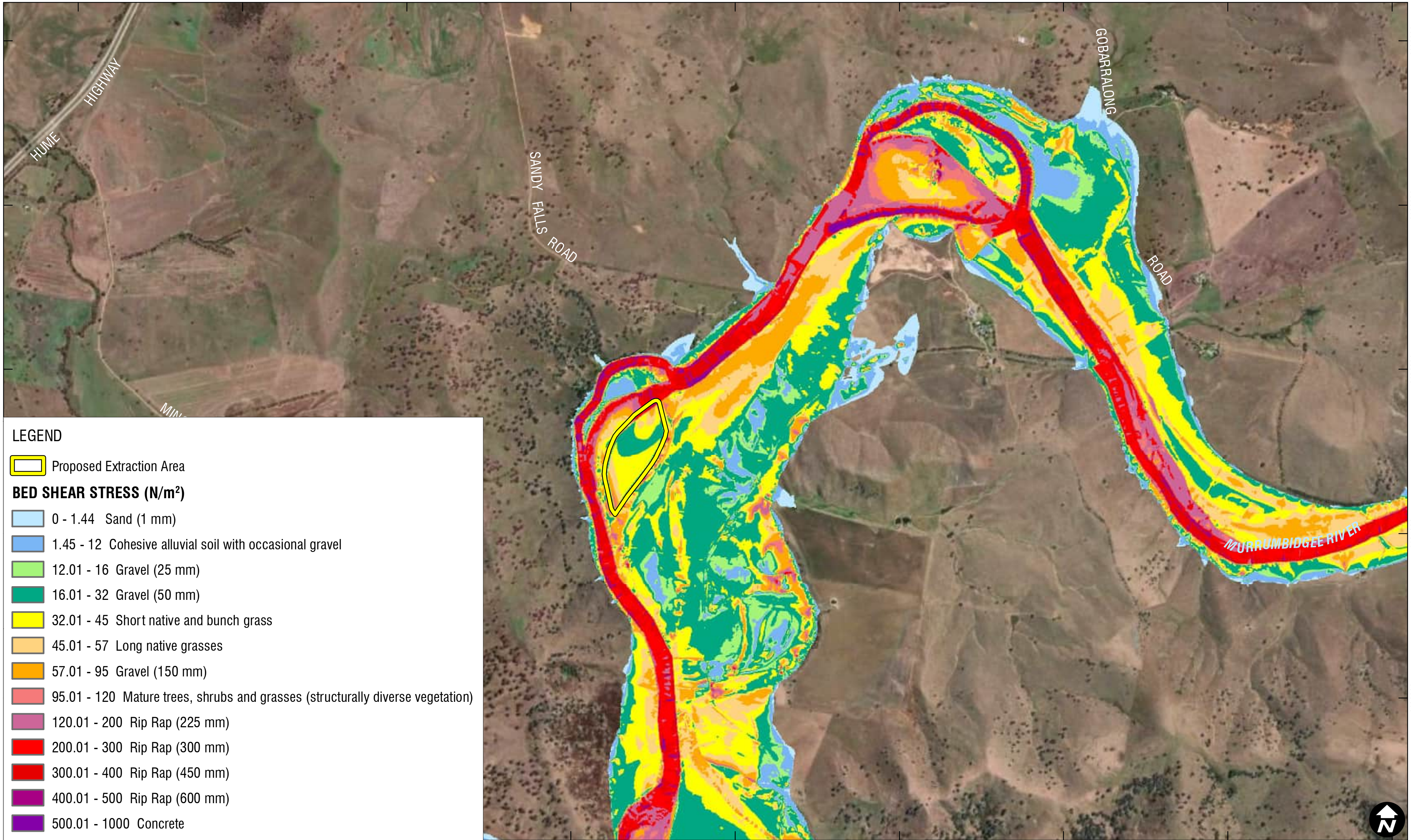
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
VELOCITIES - 63% AEP

FIGURE C-14

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPC-14_OpSc01_63pcAEP_V_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

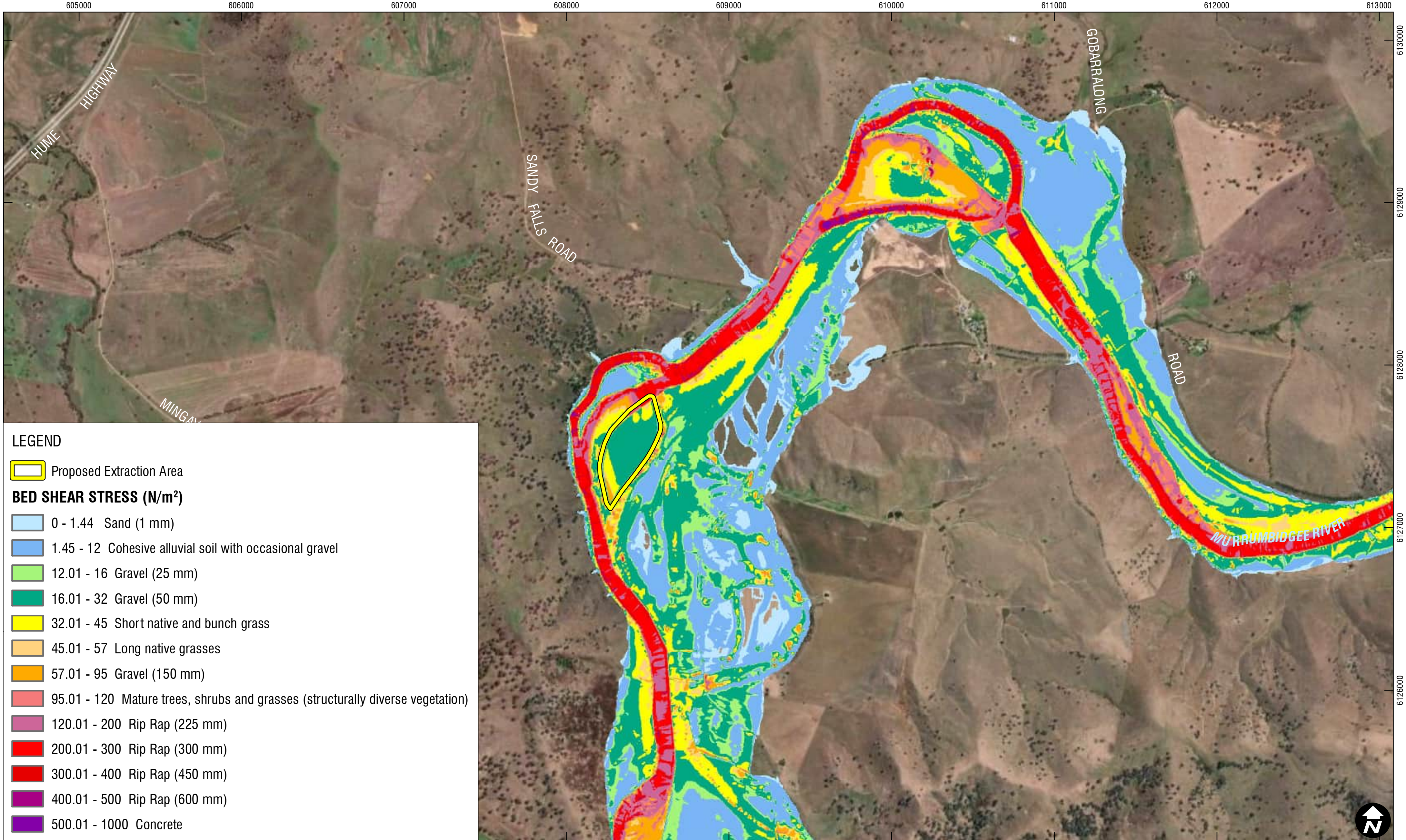
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 1% AEP

FIGURE C-15

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-15_OpSc01_1pcAEP_BSS_02.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

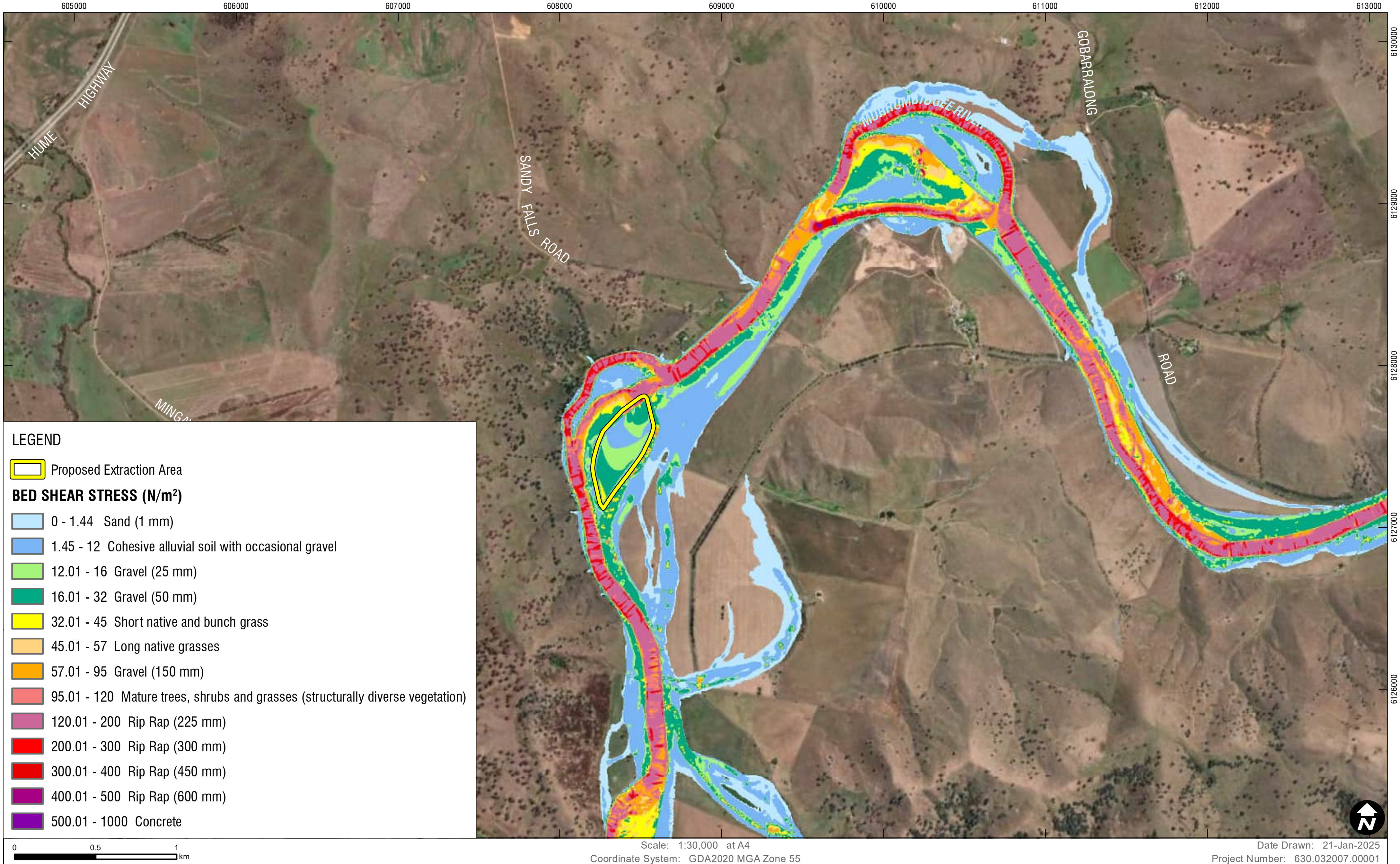
Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 2% AEP

FIGURE C-16



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

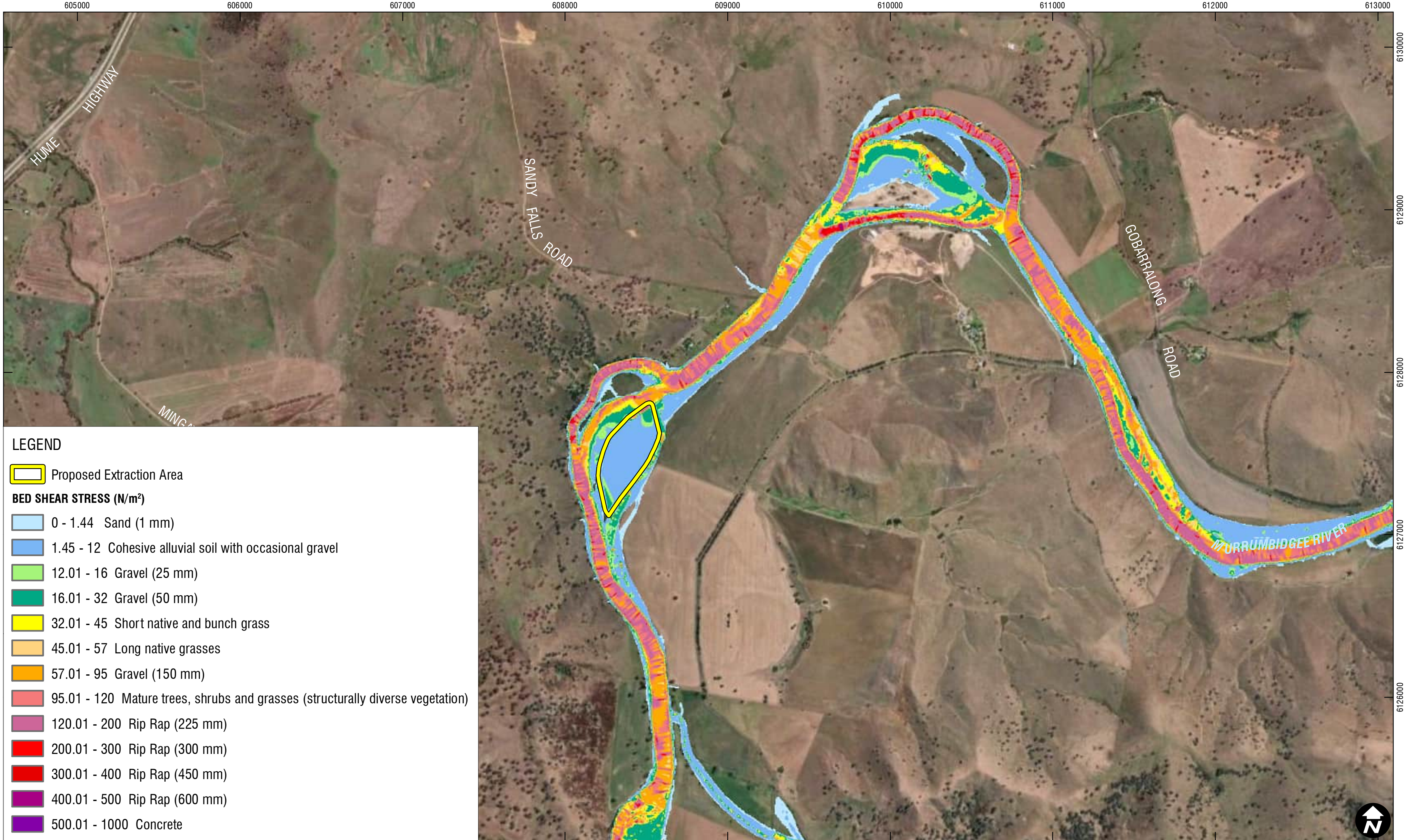
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 5% AEP

