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Stockton Quarry Dry Sand Extraction Project

ENVIRONMENTAL IMPACT STATEMENT

Prepared for Boral Resources (NSW) Pty Ltd | August 2023

Stockton Quarry Dry Sand Extraction Project

Environmental Impact Statement

Prepared for Boral Resources (NSW) Pty Ltd

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0-1	19 July 2023	Draft	Nicholas Hall / John Arnold	John Arnold / David Ireland
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Environmental Impact Statement Certification

Certification	
Project details	
Project mane:	Stockton Dry Sand Extraction Project
Application number	SSD-52984213
Address of the land in respect of which the development application has been made	Lot 1 DP 1006399 Lot 2 DP 1006399 Lot 3 DP 664552
Applicant details	
Applicant name	Boral Resources (NSW) Pty Ltd
Applicant address	Triniti 2, 39 Delhi Road North Ryde NSW 2113
Details of person by whom this EIS was prepared	
Name	John Arnold / Nicholas Hall / David Ireland
Address	Suite 607, 310 George Street, Sydney NSW 2001
Declaration by registered environmental assessment practitioner	
Name	David Ireland
Registration number	7775
Organisation registered with	Planning Institute of Australia
Declaration	The undersigned declares that this environmental impact statement (EIS): • has been prepared in accordance with Schedule 2 of the NSW *Environmental Planning and Assessment Regulation 2021*; • contains all available information relevant to the environmental assessment of the development, activity or infrastructure to which this EIS relates; • does not contain information that is false or misleading; • addresses the Planning Secretary's environmental assessment requirements (SEARs) for the project; • identifies and addresses the relevant statutory requirements for the project, including any relevant matters for consideration in environmental planning instruments; • has been prepared having regard to the NSW Department of Planning's *State Significant Development Guidelines - Preparing an Environmental Impact Statement*; • contains a simple and easy to understand summary of the project as a whole, having regard to the economic, environmental and social impacts of the project and the principles of ecologically sustainable development; • contains a consolidated description of the project in a single chapter of this EIS; • contains an accurate summary of the findings of any community engagement; and • contains an accurate summary of the detailed technical assessment of the impacts of the project as a whole.
Signature	
Date	23/08/2023

Executive summary

ES1 Introduction

Boral Resources (NSW) Pty Ltd (the applicant) owns and operates the Stockton Sand Quarry (the site or the quarry), located on Coxs Lane, Fullerton Cove, a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

The site has an area of approximately 246 hectares (ha) and has been used for the purposes of extractive industries (sand quarrying) since the 1970s. At present, there is an existing quarry located on the windblown (transgressive) sand dunes of Stockton Bight, which transports up to 500,000 tonnes per annum (tpa) of product (the existing windblown project).

The existing windblown project was granted consent (DA 140-6-2005) in 2006, with the consent due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to the NSW Department of Planning and Environment (DPE) in 2020, seeking consent to extract and dredge up to 9 million tonnes of sand from the inland dunes area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that, to keep the quarry operating, an interim application is required, and is seeking SSD approval (Ref: SSD 52984213) to extract only the remaining dry sand resource located above the water table and from within the same extraction area (the project).

Secretary's environmental assessment requirements (SEARs) were issued by DPE for the project on 18 January 2023 (amended 31 March 2023).

This environmental impact statement (EIS) has been prepared to address the requirements of the SEARs.

ES2 Site and surrounding area

The site is in Fullerton Cove, approximately 9.8 km north-east of the Newcastle CBD and is located in the Port Stephens local government area (LGA).

The regional site context is shown in Figure ES2.1.

The site is approximately 246 ha in size and is legally described as comprising:

- Lot 1 DP 1006399 - comprising 234 ha and located predominantly on the eastern side of Nelson Bay Road, with a small portion also situated on the western side of Nelson Bay Road;
- Lot 2 DP 1006399 - comprising 10.4 ha and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road; and
- Lot 3 DP 664552 - comprising 1.62 ha and located wholly on the eastern side of Nelson Bay Road.

The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the DPE – Crown Lands.

Land use surrounding the site is a mix of rural, residential, public recreation and environmental conservation areas.

To the north-west of Nelson Bay Road is the rural residential area of Fullerton Cove, which comprises a mix of residential and commercial premises. These properties are separated from the quarry by Nelson Bay Road, with the closest approximately 480 m from the entrance to the quarry. A new residential development at Fern Bay (Fern Bay Seaside Village) is approximately 1.5 km to the west-south-west of the quarry.

Most of the environmental conservation areas near the site are Crown land and extend along the Stockton Bight beach and dune system, including the Worimi Conservation Area and beyond that the Worimi Regional and National Parks (collectively referred to as the Worimi areas). The beach and dune area are used for recreation including fishing, four-wheel driving, quad bike riding, hiking and horse riding. The main public access to Stockton Bight dunes and beach is via Lavis Lane, approximately 3 km to the north of the site.

The local site context is shown in Figure ES2.2.

The site is zoned RU2 – Rural Landscape under the *Port Stephens Local Environmental Plan 2013* (PSLEP 2013). Land to the north, south and east of the site is zoned C1 – National Parks and Nature Reserves, and this land comprises the environmental conservation areas of Stockton Bight. A portion of land adjacent to the north-east of the site is zoned as C3 – Environmental Management and the Crown Reserve is zoned RE1 – Public Recreation.

ES3 The project

ES3.1 The project site

As shown in Figure ES3.1, the project site is in the central portion of the quarry and covers an area of approximately 38 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the current dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

ES3.2 Project overview

The project involves the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the current dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in Figure ES3.2, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

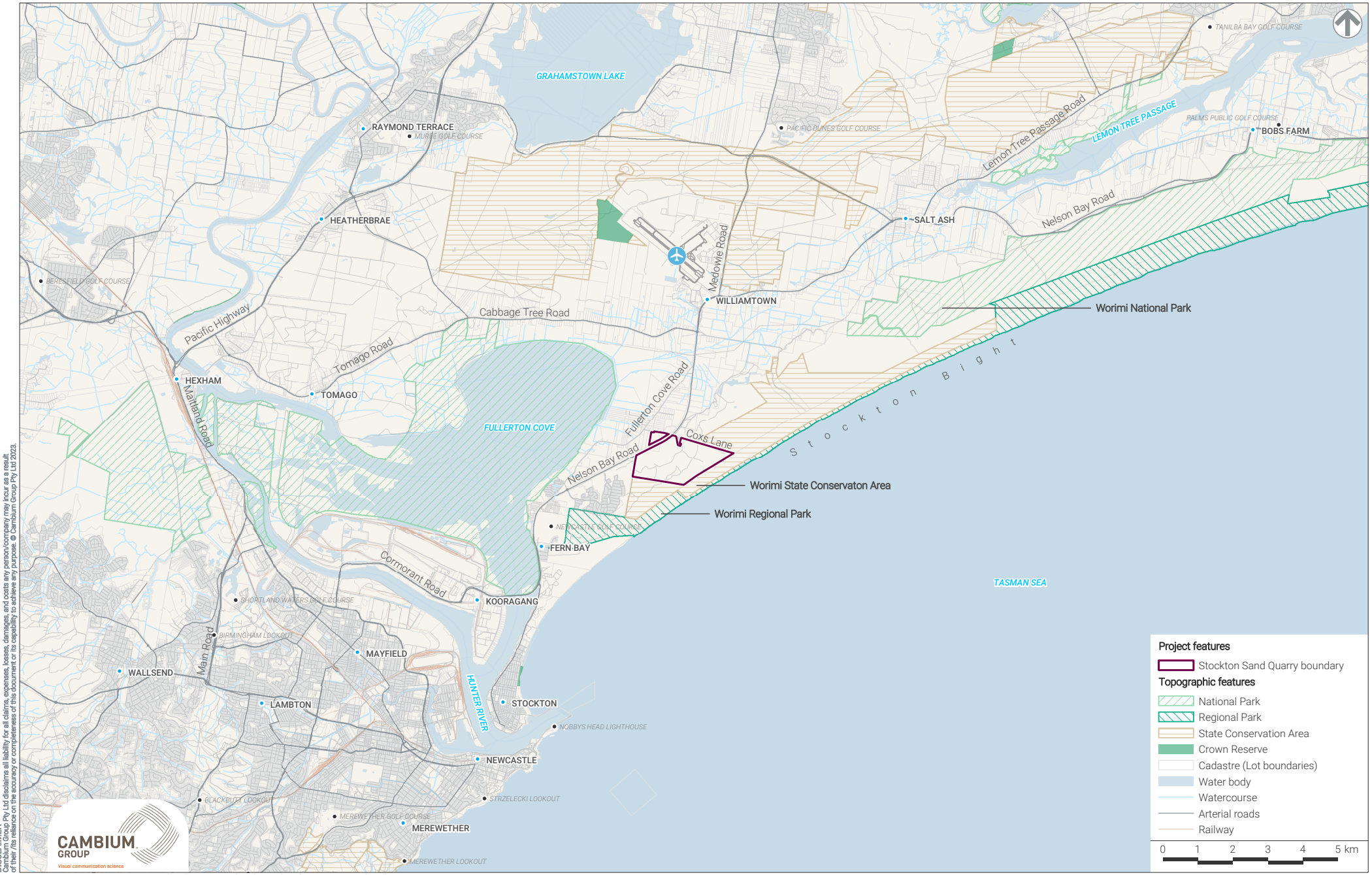
The five stages of the project (shown in Figure ES3.2) mirror the first five stages of the current dredge application (shown in Figure ES3.3). This has been designed so that, should the current dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the current dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the current dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

Figure ES2.1
Regional context



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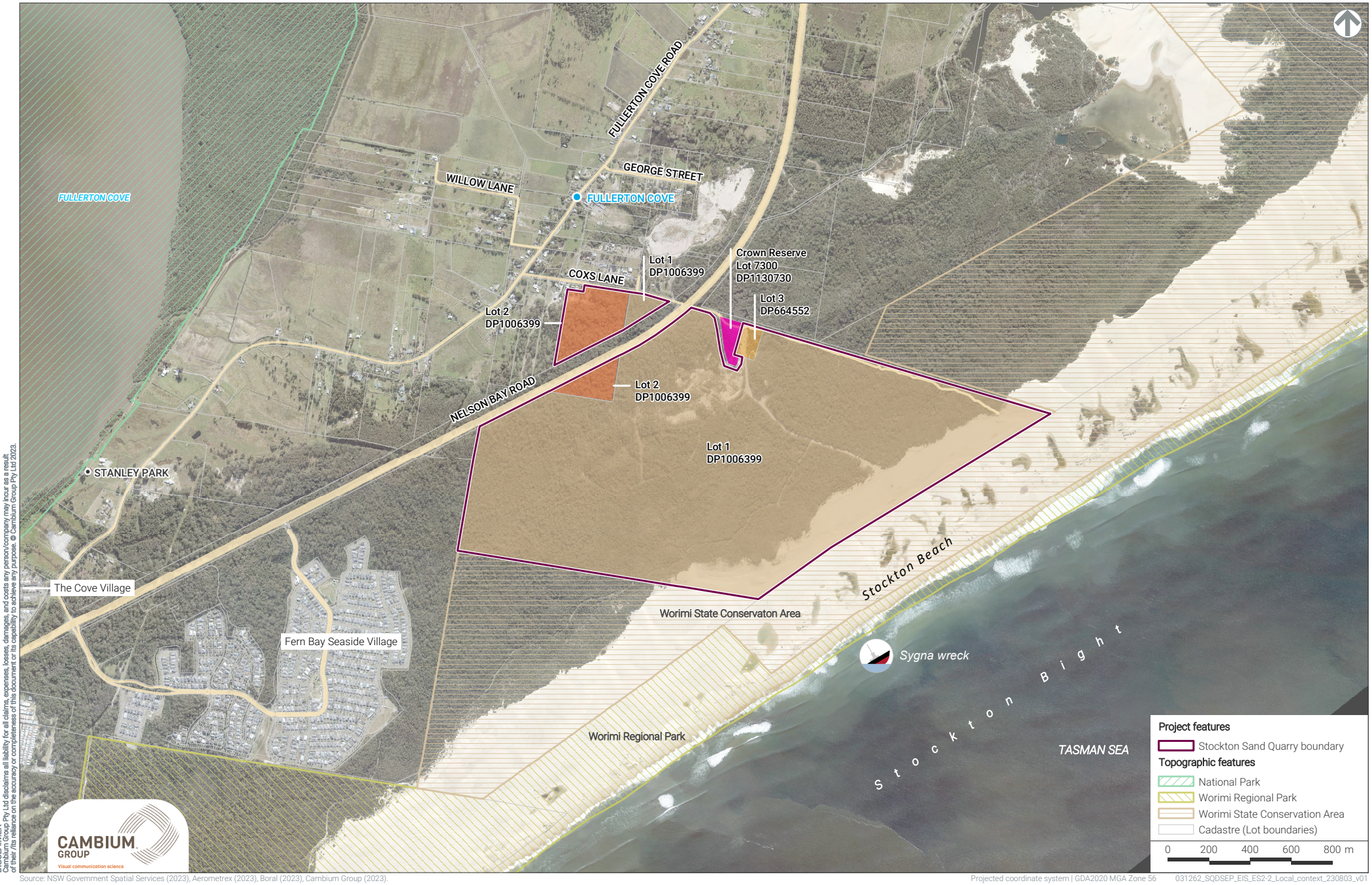
Projected coordinate system | GDA2020 MGA Zone 56

Figure ES2.2
Local context



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Projected coordinate system | GDA2020 MGA Zone 56

ES3.3 Site establishment

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a concrete pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in Figure ES3.1, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

ES3.4 The current dredge application (SSD 9490)

In preparation for the lapsing of the existing windblown consent in 2020, Boral submitted the current dredge application (SSD 9490) to DPE to extract up to an additional 9 million tonnes of sand from the inland dunes.

The proposal sought to minimise adverse impacts by extracting from an area of previous disturbance (the inland dunes area) to remove sand from between 9 m and 5 m AHD down to -15m AHD over six operational stages (as illustrated in Figure ES.3.3). Sand would be extracted in two forms, as dry sand above the water table (Stages 1 and 2), then as a wet sand slurry as a dredge pond is created. The dredge pond would progress over Stages 2 to 5, then return to extract sand below the water table over the Stage 1 area (referred to as Stage 6).

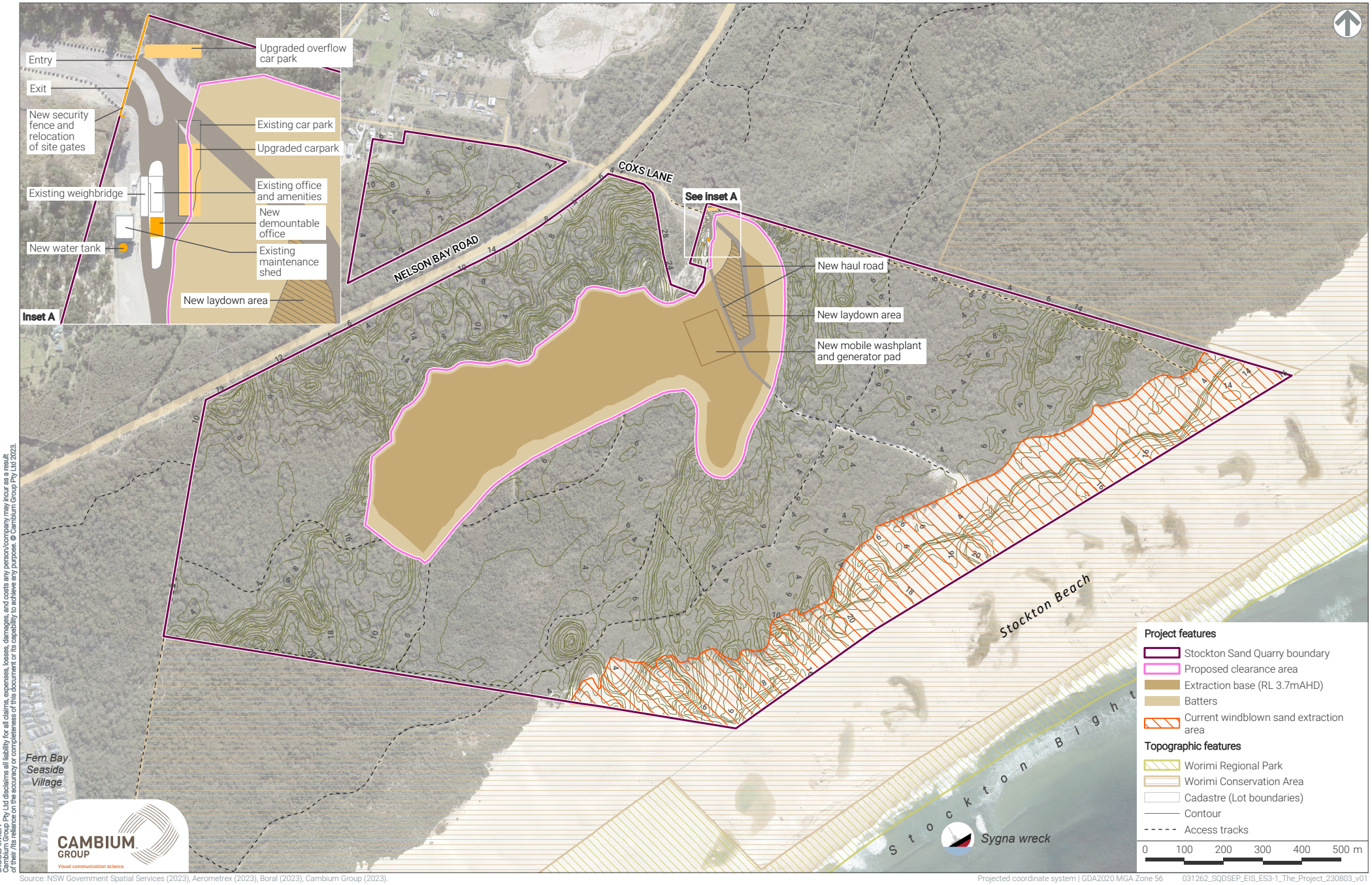
The application, as originally submitted and exhibited, sought a site-wide dispatch limit of 750,000 tpa (i.e. the windblown project and the dredge operations combined) up to 2028, after which the site-wide dispatch limit would reduce to no more than 500,000 tpa. The increase in the site-wide dispatch limit was sought to permit maximum flexibility across the existing and proposed sand extraction areas (located on the same quarry site). The total consent period being sought is 25 years.

The submitted EIS (Element, 2020), and the accompanying technical studies assessed the potential impacts of the proposal based on the proposed site-wide dispatch limit of 750,000 tpa (until 2028). The EIS was placed on exhibition between March and April 2020. Following three rounds of requests for information, issues raised primarily in relation to groundwater and acid sulfate soils, remain unresolved. It is noted that Boral sought to reduce the site-wide dispatch limit from 750,000 tpa to 500,000 tpa at the response to submissions stage, in line with the selected dredge and in order to reduce the overall water demand of the project.

The dry sand extraction project is proposed as an interim solution, while issues associated with the current dredge application are being resolved. The rate of extraction and dispatch and the extraction and disturbance area are the same as originally proposed

for the current dredge application. This has enabled the majority of the technical studies accompanying the current dredge application to be updated for the project.

Figure ES3.1
The Project



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Projected coordinate system | GDA2020 MGA Zone 56

Figure ES3.2

Extraction staging plan (The Project)

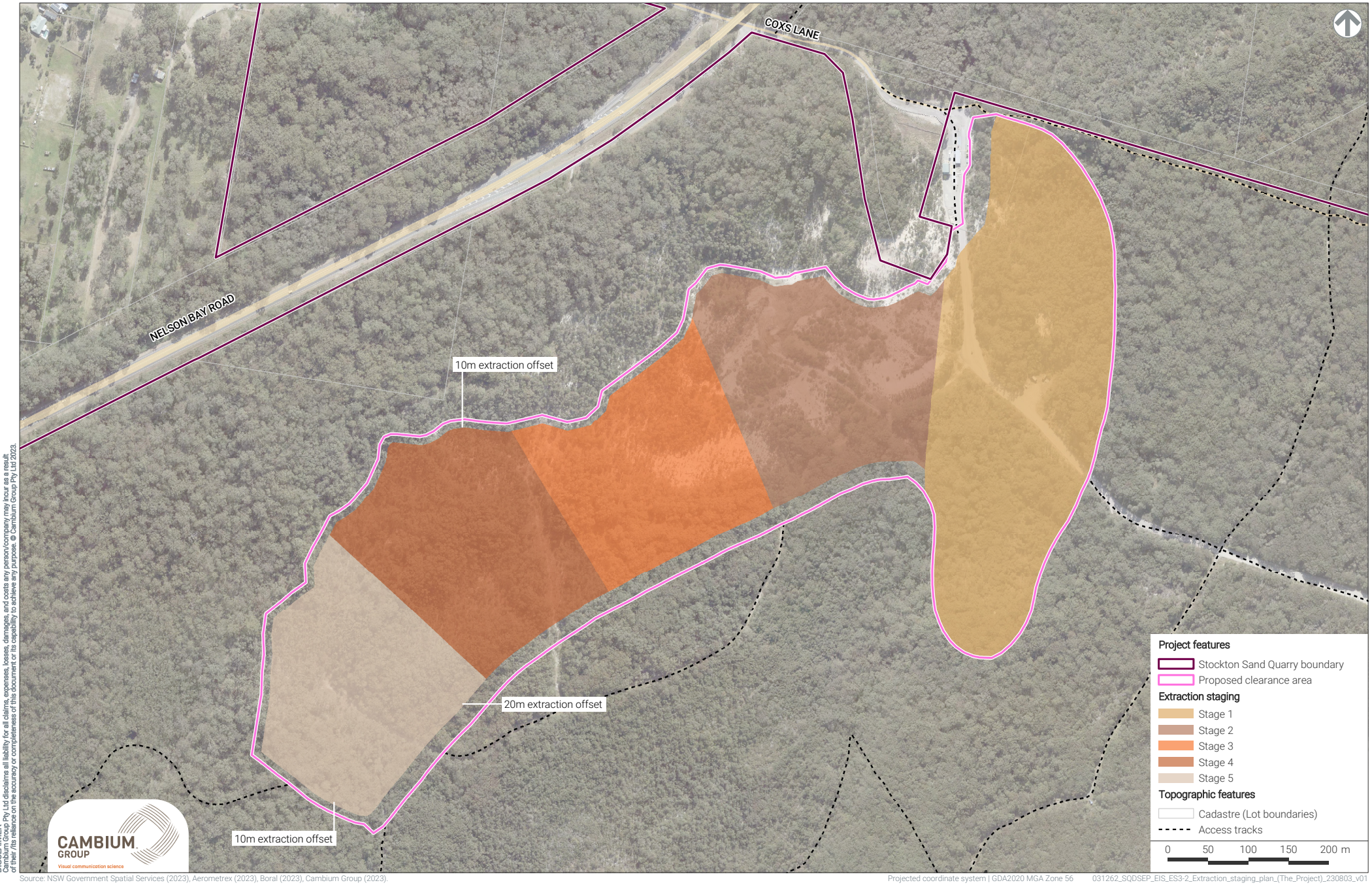

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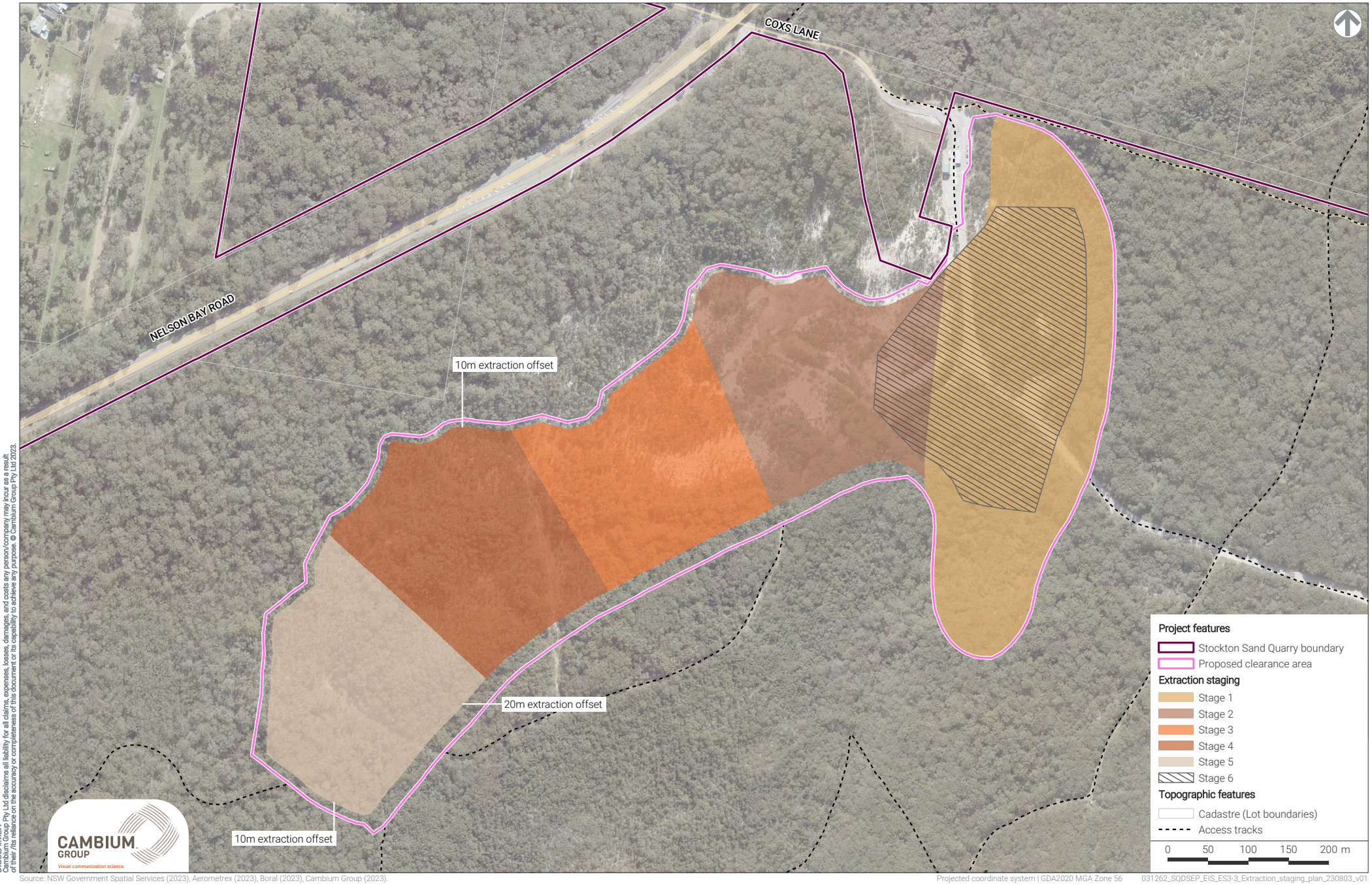
Figure ES3.3

Extraction staging plan (current dredge application)



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ES4 Impact assessment

As highlighted, the project proposes only dry sand extraction from above the water table. All other components of the project, in terms of the rate of extraction and dispatch, and the extraction and disturbance area, remain the same as originally proposed for the current dredge application. Potential issues associated with the project are therefore well understood, and this approach has enabled the majority of the technical studies accompanying the current dredge application to be updated for the project.

The following technical studies have been updated/prepared to accompany this EIS:

- Groundwater assessment;
- Acid sulfate soils advice;
- Coastal assessment;
- Biodiversity development assessment report;
- Biodiversity due diligence;
- Air quality and greenhouse gas assessment;
- Noise impact assessment;
- Traffic and transport assessment;
- Social impact assessment;
- Aboriginal cultural heritage assessment report;
- Surface water assessment;
- Economic assessment;
- Rehabilitation strategy; and
- Bushfire assessment report.

Commensurate with the projected levels of impacts, other environmental aspects, including in relation to visual, historic heritage waste and hazards, have been assessed via qualitative desktop assessments, addressed within this EIS.

ES4.1 Groundwater

A groundwater assessment was prepared by Umwelt to accompany this EIS and is provided in Appendix E.

The groundwater assessment included a review and consolidation of the site groundwater monitoring network and available groundwater data, statistical analysis of site baseline groundwater level data and climatic trends to inform the assessment of water table levels within the project site and the development of a conceptual ecohydrological model (CEM).

The CEM was developed using long term monitoring of groundwater levels to describe the aquifer and groundwater conditions at the project site. The following was identified:

- There is a single hydrogeological stratigraphical unit (HSU) at the project site, which is composed of porous, unconsolidated sand to depth of at least 30 m. The porosity of the sand is expected to be high. Therefore, the groundwater is present in and transmitted through the pores between the sand grains.
- Groundwater elevations range from 0.5 m AHD to 3.5 m AHD. The elevation contours suggest that the groundwater flows from the south-east to the north-west away from the coast and towards Fullerton Cove. It is interpreted that the groundwater

gradient is reversed from that expected by preferential rainfall recharge along the unvegetated belt close to the coast. It is thought that the main groundwater flow direction will be towards the sea. If the main groundwater flow direction was truly from the coast to inland, then it would be expected that the groundwater salinity would be much higher than recorded.

- The main recharge mechanism is expected to be from direct rainfall infiltration, which is thought to be higher where there is a lack of vegetation cover.
- No surface water bodies are present within the extraction area. Therefore, there is no groundwater interaction with surface water.
- The groundwater is recorded as fresh in all the monitoring bores at site. There is little seasonal or long-term variation in groundwater quality/chemistry.
- Hydraulic conductivity tests (slug tests) were carried out (in both deep and shallow bores). The analyses provide a high hydraulic conductivity value that is in keeping with the published literature.

Correspondence received from DPE – Water during the assessment of the current dredge application raised concerns about the dredge project in its current form, recommending that:

> *'…the project be modified to limit extraction to a height that maintains at least a 0.7 metre buffer above the groundwater table with the final landform to be a minimum of 1 metre above the groundwater table consistent with other approved projects of the area'* (DPE, 2021).

These extraction height limits have been applied to the project to ensure that an adequate buffer to the water table is maintained.

The 95th and 99th percentile groundwater elevation data were gridded and contoured and the 99th percentile groundwater elevation contours were used as the basis for determining the extent of the lowest excavation level. A value of 0.7 m was added onto the 95th and 99th percentile groundwater levels. The 99th percentile plus 0.7 m exceeds the maximum observed water levels for all site bores. Therefore, it is proposed that the depth of excavation be limited to the 99th percentile plus 0.7 m to ensure no interaction with the water table. These contours range from 3.5 m AHD to 3.65 m AHD being lower to the west and higher to the east of the project site.

To maintain a minimum 0.7 m buffer to the water table, and to ensure that the project does not intercept groundwater, extraction would not occur below 3.7 m AHD.

ES4.2 Acid sulfate soils

An acid sulfate soils advice letter was prepared by Sage Environmental Consulting (SAGE) to accompany this EIS and is provided in Appendix F.

The main purpose of the advice letter was to undertake a review of past assessments to provide a discussion on acid sulfate soils (ASS)/potential acid sulfate soils (PASS) risk in relation to the project.

The project site was considered in the context of the *Port Stephens Local Environmental Plan 2013* (PSLEP 2013) *Acid Sulfate Soils Risk Map – Sheet ASS_004*. The project site is considered low probability for ASS in general. The southern boundary of the project site is mapped low probability between 1–3 m below ground surface (BGS) beneath dunes, whilst the remainder and majority of the project site is mapped low probability for ASS, being greater than 3 m BGS. The occurrence of PASS in the region is linked to the depositional environments of Tilligerry Creek and Fullerton Cove to the north of the site, rather than the Stockton (or Tomago) Sandbeds. Additionally, there is no evident risk of oxidation of mineral sands containing heavy minerals such as rutile, zircon, ilmenite, and monazite, which are associated with specific portions of the Tomago Sandbeds. These sandbeds are located well to the north, approximately 10 km inland, forming part of the Rutile and Zirconium Mine (RZM).

The advice determined that, through the completion of desktop research, field testing, and laboratory analysis, there is a low risk of actual ASS occurring onsite within the sands above the water table. Additionally, since the sands above the water table have already been exposed to air and are not submerged, it is reasonable to conclude that no PASS are capable of existing.

Overall, the advice concluded that, the proposed dry sand extraction from above the water table has very low potential to impact the environment with respect to ASS or PASS. The dry sand extraction activities are not expected to inhibit progression of the original dredging application; rather, it should aid in the progression of the submission due to more information/data being accessible for collection.

ES4.3 Coastal processes

A coastal processes, hazards and impacts report was prepared by Professor Andrew Short of Coastal Studies to accompany this EIS and is provided in Appendix G.

The report identified that the project site, being approximately 1.2 to 1.8 km inland from Stockton Beach, is physically remote from coastal processes and hazards, including beach erosion, storm surge, beach rotation and beach recession, which at the most can impact 100 m inland. The mobile dunes, at their present rate of movement, would require 120-200 years to reach the project site. The site is above both present levels of coastal inundation and, at the lowest excavation of 3.7 m AHD, is predicted to be more than 2 m above the forecast 84 cm sea leave rise by 2100.

There would be no additional physical impact on the surrounding environment, outside of the surrounding buffer, which comprises densely vegetated coastal sand dunes at least 290 m wide and between approximately 5-20 m in height. Overall, the report considered that the project is also located too remotely from active marine processes including waves, tides, ocean currents and longer-term processes including beach rotation, periodic storm erosion and predicted sea level rise to be directly impacted during its operational life span.

The report also considered the potential impacts of the project on the Worimi State Conservation and Regional Park areas (the Worimi areas), which border the quarry on three sites and found that, given the Worimi areas are separated from the project site by a minimum 290 m of densely vegetated dunes, the project is not expected to have any significant adverse direct or indirect impacts to these areas.

ES4.4 Biodiversity

A biodiversity development assessment report (BDAR) was prepared by Niche Environment and Heritage (Niche) to accompany this EIS and is provided in Appendix H.

Biodiversity impacts were assessed in accordance with DPE's Biodiversity Assessment Method (BAM), to determine the impact the project would have on biodiversity, to identify appropriate management and mitigation measures and to calculate the project's biodiversity offset requirement using the (BAM) Credit Calculator.

Vegetation in the project site was mapped in accordance with the BAM, and identified as comprising:

- 35.67 ha of vegetation that meets the definition of native vegetation (noting that the project site is located within the footprint of former inland extraction area, which was cleared over the past two decades and has since been rehabilitated with native plantings); and
- 2.49 ha non-native vegetation.

Of the above, clearing of approximately 0.5 ha of native vegetation is proposed across the project site prior to extraction. This would facilitate a widespread drilling program that would enable Boral to monitor the level of the water table over the life of the project and provide an accurate representation of the quality of the sand resource across the project site.

The following two plant community types (PCTs) were mapped within the project site:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast - recorded in five different condition classes that are representative of the age of the former quarry pit rehabilitation; and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast - recorded in one condition class which is representative of historic plantings.

None of the PCTs recorded align to threatened ecological communities (TECs) listed on the NSW *Biodiversity Conservation Act 2016* (BC Act). Seven threatened species listed on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were identified as having a moderate to high likelihood within the project site. Formal assessments of significance were completed, which concluded that the project would not significantly impact these species and a referral under the EPBC is not required.

No threatened flora were recorded within the project site during targeted field surveys.

Three threatened fauna were recorded within the subject site during the field survey: Greater Broad-nosed Bat, Eastern Bentwing Bat and White-bellied Sea Eagle. All are regarded as 'ecosystem credit' species for this assessment given breeding habitat within the project site. The assessment concluded that the Squirrel Glider (species credit) is likely to occur due to a historic record within the project site.

The BAM Credit Calculator calculated that the project requires a total of 571 ecosystem credits and 700 species credits, comprising:

- Ecosystem credits:
  - PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast - 540 credits; and
  - PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast - 31 credits.
- Species credits:
  - Squirrel Glider - 700 credits.

Boral commits to satisfying the credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits and/or contribution to the Biodiversity Conservation Fund).

Boral proposes to implement a staged-offset approach to reflect the progressive vegetation clearing, consistent with that proposed for the current dredge application. The staged offset would involve the retirement of the required credits to reflect the clearing associated with each of the five stages of extraction.

In conclusion, it is considered that the direct loss of habitat associated with the project would be offset in accordance with the NSW Biodiversity Offset Scheme, which would result in no net loss in biodiversity.

ES4.5 Air quality and greenhouse gas

An air quality impact and greenhouse gas assessment was prepared by Todoroski Air Sciences (TAS) to accompany this EIS and is provided in Appendix I.

The air quality impact assessment considered the effects of the project on nearby sensitive residential receptors. The assessment included the contribution of existing local emission sources and was undertaken in accordance with the NSW Environment Protection Authority's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2017b). Total suspended particulates, deposited dust, PM_{10} and $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 10 µm and 2.5 µm or less) would be the primary emissions from the project.

Worst case pollutant generation scenarios for the project were assessed using emissions reduction factors, which assumed the implementation of management and mitigation measures. Overall, the air quality impact assessment identified that the project, in combination with other local emissions sources, would not result in exceedances of particulate matter and dust deposition criteria at any privately-owned sensitive residential receptors.

An air quality management plan would be prepared prior to the start of project operations. The plan would outline the measures to manage dust emissions at the site and include key performance indicators, response mechanisms, compliance reporting and complaints management.

The greenhouse gas (GHG) assessment considered the emissions generated from the project on direct sources (Scope 1 emissions, being sources with the boundary of an organisation as a result of that organisation's activities) and indirect sources (Scope 2 and 3 emissions, generated in the wider economy as a consequence of an organisation's activities).

Scope 1 and 2 GHG emission sources identified from the operation of the project would be the on-site combustion of diesel fuel, oil and grease consumption and on-site consumption of electricity.

Scope 3 emissions were identified as resulting from the purchase of diesel, oil and grease, electricity for use on-site and the transport of product material.

The total estimated annual average GHG emission for the project was estimated to be 0.001million tonnes of carbon dioxide equivalent (Mt CO_2-e). The estimated annual greenhouse emissions for Australia during 2022 was 486.9 Mt CO_2-e (Department of Climate Change, Energy, the Environment and Water, 2022b). Based on this, the annual contribution of GHG emissions from the project, in comparison to the Australian greenhouse emissions for the 2022 period, is estimated to be approximately only 0.0003%.

Notwithstanding the relatively low level of GHG emissions predicted to be generated by the project, Boral has committed to applying greenhouse management practices during construction and operation of the project to minimise the overall generation of GHG emissions.

ES4.6 Noise

A noise impact assessment (NIA) was prepared by RWDI Australia Pty Ltd (RWDI) to accompany this EIS and is provided in Appendix J.

Operational noise emissions from the project were predicted at 35 nearby sensitive residential receivers using the CadnaA acoustic noise prediction software and the CONCAWE noise prediction algorithm. The predictions were compared to the noise criteria in the EPA's *Noise Policy for Industry* (NPfI) (EPA, 2017a).

Minor construction works are proposed for the project and potential noise emissions from these activities were considered under the NSW Government's *Interim Construction Noise Guideline* (ICNG) (DECCW, 2009).

The project would generate heavy vehicle movements along Nelson Bay Road, Cabbage Tree Road and Medowie Road, and therefore a detailed assessment of road traffic noise was conducted in accordance with the NSW Government's *NSW Road Noise Policy* (RNP) (DECCW, 2019).

The worst-case scenario for the project was identified as being the operating periods between 7 am and 6 pm (day time) and 6 pm to 7 am (night time). In accordance with the NPI, project 'trigger levels' (operating noise criteria) were developed for the project and potential noise generation modelled, using details of machinery and its location on site.

The NIA determined that predicted noise levels for proposed day time and morning shoulder operations would comply with the operational noise trigger levels at all locations. The NIA also determined that the project would achieve compliance with all road traffic noise criteria.

The residual noise impact is the exceedance of the project noise trigger level after all feasible and reasonable mitigation measures have been considered. No residual impacts were predicted at any privately-owned receivers and, therefore, receiver-based treatments or controls were not considered necessary.

Boral would continue its noise compliance monitoring and community consultation and would implement management and mitigation measures as required if any exceedances were detected or complaints received from the local community.

ES4.7 Traffic and transport

A traffic impact assessment (TIA) was prepared by Traffix to accompany this EIS and is provided in Appendix K.

The TIA was undertaken to determine the potential effect of the project on the capacity of the local and regional road network. A road safety audit was also completed.

The project would result in 132 additional heavy vehicle movements (66 in, 66 out) during a peak day. This is consistent with the predicted traffic generation for the current dredge application, noting that both traffic assessments included an assessment of the worst-case scenario of the transportation of up to 750,000 tpa of sand product and 70,000 tpa of virgin excavated natural material (VENM) until 2028.

Traffic modelling undertaken as part of the TIA indicated that all intersections along transport routes to be used by Boral would have sufficient capacity for background traffic growth as well as project related traffic until 2028, maintaining their existing levels of service. After 2028, the project proposes to reduce sand production back to the existing approved level, which would not result in any additional sand product trucks over the approved development.

Whilst the modelling of traffic growth up to 2028 represents standard practice based on relevant Transport for NSW (TfNSW) guidelines, to address the SEARs and to provide input to Council and TfNSW in relation to their ongoing strategic planning responsibilities, further modelling was undertaken that reflects a 10-year growth scenario, arising from 10 years of 'background' traffic growth at a rate of 2.5% per annum. This identified that there would be a change in level so service at the Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road intersection and that the intersection would be at capacity in 2032. However, it is noted that this would likely occur irrespective of the project and the need for improvements is the responsibility of TfNSW in addressing their strategic planning responsibilities.

Overall, the project would not result in any negative impacts to other road users and would not require any upgrades to road infrastructure when operating at maximum capacity until 2028.

ES4.8 Social

A social impact assessment (SIA) was prepared by AIGIS to accompany this EIS and is provided in Appendix L.

The SIA was prepared in accordance with the requirements of DPE's *Social Impact Assessment Guideline for State Significant Projects* and its associated Technical Supplement (DPE, 2023), drawing on relevant material from the preceding SIA (Element, 2019) for the current dredge application.

The preceding SIA (Element, 2019) addresses the larger scale of the current dredge application. The application of the DPE scoping tool used for the preceding SIA (Element, 2019) was reviewed, with the conclusion that, given the lower risks of impacts from the project, it was appropriate to adopt those scoping outputs for the current SIA.

The community was extensively consulted in 2018 and 2019 for the current dredge application via correspondence, meetings, the media and social media to understand attitudes towards the existing quarry and issues of most importance to the community. Issues of concern to the community were general in nature and predominantly associated with road safety and traffic impacts. The majority of community members consulted were unaware of the existing quarry and as such had no concerns around acoustic or visual amenity.

Further community engagement was undertaken for the project produced limited stakeholder response. Only two responses were recorded, one of which was an incidental direct engagement, indicating that the quarry is not a matter of concern. The other response noted that sand produced by the quarry is essential to supporting industry and employment, indicating a positive understanding of the need for sand extraction.

All potential social impacts associated with the project would be managed via the implementation of mitigation, monitoring and management measures provided in this EIS, coupled with ongoing community consultation and liaison, including notification of the exhibition of the EIS to potentially affected landowners.

ES4.9 Aboriginal heritage

An Aboriginal Cultural Heritage Assessment Report (CHAR) was prepared by Kelleher Nightingale Consulting Pty Ltd (KNC, 2023) to accompany this EIS and is provided in Appendix M.

The CHAR drew largely on the findings of the CHAR (KNC, 2019) for the current dredge application and included new consultation with Aboriginal stakeholders, sixteen groups or individuals previously registered an interest in the assessment process, and three new stakeholders were identified as a result of the new consultation. Responses relating to the proposed assessment methodology were received from three stakeholder groups, which all supported the proposed assessment methodology. No issues or objections were raised in relation to the project.

As part of the ACHA, the Aboriginal Heritage Information Management System (AHIMS) was searched for previous records of sites in and adjacent to the project site, combined with surveying the project site for new Aboriginal objects.

Surveying of the project site included visual inspection by the archaeologist and Aboriginal parties to confirm the extent and nature of previous disturbance. Previously disturbed areas were identified as having little to no archaeological potential given the previous removal of the dune mass. Therefore, it was concluded that no further detailed investigation (test excavation) was warranted.

Aboriginal objects are known to occur in adjacent landforms, and these would be avoided by all project operations. The boundary of the project site would be clearly delineated, and Aboriginal heritage avoidance measures would be included in Boral's existing environmental management strategy for the site.

ES4.10 Surface water

A surface water assessment was prepared by Southeast Engineering and Environmental (Southeast) to accompany this EIS and is provided in Appendix N.

The project site is a formed basin and has no surface flow connection to adjacent areas, accordingly there would be no discharge of surface water off the project site.

The site is located over the Stockton Groundwater Source (SGS) which is regulated by the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016. The WSP specifies the planned environmental water provisions, water for basic landholder rights, share components of existing aquifer access licenses and long term average annual extraction limits for this water source. As of April 2023, 1,827.5 shares had been allocated, leaving approximately 11,919 mega litres per year (ML/yr) unassigned, which may be made available as controlled allocations.

Maximum water use from the SGS for the project is the total of dust suppression water use (calculated at 39.25 ML/yr) and sand processing water use (calculated at 90 ML/yr), a total of 129.25ML/y. This is a worst-case water use estimate as it includes a maximum area requiring dust suppression, and maximum extraction with all sand being washed.