FIGURE C-17

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-17_OpSc01_5pcAEP_BSS_02.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

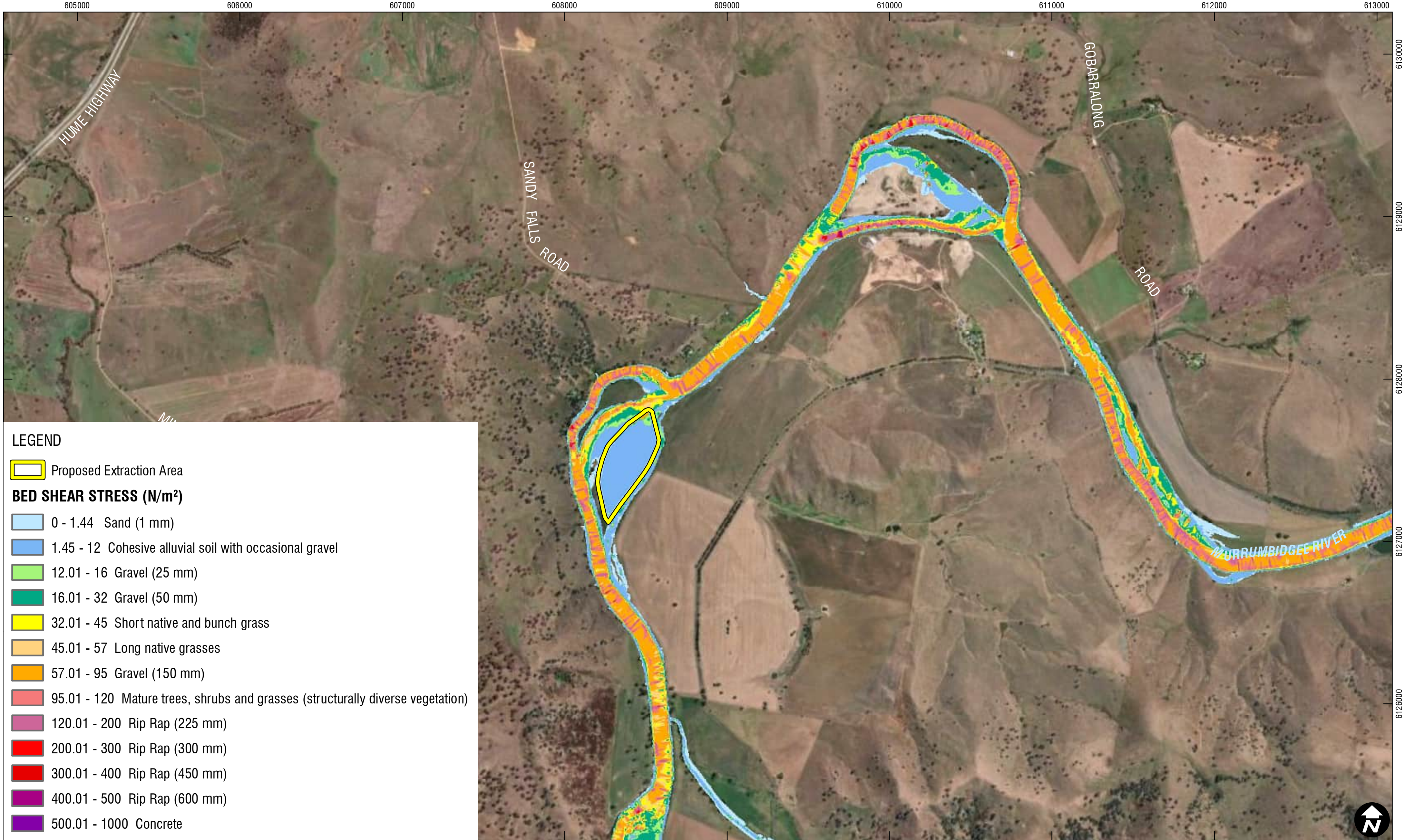
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 10% AEP

FIGURE C-18

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-18_OpSc01_10pcAEP_BSS_02.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

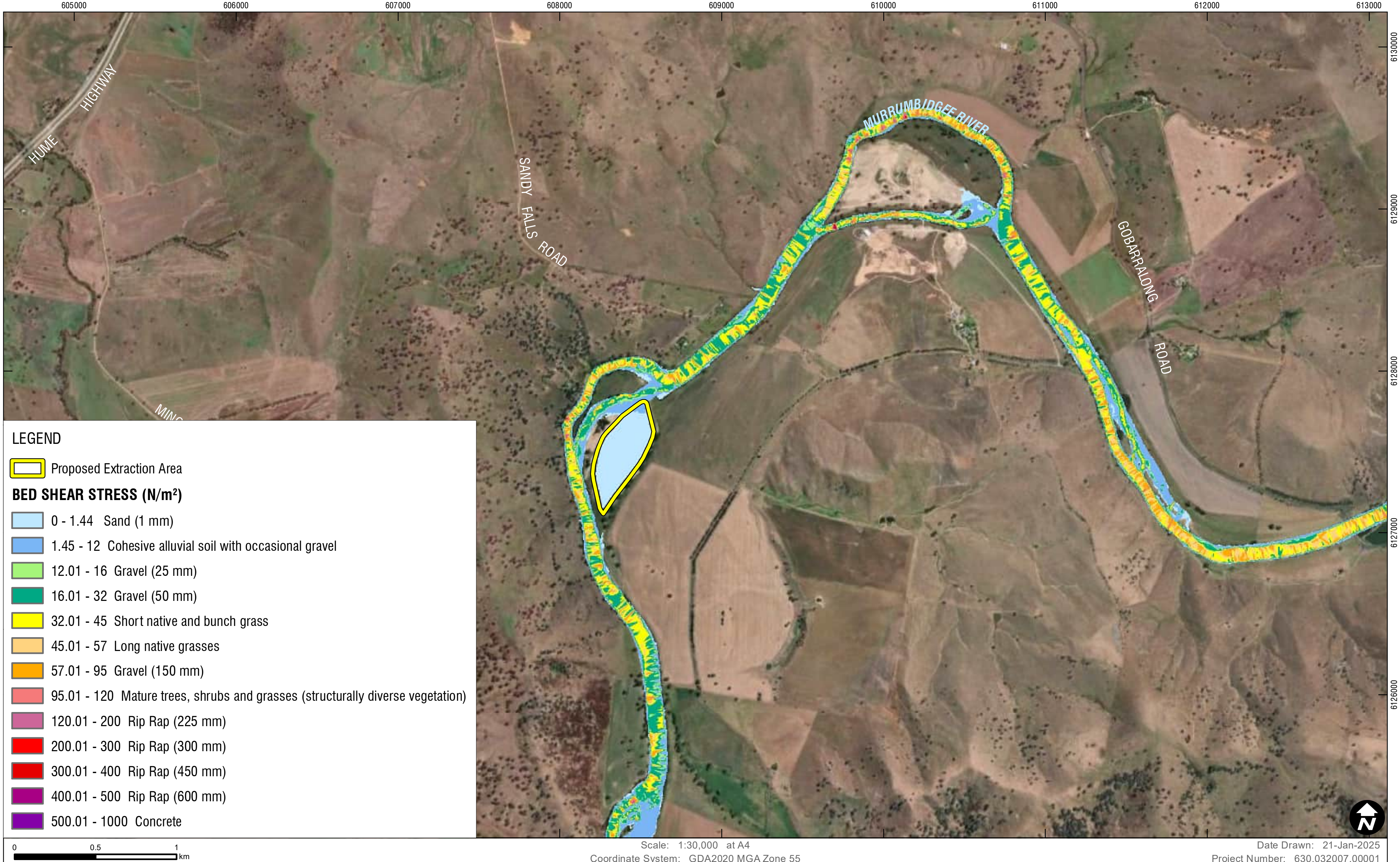
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 20% AEP

FIGURE C-19

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-19_OpSc01_20pcAEP_BSS_02.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

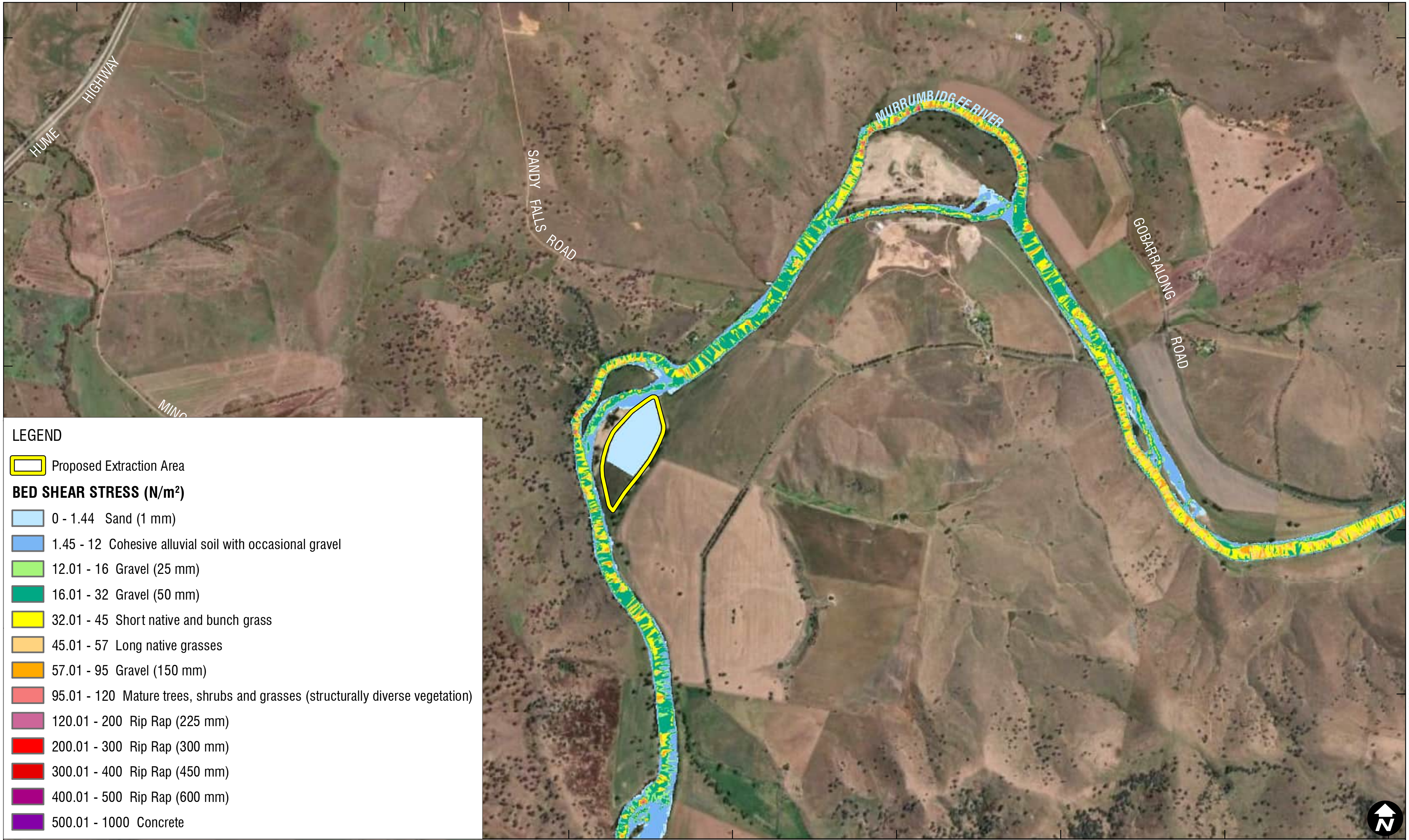
Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 50% AEP

FIGURE C-20

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-20_OpSc01_50pcAEP_BSS_02.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DESIGN SCENARIO
PEAK FLOOD
BED SHEAR STRESS - 63% AEP

FIGURE C-21

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPC-21_OpSc01_63pcAEP_BSS_02.mxd

.

Appendix D

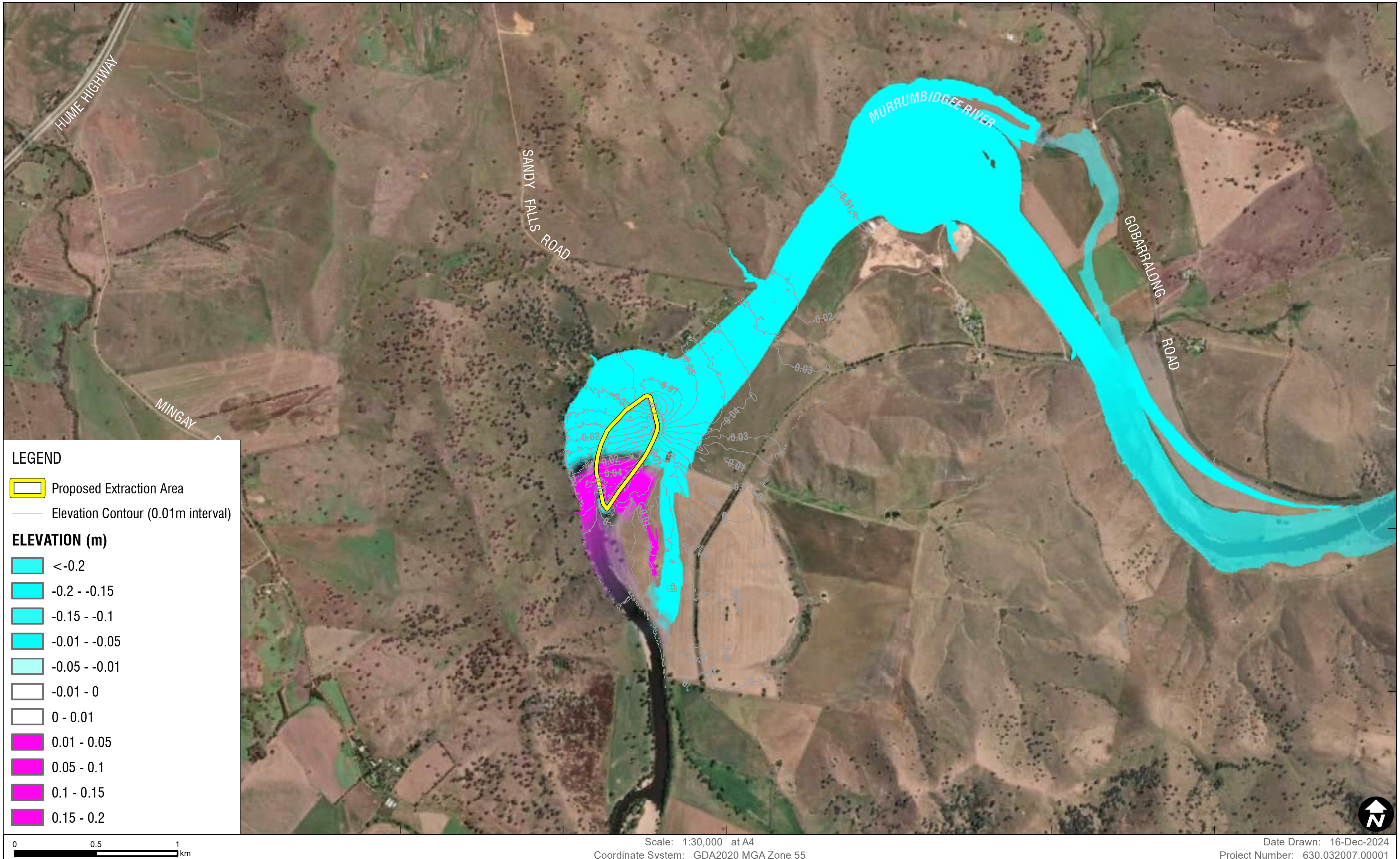
Flood Difference Mapping

Eulonga Quary Proposed Extraction Area

Eulonga Quarries Pty Limited

SLR Project No.: 630.032007.00001

17 March 2025



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Dec-2024
Project Number: 630.032007.00001