Boral has obtained several Water Access Licences (WAL) with a total allocated share volume is 524 mega litres per year (ML/yr), well in excess of the maximum water demand required for the project. The water extraction from the SGS necessitates an aquifer interference approval under Section 91 of the NSW *Water Management Act 2000*.

ES4.11 Economics

An economic assessment was prepared by Gillespie Economics to accompany this EIS and is provided in Appendix O.

The project was considered for economic effects at a local and regional scale. The methods of determining economic effects were a cost benefit analysis (CBA) model that included consideration of the project not proceeding and the site operations ending in 2028.

CBA considers whether the incremental benefits of the project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the project compared to 'without' it. The CBA compared the production and environmental costs with the production benefits, such as the value of the sand resource and residual land values at the end of the project.

The CBA determined the project would have net social benefits to Australia of $19 million (M) and to NSW of $9 M, including employment benefits. Any unquantified residual impacts of the project after mitigation, offset and compensation would need to be valued at greater than these amounts for the project to be questionable from a national and NSW economic efficiency perspective. Given this would not be the case, the project is desirable and justified from an economic efficiency perspective.

ES4.12 Rehabilitation

A project specific rehabilitation strategy has been prepared by Environmental Earth Sciences (EES) to accompany this EIS and is provided in Appendix P.

The project site is generally consistent with the footprint of the previous inland extraction area, which has and continues to be subject to rehabilitation in accordance with the *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry* (ERM, 2007a), which outlines rehabilitation methods comprising species selection, weed and pest management measures, and monitoring and reporting requirements for rehabilitated areas.

The project specific rehabilitation strategy has been formulated, which aims to integrate the successful aspects of previous rehabilitation efforts at the site.

The proposed final land use of the project site once dry sand extraction operations cease is to re-plant species endemic to coastal woodland. As the land would be cleared for the purposes of quarrying, there would be a requirement to revegetate post completion. The following terrestrial areas would require specific rehabilitation/revegetation:

- where vegetation has been cleared for sand extraction area; and
- where vegetation has been cleared for project-specific infrastructure (e.g. haul road corridors/accessways).

Rehabilitation activities in these areas would comprise soil preparation (i.e., deep ripping haul road corridors) and establishment of native vegetation in disturbed areas to minimise soil erosion and establish slope stability.

It is noted that, should the current dredge application commence, then rehabilitation strategy (EES, 2019a) prepared to accompany the dredge application would be referred to in place of the proposed rehabilitation strategy.

ES4.13 Hazards and risks

The project would present some minimal hazards and risks, including storage and management of hazardous substances and dangerous goods.

The project site would continue to store fuels associated with the operation of plant. All fuels would be stored safely in self-bunded areas and refuelling of plant would only occur within the depot site to reduce the incidence of spills impacting on soil and water health.

Hazardous substances to be used at the site were screened against the thresholds in DPE's *Applying SEPP 33* to determine if the project would be hazardous or offensive development under the NSW *State Environmental Planning (Resilience and Hazards) 2021*. The quantities of dangerous goods proposed to be stored and handled at the project were found to be below relevant thresholds.

The project site is on bushfire prone land. A bushfire assessment prepared to accompany this EIS (refer Appendix Q) identified several points of upgrade to ensure protection of the site as well the provision of infrastructure to support firefighting efforts by the NSW Rural Fire Service. The implementation of these measures would protect Boral assets and improve protection of surrounding land.

Boral would update the existing pollution and incident response management plan, along with emergency and bushfire management procedures to reflect the project, which would continue to be implemented at the site to reduce hazards and risk associated with the continuation of sand extraction operations.

ES4.14 Waste

All waste generated at the quarry is separated, collected in designated waste disposal bins, reused where possible, or disposed of at an appropriately licenced waste facility.

Boral has developed a waste management system for the quarry that ensures all waste generated on site is classified and managed in accordance with the EPA's *Waste Classification Guidelines* and relevant regulatory requirements of the NSW *Waste*

Avoidance and Resource Recovery Act (WARR Act) and the NSW *Protection of the Environment Operations Act 1997* (POEO Act).

In accordance with the WARR Act, Boral adopts the principles of the waste management hierarchy. These principles would continue to be upheld during the project, and be achieved by:

- purchasing recycled products where appropriate;
- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licenced facility.

ES4.15 Visual

The project site remains the same as the project site for the current dredge application, although noting that there would be no requirement for a pond in the final landform, given that the project does not involve dredging.

As detailed in the EIS (Element, 2020) for the current dredge application, the project site would not be visible from Nelson Bay Road or surrounding residential areas. The only likely viewpoint of the project for the public would be along a discrete section of Stockton Bight beach immediately adjacent to the quarry boundary, with temporary views confined to the highest elevation of the project site. As this area is quarried, the remainder of the project would be entirely concealed from public view.

ES4.15 Historic heritage

Commonwealth, State and local heritage databases were searched to determine the presence of registered historic heritage items in the project site and surrounds. The project would not impact a registered heritage item/place protected under the NSW *Heritage Act 1977* or the *Port Stephens Local Environmental Plan 2013* (PSLEP 2013).

The only listed heritage item within 500 m of the project is the 'Stockton Beach Dune System', which is listed in PSLEP 2013 and is directly adjacent (north-east and south-east) to the quarry boundary. Despite proximity to the Stockton beach dune system, the project would not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments. As such, the project would not impact upon the natural landscape features comprising the listing.

The project site has been subject to previous surface disturbance and is unlikely to contain any unknown historic heritage items.

ES5 Conclusion

The project would provide the following benefits:

- It would enable the continued operation of the existing quarry and the provision of a high demand sand resource, maximising the re-use of existing plant and infrastructure and with minimal environmental impacts.
- It would supply essential natural sand to major infrastructure and associated development projects in the Hunter and greater Sydney regions.
- It would provide continued employment of five employees, with an additional two full time employees and one causal employee.
- It would have net social and economic benefits to Australia of $19 M and to NSW of $9 M, including employment benefits.

The project would not have significant adverse environmental impacts and would provide significant socio-economic benefits.

A detailed groundwater assessment and conceptual ecohydrological model have been prepared to accurately predict the maximum height of the water table, to ensure that an appropriate buffer between the level of extraction and the water table is maintained.

Potential amenity impacts from air and noise have been predicted to meet all relevant government criteria at the closest residential receivers and the local road network has adequate capacity to accommodate the additional traffic generated by the project. The residual impacts on terrestrial biodiversity as a result of clearing would be offset in accordance with NSW policy with the benefit of protecting areas of similar native vegetation communities in perpetuity.

Overall, it is considered that the project is justified on economic, social and environmental grounds, as demonstrated with its consistency with the objects of the EP&A Act and ecologically sustainable development.

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1 Introduction

This chapter provides an introduction to the Stockton Quarry Dry Sand Extraction Project (the project).

1.1 Overview

Boral Resources (NSW) Pty Ltd owns and operates the Stockton Sand Quarry (the site or the quarry), located on Coxs Lane, Fullerton Cove, a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

The site has an area of approximately 246 hectares (ha) and has been used for the purposes of extractive industries (sand quarrying) since the 1970s. At present, there is an existing quarry located on the windblown (transgressive) sand dunes of Stockton Bight, which transports up to 500,000 tonnes per annum (tpa) of product (the existing windblown project).

The existing windblown project was granted consent in 2006, with the consent due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to the NSW Department of Planning and Environment (DPE) in 2020, seeking consent to extract and dredge up to 9 million tonnes of sand from the inland dunes area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that, to keep the quarry operating, an interim application is required, and is seeking SSD approval (Ref: SSD 52984213) to extract only the remaining dry sand resource located above the water table and from within the same extraction area (the project).

Consistent with the current dredge application, the project seeks a site-wide dispatch limit of up to 750,000 tonnes per annum (tpa) (i.e. the existing windblown sand extraction area and the project operations combined) until either:

- the current dredge application is approved and commenced, after which extraction under the project would cease and be replaced with the approved dredging proposal (noting that the staging of the project and the current dredge application have been aligned to allow for this); or
- the current dredge application is not approved and the existing windblow consent lapses in 2028, after which the site-wide dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

Secretary's environmental assessment requirements (SEARs) were issued by DPE for the project on 18 January 2023 (amended 31 March 2023). This environmental impact statement (EIS) has been prepared to address the SEARs for the project.

1.2 The applicant

The applicant for the project is Boral Resources (NSW) Pty Ltd, a wholly owned subsidiary of Boral Limited (Boral). Boral is the largest integrated construction materials company in Australia, producing and selling a broad range of construction materials, including quarry products, cement, concrete, asphalt and recycled materials. Relevant details for Boral are provided in Table 1.1.

Table 1.1 Applicant details

Details	Particulars
Applicant	Boral Resources (NSW) Pty Ltd
ABN	51 000 756 507
Applicant address	T2/39 Delhi Road, North Ryde, NSW 2113

Table 1.1 Applicant details

Details	Particulars
Contact	Kelli Adair, Property – Planning & Approvals Lead
Contact details	Kelli.Adair@boral.com.au

Boral has over 4,500 employees in its quarry, concrete, asphalt, cement, recycling, and concrete and placing operations. The business is a major supplier of products to the dwelling, commercial construction, and roads and engineering markets.

Boral operates 25 quarries in NSW and ACT, producing products such as concrete aggregates, crushed rock, asphalt and sealing aggregates, road base materials, sand and gravels for the Australian construction materials industry.

1.3 The site and surrounding area

The site is in Fullerton Cove, approximately 9.8 km north-east of the Newcastle CBD and is located in the Port Stephens local government area (LGA).

The regional site context is shown in Figure 1.1.

The site is approximately 246 ha in size and is legally described as comprising:

- Lot 1 DP 1006399 - comprising 234 ha and located predominantly on the eastern side of Nelson Bay Road, with a small portion also situated on the western side of Nelson Bay Road;
- Lot 2 DP 1006399 - comprising 10.4 ha and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road; and
- Lot 3 DP 664552 - comprising 1.62 ha and located wholly on the eastern side of Nelson Bay Road.

The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the DPE – Crown Lands

Land use surrounding the site is a mix of rural, residential, public recreation and environmental conservation areas.

To the north-west of Nelson Bay Road is the rural residential area of Fullerton Cove, which comprises a mix of residential and commercial premises. These properties are separated from the quarry by Nelson Bay Road, with the closest approximately 480 m from the entrance to the quarry. A new residential development at Fern Bay (Fern Bay Seaside Village) is approximately 1.5 km to the west-south-west of the quarry.

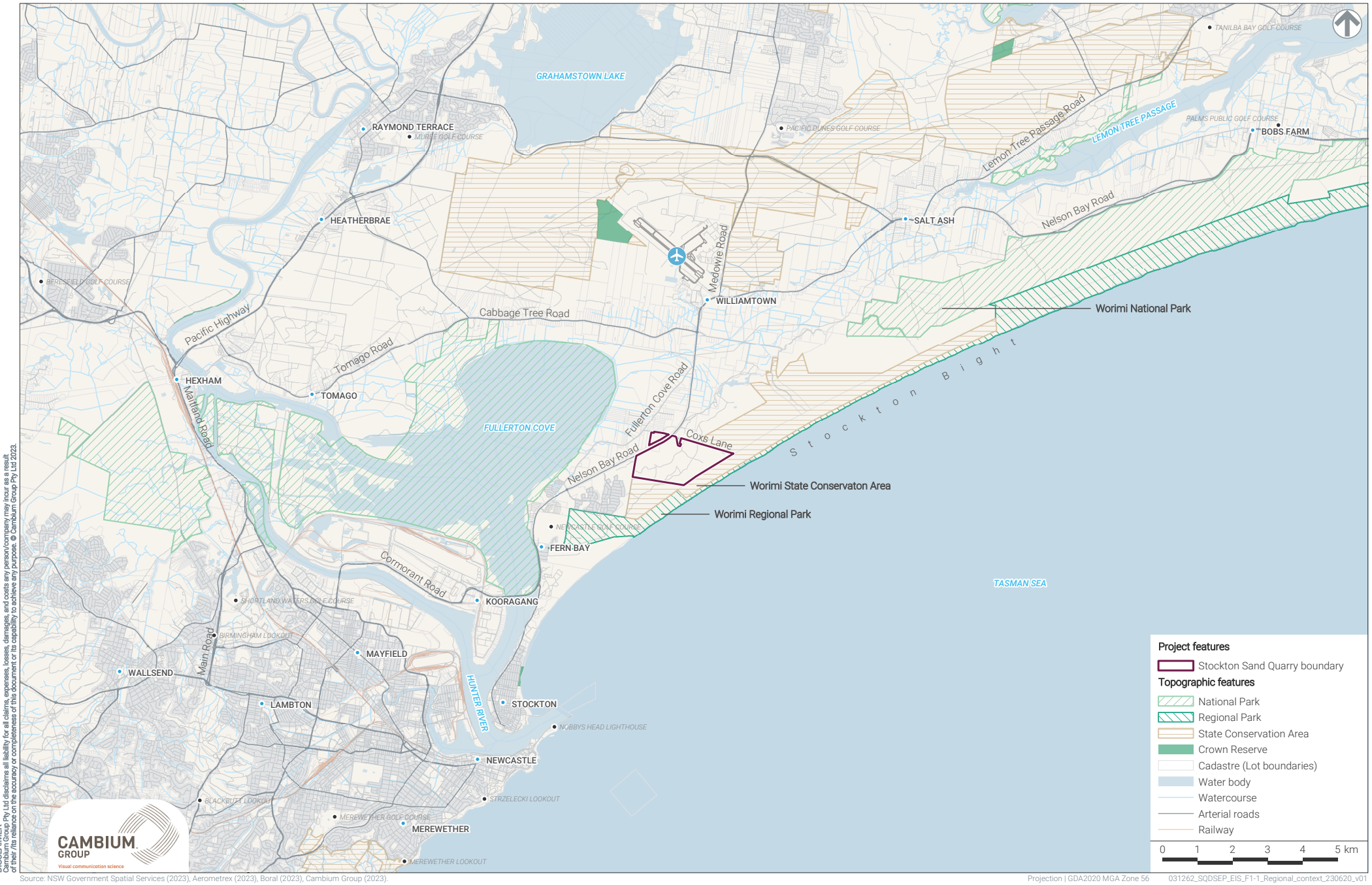
Most of the environmental conservation areas near the site are Crown land and extend along the Stockton Bight beach and dune system, including the Worimi Conservation Area and beyond that the Worimi Regional and National Parks (collectively referred to as the Worimi areas). The beach and dune area are used for recreation including fishing, four-wheel driving, quad bike riding, hiking and horse riding. The main public access to Stockton Bight dunes and beach is via Lavis Lane, approximately 3 km to the north of the site.

The local site context is shown in Figure 1.2.

The site is zoned RU2 – Rural Landscape under the *Port Stephens Local Environmental Plan 2013* (PSLEP 2013). Land to the north, south and east of the site is zoned C1 – National Parks and Nature Reserves, and this land comprises the environmental conservation areas of Stockton Bight. A portion of land adjacent to the north-east of the site is zoned as C3 – Environmental Management and the Crown Reserve is zoned RE1 – Public Recreation.

The zoning of the site and surrounding area is shown in Figure 1.3.

Figure 1.1
Regional context



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projection | GDA2020 MGA Zone 56 031262_SQDSEP_EIS_F1-1_Regional_context_230620_v01

Figure 1.2
Local context

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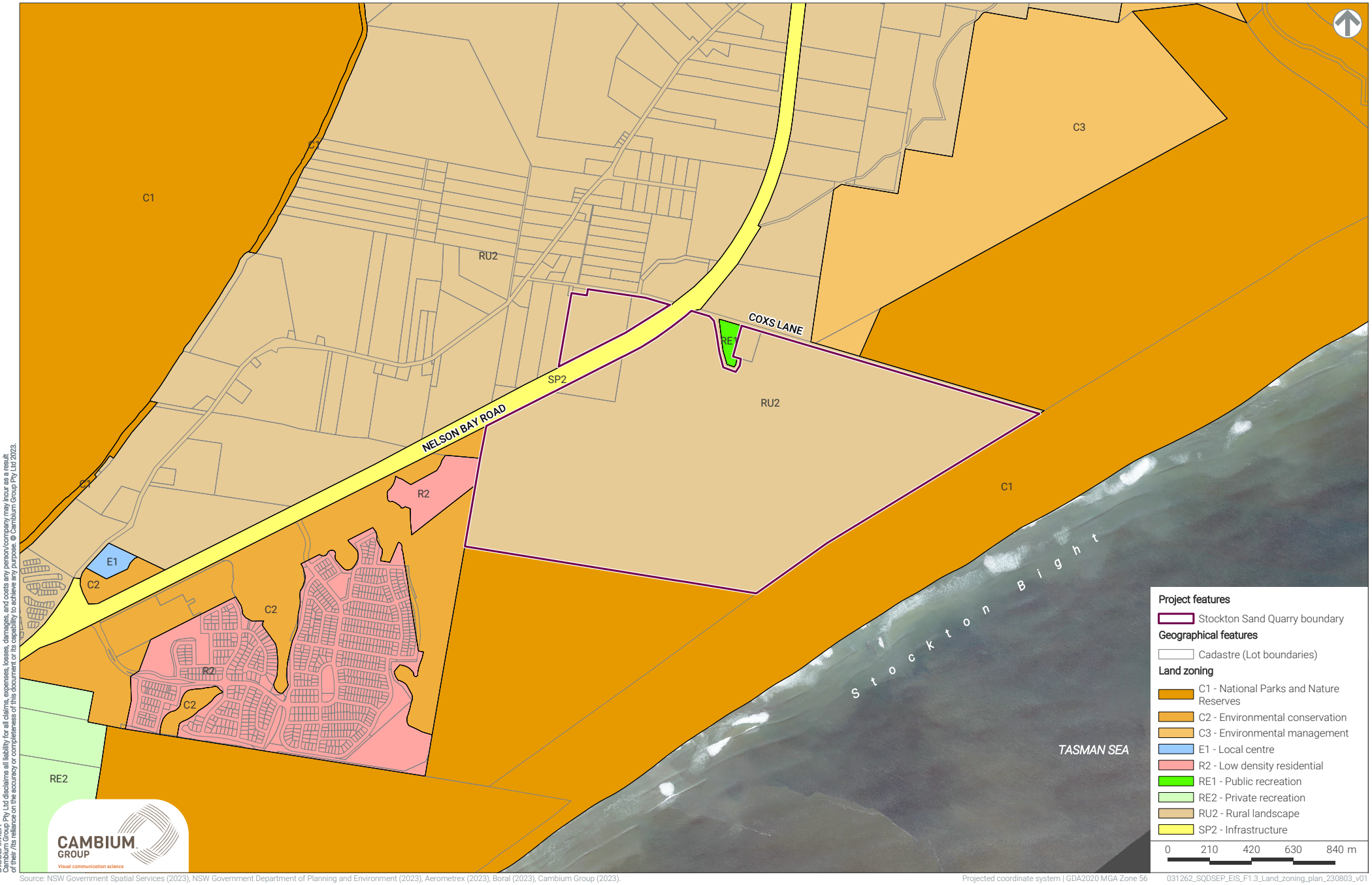
Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Figure 1.3
Land zoning plan



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Source: NSW Government Spatial Services (2023), NSW Government Department of Planning and Environment (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56

1.4 Approval history

A summary of development applications relevant to the site and the project is provided in Table 1.2.

Table 1.2 Summary of development approvals

DA Ref	Approval date	Details	Status
DA 2010-94	1/5/1996	Sand extraction on the vegetated dunes in the middle of the site above 5 m AHD (the inland extraction area) and road transport up to 500,000 tpa for a period of 13 years.	Not operational – consent lapsed
DA 2010-94 (Modification 1)	6/6/1996	Modification to amended certain administrative conditions of consent and impose additional conditions regarding heavy vehicle movements and a restriction to extract no more than 500,000 tpa.	Not operational – consent lapsed
DA 140-6-2005	24/1/2006	A new extraction area on the un-vegetated windblown sand dunes (above 2.5 m Australian height datum (AHD)) adjoining the beach to the east (the existing windblown project). Maximum transportation limit of 500,000 tpa for a period of 20 years.	Current and operational
DA 140-6-2005 (Modification 1)	10/5/2006	Modification to remove reference to a portion of land incorrectly specified under the 2006 consent and permit extraction of windblown sand on Lots 1 and 2 DP1006399 and Lot 3 DP664552.	Current and operational
DA 140-6-2005 (Modification 2)	24/6/2011	Modification including controls to manage interactions with the public in active extraction areas.	Current and operational
DA 140-6-2005 (Modification 3)	Undetermined	Modification to expand the 2006 windblown sand extraction area by removing a portion of a 15 m wide buffer along the seaward and part of the south-western return boundaries, allowing for the extraction of up 475,000 tonnes of additional sand resource.	Application withdrawn
SSD 9490	Undetermined	The current dredge application - refer details in Section 1.7.	Under assessment by DPE

A summary of other licences and approvals relevant to the site and the project is provided in Table 1.3.

Table 1.3 Summary of other licences and approvals

Licence/approval	Reference	Comments
Crown Land Licence	LI 196915	Licence agreement for Crown land title (Lot 7300 DP1130730)
Water Access Licence	20AL213136	WAL No. 37223; aquifer extraction; no nominated works; 0 share/volume allocated
	20AL220991	WAL No. 43827; aquifer extraction; nominated works 20WA221084; 100 share/volume allocated
	20AL221243	WAL No. 44499; aquifer extraction; no nominated works; 320 share/volume allocated
	20AL221416	Aquifer extraction; no nominated works; 104 share/volume allocated
Bore Licence	20BL171772	Ten monitoring bore licences issued on 4 March 2008 in perpetuity
Environment Protection Licence (EPL)	EPL 10132	Permits the scheduled activity of 'extractive activities'. The EPL permits the extraction, storage and processing of 100,000 to 500,000 tpa

1.5 Existing operations

Boral currently extracts sand from the transgressive dunes, referred to as the windblown sand extraction area. Sand extraction commenced in 2008 in accordance with development consent DA 140-6-2005 (refer Table 1.1).

DA 140-6-2005 permits extraction and transportation of up to 500,000 tpa of sand products over a 20-year period.

The approved scope of works and method comprise:

- extraction of sand annually through regular harvesting of windblown sand and dry excavation of the dune mass;
- transportation of up to 500,000 tpa of product;
- campaign mobile screening, where required;
- maintenance of the haul road to transport sand from the extraction area;
- haulage of product from the existing depot/weighbridge to Nelson Bay Road and the wider road network; and
- progressive stabilisation of the windblown vegetation edge.

Boral established a fenced site depot as part of its previous inland extraction area project, and this depot has been maintained for the existing operations. The fenced depot contains the following infrastructure:

- an amenities/office building providing an office, lunchroom, toilet and shower;
- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for a front-end loader and 4,200 litre above ground bunded fuel tank.

The location of the current windblown project is shown in Figure 3.1.

1.5.1 Hours of operation

The site operates in accordance with the following approved hours of operation in DA 140-6-2005:

- Monday to Friday – 6:15 am to 5:00 pm;
- Saturday – 6:15 am to 12 noon; and
- no operation on Sundays or Public Holidays.

The quarry is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15 am to 6:00 pm;
- Saturday – 6:15 am to 3:00 pm; and
- no operation on Sundays or Public Holidays.

1.5.2 Transport and access

Under DA 140-6-2005, Boral has consent to transport up to 500,000 tpa of sand products by road form the quarry, utilising the following transport routes:

- north onto Nelson Bay Road between Cabbage Tree Road and Cox Lane for access to the Central Coast, Sydney and Hunter Valley - this route accounts for approximately 50% of vehicle movements;
- south onto Nelson Bay Road between Cox Lane and Teal Street and Cormorant Road for access to the Newcastle area - this route accounts for approximately 45% of vehicle movements; and
- north onto Nelson Bay Road, north of Cabbage Tree Road and Medowie Road for access to Port Stephens and North Coast - this route accounts for approximately 5% of vehicle movements.

1.5.3 Plant and equipment

Mobile equipment operated at the site comprises:

- a front-end loader (nine tonne capacity);
- a dozer (part time);
- a water truck (13,000 litre capacity); and
- a mobile screen (4 mm mesh screen and a 5 m^3 capacity receiving bin).

1.5.4 Employment

Boral employs four full time staff along with one casual staff member in the operation of the existing quarry.

1.5.5 Utilities and services

The following utilities and services are available at the quarry:

- **Water**: rainwater tanks (10,000 litre maximum capacity) are installed adjacent to site buildings for use and a water truck is used to provide dust suppression.
- **Electricity**: the site office, workshop and amenities building are connected to mains power.
- **Wastewater**: a septic tank captures wastewater generated by the site office and amenities building.

1.6 Environmental management

Environmental management and monitoring at the quarry is in accordance with the following documents, previously prepared and approved under DA 140-6-2005:

- *Environmental Management Strategy* (ERM, 2007a);
- *Erosion and Sediment Management Plan* (ERM, 2007b);
- *Rehabilitation and Landscape Management Plan* (ERM, 2007c); and
- *Groundwater Monitoring Program* (ERM, 2008).

The quarry has a complaints hotline, with all community or regulator complaints logged in a complaints register and investigated and actioned immediately.

1.7 The current dredge application (SSD 9490)

In preparation for the lapsing of the existing windblown consent in 2020, Boral submitted the current dredge application (SSD 9490) to DPE to extract up to an additional 9 million tonnes of sand from the inland dunes.

The proposal sought to minimise adverse impacts by extracting from an area of previous disturbance (the inland dunes area) to remove sand from between 9 m and 5 m AHD down to -15m AHD over six operational stages (as illustrated in Figure ES.3.3). Sand would be extracted in two forms, as dry sand above the water table (Stages 1 and 2), then as a wet sand slurry as a dredge pond is created. The dredge pond would progress over Stages 2 to 5, then return to extract sand below the water table over the Stage 1 area (referred to as Stage 6).

The application, as originally submitted and exhibited, sought a site-wide dispatch limit of 750,000 tpa (i.e. the windblown project and the dredge operations combined) up to 2028, after which the site-wide dispatch limit would reduce to no more than 500,000 tpa. The increase in the site-wide dispatch limit was sought to permit maximum flexibility across the existing and proposed sand extraction areas (located on the same quarry site). The total consent period being sought is 25 years.

The submitted EIS (Element, 2020), and the accompanying technical studies assessed the potential impacts of the proposal based on the proposed site-wide dispatch limit of 750,000 tpa (until 2028). The EIS was placed on exhibition between March and April 2020. Following three rounds of requests for information, issues raised primarily in relation to groundwater and acid sulfate soils, remain unresolved. It is noted that Boral sought to reduce the site-wide dispatch limit from 750,000 tpa to 500,000 tpa at the response to submissions stage, in line with the selected dredge and in order to reduce the overall water demand of the project.

The dry sand extraction project is proposed as an interim solution, while issues associated with the current dredge application are being resolved. The rate of extraction and dispatch and the extraction and disturbance area are the same as originally proposed for the current dredge application. This has enabled the majority of the technical studies accompanying the current dredge application to be updated for the project.

1.8 Project summary

A summary comparison of the main components of the project with the existing windblown project and the current dredge application is provided in Table 1.4.

The project is described in detail in Chapter 3 and shown in Figure 3.1.

Table 1.4 Project profile comparison against existing operations and the current dredge application

Component	Existing windblown consent (DA 140-6-2005)	Current dredge application (SSD 9490)	The project (SSD 52984213)
Location on site	Windblown (transgressive dunes)	Inland dunes	Inland dunes
Hours of operation	• Monday to Friday: 6:15 am to 5:00 pm • Saturday: 6:15 am to 12 noon • Sunday and Public Holidays: Closed	No change	No change
Number of staff	• Four full time • One causal	• Up to six full time • Up to two casual	• Up to six full time • Up to two casual
Total resource	Approximately 76,000 tonnes remaining	9 million tonnes	3.1 million tonnes
Consent period	20 years (due to cease in 2028)	25 years from commencement	10 years from commencement (or until the current dredge application is approved and commenced)
Production and transport limits	Up to 500,000 tpa	Up to 500,000 tpa	Up to 750,000 tpa (inclusive of the windblown sand operations) until either the current dredge application is approved and commenced or the windblown sand development consent lapses in 2028, after which production/transportation would reduce to up to 500,000 tpa
Extraction method and stages	Dry sand extraction only	Stage 1 - dry extraction using front end loaders Stages 2–6 - dredge	Stages 1-5 dry extraction using front end loaders
Processing	Minimal – sand is typically loaded directly into trucks for dispatch	Stage 1 - as needed dry screen prior to dispatch (dependent on quality) Stages 2-6 - sand is dredged and processed through a wash plant prior to being stockpiled	Stage 1 - as needed dry screen prior to dispatch (dependent on quality) Stages 2-5 - dry extraction (sand of lower quality would be processed through a wash plant and water recycling and filter press prior to being stockpiled)
Vegetation clearing, offsets and rehabilitation	Progressive clearing and rehabilitation	Clearing of 38.14 ha of vegetation with staged offsets to reflect extraction stages. Creation of a freshwater pond and rehabilitation comprising: • rehabilitating the pond edge • plant species planted along the edges of the pond would be selected to maximise the bank stability	Clearing of 38.14 ha of vegetation with staged offsets to reflect extraction stages Preliminary clearing/offset stage to allow for a site wide drilling program to commence prior to extraction Standalone rehabilitation strategy comprising progressive stabilisation and rehabilitation of disturbed areas

Table 1.4 Project profile comparison against existing operations and the current dredge application

Component	Existing windblown consent (DA 140-6-2005)	Current dredge application (SSD 9490)	The project (SSD 52984213)
		• stabilising re-profiled areas as soon as possible, minimise potential erosion and degradation of areas of exposed topsoil	with species endemic to coastal woodland
Site infrastructure and plant	Established depot at the site which contains: • an amenities/office building providing an office, lunchroom, toilet and shower • weighbridge • designated parking area for employees and visitors • maintenance shed • 4,200 litre above ground bunded fuel tank	Retain all existing improvements and augment/upgrade to include: • new prefabricated office building • relocation of onsite materials storage (currently in the footprint of proposed Stage 1) • replacement of roofing for the workshop • new 30,000 litre water storage tank • new washplant and stacker	Retain all existing improvements and augment/upgrade to include: • new prefabricated office building • relocation of onsite materials storage (currently in the footprint of proposed Stage 1) • replacement of roofing for the workshop • new 20,000 litre water storage tank • new laydown area • new wash plant and water recycling and filter press

1.9 Secretary's environmental assessment requirements

In accordance with Clause 191 of the NSW *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation), this EIS addresses the specific requirements in the Secretary's environmental assessment requirements (SEARs) issued by DPE 18 January 2023 (revised 31 March 2023). The SEARs are listed in Appendix A along with identification on where each requirement has been addressed in this EIS.

1.10 Purpose and structure of this EIS

This EIS has been prepared to support the SSD application for development consent under Section 4.12 (8) of the EP&A Act. It has been prepared in accordance with the form and content requirements in Clause 190 and Clause 192 of the EP&A Regulation and to meet the requirements of the SEARs.

The requirements for the form and content of an EIS and how they have been addressed in this EIS are detailed in Table 1.5.

Table 1.5 EIS requirements

Requirements	How addressed
Clause 190 - Form of environmental impact statement:	
1. An environmental impact statement must contain the following information: a) The name, address and professional qualifications of the person by whom the statement is prepared;	Certification Page ii
b) The name and address of the responsible person	Certification Page ii
c) The address of the land: i) in respect of which the development application is to be made, or ii) on which the activity or infrastructure to which the statement relates is to be carried out,	Section 1.3 The site and surrounding area
d) A description of the development, activity or infrastructure;	Chapter 3 Project description

Table 1.5 EIS requirements

Requirements	How addressed
e) An assessment by the person by whom the statement is prepared of the environmental impact of the development, activity or infrastructure to which the statement relates, dealing with the matters referred to in this Division; and	Chapters 7-21 Impact assessment
2. The person preparing the statement must consider: a) For SSD – the State significant development guidelines.	This EIS has been prepared in accordance with the requirements of Appendix B of the *State significant development guidelines – preparing an environmental impact statement* (DPIE, 2021).
3. A declaration by the person by whom the statement of the following: a) the statement has been prepared in accordance with this Division, b) the statement contains all available information that is relevant to the environmental assessment of the development, activity or infrastructure, and c) that the information contained in the statement is not false nor misleading.	Certification Page ii
Clause 192 – Content of environmental impact statement	
4. An environmental impact statement must also include each of the following: a) summary of the environmental impact statement	Executive summary
b) a statement of the objectives of the development, activity or infrastructure;	Section 2.2.4 Project objectives
c) an analysis of any feasible alternatives to the carrying out of the development, activity or infrastructure, having regard to its objectives, including the consequences of not carrying out the development, activity or infrastructure;	Section 2.2.3 Alternatives considered
d) an analysis of the development, activity or infrastructure, including: i) a full description of the development, activity or infrastructure;	Chapter 3 Project description
ii) a general description of the environment likely to be affected by the development, activity or infrastructure, together with a detailed description of those aspects of the environment that are likely to be significantly affected;	Chapter 2 Strategic context, and relevant sections of impact assessments (Chapters 7-21)
iii) the likely impact on the environment of the development, activity or infrastructure;	Chapters 7-21 Impact assessments
iv) a full description of the measures proposed to mitigate any adverse effects of the development, activity or infrastructure on the environment; and	Appendix D Management and mitigation measures
v) a list of any approvals that must be obtained under any other Act or law before the development, activity or infrastructure may lawfully be carried out.	Appendix B Statutory compliance table
e) a compilation (in a single section of the environmental impact statement) of the measures referred to in item (d) (iv),	Appendix D Management and mitigation measures
f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, economic and social considerations, including the principles of ecologically sustainable development set out in section 193.	Chapter 22 Project justification and conclusion

This EIS includes the main report that describes the project in the context of the existing environment, the planning framework, key environmental issues, potential impacts, proposed management and mitigation measures and residual impacts. It is informed by the technical assessment reports in the appendices and summarises the findings of these reports.

2 Strategic context

This chapter provides the strategic context for the project and addresses the relevant project SEARs, as detailed in Table 2.1

Table 2.1 SEARs (strategic context)

Relevant SEARs	How/where addressed
DPE – Planning (general requirement)	
• A strategic justification of the development focusing on site selection and the suitability of the proposed site	Section 2.2 Strategic context
• A description of the existing environment likely to be affected by the development, using sufficient baseline/background data	Section 2.3 and as relevant for each environmental assessment (Chapter 7-21)
DPE – Planning (strategic context)	
Address the relevant planning provisions, goals and strategic planning objectives in the following: • Hunter Regional Plan 2041; and • Port Stephens Local Infrastructure Contributions Plan	Section 2.1.1 - Hunter Regional Plan 2041 Section 2.1.2 - Port Stephens Local Infrastructure Contributions Plan

2.1 Strategic planning policies

2.1.1 Hunter Regional Plan 2041

The NSW Government's *Hunter Regional Plan 2041* (regional plan) (DPE, 2022) is a strategic regional land use plan which sets a 20-year vision to manage growth and change for the Hunter region in the context of social, economic and environmental matters. It provides the overarching strategic planning framework for the Hunter region.

The regional plan recognises the Hunter as the leading regional economy in Australia, predicting an increase in the population from 860,000 to 949,850 people by 2041, requiring an estimated additional 101,800 dwellings.

A key objective of the regional plan to support the predicted growth is the creation of 15-minute neighbourhoods, which is proposed to be achieved through a number of initiatives, including :

- identifying higher density residential development for a number of Newcastle suburbs near public transport and open space;
- reinforcing the revitalisation of Newcastle City Centre and continuing transformation along the waterside;
- growing existing strategic centres, including Charlestown and centres along the New England Growth Corridor;
- progressing new urban areas at North West Lake Macqaurie, Wallsend, Eden Estates and at the Hydro site at Kurri Kurri;
- expanding the John Hunter Health and Innovation Precinct; and
- planning for a number of regionally significant growth areas, including Broadmeadow, North West Lake Macquarie, Hunter Expressway, Anambah to Branxton, and the National Pinch Point (the convergence of national road and rail routes between Hexham and Buchannan).

The regional plan catalyses an 'infrastructure-first and place-based approach' to development, requiring infrastructure providers, the development industry, and public authorities to take an integrated and coherent place-based approach to land use planning. Key infrastructure projects identified in the regional plan, include:

- the M1 Extension, which would deliver a 15 km dual carriageway extension of the M1 Pacific Motorway connecting the motorway at Black Hill to the Pacific Highway at Raymond Terrace; and
- The Lower Hunter Freight Corridor, which would help to separate freight and passenger movements on the rail network and improve the rail service reliability.

The regional plan emphasises the need for management of a variety of resources that would support future regional growth. This includes the need to secure supply of construction materials (including sand) to support the continuing demand for additional housing and supporting infrastructure. The project is clearly consistent with this objective.

Oher elements of the regional plan relevant to the project are detailed in Table 2.2.

Table 2.2 Relationship of the project to the regional plan

Reference	Element	Relevance to the project
P.11	**The 2041 Vision for the Hunter** Productive agricultural land and natural resources are the foundations of the region's economy with greater economic diversification in growing health, defence and aerospace, energy, tourism and transport sectors.	The project would support continuing use of a natural resource, on an existing site and using extraction methods consistent with past and present activity. The sand produced is a critical construction material that is needed to support the identified economic diversification and growth in the Hunter region.
P.87	NSW needs a reliable supply of construction materials to support continued growth. These include sand and gravel, crushed rock, recycled materials and secondary aggregates created from construction, demolition and excavation.	The project would directly address this requirement through the provision of a reliable supply of sand to the market for the next 10 years.
P.143 Cont.	**PLANNING PRIORITY 5:** **Promote sustainable use of mineral and energy resources** Mineral and energy resources need to be managed and protected from incompatible development or encroachment that could lead to mineral resource sterilisation. This could lead to higher management costs or a reduced potential to sustain or grow rural and resource industries. The district contains regionally significant construction, mineral and energy resources such as sand, gravel, hard rock, sandstone (dimension stone), clay and coal deposits. Extraction of these resources supports major infrastructure projects, industries and agricultural businesses. Development proposals for aggregate extraction will be promoted if they are in accordance with the district planning principles and local strategic planning. They should balance economic benefits with the protection of the environment and local communities. Planning for these areas and the surrounding areas must ensure: • mining and quarrying remain a permissible use, with development consent, in the resource areas • appropriate land use buffers are provided between these areas and future development • these areas contribute to the longer term formation of a green corridor, both during extraction (e.g. by maintaining existing vegetation links and/or restoration on areas not being quarried or mined) and on completion of resource extraction	The project would allow for the ongoing extraction of a regionally significant sand resource at an established quarry site. Sand extraction would support construction and infrastructure development. The proposed activity is similar to the existing activity on the site, which complies with regulatory obligations and regional strategic objectives, balancing the need between socio-economic benefits and protecting the environment. As detailed in the project rehabilitation strategy (refer Chapter 18, Appendix P of this EIS), rehabilitation would include the progressive stabilisation and rehabilitation of disturbed areas with species endemic to coastal woodlands. As considered further in Section 10.1.5 of this EIS, this would contribute to the longer-term formation of a green corridor.

2.1.2 Port Stephens Local Infrastructure Contributions Plan

The *Port Stephens Local Infrastructure Contributions Plan* authorises the imposition of conditions of consent requiring contributions and provides the framework for the calculation and collection of contributions for new development. It requires extractive industry and/or mining to contribute a road haulage/maintenance levy for the upgrade and maintenance of roads within the LGA.

As detailed in the EIS (Element, 2020) for the current dredge application, Boral's existing windblown project, which has consent to transport 500,000 tonnes of product by road annually, has previously been granted an exemption from the payment of contributions by Port Stephen's Council. The exemption was granted as the Boral fleet utilise the state road network (other than the short section of Coxs Lane, which provides access to the site).

Given the project would utilise the same haulage routes and road network, it is considered that this exemption should continue to apply to the project.

2.1.3 Aquifer Interference Policy

The NSW Government's *Aquifer Interference Policy* (DPI, 2012) explains the requirements for obtaining licences for aquifer interference activities and defines the considerations for assessing whether the interference is considered a minimal impact.

The policy outlines the framework for assessing the impacts and the key tests that the project should meet when the approval for aquifer interference is being assessed, including:

- demonstrating the ability to obtain necessary licences;
- demonstrating that the minimal impact considerations can be met; and
- proposing remedial actions should the impacts of the approval be greater than predicted.

As considered further in Section 16.2.1, Boral intends to take up to 129.25ML/y of water from the Stockton Groundwater Source (SGS), for use in dust suppression (39.25 ML/yr) and sand processing water use (90 ML/yr). Boral's current allocations of 524 ML/yr from the SGS are well in excess of the maximum water demand required for the project.

As detailed in Section 5.3 (Table 5.2) of this EIS, the water extraction from the SGS necessitates an aquifer interference approval under Section 91 of the NSW *Water Management Act 2000*.

2.2 Strategic project justification

2.2.1 Project need

As set out in the *Hunter Regional Plan 2041*, the Hunter region is the largest regional economy in Australia and is experiencing significant growth, with an additional 89,850 people predicted in the region over the next 20 years. This growth has been compounded by the Covid-19 pandemic, which has seen a significant rise in migration from capital cities to regional areas, with regional New South Wales (up 26,800 over 2020-21 (Australian Bureau of Statistics)) growing faster than any other regional area.

The highest volume of growth is emerging through the renewal of Newcastle's City Centre, increasing densities around the University of Newcastle's Callaghan campus, and where greenfield development sites are available in Central Hunter, bounded by the strategic centres of Maitland, Singleton and Cessnock (Hunter and Central Coast Development Corporation, 2021). Major commercial and health infrastructure development has also been forecast, with proposed expansions of the Newcastle Airport, the Port of Newcastle, John Hunter Hospital, and the University, as well as strategic road infrastructure projects, including the extension of the M1 Pacific Highway, the extension of the Newcastle inner city bypass, and the Nelson Bay Road duplication. These projects would be reliant on concrete and other construction materials, of which fine sand resources, such as those extracted from the quarry, are a vital component.

As well as being a critical resource for local construction, the sand resource at the quarry also helps supply the Greater Sydney Region (GSR). In 2019, in response to the NSW Government's *Greater Regional Plan*, DPE commissioned R.W.Corkery & Co.Pty.Ltd (RW Corkery) to prepare a report (RW Corkery, 2019), to investigate the supply and demand profile of geological construction material (including natural sand) for the GSR until 2036.

Relevant to the project, the report made the following key findings:

- In the 2018 financial year, approximately 5.9 million tonnes (Mt) of natural sand was consumed in the GSR, inclusive of 2.27 Mt (38%) sourced from Stockton Bight and the Central Coast regions.
- A number of the quarries currently supplying natural sand products to the GSR are forecast to be depleted by 2036, although noting that there are sufficient potential sand resources within and adjacent to a number of these quarries (subject to development consent) to enable existing quarries to supply the GSR demand up to and beyond 2036.
- Predicted demand for construction materials (inclusive of natural sand) is forecast to increase exponentially after 2023, consistent with population growth and sustained higher levels of building and construction activity.
- The demand for natural sand products in the GSR is forecast to be:
    - 5.7 Mt in 2021 through to 2026;
    - 6.6 Mt in 2031; and
    - 7.0 Mt in 2036.
- The total cumulative demand for natural sand product would extend to approximately 118 Mt through to 2036.
- Despite the emerging use of manufactured sand, natural sands would continue to be required to supply the production of construction materials and may account for up to 31% of the constituents required to produce such materials.

The findings of the report indicate that the demand for extractive materials, such as natural sands to produce construction materials, would continue to experience growth. In 2036, it is estimated that the GSR would require 7 Mt of natural sand product, of which up to 38% may continue to be sourced from the Stockton Bight and Central Coast feeder areas.

With the availability of natural sand extractive operations on the Stockton Bight limited, the need for the project is clear, in that it would allow for an existing sand extraction operation to continue to help meet the demand for natural sand to the Hunter region and the GSR, through to 2036.

2.2.2 The resource

As detailed in the EIS (Element, 2020) for the current dredge application, sand suitable for use in the construction and foundry industries occurs in the Stockton Bight dunes. Although the entire sand unit possesses some potential for a particular use, there are optimum areas from which these materials can be obtained. Previous resource investigations carried out at the quarry in 2013 and 2016 confirm the sand within Boral's land holding comprises a fine to medium grained sand suitable for use as a fine aggregate in concrete.

Sand suitable for concrete use must comply with relevant Australian Standards, and factors such as grain shape, composition and grading of the sand must be considered. The sand must be clean, fine to medium grained, and free of deleterious materials including friable particles, organic impurities, structurally weak substances, and alkali reactive materials. The sand in Boral's land holding meets these requirements and the main use proposed for the sand is concrete production within Boral's own concrete plants in the Hunter region and NSW beyond.

Leaching of the upper layers of vegetated dune sands, by organic acids, produces white, low iron sand below the organically enriched sandy topsoil layer. The leached white sand layer on Boral's property is of variable thickness but is generally thin. Below this thin white sandy capping there is a zone of iron enrichment, the sandy material within this zone being commonly termed

'coffee rock' or 'waterloo rock'. This material varies in character from a thin crusty layer of loosely bound iron coated sand grains to a thick layer of moderately iron-stained amber-brown sand. 'Coffee rock' or 'waterloo rock' is unsuitable for concrete production and (where it occurs) is blended with the thin white sand layer above (where it occurs) to produce a fill sand or is reused elsewhere on site for the purposes of rehabilitation.

Fill sand is used in numerous construction applications, including use as a support filler under house slabs, as a filter material for pipe bedding and as a drainage layer under roads. Sand used for this purpose does not have to conform to the rigid specifications outlined for specialised sands. The sand, however, needs to be reasonably 'clean' (some impurities such as charcoal, shell material, and iron-staining can be tolerated) and not too fine grained.

In the manufacture of concrete, the fine aggregate component is achieved by blending fine sand with a coarse sand. In Boral's case, the coarse sand is manufactured sand, which is a made from further processing of hard rock quarry dust, which is a product of the crushing process.

Stockton fine sand is ideally matched to manufactured sand from Boral's Peppertree Quarry, which supplies most of Boral's concrete production requirements in the Hunter and Sydney regions. This means that Stockton sand allows the greatest utilisation of manufactured sand in the concrete blend, and therefore better utilises this scarce resource over a greater volume of total production than would otherwise have been produced with a less superior grading.

In this regard, Boral's Stockton sand resource reduces the natural fine sand usage and avoids the need to find and develop a more resource intensive source of fine sand (Element, 2020).

2.2.3 Alternatives considered

i Do nothing

Boral's sand resource across all assets have been substantially depleted due to sustained demand across the building and construction industry. As shown in Figure 2.1, based on the continuation of the current windblown project and taking account of current fine sand production and demand, the existing windblown project resource is projected to be depleted by December 2023.

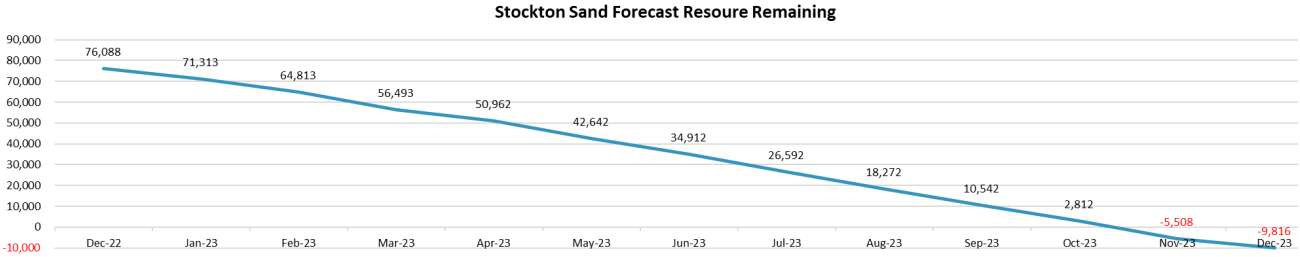


Figure 2.1 Projected remaining windblown project resource (Source: Boral)

If the project is not approved, the quarry would cease to operate, which would result in the following significant economic and environmental impacts to Australia's largest regional economy:

- loss of employment;
- reduced revenue to local service providers;
- reduced regional expenditure in the Port Stephens and Newcastle local government areas;
- sterilisation of a valuable resource;
- shortages of raw construction materials for essential housing and infrastructure projects in the Hunter and the GSR; and
- increased cost to deliver essential housing and infrastructure projects in the Hunter and the GSR.

With other sand quarries on the Stockton Bight at capacity, or closing due to depleted resources (noting that Macka's Sand has recently closed one of its two pits, which operated at 1 Mtpa, and Newcastle Sand is operating at its consent limit of 500,000 tpa), sand would then need to be sourced from further away from the end user, including potentially from Central NSW, which would result in additional truck movements and associated traffic impacts and air emissions.

Should the project not proceed, Boral would have to close the quarry and rely on other sand sources locally or further afield, depleting those resources sooner and increasing costs to deliver essential housing and infrastructure projects in the Hunter and the GSR. Importantly, not proceeding would mean that the community lose the opportunity for the further development of an existing quarry operation with minimal environmental impacts.

ii Other alternatives

Alternative locations

In terms of weight and volume, more sand products have to be quarried and transported to construction sites than any other type of resource material. It is for these reasons that extractive sand sources need to be located as close as possible to the point of usage. The value to weight ratio is very low, making transport costs to the market highly sensitive.

Establishing sand extraction operations close to the construction market represents considerable savings in terms of construction and associated transport costs for projects in the Hunter region and the GSR that are to be serviced by the quarry. Over the life of the quarry this represents a significant benefit to the local community and the state in terms of reduced transport and associated infrastructure maintenance costs. Reduced transport also has the benefit of reduced 'carbon miles', representing the amount of carbon emissions produced for each km travelled.

The quarry is one of Boral's few remaining natural sand quarries, which are all operating at full capacity in response to the significant increase in demand for natural sand. There are millions of tonnes of remaining sand suitable for production of concrete at the site and all necessary infrastructure is in place. For these reasons the project location represents the most environmentally, socially and economically sensible option in the short term.

Alternative materials

Minor quantities of manufactured sand are derived from quarrying and processing of hard rock (quarry dust). Manufactured sand is assisting to prolong the life of the natural sand reserves; however, manufactured sand is generally not suitable for use in concrete on its own and is typically either used in road base or blended with natural sand to produce an acceptable grade concrete sand.

There are few alternative materials to replace natural sand in the production of construction materials. Whilst alternative materials (such as manufactured sand) exist, which can supplement natural sands, given the unique structural characteristics of natural sand required for strict design specification of construction materials, these alternative materials cannot replace natural sand reserves entirely (Element, 2020).

Alternative project design

To ensure that potential impacts of the project would not exceed those assessed as part of the current dredge application, the project has been designed to reflect the rate of extraction and dispatch and the extraction and disturbance area originally proposed and exhibited. This would enable the existing technical studies to be updated for the project. Furthermore, the staging of the project reflects the staging of the current dredge application, which would enable the dry sand extraction to transition to dredging should the current dredge application be approved and dredging commences. There is no alternative project design option that would allow for this to occur.

2.2.4 Project objectives

Based on the project need and the strategic justification for the project, Boral has identified the following project objectives to ensure the continued operation of the quarry:

- assist in meeting demand for sand products in the Hunter and GSR;
- to expedite approval and allow for the extraction of approximately 3.1 million tonnes of the dry sand reserve located above the water table;
- to ensure the design, staging and implementation of the project allows for Boral to progress the current dredge application (SSD 9490) if a consent is granted;
- to meet government expectations in terms of avoiding impacts to groundwater and acid suflate soils;
- provide a consent that would enable Boral to undertake a widespread drilling program across the site to:
    - allow for ongoing monitoring of the level of the water table over the life of the project; and
    - provide an accurate representation of the quality of the sand resource across the project site.
- to utilise existing technical information to enable a robust and timely assessment of the potential impacts of the project; and
- to provide for the most environmentally, socially and economically sensible option of progressing development on the site.

2.3 Biophysical factors

2.3.1 Climate

Rainfall and climate data is publicly available from the Scientific Information for Landowners (SILO) database. The SILO database provides the most complete long-term dataset and is therefore the most useful for assessing long term rainfall trends. SILO data has been obtained from the Williamtown RAAF site (Latitude -32.7939, Longitude 151.8364) and used to calculate longer term data trends from 1957 to 2023, as summarised Table 2.3.

Table 2.3 shows that monthly rainfall varies (on average) between 61 mm and 131 mm, with a yearly average of 1,130 mm (SILO, 2023). Rainfall is higher in late summer and winter and lower in spring and early summer. The SILO database also shows that the total actual evapotranspiration (Morton) of 949 mm per year is exceeded by the yearly rainfall total. Evapotranspiration is much lower in winter than summer and on average is exceeded by rainfall from March through to August. Figure 2.2 presents the average rainfall and evapotranspiration graphs.

Table 2.3 Climate data summary (Souce: Silo)

Reference	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual
Site data average rainfall (mm)	97	114	131	114	107	124	74	66	61	77	84	81	1130
SILO average rainfall (mm)	203	163	142	106	79	68	77	104	135	165	182	211	1637
SILO average pan evaporation (mm)	198	160	140	106	78	68	78	103	133	162	179	204	1610
SILO average actual EVT Morton (mm)	139	117	101	62	33	21	23	39	65	96	117	135	949

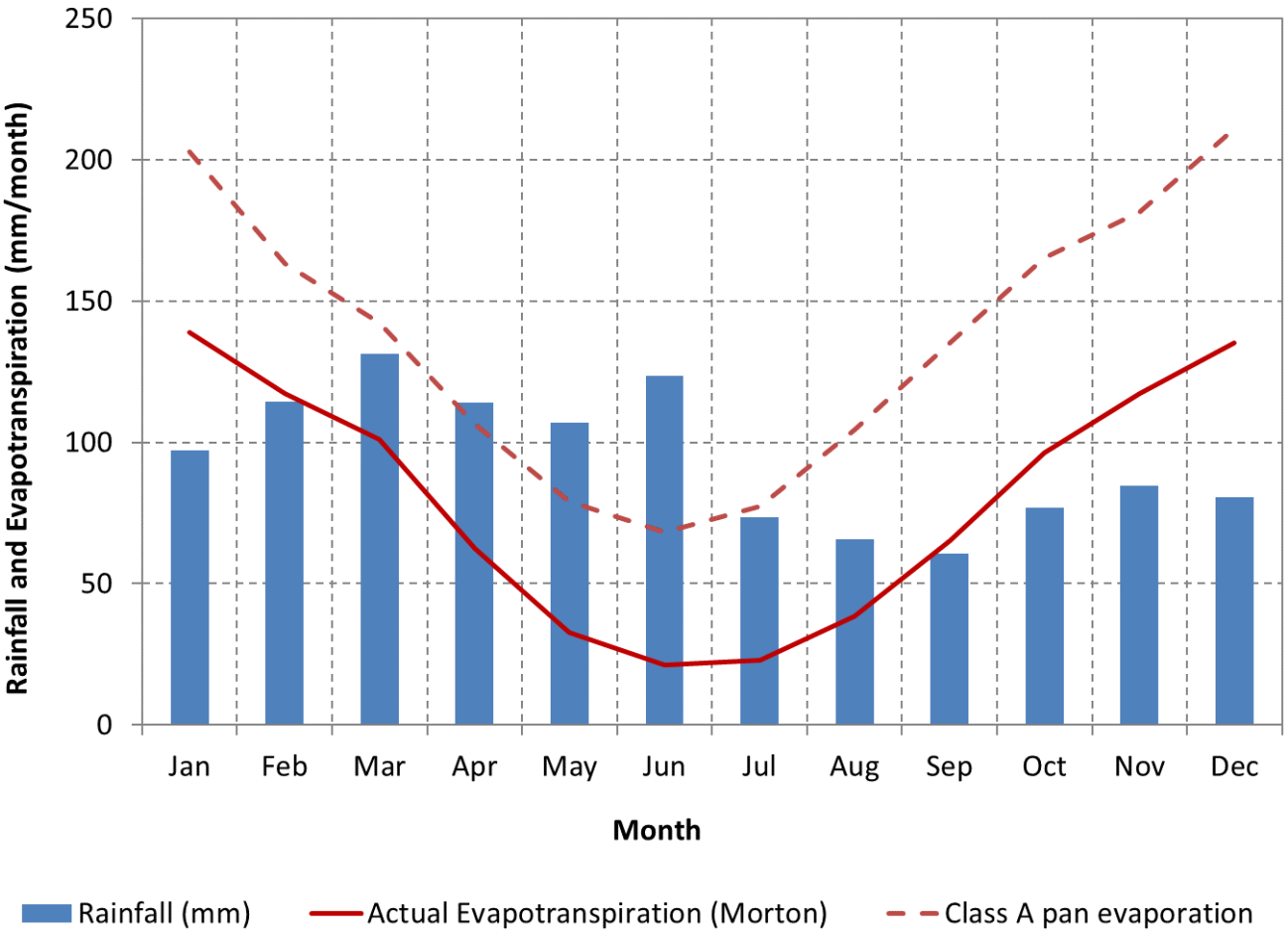


Figure 2.2 Average monthly rainfall and evaporation (Source: Silo)

Figure 2.3 presents monthly rainfall from the SILO dataset, compared to the CRD calculated from SILO data from 1957 to 2023. The graph shows the region experiences cyclical periods of above average and below average rainfall. The region experienced below average rainfall from 1990 to 1998, above average rainfall from 1998 to around 2001, with another period of below average rainfall from 2001 to 2007 (Millennium Drought). From 2007 the rainfall trends were more variable, until 2016 when a period of sustained below average rainfall occurred until 2020. More recently the region experienced above average rainfall, from 2020 to the end of 2022.

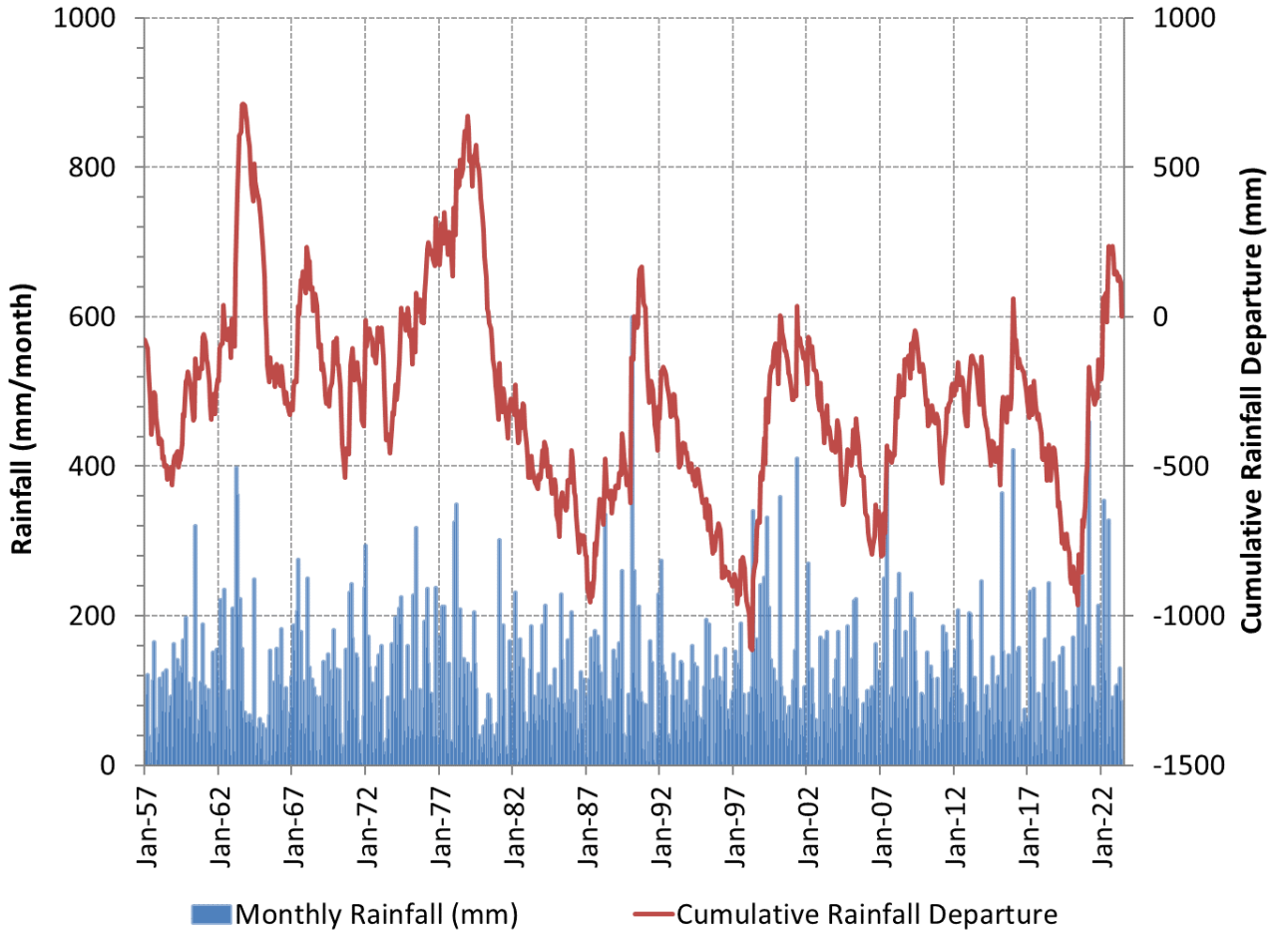


Figure 2.3 **Monthly rainfall and cumulative rainfall departure (Source: Silo)**

2.3.2 Geology and geomorphology

i Geology

The site is part of a dual sand barrier system known as the Stockton Bight. Stockton Bight is a wide south facing coastal embayment bordered by Nobbys Head at Newcastle in the south, and Birubi Point at Anna Bay in the north. The beach is approximately 32 km long and extends up to 10 km inland.

The bedrock of Nobbys Header and the higher relief of Newcastle CBD border the southern side of Stockton Bight. The rocks consist of Permian aged coal measures and some sandstone. The Hunter River has been deflected to the south by the Stockton Bight sand barrier system and enters the sea at Nobbys Head.

The Bight sediments abut the sedimentary Permian rocks of the Tomago coal measures and Mulbring siltstone between Raymond Terrace and Big Swan Bay, and at the northern end of the Bight abut the Carboniferous Nerong Volcanics at Birubi Point. Between the Stockton training wall of the Hunter River and Birubi Point is the Stockton sand barrier system (ERM, 2005).

ii Soils

The site contains three soil landscapes, described as Stockton Beach soil landscape, Boyces Track soil landscape and Hawks Nest soil landscape. Most of the project site is confined to the Boyces Track soil landscape unit, with the central southern portion of the project site encompassing the Hawks Nest soil landscape unit.

The soils of the area are highly susceptible to wind erosion when exposed.

The Stockton Beach soil landscape is characterised by beaches and the active unvegetated dunefield in the eastern portion of the site. The soil in this landscape is deep unstratified fine to medium grained loose aeolian sand with shell fragment inclusions (ERM, 2005).

The Stockton Beach soil landscape active transgressive dune is gradually engulfing the Boyces Track soil landscape and Hawks Nest soil landscape. Boyces Track is an aeolian landscape characterised by steep Quaternary Holocene sand dunes on the Tomago Coastal Plain, with tall open forest. Soils are deep (>300 centimetres (cm)) well-drained, weakly developed podzols (ERM 2005).

The soil landscape in the low-lying swales and low dunes immediately west of the active transgressive dune is the Hawks Nest soil landscape. Hawks Nest is an aeolian landscape characterised by low Holocene sandsheets and low transgressive dunes of the Tomago Coastal Plain, with dry scrubland, woodland and tall open forest. There are small shallow swamps that occur in the low-lying, poorly drained swales and depressions. Soils are deep (>300 cm) well drained podzols and siliceous sands and podzols on dunes (ERM, 2005).

As considered further in Chapter 8, the project site was considered in the context of the *Port Stephens Local Environmental Plan 2013* (PSLEP 2013) *Acid Sulfate Soils Risk Map – Sheet ASS_004*. The project site is considered low probability for ASS in general. The southern boundary of the project site is mapped low probability between 1–3 m below ground surface (BGS) beneath dunes, whilst the remainder and majority of the project site is mapped low probability for ASS, being greater than 3 m BGS. A summary of information regarding the low probability of ASS in the project site is provided in Table 8.2.

According to the Strategic Agricultural Land Map - Sheet STA_047 (DP&E, October 2013), the nearest Biophysical Strategic Agricultural Land (BSAL) is approximately 13.2 km to the north-west of the project site, west of Raymond Terrace.

The project would not impact any areas of BSAL, nor land resources suited to agriculture.

iii Coastal sand dune system

The quarry is located towards the southern extent of the Stockton Bight coastal sand dune system. A coastal processes and hazards report (refer Chapter 9, Appendix G of this EIS) was prepared by Professor Andrew Short of Coastal Studies to accompany this EIS. The report provides a detailed description of the coastal dune system, as summarised below.

The Stockton Bight sand barrier extends for approximately 32 km from Birubi Point to Newcastle and is up to 8 km wide, the largest such system in NSW. It is a product of coastal processes delivering sand to the shoreline and building the beaches and dunes that comprise the barrier.

The beach and backing dune systems of Stockton Bight have evolved during two episodes of beach-dune (barrier) building, one approximately 120,000 years ago and the other over the past several thousand years, both occurring during periods of high global sea level, as at present. This period is geologically known as the Quaternary and the Quaternary geology of Stockton Bight and is illustrated in Figure 2.4.

A barrier refers to the entire beach and the backing sand dunes, with Stockton Bight containing an inner and outer barrier. The inner barrier, which contains the Tomago Sands, formed approximately 120,000 years ago when sea level was at least as high as present and probably up to 2 m higher. It is separated from the modern outer barrier by a low largely water-filled inter-barrier depression occupied by Fullerton Cove, Salt Ash and Tilligerry Creek. The outer barrier, which includes the modern beach and dunes, was initiated by waves and wind once sea level stabilised at its present level about 6,500 years ago.

As sand continued to be supplied to the coast, the shoreline built seaward by up to 2 km. The prograding shoreline was capped by a series of well vegetated undulating foredune ridges and swales with an elevation between approximately 5-10 m.

The sand supply continued until about 5,000 years ago, following which was the first of three phases of dune instability and landward migration of bare mobile sand dunes and shoreline recession. The evolution of the system can be summarised in the following three phases:

Phase 1

The first phase of mobile dunes occurred between 5,200 and 4,000 years ago. These dunes moved up to 2 km inland and rose to elevations reaching 20 m. They moved over and completely buried the former foredune ridges, before stabilising with dense vegetation.

Phase 2

The second phase of mobile dune activity occurred approximately 2,000 years ago. These dunes moved up to 1.5 km inland partially burying the Phase I dunes and the foredune ridges, before again stabilising with vegetation.

Phase 3

The third phase commenced approximately 500 years ago and remains active today. The phase includes bare mobile sand extending on average several hundred metres inland (up to 2 km inland to the east of Williamtown) and occupying 12% of the total Stockton barrier system. The remaining original foredune ridges and Phase I and II dunes (comprising 88% of the dunes), are well vegetated and stable.

An illustration of the geomorphology of the Stockton Bight is presented in Figure 2.4 and a cross section of Section Bight sand dunes is provided in Figure 2.5.

Stockton Bight has an exposed 30-50 m wide high energy beach composed of medium to fine quartz sand. Sand from the beach is blown into the approximately 100 m wide, approximately 4-10 m high foredune that parallels the rear of the beach, and in places, though gaps in the foredune into a 100-300 m wide deflation basin, which has an elevation between 2-6 m. Sand is exported from the deflation basin by strong southerly winds and deposited in the 5-20 m high bare mobile dune field (the Phase III dunes), which in the vicinity of the quarry are between 200-300 m wide.

As the sand moves out of the deflation basin, it erodes the western wall of the basin, exposing the long buried foredune ridges and their buried dark soil horizon and remnant vegetation. The mobile dune field has been arranged by strong south westerly winds into transverse dunes, with crests aligned south-east to north-west.

The transverse dunes average 15m in height and are spaced between 100-200m apart. Strong southerly winds cause the transverse dunes to migrate to the north-east at rates between 5-15 m per year, and to the north-west at rates between 3-5m per year. In the process, the dunes move into and bury the vegetated hind dunes (Phases II and I). This third phase of dune activity is natural and has been operating at this scale for approximately the past 500 years. However, offroad vehicle activity is presently exacerbating the dune instability in the areas it is permitted.

ERM (1994) examined the age of the dune system within the previous inland extraction area. The study identified that the majority of the inland extraction area, and hence the project site, is positioned within the dune system estimated to be between 1,200-2,300 years old (Phase II transgression), with a small portion of the extraction area along the northern boundary of the quarry adjacent to Nelson Bay Road identified to be around 4,500 years old (Phase I transgression). The location of Phase I, II and III dunes on the quarry is shown in Figure 2.6 and a cross section of the dunes at the quarry is provided in Figure 2.7.

2.3.3 Topography

Elevations of the dunes adjacent to the quarry range from 8-16 m AHD, with some in excess of 20 m AHD, while the lowest interdunal areas are approximately 4 m AHD (RPS, 2016).

Topography in the project site forms the shape of a basin, reflective of former sand extraction in this area. Topography in the project site ranges from approximately 26.5 m AHD to approximately 5 m AHD.

2.3.4 Groundwater

The Stockton Sandbeds and transgressive dune sands are the main aquifer at the quarry and comprise the Stockton Groundwater Source of the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources. Underlying and hydraulically connected with the Stockton Sandbeds are the Tomago Sandbeds of the Tomago Groundwater Source.

Recharge to the aquifer is expected to occur primarily through infiltration of rainfall. Due to the high porosity and hydraulic conductivity of the sand, little rainfall is expected to go to surface runoff. That which is not returned to the atmosphere by evapotranspiration, is expected to infiltrate into the ground (Umwelt, 2023).

A groundwater assessment has been prepared to accompany this EIS (refer Chapter 7, Appendix E), which identified the maximum heigh of the water table across the project site as ranging from 3.5 m AHD to 3.65 AHD, being lower to the west and higher to the east.

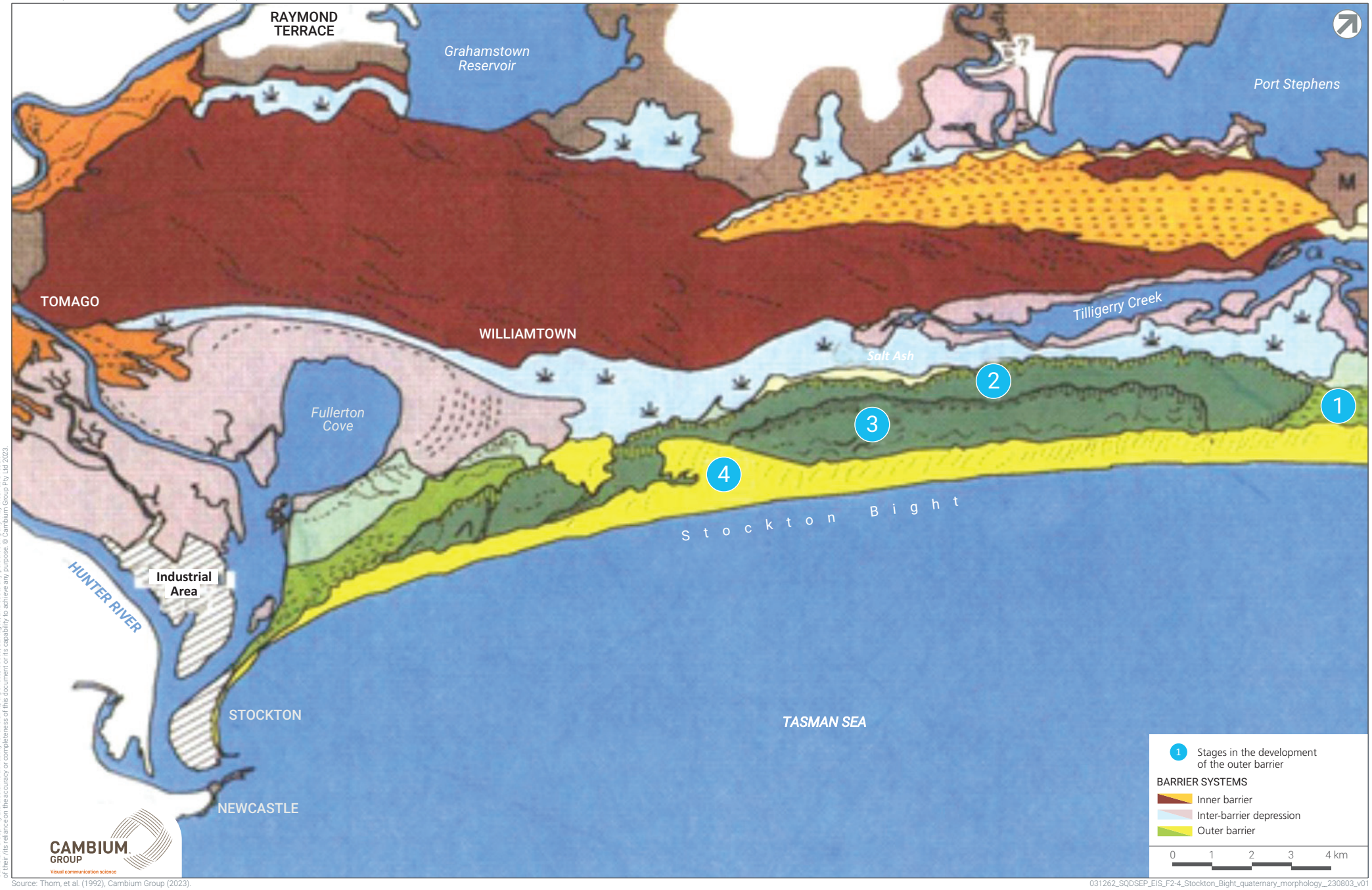
As shown in Figure 2.8, the quarry groundwater monitoring network currently comprises 24 bores, of which 11 are currently included in the site monitoring program.

2.3.5 Surface water

There are no permanent streams or waterbodies in the site indicating that surface runoff is minimal, and infiltration occurs quickly through porous sands.

Some temporary ponding of water is evident in the dune system in the project site and along Stockton Bight to the south-east of the site. However, it is likely this ponding is associated with naturally low lying interdunal swales where there is interaction with shallow groundwater (South East Engineering, 2023).

Figure 2.4
Stockton Bight quaternary geomorphology



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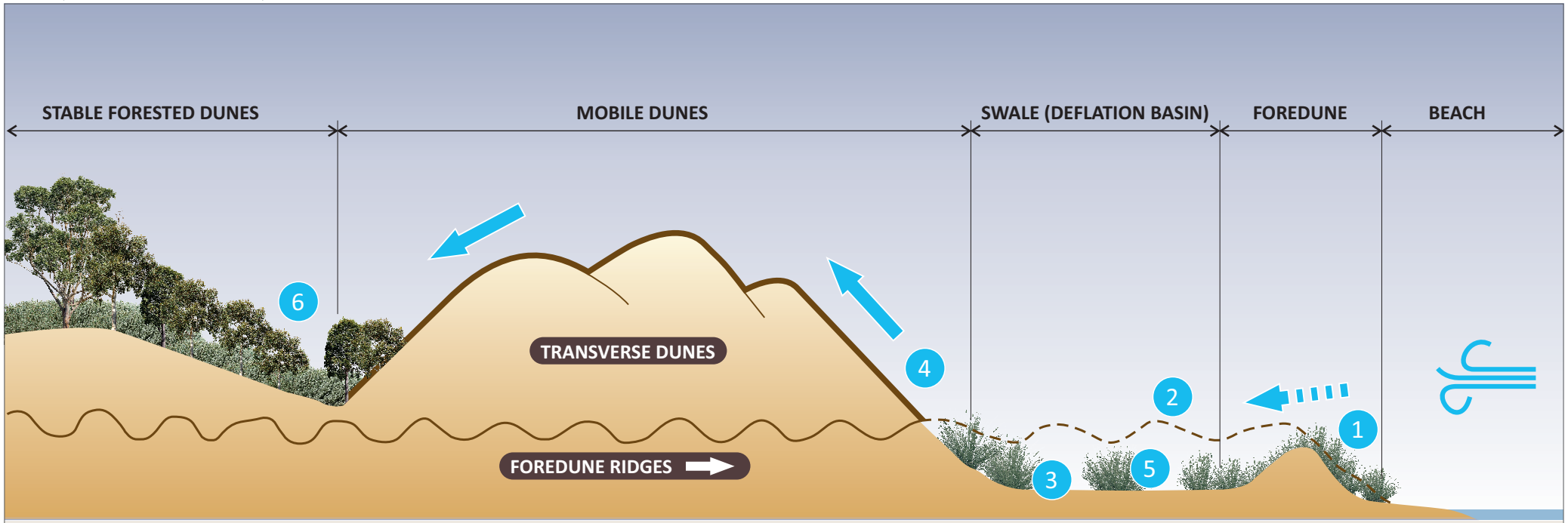
Source: Thom, et al. (1992), Cambium Group (2023).

Figure 2.5
Cross section of the Stockton Bight sand dunes



The Stockton dunes are a highly dynamic system with sand moving from the beach into the dune system in the following manner.

1	2	3	4	5	6
Sand is blown from beach to foredune by strong onshore (south to southeast winds), where it is either trapped by vegetation in the foredune or blown through gaps into the deflation basin.	Sand is blown from the unstable and/or unvegetated foredune areas into the deflation basin.	During storms like the June 2016 storm, waves can wash across the beach and through gaps in the foredune to flood parts of the deflation basin. As some of this water returns seaward it can scour channels down the beach. The channels will be filled in during periods of calmer waves.	Sand is blown from the deflation basin into mobile transverse dunes, exposing the dark soil horizon which marks the crest of the buried foredune ridges.	Deflation basin is lowered/deflated until a cohesive surface is reached (shell lag, wet sand, reeds). It cannot deflate below the water table.	The strong onshore southeast winds move the transverse dunes towards the northwest and into the vegetation and burying Phase II dunes, while strong west to northwest winds move them to the northeast, parallel to the shore arranged as transverse dunes.

Source: Modified from OEH: Plan of Management (2015), Cambium Group (2023).

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Figure 2.6
Location of Phase I, II and III dunes

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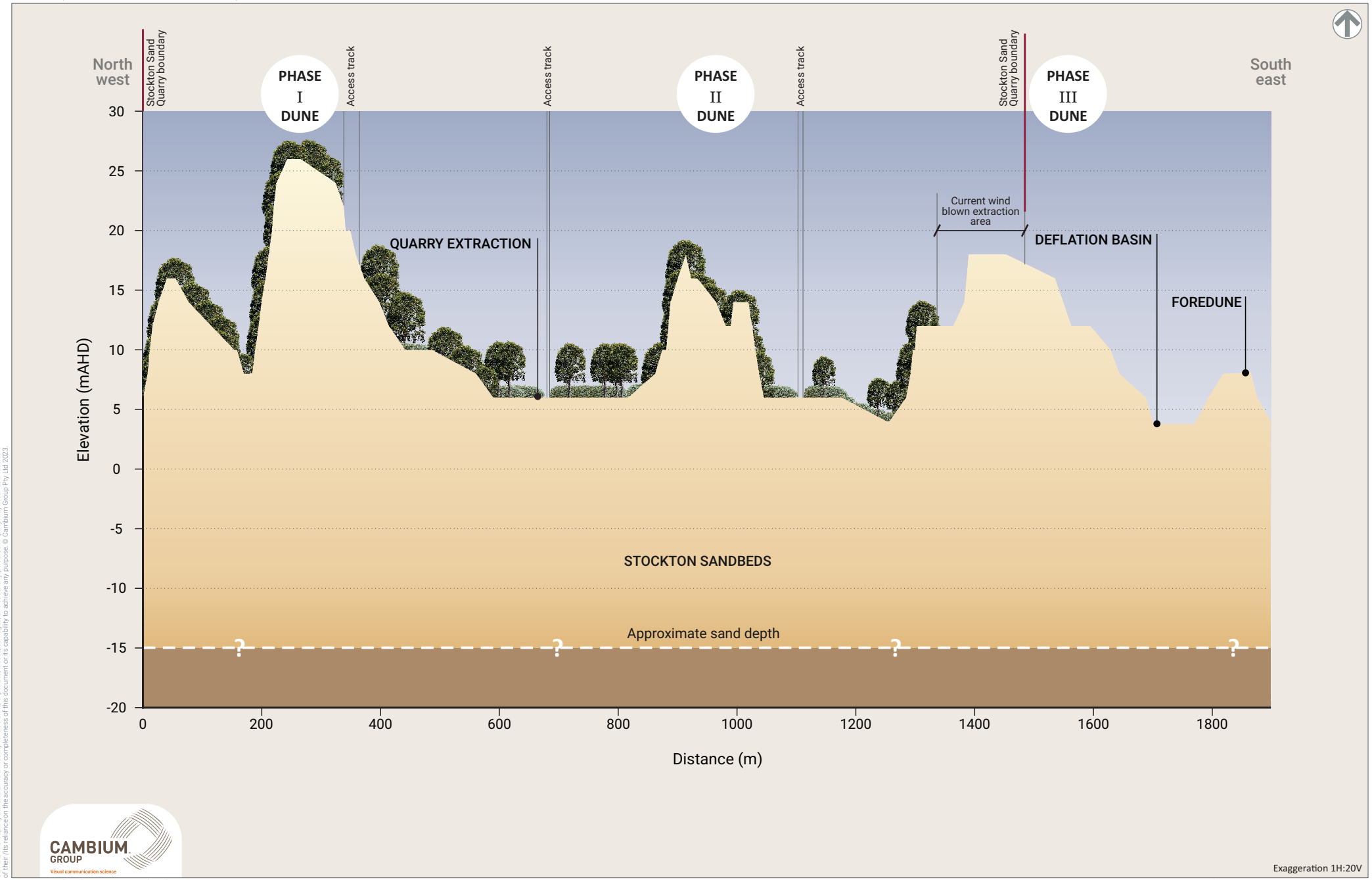
Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56

Figure 2.7

Cross section of the sand dunes at the Quarry



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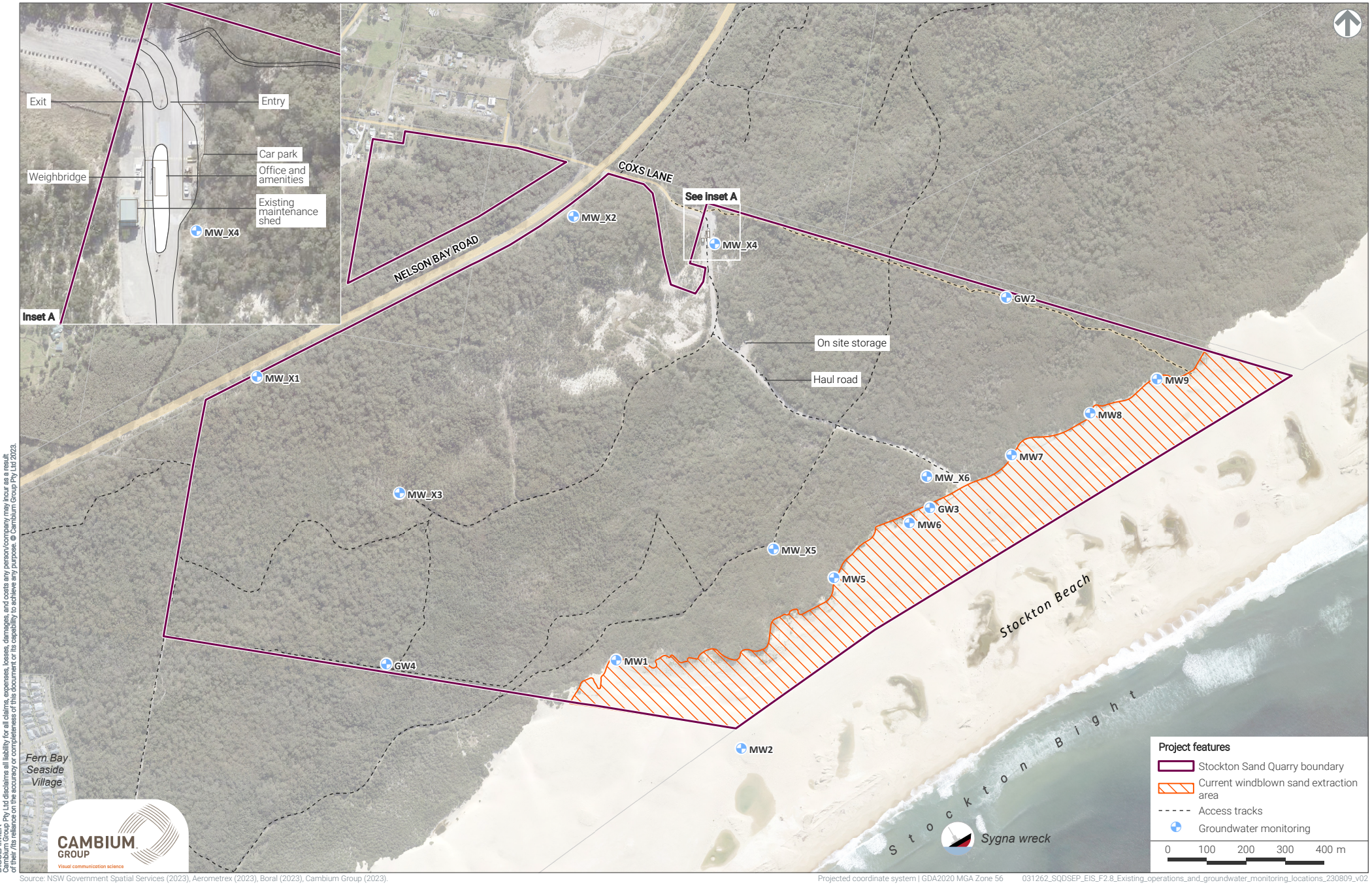
Source: Boral (2023), Cambium Group (2023).

Figure 2.8

Existing operations and groundwater monitoring locations



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56 031262_SQDSEP_EIS_F2.8_Existing_operations_and_groundwater_monitoring_locations_230809_v02

2.3.6 Biodiversity

A biodiversity development assessment report (BDAR), prepared by Niche Environment and Heritage (Niche, 2023) (refer Chapter 10, Appendix H) to accompany this EIS, characterises the existing biodiversity on the site as follows.

i Vegetation

The vegetation surrounding the project site is consistent with the Coastal sand apple-blackbutt vegetation community.

The BDAR confirmed the project site mainly comprises native regeneration associated with rehabilitation of the former inland extraction area, including the following two plant community types (PCT):

- PCT1646 - Smooth-barked Apple/Blackbutt/Old Man Banksia woodland on coastal sands of the Central and Lower North Coast; and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast.

No threatened ecological communities (TEC) as defined by the NSW *Biodiversity Conservation Act 2016* (BC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act1999* (EPBC Act) were identified at the project site.

ii Threatened flora

Targeted surveys were undertaken to inform the preparation of the BDAR and no threatened flora species were identified in the project site.

iii Threatened fauna

The BDAR confirmed that 16 threatened and migratory fauna species are considered to have a moderate or high likelihood of occurrence within the project site; however, most of these species were determined to only utilise the project site for foraging on an intermittent basis. Of these species, only the Squirrel Glider (*Petaurus norfolcensis*) was assumed to be present within the project site.

2.4 Cultural factors

2.4.1 Aboriginal heritage

An Aboriginal cultural heritage assessment report (CHAR) (refer Chapter 15, Appendix M) was prepared by Kelleher Nightingale Consulting (KNC, 2023) to accompany this EIS.

In preparing the CHAR, the Aboriginal Heritage Information System (AHIMS) was searched to identify existing recorded Aboriginal sites in the area. A total of 75 registered AHIMS sites were identified, comprising a diverse range of site types, the most common of which being open context occurrences of artefacts and shell (middens).

The presence of numerous recorded sites near the project site demonstrates that the local landscape was used by Aboriginal people in the past and that material traces of this landscape use have survived in the form of Aboriginal objects and archaeological deposit.

There are no registered AHIMS sites in the project site, although several are present on the wider quarry property.

2.4.2 Historic heritage

The following Commonwealth, State and local heritage databases were searched to determine the presence of registered historic heritage items in the project site and surrounds:

- National Heritage Register made under the EPBC Act;

- Commonwealth Heritage Register made under the EPBC Act;
- State Heritage Register made under the *NSW Heritage Act 1977* (Heritage Act);
- Heritage and Conservation Register (s170 Register) made under the Heritage Act;
- Schedule 5 of the *Port Stephens Local Environment Plan 2013* (PSLEP 2013); and
- State Heritage Inventory, which is a central collection of statutory heritage listings in NSW.

As considered further in Chapter 21 (Table 21.1) of this EIS, the only listed heritage item within 500 m of the project is the 'Stockton Beach Dune System', which is listed in PSLEP 2013 and is directly adjacent (north-east and south-east) to the quarry boundary.

3 Project description

This chapter provides a description of the project and addresses the relevant project SEARs, as detailed in Table 3.1.

Table 3.1 SEARs (strategic context)

Relevant SEARs	How/where addressed
DPE – Planning (general requirement)	
In particular, this EIS must include: • a full description of the development, including the resource to be extracted, including the amount, type and composition	Chapter 2, Section 2.2.2 - The resource Section 3.2.8 - Production schedule
• the site layout and extraction plan, including cross-sectional plans	Figure 3.1 - The project Figure 3.2 - Extraction staging plan (the project) Figure 3.5 – Sections
• the production process and processing activities, including the in-flow and out-flow of materials and points of discharge to the environment	Section 3.2.3 - Sand extraction, staging and processing
• surface infrastructure and facilities (including any infrastructure that would be required for the development, but the subject of a separate approvals process)	Section 3.2.1 - Site establishment
• a waste (overburden, rejects, tailings etc) management strategy	Section 3.2.3 - Sand extraction, staging and processing

3.1 Project site

The project site is in the central portion of the quarry and covers an area of approximately 38 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the current dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road and a concrete pad for a wash plant and water recycling and filter press.

The project site is shown in Figure 3.1.