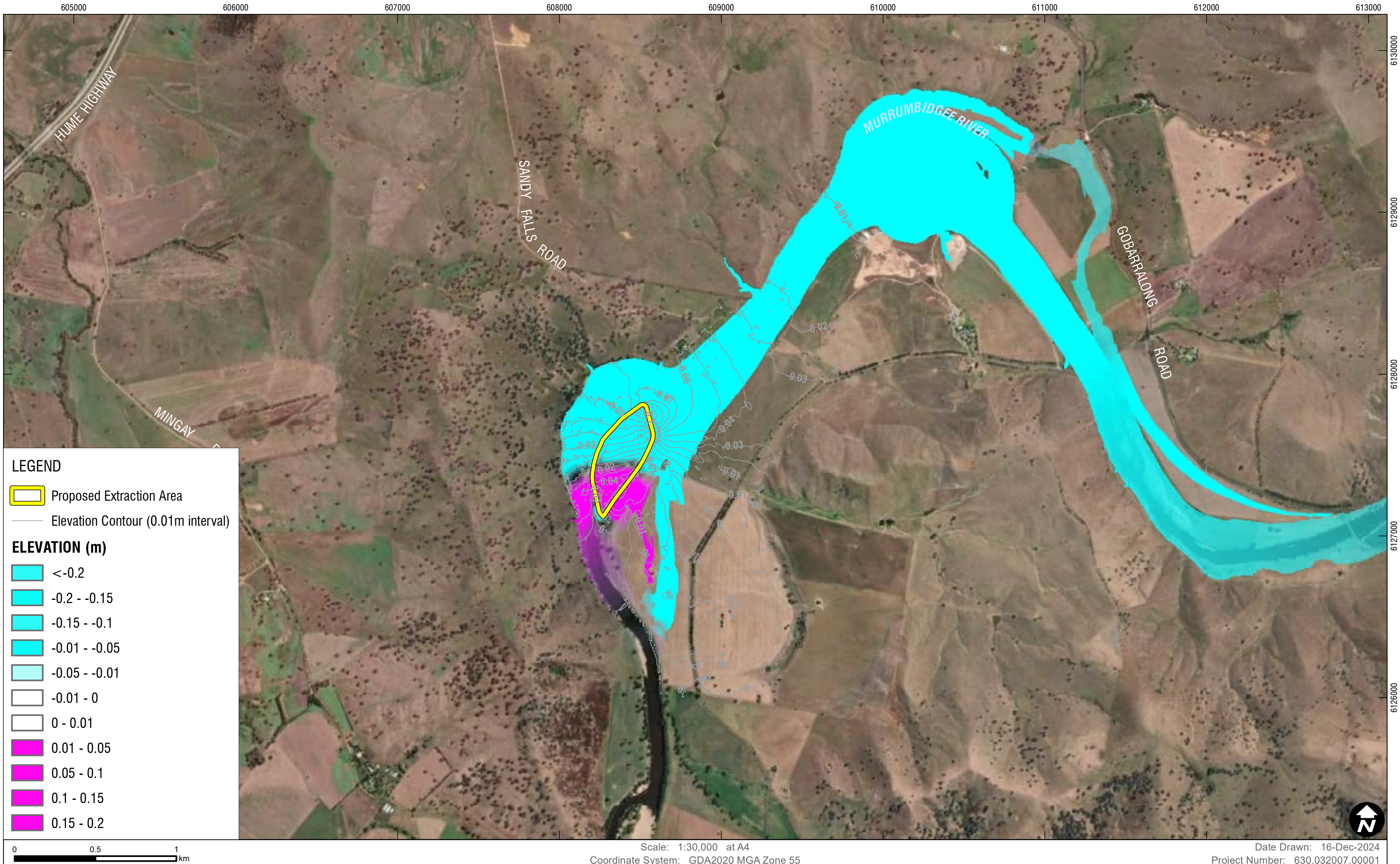
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD DEPTHS - 1% AEP

FIGURE D-1

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-1_OpSc01_1pcAEP_ELEV_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Dec-2024
Project Number: 630.032007.00001

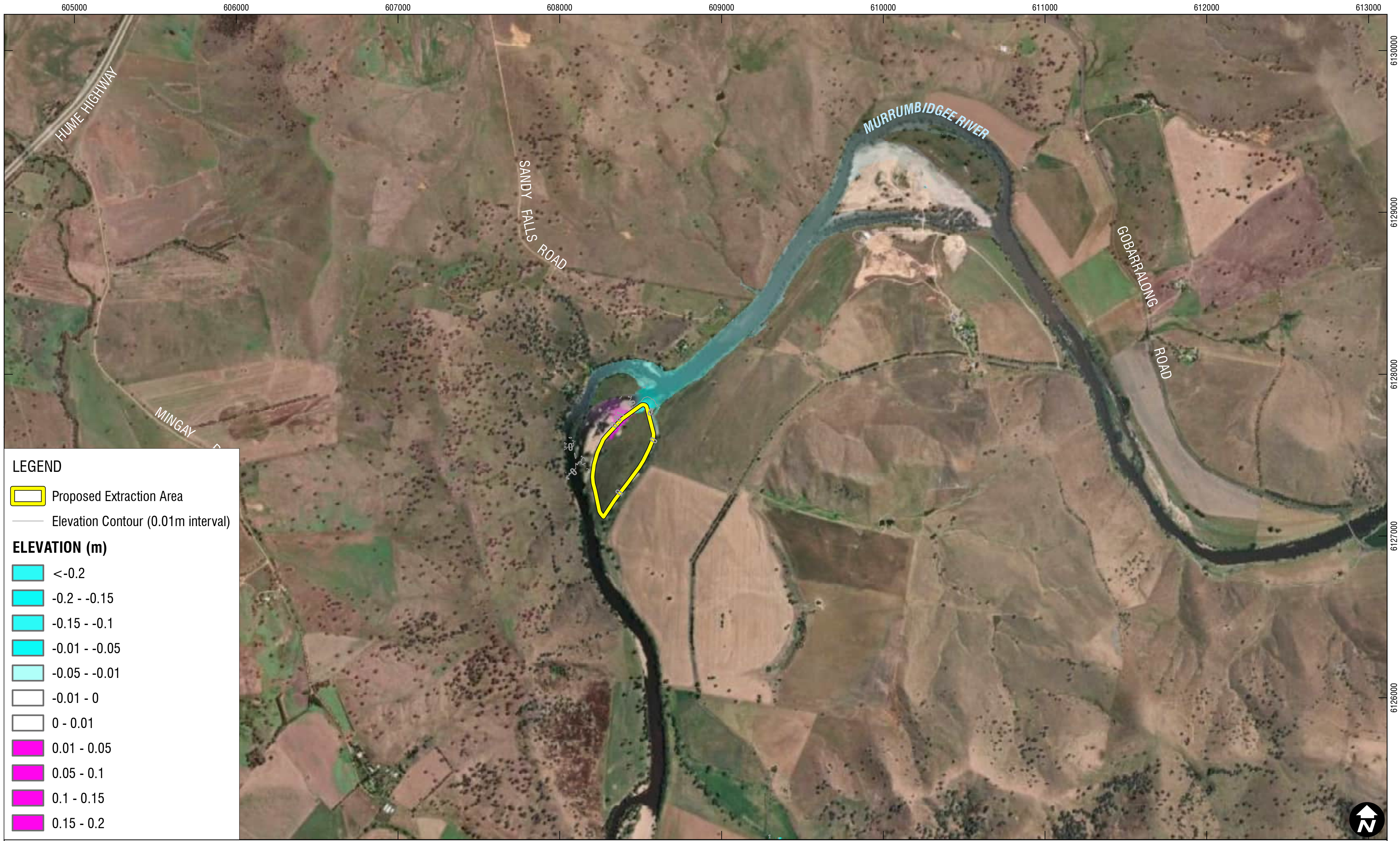
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD DEPTHS - 5% AEP

FIGURE D-2

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-2_OpSc01_5pcAEP_ELEV_DIFF_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 16-Dec-2024
Project Number: 630.032007.00001

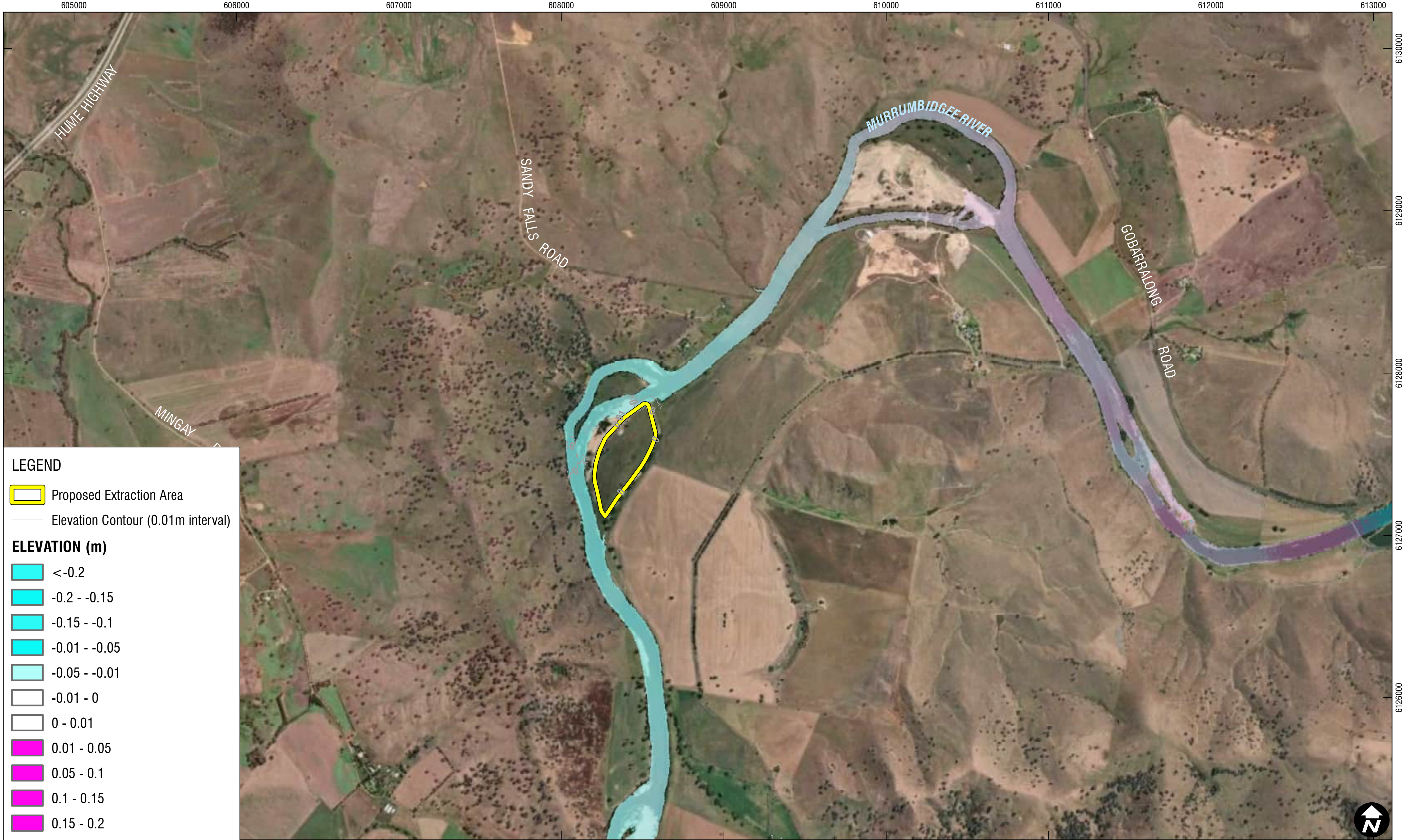
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD DEPTHS - 20% AEP

FIGURE D-3

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-3_OpSc01_20pcAEP_ELEV_DIFF_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