3.2 Project description

The project would involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the current dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in Figure 3.2, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project (shown in Figure 3.2) mirror the first five stages of the current dredge application (shown in Figure 3.3). This has been designed so that, should the dredge application be approved, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource within the project site, above the water table. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the current dredge application is approved and commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the current dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

3.2.1 Site establishment

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

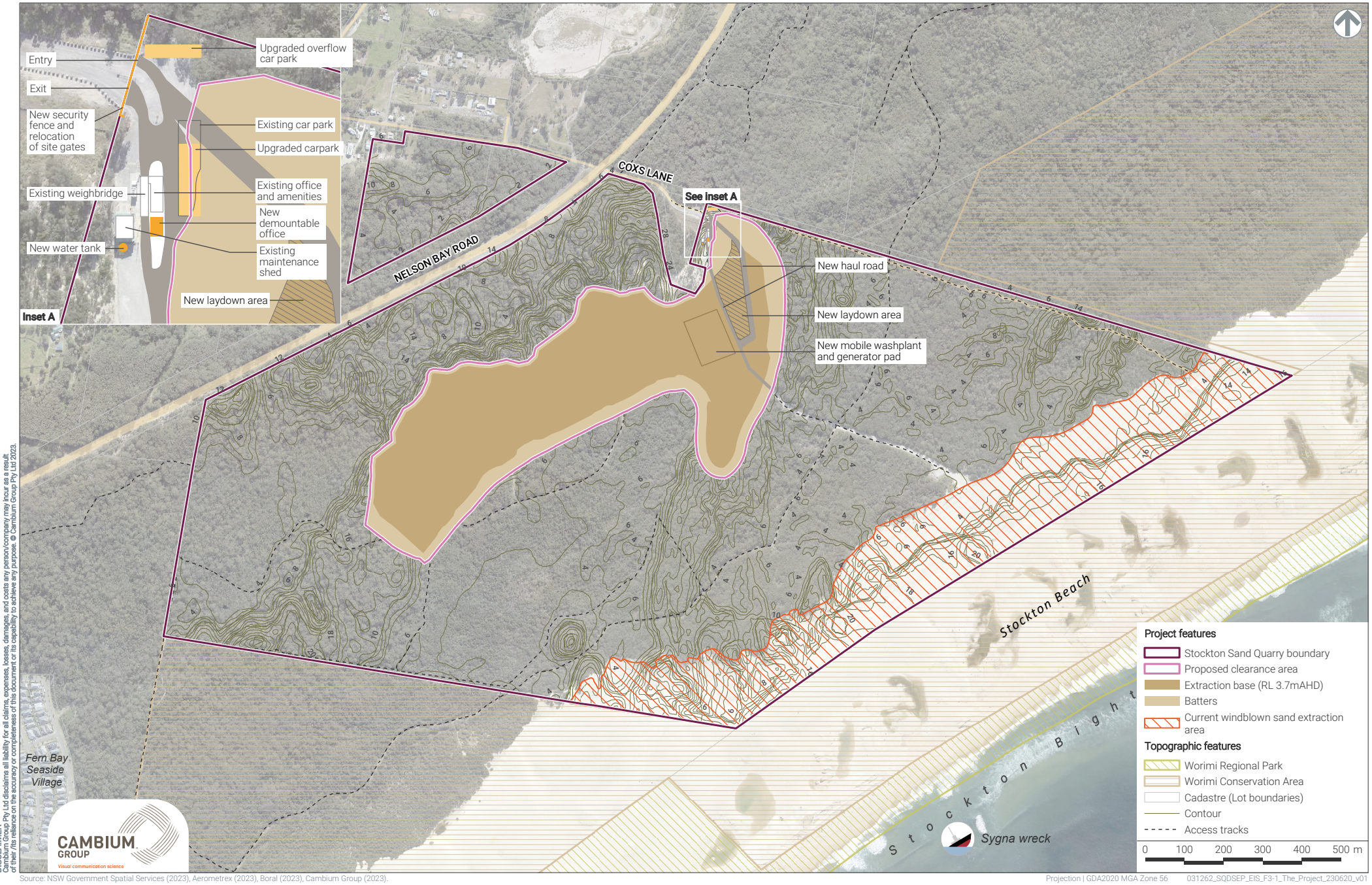
- construction of a new (internal) entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the haul road;
- construction of a concrete pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in Figure 3.1, the existing site depot would also be reconfigured for the project as part of Stage 1, including:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

Figure 3.1
The Project

BORAL Building something great



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Figure 3.2
Extraction staging plan (The Project)

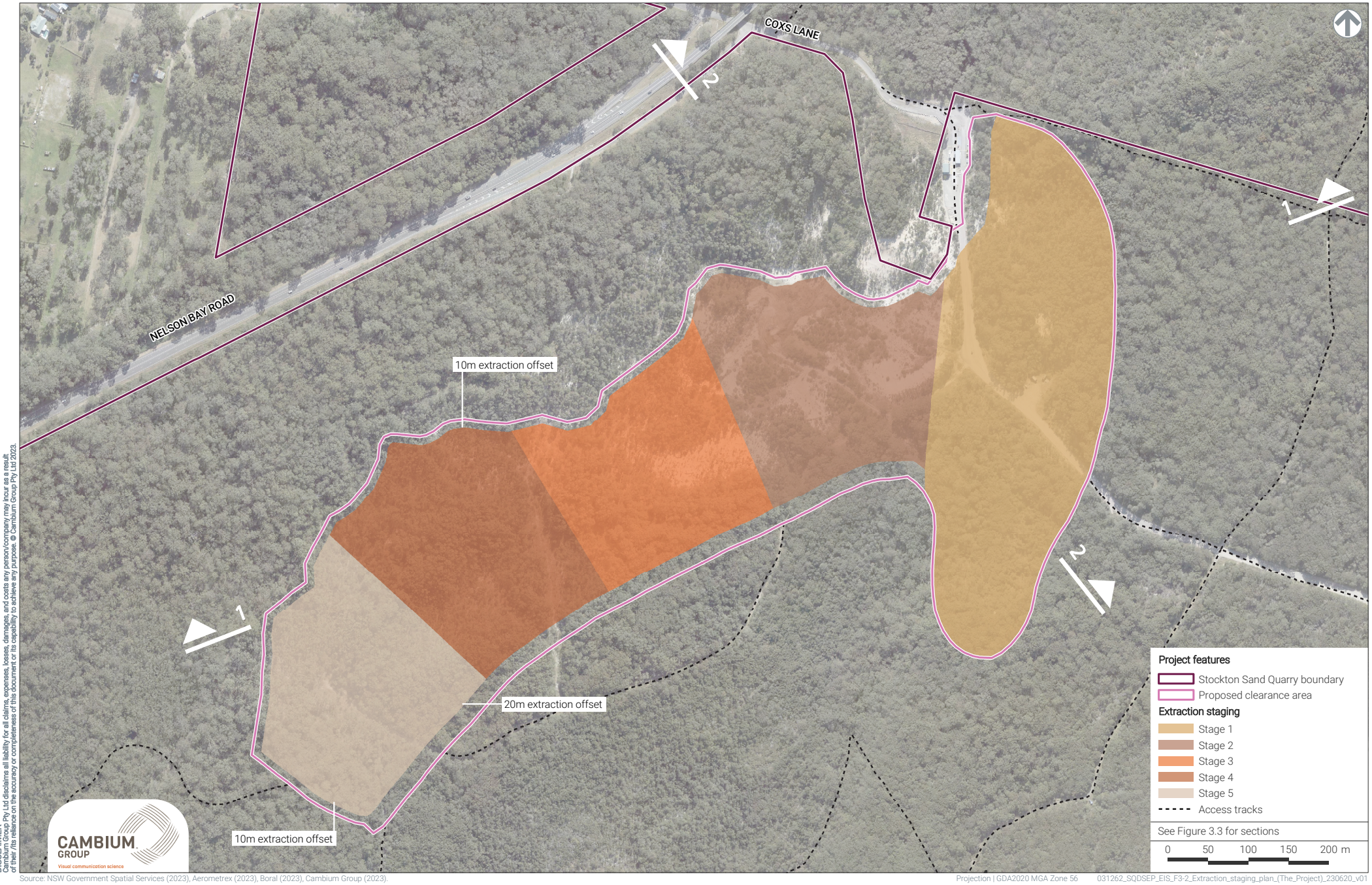

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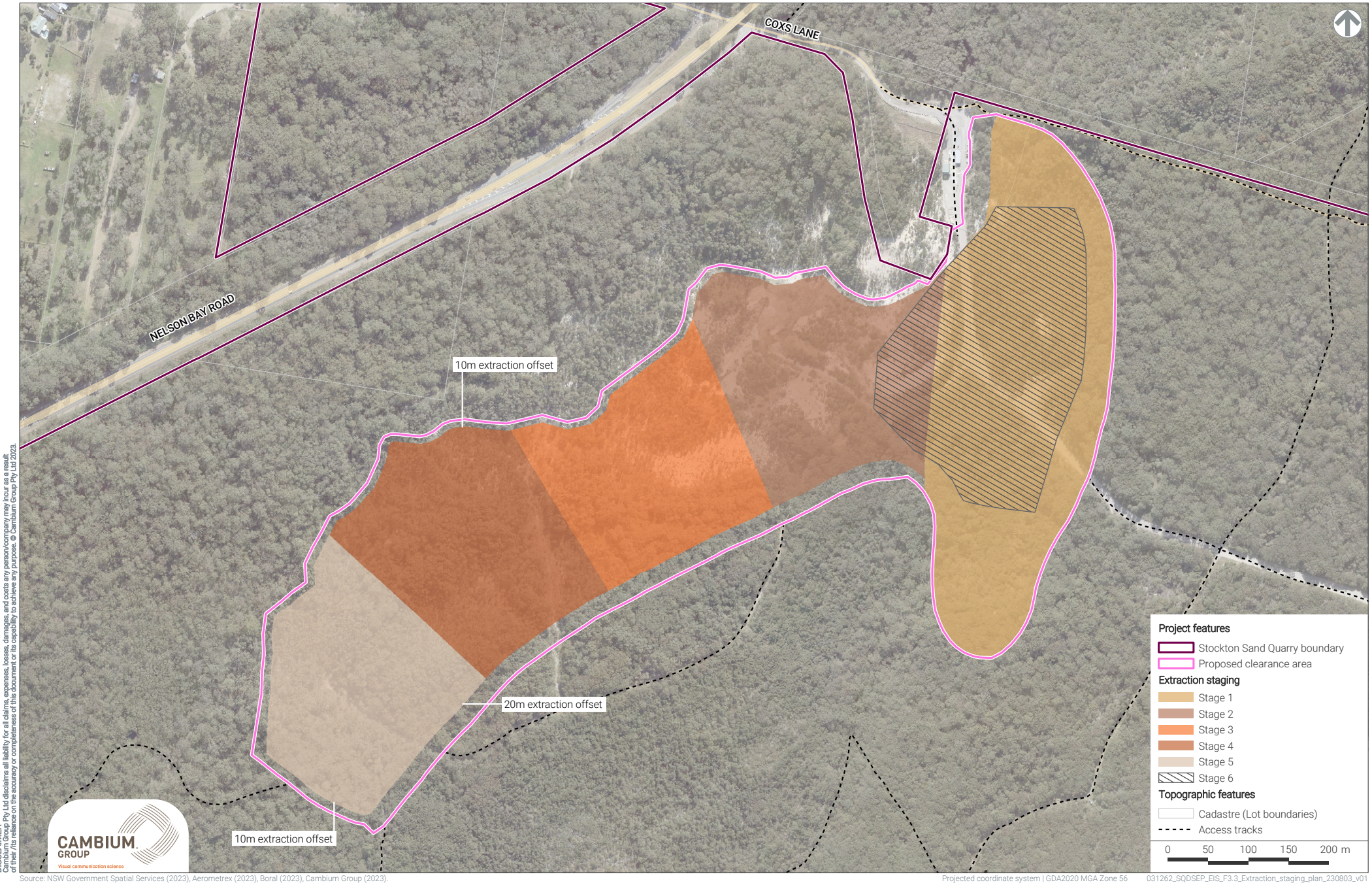
Figure 3.3
Extraction staging plan (current dredge application)



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Projected coordinate system | GDA2020 MGA Zone 56

3.2.2 Drilling program and preliminary vegetation clearing

Boral proposed to undertake a widespread drilling program that would enable them to:

- monitor the level of the water table over the life of the project; and
- provide an accurate representation of the quality of the sand resource across the project site.

As shown in Figure 3.4, a systematic grid-based approach is proposed, comprising 63 boreholes across full extent of the extraction area.

To enable drilling to commence prior to extraction, preliminary clearing of approximately 0.5 ha of vegetation is proposed to allow for the required network of access tracks and turning areas. Access tracks would be a maximum 2.6 m wide and turning areas a maximum of 40 m^2 (10 m x 4 m). Preference has been given to locating the proposed boreholes in low lying areas and areas of cleared vegetation to minimise clearing where possible.

Potential biodiversity impacts and offset requirements associated with the preliminary clearing are considered in the biodiversity development assessment report (refer Chapter 10, Appendix H of this EIS).

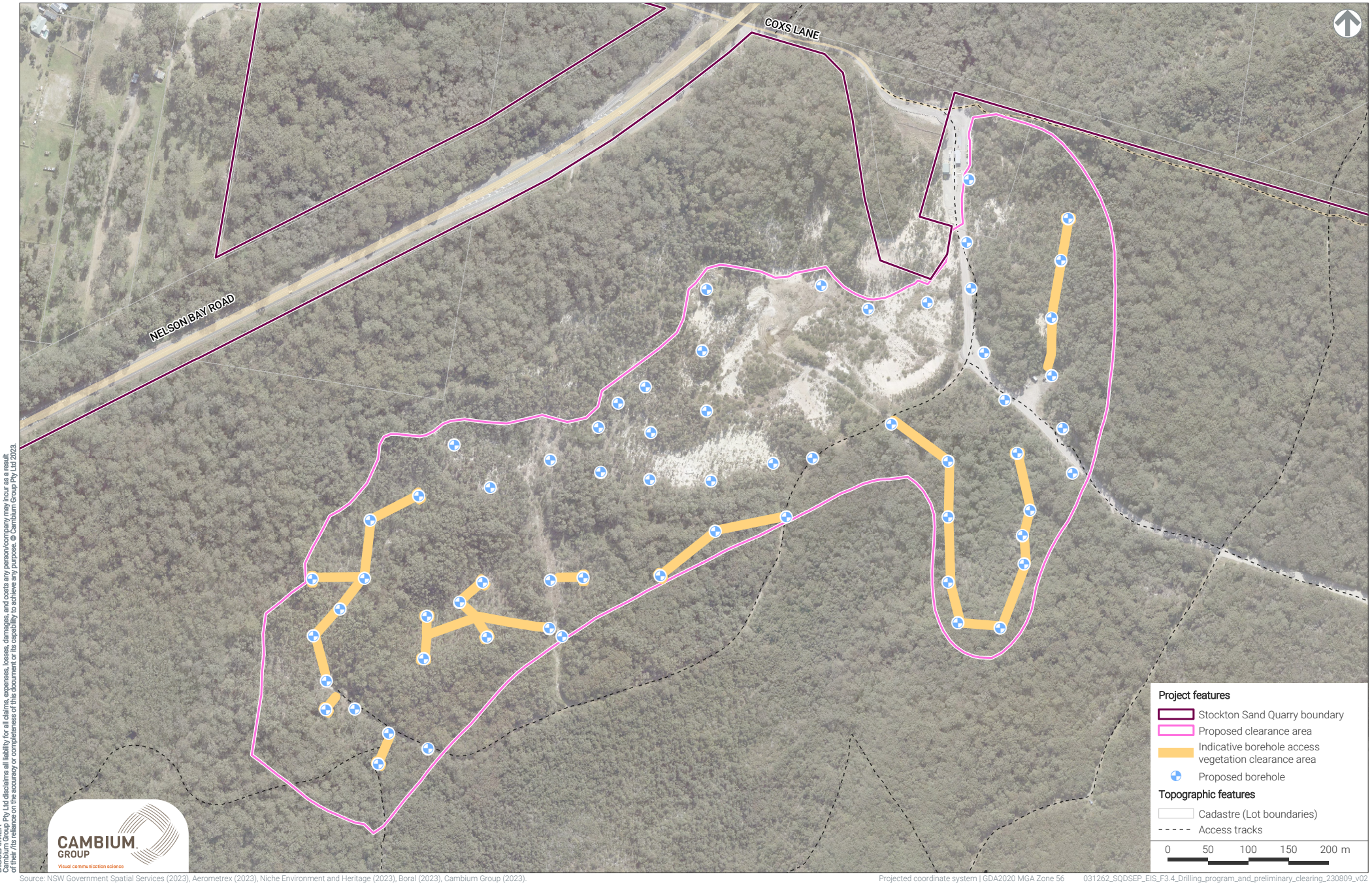
A biodiversity management action plan has been prepared and is provided in Appendix R of this EIS. The purpose of the plan is to provide Boral and its subcontractors with biodiversity management measures for them to follow when carrying out the proposed drilling program. This would ensure potential direct and indirect impacts to terrestrial biodiversity values are appropriately managed through:

- the demarcation of disturbance areas;
- general pre-clearance procedures;
- tree felling procedures (including for non-hollow and hollow-bearing trees);
- revegetation of temporary disturbance areas; and
- record management and reporting.

A separate biodiversity management plan would be prepared for the extraction area post-approval.

Figure 3.4

Drilling program and preliminary clearing



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Projected coordinate system | GDA2020 MGA Zone 56

3.2.3 Sand extraction, staging and processing

The project would progress in five stages as shown on the proposed extraction staging plan (Figure 3.2).

Consistent with that proposed for the current dredge application, site preparation would involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Cleared vegetation would be mulched or stockpiled on-site for later use in rehabilitation. Similarly, any stripped topsoil would be retained for use in rehabilitation. Further details of project rehabilitation are provided in the rehabilitation strategy (refer Chapter 18, Appendix R of this EIS).

i Extraction (Stage 1)

Stage 1 would involve dry sand extraction to a maximum depth of 3.7 m AHD, to ensure that a minimum buffer of 0.7 m is maintained to the water table. The depth of the water table and the adequacy of the buffer is considered further in the groundwater assessment (refer Chapter 7, Appendix E of this EIS).

A front-end loader would push into the exposed sand face and as the sand is relatively free-flowing, material would fall towards the front-end loader at the natural angle of repose.

Sand extracted from Stage 1 would generally contain a low volume of organics. Due to the quality of the sand, it would not require processing (i.e. washing and filtering), rather the sand would be dry screened for immediate sale or stockpiled (refer sub-section iv below).

Stage 1 would also include delivery and installation of a prefabricated office building and commencement of the other alterations (outlined in Section 3.2.1 above) to the existing site depot.

ii Extraction (Stages 2-5)

As Stage 1 is nearing completion, Stage 2 would commence. To limit the loss of sand to wind erosion, a maximum extent of 200-300 m of vegetation and ground cover would be cleared at any one time.

As with Stage 1, Stages 2-5 would involve dry extraction to a maximum depth of 3.7 m AHD. The method described in Stage 1 would be repeated in each subsequent stage, with extraction progressing in a south-westerly directly from Stage 2 until the completion of Stage 5.

Sand extracted from Stages 2-5 would generally contain higher volumes of organics and would require further processing (i.e. washing and filtering) through the wash plant and water recycling and filter press (refer sub-section v below).

Sections of the proposed dry sand extraction are provided in Figure 3.5 below.

iii Staging alignment with the current dredge application

Stages 1-5 of the project (shown in Figure 3.2) mirror the first five stages of the current dredge application (shown in Figure 3.3). This has been designed so that, should the current dredge application be approved, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

If the project transitions to dredging, a pond would be created in Stage 2. The pond would be large enough to float a dredge, which would move progressively through the extraction area in a south-westerly direction in a staged process. Extraction would then move to the east and culminate with relocation of the proposed processing and stockpile area to a confined area in Stage 1 and subsequent dredging of the majority of the Stage 1 extraction area (which would then become Stage 6). This process is described in more detail in the EIS (Element, 2020) accompanying the current dredge application.

iv Stockpiling

A processing and stockpile area would be established generally within the area of Stage 1 and would encompass stockpiles of topsoil, cleared/mulched vegetation, and sand products. Sand extracted by front-end loader and/or excavator would be

transported to the Stage 1 area, dry screened for immediate sale or stockpiled for processing through the wash plant and water recycling and filter press. Processed sand would be stockpiled and stored for as long as is practical for excess water to be drained to achieve a 6-9% moisture content. The final processed sand would then be loaded with a front-end loader and/or excavator into trucks for dispatch offsite via the existing weighbridge.

v Sand processing

Sand extracted from Stages 2-5 would generally contain higher volumes of organics and would require further processing (i.e. washing and filtering) through the wash plant and water recycling and filter press.

A level concrete pad for the wash plant and water recycling and filter press would be constructed as soon as practicable after vegetation removal and sand extraction between Stage 1 and Stage 2. The pad would support the installation of:

- a wash plant;
- a water recycling plant and filter press;
- a stacker;
- two diesel generators; and
- water holding tank(s).

Once the pad has been constructed and the wash plant and water recycling and filter press installed, water would be pumped from the aquifer via a licensed water supply bore to fill a clean water holding tank. This is an initial 'take' of water required to commence the operation of the wash plant. The clean water tank would need to be intermittently topped up to account for water losses associated with moisture content in the sand.

The wash plant process would entail sand/water (with water added from the water holding tank) being fed over a dual deck washing screen to separate oversize organic matter or debris. After screening, the sand would be pumped through a cyclone separator to remove excess water and the <150 micro fraction material and would then pass over a dewatering screen before being stockpiled by radial conveyor for further dewatering. Any excess water from this process would be used for dust suppression across the site, including both the project site and the existing windblown site.

The wash plant and water recycling and filter press have been designed so that, should the current dredge application be approved and the project transitions to dredging, the sand/water from the dredge could be pumped directly into the wash plant.

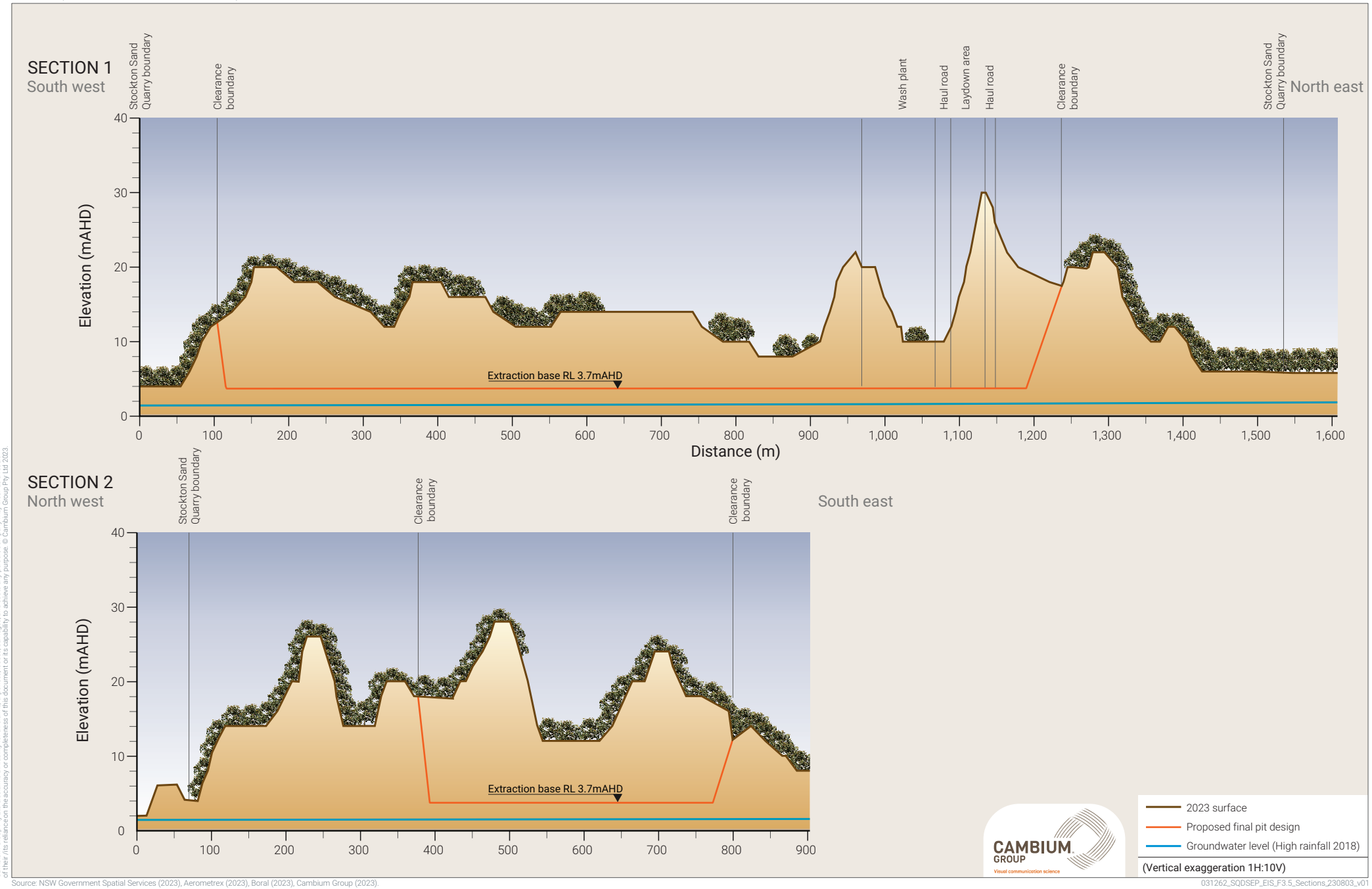
Water recycling plant

To optimise the use of water extracted from the aquifer, a water recycling plant would be introduced. The water recycling would allow water to reused/recirculated for processing sand. The water recycling plant would include the following built elements:

- clean water holding tank(s) with capacity to hold 200,000 litre (maximum);
- one thickener (dirty/grey) tank;
- an open sided shelter covering the filter press;
- installation of a control room; and
- associated pipes and pumps.

The sand extracted from Stages 2-5 would be passed over a screen where medium to fine grain sand is separated from the water by a screen/cyclone and stockpiled using a stacker. Water removed in the screening process would be directed to the thickener tank where a flocculent/coagulant would be added to combine the residual fines and organic material. These residual materials would sink to the bottom of the holding tank and form a slurry that is then pumped into the filter press, leaving behind clean water that is pumped back to the holding tank to be reused in the washing process.

Figure 3.5
Sections



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Filter press

Boral propose to use a hydraulic filter press with membrane for the removal of fines material from the slurry (i.e. fines and residual water) formed in the thickener tank. The process of separating the fines from residual processing water would create a residual product in the form of a 'filter cake' that could be used in the gardening and landscaping industry.

The use of the filter press would minimise overall water demand of the project by recouping as much water as possible for reuse in the processing of sand and when used in conjunction with the water recycling plant would result in a closed loop water reuse system. The filter press would use hydraulic pressure to feed the 'slurry' (water containing fines and organic material) through a series of chambers.

As pressure builds in the chambers between the plates of the press a cake would be formed. The pressure applied squeezes water from the fines, which would be drained and returned to the clean water holding tank. The plates would then be opened, and the cake would be released to a bay below where the fines cake could either be stored or loaded directly into a waiting truck for direct dispatch from the site.

The water removed from the fines would then be returned to the clean water storage tank of the recycling plant for recirculation and use in the processing of the sand.

The filter press would be approximately 5-6 m high and raised approximately 3 m above ground level so that cakes formed during the filter process would fall from the bottom of the press to the chamber below.

3.2.4 Haulage route

As shown in Figure 3.1, the new internal haulage route would be constructed to create a one-way entry to and one-way exit from the site, with a new laydown area in between. The haulage route would become two-way south of the laydown area providing access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east. The haul road would be up to 10 m wide and when complete (at the end of Stage 5) and would be used to support access for rehabilitation works and future site management.

3.2.5 Dust suppression

A water cart would be used to suppress dust during initial site establishment works where necessary, focussing on the existing and proposed haulage routes and the Stage 1 extraction area. The water cart would then be used for dust suppression of all haul road and stockpiles post construction. Water for dust suppression would be taken from a licensed water supply bore or from residual water from the wash plant (refer Section 3.2.3 above).

3.2.6 Rehabilitation

On completion of extraction activities, the following areas would require specific rehabilitation/revegetation:

- where native vegetation has been cleared across the proposed extraction area; and
- where native vegetation has been cleared for project-specific infrastructure (i.e. haul road corridors and internal accessways).

Rehabilitation activities in these areas would comprise soil preparation (i.e. deep ripping for haul road corridors) and establishment of native vegetation in disturbed areas, utilising suitable rehabilitation species (refer Section 18.2.5 of this EIS), to minimise soil erosion and establish slope stability.

Further details of project rehabilitation are provided in the rehabilitation strategy (refer Chapter 18, Appendix R of this EIS).

3.2.7 Stabilisation measures

To stabilise the proposed extraction area, batters would be required to be constructed to a batter slope of 3H:1V (Horizontal:Vertical).

Preliminary geotechnical advice has been provided by Pells Sullivan Meynick Pty Ltd, which recommended regular inspection of the batters to ensure management responses are taken. Where necessary, a protective layer of appropriate VENM would be used to stabilise the embankments.

Management options for stabilisation and embankment erosion would be:

- progressive rehabilitation using planted edges; and/or
- VENM emplacement, including application of 450 mm rock.

Boral proposes to import up to 70,000 tpa of VENM by road to stabilise slopes and batters as required and for the construction of the proposed laydown area.

3.2.8 Production schedule

Boral proposes to extract approximately 3.1 million tonnes (Mt) of resource (including overburden) from above the water table and seeks a site wide limit of 750,000 tpa (inclusive of the existing windblown project), until either the existing windblown project consent lapses in 2028 or the current dredge application is commenced, after which time the site wide limit would reduce to 500,000 tpa.

As detailed in the indicative production schedule in Table 3.2, at a maximum extraction rate of 750,000 tpa until 2028 and then 500,000 tpa thereafter, the reserve would last for approximately seven and a half years. However, Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

Should the current dredge application be approved and dredging commences, then production would occur in line with the production schedule provided in the EIS (Element, 2020) accompanying the dredge application.

Table 3.2 Indicative production schedule

Stage	Reserve (tonne)	Duration (years)	Approximate dates (subject to market demand)
1	1,570,000	2.5	2024-2026
2	268,000	1	2026-2027
3	151,000	1	2027-2028
4	153,000	1	2028-2029
5	940,000	2	2029-2031
Total (Stages 1-5)	**3,082,000**	**7.5**	**2024-2031**

3.2.9 Site wide dispatch

Consistent with the site wide extraction limit, Boral is seeking a site wide dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa (inclusive of the existing windblown project) until either the existing windblown project consent lapses in 2028 or the current dredge application is commenced, after which, the dispatch and transportation of product would reduce to 500,000 tpa.

The following two products would be dispatched from the site:

- sand; and
- high organic content filter ‘cakes’.

A maximum 150 tonnes of filter 'cakes' would be dispatched per week. The dispatch of sand would be a priority for the site and where required the dispatch of filter 'cakes' would be decreased to optimise the dispatch of sand.

The project would not alter the directional split of traffic movements to or from the quarry, with trucks travelling both north and south along Nelson Bay Road and beyond.

At maximum production, the project would generate an additional approximately 132 heavy vehicle movements (66 in, 66 out) during a peak day.

3.2.10 Water demand

As detailed in Table 3.3 below, the project water demand is 129.25 mega litre per annum (ML/pa). This reflects the 'base case' (worst case scenario) of the project at a maximum extraction rate of 750,000 tpa until 2028 and then reducing to 500,000 tpa for the remainder of the project.

Table 3.3 Estimated project water take (Source: Southeast Engineering)

Stage	Water use	Maximum water use (ML/pa)
Stage 1-5	Dust suppression	39.25
Stages 2-5	Sand processing	90
Total		129.25

A detailed site water balance has been prepared as part of the surface water assessment prepared to accompany this EIS (refer Chapter 16, Appendix N).

3.2.11 Hours of operation

The project would continue to operate in accordance with the following hours specified in the existing windblown project consent (DA 140-6-2005):

- Monday to Friday – 6:15 am to 5:00 pm;
- Saturday – 6:15 am to 12 noon; and
- no operation on Sundays or Public Holidays.

The site is also approved under DA 140-6-2005 to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15 am to 6:00 pm;
- Saturday – 6:15 am to 3:00 pm; and
- no operation on Sundays or Public Holidays.

Boral seeks the continuation of the existing hours of operation, including extended operations as and when required. The additional one-hour Monday to Friday and three hours on a Saturday would allow for a limited range of flexibility in operations to meet fluctuating project demands.

3.2.12 Employment

The project would provide employment for up to an additional two full time personnel and one casual employee, bringing the total employment for the quarry up to six full time and two casual employees.

3.3 Project comparison

A summary of the key project elements in comparison to the existing windblown project and the current dredge application is provided in Table 3.4.

Table 3.4 Project profile comparison against existing operations and the current dredge application

Component	Existing windblown consent (DA 140-6-2005)	Current dredge application (SSD 9490)	The project (SSD 52984213)
Location on site	Windblown (transgressive dunes)	Inland dunes	Inland dunes
Hours of operation	• Monday to Friday: 6:15 am to 5:00 pm • Saturday: 6:15 am to 12 noon • Sunday and Public Holidays: Closed	No change	No change
Number of staff	• Four full time • One causal	• Up to six full time • Up to two casual	• Up to six full time • Up to two casual
Total resource	Approximately 76,000 tonnes remaining	9 million tonnes	3.1 million tonnes
Consent period	20 years (due to cease in 2028)	25 years from commencement	10 years from commencement (or until SSD 9490 is commenced)
Production and transport limits	Up to 500,000 tpa	Up to 500,000 tpa	Up to 750,000 tpa (inclusive of the windblown sand operations) until either SSD 9490 is commenced or the windblown sand development consent lapses in 2028, after which production/transportation would reduce to up to 500,000 tpa
Extraction method and stages	Dry sand extraction only	Stage 1 - dry extraction using front end loaders Stages 2–6 – dredge	Stages 1-5 dry extraction using front end loaders
Processing	Minimal – sand is typically loaded directly into trucks for dispatch	Stage 1 - as needed dry screen prior to dispatch (dependent on quality) Stages 2-6 - sand is dredged and processed through a wash plant prior to being stockpiled	Stage 1 - as needed dry screen prior to dispatch (dependent on quality) Stages 2-5 - dry extraction (sand of lower quality would be processed through a wash plant and water recycling and filter press prior to being stockpiled)
Vegetation clearing, offsets and rehabilitation	Progressive clearing and rehabilitation	Clearing of 38.14 ha of vegetation with staged offsets to reflect extraction stages. Creation of a freshwater pond and rehabilitation comprising: • rehabilitating the pond edge • plant species planted along the edges of the pond would be selected to maximise the bank stability • stabilising re-profiled areas as soon as possible, minimise potential erosion and degradation of areas of exposed topsoil	Clearing of 38.14 ha of vegetation with staged offsets to reflect extraction stages Preliminary clearing/offset stage to allow for a site wide drilling program to commence prior to extraction Standalone rehabilitation strategy comprising progressive stabilisation and rehabilitation of disturbed areas with species endemic to coastal woodland

Table 3.4 Project profile comparison against existing operations and the current dredge application

Component	Existing windblown consent (DA 140-6-2005)	Current dredge application (SSD 9490)	The project (SSD 52984213)
Site infrastructure and plant	Established depot at the site which contains: • an amenities/office building providing an office, lunchroom, toilet and shower • weighbridge • designated parking area for employees and visitors • maintenance shed • 4,200 litre above ground bunded fuel tank	Retain all existing improvements and augment/upgrade to include: • new prefabricated office building • relocation of onsite materials storage (currently in the footprint of proposed Stage 1) • replacement of roofing for the workshop • new 30,000 litre water storage tank • new washplant and stacker	Retain all existing improvements and augment/upgrade to include: • new prefabricated office building • relocation of onsite materials storage (currently in the footprint of proposed Stage 1) • replacement of roofing for the workshop • new 20,000 litre water storage tank • new laydown area • new wash plant and water recycling and filter press

Boral seeks consent for the project as a standalone consent that would operate in accordance with project specific controls and criteria, which have been established considering all existing sources (including the existing windblown project operations).

In this regard, it is noted that the points of commonality or crossover occur only in relation to the following aspects:

- access/haul roads (predominately those located in the north west of the site);
- site depot amenities and infrastructure;
- fuel storage; and
- transport limits.

In all other respects, the project would operate independent of the existing windblown sand operations. The minor nature of the shared elements is unlikely to give rise to inconsistencies in the project consents that would impact on the management of the site. In all other respects, project compliance would be tracked individually in accordance with project specific, environmental management, compliance and reporting mechanisms.

Should the current dredge application be approved, and the project transitions to dredging, then the site would operate under the project specific controls and criteria established for the dredge consent.

As highlighted above, whether the project proceeds without the current dredge application or whether the project transitions into dredging (should the current dredge application be approved), the site wide extraction and transportation limit would reduce to 500,000 tpa in 2028 when the windblown project consent (DA 140-6-2005) lapses.

A modification to DA 140-6-2055 may be required to allow for the site wide limit of 750,000 tpa until 2028.

4 Engagement

This chapter provides an overview of the project engagement activities and addressed the relevant SEARs, as detailed in Table 4.1.

Table 4.1 SEARs (engagement)

Relevant SEARs	How addressed
DPE – Planning (general requirements)	
During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you must consult with: • affected landowners • community groups • Aboriginal stakeholders • Port Stephens Council • The Biodiversity Conservation Division within the Department of Planning and Environment (the Department) • The Water Division within the Department • Heritage NSW • NSW Environment Protection Authority • Regional NSW – Mining, Exploration & Geoscience Division • Department of Primary Industries (including Agriculture and Fisheries) within the Department • Hunter Water Corporation • NSW Rural Fire Service • Transport for NSW	Section 4.1.1 - Community engagement Section 4.1.2 - Government agency engagement Section 4.1.3 - Aboriginal engagement
Establish a Community Consultative Committee for the project in accordance with the Community Consultative Committee Guidelines for State Significant Projects, and consult with the committee during the preparation of the EIS	As part of the response to submissions report (Boral, 2020) for the current dredge application, Boral queried the need for a community consultative committee, due to the 'perpetually low engagement response from the local community with many unaware of or unconcerned by Boral's operation'. Based on this, the DPE assessment team removed the requirement for a CCC. For these reasons and given that the project reflects a reduced scale of development to the current dredge application, Boral requests the requirement for a CCC also be removed for the project.
The EIS must detail the engagement undertaken and demonstrate how it was consistent with the Undertaking Engagement Guidelines for State Significant Projects. The EIS must detail how issues raised and feedback provided have been considered and responded to in the project	Sections 4.1-4.3

4.1 Engagement strategy

To address the requirements of the SEARs, engagement has been split between the local community (Section 4.1.1), government agencies (Section 4.1.2) and representative Aboriginal groups (Section 4.1.3), with the methods and outcomes of the consultation documented, including how issues raised have addressed in the preparation of this EIS.

Engagement for the project has been undertaken in accordance with the DPE guidelines *Undertaking Engagement for State Significant Project, October 2022* (DPE, 2022), which reflects a proponent led engagement strategy to engage as early possible and ensure that engagement is effective and proportionate to the scale and impact of the project.

4.1.1 Community engagement

A social impact assessment (SIA) (refer Chapter 14, Appendix L) has been prepared by AIGIS Group (AIGIS, 2023) to accompany this EIS. The SIA adopted the same scoping outputs as the preceding SIA (Element, 2019) for the current dredge application (given the lower predicted risk of impacts from the project), including adoption of the of the same 'area of social influence' as an appropriate representation of the local community. The area of social influence is shown in Figure 4.1.

A total of 125 properties were canvassed in the area of social influence, which included Fullerton Cove residential area (to the west and north of the quarry), Fern Bay Seaside Village (a community title scheme to the south of the quarry) and The Cove Village (a community title scheme within Fullerton Cover residential area). A letter providing details of the project and requesting comments was direct mail delivered to each property.

There was little response to the local community engagement attempts for the project. Two responses were recorded, one of which was an incidental direct engagement, and which indicated that the quarry is not a matter of concern. It was also noted that sand produced by the quarry is essential to supporting industry and employment, which indicates a positive understanding of the need for sand extraction.

4.1.2 Government agency engagement

i Pre-SEARs request

An initial project meeting was held with representatives of Boral and DPE - Planning on 23 September 2022 around the following broad topics:

- justification and need for the project given the delays associated with the current dredge application;
- Boral's intention to lodge a separate standalone SSD application for the project;
- assessment and consultation requirements; and
- project program and next steps.

At the initial project meeting, DPE Planning recommended that Boral also engage with DPE - Biodiversity Conservation Division (BCD) and DPE - Water. Boral subsequently met with DPE - BCD on 9 December 2022, where an overview of the project was provided, and the following matters discussed/confirmed in relation to updating the existing *Stockton Sand Quarry Dredging Revised Biodiversity Development Assessment Report* (Niche, 2020):

- requirement for additional plot surveys where survey information is more than five years old;
- requirement to update the existing BDAR report to reflect the (former) NSW Office of Environment and Heritage's *Biodiversity Assessment Methodology* (OEH, 2020); and
- potential for and increase in the offset liability for the project given the change to BAM 2020 and the potential for regeneration to have occurred over time.

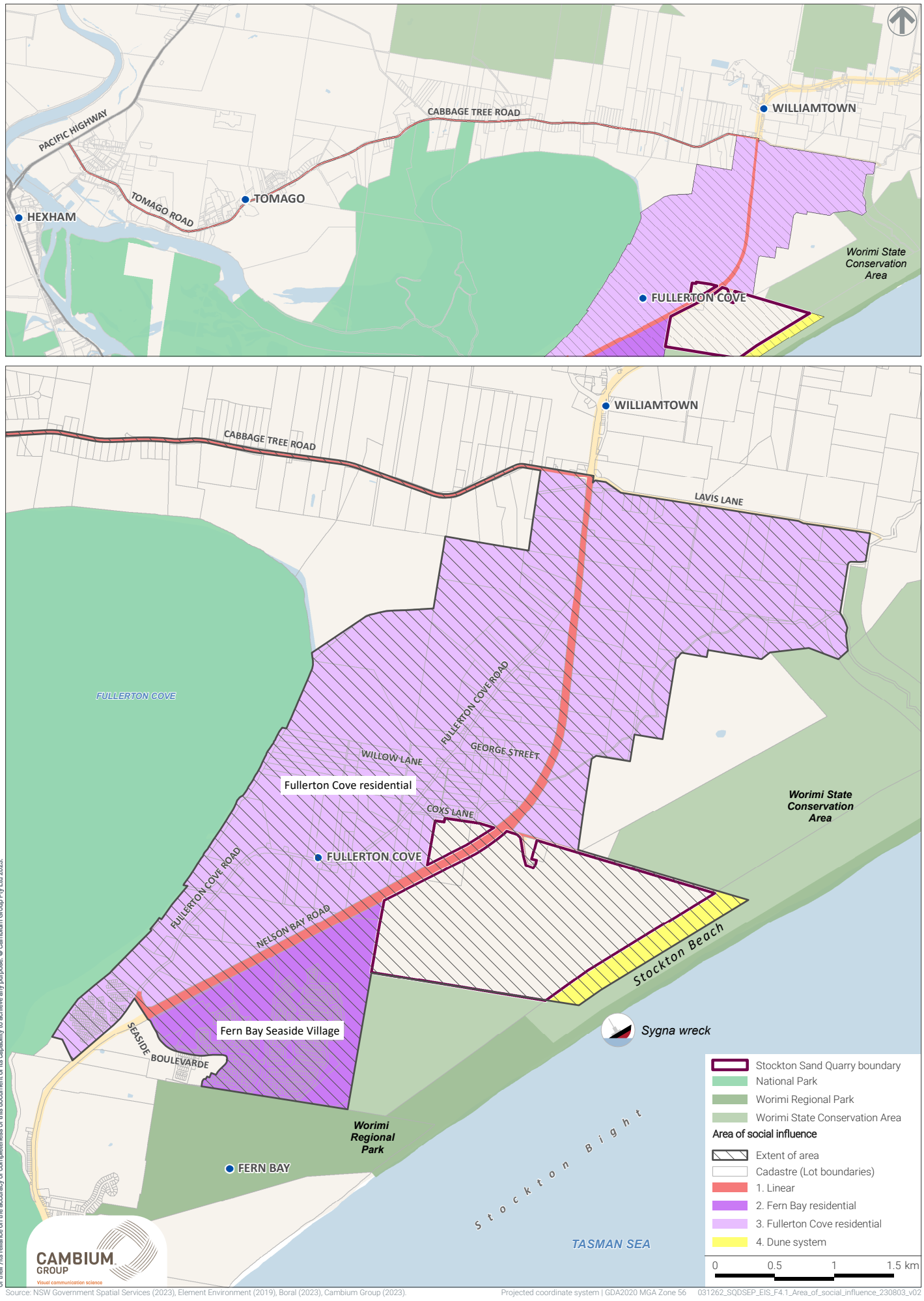
Boral's consultants spoke with representative from DPE - Water who advised in email correspondence, dated 13 December 2022, that a briefing meeting was not considered warranted given that the water table would not be impacted.

ii Preparation of EIS

To inform the preparation of this EIS and to address the SEARs, Boral undertook consultation with relevant government agencies. A letter providing details of the project was provided to the government agencies on 23 February 2023 and comments requested by 10 March 2023. Responses received and how they have been addressed are detailed in Table 4.2 and a copy of the letter is provided in Appendix C of this EIS.