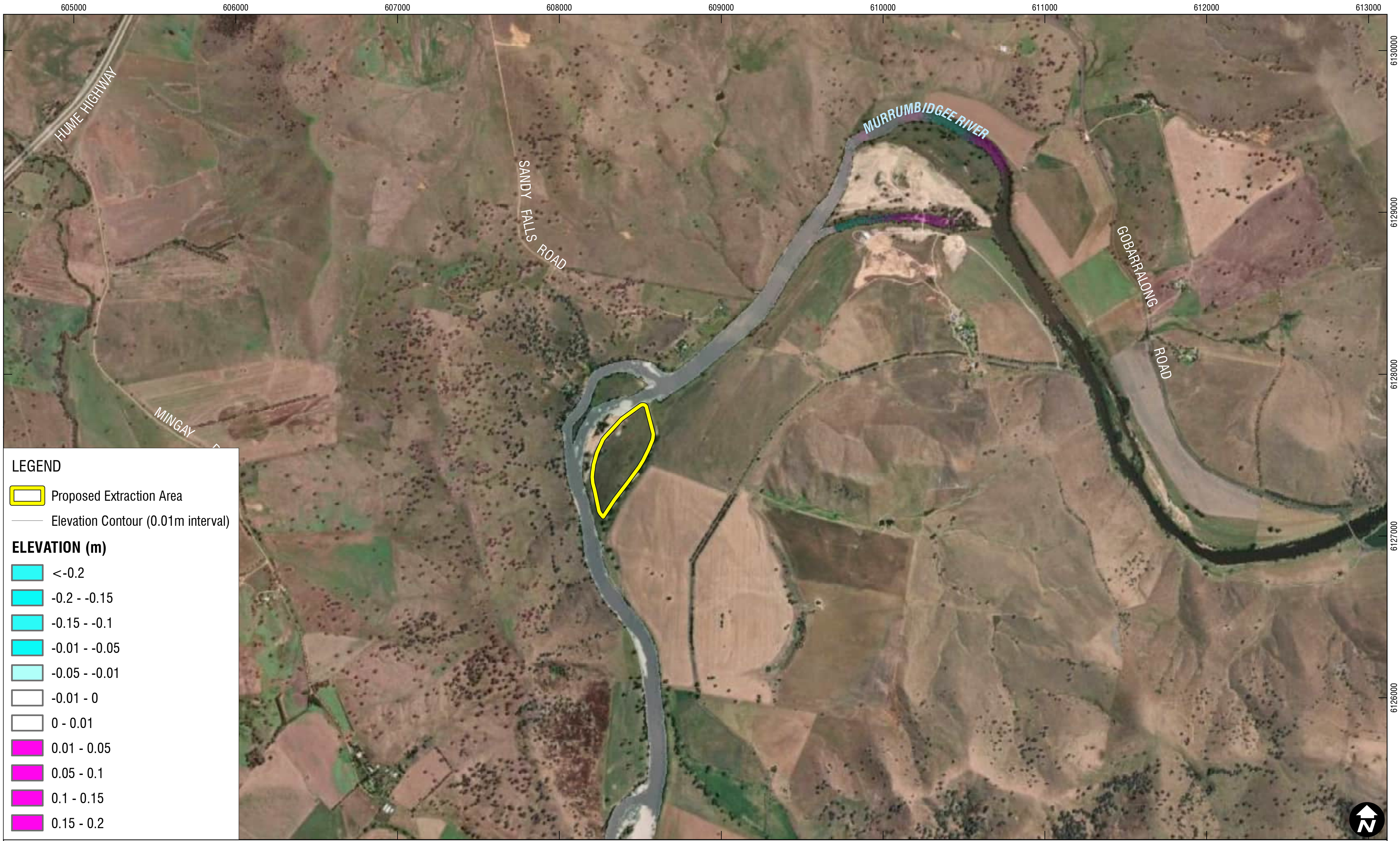
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD DEPTHS - 50% AEP

FIGURE D-4

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-4_OpSc01_50pcAEP_ELEV_DIFF_01.mxd



LEGEND

Proposed Extraction Area

Elevation Contour (0.01m interval)

ELEVATION (m)

- <-0.2
- -0.2 - -0.15
- -0.15 - -0.1
- -0.01 - -0.05
- -0.05 - -0.01
- -0.01 - 0
- 0 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 17-Dec-2024
Project Number: 630.032007.00001

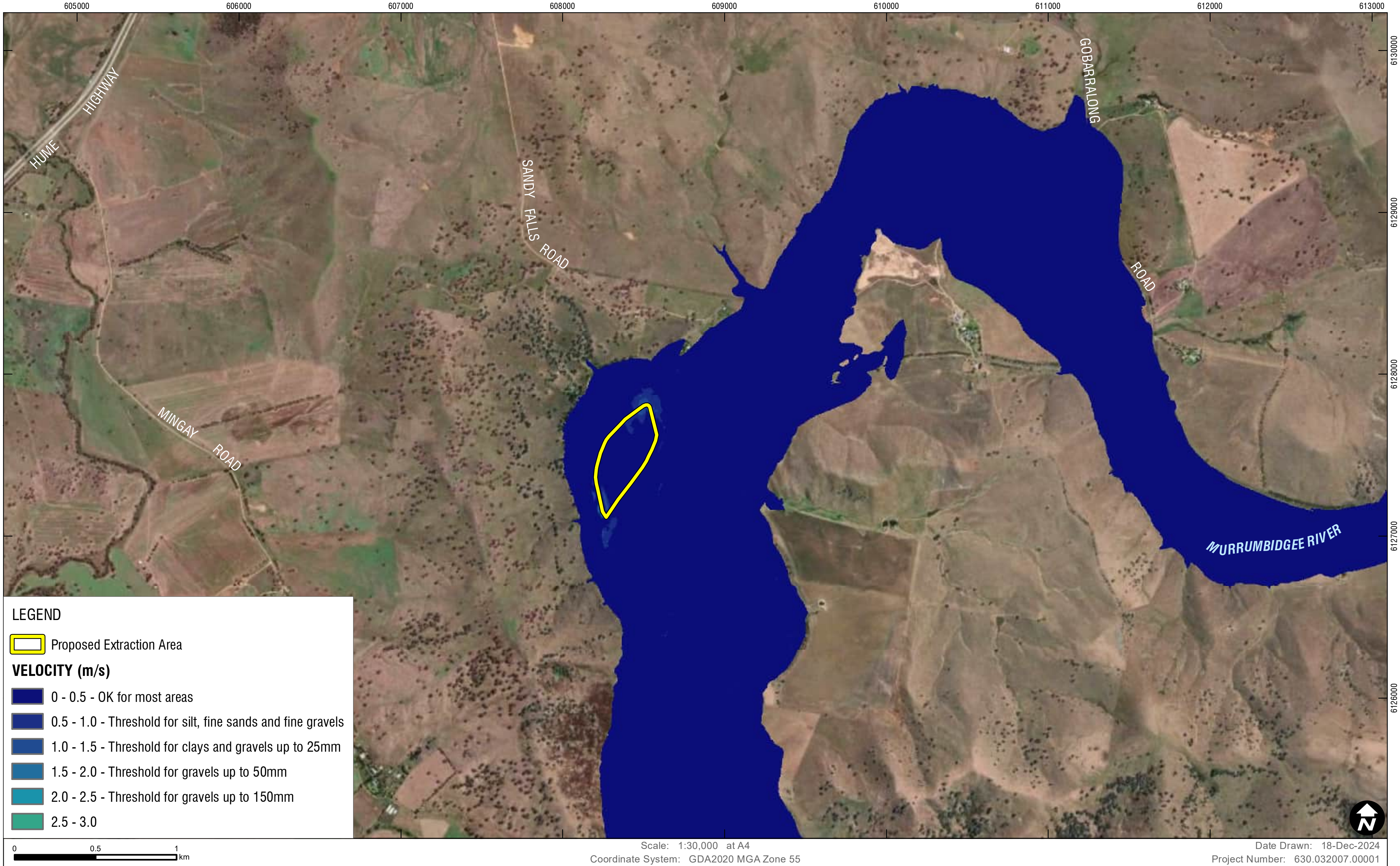
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD DEPTHS - 63% AEP

FIGURE D-5

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-5_OpSc01_63pcAEP_ELEV_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

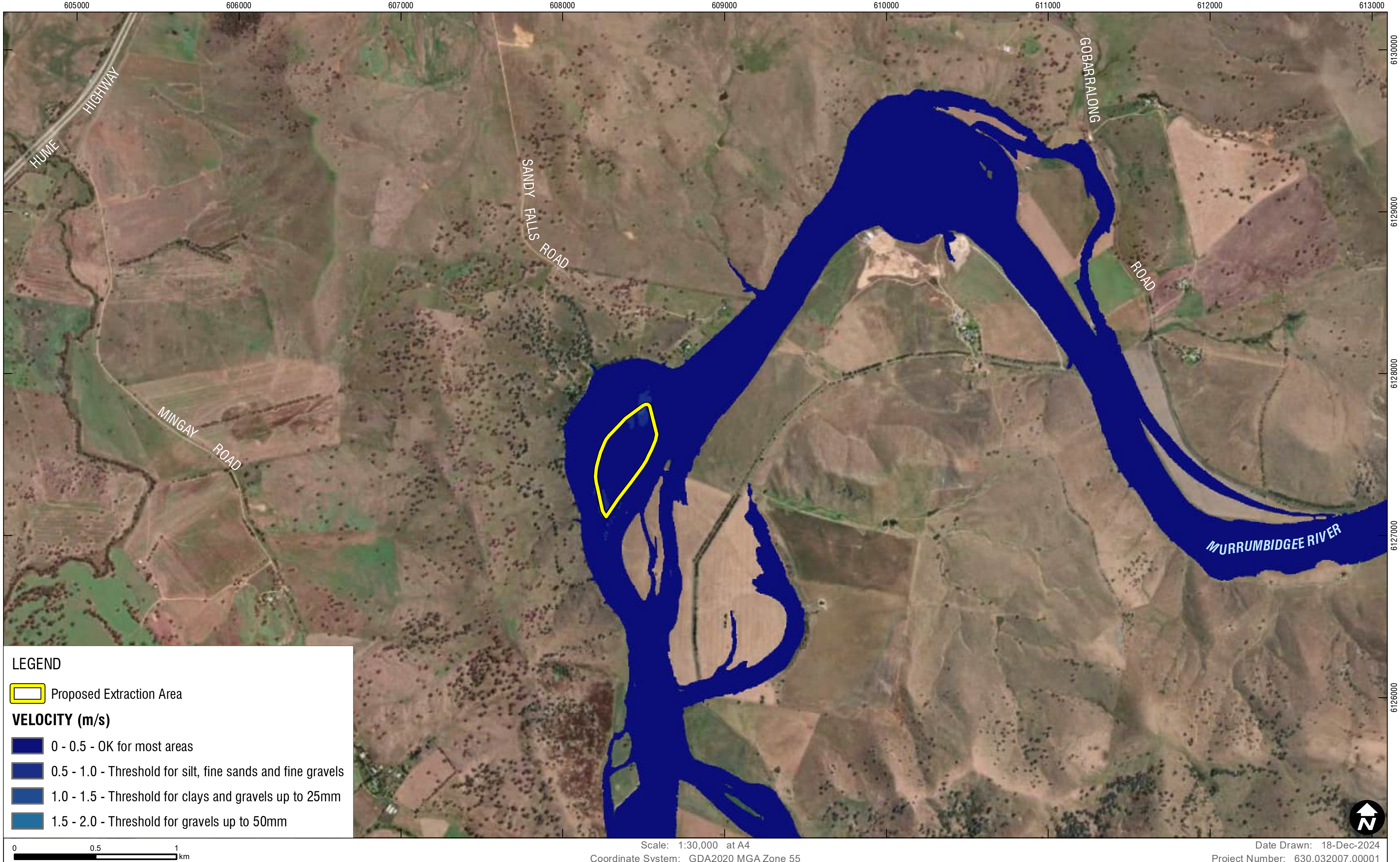
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 1% AEP

FIGURE D-6

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_D-6_OpSc01_1pcAEP_VELOCITY_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

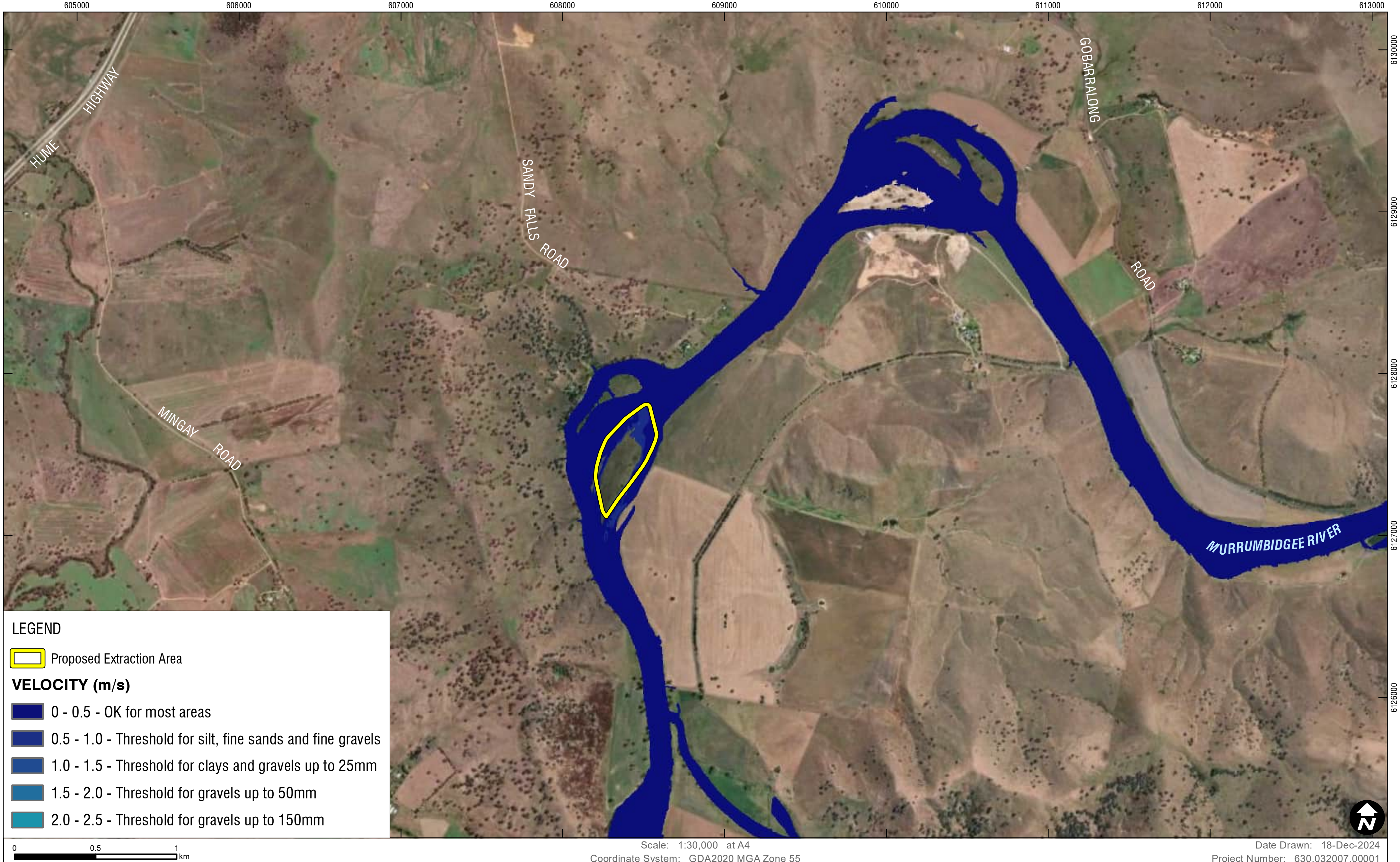
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 5% AEP

FIGURE D-7

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-7_OpSc01_5pcAEP_VELOCITY_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

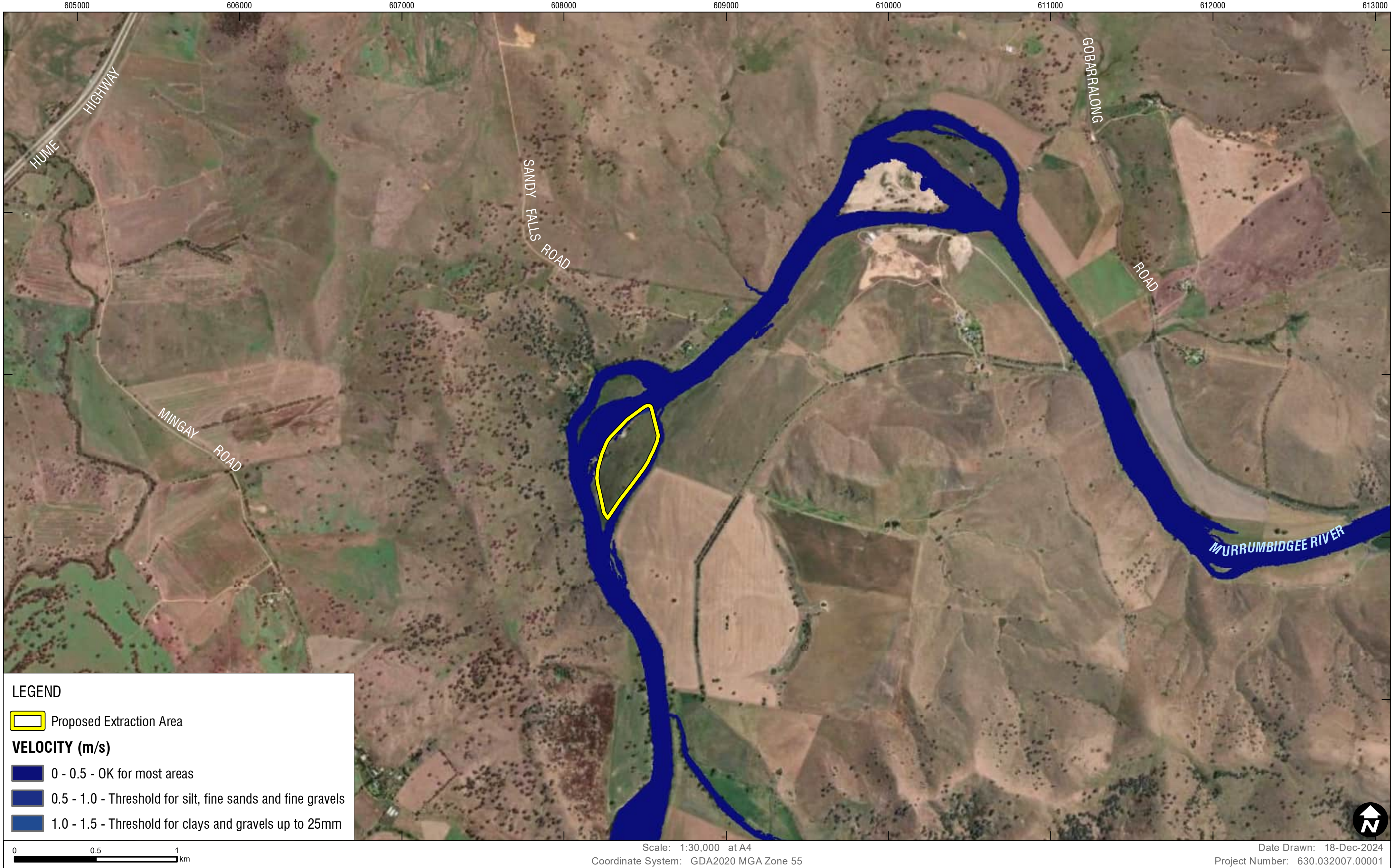
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 10% AEP

FIGURE D-8

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-8_OpSc01_10pcAEP_VELOCITY_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

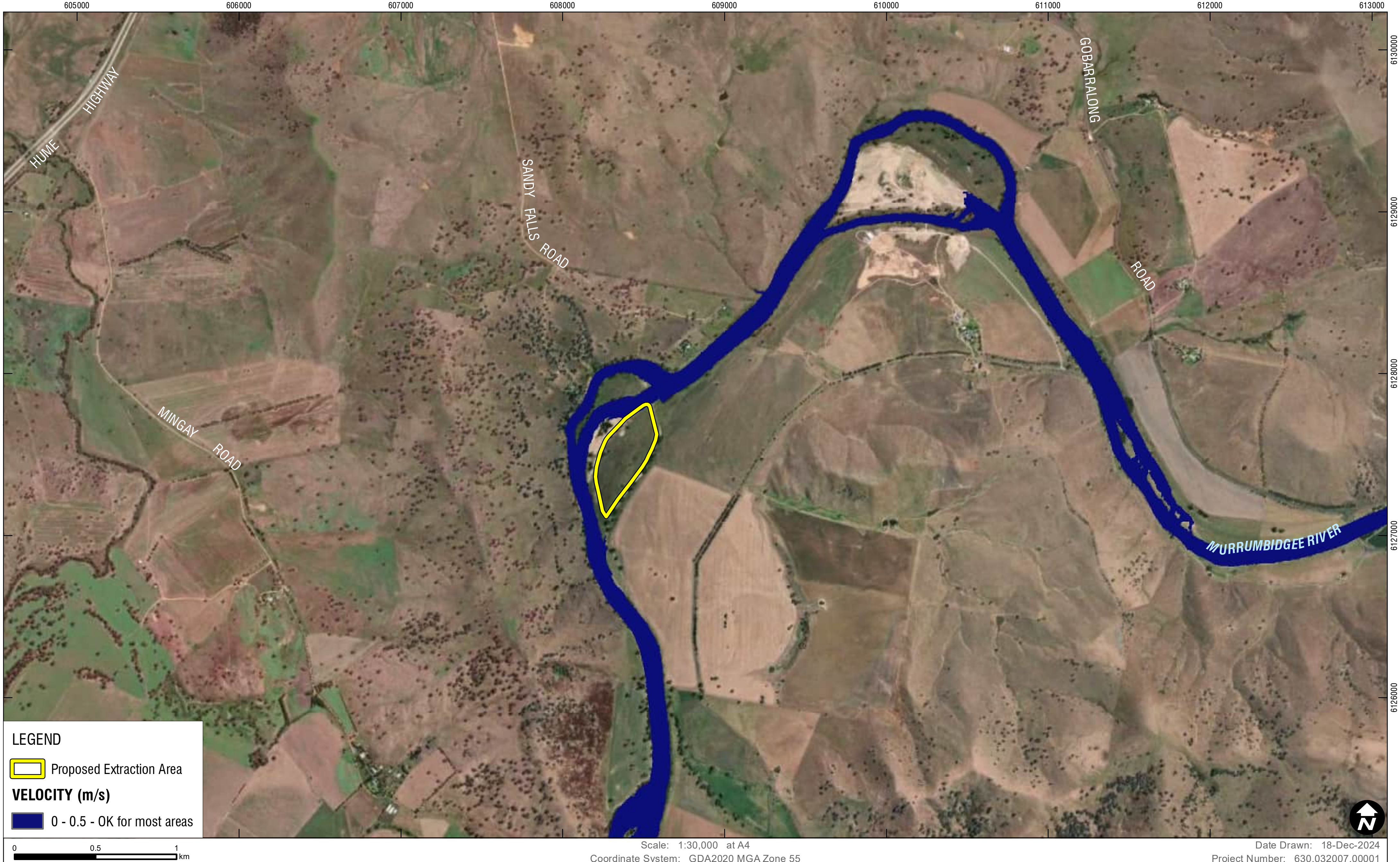
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 20% AEP

FIGURE D-9

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-9_OpSc01_20pcAEP_VELOCITY_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

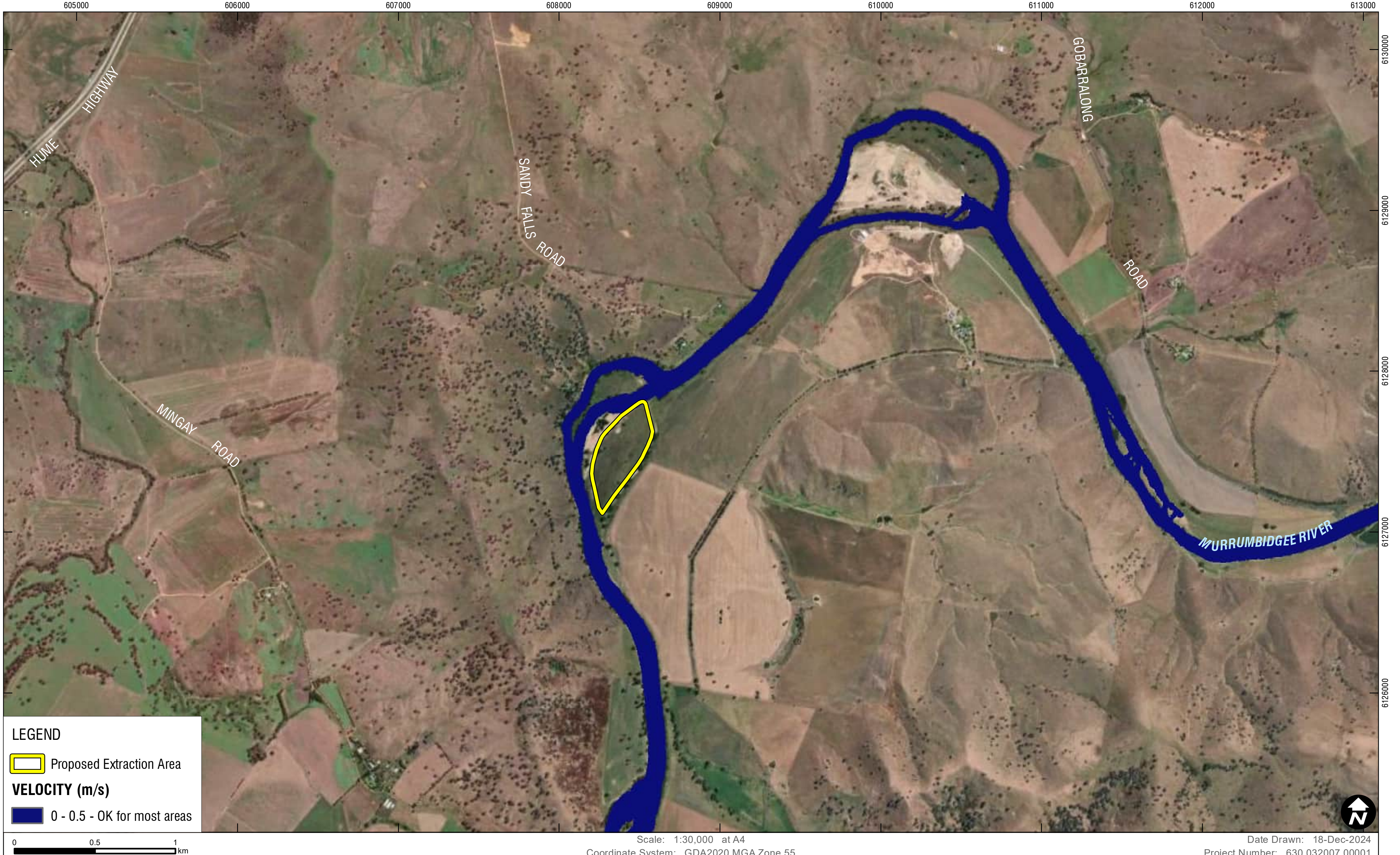
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 50% AEP

FIGURE D-10

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_APPD-10_OpSc01_50pcAEP_VELOCITY_DIFF_01.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 18-Dec-2024
Project Number: 630.032007.00001

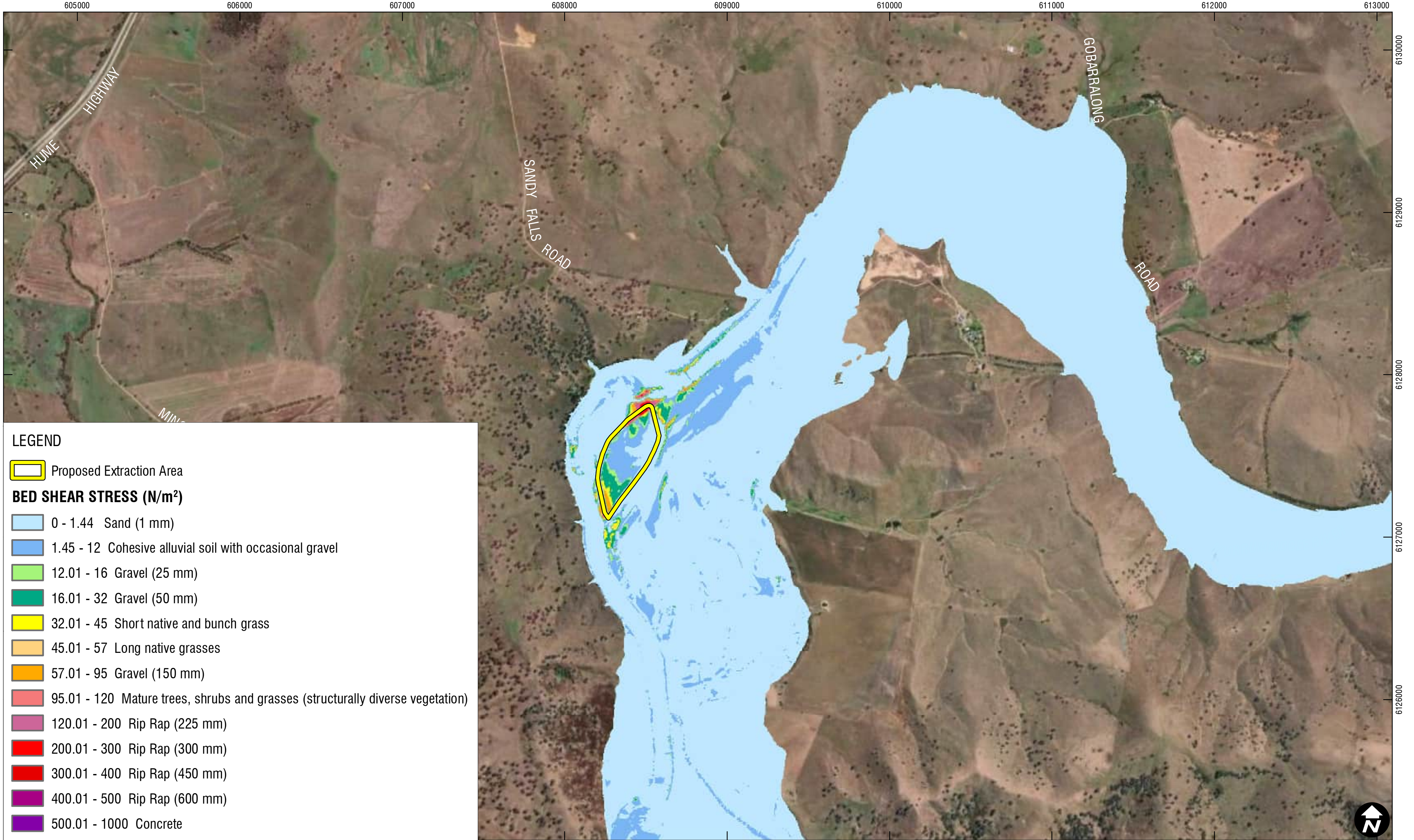
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
VELOCITY - 63% AEP