Figure 4.1

Area of social influence for current dregde application (SSD 9490)



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Source: NSW Government Spatial Services (2023), Element Environment (2019), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56

Table 4.2 Government agency consultation

Stakeholder	Comments	Response
Port Stephens Council (Council)	An email response was received from Council (Courtney Sargent) on 16 March 2023, including the following points raised: **Strategic Planning** Council is currently preparing the Fullerton Cove Place Strategy for land in the vicinity of the development. The Place Strategy is being prepared in consultation with the Hunter Regional Office of DPE to deliver a new local centre and additional housing in Port Stephens. The SEARs could require State Environmental Planning Policy (Resources and Energy) 2021 to be addressed, which requires a consent authority to consider whether or not the development is likely to have a significant impact on the uses that, in the opinion of the consent authority having regard to land use trends, are likely to be the preferred uses of land in the vicinity of the development, and any ways in which the development may be incompatible with any of those existing, approved or likely preferred uses. The SEARs could require the applicant to prepare their response in consultation with Council, having regard for the Fullerton Cove Place Plan currently being prepared.	As required by the SEARs, Section 5.4 of this EIS includes an assessment of the project against the relevant provisions of the NSW *State Environmental Planning Policy (Resources and Energy) 2021.* The SEARs do not require the applicant to prepare their response in consultation with Council, having regard to Council's *Fullerton Cove Place Strategy* (the strategy), currently being prepared. From information provided on Council's website, it is understood that whilst a study area has been identified (refer excerpt below in Figure 4.2) for the strategy, which includes the area to the north-west of Nelson Bay Road and adjacent to the north-west of the quarry, the next phase of the program is to refine the development footprint and determine the required inputs needed to develop the strategy. This involves undertaking studies and assessments to identify land constraints and to inform and prepare a development planning map. **Figure 4.2 Excerpt of Fullerton Cove Place Plan study area** In the absence of an established development footprint and development planning map showing future uses, it is not possible to determine compatibility with the project.

Table 4.2 Government agency consultation

Stakeholder	Comments	Response
		However, it is noted that the air (refer Chapter 11, Appendix I of this EIS) and noise assessments (refer Chapter 12, Appendix J of this EIS) have predicted potential project impacts at nearby residences, including within the area study area, with no predicted exceedances of relevant government criteria. In addition, the traffic and transport assessment (refer Chapter 13, Appendix K of this EIS) does not identify any capacity issues with the local road network, with all key intersections currently operating at good levels of service (level of service A and B). Overall, based on the outcomes of the aforementioned technical studies, and given the buffer between the project site and the study area, it is not considered that there would be issues of compatibility with any future uses.
	Ecology Council's Natural Systems Team have reviewed the scoping report and requests the following information be included in the EIS prepared for the project: a) Within the project justification / project need section, it is requested that a detailed analysis of sand depletion be presented, taking into consideration modelling for this resource to be continually replenished by wind blown sand incursion (dune transgression). This should be supported by a coastal processes assessment. b) It is noted that there has been historical extractive industries at the proposal site (since the 1970s). However, the proposal site appears to have undergone substantial disturbance / expansion between 1992 -2010 that is not described or unaccounted for in Table 3.1 of the scoping report. Please provide details of the disturbance history of the site and any relevant prior operations or rehabilitation requirements. c) A Biodiversity Development Assessment Report must be prepared. Council acknowledges that it is the proponent's intention to provide an updated BDAR (previously prepared for sand dredging application) to ensure that surveys and assessment comply with BAM 2020. d) Council notes a recent nearby record of Mahoney's Toadlet adjacent to the proposal site. Potential direct and indirect impacts to this species should be assessed in the updated BDAR. This should include assessment of potential impacts to groundwater dependent ecosystems. e) Given the transgressive landward nature of the dunes, vegetated buffers along the dune system are incredibly important in ensuring long-term protection of infrastructure and property. The project should include a discussion on the potential for current vegetation to buffer landward sand	a) A project justification, including analysis of the sand depletion at both the quarry and the surrounding area is provided in Section 2.2 and a coastal process assessment (refer Chapter 9, Appendix G) has been prepared to accompany this EIS. b) A rehabilitation strategy (refer Chapter 18, Appendix R) has been prepared to accompany this EIS, which considers the effectiveness of the previous rehabilitation strategy undertaken at the site. c) A BDAR (refer Chapter 10, Appendix H) has been prepared to accompany this EIS. d) The BDAR considers potential fauna impacts. However, it is noted that the project is for dry sand extraction above the water table and so would not impact ground water dependent ecosystems. This is considered further in the groundwater assessment (refer Chapter 7, Appendix E of this EIS). e) The coastal processes assessment considered the transgressive landward nature of the dunes and identified that the project site is located at least 1 km from the Stockton Beach shoreline. At the current rate of migration (3-5 metres per year) it would take between 120 and 200 years to reach the excavation site. As the life of the project is 10 years, and rehabilitation would occur progressively with the stages of extraction, a significant vegetated buffer between the transgressive dunes and the project site would not be compromised. The effectiveness of the rehabilitation proposed is considered in the rehabilitation strategy (refer Chapter 18, Appendix P of this EIS).

Table 4.2 Government agency consultation

Stakeholder	Comments	Response
	transgression versus the effectiveness of rehabilitated vegetation upon closure of the quarry. This discussion should include consideration of the time proposed for quarrying operations, the time it takes for vegetation to establish and mature, and the type of vegetation on site under both scenarios.	
	Noise The scoping report indicates that an updated Noise Impact Assessment will be prepared. The noise impact assessment should include all the components specified in Table 6.1 of the scoping report. As noise monitoring for the previous noise assessment occurred in 2018, it is recommended that additional noise monitoring be undertaken as part of the updated assessment to account for any potential changes in background noise levels. The assessment should also take into consideration the increased residential usage in the neighbouring vicinity	The noise impact assessment (NIA) (refer Chapter 12, Appendix J of this EIS) included updated noise monitoring and an assessment of the potential noise impacts at the closest residences. No exceedances of relevant government assessment criteria were predicted.
	Sewer servicing The site is currently serviced by an on-site sewerage management system. The system was last inspected by Council officers in June 2022 and was found to be in a satisfactory condition. If the proposal results in increased staff levels or additional waste water load the pump out frequency should be revised accordingly.	As detailed in the surface water assessment (refer Chapter 16, Appendix N of this EIS), the project would increase staff numbers to up to six full time staff and three casual staff. The existing wastewater system can accommodate this additional load, with the option to increase pump out frequency as required.
	Air Quality The scoping report indicates that an updated air quality assessment report will be prepared. The air quality assessment should include all the components specified in Table 6.1 of the scoping report.	An updated air quality and greenhouse gas assessment (refer Chapter 11, Appendix I) has been prepared to accompany this EIS to meet all components specified in the scoping report and to meet the relevant requirements of the project SEARs.
DPE – Biodiversity Conservation Division (BCD)	No response received	No response required
DPE - Water	An email response was received from DPE –Water (Patricia Borges) on 24 February 2023, advising that DPE water will wait for the EIS to be lodged before commencing their assessment.	No response required
Department of Regional NSW – Mining,	An email response was received from MEG-GSNSW (Malcolm Drummond) on 6 March 2023 noting that they will have an opportunity to provide comments/advice via formal inter-agency consultation with DPE during the exhibition of the EIS,	No response required

Table 4.2 Government agency consultation

Stakeholder	Comments	Response
Exploration & Geoscience (MEG-GSNSW)	and at this stage MEG-GSNSW does not have any concerns regarding the project.	
Environment Protection Authority (EPA)	An automated response was received 23 February 2023 with no further response provided.	No response required
Hunter Water Corporation (HWC)	An email with attached letter was received from HWC (Greg McHarg) on 14 March 2023 and makes the following comments: • HWC acknowledge the difference between the project and the dredge application and note that in the current proposal Boral proposes that sand extraction be limited to a height that maintains at least a 0.7 metre buffer above the groundwater table and the final landform to be a minimum of 1 metre above the groundwater table, which is consistent with other approved quarry projects in the area. • HWC requests that attention be given in the EIS to the proposed water management strategy and particularly aspects of the operation that may impact on water quantity and water quality in the Stockton Sandbeds aquifer from all aspects of the proposed extractive activities. In that regard, the matters described in the SEARs under the heading 'water' are considered to adequately capture Hunter Water's interests and requirements to be addressed in the EIS. • HWC has reviewed the Scoping Report accompanying the application and, in particular, the environmental advice letter from Environmental Earth sciences in Appendix B of the Scoping Report regarding acid sulfate soils (ASS), groundwater numerical modelling and hydrogeology (groundwater impact assessment) for the proposed dry sand extraction activities. References to the Tomago Sandbeds in section 5.6 of Appendix B to the Scoping Report regarding the hydrogeology of the project site are confusing and we suggest the information should be reviewed during preparation of the EIS.	• Noted • The water requirements of the SEARs have been addressed in the surface water assessment (refer Chapter 16, Appendix N of this EIS) and the groundwater assessment (refer Chapter 7, Appendix E of this EIS). • This comment was provided to the groundwater consultant and addressed.
Heritage NSW	An email response was provided by Heritage NSW (Nicole Davis) on 22 March 202 who advised that there were no comments at this stage of the process.	No response required
Regional NSW – Mining, Exploration & Geoscience Division	No response received	No response required

Table 4.2 Government agency consultation

Stakeholder	Comments	Response
Transport for NSW (TfNSW)	An email response was provided by TfNSW (Masa Kimura) on 28 February 2023 advising that TfNSW had no further comments than those provided to DPE as part of the SEARs.	TfNSW comments were provided with the agency advice as part of the SEARs and are addressed in the traffic and transport impact assessment (refer Chapter 13, Appendix K of this EIS).
NSW Rural Fire Service (RFS)	An automated response was received 23 February 2023 with no further response provided.	No response required
Department of Primary Industries (including Agriculture and Fisheries) within the Department	No response received	No response required
DPE - Crown Lands	An email response was received from DPE – Crown Lands (Alison Howard) on 28 February 2023, advising that no comments would be provided at this time.	No response required

4.1.3 Aboriginal consultation

Consultation with the Aboriginal community was undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010), during the preparation of the CHAR (Kellher Nightingale, 2023). This included consultation with the following registered Aboriginal parties (RAPs):

- Worimi Local Aboriginal Land Council;
- Murra Bidgee Mullangari Aboriginal Corporation;
- Didge Ngunawal Clan;
- Merrigarn Indigenous Corporation;
- Muragadi Heriage Indigenous Corporation;
- Nur-Run-Gee Pty Ltd;
- Lower Hunter Wonnarua Cultural Services;
- Worimi Traditional Owners Indigenous Corporation;
- A1 Indigenous Services;
- Murrooma Incorporated;
- Karuah Indigenous Corporation;
- Widescope Indigenous Group;
- Worimi Conservation Lands Board of Management; and
- Amanda Kickey Cultural Services.

The consultation was undertaken to identify Aboriginal cultural/social heritage values of the site. In particularly, the RAPs expressed the cultural importance and significance of the vegetated hind dune landscape around the project site, which was considered as part of the assessment. No objections were raised in relation to the project.

4.2 Further engagement to be carried out for the project

Boral is committed to continuing its engagement with stakeholders, the community and relevant government agencies for the life of the project.

5 Statutory context

This chapter considers the relevant planning framework applicable to the project and addresses the relevant project SEARs, as detailed in Table 5.1.

Table 5.1 SEARs (statutory context)

Relevant SEARs	How addressed
DPE – Planning (general requirements)	
A list of any approvals that must be obtained before the development may commence	Appendix B - Statutory compliance table
Consideration of the development against all relevant environmental planning instruments (including Part 2 of the State Environmental Planning Policy (Resources and Energy) 2021)	Table 5.3 - Matters for consideration
DPE – Planning (statutory context)	
Address the statutory provisions applying to the development contained in all relevant environmental planning instruments, including: • SEPP (Resources and Energy) 2021) • SEPP (Planning Systems 2021) • SEPP (Transport and Infrastructure) 2021 • SEPP (Biodiversity and Conservation) 2021 • SEPP (Resilience and Hazards) 2021 • Port Stephens Local Environmental Plan 2013	Table 5.3 - Matters for consideration

5.1 Power to grant approval

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and NSW *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation) provides the statutory framework for planning approval and environmental assessment in NSW.

Section 4.36 (2) of the EP&A Act states that a State environmental planning policy (SEPP) may declare any development, or any class or description of development, to be State significant development (SSD). The NSW *State Environmental Planning Policy (Planning Systems) 2021* (Planning Systems SEPP) identifies development that is SSD. Section 2.6 (1) of the Planning Systems SEPP states:

> *(1) Development is declared to be State significant development for the purposes of the Act if:*
>
> *(a) the development on the land concerned is, by the operation of an environmental planning instrument, not permissible without development consent under Part 4 of the Act, and*
>
> *(b) the development is specified in Schedule 1 and 2.*

Section 7 of Schedule 1 of the Planning Systems SEPP provides the following definition of extractive industries:

> *7 Extractive industries*
>
> *(1) Development for the purpose of extractive industry that—*
>
> *(a) extracts more than 500,000 tonnes of extractive materials per year, or*
>
> *(b) extracts from a total resource (the subject of the development application) of more than 5 million tonnes, or*
>
> *(c) extracts from an environmentally sensitive area of State significance.*

The project is development for the purpose of an extractive industry that proposes to extract more than 500,000 tpa and is therefore SSD pursuant to Section 2.6 (1) (b) of the Planning Systems SEPP.

Consent for the project is sought under Part 4, Division 4.7 of the EP&A Act. Under Part 4, Division 4.2 of the EP&A Act, the consent authority for SSD is either the Minister for Planning, unless any of the following circumstances apply, then the Independent Planning Commission (IPC) is the consent authority:

- Port Stephens Council makes a submission by way of objection under the mandatory requirements for community participation;
- at least 50 submissions (other than from a council) are made by way of objection under the mandatory requirements for community participation; or
- the Proponent has disclosed a reportable political donation.

5.2 Permissibility

As shown in Figure 1.3 (refer Section 1.3), the site is zoned RU2 – Rural Landscape pursuant to the PSLEP 2013. Extractive industries are permissible with consent in the RU2 zone.

The portion of Crown land that is used to provide access to the site is zoned RE1 – Public Recreation pursuant to PSLEP 2013. No works are proposed on this portion of land. Notwithstanding, roads are permissible without consent in the RE1 zone.

5.3 Other approvals

Other approvals required under relevant Commonwealth and NSW legislation are detailed in Table 5.2

Table 5.2 Other approvals required

Approval category	Legislation	Requirement
Consistent approvals Section 4.42 of the EP&A Act outlines that these approvals cannot be refused if necessary for carrying out an approved SSD and are to be consistent with the terms of the SSD approval.	NSW *Protection of the Environment Operations Act 1997* (POEO Act)	Section 48 of the POEO Act outlines that an EPL is required for any scheduled activities at a premise at which Schedule 1 of the Act indicates that a licence is required. Crushing, grinding or separating activities with a capacity to process more than 150 t of materials per day or 30,000 tpa, and land based extractive activities involving the extraction, processing or storage of more than 30,000 tpa of extractive materials, are scheduled activities under the POEO Act and applicable to the project. EPL 10132 applies to existing operations at the quarry. A variation to the EPL would be required to increase the permitted limit to a maximum of 750,000 tpa.
Commonwealth approvals	*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).	The EPBC Act provides for the assessment of environmental impacts on matters of national environmental significance (MNES) and on Commonwealth land. A search of the Department of Agriculture, Water and Environment's (DAWE) website using the Protected Matters Search Tool (PMST) was undertaken during the preparation of the BDAR (Chapter 10) for a list of flora and ecological communities identified as MNES known or with potential habitat within a 10 km radius of the quarry. Seven threatened fauna species listed under the EPBC Act that may be impacted by removal of potential foraging habitat were identified. Therefore, 'assessments of significance' were undertaken for these species, which concluded that the project would not significantly impact these species and that no referral under the EPBC Act was required. No other MNES or areas of Commonwealth land were identified as being impacted by the project.

Table 5.2 Other approvals required

Approval category	Legislation	Requirement
	National Greenhouse and Energy Reporting Act 2007 (NGER Act)	The NGER Act provides a single national framework for the reporting and dissemination of information about the greenhouse gas emissions, greenhouse gas projects, and energy use and production of corporations. It makes registration and reporting mandatory for corporations whose energy production, energy use or greenhouse gas emissions meet specified thresholds. Boral triggers the threshold for reporting under the NGER Act, and reports energy use and greenhouse gas emissions from its operations, including the quarry. As detailed in Section 11.2 of this EIS, the project is anticipated to generate minimal quantities of greenhouse gas emissions. Notwithstanding, management and mitigation measures are proposed to minimise greenhouse gas emissions from the project and Boral would continue to monitor and report energy use and greenhouse gas emissions associated with the project.
Other approvals	NSW *Biodiversity Conservation Act 2016* (BC Act)	Part 7, Section 7.9 of the BC Act specifies that an application for development consent under Part 4 of the EP&A Act' for SSD must be accompanied by a BDAR. A BDAR (refer Chapter 10, Appendix H) has been prepared to accompany this EIS.
	NSW *Contaminated Land Management Act 1997* (CLM Act)	The CLM Act establishes a process for investigating, and where required remediating contaminated lands, that pose a risk to human health and the environment. The EPA's Contaminated Land Record and List of Contaminated Sites notified to the EPA in the Port Stephens LGA was searched in July 2023. The quarry is not recorded or identified on the relevant registers.
	NSW *Hunter Water Act 1991* (HW Act)	The HW Act establishes the Hunter Water Corporation (HWC) and outlines a range of activities and controls related to the extraction and provision of water. These include the requirement for a consent authority to notify the HWC of applications of developments that have the potential to impact water quality. Specifically, Section 51 states that: *(2) If a consent authority within the area of operations or a special area receives a development application or building application in relation to any matter that, in the opinion of the consent authority, may:* *(a) significantly damage or interfere with the Corporation's works, or* *(b) significantly adversely affect the Corporation's operations, or* *(c) significantly adversely affect the quality of the water from which the Corporation draws its supply of water in a special area,* *the consent authority must, within 7 days of the receipt of the application, give the Corporation notice of the application.* Although the project is not itself located within a 'special area', there is potential to impact water quality, as the Stockton aquifer extends beyond the special area boundary. However, as extraction is being undertaken above the water table, significant impacts are highly unlikely. This is considered further in the groundwater assessment (refer Chapter 7, Appendix E of this EIS).
	NSW *Waste Avoidance and Resource Recovery Act 2001* (WARR Act)	The purpose of the WARR Act is to encourage the most efficient use of resources and to reduce environmental harm in accordance with the principles of ESD. This Act provides for the making of policies and strategies to achieve this. This WARR Act promotes a hierarchy of avoidance of unnecessary resource consumption; resource recovery (including reuse, reprocessing, recycling and energy recovery), and disposal (as a last resort). As described in Chapter 20, the following management strategies have been developed in accordance with the WARR Act, which would continue to be applied for the project:

Table 5.2 Other approvals required

Approval category	Legislation	Requirement
		• purchasing recycled products where appropriate; • developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site; • recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and • where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licensed facility.
	NSW *Coastal Management Act 2016* (CM Act)	The objectives of the CM Act are to manage the coastal environment of NSW in a manner consistent with the principles of ESD for the social, cultural and economic well-being of the people of the State. The CM Act defines the coastal zone as comprising the following four coastal management areas: 1. coastal wetlands and littoral rainforests area; 2. coastal vulnerability area; 3. coastal environment area; and 4. coastal use area. The CM Act establishes management objectives specific to each of these management areas, reflecting their different values to coastal communities. The CM Act is supported by the *State Environmental Planning Policy (Resilience and Hazards) 2021* (Hazards SEPP), which maps coastal zones within NSW. The site is in a mapped coastal environment area as considered further in Table 5.3 below.
	Water Management Act 2000 (WM Act)	Notwithstanding the provision of Section 4.41 of the EP&A Act (refer section below), given that the project would involve extraction of water from the Stockton aquifer, an aquifer interference approval would be required for the project pursuant Section 91 of the WM Act. The legislative requirements relating to the aquifer interference approval are considered further in the surface water assessment (refer Chapter 16, Appendix N of this EIS).
Approvals not required	Under Section 4.41 of the EP&A Act, the following authorisations are not required for SSD that is authorised by a development consent: • a permit under Section 201, Section 205 or Section 219 of the NSW *Fisheries Management Act 1994*; • an approval under Part 4, or an excavation permit under Section 139 of the NSW *Heritage Act 1977*; • an Aboriginal heritage impact permit (AHIP) under Section 90 of the NSW *National Parks and Wildlife Act 1974* (NPW Act); • a bushfire safety authority under Section 100B of the NSW *Rural Fires Act 1997*; and • a water use approval under Section 89, a water management work approval under Section 90 or an activity approval (other than an aquifer interference approval) under Section 91 of the NSW *Water Management Act 2000* (WM Act). Notwithstanding the above, potential impacts on biodiversity (Chapter 10), historic heritage (Chapter 21), Aboriginal heritage (Chapter 15), groundwater (Chapter 7) and surface water (Chapter 16) have been assessed as required by the SEARs for the project.	

5.4 Mandatory matters for consideration

The consent authority is required to consider a range of matters when deciding whether to grant consent for the project. These are referred to as mandatory considerations and are detailed in Table 5.3.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
Considerations under the EP&A Act and Regulation		
Section 1.3 Objects of the EP&A Act	a) To promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State's natural and other resources	The project would enable the continued operation of the existing quarry and the provision of a high demand sand resource to the building and construction industry, maximising the re-use of existing plant and infrastructure and with minimal environmental impacts. The socio-economic benefits of the project are further considered in the social impact assessment (Chapter 14, Appendix L) and the economic assessment (refer Chapter 17, Appendix O) prepared to accompany this EIS.
	b) to facilitate ecologically sustainable development by integrating relevant economic, environmental and social considerations in decision-making about environmental planning and assessment	The project would facilitate the following principals of ecologically sustainable development: *Precautionary principle* Project issues are well understood based on the assessment of the current dredge application and assessments have been updated as required for the project, ensuring the project is consistent with the precautionary principle. *Inter-generational equity* The principle of inter-generational equity puts an onus on society to ensure that the health, diversity and productivity of the environment are maintained, or enhanced for the benefit of current and future generations. As demonstrated in this EIS, the project would have negligible potential to adversely affect the health, diversity, or production of the environment and, therefore, would not adversely impact current or future generations. *Conservation of biological diversity and maintenance of ecological integrity* The direct loss of habitat associated with the project would be offset in accordance with the NSW Biodiversity Offset Scheme, which would result in no net loss in biodiversity. *Improved valuation and pricing of environmental resources* Potential environmental impacts form the project are limited and would be addressed via offsets and through management/mitigation measures as required. The continued operation of the quarry would ensure that environmental resources are valued both during and post quarrying.
	c) to promote the orderly and economic use and development of land	The project would allow for the continued use of an existing quarry that is a permissible use in the RU2 zoning of the site. The quarry is geographically separated from nearby residential areas and there is a significant buffer to nearby environmentally sensitive areas, including the Worimi areas (refer Section 9.3.2 of this EIS). As detailed in this EIS, the project would result in positive socio-economic impacts through continued employment and the financial contribution to the Australian and NSW economy.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
		Potential environmental impacts have been assessed as part of this EIS and a comprehensive suite of management and mitigation measures identified. As demonstrated, the project would meet relevant government air and noise criteria at all nearby residences and the local road network has adequate capacity to accommodate the predicted project traffic. For these reasons it is considered that the project would promote the orderly and economic use of the land.
	d) to promote the delivery and maintenance of affordable housing	Not applicable to the project.
	e) to protect the environment, including the conservation of threatened and other species of native animals and plants, ecological communities and their habitats	The project site has been sited over an area of previous disturbance to avoid, preserve and protect areas of established vegetation and fauna habitat. The project BDAR (Chapter 10) includes a biodiversity offset strategy to ensure that compensatory land is protected in perpetuity. As detailed in the groundwater assessment (refer Chapter 7, Appendix E of this EIS), the closest known listed groundwater dependent ecosystems (GDEs) to the project site are the Tilligerry Creek Wetlands and Hunter River Wetlands, located over 10 km to the north-east and south-west of the site, respectively. The project would maintain a minimum 0.7 m buffer to the water table. As there would be no interception of groundwater as a result of extraction, and given the distance to the closest known listed GDEs, there are not expected to be any adverse impacts to GDEs from the project.
	f) to promote the sustainable management of built and cultural heritage (including Aboriginal cultural heritage)	There are no items of non-Aboriginal heritage present within the site and the project is unlikely to adversely impact those in proximity (refer Chapter 21, Table 21.1 of this EIS). The CHAR (Chapter 15, Appendix M of this EIS) identified that, given the project is contained to an area of previous disturbance, it would unlikely result in unsustainable management of cultural heritage and management and mitigation measures would be implemented to ensure the protection of any unidentified objects.
	g) to promote good design and amenity of the built environment	Potential noise (refer Chapter 12, Appendix J of this EIS) and air quality (refer Chapter 11, Appendix I of this EIS) impacts have been assessed, and the project has been designed in a manner which aims to avoid the potential for impacts in the first instance, with measures proposed to further manage/mitigate potential impacts where necessary.
	h) to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants	The project would not require the construction of new buildings other than installation of a portable site office, and replacement roofing for the maintenance shed, as recommended for bushfire hazard mitigation (refer Chapter 19, Appendix R of this EIS). All built structures for the project would comply with relevant building standards and be implemented to improve the health, well-being and safety of site personnel. Existing buildings at the site depot would be maintained for the project and any potentially hazardous substances managed in accordance with relevant legislation (refer Section 19.1 of this EIS).

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
	i) to promote the sharing of the responsibility for environmental planning and assessment between the different levels of government in the State	Whilst the Minister for Planning is the consent authority for the project, Port Stephens Council (as the relevant local government authority) and other government agencies, have been consulted throughout the planning phase of the project and during the preparation of this EIS and relevant comments raised have been addressed as part of the project engagement (refer Chapter 4 of this EIS).
	j) to provide increased opportunity for community participation in environmental planning and assessment	As outlined in Chapter 4 of this EIS, Boral has consulted with relevant government agencies, the local community, and other stakeholders.
Section 4.15 of the EP&A Act - Evaluation	1. Matters for consideration—general In determining a development application, a consent authority is to take into consideration such of the following matters as are of relevance to the development the subject of the development application— a) the provisions of— i) any environmental planning instrument	Refer below (Considerations under relevant Environmental Planning Instruments (EPIs))
	ii) any development control plan	Under the provisions of Section 2.10 of the Planning Systems SEPP development control plans do not apply to SSD.
	iii) (any planning agreement that has been entered into under section 7.4, or any draft planning agreement that a developer has offered to enter into under section 7.4	No planning agreement exists for the project.
	iv) the regulations (to the extent that they prescribe matters for the purposes of this paragraph)	Refer Section 1.10, Table 1.4 of this EIS.
	b) the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality	Assessment of the key environmental and social impacts relating to the project are provided in Chapters 7-21 of this EIS, and the corresponding technical studies. Overall, it is considered that the project is unlikely to have significant adverse impacts on the natural and built environment and there would be socio-economic benefits associated with the ongoing use of the quarry.
	c) the suitability of the site for the development	As detailed in Section 5.3, the quarry is zoned RU2 – Rural Landscape pursuant PSLEP 2013 and Extractive industries are permissible with consent in the RU2 zone.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
		As detailed above, the project would enable the continued operation of the existing quarry and the provision of a high demand sand resource to the building and construction industry, maximising the re-use of existing plant and infrastructure at the site and with minimal environmental impacts. As demonstrated in this EIS, the project would meet relevant government air (refer Chapter 11, Appendix I) and noise (refer Chapter 12, Appendix J) criteria at all nearby residences and the local road network has adequate capacity to accommodate the predicted project traffic. For these reasons, the site is considered suitable for the project.
	d) any submissions made in accordance with this Act or the regulations	This EIS would be placed on exhibition by DPE for a minimum period of 28 days and submissions would be considered during the assessment of the project.
	e) the public interest	This EIS has been prepared on the basis of detailed investigations aimed at defining the current social, biophysical and economic environment. Detailed assessment undertaken by appropriate technical specialists demonstrates that, on balance, the project is unlikely to have significant impact on the receiving environment and would provide significant socio-economic benefits. For these reasons the project is considered to be in the public interest.
Considerations under relevant Environmental Planning Instruments (EPIs)		
State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP)	Chapter 2 Coastal management 2.10 Development on land within the coastal environment area 2. Development consent must not be granted to development on land that is within the coastal environment area unless the consent authority has considered whether the proposed development is likely to cause an adverse impact on the following— a) the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment, b) coastal environmental values and natural coastal processes, c) the water quality of the marine estate (within the meaning of the Marine Estate Management Act 2014), in particular, the cumulative impacts of the	The aim of Chapter 2 Coastal management is to promote an integrated and co-ordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the CM Act. A review of the SEPP mapping indicates the project is adjacent to a coastal environment area in Stockton Bight and Chapter 2 is not directly applicable to the project. However, indirect impacts on the adjacent coastal environment have been considered in the coastal assessment (refer Chapter 9, Appendix G) accompanying this EIS. The project design has responded to the attributes of the site, including biophysical, social and cultural values. As set out in the environmental assessment chapters (Chapters 7-21 of this EIS), the project would not adversely impact other attributes listed in Clause 2.10 of Chapter 2 of the Resilience and Hazards SEPP.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
	proposed development on any of the sensitive coastal lakes identified in Schedule 1, d) marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms, e) existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability, f) Aboriginal cultural heritage, practices and places, g) the use of the surf zone. 3. Development consent must not be granted to development on land to which this section applies unless the consent authority is satisfied that— a) the development is designed, sited and will be managed to avoid an adverse impact referred to in subsection (1), or b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or c) if that impact cannot be minimised—the development will be managed to mitigate that impact.	
	Chapter 3 Hazardous and offensive	Chapter 3 Hazardous and offensive, requires the consent authority to consider whether a development proposal is a potentially hazardous industry or a potentially offensive industry. As detailed in Chapter 19 of this EIS, the project is not classified as hazardous or offensive industry and no further assessment has bene undertaken.
	Chapter 4 Remediation of land	Chapter 4 Remediation of land, aims to provide a state-wide planning approach to the remediation of contaminated land and to reduce the risk of harm to human health and the environment by consideration of contaminated land as part of the planning process. Under Chapter 4, a consent authority must not consent to the carrying out of development on land unless it has considered potential contamination issues.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
		Notwithstanding, as considered under the CLM Act (refer Table 5.2 of this EIS), there is no known contamination on the site and no duty to report identified contamination to the EPA under Section 60 (3) of the CLM Act. If previously unidentified contaminated land is identified during construction or operation of the project, the requirements of Chapter 4 would be complied with.
Planning Systems SEPP	2.6 Declaration of State significant development	The project is declared to be SSD (refer Section 5.1 of this EIS).
State Environmental Planning Policy (Resources and Energy) 2021 (Resources SEPP)	Part 2.3 Development applications—matters for consideration	The project is permissible with consent under PSLEP 2013 and does not rely on the provisions of the Resources SEPP to enable the making of an application. Notwithstanding, the Resources SEPP contains matters for consideration that are relevant in the assessment of an application for extractive industries. Part 2.3 (Section 2.17 to 2.23) stipulates matters for consideration by the consent authority before determining an extractive industry (as considered below).
	2.17 Compatibility of proposed mine, petroleum production or extractive industry with other land uses	Section 2.17 requires consent authorities to consider existing land uses, and whether the development may significantly impact upon, or be incompatible with them. Land uses near the quarry (refer Section 1.3 of this EIS) include extractive industry, rural residential, tourism and environmental conservation. Potential amenity impacts on these land uses, including in relation to air, noise and traffic, have been assessed in this EIS, demonstrating that the project would not have a significant impact on existing and approved land uses around the quarry.
	2.18 Consideration of voluntary land acquisition and mitigation policy	Section 2.18 requires consent authorities to consider applicable provisions of the Voluntary Land Acquisition and Mitigation Policy (VLAMP) before determining a development application. Noise (Chapter 12) and air emissions (Chapter 11) generated by the project are not predicted to exceed the relevant government assessment criteria at nearby residences, and therefore further consideration of the VLAMP is not required.
	2.19 Compatibility of proposed development with mining, petroleum or extractive industry	Section 2.19 relates to matters a consent authority must take into consideration when determining applications for development that is: • near an existing mine, petroleum production facility or extractive industry; • identified on a map as being the location of State or regionally significant resources of minerals, petroleum or extractive materials; or • identified by an environmental planning instrument as being the location of significant resources of minerals, petroleum or extractive materials. The intent of Section 2.19 is to protect operating extractive industries from incompatible land uses, which may be approved by relevant consent authorities. Land surrounding the site is used for extractive industry, rural, residential and environmental conservation.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
		There are no mining, petroleum production or extractive industries near the quarry, noting that the nearby Fullerton Cove Quarry ceased operations in June 2020, with the majority of extractive industry operations centred around Bobs Farm and Salt Ash further to the north. The independent continued operation of the quarry would not impact these extractive industries, nor impede access to geological resources extracted at these operations. The project is therefore compatible with other extractive industries in the region.
	2.20 Natural resource management and environmental management	Section 2.20 requires that before granting consent for development for the purposes of extractive industry, the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring that the development is undertaken in an environmentally responsible manner, including conditions to ensure the following: • that impacts on significant water resources, including surface and groundwater resources, are avoided, or are minimised to the greatest extent practicable; • that impacts on threatened species and biodiversity, are avoided, or are minimised to the greatest extent practicable; and • that greenhouse gas emissions are minimised to the greatest extent practicable. The project is for dry sand extraction and has been designed to avoid impacts from extraction on the water table, by maintaining a minimum 0.7 m buffer to the water table. Therefore, no significant impact on groundwater or surface water resources are anticipated, with the project having a significantly reduced water take from the current dredge application. A greenhouse gas assessment has been prepared (refer Chapter 11, Appendix I of this EIS) and has identified management and mitigation measures to minimise greenhouse gas emissions.
	2.21 Resource recovery	Section 2.21 requires the consent authority to consider the efficiency of resource recovery. As outlined in Section 3.2.3 of this EIS, the project has been designed to maximise the efficiency of extracting the sand resource from the site and the staging has been designed to mirror the current dredge application to allow for the transition into dredging should the dredge application be approved and dredging commences.
	2.22 Transport	Section 2.22 requires the consent authority to consider the implications of transporting materials on public roads. The project involves the transport of up to 750,000 tpa (until 2028) of materials along Nelson Bay Road and the wider public road network. The TTIA (refer Chapter 13, Appendix K of this EIS) demonstrates that the project would not have a significant impact on the local road network.
	2.23 Rehabilitation	Section 2.23 requires that the consent authority must consider whether or not the consent should be issued subject to conditions aimed at ensuring the rehabilitation of land that would be affected by the development. The project would be rehabilitated as described in Chapter 18 of this EIS.

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
State Environmental Planning Policy (Biodiversity and Conservation) 2021 (BCD SEPP)	Chapter 3 Koala habitat and protection and Schedule 1	Chapter 3 of the BCD SEPP aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline: (a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and (b) by encouraging the identification of areas of core koala habitat, and (c) by encouraging the inclusion of areas of core koala habitat in environment protection zones. Chapter 3 applies where a LGA is listed in Schedule 1 of the BCD SEPP and where a development has an area of more than 1 ha. The project site exceeds 1 ha and is located within the Port Stephens LGA, which is listed in Schedule 1. Under Chapter 3, 'potential Koala habitat' is defined as: *'areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component'.* As considered further as part of the project biodiversity development assessment report (refer Chapter 10, Appendix H of this EIS), of the tree species listed in Schedule 2, only *Eucalyptus robusta* was recorded within and near the project site. *Eucalyptus robusta* comprised less than 15 per cent of the total number of trees present in the project site, and therefore, the habitat present is not regarded as 'potential Koala habitat'. 'Core Koala habitat' is defined in the Chapter 3 of the BDC SEPP as: *'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'.* The Koala was not recorded on the project site during the surveys undertaken as part of the BDAR and there are no historical records of the species in the project site.
State Environmental Planning Policy (Transport and Infrastructure) 2021 (Infrastructure SEPP)	Schedule 3 – Traffic generating development	The Infrastructure SEPP provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. Under the Infrastructure SEPP, DPE is required to formally forward development applications to TfNSW for certain developments and consider any representations made by TfNSW. The project does not trigger traffic generating development under Schedule 3 of the SEPP (being more than 90 m from a classified road (Nelson Bay Road) and not resulting in more than 200 vehicle movements per hour). Notwithstanding, TfNSW has been consulted by DPE for input to the SEARs and further consulted with during preparation of this EIS. The TfNSW requirements are addressed in the TTIA (Chapter 13 of this EIS).
	Table 5.9 – Consideration of land use zone objectives:	RU2 zone objective:

Table 5.3 Matters for consideration

Statutory reference	Requirement	Consideration
Port Stephens Local Environmental Plan 2013 (PSLEP 2013)		To encourage sustainable primary industry production by maintaining and enhancing the natural resource base. Response: Extractive industries are a form of primary industry. The project seeks to achieve sustainable management through a comprehensive suite of environmental management and mitigation measures to ensure potential adverse impacts (i.e. noise, dust, erosion, water quality and traffic) are minimised.
		RE1 zone objective: To maintain the rural landscape character of the land. Response: Chapter 21 considers the potential for visual impacts of the project and identifies that, due to the relatively low-lying area of the project site and given the existing vegetation that obscures it, the project would be largely obscured from the view of the public. As such, the landscape character of the site when viewed from adjacent public or private land would not be visibly altered. Furthermore, the proposed rehabilitation strategy (refer Chapter 18, Appendix R of this EIS) would ensure that the final landform is compatible with the landscape character.
		RE1 zone objective: To provide for a range of compatible land uses, including extensive agriculture. Response: The proposed extractive industry is considered compatible with the surrounding land uses, which include a mix of extractive industry, rural residential, tourism and environmental conservation.
	Development provisions (general)	PSLEP 2013 includes general development provisions, including in relation to heritage conservation, bushfire hazard reduction, ASS, flood planning, drinking water catchments, wetlands, essential services and public infrastructure, which have been considered in this EIS and technical studies where relevant.

5.5 Surrender of consent

Section 4.63 of the EP&A Act allows for the surrender of a development consent. As detailed in Section 1.7 of this EIS, the project is proposed as an interim solution, to allow access to the dry sand resource, whilst issues with the current dredge application are being resolved.

Should the project be approved prior to the current dredge application, then it is envisaged that extraction of the dry sand resource would occur until such time as the current dredge application is commenced, with dry sand transitioning to dredging under the new approval. As detailed in Chapter 3, the staging of the project aligns with the staging in the current dredge application to allow for this. Should this situation eventuate, then Boral would agree to surrender consent for the project, the requirement of which could be included as a condition of consent of the dredge application.

6 Impact assessment

This chapter outlines the impact assessment approach adopted in this EIS to address the requirements of the SEARs.

As detailed in Section 1.7, the project proposes only dry sand extraction from above the water table. All other components of the project, in terms of the rate of extraction and dispatch, and the extraction and disturbance area, remain the same as originally proposed for the current dredge application. Potential issues associated with the project are therefore well understood, and this approach has enabled the majority of the technical studies accompanying the current dredge application to be updated for the project.

The following technical studies have been updated/prepared to accompany this EIS:

- Groundwater assessment (Chapter 7, Appendix E);
- Acid sulfate soils advice (Chapter 8, Appendix F);
- Coastal assessment (Chapter 9, Appendix G);
- Biodiversity development assessment report (Chapter 10, Appendix H);
- Air quality and greenhouse gas assessment (Chapter 11, Appendix I);
- Noise impact assessment (Chapter 12, Appendix J);
- Traffic and transport assessment (Chapter 13, Appendix K);
- Social impact assessment (Chapter 14, Appendix L);
- Aboriginal cultural heritage assessment report (Chapter 15, Appendix M);
- Surface water assessment (Chapter 16, Appendix N);
- Economic assessment (Chapter 17, Appendix O);
- Rehabilitation strategy (Section 18, Appendix P);
- Bushfire assessment report (Chapter 19, Appendix Q); and
- Biodiversity due diligence (Section 3.2.3, Appendix R).

Commensurate with the projected levels of impacts of other environmental aspects, including in relation to visual, historic heritage, waste and hazards have been assessed via qualitative desktop assessments, addressed within the specific subsequent chapters of this EIS.

The potential for cumulative impacts was identified for the following matters and has been considered further in this EIS and in the accompanying technical studies:

- biodiversity (Section 10.2.3);
- air quality (Section 11.1.1);
- noise (Section 12.2.4 and 12.2.7);
- traffic (Section 13.3.5);
- hazards (Section 19.1.7); and
- waste (Section 20.2.3).

7 Groundwater

A groundwater assessment, prepared by Umwelt Australia Pty Ltd (Umwelt) (Umwelt, 2023) to accompany this EIS, is provided in Appendix E.

Table 7.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarise the outcomes of the groundwater assessment.

Table 7.1 SEARs (groundwater)

Relevant SEARs	Section EIS addressed
DPE – Planning (water)	
A conceptual groundwater model that assesses the potential groundwater hazards and impacts associated with the development in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012) having regard to the NSW Aquifer Interference Policy (2012)	Section 7.1.4
A detailed assessment of any need to maintain an adequate buffer between excavations and the highest predicted or recorded regional groundwater table	Section 7.2.1
An assessment of the likely impacts (including cumulative impacts) on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	Appendix E, Section 6.0
An assessment of the likely impacts (including cumulative impacts) of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users. This assessment must include a strategy for managing potential impacts during the life of the development and identify any conservation outcomes	Appendix E, Section 6.0
An assessment of the potential water quality hazards surrounding the site including acidity, metals, salinity and contaminants including poly-fluoroalkyl substances (PFAS). This assessment must include: • measures proposed to reduce or manage the hazards and potential • interactions on the development and surrounding water users	Appendix E, Section 4.6 and Section 6.0
DPE – BCD (water and soils)	
The EIS must map the following features relevant to water and soils including: • Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) • Groundwater • Groundwater dependent ecosystems	Appendix E, Section 4.2 and Section 4.7.2
The EIS must describe background conditions for any water resource likely to be affected by the development, including existing surface and groundwater	Appendix E, Section 4.0
DPE – Water (water take and licensing)	
Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent	Sand extraction would occur above the water table. Project Water Access Licence requirements are considered in Section 16.1.3 of this EIS.

Table 7.1 SEARs (groundwater)

Relevant SEARs	Section EIS addressed
A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions	Appendix E, Section 4.3 and Section 4.8
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts	Appendix E, Section 6.0
Proposed surface and groundwater monitoring activities and methodologies	Section 7.3 Appendix E, Section 6.2

7.1 Assessment methodology

To address the requirements of the SEARs, the groundwater assessment scope of works included:

- review and consolidation of the site groundwater monitoring network and available groundwater data;
- review of site specific and publicly available data to characterise the existing environment, including the climatic conditions and surface water, groundwater regime and groundwater users;
- statistical analysis of site baseline groundwater level data and climatic trends to inform the assessment of water table levels within the project site;
- presentation of groundwater level trends and a groundwater levels relative to the project;
- preparation of a conceptual ecohydrological model, including cross sections to present the groundwater processes and project design;
- a qualitative risk assessment to identify and discuss potential impacts to groundwater resources and users, relevant to the project design and site characterisation; and
- recommendations for ongoing monitoring and mitigation measures to address potential risks.

7.1.1 Groundwater monitoring network

As shown in Figure 2.8, the site groundwater monitoring network comprises 24 bores, of which 11 are currently included in the site monitoring program. Groundwater levels have been monitored with data from 1997. A summary of the monitoring bore details is presented in Table 7.2.