FIGURE D-11

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\SLR630.032007_D-11_OpSc01_63pcAEP_VELOCITY_DIFF_01.mxd



0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

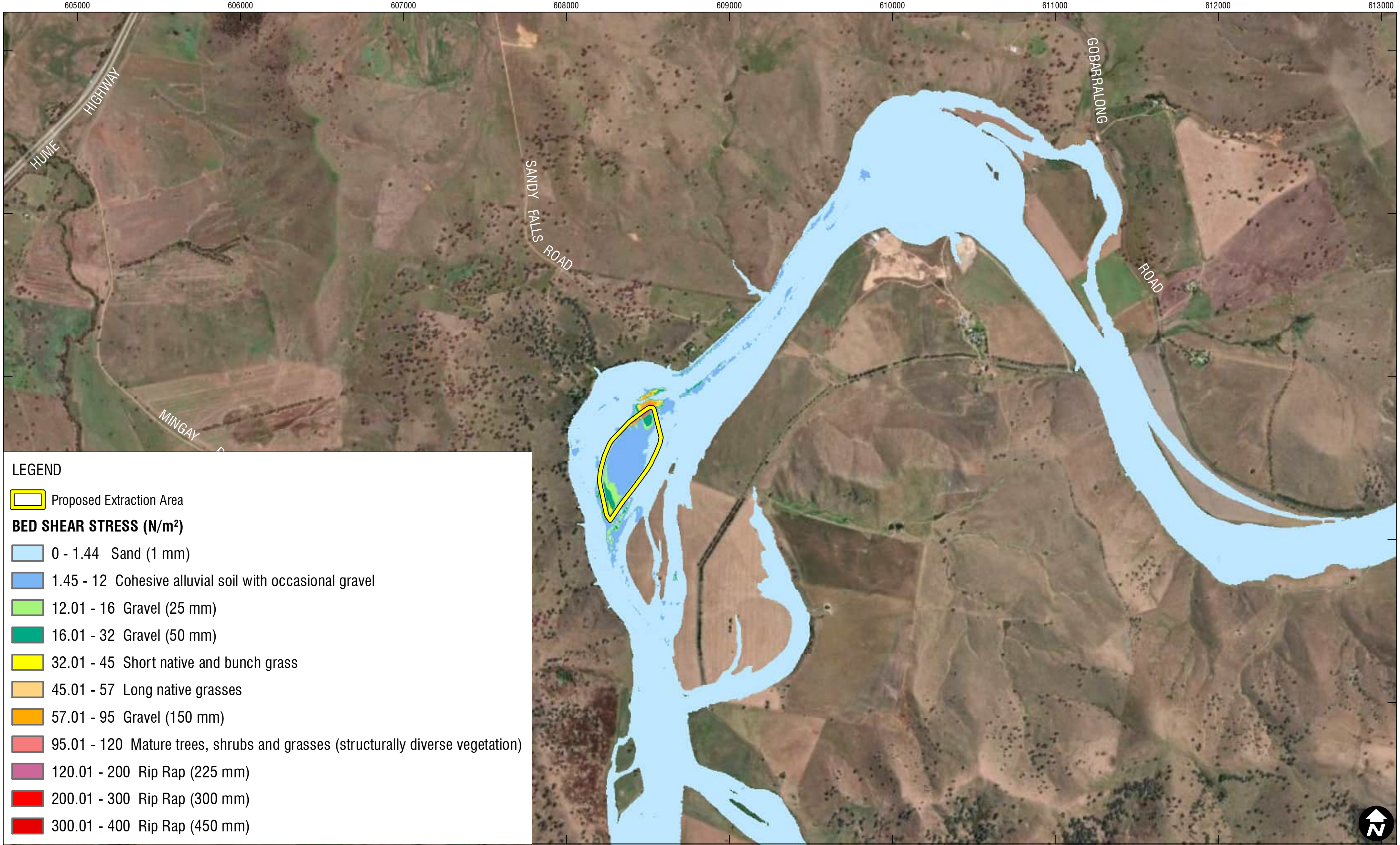
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 1% AEP

FIGURE D-12

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPD-12_OpSc01_1pcAEP_BSS_DIFF_02.mxd



LEGEND

Proposed Extraction Area

BED SHEAR STRESS (N/m²)

- 0 - 1.44 Sand (1 mm)
- 1.45 - 12 Cohesive alluvial soil with occasional gravel
- 12.01 - 16 Gravel (25 mm)
- 16.01 - 32 Gravel (50 mm)
- 32.01 - 45 Short native and bunch grass
- 45.01 - 57 Long native grasses
- 57.01 - 95 Gravel (150 mm)
- 95.01 - 120 Mature trees, shrubs and grasses (structurally diverse vegetation)
- 120.01 - 200 Rip Rap (225 mm)
- 200.01 - 300 Rip Rap (300 mm)
- 300.01 - 400 Rip Rap (450 mm)

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 22-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 5% AEP

FIGURE D-13

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPD-13_OpSc01_5pcAEP_BSS_DIFF_02.mxd

0 0.5 1 km

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 22-Jan-2025
Project Number: 630.032007.00001

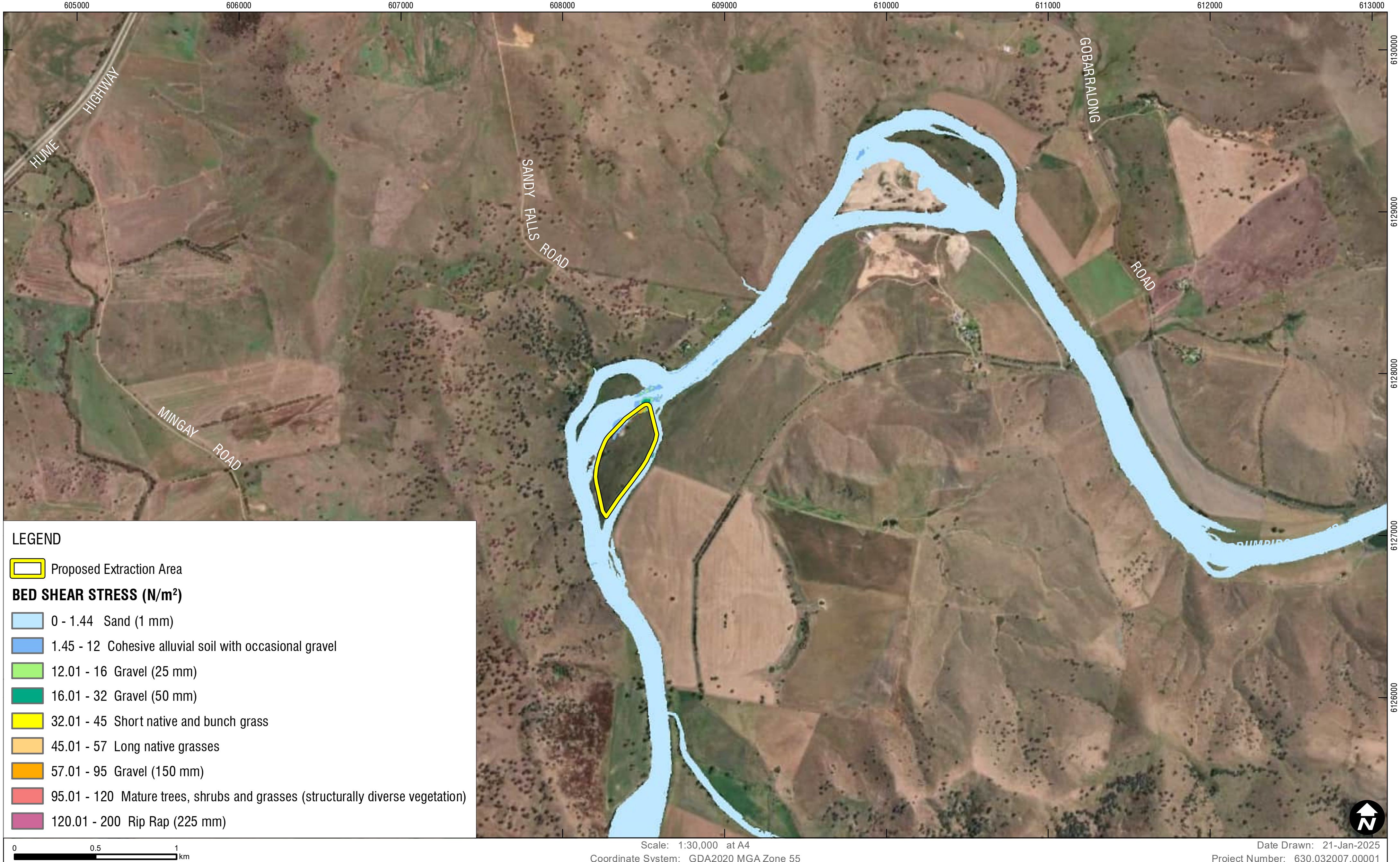
Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 10% AEP

FIGURE D-14

H:\Projects-SLR\630-SrvNTL\630-NTL\630.032007.00001 Eulonga Quarry Expansion\06 SLR Data\01 GIS\GIS\Difference Mapping\Figures\Revised Appendix Figures Jan 2025\SLR630.032007_APPD-14_OpSc01_10pcAEP_BSS_DIFF_02.mxd



Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 21-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 20% AEP

FIGURE D-15

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Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 22-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 50% AEP

FIGURE D-16

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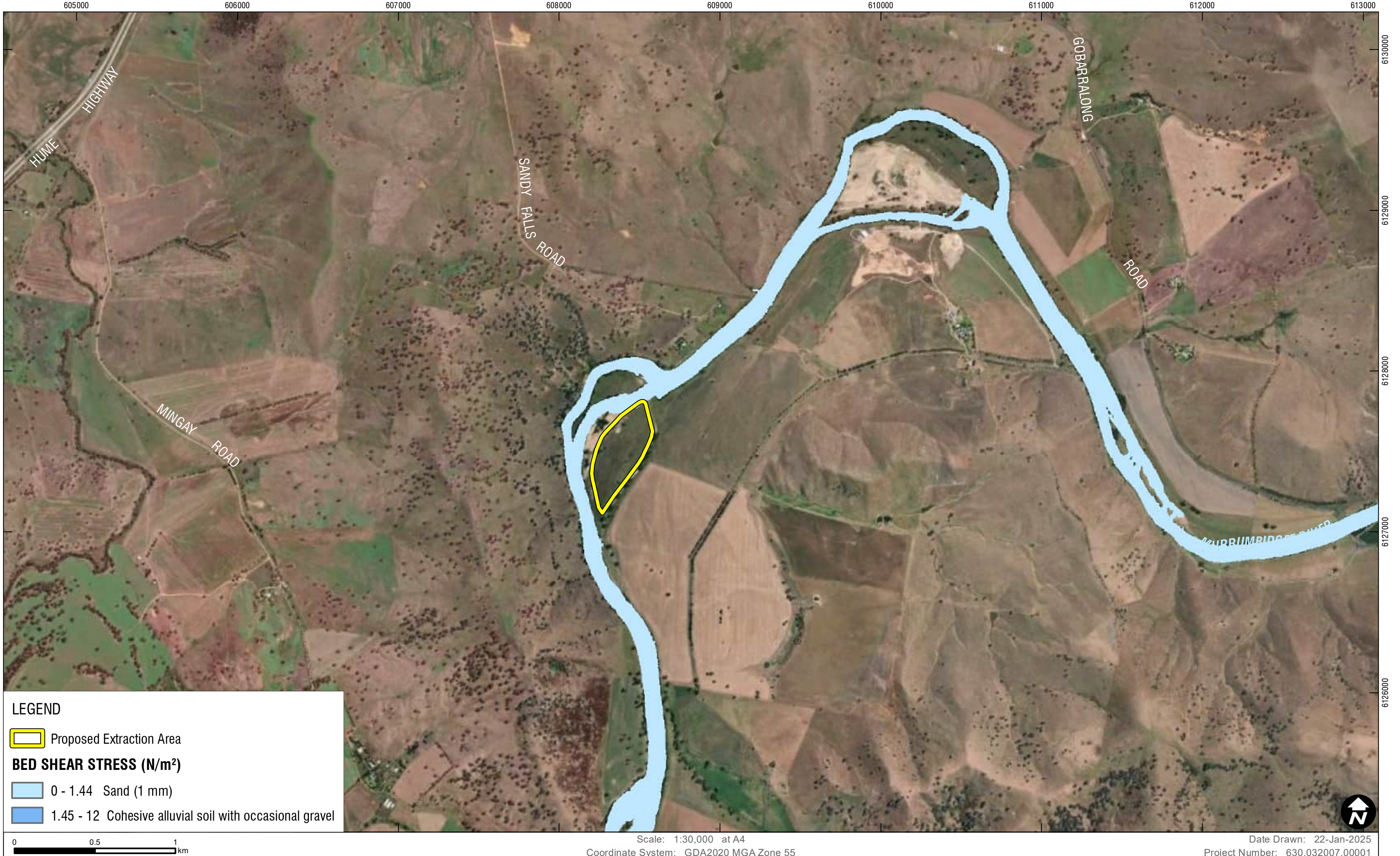

Scale: 1:30,000 at A4
Coordinate System: GDA2020 MGA Zone 55

Date Drawn: 22-Jan-2025
Project Number: 630.032007.00001

Data Source: Imagery ESRI Base Maps

SLR

DIFFERENCE MAPPING
PEAK FLOOD
BED SHEAR STRESS - 63% AEP

FIGURE D-17

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Appendix E

Water Balance Modelling

Eulonga Quary Proposed Extraction Area

Eulonga Quarries Pty Limited

SLR Project No.: 630.032007.00001

17 March 2025

. General Water Balance Model (WBM)

. Available Data

Key information sources that were made available for this assessment are documented in Table E-1.

Table E-1: Information sources used in assessment

Data	Description and limitations	Source
DEM Eulonga proposed quarry	Digital Elevation Model (4.0 m resolution). .	October 2024.
Site Topography	Existing Surface Tif file 1 m resolution	October 2024
Road alignment	The road will be built out of locally sourced granite for the sub base with a 300mm capping of imported DGS20 road base that will help reduce the dust. The road will be 5m wide and the length is approximately 1.5km the last of the road that will be essentially on top of sand will not be formed up with imported material.	October 2024
Approval details Ground Water	A total volume of groundwater extracted from all water supply works authorised should not exceed 2 ML/year	(WaterNSW, 2020)

. Methodology

The WBM was developed in the GoldSim modelling package (Version 14.0). GoldSim is a software program developed by the GoldSim Technology Group (GTG, 2004) that can analyse complex time-dependent systems and has the ability to assess stochastic systems resulting in probabilistic outcome ranges.

Conceptual Model

A conceptual model for the surface water management on site is represented in Figure E.1, indicating the key site features and the WBM boundary. The key feature of this conceptual model includes the proposed quarry.

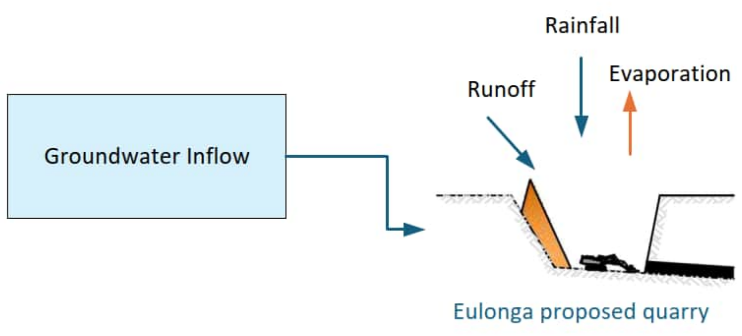

Figure E.1: Conceptual WBM of the proposed quarry

Model Assumptions

The following assumptions have been made:

- A total of volume of groundwater inflow cannot exceed the 2 ML/yr (WaterNSW 2020), this groundwater rate it will be include as an average daily flow in the simulation.
- Seepage is considered negligible to zero.
- Groundwater interaction and connection are excluded of this assessment.
- There is no external catchment runoff contributing to the proposed quarry, as the pit functions as a self-contained turkey nest.
- Additional outflows from the pit correspond to dust suppression request for the road area (5m width by 1500 m length). SLR will estimate the surplus of water available in the pit to check how much volume can supply for the dust suppression demand, based on the conceptual WBM.
- Assumptions for quarry operations: The quarry will operate ~5.5 days per week, ~48 weeks of the year ~264 operational days.
- The dust suppression target demand corresponds to NPI benchmark of 2.0 L/m2/h based on Air Quality Report (SLR, 2025)
- Initial water level for the start of the simulation corresponding to the minimum elevation of the DEM dated October 2024, 222 m AHD.
- Pump transfer system will only activate when storage level as a minimum of volume above 1ML stored.
- This WBM is high level assessment, reflecting the preliminary stage of the project. As this stage, dust suppression demand has not been included as an outflow within the system. The quantification of this outflow will depend on variables such as the type of surfacing applied to the access road and the implementation of recommendations to minimise the dust impact.
- The WBM can only provide an approximation of natural hydrological responses and dynamics; they inherently have limitations and are based on a range of assumptions. However, much has been done to increase confidence in the model to provide credible semi-quantitative estimates required to meet the model objectives. This confidence comes from the accepted physical principles adopted and applied in the model.

Key Statistics

A vital component of the WBM is the variability of climatic conditions. The WBM is simulated with a range of rainfall conditions, statistically equivalent to the historical records, to allow for the calculation of percentiles of key model outputs. These percentiles represent the results range due to the variability in the climate. These percentiles can be interpreted as the chance of the statistic being exceeded. The results of the WBM focus on the 5^{th} (dry), 50^{th} (median) and 95^{th} percentile (wet) conditions.

Simulation Settings

The WBM applies the probabilistic simulation (Monte Carlo) for the historical climate data. A total of 66 model realisation in response to historical climate data (from 1957[1] to 2024), refer to the Climate section in **Section**

. Climate

.

The operation is projected to be ten (10) years. Details of the simulation period are provided in **Table E-2**

Table E-2: Simulation period

Pit	Simulation periods
Proposed quarry	01 January 2025 to 31 December 2035

Initial Conditions

The initial conditions of the storage levels were established based on DEM data at the time of acquisition.

A summary of initial water levels for each storage unit is provided in **Table E-3**

Table E-3: Initial water levels

Pit	Initial water level elevation (m AHD*) DEM 2024	Capacity at the Pit (ML)
Proposed quarry	222	0

* metres Australian Height Datum

. Climate

Climate historical data used in the WBM to simulate rainfall, runoff, and evaporation losses were sources from the BoM via the Scientific Information for Land Owners (SILO, 2024) grid data. Long-term data was retrieved for the site (-35.0,148.20) from a period of 1957* to 2024. This included daily rainfall (**Section Rainfall**), evaporation (Morton's Lake) and evapotranspiration records (**Section Evaporation**).

Rainfall

[1] 1957 when routine of digitalisation data begins, (SILO, 2024)

The annual average rainfall for the site is 692 mm and the daily average per month is shown in Figure E-2

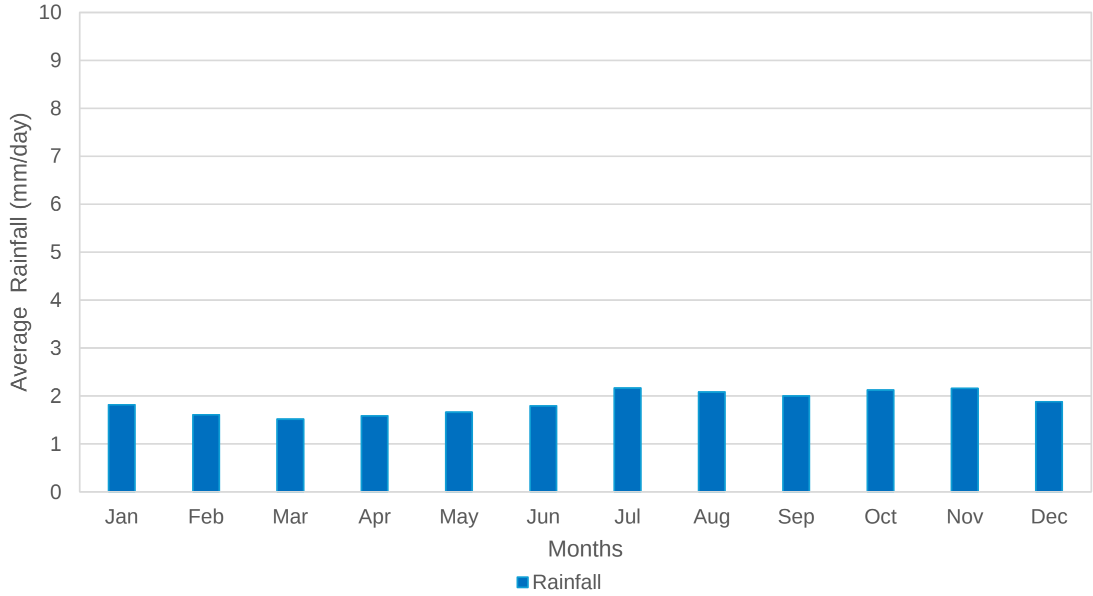

Figure E-2 Average daily rainfall per month

Evaporation

The WBM incorporates two types of evaporation: Morton's shallow lake evaporation is used for water storage (Morton, 1983), and the evapotranspiration potential of Morton is used to estimate the losses in the surface runoff.

The average daily evaporation values per months are shown in Figure A-3.

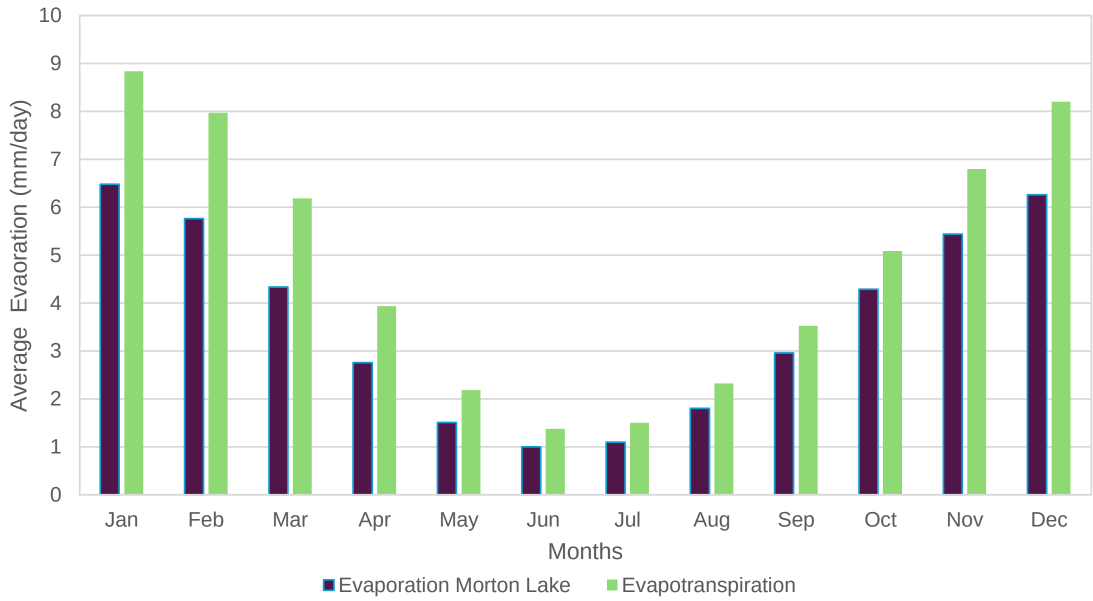

Figure E-3 Average daily evaporation and evapotranspiration per month

. Runoff modelling

The WBM utilises the Australian Water Balance Model (AWBM) rainfall runoff module to calculate the rainfall and runoff inflows from the catchment.

The rainfall is converted to runoff using the AWBM, illustrated in Figure E-4**.** This runoff can be split into two forms:

1. Surface runoff which travels overland to the destination; or
2. Sub-surface which travels through the ground to reach the destination.

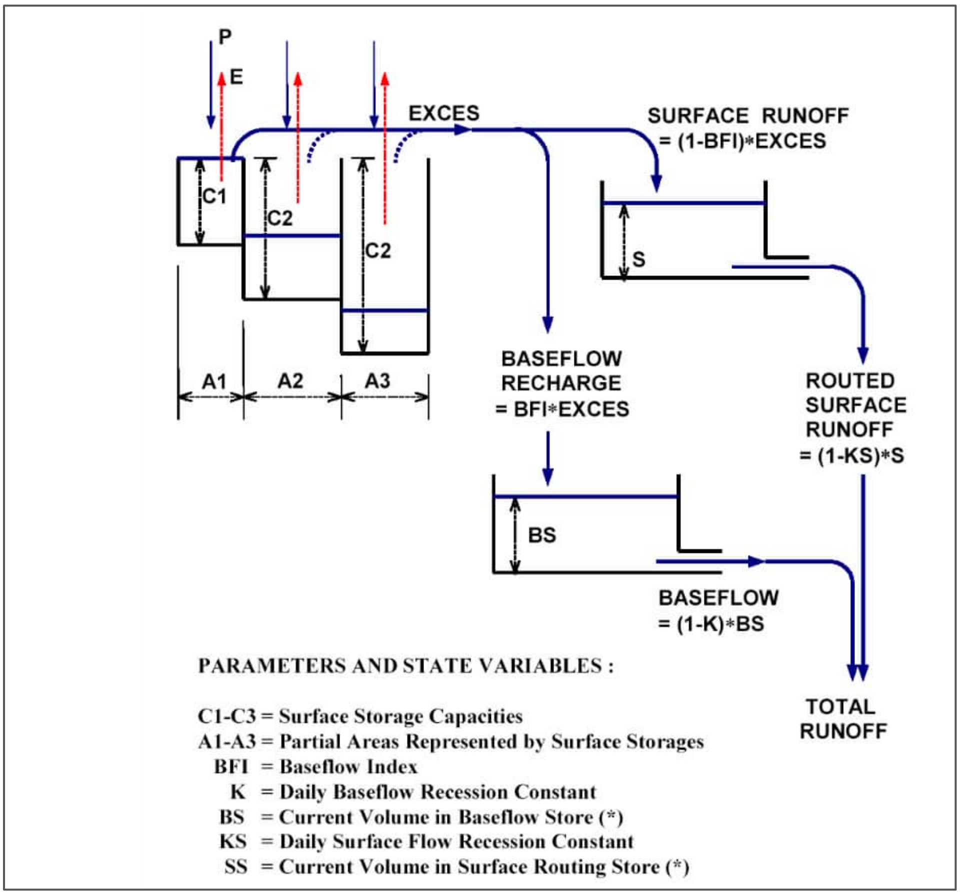

Figure E-4 Australian Water Balance Model Schematic

The AWBM parameters were adopted from the literature AWBM parameters that are recommended for use on ungauged catchment (Boughton, 2003), and based on previous SLR GoldSim models developed for pits voids in Australia (SLR, 2022). A summary of the AWBM parameters used for each catchment type is presented in Table E-4.

Table A-4: Adopted AWBM parameters sources SLR and (Boughton, 2003)

Parameter	Abbreviation	Adopted Pit voids surface
Small storage capacity (mm)	C1	5
Medium storage capacity (mm)	C2	25
Large storage capacity (mm)	C3	25
Small partial area portion	A1	0.134
Medium partial area portion	A2	0.433
Large partial area portion	A3	0.433
Baseflow Index	BFI	0.1
Baseflow recession	K_b	0.95
Daily streamflow recession	K_s	0.95

. Geometry Storages

The stage-storage and surface area relationship curves were derived from the DEM provided by the client. Table E-5 shows the geometry and storage characteristics per storage, detailed illustration of the cumulative volume and surface area vs elevation is provided in Figure E-5.

Table E-5: Geometry and storage characteristics

Pit	Maximum Pit Wall Level (m AHD)	Maximum Capacity (ML)	Maximum Surface Area (ha)
Proposed quarry	227	627	13.9

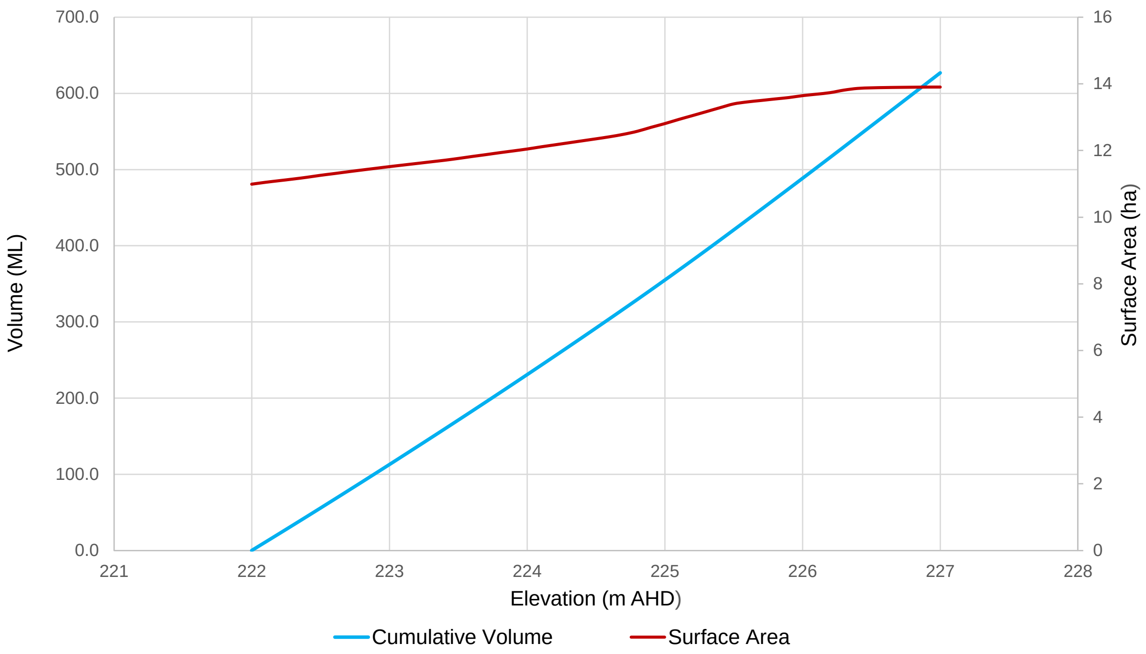

Figure E-5: Stage storage curve Eulonga proposed quarry

. Inflows

. Groundwater

As it was mentioned in the section0 assumptions, there is a maximum of groundwater authorized of 2 ML/year use for supply works (WaterNSW, 2020).