Table 7.2 Monitoring bore details (Source: Umwelt)

ID	Easting	Northing	Ground elevation (mAHD)	Year installed	Screen top (mbgl)[2]	Screen bottom (mbgl)[2]	Comments
GW1[1]	391407	6364885	9.60	1997	6.2	6.9	Logger installed – not used
GW2[1]	392029	6365103	2.67	1997	2.9	3.6	Logger installed – data used
GW3[1]	391885	6364615	3.02	1997	3.5	4.2	Logger installed – data used
GW41	390446	6364167	3.24	1997	4.1	4.8	Logger installed – data used
MW X1	390115	6364901	6.10	2017	12.2	9.2	Logger installed – data used

Table 7.2 Monitoring bore details (Source: Umwelt)

ID	Easting	Northing	Ground elevation (mAHD)	Year installed	Screen top (mbgl)[2]	Screen bottom (mbgl)[2]	Comments
MW X2	390924	6365311	5.74	2017	n/a	n/a	Logger installed – data used
MW X3 Deep	390480	6364605	6.43	2017	26.0	5.3	Logger installed – data used
MW X3 Shallow	390480	6364604	6.39	2017	11.4	8.4	Logger installed – data used
MW X4 Deep	391283	6365241	9.90	2017	24.5	8.7	Logger installed – data used
MW X4 Shallow	391284	6365241	10.21	2017	12.1	8.9	Logger installed – data used
MW X5	391435	6364461	3.82	2017	24.2	21.2	Logger installed – data used
MW X6	391826	6364647	3.15	2017	27.6	24.6	Logger installed – data used
MW X7	391159	6365084	4.61	2017	-	11.24	-
MW1[1]	391024	6364177	4.20	2013	19.0	25.0	Dipper data used
MW2[1]	391295	6363895	9.86	2013	19.0	25.0	Dipper data used
MW3	390480	6364598	19.5	2013	2.0	8.0	Little data – uncertain location
MW4	392243	6364808	9.5	2013	2.0	8.0	Little data – uncertain location
MW5[1]	391588	6364385	4.98	2013	2.0	8.0	Reliable dipper data from 2013
MW6[1]	391788	6364541	3.82	2013	2.0	8.0	Reliable dipper data from 2013
MW7[1]	392042	6364701	4.05	2013	2.0	8.0	Reliable dipper data from 2013
MW8[1]	392242	6364807	3.27	2013	19.0	25.0	Reliable dipper data from 2013
MW9[1]	392413	6364895	5.90	2013	19.0	25.0	Reliable dipper data from 2013
MW10	391352	6363951	-	2013	19.0	25.0	Little data
MW11	n/a	n/a	-	n/a	n/a	n/a	Little data

Note [1]: *bore currently in the site groundwater monitoring program*
Note [2]: metres below ground level

7.1.2 Groundwater database

A consolidated site groundwater level database was developed to inform the groundwater assessment. The original groundwater level data was provided in various forms, including:

- an Excel file of depths to water level below top of casing (mbTOC) for the water level loggers – data recorded at one-hour intervals;
- a number of Excel files provided by Boral and VGT (previous sub-contractor) of the monthly dipmeter monitoring - some as depth to groundwater table below reference point (mbTOC) and some as groundwater elevation referenced to m AHD, or both; and
- monthly reports submitted to Boral by VGT of the groundwater levels taken by dipmeter.

A quality control (QC) check was conducted on the various data, and where identified, spurious data removed. Part of the QC process involved determining whether the data is reported as mbTOC or m AHD and in the former case whether the elevation of the top of casing is reliable.

7.1.3 Groundwater elevation and flow data

The available site groundwater level data was analysed in two ways:

- to assist with the site hydrogeological conceptualisation, groundwater flow directions and determine groundwater elevation highs and lows; and
- to determine a suitable elevation below which the extraction activities should not lower the ground level.

The graphs presented in Appendix B of the groundwater assessment (refer Appendix E of this EIS) show the change in groundwater levels over time, compared to rainfall. The graphs highlight groundwater level response to rainfall events. The hydrographs show that the groundwater levels were relatively low prior to 2021 and there is a general increase occurring in late 2020. The response to rainfall is rapid indicating rapid infiltration. Seasonally the groundwater levels are higher in the summer months corresponding to the higher rainfall in summer.

To spatially present groundwater conditions, two points in time were taken, gridded and contoured. The levels do not represent the lowest and highest recorded levels, but the lowest and highest levels for which reliable data is available for most bores (16 January 2020 for the low point and 24 March 2021 for the high point). It was found that groundwater elevation ranges from 0.9 m AHD to 1.1 m AHD for the low level and 2.9 m AHD to 3.1 m AHD for the high level. Figure 7.1 below shows the contour mapping for the high level groundwater range.

The contour mapping indicates that the local groundwater flow direction is from south-east to north-west, away from the coast and towards Fullerton Cove and Tilligerry Creek. It is noted that the gradient for both low and high levels is approximately 0.2 m per 800 m in the area of the planned excavation. It is interpreted that this gradient is very localised and that the main regional groundwater flow direction is towards the coast.

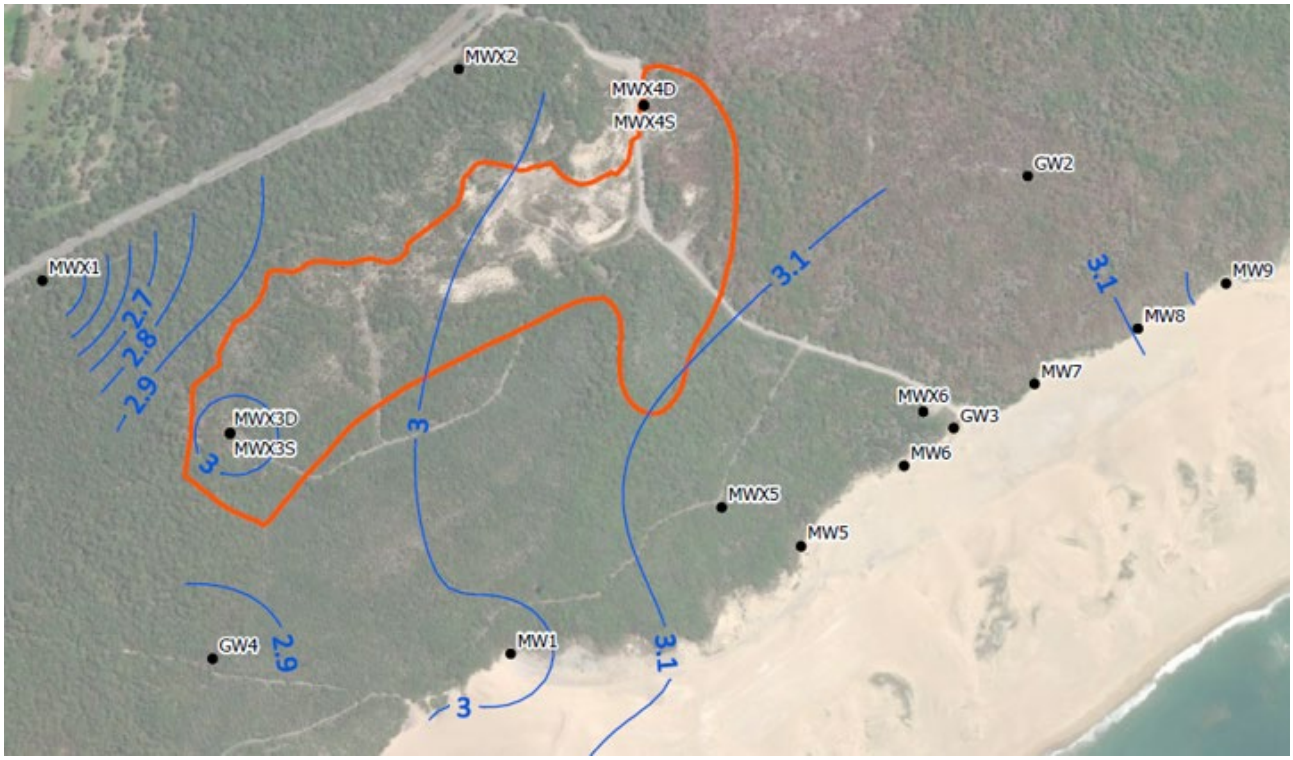

Figure 7.1 Groundwater elevation contours at high level (Source: Umwelt)

7.1.4 Conceptual ecohydrological model

A conceptual ecohydrological model (CEM) has been developed to describe the aquifer and groundwater conditions at the project site and identify possible impacts on receptors. The CEM has been developed from long term monitoring of groundwater levels and chemistry, along with borehole logs. Based on available information, the following was identified for the project site:

- There is a single hydrogeological stratigraphical unit (HSU) at the project site, which is composed of porous, unconsolidated sand to depth of at least 30 m. The porosity of the sand is expected to be high. Therefore, the groundwater is present in and transmitted through the pores between the sand grains.
- Groundwater elevations range from 0.5 m AHD to 3.5 m AHD. The elevation contours suggest that the groundwater flows from the south-east to the north-west away from the coast and towards Fullerton Cove. It is interpreted that the groundwater gradient is reversed from that expected by preferential rainfall recharge along the unvegetated belt close to the coast. It is thought that the main groundwater flow direction will be towards the sea. If the main groundwater flow direction was truly from the coast to inland, then it would be expected that the groundwater salinity would be much higher than recorded.
- The main recharge mechanism is expected to be from direct rainfall infiltration, which is thought to be higher where there is a lack of vegetation cover.
- No surface water bodies are present within the extraction area. Therefore, there is no groundwater interaction with surface water.
- The groundwater is recorded as fresh in all the monitoring bores at site. There is little seasonal or long-term variation in groundwater quality/chemistry.
- Hydraulic conductivity tests (slug tests) were carried out (in both deep and shallow bores). The analyses provide a high hydraulic conductivity value that is in keeping with the published literature.

Schematic representations (cross sections) of the CEM are presented in Figure 4.7 to Figure 4.9 of the groundwater assessment (refer Appendix E of this EIS). The figures show the proposed extraction area is maintained above the water table.

7.2 Impact assessment

7.2.1 Maximum operating depth

Correspondence received from DPE – Water during the assessment of the current dredge application raised concerns about the dredge project in its current form, recommending that:

> *'…the project be modified to limit extraction to a height that maintains at least a 0.7 metre buffer above the groundwater table with the final landform to be a minimum of 1 metre above the groundwater table consistent with other approved projects of the area'* (DPE, 2021).

These extraction height limits have been applied to the project to ensure that an adequate buffer to the water table is maintained.

Following the QC process carried out on the groundwater level data, box and whiskers plots were created. The 95th and 99th percentiles were also calculated. The results are presented in Table 7.3 and the plot in Figure 7.2.

Table 7.3 Statistical results of the groundwater elevation data in mAHD (Source: Umwelt)

	Min	Max	Mean	StdDev	Median	Q1	Q3	95th %ile	99th %ile
MW1	0.85	3.61	1.80	0.46	1.76	1.46	2.04	2.63	2.97
MW2	1.14	3.55	1.72	0.47	1.61	1.41	1.80	2.75	3.25
MW3	1.12	3.54	1.89	0.51	1.80	1.66	2.03	2.46	3.31

Table 7.3 Statistical results of the groundwater elevation data in mAHD (Source: Umwelt)

	Min	Max	Mean	StdDev	Median	Q1	Q3	95th %ile	99th %ile
MW4	1.17	3.38	1.82	0.48	1.73	1.57	1.90	2.35	3.18
MW5	1.17	3.58	1.82	0.40	1.75	1.52	2.02	2.50	3.10
MW6	0.76	3.17	1.80	0.49	1.76	1.44	2.13	2.68	3.05
MW7	1.08	3.63	1.88	0.41	1.80	1.58	2.13	2.58	3.06
MW8	1.08	3.33	1.86	0.38	1.80	1.58	2.10	2.56	2.85
MW9	1.20	2.98	1.86	0.37	1.82	1.56	2.11	2.55	2.86
MW10	1.24	2.47	1.90	0.31	1.91	1.69	2.04	2.39	2.45
MW11	1.60	2.10	1.93	0.29	2.10	1.85	2.10	2.10	2.10
GW1	1.26	3.09	2.53	0.35	2.57	2.41	2.74	3.03	3.08
GW2	1.15	3.09	1.92	0.51	1.85	1.47	2.33	2.92	3.03
GW3	1.12	3.15	1.84	0.44	1.76	1.50	2.18	2.66	2.90
GW4	1.05	3.01	1.70	0.44	1.61	1.35	1.98	2.63	2.89
MWX1	0.61	2.34	1.33	0.39	1.32	1.00	1.62	2.00	2.23
MWX2	0.89	2.95	1.70	0.52	1.66	1.24	2.09	2.69	2.86
MWX3D	0.94	3.01	1.66	0.49	1.60	1.24	1.98	2.66	2.89
MWX3S	0.95	3.01	1.63	0.46	1.57	1.22	1.94	2.56	2.90
MWX4D	0.99	3.08	1.80	0.54	1.76	1.32	2.18	2.82	3.00
MWX4S	1.00	3.09	1.83	0.52	1.79	1.36	2.19	2.77	3.00
MWX5	1.14	3.14	1.82	0.46	1.71	1.44	2.15	2.72	2.92
MWX6	1.16	3.20	1.89	0.46	1.81	1.51	2.24	2.74	2.97

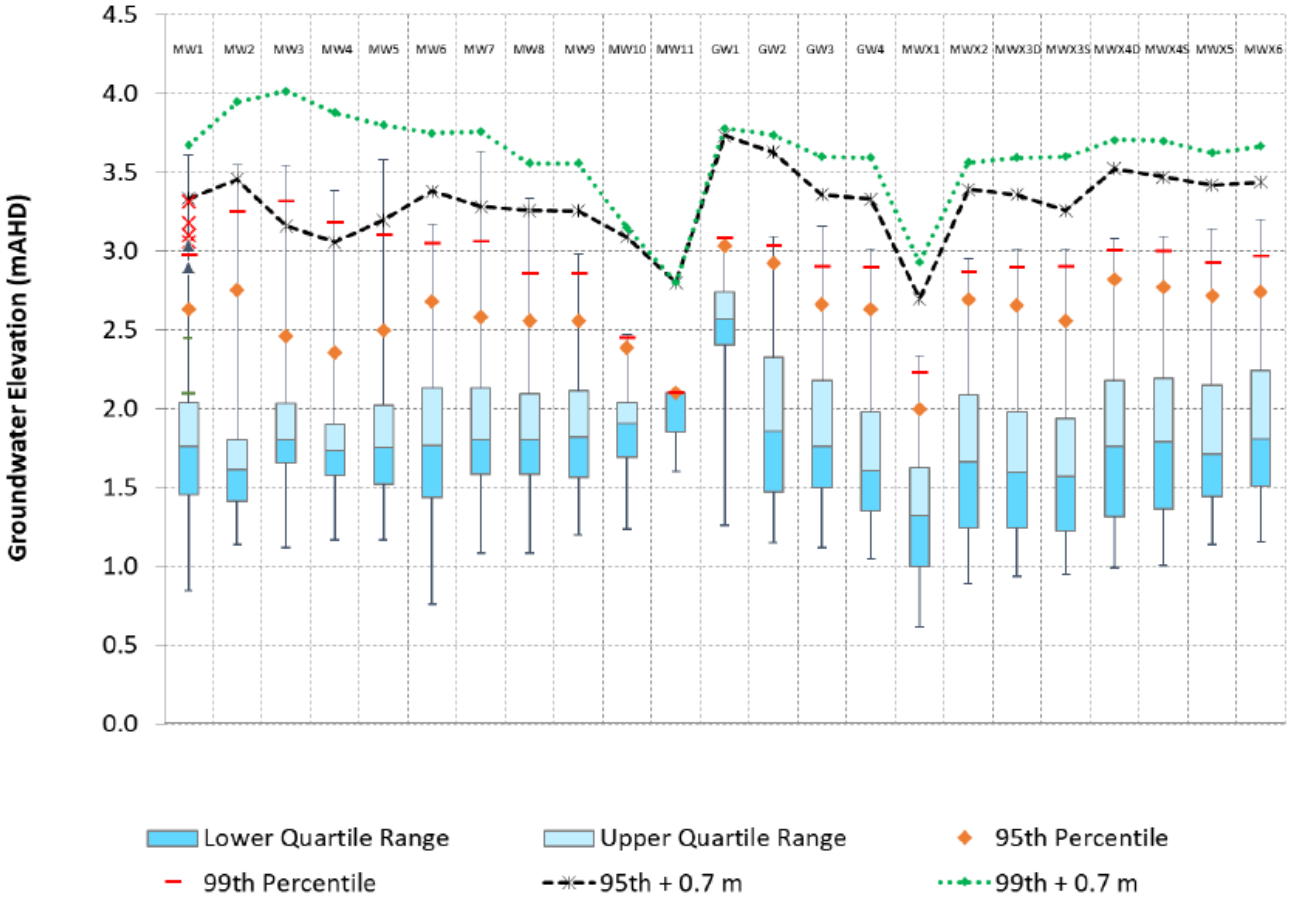

Figure 7.2 Box and whiskers plot for groundwater elevation (Source: Umwelt)

Figure 7.2 boxplots present the maximum and minimum by the whiskers, the median value (50th percentile) and the upper and lower quartiles that represent the 25th and 75th percentiles and are annotated with the 95th and 99th percentiles. Outliers are also noted as crosses, which represent values over three times the standard deviation from the mean.

The 95th and 99th percentile groundwater elevation data were gridded and contoured. Based on a comparison of these contours and the maximum contours displayed in Figure 7.1, the 99th percentile groundwater elevation contours were used as the basis for determining the extent of the lowest excavation level.

A value of 0.7 m was added onto the 95th and 99th percentile groundwater levels. As demonstrated in Figure 7.2 the 99th percentile plus 0.7 m exceeds the maximum observed water levels for all site bores. Therefore, it is proposed that the depth of excavation be limited to the 99th percentile plus 0.7 m to ensure no interaction with the water table. The spatial distribution of maximum operating depth is presented in Figure 7.3 below. These contours range from 3.5 m AHD to 3.65 m AHD being lower to the west and higher to the east.

To maintain a minimum 0.7 m buffer to the water table, and to ensure that the project does not intercept groundwater, extraction would not occur below 3.7 m AHD.

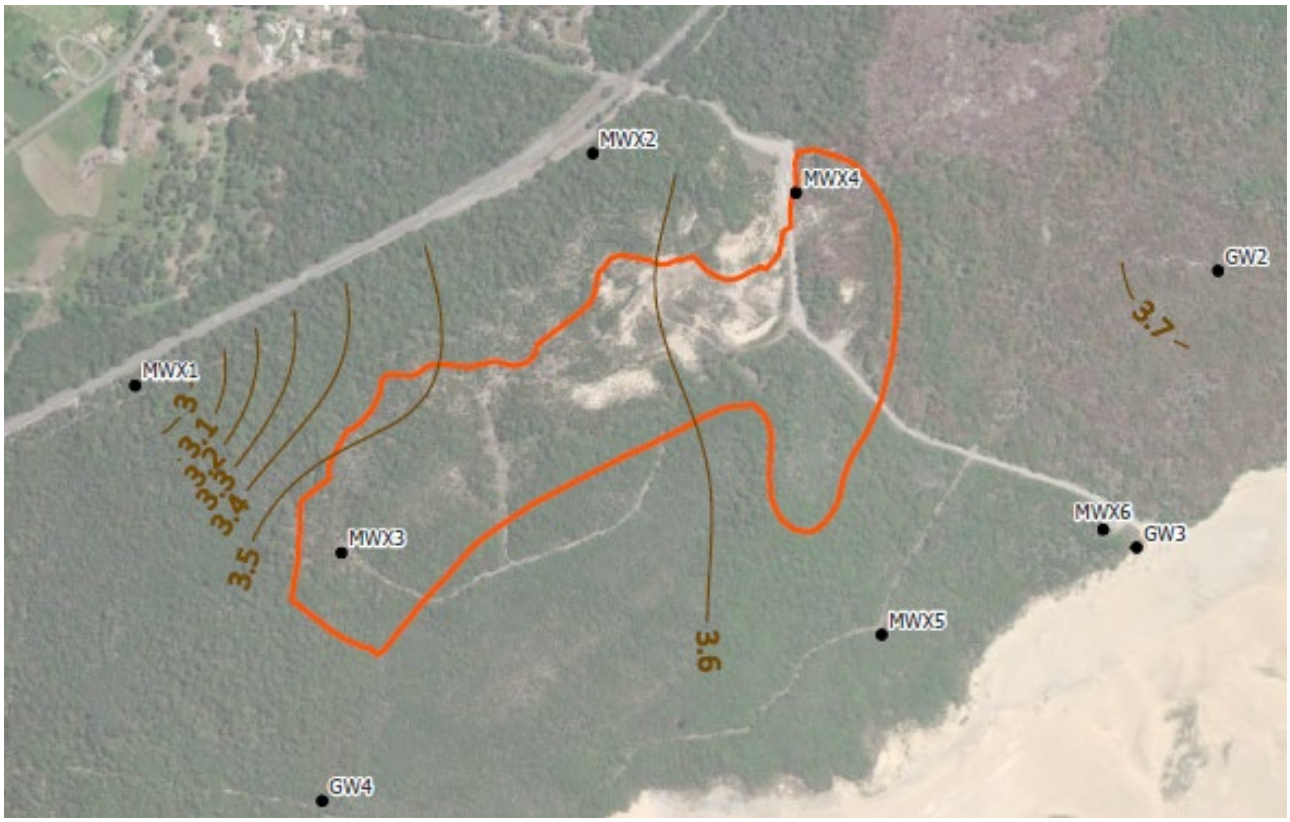

Figure 7.3 Maximum excavation contours in m AHD (Source: Umwelt)

7.2.2 Minimal impact considerations

Groundwater within the project site is regulated by the Stockton Groundwater Source (SGS) under the North Coast Coastal Sands Groundwater Sources 2016 WSP and is classified as 'Highly Productive' under NSW Aquifer Interference Policy (AIP). The AIP assessment framework requires that predicted impacts are less than the Level 1 minimal impact considerations to be acceptable. As outlined in Table 7.4 the predicted impacts are less than the Level 1 minimal impact considerations.

Table 7.4 Noise monitoring locations

Level 1 minimal impact considerations	Assessment
Water Table: Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	Level 1 – Acceptable. The proposed extraction is planned to be maintained above the maximum water table level and would not interfere with surface catchment extent or impede throughflow. Therefore, changes to the local water table at site or in the immediate surrounds during operations or post closure are considered unlikely. The project is considered to adequately satisfy the water pressure minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.
Water Pressure: A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Level 1 – Acceptable. The proposed extraction is planned to be maintained above the maximum water table level and would not interfere with surface catchment extent or impede throughflow. Therefore, changes to the local water table at the project site or in the immediate surrounds during operations or post closure are considered unlikely.

Table 7.4 Noise monitoring locations

Level 1 minimal impact considerations	Assessment
	The project is considered to adequately satisfy the water pressure minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.
Water Quality: Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Level 1 – Acceptable. The project is considered to adequately satisfy the water quality minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.

7.3 Monitoring and mitigation measures

The following groundwater monitoring and mitigation measures shall be put in place to manage the potential risk to groundwater:

Groundwater monitoring network:

- Ongoing groundwater monitoring shall be conducted at the site in accordance with the existing groundwater monitoring program.
- Additional monitoring locations shall be installed to provide additional baseline data to characterise the groundwater regime and for ongoing monitoring over the life of the project, given that several of the existing bores are within the disturbance footprint (Note: the proposed groundwater monitoring network is presented in Table 7.1 and additional monitoring locations are shown in Figure 7-1 of the groundwater assessment (refer Appendix E of this EIS)).

Groundwater monitoring network:

- Groundwater level monitoring shall be conducted at the frequency outline in Table 7.1 of the groundwater assessment (refer Appendix E of this EIS).
- Logger data shall be recorded at hourly intervals with data downloaded on a monthly basis at the same time as the water levels are dipped.
- Groundwater quality monitoring shall be conducted at the frequency outlined in Table 7.1 of the groundwater assessment (refer Appendix E of this EIS).
- The existing site groundwater management plan shall be updated to reflect the updated monitoring locations and approach.
- Groundwater monitoring shall be undertaken in accordance with industry standards, with data stored within a central database and routine QA/QC conducted to verify data input.
- Groundwater sampling shall include collection of field parameters for pH, temperature and EC, as well as observations on the colour and odour of the sample noted.
- Samples shall be collected in laboratory supplied bottles for analysis.
- Field filtering for metals analysis shall be undertaken. Samples shall be stored in a chilled esky and submitted to a National Association of Testing Authorities (NATA) accredited laboratory with a chain of custody (CoC) form for water quality analysis.
- The samples shall be analysed for:
    - turbidity;
    - total dissolved solids (TDS);

- chloride and fluoride;
- major ions: sulphate, calcium, potassium, sodium, magnesium, hardness as CaCO3, bicarbonate (HCO3);
- alkalinity;
- nutrients: filtrable phosphorous and nitrate as N;
- total and dissolved metals: aluminium, arsenic, barium, cadmium, chromium, copper, iron, manganese, nickel, lead, selenium, zinc and mercury; and
- PFAS, PFOA.

Groundwater triggers and reporting:

- The groundwater data shall be compared to relevant triggers following each sampling event.
- Trigger levels shall be applied for groundwater levels, pH and EC. Trigger levels are proposed as:
  - 95th percentile of groundwater levels recorded during low rainfall periods (less than 80 mm per month);
  - 95th percentile of groundwater levels recorded during high rainfall periods (more than 80 mm per month);
  - EC based on 95th percentile of baseline groundwater data; and
  - pH based on 5th and 95th percentile of baseline groundwater data.
- The groundwater trends shall be reviewed on an annual basis and reported on in the AEMR.

8 Acid sulfate soils

An acid sulfate soils advice letter, prepared by SAGE Environmental Consulting (SAGE) (SAGE, 2023) to accompany this EIS, is provided in Appendix F.

Table 8.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarise the outcomes of the advice letter.

Table 8.1 SEARs (acid sulfate soils)

Relevant SEARs	Section EIS addressed
EPA (land)	
Identify if the soils in the area of the Proposal are contaminated or are acid forming (i.e. acid sulphate soils) and if so, identify best practice mitigation measures (pollution control) and strategies or remedial and/or disposal actions that will be required/undertaken if applicable in accordance with relevant guidance/standards	Section 8.1.1 – Acid sulfate soils Appendix F, Section 4.6.2 and Section 6.1
DPE – BCD (water and soils)	
The EIS must map the following features relevant to water and soils including: • Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) • Groundwater • Groundwater dependent ecosystems	Appendix F, Figure 7

8.1 Assessment methodology

The acid sulfate soils advice letter was prepared to include the following information:

- a summary of the site setting, including topography, geology, hydrogeology and history;
- a summary of past assessments including information on soil located from the top of the water table and above.
- discussion on acid sulfate soils (ASS)/ potential acid sulfate soils (PASS) risk in relation to the project; and
- conclusion on suitability and recommendations (where required) regarding potential environmental risk involved with the project.

8.1.1 Acid sulfate soils

i General

The term ASS encompasses two types of acid sulfate soils: actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). Actual ASS refers to soils with highly acidic horizons, generating an excess of hydrogen ions beyond the sediment's ability to neutralise the acidity. This results in a soil with potential of hydrogen (pH) of 4 or less during when measured in dry season conditions. PASS refers to soils containing sulfidic material that remains unoxidised and pose an environmental risk. When exposed to air and oxidized, these soils become acidic.

ii Project specific

The project site was considered in the context of the PSLEP 2013 *Acid Sulfate Soils Risk Map – Sheet ASS_004*. The project site is considered low probability for ASS in general. The southern boundary of the project site is mapped low probability between

1–3 m below ground surface (BGS), whilst the remainder and majority of the project site is mapped low probability for ASS, being greater than 3 m BGS.

A summary of information regarding the low probability of ASS in the project site is provided in Table 8.2.

Table 8.2 Summary of ASS in the project site

Low probability of ASS[1]		
ASS MAP class description[1]	The depositional environment has generally not been suitable for ASS formation. ASS, if present, is sporadic and may be buried by windblown sediments.	
Environmental risk[1]	Majority of these landforms are not expected to contain ASS. Land management is generally not affected by ASS. Highly localised occurrences may be found, especially near boundaries with environments with a high probability for ASS (not present within the project site). Environmental risk varies with elevation and depth of disturbance.	
Typical landform types[1]	Wa2 – Aeolian sandplain >2-4m AHD	Wd4 – Aeolian dunes >4m AHD
Depth to sulfidic soil[1]	Between 1–3 m BGS	>3 m BGS
PSLEP 2013 class of land[2]	Class 3 Development consent required for: • Works >1 m BGS. • Works by which the water table is likely to be lowered >1 m BGS.	Class 4 Development consent required for: • Works >2 m BGS. • Works by which the water table is likely to be lowered >2 m BGS.
Soil landscape[3]	Hawks Nest	Boyces Track

Note[1]: Sourced from the Williamtown 1:50 000 Acid Sulfate Soils Map (DLWC, 1997).

Note[2] Sourced from Port Stephens Local Environmental Plan 2013, Part 7 Clause 7.1 – Acid Sulfate Soils.

Note[3] Sourced from eSPADE v2.0 published by the NSW Office of Environment & Heritage (2018)

The occurrence of PASS in the region is linked to the depositional environments of Tilligerry Creek and Fullerton Cove to the north of the site, rather than the Stockton (or Tomago) Sandbeds. Additionally, there is no evident risk of oxidation of mineral sands containing heavy minerals such as rutile, zircon, ilmenite, and monazite, which are associated with specific portions of the Tomago Sandbeds. These sandbeds are located well to the north, approximately 10 km inland, forming part of the Rutile and Zirconium Mine (RZM).

iii Past assessments

The *Acid Sulfate Soil Impact Assessment, Stockton Sand Quarry, Cox's Lane, Fullerton Cove, NSW* (EES, 2019b) prepared to accompany the EIS for the current dredge application was reviewed, with the following findings:

- Desktop review of both regional and state government investigations and mapping confirmed that PASS risk is low in the proposed extraction area.
- Ground conditions assessed in the proposed extraction area typically comprised medium-grained sand that extend past the base of the dredging area, to the final depth of investigation (18 to 24 m BGS). Sediments such as estuarine muds, clays or silts were not typically observed.
- Based on the results of the investigation, which collected 632 samples from 11 borehole locations over two campaigns (March 2018 and April 2021), two samples (0.3%) had a pH field oxidation (pHFOX) <2.5, and 32 samples (5%) had a pHFOX ≤3.0, while the minimum pH field (pHF) was 4.5 and the normally distributed mean pHF was 6.6.
- All metal concentrations in 22 samples analysed were within background ranges. Iron concentrations ranged between 90 and 8,940 milligrams to kilograms (mg/kg) (mean and median of 981 and 565 mg/kg respectively), which is significantly lower than the range of 900-9,000 mg/kg with a mean of 3,550 mg/kg reported for the RZM sediments (after Thom and Jones 1999).

- All soils analysed were classified as “not acid sulfate soils” (NASS) or “no risk – non-reactive” (NRNR).
    - Given the above, it is reasonable to extrapolate that a natural buffering capacity exists across the project site due to the presence of shell grit ($CaCO_3$) within sand deposits.
    - It is also reasonable to conclude, based on the data collected from the incubation assessment in particular, that the natural buffering capacity measured in the laboratory can be replicated at field-scale and therefore can be relied upon.

8.2 Impacts

Through the completion of desktop research, field testing, and laboratory analysis, it was determined that there is a low risk of Actual ASS occurring onsite within the sands above the water table (noting, that in Section 7.2.1 of this EIS, the maximum operating depth has been confirmed to be 3.7 m AHD, being 0.7m above the 99th percentile groundwater level). Additionally, since the sands above water table have already been exposed to air and are not submerged, it is reasonable to conclude that no PASS are capable of existing.

It is reasonably concluded that the proposed dry sand extraction from above the water table has very low potential to impact the environment with respect to ASS or PASS. The dry sand extraction activities are not expected to inhibit progression of the current dredging application; rather, it should aid in the progression of the submission due to more information/data being accessible for collection.

9 Coastal processes

9.1 Introduction

A coastal processes, hazards and impacts report, prepared by Professor Andrew Short of Coastal Studies (Coastal Studies, 2023) to accompany this EIS, is provided in Appendix G.

Table 9.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarise the outcomes of the report.

Table 9.1 SEARs (Coastal process and hazards)

Relevant SEARs	Section EIS addressed
DPE (Flooding and coastal erosion)	
The EIS must describe the potential effects of coastal processes and hazards (within the meaning of the Coastal Management Act 2016), including sea level rise and climate change: • On the proposed development • Arising from the proposed development	Section 9.3.1 - Impact on the coastal dune system
DPE (Environmentally sensitive areas)	
The EIS must include an assessment of the potential impacts (direct and indirect) of the development on the Worimi State Conservation Area and the Worimi Regional Park, as per the *guideline 'Developments adjacent to National Parks and Wildlife Service lands'* (NPWS, 2020).	Section 9.3.2 - Impact on the Worimi areas

9.2 Existing environment

As detailed further in Section 2.3.3 of this EIS, the quarry is located in the vegetated dune systems of Stockton Bight. The dunes are part of a 6,500-year-old coastal sand barrier that has seen four phases of beach and dune building, with the present phase actively moving the dunes inland.

The quarry is bordered on three sides by the Worimi Conservation Area and beyond that the Worimi Regional and National Parks (the Worimi areas). The Worimi Regional Park incorporates much of Stockton beach and mobile dunes and the Worimi National Park incorporates much of the vegetated transgressive dunes.

9.3 Assessment of impacts

9.3.1 Impact on the coastal dune system

The project site is located approximately 1.2 to 1.8 km inland from Stockton Beach, and as such, is physically remote from coastal processes and hazards, including beach erosion, storm surge, beach rotation and beach recession, which at the most can impact 100 m inland. The mobile dunes, at their present rate of movement, would require 120-200 years to reach the project site. The site is above both present levels of coastal inundation and, at the lowest excavation of 3.7 m AHD, is predicted to be more than 2 m above the forecast 84 cm sea leave rise by 2100.

The project would have no additional physical impact on the surrounding environment, outside of the surrounding buffer, which comprises densely vegetated coastal sand dunes at least 290 m wide and between approximately 5-20 m in height. The operation is also located too remotely from active marine processes including waves, tides, ocean currents and longer-term processes including beach rotation, periodic storm erosion and predicted sea level rise to be directly impacted during the operational lifespan of the project.

Overall, it is considered that the project would not be exposed to nor vulnerable to coastal processes and cannot impact any of the coastal processes identified.

9.3.2 Impact on the Worimi areas

As shown in Figure 9.1, the quarry is bordered on three sides by the Worimi State Conservation and Regional Park areas (the Worimi areas).

The NSW National Parks and Wildlife Service's (NPWS) has prepared guidelines (*Developments adjacent to National Parks and Wildlife Service lands: Guidelines for consent authorities* (NPWS, 2020)) for planning authorities assessing development applications adjacent to land managed by NPWS, which includes the Worimi areas.

The guidelines aim to avoid any direct or indirect impact on NPWS managed land and identities a number of key issues that need to be considered by planning authorities. These issues and a consideration of the potential impacts from the project are detailed in Table 9.2.

Table 9.2 Consideration of the project against NPWS guidelines

Aim of the guidelines	Risks to NPWS	Potential impact
Erosion and sediment control		
To prevent erosion and the movement of sediment onto NPWS land.	Removal of vegetation and disturbance of groundcover from construction activities will expose the soil and increase the risk of erosion. Eroded sediments, including those from soil stockpiles, may be transported downstream or down slope, and deposited on vegetation and in creeks, rivers, wetlands and other aquatic habitats.	As detailed in Section 3.2.3 of this EIS, the project would include stockpiles of sand, VENM and cleared vegetation. There are no watercourses within the project site that would enable transportation of eroded sediment, and erosion and sediment management controls would be implemented as part of the site establishment and rehabilitation. Given the separation of the project site from the Worimi areas, and with the implementation of the specific erosion and sediment control management measures, the project is not expected to result in adverse direct or indirect impacts to these areas.
Stormwater runoff		
Nutrient levels are minimised, and stormwater flow regimes and patterns mimic natural levels before reaching NPWS land, to ensure no detrimental change to hydrological regimes.	The discharge of stormwater to NPWS land poses a threat to the values of land and downstream environments by: • dispersing litter and pest species (especially weeds) • altering nutrient composition and pollutant levels, which can damage native vegetation and aquatic ecosystems, reduce water recreation safety and promote weed growth • causing potential erosion and sedimentation in watercourses, particularly where new developments have led to an increased volume and concentration of flow impacting on Aboriginal sites, which are frequently located close to watercourses, and historic heritage.	As detailed in the surface water assessment (refer Chapter 16, Appendix N of this EIS), the project site is a basin with no surface flow connection to adjacent areas and no watercourses within the project site. Therefore, there would be no potential for discharge of stormwater to the adjacent Worimi areas from the project.
Wastewater		

Table 9.2 Consideration of the project against NPWS guidelines

Aim of the guidelines	Risks to NPWS	Potential impact
There are no adverse impacts on NPWS land due to wastewater from nearby development.	If wastewater disposal systems are not designed, installed, operated and maintained correctly they can pose significant risks to NPWS land.	The wastewater disposal system on the site would be upgraded as required for the project and designed, installed and operated in accordance with relevant standards.
Pests, weeds and edge effects		
Adjoining or nearby development does not: • lead to increased impacts from invasive species (weeds and pests), domestic pets and stock • facilitate unmanaged visitation, including informal tracks, resulting in negative impacts on cultural or natural heritage values • lead to impacts associated with changes to the nature of the vegetation surrounding the park • impede NPWS access for management purposes, including inappropriate fencing	Development adjoining or in the vicinity of NPWS land has the potential to significantly affect the management of NPWS land, resulting in damage to conservation values and cost implications for future management. Development may result in: • inappropriate and unauthorised access and uses (such as by trail-bike riders) • increase in invasive species and decline in biodiversity and ecosystem health (such as dieback) • impacts on areas of particular environmental sensitivity, including Aboriginal and historic heritage sites, watercourses, threatened ecological communities and threatened species habitat • disturbance and predation by domestic pets or ingress by stock animals. Clearing of vegetation (including aquatic vegetation) along or near the boundary of NPWS land can lead to edge effects such as: • increased drying of soils and consequent changes to vegetation at the land boundary • decline in fauna species that are sensitive to changes in vegetation along newly created edges • increased predation in the vicinity of the NPWS land boundary associated with aggressive species in open situations (such as nest predation by ravens and currawongs).	Vegetation clearing would be limited to the area of extraction, which would be set back a minimum of 290 m from the nearest (southern) boundary with the Worimi State Conservation Area (refer Figure 9.1). There would be no development or clearing adjoining or in proximity to NPWS land, with a significant buffer, which includes the densely vegetated dunes, maintained from the project site.
Fire and the location of asset protection zones		
All asset protection measures are within the development area, and there is no expectation for NPWS to change its fire management regime for the land it manages.	Fire poses a significant threat to life and property, and altered fire regimes may degrade park values including biodiversity, cultural heritage and tourism.	A bushfire assessment report (Chapter 19, Appendix Q) has been prepared to accompany this EIS. Appropriate asset protection zones are proposed and would be implemented and maintained for the project in accordance with the relevant NSW RFS requirements set out in *Planning for Bushfire Protection 2019.*
Boundary encroachments and access through NPWS land		
No pre-construction, construction or post-construction activity occurs on land managed by NPWS. Any access that does occur must be	Unauthorised access to NPWS land can have direct physical impacts on the conservation values of parks, such as those due to the removal of vegetation, erosion and soil disturbance.	No project access or activities would be required on NPWS land.

Table 9.2 Consideration of the project against NPWS guidelines

Aim of the guidelines	Risks to NPWS	Potential impact
legally authorised and comply with park management objectives.		
Visual, odour, noise, vibration, air quality and amenity impacts		
There is no reduction of amenity on NPWS land due to adjacent development.	Certain developments may significantly intrude on the environment of NPWS lands, affecting the senses of wildlife and park visitors.	The potential visual (Chapter 21), noise (Chapter 12) and air quality (Chapter 11) impacts of the project have been assessed and, where relevant, measures proposed to manage/mitigate potential impacts. With the implementation of these measures, and given the significant buffer from the project site, it is not considered that there would be significant adverse amenity impacts to the adjoining Woirmi areas.
Threats to ecological connectivity and groundwater-dependent ecosystems		
Native vegetation and other flora and fauna habitats that provide a linkage, buffer, home range or refuge role on land that is adjacent to parks are maintained and enhanced, where possible. Groundwater-dependent ecosystems in NPWS land are protected.	Naturally vegetated areas adjoining NPWS land provide essential linkages for the maintenance of biodiversity and also minimise potential edge effects. Avoiding native vegetation clearing and fragmentation and retaining landscape connectivity will also assist in mitigating some of the impacts of climate change on biodiversity	As detailed above, vegetation clearing would be limited to the area of extraction, which would be set back a minimum of 290 m from the nearest (southern) boundary with the Worimi State Conservation Area (refer Figure 9.1). There would be no development or clearing adjoining or in proximity to NPWS land, with a significant buffer, which includes the densely vegetated dunes, maintained from the project site. The project involves dry sand extraction only, with a minimum 0.7 m buffer above the height of the water table. As such, no impacts are predicted to groundwater-dependent ecosystems.
Cultural heritage		
Areas and sites of heritage value on NPWS land, including Aboriginal cultural heritage, are protected.	Cultural heritage values can, and often do, extend across the landscape, spanning multiple land tenures and properties. Ensuring that these values endure and can be interpreted and appreciated by future generations requires protective action across boundaries.	In relation to Aboriginal cultural heritage, it is understood that dune movement has resulted in the exposure of cultural sites within the Worimi areas. However, it is noted that this is a consequence of long-term natural dune movement and surface deflation, exacerbated in recent decades by ongoing off-road vehicle activity, and not a consequence of sand extraction at the quarry. Registered Aboriginal parties were consulted during the preparation of the Aboriginal cultural heritage assessment report (refer Chapter 15, Appendix M of this EIS) and no objections or issues were raised in relation to the project. In relation to historic heritage, and as considered further in Chapter 21, the only listed heritage item within 500 m of the project is the 'Stockton Beach Dune System'. Given the proximity of the project site to the dune system, it is considered that the project would not impact upon the natural landscape features comprising the listing.
Access to parks		
Adjacent developments do not compromise public and NPWS access to parks.	Maintaining legal and viable access to NPWS land is important in ensuring park values are conserved and that NPWS can	The project would utilise existing authorised access to the site and would not impact access to the Worimi areas.

Table 9.2 Consideration of the project against NPWS guidelines

Aim of the guidelines	Risks to NPWS	Potential impact
	undertake its functions as the manager of the land.	

Overall, given that the Worimi areas are separated from the project site by a minimum 290 m of densely vegetated dunes, and with the implementation of the relevant management and mitigation measures, the project is not expected to have any significant adverse direct or indirect adverse impacts to the Worimi areas.

Figure 9.1
Proximity to Worimi areas

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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56 031262_SQDSEP_EIS_F9.1_Proximity_to_Worimi_areas_230803_v01

10 Biodiversity

A biodiversity development assessment report (BDAR), prepared by Niche (Niche, 2023) to accompany this EIS, is provided in Appendix H.

Table 10.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarise the outcomes of the BDAR.

Table 10.1 SEARs (biodiversity)

Relevant SEARs	Section EIS addressed
DPE Planning (Biodiversity)	
Accurate predictions of any vegetation clearing on site	Section 10.1.4 – Native vegetation and flora assessment
A detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report	Appendix H
A detailed consideration of the potential for off-site and in-direct impacts on local biodiversity and surrounding ecological corridors or habitat	Section 10.2.2 – Indirect impacts
A strategy to offset any residual impacts of the development in accordance with the Biodiversity Offsets Scheme	Section 10.2.4 – Biodiversity offset strategy
DPE BCD (Biodiversity)	
Biodiversity impacts related to the proposed development (SSD-52984213) are to be assessed in accordance with the Biodiversity Assessment Method 2020 and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method 2020	Appendix H
The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method 2020	Appendix H, Section 5.1 and Section 5.2
The BDAR must include details of the measures proposed to address the offset obligation as follows: • the total number and classes of biodiversity credits required to be retired for the development/project	Section 10.2.4 – Biodiversity offset strategy
• the number and classes of like-for-like biodiversity credits proposed to be retired	Section 10.2.4 – Biodiversity offset strategy
• the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules	Section 10.2.4 – Biodiversity offset strategy
• any proposal to fund a biodiversity conservation action	Section 10.2.4 – Biodiversity offset strategy
• any proposal to conduct ecological rehabilitation (if a mining project)	N/A
• any proposal to make a payment to the Biodiversity Conservation Fund	Section 10.2.4 – Biodiversity offset strategy

Table 10.1 SEARs (biodiversity)

Relevant SEARs	Section EIS addressed
If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits	N/A
The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016	Appendix H, Section 1.7
The Department now has a template guideline for the production of BDARs titled 'Guidance for the Biodiversity Development Assessment Report Template', available at: • https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-andplants/ • Biodiversity/biodiversity-development-assessment-report-template-guide-220209.pdf	Template considered in the preparation of the BDAR (Appendix H)

10.1 Assessment methodology

10.1.1 Overview

Biodiversity impacts were assessed in accordance with DPE's Biodiversity Assessment Method (BAM), to determine the impact the project would have on biodiversity, to identify appropriate management and mitigation measures and to calculate the project's biodiversity offset requirement using the (BAM) Credit Calculator. This comprised the following two stages:

- Stage 1 – biodiversity assessment, involving determination of:
  - habitat value through assessment of landscape features;
  - native vegetation; and
  - threatened species and populations.
- Stage 2 – impact assessment, involving consideration of:
  - how to avoid and minimise impacts on biodiversity values;
  - impact and offset thresholds; and
  - offset requirements.

10.1.2 Consultation

As detailed in Section 4.1.2 of this EIS, a meeting was held with DPE - BCD on the 9 December 2022 to discuss the BDAR for the project. Niche discussed that the BDAR would essentially be the same as the BDAR (Niche, 2019) submitted as part of the current dredge application, which had been reviewed and approved by DPE - BCD, with the following updates to address contemporary assessment and survey requirements:

- changes to benchmarks within the BAM, requiring a new run of the calculator;
- updates of BAM plot data that is older than five years;
- updates to sections of the report to adhere to guidance material that has been released since the previous BDAR (Niche, 2019) was submitted; and

- updates to project descriptions, SEARs, plot data lists, vegetation integrity scores, and tables depicting biodiversity credits.

10.1.3 Landscape assessment

A landscape assessment was undertaken to determine the landscape value of the project, which included an assessment of the following factors, with information sourced from aerial photographs, maps, database searches and site observations:

- native vegetation cover;
- rivers, streams and estuaries;
- areas of geological significance; and
- habitat connectivity.

10.1.4 Native vegetation and flora assessment

i Native vegetation

A review of relevant literature, databases and existing vegetation mapping was undertaken to identify vegetation, threatened flora and threatened ecological communities (TECs) with potential to occur at the project site.

Field surveys were carried out on the following dates to stratify the vegetation at the project site as per the BAM:

- 27-29 September 2017;
- 20 August 2018;
- 26 May 2020;
- 30 July 2020;
- 1 July 2020;
- 7 February 2023; and
- 8 February 2023.

The field surveys confirmed that the project site consists predominately of native vegetation, including a large portion of infill planting, which was conducted over the last two decades to rehabilitate the former inland dunes extraction area as part of DA 2010-94. Different condition classes were assigned to vegetation where obvious differences in structure and quality occurred, resulting in two plant community types (PCTs) and six vegetation categories (zones), presented in Table 10.2 and shown in Figure 10.1 below.

Of the project site area of 38.16 ha, 35.67 ha comprises native vegetation, attributed to the following two PCTs:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast (33 ha); and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast (2.67 ha).

All vegetation within the project site is proposed to be removed to allow for the proposed extraction.

Table 10.2 Plant community types

Vegetation zone	PCT	Vegetation formation	Vegetation class	TEC	PCT %cleared	Total (ha)	Plots required	Plots completed
1	PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests	-	45	14.14	3	4
2						3.83	2	2
4						5.12	3	3
5						1.70	1	1
6						8.21	3	4
3	PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	South Coast Sands Dry Sclerophyll Forests	-	86	2.67	2	2
-	Non-native	-	-	-	-	2.49	-	-
	Total					**38.16**	**14**	**16**
	Total native vegetation					**35.67**		

ii Preliminary clearing

As considered further in Section 3.2.2, preliminary clearing of approximately 0.5 ha of native vegetation is proposed across the project site prior to extraction. This would facilitate a widespread drilling program that would enable Boral to monitor the level of the water table over the life of the project and provide an accurate representation of the quality of the sand resource across the project site.

iii High threat and priority weeds

The BCD has a list of high threat weeds (HTW) that need to be taken into consideration in the BDAR.

During the field surveys, the following three HTWs were recorded in the BAM plots:

- *Bidens pilosa* (Farmers Friend);
- *Ehrharta erecta* (Panic Veldtgrass); and
- *Eragrostis curvula* (Africa Lovegrass).

Although the three HTWs were located across all vegetation zones, they were concentrated adjacent to existing disturbance areas.

iv Threatened ecological communities

A list of generated from relevant database searches, identified 25 TECs that have been identified as potentially occurring within the locality. However, based on the results of the detailed vegetation validation, and review of the conservation advice of the TECs, no TECs were recorded in the project site or are considered likely to occur.

v Threatened flora

The BAM calculator predicted 21 threatened flora species could occur in the project site. However, no threatened flora listed under the BC Act or EPBC Act were recorded during the field surveys.

10.1.5 Fauna and fauna habitat assessment

i Fauna habitat

The field survey observed a clear difference in fauna habitat across the project site, attributed to the age of rehabilitation vegetation.

Areas of relatively recent rehabilitation contained scattered logs, generally sparse ground cover and lacked a mid and canopy stratum. Conversely, older rehabilitation areas had a developing canopy and midstorey cover. As such, the remnant and older patches of rehabilitation would offer greater foraging habitat for a variety of fauna, including that of nectivorous birds and the Squirrel Glider.

The survey of rehabilitated areas did not identify trees mature enough to contain hollows, and as such, roosting and breeding habitat for a range of hollow-dependent species, such as microbats, was absent. Limited hollows within adjoining areas of the remnant vegetation occur, none of these had any evidence of owl usage.

Logs have been scattered throughout the rehabilitation areas which provide habitat for reptiles and small ground-dwelling mammals, and foraging resources for birds.

The ground cover of rehabilitated areas is particularly sparse, however the sandy substrate may provide habitat for small to medium-sized mammals to create burrows for shelter.

No habitat in the form of bush rock or rock platforms were identified, nor was there any permanent or ephemeral aquatic habitats on the site.

ii Habitat connectivity

The project site adjoins a large native vegetation corridor which extends along Stockton Bight to Anna Bay in the north, and Stockton in the south. The stretch of the vegetation corridor encompasses the Worimi Regional Park and Worimi State Conservation Area (refer Figure 9.1).

To the west of the site, connectivity of this corridor is fragmented by Nelson Bay Road and the contiguous areas of cleared rural agricultural lands. These existing intrusions form a barrier to fauna movement in the area.

The removal of vegetation (predominantly tubestock plantings within the former inland extraction area) and habitat within the project site would not reduce the amount of important habitat features (e.g. hollow bearing trees) within the corridor to the degree that fauna roosting and foraging habitat would be significantly impacted.

The removal of the vegetation within the project site is unlikely to restrict fauna movement along the corridor extending from Stockton Beach to Anna Bay given the following:

- the area to be disturbed is centred on the former inland extraction area which was historically cleared;
- vegetation would be retained along Nelson Bay Road and towards Stockton Beach allowing continued fauna movement along the corridor; and
- the haul road that is currently in operation for the windblown sand extraction area would not be widened as part of the project and as such no changes to existing fauna movement are likely.

Figure 10.1
Validated vegetation mapping

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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Niche Environment and Heritage (2023), Boral (2023), Cambium Group (2023).

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iii Threatened fauna

The BAM Calculator predicted the potential for 85 threatened fauna species (refer to Appendix 1 of Appendix E of this EIS) to occur in the 10 km search radius. A total of 21 of these were identified as 'candidate' fauna species (i.e. species credit species). The list of candidate species was then reduced to the Squirrel Glider after validation via fieldwork.

The following threatened species were observed, or recorded via Anabat analysis during fieldwork:

- Greater Broad-nosed Bat *(Scoteanax rueppellii*);
- Eastern Bent-wing Bat (*Miniopterus schreibersii*); and
- White-bellied Sea Eagle (*Haliaeetus leucogaster*).

The locations of the threatened species recorded at the project site and areas of potential habitat for the Squirrel Glider are shown in Figure 10.2.

The Eastern Bentwing-bat and White-bellied Sea Eagle are 'species credit' fauna which require biodiversity offsetting if their habitat is present and/or habitat would be impacted by the project. These species are 'dual credit' species with the species credit component only triggered if breeding habitat is present. No breeding habitat was detected for the two species in the project site.

The remainder of the species are 'ecosystem credit' species, which are assumed to have habitat in the vegetation types of the project site.

iv Migratory species

No migratory species listed under the EPBC Act were observed adjacent to or in the project site.

It was determined that eight migratory species could occur in or adjacent to the project site. These species could occur due to the presence of opportunistic foraging habitat.

The extensive native vegetation to the north and south of the quarry in the Worimi Regional Park and Worimi State Conservation Area contains more habitat for the species.

10.2 Assessment of impacts

10.2.1 Direct impacts

Most impacts from the project on biodiversity would occur during establishment of the extraction areas, associated with clearing of native vegetation and removal of habitat.

The following direct impacts would result from the project:

- clearing of native vegetation and associated habitat, conservatively estimated to be 35.66 ha, including 32.75 ha of previously rehabilitated areas;
- clearing of approximately 2.48 ha of exotic vegetation; and
- clearing of 26.59 ha of associated species credit fauna habitat for the Squirrel Glider.

Figure 10.2

Survey type, recorded threatened species and fauna habitat

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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Niche Environment and Heritage (2023), Boral (2023), Cambium Group (2023).

i Potential serious and irreversible impacts

The BC Act imposes various obligations on decision-makers in relation to impacts on biodiversity values that are at risk of potential serious and irreversible impacts (SAII). These obligations generally require a decision-maker to determine whether the residual impacts of a proposed development on biodiversity values (that is, the impacts that would remain after any proposed avoid or mitigate measures have been implemented) are serious and irreversible.

No threatened biodiversity at risk of SAII (as assigned at March 2023) are known in the project site or are considered to potentially be impacted by the project.

ii Potential impacts to Commonwealth threatened biodiversity

Eight species listed under the EPBC Act may be impacted by removal of potential foraging habitat. Therefore, 'assessments of significance' were undertaken for these species (refer to Appendix 7 of the BDAR – Appendix H of this EIS). The assessments of significance concluded the project would not significantly impact these species and that a referral under the EPBC is not required.

10.2.2 Indirect impacts

Indirect impacts would mostly occur during the establishment of the project and would be short term and largely confined to the project site and immediate surrounds, including in relation to increased noise and dust from construction and operation the spread of weed propagules, which could lead to invasion of native vegetation by weeds. With the implementation of the management and mitigation measures identified in Section 10.3 of this EIS, these indirect impacts would be minimised.

10.2.3 Cumulative impacts

Potential cumulative biodiversity impacts are considered to be the total impact on the environment that would result from the current project plus any additional impacts likely to occur due to subsequent projects that are of a similar nature or that are partly or wholly contingent on the project.

Identifiable cumulative impacts to be considered in the locality include the following quarry operations:

- Salt Ash Sand Project (Nelson Bay Road), which has approval to operate until 2030;
- Cabbage Tree Road Sand Quarry, which has approval to operation until 2033; and
- Mackas Sand Project, Nelson Bay Road.

The above operations would have approval to impact biodiversity and there is potential for additional clearing of native vegetation and habitat if the operations are modified, or new operations are approved, which would be subject to relevant assessment, approval, and offset requirements. Residential, commercial and industrial development is also identified as a continuous cumulative biodiversity pressure associated with the wider Port Stephens and Newcastle LGAs. Whilst the project would result in removal of native vegetation from within the North Coast bioregion, it would primarily relate to planted rehabilitation. The project provides for offsets that would contribute to in-perpetuity as part of managed conservation areas within the wider bioregion.

10.2.4 Biodiversity offset strategy

The BAM identifies the BAM Calculator as the appropriate tool for quantifying the offsets required, which is expressed as numbers of ecosystem and species credits. A calculation of the nature and extent of biodiversity credits required due to ecological impacts associated with the project identified the following credit requirements:

- Impacts to native vegetation communities within the development site generate a requirement for 571 ecosystem credits, comprising:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast – 540 credits; and
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast – 31 credits.

- Impacts to the squirrel glider threatened species with the development site generated the requirements for 700 species credits.

Boral commits to satisfying the credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits and/or contribution to the Biodiversity Conservation Fund).

Boral propose to implement a staged-offset approach to reflect the progressive native vegetation disturbance, consistent with that proposed for the current dredge application. The staged offset would involve the retirement of the required credits aligned to the five stages of extraction (refer Figure 3.2 of this EIS).

A preliminary offset stage (Stage 0) is proposed for the clearing that would facilitate the proposed drilling program (refer Section 3.2.2 of this EIS). The preliminary offset stage is proposed in 2023 and would involve the retirement of the following credits prior to vegetation disturbance:

- PCT1644 - Coast Tea Tree/ Old Man Banksia coastal shrubland – 1 credits;
- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland – 4 credits; and
- Squirrel Glider –12 credits.

The area of native vegetation and habitat associated with each offset stage is provided in Table 10.3, and associated credits provided in Table 10.4.

Table 10.3 Area of vegetation/habitat impact within each offset stage

PCT	Zone	Stage offset approach – area (ha)						Area
		0 (2023)	1 (2024)	2 (2027)	3 (2028)	4 (2029)	5 (2031)	
Non-native	Non-native	0	1.28	0.5	0	0.44	0.26	2.48
PCT1644 - Coast Tea Tree/ Old Man Banksia coastal shrubland	Zone 3	0.08	2.59	0	0	0	0	2.67
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 1	0.25	4.34	0.47	1.64	4.98	2.46	14.14
	Zone 2	0	0	0.77	2.25	0.81	0	3.83
	Zone 4	0	0.34	4.10	0.68	0	0	5.12
	Zone 5	0	0.86	0.13	0	0.1	0.61	1.70
	Zone 6	0.14	2.14	1.02	1.61	0.42	2.88	8.21
Squirrel Glider								
PCT 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower	Zone 3	0.08	2.59	0	0	0	0	2.67
	Zone 1	0.25	4.34	0.47	1.64	4.98	2.46	14.14

Table 10.3 Area of vegetation/habitat impact within each offset stage

PCT	Zone	Stage offset approach – area (ha)						Area
		0 (2023)	1 (2024)	2 (2027)	3 (2028)	4 (2029)	5 (2031)	
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 5	0	0.86	0.13	0	0.10	0.61	1.70
	Zone 6	0.14	2.14	1.02	1.61	0.42	2.88	8.21

Table 10.4 Credits per offset stage

Credit type	Zone	Credits required	Total area (ha)	Credits per ha	Credits per stage (indicative year for credit retirement)					
					0 (2023)	1 (2024)	2 (2027)	3 (2028)	4 (2029)	5 (2031)
Ecosystem credits										
PCT 1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower	Zone 3	31	2.7	11.5	1	30	0	0	0	0
	Zone 1	288	14.1	20.4	1	90	11	34	102	50
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 2	39	3.8	10.2	0	0	8	23	8	0
	Zone 5	42	1.7	243.7	0	21	4	0	2	15
	Zone 6	171	8.2	20.9	3	45	21	34	8	60
Total	-	571	-	-	5	186	44	91	120	125
Species credits										
Total Species credits (Squirrel Glider)	-	700	26.7	26.2	12	260	42	85	145	156

10.3 Management and mitigation measures

General

- A project specific landscape and rehabilitation management plan shall be prepared to reflect biodiversity management measures associated with the project and having regard to the rehabilitation management requirements and controls outlined in Section 18.2.6 of this EIS.

Fencing and signposting

- Fencing and/or the use of highly visible rope or tape boundaries shall be used to delineate the boundary of vegetation clearing at the edge of the proposed extraction area.
- Signposting shall be used to inform project personnel and site visitors of areas of conservation value, to restrict entry or inform behaviour that would reduce incidental interactions with threatened species (e.g speed limits along access roads to reduce potential for fauna vehicle strikes).

Employee education and general environmental controls

- Employees and contractors shall be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the project:
    - dust generation shall be minimised by minimising the extent and time that bare sand is exposed and by appropriate sand suppression;
    - procedures for the management of hydrocarbon and/or chemical spills throughout the project site shall be undertaken, including the requirements for vehicles to carry spill kits; and
    - vehicles shall remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going project discussions.

Vegetation clearance protocol

- Boral has an established vegetation clearing protocol provided in the existing *Project Landscape and Rehabilitation Management Plan* (ERM 2007a). This protocol shall be adopted under a project specific landscape and rehabilitation management plan, including the following key protocols:
    - prior to clearing of native vegetation, ecologists shall survey for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed;
    - prior to clearing of remnant hollow-bearing trees or habitat trees, ecologists shall be be engaged to supervise felling;
    - all hollow-bearing trees that are accessible safely from the ground shall be checked and identified fauna relocated; and
    - hollows bearing trees not accessible from the ground shall be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.
- Any fauna displaced during clearing shall be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so).
- In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) shall be contacted to handle and collect for appropriate care and rehabilitation.

Pest and weed management

- A project specific pest and weed management plan shall be developed and implemented. It is envisaged that this plan would adopted protocols and strategies similar to those implemented under the existing management plan adopted for the existing windblown project (ERM 2010) with the following additional matters to be included:
    - management protocols for feral animals such as dogs, rabbits and foxes within the rehabilitation area; and
    - management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the site).

11 Air quality and greenhouse gas

An air quality impact assessment (AQIA) and greenhouse gas (GHG) assessment, prepared by Todoroski Air Sciences (TAS, 2023) to accompany this EIS, is provided in Appendix I.

Table 11.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarise the outcomes of the AQIA and GHG assessment.

Table 11.1 SEARs (air quality)

Relevant SEARs	Section EIS addressed
DPE – Planning (air quality and odour)	
A detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy	Section 11.1 - Air quality
An assessment of potential dust and other emissions generated from processing, operational activities and transportation of quarry products	Section 11.1.2 - Impact assessment
Reasonable and feasible mitigation measures to minimise dust and emissions	Section 11.1.3 - Management measures
Monitoring and management measures, in particular, real-time air quality monitoring	Section 11.1.3 - Management measures
A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant EPA guidelines	Section 11.1 - Air quality
A detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy	Section 11.1 - Air quality
A greenhouse gas assessment of the operation of the development	Section 11.2 - Greenhouse gas
EPA (Air)	
Impacts related to the following environmental issues need to be assessed, quantified and reported on: Air Issues, including odour: air quality including dust and odour generation from the operation on the surrounding landscape and/or community	Section 11.1 - Air quality
The EIS must demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997*) and the POEO (*Clean Air) Regulation* (*2002*). Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour"	Section 11.1 - Air quality
The EIS must include an air quality impact assessment (AQIA). The AQIA must be carried out in accordance with the document, *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2016), available at: https://www.epa.nsw.gov.au//media/epa/corporate-site/resources/air/approvedmethods-for-modelling-and-assessmentof-air-pollutants-in-nsw-160666.pdf	Section 11.1 - Air quality Appendix I – Air quality and greenhouse gas assessment
The EIS must detail emission control techniques/practices that will be employed at the site and identify how the proposed control techniques/practices will meet the requirements of the POEO Act, POEO (Clean Air) Regulation and associated air quality limits or guideline criteria	Section 11.1.3 - Management measures

11.1 Air quality

11.1.1 Assessment methodology

The purpose of the AQIA was to provide an assessment of the maximum likely effects on air quality that may arise due to the project.

The AQIA identified that the following atmospheric pollutants are likely to be generated by the project:

- Particulate matter, comprising:
  - deposited dust; and
  - total suspended particulate (TSP) matter, which is nominally taken to be less than 30 micrometres (µm) in diameter and refers to all suspended particles in the air;
- PM^{10}, which is a subset of TSP and have a diameter of 10 micrograms (µm) or less; and
- $PM^{2.5}$, which is a subset of TSP and have a diameter of 2.5 µm or less;
- crystalline silica; and
- pollutants generated through the combustion of fuel in vehicle engines.

Dispersion of air pollutants was modelled using the 'CALPUFF Modelling System', which combines estimated emission rates, neighbouring emission sources, proposed mitigation measures and local meteorology to predict incremental and cumulative air quality impacts.

i Sensitive receptors

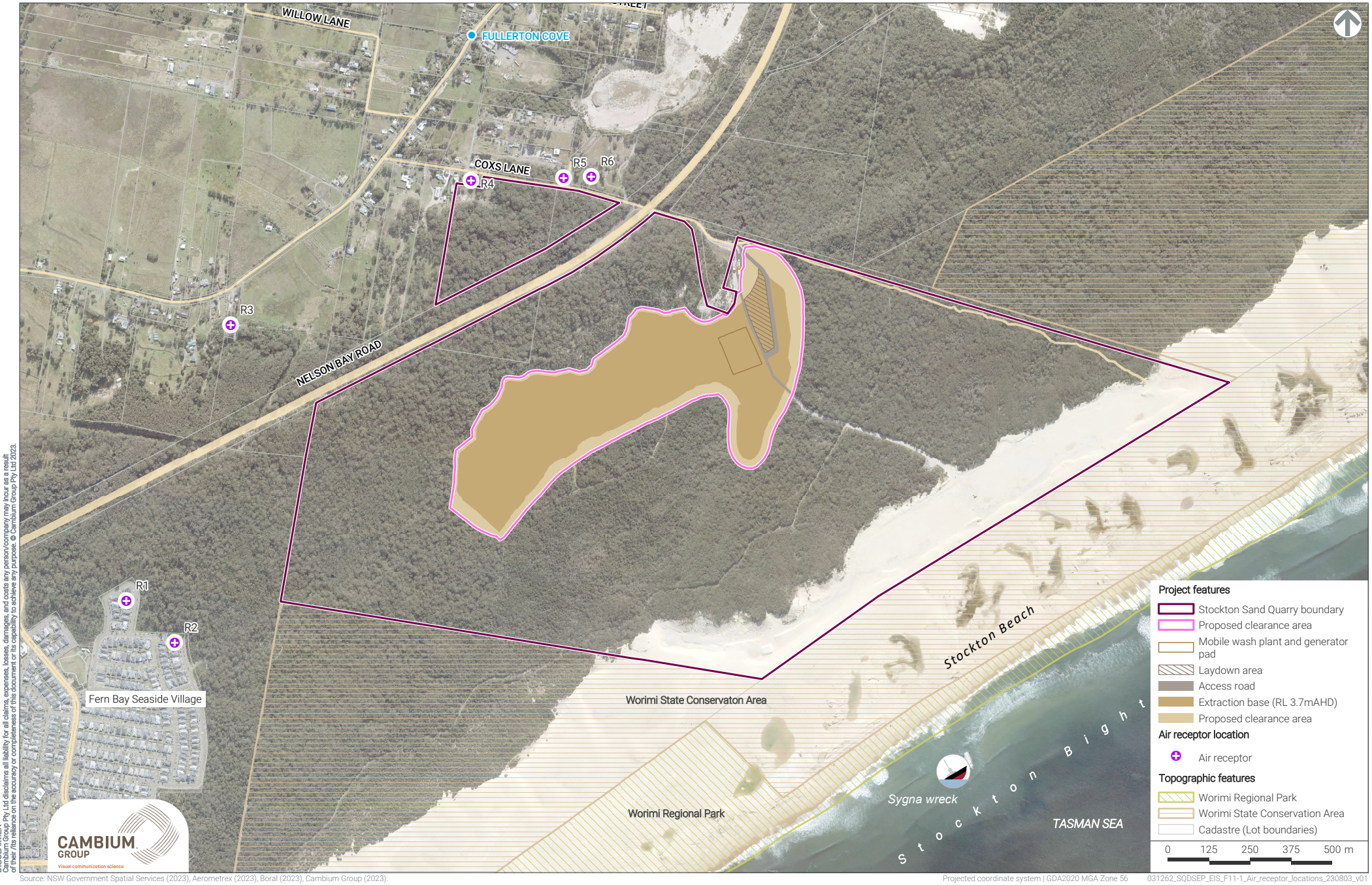
As described in Section 1.3, land use surrounding the quarry is a mix of extractive industry, rural, residential, public recreation and environmental conservation areas.

Sensitive residential receptors considered in the AQIA are identified in Table 11.2 and shown in Figure 11.1.

Table 11.2 Sensitive receiver locations

Receiver	Address	Proximity to the project
R1	101 Norfolk Street, Fern Bay	Approximately 1.4 km to the south-west
R2	14 Tuckeroo Circuit, Fern Bay	Approximately 1 km west-south-west
R3	260 Fullerton Cove Road, Fullerton Cove	Approximately 800 m north-west
R4	12 Coxs Lane, Fullerton Cove	Approximately 500 m north-west
R5	17A Coxs Lane, Fullerton Cove	Approximately 500 m north
R6	21 Coxs Lane, Fullerton Cove 4	Approximately 500 m north

Figure 11.1
Air receptor locations



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ii Air quality criteria

Particulate matter

Table 11.3 summarises the air quality criteria relevant to the project as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2022).

Table 11.3 NSW EPA air quality impact assessment criteria

Pollutant	Averaging period	Impact	Criterion
TSP	Annual	Total	90 µg/m^3
PM^{10}	Annual	Total	25 µg/m^3
	24 hour	Total	50 µg/m^3
$PM^{2.5}$	Annual	Total	80 µg/m^3
	24 hour	Total	25 µg/m^3
Deposited dust	Annual	Incremental	2 g/m^2/month
		Total	4 g/m^2/month

µg/m³ = micrograms per cubic metre
g/m²/month = grams per square metre per month

The NSW Government's *Voluntary Land Acquisition and Mitigation Policy (VLAMP)* (NSW Government, 2018) describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum, and extractive industry developments.

Voluntary mitigation and acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of relevant criteria. As considered in Section 11.1.2, dispersion modelling for the project did not predict any exceedance of the relevant criteria and therefore potential voluntary land acquisition and mitigation rights do not apply to the project.

Nitrogen dioxide

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called oxides of nitrogen (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers. It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generate (TAS, 2023).

Silica

Silica occurs in nature in a crystalline or amorphous form and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis. However, given that the project would solely be washing then screening the material with no crushing proposed for operations, there is minimal risk for exposure and thus respirable crystalline silica was not assessed as part of the AQIA (TAS, 2023).

iii Estimated background dust levels

In the absence of readily available site specific monitoring data, background air quality levels from a DPE monitoring station at Stockton for the 2021 calendar year were used to represent the background levels for the project, noting that the 2021 calendar period corresponds to the period of meteorological modelling based on an analysis of long-term data trends in meteorological data recorded for the area, as outlined in Appendix A of the AQIA (refer Appendix I of this EIS).

$PM^{2.5}$ and PM^{10}

The $PM^{2.5}$ and PM^{10} concentrations at the Stockton monitor were identified as elevated due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles. To account for this, background $PM^{2.5}$ and PM^{10} concentrations were adjusted to discount the contribution associated with salt laden air and estimated at an approximate annual average $PM^{2.5}$ and PM^{10} concentration of 6.4 µg/m³ and 14.5 µg/m³, respectively. These estimates for the annual average $PM^{2.5}$ and PM^{10} concentrations were comparable with levels measured at other nearby monitors (Beresfield and Wallsend).

TSP and deposited dust

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between PM^{10}, TSP and deposited dust concentrations and the measured PM^{10} levels.

This relationship assumes that an annual average PM^{10} concentration of 25 µg/m³ corresponds to a TSP concentration of 90 µg/m³ and a dust deposition value of 4 g/m²/month. This assumption is based on the EPA air quality impact criteria.

Applying this relationship with the measured annual average PM^{10} concentration of 14.5 µg/m³ indicates an approximate annual average TSP concentration and deposition value of 52.1 µg/m³ and 2.3v g/m²/month, respectively (TAS, 2023).

iv Dispersion modelling (scenarios)

Dust emissions from each operational activity of the project were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

To identify a potential worst-case operating scenario for the project, each of the activities associated with the different stages were analysed in regard to the quantity of material extracted and handled in each year, the location of the activity and the potential to generate dust at the receptor locations.

Three potential operating scenarios representing the project were investigated in detail to identify which would likely represent a worst-case operating scenario. These include:

- **Scenario 1:** Sand extraction occurring from the existing windblown sand extraction area concurrently with sand extraction using an excavator in Stage 1.
- **Scenario 2:** Sand extraction occurring from Stage 1 only at a maximum production rate of 750,000 tpa.
- **Scenario 3:** Sand extraction occurring from only Stage 5 at a maximum production rate of 750,000 tpa.

v Emission estimation

Construction emissions

The establishment of the project would involve the construction of the associated infrastructure including the wash plant and recycling facility, the laydown area and haul roads. This construction activity has the potential to generate small amounts of dust emissions.

Potential construction dust emissions would be primarily generated due to material handling, vehicle movements and windblown dust generated from exposed areas and stockpiles. Exhaust emissions would be generated from the operation of construction vehicles and plant. The potential dust impacts due to these activities are difficult to accurately quantify on any given day due to the short sporadic periods of dust generating activity which may occur over the construction time frame. The sources of dust are temporary in nature and would only occur during the construction period.

Overall, the AQIA identified that the total amount of dust generated from the construction process is unlikely to be significant given the nature of the activities. Additionally, the potential dust emissions generated by the construction activities would be less

than the emissions produced during the operational stages of the project and, given that these activities would occur for a limited period, no significant or prolonged effect at any off-site receptor was predicted to arise.

Odour emissions

The AQIA identified that odour emissions have some potential to arise from the diesel exhaust emissions of on-site plant equipment as well as vehicles travelling on and off site. However, these odorous emissions were generally considered to be too low to generate any significant off-site pollutant concentrations and were not assessed further. Overall, it was considered that the project would emit a wet sand odour given the nature of the material handled as well as the proximity of the project to the beach and the surrounding sand quarry operations.

Dust emissions

The AQIA identified that the significant dust generating activities associated with operation of the project are the loading/unloading of material, vehicles travelling on-site, screening sand material and windblown dust from exposed areas and stockpiles. The on-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates for each of the scenarios were calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

Based on the estimated dust emissions, Scenario 3 is estimated to generate the most dust overall for the scenarios considered and as such, the dispersion modelling for the project is based on Scenario 3, representing a worst-case potential operating scenario.

NO_x emissions

The NO_X emissions associated with operation of the project were identified from exhaust emissions from on-site vehicle and plant equipment.

11.1.2 Assessment of impacts

This section presents the predicted air quality levels which may arise from air emissions generated by the project.

i Dust concentrations

Table 11.5 presents the predicted incremental and cumulative particulate dispersion modelling results at each of the assessed residential receptor locations. The predicted incremental results show that minimal incremental effects would arise at the assessed receptors due to the project. The predicted cumulative results indicate that the assessed residential receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

Table 11.5 Dust dispersion modelling results

Receptor ID	Incremental						Cumulative			
	$PM^{2.5}$		PM^{10}		TSP	DD*	$PM^{2.5}$	PM^{10}	TSP	DD
	µg/m³)		(µg/m³)		(µg/m³)	(g/m²/ mth)	µg/m³)	(µg/m³)	(µg/m³)	(g/m²/ mth)
	24-hr average	Annual average	24-hr average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R1	0.2	<0.1	1.1	<0.1	<0.1	<0.1	6.4	14.5	52.2	2.3

Table 11.5 Dust dispersion modelling results

Receptor ID	Incremental						Cumulative			
	$PM^{2.5}$		PM^{10}		TSP	DD*	$PM^{2.5}$	PM^{10}	TSP	DD
	µg/m³)		(µg/m³)		(µg/m³)	(g/m²/ mth)	µg/m³)	(µg/m³)	(µg/m³)	(g/m²/ mth)
	24-hr average	Annual average	24-hr average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average	Annual average
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R2	0.2	<0.1	1.3	<0.1	0.1	<0.1	6.4	14.6	52.2	2.3
R3	0.2	<0.1	1.3	<0.1	0.1	<0.1	6.4	14.6	52.2	2.3
R4	0.3	<0.1	1.5	0.1	0.3	<0.1	6.4	14.6	52.4	2.3
R5	0.4	<0.1	2.2	0.2	0.4	<0.1	6.4	14.7	52.5	2.4
R6	0.4	<0.1	2.7	0.2	0.5	<0.1	6.4	14.7	52.6	2.4

**Deposited dust*

ii Assessment of Total (Cumulative) 24-hour average $PM^{2.5}$ and PM^{10} Concentrations

The results for incremental 24-hour average $PM^{2.5}$ and PM^{10} concentrations indicate there are no predicted exceedances of the relevant criteria at the residential receptor locations for the assessed scenario and the project would not increase the number of days above the 24-hour average criterion at any of the residential receptor locations.

iii NOx concentrations

Table 11.6 presents the predicted incremental and cumulative NO_2 dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to NO_2 emissions associated with the project and predicted cumulative levels would be below the relevant criteria.

Table 11.6 NO_2 dispersion modelling results

Receptor ID	Incremental		Cumulative	
	1-hour average	Annual average	1-hour average	Annual average
	Air quality impact criteria			
	-	-	164	31
R1	12.6	<0.1	109.0	16.4
R2	10.2	<0.1	106.6	16.4
R3	10.8	<0.1	107.2	16.5
R4	19.6	0.1	116.0	16.5
R5	26.1	0.1	122.5	16.5
R6	26.8	0.1	123.2	16.5

11.1.3 Management and mitigation measures

The project has the potential to generate dust emissions. Therefore, to ensure that activities associated with the project have a minimal effect on the surrounding environment and at residential receptor locations, where feasible and reasonable, the following management and mitigation measures shall be implemented:

General:

- Activities shall be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
- Weather forecast shall be checked prior to undertaking material handling or processing.
- Engines of on-site vehicles and plant shall be switched off when not in use Vehicles and plant shall be fitted with pollution reduction devices, where practicable.
- Vehicles and plant shall be fitted with pollution reduction devices, where practicable.
- Vehicles shall be maintained and serviced according to manufacturer's specifications.
- Visual monitoring of activities shall be undertaken to identify dust generation.

Exposed areas/stockpiles:

- The extent of exposed surfaces and stockpiles shall be kept to a minimum.
- Exposed areas and stockpiles shall either be covered or shall be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours.
- Dust generation shall be minimised by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.

Material handling:

- Drop heights shall be reduced from loading and handling equipment where practical.
- Material shall be dampened during handling when excessively dusty.

Hauling activities:

- Haul roads shall be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur.
- Regular inspection of haul road and maintenance of surfaces shall be undertaken to remove potholes or depressions.
- Driveways and hardstand areas shall be swept/cleaned regularly as required.
- Vehicle traffic shall be restricted to designated routes.
- Speed limits shall be enforced.
- Vehicle loads shall be covered when travelling off-site.

11.2 Greenhouse gas

11.2.1 Assessment methodology

The National Greenhouse Accounts (NGA) Factors document published by the Department of the Environment and Energy defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions generated are from 'direct' or 'indirect' sources.

Scope 1 emissions encompass the direct sources from the project, defined as:

> *...from sources within the boundary of an organisation as a result of that organisation's activities.*

Scope 2 and 3 emissions occur due to the indirect sources from the project as:

> *...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation.*

For the purpose of the GHG assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total GHG emissions generated from the project.

Scope 3 emissions can be a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the operation. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the project.

i Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the project are the on-site combustion of diesel fuel, oil and grease consumption and on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, oil and grease, electricity for use on-site and the transport of product material.

Estimated quantities of materials that have the potential to emit GHG emissions associated with Scope 1 and 2 emissions for the project have been summarised in Table 11.8

Table 11.8 Summary of annual quantities of materials estimated for the project

Type	Project	Units
Diesel	473	kL
Electricity	10	MWh
Oils and greases	2	kL

kL = kilolitres, t = tonne and MWh = megawatt hour

The quantity of diesel fuel required to transport the materials for the project to and from site has been estimated based on an approximate return travel distance. Table 11.9 summarises the estimated travel distance calculations.

Table 11.9 Estimated travel distance

Distance (km)	Amount of material transported (tpa)	Payload (t)	Estimated travel distance (km)
35	337,500	34	347,426
120	187,500	34	661,765
180	187,500	34	992,647
45	37,500	34	49,632

ii Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the project, emission factors obtained from the NGA Factors (Department of Climate Change, Energy, the Environment and Water, 2021b), were used, as summarised in Table 11.10

Table 11.10 Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
Diesel	38.6	69.9	0.1	0.2	kg CO_2-e/GJ	1
		17.3	-	-		3
Petroleum based greases	38.8	3.5	-	-	kg CO_2-e/GJ	1
		18	-	-		3
Electricity	-	0.73	-	-	kg CO_2-e/kWh	2
		0.06	-	-		3

11.2.2 Assessment of impacts

Table 11.11 summarises the estimated annual CO_2-e emissions due to the project.

Table 11.11 Summary of CO2-e emissions for the project (t CO2-e)

Distance (km)	Amount of material transported (tpa)	Payload (t)	Estimated travel distance (km)
Diesel	1,281	-	316
Electricity	-	7	0.6
Oils and greases	0.3	-	1
Transport of product	-	-	2,952
Total	**1,281**	**7**	**3,269**

Table 11.12 summarises the emissions associated with the project based on Scopes 1, 2 and 3.

Table 11.12 Summary of CO2-e emissions per scope (kt CO2-e)

Period	Scope 1	Scope 2	Scope 3
Annual	1,281	7	3,629

The estimated annual greenhouse emissions for Australia during 2022 was 486.9 Mt CO_2-e (Department of Climate Change, Energy, the Environment and Water, 2022b). In comparison, the estimated annual average greenhouse emission for the project is 0.001 Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the project in comparison to the Australian greenhouse emissions for the 2022 period is estimated to be approximately only 0.0003%.

At a state level, the estimated greenhouse emissions for NSW in the 2019 period was 136.6Mt CO_2-e (Department of Climate Change, Energy, the Environment and Water, 2022b). The annual contribution of greenhouse emissions from the project in comparison to the NSW greenhouse emissions for the 2019 period is estimated to be approximately only 0.001%.

The estimated GHG emissions generated in all three scopes are based on approximated quantities of materials and where applicable, generic emission factors. Therefore, the estimated emissions for the project are considered conservative (TAS, 2023).

As noted in the project alternatives (Section 2.2.3 of this EIS), should operations at the quarry cease, then Boral would need to utilise alternate quarries to service construction with the Sydney region. As these quarries are located at a greater distance to the end user the emissions from transport would be greater.

11.2.3 Management and mitigation measures

The project shall utilise various management and mitigation measures to minimise the overall generation of GHG emissions. Some examples of GHG management practices that could be applied during construction and operation of the project include:

- investigating ways to reduce energy consumption throughout the life of the project and reviewing energy efficient alternatives;
- ensuring regular maintenance of plant and equipment;
- ensuring plant and equipment are switched off when not in use;
- monitoring the consumption of fuel and regularly maintaining diesel powered equipment to ensure operational efficiency;
- monitoring the total site electricity and investigating avenues to minimise consumption; and
- sourcing consumable materials from environmentally sustainable sources.

12 Noise

A noise impact assessment (NIA), prepared by RWDI Australia Pty Ltd (RWDI, 2023) to accompany this EIS, is provided in Appendix J.

Table 12.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the NIA.

Table 12.1 SEARs (noise)

Relevant SEARs	Section EIS addressed
DPE – Planning (noise)	
A detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy	Section 12.1 - Assessment methodology Section 12.2 - Impact assessment Appendix J - Noise impact assessment
If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely noise impacts of those activities under the Interim Noise Construction Noise Guideline	Section 12.1.6 - Sources of construction noise and assessment scenarios Section 12.2.6 - Construction noise levels
Include reasonable and feasible mitigation measures to minimise noise emissions	Section 12.3 - Management measures
Include consideration of monitoring and management measures, in particular, real-time and attended noise monitoring	Section 12.3 - Management measures
EPA (Noise)	
Construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC, 2009)	Section 12.1.6 - Sources of construction noise and assessment scenarios Section 12.2.6 - Construction noise levels
Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the Assessing Vibration: a technical guideline (DEC, 2006)	No significant sources of vibration have been identified for the project. Additionally, the distance between the quarry and the closest receivers is over 500 m). Therefore, a detailed assessment of potential vibration impacts is not considered warranted
If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990)	No blasting is required for the project and has therefore not been assessed
Operational noise from all industrial activities (including private haul roads and private railway lines) to be undertaken on the premises should be assessed using the guidelines contained in the NSW Noise Policy for Industry (EPA, 2017)	Section 12.1 - Assessment methodology Section 12.2 - Impact assessment Appendix J - Noise impact assessment
Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the NSW Road Noise Policy and associated application notes (EPA, 2011)	Section 12.1.7 - Road traffic noise criteria Section 12.2.8 - Road traffic noise

12.1 Assessment methodology

Operational noise emissions from the project were predicted at sensitive residential receivers using the CadnaA acoustic noise prediction software and the CONCAWE noise prediction algorithm. The predictions were compared to the noise criteria in the EPA's *Noise Policy for Industry* (NPfI) (EPA, 2017a).

Minor construction works are proposed for the project and potential noise emissions from these activities were considered under the NSW Government's *Interim Construction Noise Guideline* (ICNG) (DECCW, 2009).

The project would generate heavy vehicle movements along Nelson Bay Road, Cabbage Tree Road and Medowie Road, and therefore a detailed assessment of road traffic noise was conducted in accordance with the NSW Government's *NSW Road Noise Policy* (RNP) (DECCW, 2019).

12.1.1 Sensitive receivers

The NIA considered potential noise impacts of the project during operation on 35 nearby residential receivers. Details of these receivers are provided in Table 12.2 and shown in Figure 12.1.

Table 12.2 Sensitive receiver locations

Receiver	Address	Proximity to the project
R1	11 George Street, Fullerton Cove	Lot 7 DP 255734
R2	9 George Street, Fullerton Cove	Lot 6 DP 255734
R3	14 George Street, Fullerton Cove	Lot 8 DP 255734
R4	12 George Street, Fullerton Cove	Lot 9 DP 255734
R5	Unknown Address, Fullerton Cove	Lot 5 DP 1105459
R6	6 Coxs Lane, Fullerton Cove	Lot 6 DP 998656
R7	1 Zircon Lane, Fullerton Cove	Lot 72 DP 876716
R8	17a Coxs Lane, Fullerton Cove	Lot 8 DP 742586
R9	12 Coxs Lane, Fullerton Cove	Lot 1 DP 120634
R10	10 Coxs Lane, Fullerton Cove	Lot 11 DP 881613
R11	4 Coxs Lane, Fullerton Cove	Lot 1 DP 724265
R12	306 Fullerton Cove Road, Fullerton Cove	Lot 100 DP 819758
R13	304 Fullerton Cove Road, Fullerton Cove	Lot 101 DP 819758
R14	14 Tuckeroo Circuit, Fern Bay	Lot 28 DP 280063
R15	16 Tuckeroo Circuit, Fern Bay	Lot 29 DP 280063
R16	18 Tuckeroo Circuit, Fern Bay	Lot 30 DP 280063
R17	20 Tuckeroo Circuit, Fern Bay	Lot 31 DP 280063
R18	22 Tuckeroo Circuit, Fern Bay	SP98989
R19	101 Norfolk Street, Fern Bay	Lot 49 DP 280063
R20	99 Norfolk Street, Fern Bay	Lot 48 DP 280063
R21	97 Norfolk Street, Fern Bay	Lot 47 DP 280063
R22	93 Norfolk Street, Fern Bay	Lot 45 DP 280063
R23	91 Norfolk Street, Fern Bay	Lot 44 DP 280063

Table 12.2 Sensitive receiver locations

Receiver	Address	Proximity to the project
R24	2 Uralla Street, Fern Bay	Lot 43 DP 280063
R25	87 Norfolk Street, Fern Bay	Lot 37 DP 280057
R26	85 Norfolk Street, Fern Bay	Lot 38 DP 280057
R27	81 Norfolk Street, Fern Bay	Lot 40 DP 280057
R28	79 Norfolk Street, Fern Bay	Lot 41 DP 280057
R29	77 Norfolk Street, Fern Bay	Lot 42 DP 280057
R30	75 Norfolk Street, Fern Bay	Lot 43 DP 280057
R31	73 Norfolk Street, Fern Bay	Lot 44 DP 280057
R32	71 Norfolk Street, Fern Bay	Lot 45 DP 280057
R33	69 Norfolk Street, Fern Bay	Lot 46 DP 280057
R34	248 Fullerton Cove Road, Fullerton Cove	Lot 3421 DP 1232950
R35	260 Fullerton Cove Road, Fullerton Cove	Lot 1 DP 745337

12.1.2 Noise criteria

i Existing noise levels

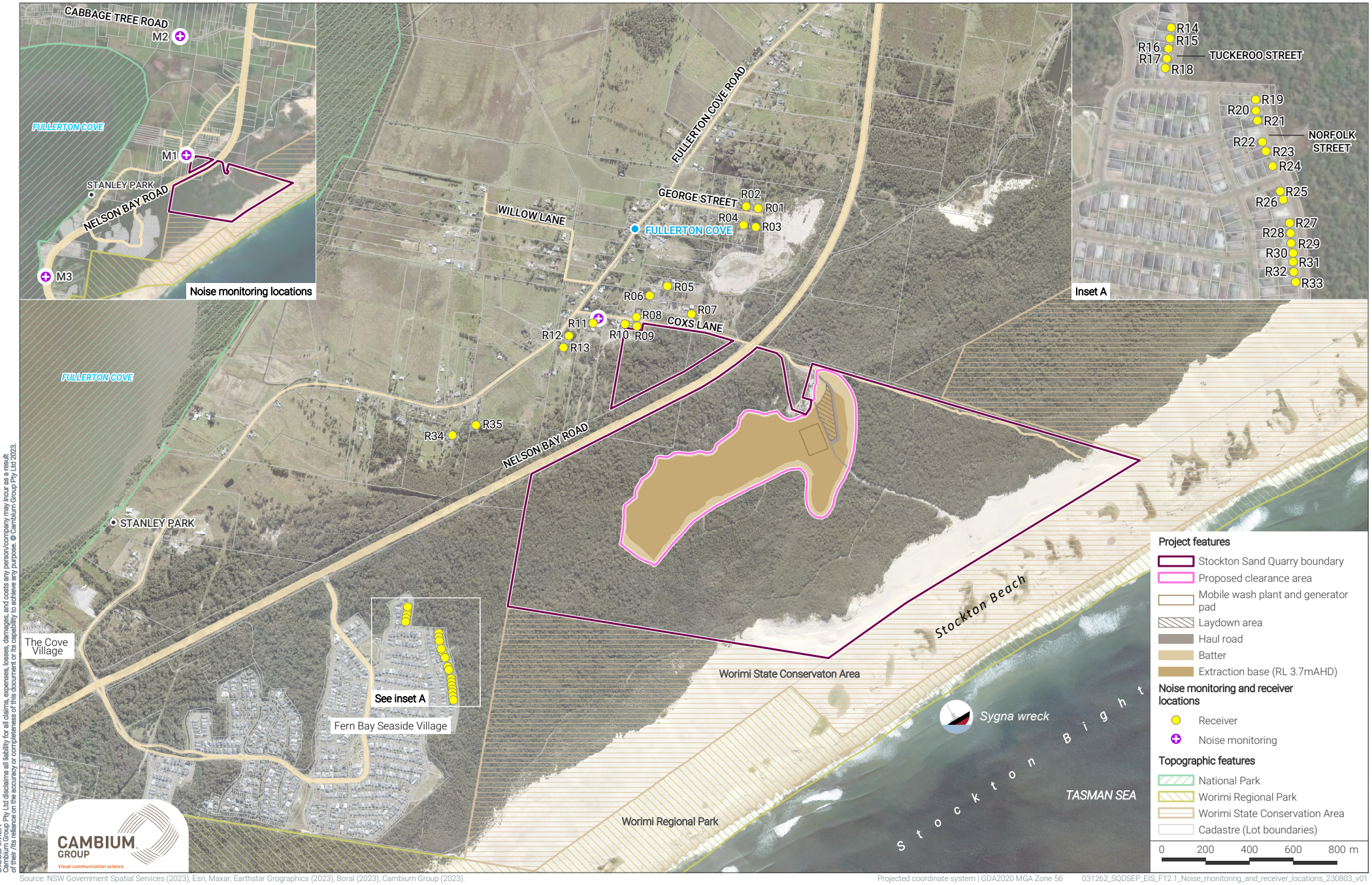
To establish the existing ambient and traffic noise levels of the nearest residential areas, unattended environmental noise monitoring was conducted between 27 March and 6 April 2023. As presented in Table 12.3, the monitoring was undertaken at three locations. Figure 12.1 presents the location of noise monitoring relative to the project.