. Water Balance Results

Based on the projections and the assumptions regarding inflows and outflows (see Figure E-5 and Figure E-6), the model results did not indicate any spills from the proposed quarry throughout the simulation period, which encompasses 66 realization of 10 years of climate data (equivalent 660 years).

Analysis of climate data shows that, on average, daily evaporation rates exceed daily rainfall rates. As a result, even under wet conditions, some rainy days could not generate excess of water in the pit as evaporation will effectively remove any surplus. Therefore the model predicts few days between July and August could generate a minimum surplus on site.

The probabilistic simulation of the Pit volume, Figure E-7, shows the oscillation in the volume is driven by the climate variability and its maximum statistic results it's about the 17 ML about 2% of its maximum capacity 627 ML.

As it's shown in the following illustration, water levels remains low and far below of the pit wall level (see levels in Figure E- 8).

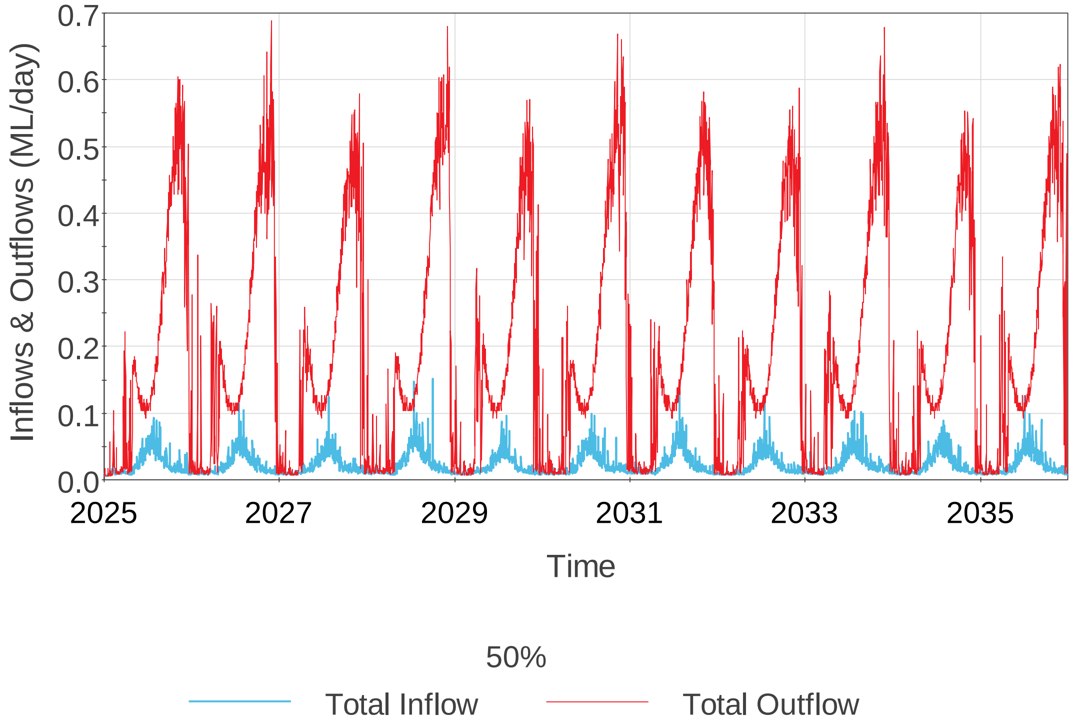

Figure E-5: Median daily values of Total Inflow and Outflows of the Pit

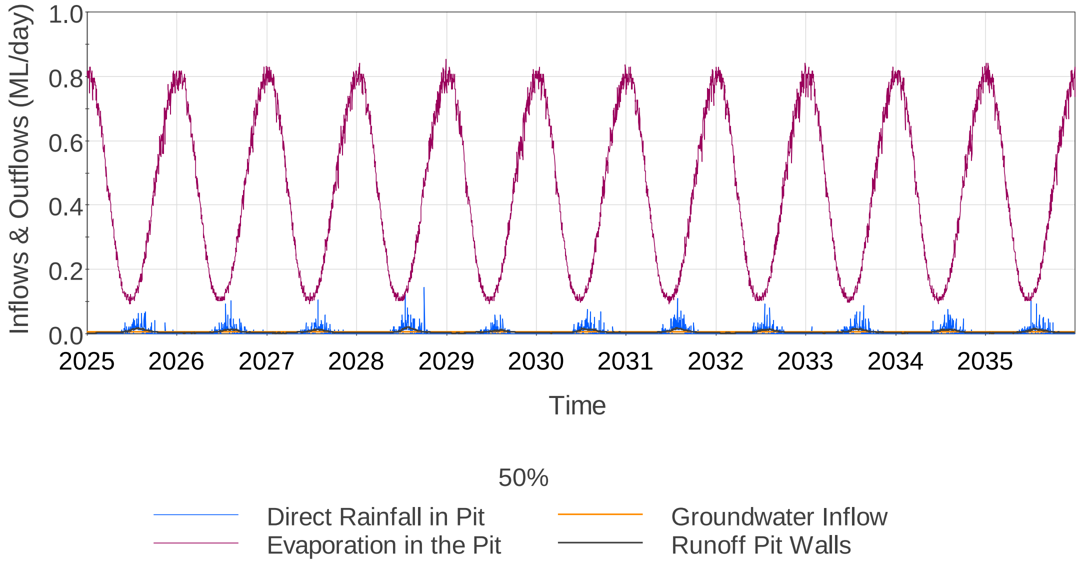

Figure E-6: Median daily values of each inflow and outflows of the Pit

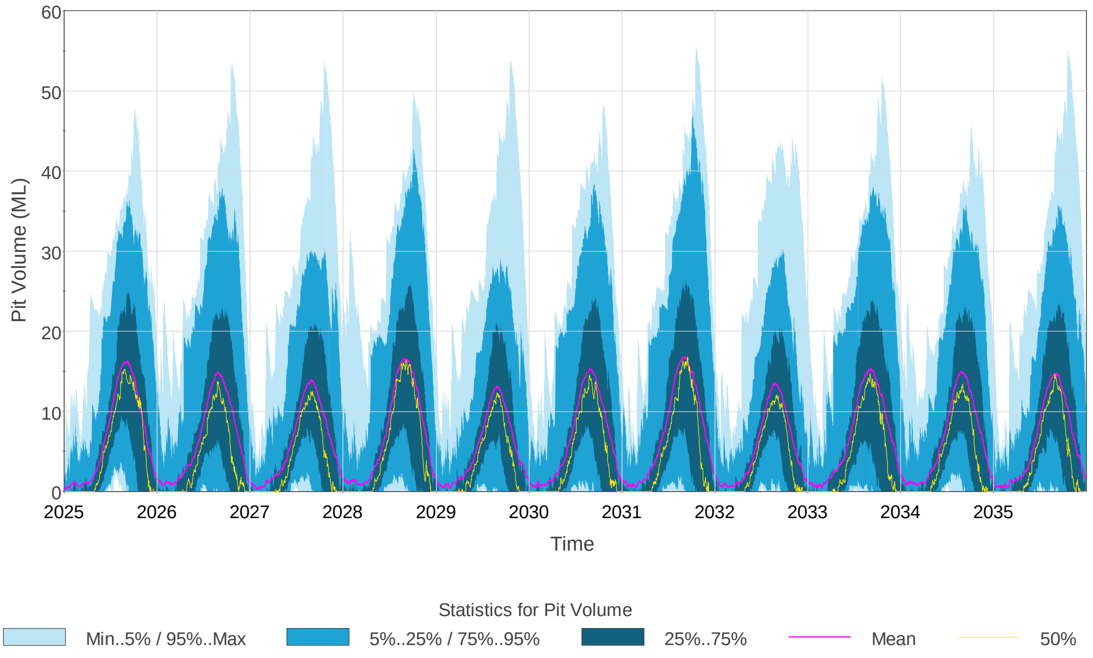

Figure E-7: Pit projected capacity (Max. Capacity = 627 ML)

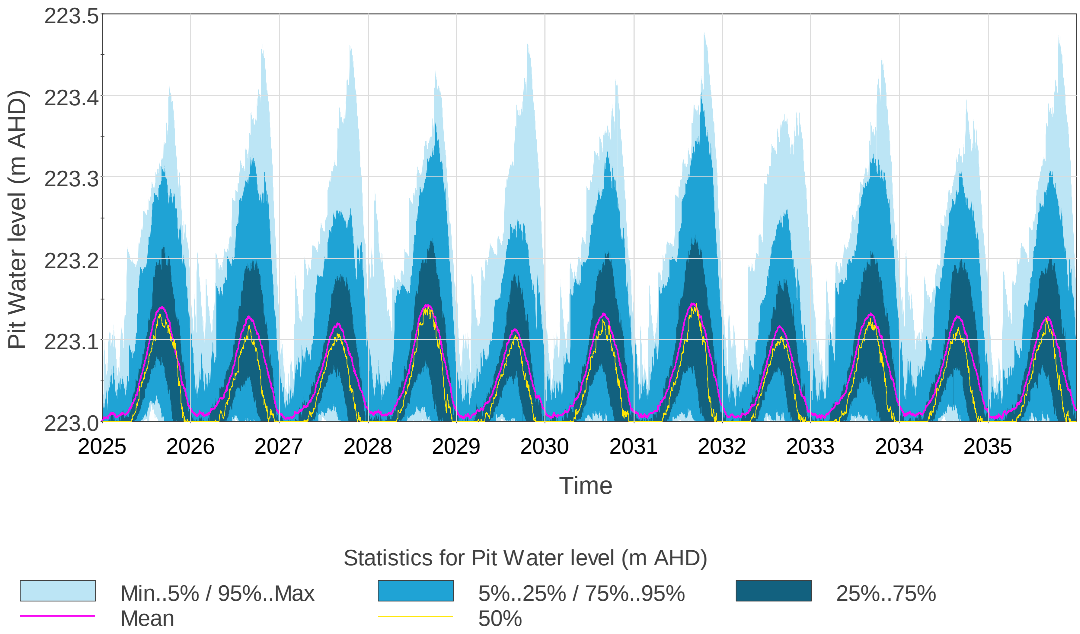

Figure E-8: Simulation of Pit water level

An additional analysis of rainfall data at the site was conducted to estimate the water demand for dust suppression during dry days. Based on a 10-year simulation, the model predicts a median of 570 rainy days over the period, equating to approximately 57 rainy days per year (Figure E-9). As outlined in the assumptions, the quarry operates for 264 days annually. This implies that dust suppression measures will not be required on the 57 rainy operational days, leaving 207 dry operational days per year.

To meet dust suppression requirements during dry days, the analysis estimates a demand of three water carts with a capacity of 12 kiloliters (kL) each, resulting in water usage of approximately 7.5 megaliters per year (ML/yr).

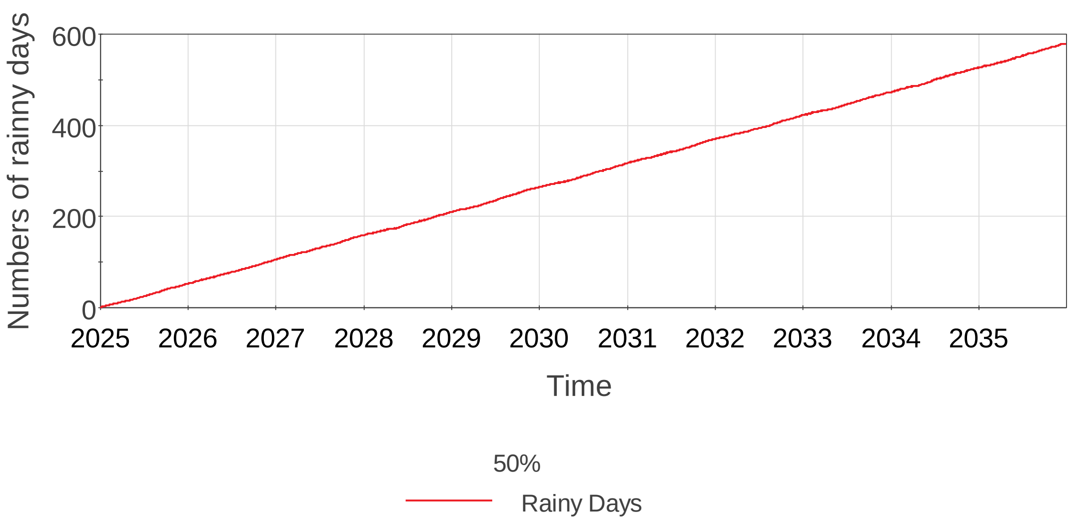

Figure E-9: Average rainy days for the entire simulation period (10 years)

Conclusion and Recommendations

The key findings from our WBM analysis shows:

- The Eulonga proposed quarry is expected to maintain low water levels throughout the 10-year simulation period, primarily driven by the interaction between inflows and, evaporation.
- The simulation results confirm that no water spills are anticipated from the quarry pit during the operation, even under wet climate conditions. This outcome is attributed to the high daily evaporation rates, which consistently exceed rainfall and runoff contributions, effectively preventing the accumulation of surplus water within the pit.
- The site requires approximately 7.5 ML/yr to reduce the impact of dust

Recommendations:

- As the pit does not generate enough surplus during wet conditions, is recommended that the water demand will be supplied using existing quarry licenced sources and surface water harvested onsite, in conjunction with
- Operational management recommendations that do not require water such as:
    - During dry conditions and when wind directions are not being blocked by the hills during dry conditions. Maintain awareness of where the dust plumes are going – if a dust plume is heading in the direction of a residence, stop operations until the wind direction shifts.
    - use of speed limits for various parts of the site including access roads to minimise wheel-generated dust emissions
    - dropping loads carefully into trucks e.g. minimising bucket drop heights
    - keeping a detailed record of dust complaints and addressing complaints properly.

Consideration of the model:

The accuracy of the model outcomes depends on the understanding of the conceptual model established at the outset. Given the significant number of assumptions incorporated in the model, it is imperative that these assumptions be revised and validated by the client.

The results obtained align with the assumptions and estimates based on the available data at the time of model development. However, further efforts to enhance the precision and reliability of the model results will be pursued if need it.

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