Table 12.3 Noise monitoring locations

Location	Purpose	Address
M1	Existing ambient noise levels	4 Coxs Lane, Fullerton Cove (R11)
M2	Existing traffic noise levels	157 Cabbage Tree Road, Williamtown
M3	Existing traffic noise levels	1051 Nelson Bay Road, Fern Bay

Figure 12.1

Noise monitoring and receiver locations



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Source: NSW Government Spatial Services (2023), Esri, Maxar, Earthstar Grographics (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56

Table 12.4 presents the existing ambient noise levels, measured in decibels (dBA) and showing the rating background level (RBL) and the equivalent sound level period (L_{Aeq}) for the AM shoulder, day, evening and night time periods.

Table 12.4 Existing ambient noise levels

Monitoring location	Time of day[1]	Noise levels (dBA)	
		RBL	L_{Aeq}, period
M1	AM shoulder	37	49
	Day	37	53
	Evening	37	62
	Night	35	47
M2	AM shoulder	432	62
	Day	43	64
	Evening	432	63
	Night	40	58
M3	AM shoulder	44	68
	Day	58	71
	Evening	51	69
	Night	39	64

Note [1]: Day = 7:00 am – 6:00 pm; Evening = 6:00pm – 10:00 pm; Night = 10:00 pm – 7:00 am; AM Shoulder = 5:00 am – 7:00 am

Table 12.5 presents the measured road traffic noise levels on Nelson Bay Road and Cabbage Tree Road.

Table 12.5 Measured traffic noise levels

Location	Day L_{AEQ}, 15hour	Night L_{AEQ}, 9hour
M2	59	47
M3	71	64

ii EPL Licence conditions

Section L3 of Boral's EPL states the noise limit conditions. These conditions are described in Table 12.6 below. Compliance with Limit L3.1 is to be assessed in conjunction with operational noise criteria outlined in the NPfI.

Table 12.6 Noise monitoring locations

Limit	Description
L3.1	Noise emissions from the premises must not exceed an L_{aeq} 15 minute noise emission criterion of 35 dB(A) at the nearest residential receiver.
L3.2	Noise from the premises is to be measured at the worst affected point or within the residential boundary, or the most affected point within 30 m of a dwelling (rural situations) where the dwelling is more than 30 m from the boundary, to determine compliance with the noise limit in this licence.
L3.2	The noise emission limit identified in this licence applies in the following weather conditions: - wind speed up to 3 m/s at 10 m above ground level; or - temperature inversion conditions of up to 3 C/100m and wind speed up to 2 m/s at 10 m above ground level.

12.1.3 Operational noise criteria

The NPfI provides a framework for assessing environmental noise impacts from industrial premises and industrial development proposals in New South Wales.

The NPfI recommends the development of project noise trigger levels (PNTLs), which provide a benchmark for assessing a proposal or site. The project noise trigger levels should not be interpreted as mandatory noise criteria, but rather as noise levels that, if exceeded, would indicate a potential noise impact on the community.

The project noise trigger level is the lower value of the project intrusiveness noise level and the project amenity noise level. The project intrusiveness noise level assesses the likelihood of noise being intrusive above the ambient noise level and is applied to residential receivers only. The project amenity noise level ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level (RWDI, 2023).

i Project noise trigger levels

Table 12.7 shows the project noise levels for all the sensitive receivers, with the PNTLs shown in bold.

Table 12.7 Project noise trigger levels

Receiver	Time of day[1]	Project intrusiveness Noise levels (L_{LAEQ}, 15min dBA)	Project amenity Noise levels (L_{LAEQ}, 15min dBA)
All	Morning shoulder[2]	**42**	n/a2
	Day	**42**	53
	Evening	**42**	43
	Night	40	38

Note [1]: Day = 7:00 am – 6:00 pm; Evening = 6:00pm – 10:00 pm; Night = 10:00 pm – 7:00 am; AM Shoulder = 5:00 am – 7:00 am
Note [2]: The NPfI does not specify amenity noise levels for shoulder periods

The NPfI recommends that, where the night time LA_{max} (being the maximum noise level over the sample period) receiver noise levels from a development exceeds 52 dBA or the RBL plus 15 dBA, whichever is the greater, then a more detailed assessment of potential sleep disturbance impacts is warranted. Table 12.8 presents the maximum noise trigger levels for the receivers identified in Table 12.2.

Table 12.8 Maximum noise trigger levels

Receiver	Night RBL (dBA)	RBL + 15 dBA	Maximum Noise Trigger Level (dBA)
All	35	50	52

12.1.4 Sources of operational noise and assessment scenarios

The NIA identified the following major noise sources associated with the operation of the project and assumed sound power levels based on previous measurements of similar equipment conducted by RWDI on similar sites, including the Boral operated Dunmore Lakes Sand Project:

- mobile plant, such as excavator, dozer, front end loader (FEL) and dump trucks;
- the mobile screen (Stage 1);
- the wash plant and water recycling facility (Stage 2 onwards);
- the booster pump; and

- road trucks exporting sand and importing virgin excavated natural material (VENM) during rehabilitation.

The following two separate scenarios were chosen for modelling that represent the worst-case scenarios for the nearby residential receivers.

- **Scenario 1** - considers Stage 1 where receivers to the north-west would be worst impacted given that a significant portion of the plant and activity would be located at the northern most part of the site, and noting that during Stage 1, extraction would still be taking place in the windblown sand extraction area at the same time.
- **Scenario 2** - considers Stage 5, as Stages 2-5 would be reasonably similar, and this is when plant and activities would be closest to the Fern Bay receivers to the south-west of the site.

The list of plant modelled in each scenario is presented in Table 4-1 in the NIA (Appendix J of this EIS).

12.1.5 Construction noise criteria

The ICNG requires project-specific noise management levels (NMLs) to be established for noise affected receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

In consideration of the proposed construction hours (7 am – 6 pm Monday to Friday, 8 am – 1 pm Saturday with no work on Sundays or Public Holidays), Table 12.9 presents the applicable NMLs for construction activities at all surrounding receivers that have been adopted.

Table 12.9 Site specific construction NMLs (standard hours)

Receiver	NML
All residential receivers	52

12.1.6 Sources of construction noise and assessment scenarios

The following three construction stages and sources of construction noise were developed for the construction noise modelling to represent worst case scenarios:

- **Stage 1** – Vegetation clearing and road construction;
- **Stage 2** – Earthworks and concrete slab; and
- **Stage 3** – Tank and building construction.

A list of plant modelled in each scenario and the estimated sound power level (SWL) is presented in Table 5-1 in the NIA (Appendix J).

12.1.7 Road traffic noise criteria

The RNP provides criteria for managing noise levels associated with a development that would increase traffic on a particular road.

Although trucks accessing the site would continue to operate in the same manner as for the current operations, the increase in total sand dispatched to 750,000 tpa would result in additional trucks on the surrounding road network until 2028 (or until the current dredge application is approved and commenced).

It is also proposed to import 70,000 tpa of VENM/sand post 2028, which would be utilised for stabilisation works as required within the site.

The RNP assessment criteria for residential land uses are presented in Table 12.10.

Table 12.10 Road traffic noise assessment criteria for residential receivers

Road category	Type of proposal/land use	Noise criteria (dBA)	
		Day (7am – 10 pm) (dBA)	Night (10pm – 7am) (dBA
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use development	L_{Aeq},15hr 60 (external)	L_{Aeq},9hr 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use development	L_{Aeq},1hr 55 (external)	L_{Aeq},1hr 50 (external)

12.2 Impact assessment

12.2.1 Operational noise levels - predicted daytime (L_{Aeq},15 min)

The predicted L_{Aeq},15min noise levels associated with the operation of the project during the day period are presented in Table 12.11.

There are no exceedances of the project noise trigger level for either scenario during the day period.

Table 12.11 The predicted L_{Aeq},15min noise levels (day period)

Receiver	Project Noise Trigger Level (L_{Aeq},15min dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R01	42	29	29	Yes
R02	42	30	29	Yes
R03	42	30	29	Yes
R04	42	31	30	Yes
R05	42	28	32	Yes
R06	42	27	31	Yes
R07	42	28	33	Yes
R08	42	27	32	Yes
R09	42	27	33	Yes
R10	42	27	31	Yes
R11	42	25	31	Yes
R12	42	24	31	Yes
R13	42	24	31	Yes
R14	42	21	24	Yes
R15	42	20	24	Yes
R16	42	20	24	Yes
R17	42	21	24	Yes

Table 12.11 The predicted L_{Aeq},15min noise levels (day period)

Receiver	Project Noise Trigger Level (L_{Aeq},15min dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R18	42	20	23	Yes
R19	42	25	27	Yes
R20	42	24	26	Yes
R21	42	23	26	Yes
R22	42	25	26	Yes
R23	42	25	26	Yes
R24	42	23	25	Yes
R25	42	22	25	Yes
R26	42	22	24	Yes
R27	42	21	23	Yes
R28	42	20	23	Yes
R29	42	20	23	Yes
R30	42	19	23	Yes
R31	42	18	22	Yes
R32	42	18	22	Yes
R33	42	18	22	Yes
R34	42	23	30	Yes
R35	42	23	30	Yes

12.2.2 Operational noise levels - predicted AM shoulder (L_{Aeq},15 min)

Table 12.12 presents the predicted L_{Aeq},15min noise levels associated with the operation of the project during the AM shoulder period.

There are no exceedances of the project noise trigger level for either scenario during the AM shoulder period.

Table 12.12 Predicted L_{Aeq},15min noise levels (AM shoulder period)

Receiver	Project Noise Trigger Level (L_{Aeq},15min dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R1	42	29	29	Yes
R2	42	30	29	Yes
R3	42	30	29	Yes
R4	42	31	30	Yes
R5	42	28	32	Yes
R6	42	27	31	Yes
R7	42	28	33	Yes
R8	42	27	32	Yes
R9	42	27	33	Yes

Table 12.12 Predicted L_{Aeq},15min noise levels (AM shoulder period)

Receiver	Project Noise Trigger Level (L_{Aeq},15min dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R10	42	27	31	Yes
R11	42	25	31	Yes
R12	42	24	31	Yes
R13	42	24	31	Yes
R14	42	21	24	Yes
R15	42	20	24	Yes
R16	42	20	24	Yes
R17	42	21	24	Yes
R18	42	20	23	Yes
R19	42	25	27	Yes
R20	42	24	26	Yes
R21	42	23	26	Yes
R22	42	25	26	Yes
R23	42	25	26	Yes
R24	42	23	25	Yes
R25	42	22	25	Yes
R26	42	22	24	Yes
R27	42	21	23	Yes
R28	42	20	23	Yes
R29	42	20	23	Yes
R30	42	19	23	Yes
R31	42	18	22	Yes
R32	42	18	22	Yes
R33	42	18	22	Yes
R34	42	23	30	Yes
R35	42	23	30	Yes

12.2.3 Environmental protection license noise limits

As considered in Section 1.4 of this EIS, EPL Limit L3.1 states that noise emissions from the premises must not exceed an L_{Aeq} 15min noise emission criterion of 35 dBA at the nearest residential receiver.

The NIA modelling predicted a maximum L_{Aeq} 15min noise level at any receiver of 33 dBA. Compliance with this limit condition is therefore predicted to be achieved at all times.

12.2.4 Cumulative noise impacts

The noise assessment methodology recommended by the NPfI implicitly considers potential cumulative impacts from multiple industrial activities through the amenity noise levels.

The NIA modelling predicted L_{Aeq} 15min noise levels are at least 10 dB below the recommended amenity noise level for the residential receivers of L_{Aeq} 15min 43 dBA during the night period and L_{Aeq} 15min 58 dBA during the day period. Therefore, noise emissions from the project would not increase the ambient noise level at surrounding receivers to above the recommended amenity noise level and would not result in an exceedance of cumulative noise goals.

12.2.5 L_{Amax} operational noise levels

A typical L_{Amax} sound power level can range from 3-7 dB above the operational L_{Aeq} sound power level. As detailed above, the predicted L_{Aeq} 15min noise levels during the morning shoulder period are well below the project specific criterion at each receiver. Given this, the project would also meet the maximum noise trigger levels presented in Table 12.8, and no further assessment of maximum noise levels was considered warranted.

12.2.6 Construction noise levels

Table 12.13 presents the predicted noise levels from proposed construction activity.

There are no exceedances of the NML (52 dBA) with the highest predicted noise level of 33 dBA occurring during the construction of Stage 1.

Table 12.13 Predicted construction noise levels

Receiver	NML	Predicted Noise Level L_{Aeq},15min dBA		
		Stage 1	Stage 2	Stage 3
R1	52	26	21	18
R2	52	26	21	18
R3	52	27	22	19
R4	52	27	22	19
R5	52	33	25	22
R6	52	32	21	18
R7	52	32	24	21
R8	52	33	21	16
R9	52	33	22	17
R10	52	32	22	16
R11	52	30	20	15
R12	52	30	19	14
R13	52	31	19	15
R14	52	23	13	8
R15	52	23	13	8
R16	52	24	14	9
R17	52	23	14	9
R18	52	21	12	8
R19	52	26	17	13
R20	52	26	17	12
R21	52	25	16	11
R22	52	26	18	13

Table 12.13 Predicted construction noise levels

Receiver	NML	Predicted Noise Level L_{Aeq},15min dBA		
		Stage 1	Stage 2	Stage 3
R23	52	26	18	13
R24	52	25	15	11
R25	52	22	13	9
R26	52	22	13	9
R27	52	21	11	7
R28	52	21	10	6
R29	52	21	10	6
R30	52	21	10	6
R31	52	20	10	5
R32	52	20	10	5
R33	52	20	10	5
R34	52	26	17	12
R35	52	28	19	13

12.2.7 Cumulative impacts of construction noise

Noise associated with construction activities would largely be indistinguishable from operational activities given similar plant would be deployed and construction activities would occur in areas adjacent to operational activities.

The highest noise level of 34 dBA is predicted at some of the receivers to the north when completing a logarithmic sum of predicted daytime operational noise levels and Stage 1 construction noise levels, which is below the construction NMLs, the operational noise PNTLs, and the EPL limits.

12.2.8 Road traffic noise

Based on information sourced from the TTIA (Traffix, 2023), the site would be accessed via the following routes:

- north onto Nelson Bay Road between Cabbage Tree Road and Cox Lane for access to the Central Coast, Sydney and Hunter Valley - this route accounts for approximately 50% of vehicle movements;
- south onto Nelson Bay Road between Cox Lane and Teal Street and Cormorant Road for access to the Newcastle area - this route accounts for approximately 45% of vehicle movements; and
- north onto Nelson Bay Road, north of Cabbage Tree Road and Medowie Road for access to Port Stephens and North Coast - this route accounts for approximately 5% of vehicle movements.

As considered further in Section 13.3.1 of this EIS, traffic generation from the project is predicted to result in an increase of 132 heavy vehicle movements (66 in, 66 out) during the peak day. Traffic movements on Saturdays are predicted to be minimal based on current operations and therefore assessment of Saturday movements has not been conducted.

Compliance is expected to be achieved on a busy day at all assessment locations, with predicted relative increases of less than 0.2 dB along all routes.

12.3 Management measures

The project has the potential to generate noise. Therefore, to ensure that activities associated with the project have a minimal effect on the surrounding environment and at residential receiver locations, where feasible and reasonable, the following management and mitigation measures shall be implemented:

During construction

- Prior to commencement of works a construction noise management plan (CNMP) shall be prepared and implemented in accordance with the requirements of the ICNG.
- Consultation with the local community shall continue to be undertaken to ensure potential construction noise impacts are adequately managed.
- If complaints of excessive noise occur, measures shall be undertaken to investigate the complaint, the cause of the complaint identified and changes to work practices implemented accordingly.
- Documentation and training of site staff shall occur to ensure the practices that produced the complaints are not repeated.
- A permanent 'register of complaints' shall be held and all complaints received shall be fully investigated and reported to management.

During operation

- All engines shall be turned off when not required.
- training of staff and employers shall be undertaken and shall include a noise awareness component, community consultation and response to complaints.
- The use of reversing alarms shall be minimised or alternatively 'squawkers' shall be installed.
- Plant and processes with reduced noise emissions shall be selected.
- A complaints handling process and noise monitoring procedures shall be undertaken in response to any complaints.

13 Traffic and transport

A traffic and transport impact assessment (TTIA) prepared by Traffix (Traffix, 2023) to accompany this EIS, is provided in Appendix K.

Table 13.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the TTIA.

Table 13.1 SEARs (traffic and transport)

Relevant SEARs	Where addressed in EIS
DPE – Planning (Traffic and transport)	
Accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products.	Section 13.2.1 - Traffic volumes
A road safety audit	Section 13.3.4 - Road safety
A detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network, having regard to the cumulative impacts of the development in relation to the proposed, approved and existing developments in the vicinity of the site in accordance with the Roads and Maritime Services NSW's *Guide to Traffic Generating Developments* (2002). This assessment must include a strategy to manage and/or minimise traffic impacts over the life of the development.	Section 13.2 - Assessment methodology Section 13.3 - Impact assessment Section 13.3.5 - Cumulative traffic impacts
TfNSW (General)	
Traffic Impact Assessment (TIA) be prepared by suitably qualified person/s in accordance with the Austroads Guide to Traffic Management Part 12, the complementary TfNSW Supplement and RTA Guide to Traffic Generating Developments.	Appendix K – Traffic and transport impact assessment
The TIA is to identify the impacts of the development and the proposed on-site and off-site measures proposed to mitigate the impacts of the development on any road or rail related infrastructure. The TIA must explain and justify all inputs informing the proposed mitigation measures and TIA conclusions.	Chapter 13 - Traffic and transport
The TIA should be tailored to the scope of the proposed development and include, but not necessarily be limited to, consideration of the following: A map of the proposed transport route/s identifying all public roads proposed to obtain access from the classified (State) road/s to the development site.	Chapter 13 - Traffic and transport Section 13.1 - Existing environment Figure 13.1 - Road hierarchy plan
The total impact of existing and proposed development on the road network with consideration for a 10 year horizon. This should include: Identify Annual Average Daily Traffic (AADT) volumes with percentage heavy vehicles along the transport route/s and diagrammatically demonstrate AM and PM peak hour movements at key intersections Background traffic data from published sources and/or recent survey data. The source of data and any assumptions are to be clearly explained and justified, including the growth rate applied to the future horizon The volume and distribution of existing and proposed trips to be generated by the construction, operational and decommission phases of the development. This should identify the maximum daily and hourly demands generated by the development, particularly where they coincide with the network peak hour.	Section 13.3.3 - Sensitivity testing (10-year growth)

Table 13.1 SEARs (traffic and transport)

Relevant SEARs	Where addressed in EIS
The type and frequency of design vehicles accessing the development site.	
Details of the road geometry and alignment along the identified transport route/s, including existing formations, crossings, intersection treatments and any identified hazards. This should include: An assessment of turn treatment warrants in accordance with the Austroads Guide to Traffic Management Part 6 and Austroads Guide to Road Design Part 4A for intersections along the identified transport route/s, identifying the existence of the minimum basic turn treatments and addressing the need for any warranted higher order treatments Swept path analysis demonstrating the largest design vehicle entering and leaving the development, and moving in each direction through intersections along the proposed transport route/s.	Chapter 13, Appendix K
Capacity analysis using SIDRA or other relevant application, to identify an acceptable Level of Service (LOS) at intersections with the classified (State) road/s, and where relevant, analysis of any other intersections along the proposed transport route/s.	Section 13.2 - Assessment methodology Section 13.3 - Impact assessment
A review of crash data along the identified transport route/s for the most recent 5 year reporting period and an assessment of road safety along the proposed transport route/s considering the safe systems principles adopted under Future Transport 2056.	Section 13.3.4 - Road safety
Strategic (2D) design drawings of all proposed road works and the site access demonstrating scope, estimated cost and constructability of works required to mitigate the impacts of the development on road safety, traffic efficiency and the integrity of transport infrastructure. Works must be appropriately designed for the existing posted speed limit.	Appendix K, Section 9.10.2 (noting no external works are considered necessary)
Site plan demonstrating site access, internal manoeuvring, servicing and parking areas consistent with the relevant parts of AS2890 and Council requirements.	Appendix K (Appendix A)
Details of measures to address impacts and/or provide connections for public transport services and active transport modes, such as, public and school bus services, walking and cycling.	Appendix K, Section 9.13
Details of measures to ameliorate the impacts of road traffic noise, dust, and/or glare generated along the proposed transport route/s.	Appendix K, Section 9.13
Details of any Traffic Management Plan (TMP) proposed to address the construction and operation phases of the proposed development. The TMP should be prepared and implemented in accordance with Australian Standard 1742.3 and the Work Health and Safety Regulation 2017. It is recommended that any TMP include, but not necessarily limited to, the following: A map of the primary transport route/s highlighting critical locations An induction process for vehicle operators and regular toolbox meetings Procedures for travel through residential areas, school zones and/or bus route/s Any proposed temporary measures such a Traffic Guidance Scheme (TGS) A Driver Code of Conduct for heavy vehicle operators A complaint resolution and disciplinary procedure	Appendix K, Section 9.16
Community consultation measures proposed for peak periods.	Appendix K, Section 9.15

Table 13.1 SEARs (traffic and transport)

Relevant SEARs	Where addressed in EIS
Where road safety concerns are identified at a specific location along the proposed haulage routes, TfNSW suggests that the TIA be supported by a targeted Road Safety Audit undertaken by suitably qualified persons in accordance with the Austroads Guidelines	Section 13.3.4 - Road safety
Any roadwork on classified State Road/s is to be designed and constructed in accordance with the current Austroads Guidelines, Australian Standards and TfNSW Supplements.	N/A - no roadwork proposed

13.1 Existing environment

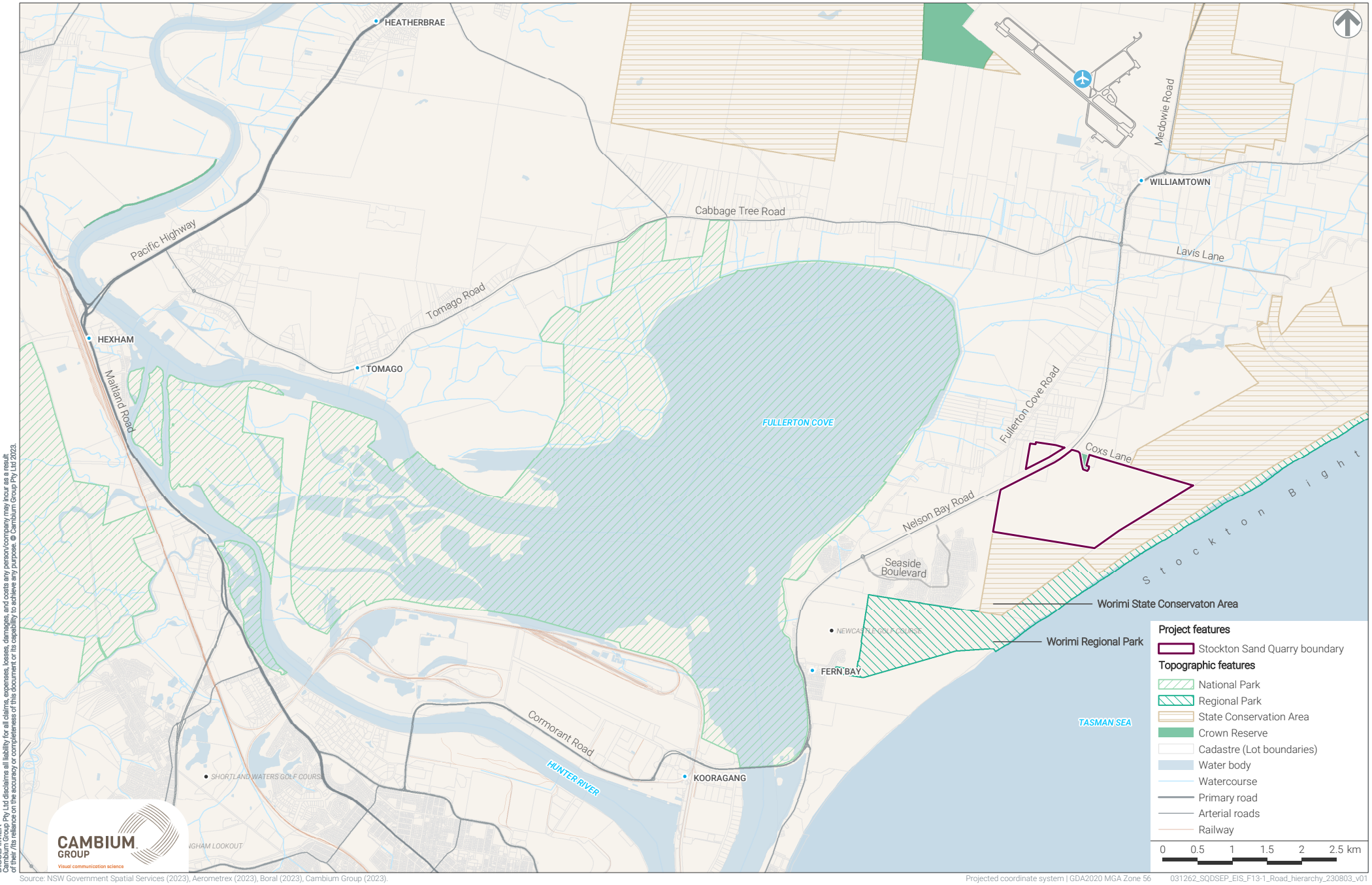
13.1.1 Road hierarchy

The road hierarchy in the vicinity of the quarry is shown in Figure 13.1, with a description of the roads provided in Table 13.2.

Table 13.2 Road hierarchy

Road	Description
Nelson Bay Road	A TfNSW Main Road (MR 108) that generally runs in a north to south direction between Galoola Drive in the north and Teal Street in the south. In the vicinity of the site, Nelson Bay Road is subject to a speed zoning of 100 km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along this road. Nelson Bay Road is an approved TfNSW 25/26 m B-double route.
Cabbage Tree Road	A TfNSW Main Road (MR 302) that generally traverses east to west between Nelson Bay Road in the east and Masonite Road in the west. In the vicinity of the site, Cabbage Tree Road is subject to a speed zoning of 60 km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along this road. Cabbage Tree Road is an approved TfNSW 25/26 m B-double route.
Seaside Boulevard	A local road that forms a loop between Nelson Bay Road in the northeast and the southwest. It is subject to a speed zoning of 60 km/h and carries a single lane of traffic in either direction. Kerbside parking is generally not permitted along either side of the road in the vicinity of the site.
Fullerton Cove Road	A local road that forms a loop between Nelson Bay Road in the northeast and the southwest. It is subject to a speed zoning of 70 km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along either side of the road.
Cox Lane	A local road that generally traverses east to west between the subject site in the east (32 Coxs Lane, Fullerton Cove) and Fullerton Cover Road in the west. It is subject to a speed zoning of 70 km/h and accommodates two-way flow of traffic. Kerbside parking is not permitted along either side of the road.
Lavis Lane	A local road that generally traverses east to west between Macs Trak in the east and Nelson Bay Road in the west. There is no posted speed limit along this road, and as such, a default local speed limit of 50 km/h is applicable. Kerbside parking is not permitted along either side of the road. Lavis Lane is an approved TfNSW 25/26 m B-double route.

Figure 13.1
Road hierarchy



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Projected coordinate system | GDA2020 MGA Zone 56

13.1.2 Key intersections

The key intersections in the vicinity of the site include:

- Nelson Bay Road, Cabbage Tree Road and Lavis Lane – a four legged roundabout intersection;
- Nelson Bay road and Cox Lane (on-ramp) – a three legged priority intersection;
- Nelson Bay Road and Cox lane (off-ramp) – a three priority intersection; and
- Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road – a four legged roundabout intersection.

13.2 Assessment methodology

The Signalised and Unsignalised Intersection Design and Research Aid (SIDRA) traffic modelling program was used to predict impacts on key intersections for the morning (AM) and afternoon (PM) peak hour periods using the existing traffic volumes together with the maximum additional vehicles generated by the project (worst case scenario).

The best criteria for assessing intersection performance are level of service (LoS), degree of saturation (DS), highest movement delay in seconds (HMD) and average vehicle delay (AVD).

Table 13.3 shows the LoS criteria for intersections identified in the (former) NSW Roads and Maritime Services (RMS) *Guide to Traffic Generating Developments* (RMS, 2002), noting that the design criteria for intersections is LoS D or better.

Table 13.3 LoS intersection performance indicators (TfNSW)

Level of service	Average delay per vehicle	Traffic signals, roundabout	Give way and stop signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents would cause excessive delays. Roundabouts require other control mode	At capacity and requires other control mode
F	More than 70	Unsatisfactory and requires additional capacity.	Unsatisfactory and requires other control mode or major treatment.

13.2.1 Traffic volumes

To determine the existing traffic conditions, a number of traffic surveys were conducted at key locations surrounding the site. Existing traffic volumes for both light and heavy vehicles during the critical morning and evening peak periods and overall daily volumes were ascertained and are presented in Figures 10-12 in the TTIA (Appendix K of this EIS). This data formed the base case volumes for software modelling undertaken to assess the performance characteristics of the key intersections under existing traffic conditions (as presented in Table 13.5 below).

In addition, data was available up until 2018 from the closest TfNSW permanent count station (located on Nelson Bay Road, approximately 5 km to the south-west of the site), which indicated that traffic along Nelson Bay Road had grown at approximately 2.5% per year over a five-year period (2014-2018).

13.2.2 Transport routes and truck types

There would be no change to the transport routes described in Section 1.5.2 of this EIS, which the Boral fleet of trucks currently use to transport sand product.

The fleet of trucks proposed to be used comprise:

- **Transport vehicles (sand product)**: Boral currently utilises 19 m truck and dogs to transport sand product out of the site. No changes are proposed to these arrangements.
- **Product transport vehicles (VENM)**: Trucks used to import VENM to the site would be a combination of both 19 m truck and dog vehicles and 12.5 m heavy rigid vehicles (HRVs). Approximately 75% of the total vehicles are anticipated to be 19 m truck and dogs with the remainder being HRVs.

13.2.3 Parking requirements

i Car parking

The *Port Stephens Council Development Control Plan 2021* (DCP 2021) does not provide a car parking rate in relation to quarry developments. As such, a first principles assessment was undertaken to determine the car parking requirements for the project.

The quarry currently provides an informal car parking area which accommodates all staff. The project would result in six full-time employees and two casual employees. Assuming a 100% car driver modal split, there would be a requirement for eight staff car parking spaces on site.

The main parking area and the proposed overflow sealed parking area at the entrance to the quarry (refer Figure 3.1) could accommodate approximately 15 cars and would therefore be able to provide adequate car parking, including for visitors and service personnel.

ii Bicycle parking

DCP 2021 does not provided a minimum requirement in terms of bicycle parking for quarry developments. Accordingly, no bicycle parking is proposed on site. This is considered appropriate for the nature of the site, which is generally isolated from cycling infrastructure and the use of the quarry itself resulting in a large number of heavy vehicle movements to and from the site.

iii Waste collection

The quarry currently accommodates 19 m truck and dogs circulating around the site. Therefore, all waste collection vehicles (whether private or Council) could be accommodated.

13.3 Assessment of impacts

13.3.1 Traffic generation (up until 2028)

The project would generate additional traffic on the public road network.

There would be a small increase in light, delivery and maintenance vehicles. The largest increase would be in product transport vehicles (heavy vehicles) associated with the additional site wide 250,000 tpa of sand production to 2028.

The importation of up to 70,000 tpa of VENM would also increase heavy vehicle movements entering and exiting the quarry.

Table 13.4 shows the daily two-way heavy vehicle movements generated by the existing quarry operations and those predicted to be generated for the project during the peak day to 2028.

Table 13.4 Heavy vehicle generation for existing and proposed operations (until 2028)

Activity	Peak day of existing operation	Peak day of project	Additional heavy vehicle movements
Sand product transportation	152	228	76
VENM importation	-	56	56
Total	152	284	132

The project would result in 132 additional heavy vehicle movements (66 in, 66 out) during the peak day until 2028. This is consistent with the predicted traffic generation for the current dredge application, noting that both traffic assessments included an assessment of the worst-case scenario of the transportation of up to 750,000 tpa of sand product until 2028.

Table 13.5 includes a summary of the modelled results and provides a comparison of the performance of the key intersections between the 'existing' approved scenario and the 'existing + development' proposed scenario.

Table 13.5 Intersection performance for existing and developed scenarios (until 2028)

Intersection	Control type	Scenario	Period	Degree of saturation	Average delay	Level of service
Nelson Bay Road, Cabbage Tree Road and Lavis Lane	Roundabout	Existing	AM	0.490	20.8	B
			PM	0.598	20.5	B
		Existing + development	AM	0.503	21.2	B
			PM	0.613	21.0	B
Nelson Bay Road and Cox Lane (On- Ramp)	Priority	Existing	AM	0.004	6.7	A
			PM	0.004	5.5	A
		Existing + development	AM	0.036	6.7	A
			PM	0.036	6.4	A
Nelson Bay Road and Cox Lane (Off- Ramp)	Priority	Existing	AM	0.003	5.7	A
			PM	0.007	6.4	A
		Existing + development	AM	0.047	6.7	A
			PM	0.043	7.1	A
Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road	Roundabout	Existing	AM	0.471	17.7	B
			PM	0.595	19.4	B
		Existing + development	AM	0.504	17.8	B
			PM	0.641	18.5	B

As shown in Table 13.5, there would be no change in the level of service of any of the four key intersections as a result of the project. The Nelson Bay Road, Cabbage,Tree Road and Lavis Lane intersection and the Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road intersection would continue to operate at a level of service B. The Nelson Bay Road and Cox Lane (on-ramp) and the Nelson Bay Road and Cox Lane (off-ramp) would continue to operate at a level of service A.

In summary, the 'existing + development' scenario would operate satisfactorily with no road network improvements required. Therefore, no strategic designs have been prepared for intersection upgrades as requested by TfNSW in the SEARs.

13.3.2 Traffic generation (after 2028)

After 2028, the project proposes to reduce sand production back to the existing approved level, which would not result in any additional sand product trucks over the approved development. The only increase in truck movements would be in relation to VENM trucks, which would result in 56 truck movements in the peak hour (28 in and 28 out), although noting that post 2028, the VENM trucks would transport both sand and VENM products.

13.3.3 Sensitivity testing (10-year growth)

Whilst the modelling of traffic growth up to 2028 represents standard practice based on relevant TfNSW guidelines, to address the SEARs and to provide input to Council and TfNSW in relation to their ongoing strategic planning responsibilities, further modelling has been undertaken that reflects a 10-year growth scenario, arising from 10 years of 'background' traffic growth at a rate of 2.5% per annum (refer Section 13.2.1).

The results of this sensitivity testing for both 'existing' and 'existing + development' scenarios are provided in Table 13.6.

Table 13.6 Sensitivity tests for existing and developed scenarios (10-year growth)

Intersection	Control type	Scenario	Period	Degree of saturation	Average delay	Level of service
Nelson Bay Road, Cabbage Tree Road and Lavis Lane	Roundabout	10 year (existing)	AM	0.640	24.2	B
			PM	0.887	75.7	F
		10 year (existing + development)	AM	0.656	25.4	B
			PM	0.945	121.7	F
Nelson Bay Road and Cox Lane (On- Ramp)	Priority	10 year (existing)	AM	0.006	6.7	A
			PM	0.005	5.5	A
		10 year (existing + development)	AM	0.037	6.7	A
			PM	0.036	6.4	A
Nelson Bay Road and Cox Lane (Off- Ramp)	Priority	10 year (existing)	AM	0.003	5.7	A
			PM	0.008	6.4	A
		10 year (existing + development)	AM	0.048	6.7	A
			PM	0.044	7.1	A
Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road	Roundabout	10 year (existing)	AM	0.603	58.4	E
			PM	0.786	43.1	D
		10 year (existing + development)	AM	0.637	85.0	F
			PM	0.839	75.1	F

As shown in Table 13.6, the only change in the level of service is at the Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road intersection, which is predicted to change from a level of service E to a level of service F in the AM period and from a level of service D to a level of service F in the PM period.

This indicates that the intersection would be at capacity in 2032 and TfNSW may need to explore a higher order of intersection control. However, it is emphasised that the above is in relation to the growth rate applied to background (existing) traffic only. This outcome reflects conditions arising from 10 years of 'background' traffic growth at a rate of 2.5% per annum, which is a cumulative increase of 25% on all movements at all intersections. These are increases that are likely to occur irrespective of the project and the need for improvements is the responsibility of TfNSW in addressing their respective strategic planning responsibilities.

13.3.4 Road safety

As part of the TTIA a road safety analysis was undertaken which considered crash data obtained from TfNSW for the length of Nelson Bay Road between Cabbage Tree Road and Fullerton Street for a five-year reporting period between 2017 and 2021. From the crash statistics (presented in Table 9 of the TTIA – refer Appendix K of this EIS), no discernible pattern was recognised, and therefore no intersection treatment or remedial measures have been recommended.

An independent Stage 5 road safety audit has been conducted along Nelson Bay Road between Cabbage Tree Road and Fullerton Street. The audit identified several minor maintenance issues, which are the responsibility of TfNSW, but did not identify any aspects that would compromise the safety of the road network.

13.3.5 Cumulative traffic impacts

A background traffic growth of 2.5% per annum on the intersections was modelled to assess potential cumulative impacts of the project, which demonstrated that at maximum production until 2028, all key intersections would continue to operate at a level of service A (the Nelson Bay Road and Cox Lane (on-ramp) and the Nelson Bay Road and Cox Lane (off-ramp)) and a level of service B (The Nelson Bay Road, Cabbage Tree Road and Lavis Lane intersection and the Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road intersection).

14 Social

A social impact assessment (SIA) prepared by AIGIS Group (AIGIS) (AIGIS, 2023) to accompany this EIS, is provided in Appendix L.

Table 14.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the SIA.

Table 14.1 SEARs (social)

Relevant SEARs	Where addressed in EIS
DPE – Planning (social)	
Provide a Social Impact Assessment prepared in accordance with the Social Impact Assessment Guideline for State Significant Projects, paying particular consideration to: • how the development might affect people's way of life, community, access to and use of infrastructure, services and facilities, culture, health and wellbeing, surroundings, personal and property rights, decision-making systems, and fears and aspirations	Chapter 14 (and Appendix L)
• the principles in Section 1.2 of the guideline	Appendix L, Annexure 2 (SIA principles matrix)
• the review questions in Appendix C of the guideline	Appendix L, Annexure 2 (DPE Guidelines compliance matrix)
The EIS must detail the engagement undertaken and demonstrate how it was consistent with the Undertaking Engagement Guidelines for State Significant Projects. The EIS must detail how issues raised and feedback provided have been considered and responded to in the project	Section 14.2 – Assessment of impacts (and Appendix L, Sections 3, 5 and 6)

14.1 Assessment methodology

The SIA was prepared and informed by:

- the project SEARs;
- the requirements of DPE's *Social Impact Assessment Guideline for State Significant Projects* and its associated Technical Supplement (DPE, 2023).; and
- drawing on relevant material from the preceding SIA (Element, 2019) for the current dredge application.

14.1.1 Scoping process

The preceding SIA (Element, 2019) addresses the larger scale of the current dredge application. The application of the DPE scoping tool used for the preceding SIA (Element, 2019) was reviewed, with the conclusion that, given the lower risks of impacts from the project, it was appropriate to adopt those scoping outputs for the current SIA.

14.1.2 Stakeholder engagement

i Stakeholder engagement undertaken for the current dredge application

Stakeholder engagement activity was undertaken for the preceding SIA (Element, 2019) and determined the 'area of social influence'. The area was also adopted for the engagement proposed as part of the current SIA, as an appropriate representation of the local community. The area of social influence is shown in Figure 4.1.

Engagement methods

Community engagement activity was undertaken via several channels, which are presented in the table in Annexure 4 of the current SIA (Appendix L of this EIS).

Engagement outcomes

Limited responses to the engagement opportunities were reported. There were no responses to community notifications. One respondent attended the community drop-in session, the notification having been delivered to 130 properties in Fullerton Cove and Fern Bay. Feedback received during unstructured interviews indicated that the quarry's operations were not a matter of concern for the interviewed local parties.

As detailed in the *Response to Submissions Report Stockton Sand Quarry Dredging Report Volume 2*, prepared by Boral Land and Property Group (Boral, 2020), a total of 24 submissions were received during the exhibition period, 13 from government agencies and 11 from the public and local/community organisations and interest groups. Boral's report on these submissions indicates that these generally related to potential groundwater and aquifer impacts of proposed dredge operations. On this basis, these stakeholder submissions are generally not relevant to the project, with extraction to only occur above the water table.

ii Project specific engagement

As detailed in the current SIA, the population in the immediate vicinity of the quarry is most likely to experience effects from the operation of the project. The area of social influence is made up of the following three areas:

- **Fullerton Cove residential** – residential area to the west and north of the quarry.
- **Fern Bay Seaside Village** – a community title scheme to the south of the quarry.
- **The Cove Village** – a community title scheme within Fullerton Cove residential area.

A total of 125 properties were canvassed in the Fullerton Cove residential area, by direct mail delivered to each property.

Notification was provided to the strata management committee for The Cove Village. Attempt was made to contact/notify the manager/administrator for Fern Bay Seaside Village but no responses were received.

There was little response to local stakeholder engagement attempts for the project. Two responses were recorded, one of which was an incidental direct engagement, indicated that the quarry is not a matter of concern. It was also noted that sand produced by the quarry is essential to supporting industry and employment, which indicates a positive understanding of the need for sand extraction.

Generally, the engagement outcomes are consistent with expectations resulting from the limited community response received in relation to the larger dredge application.

A copy of the notification is included in Annexure 5 of the current SIA (Appendix L of this EIS).

14.2 Assessment of impacts

14.2.1 Identified impacts – stakeholder engagement

The engagement process produced limited stakeholder response in relation to the project. The two responses that were recorded did not identify any matters that could be characterised as presenting a risk of material negative impacts on stakeholders.

14.2.2 Identified impacts – scoping process

As detailed above, the scoping tool prepared for the preceding SIA (Element 2019) was conservatively adopted for the project, given the lesser scale of the project compared to the current dredge application. The preceding SIA (Element 2019) characterised potential impacts under the subcategory of 'public safety', comprising:

- health risk and nuisance factors from particulate matter (dust);
- increased noise associated with extraction activities, including vehicular movements;
- increased traffic volumes; and
- unauthorised access.

14.2.3 Predicted impacts

i Impacts in the immediate area

The project would increase production by 50% from current approved rates. This 50% increase in site production infers a commensurate increase in predicted impacts (i.e. dust, noise and traffic and transport) Historically, there have been limited complaints regarding the quarry's operations.

This EIS and the accompanying technical studies have assessed potential worst-case impacts of the quarry operating at a maximum production rate of 750,000 tpa until 2028, and has found that for air (refer Chapter 11, Appendix I of this EIS), and noise (including road noise) (refer Chapter 12, Appendix J of this EIS), there are no predicted exceedances of relevant criteria at any of the closest sensitive residential receptor/receiver locations. In addition, a suite of management and mitigation measures are proposed to further reduce potential impacts. In relation to transport (refer Chapter 13, Appendix K of this EIS), the assessment identified that the local road network and the key intersections providing access to the site, could accommodate the predicted project traffic growth and continue to operate at high levels of service (A and B) without the need for upgrades.

With regard to unauthorised access to the quarry site, Boral acknowledges that instances of intentional and unintentional unauthorised access have occurred and may also occur in the future. However, Boral has taken all reasonable and necessary steps to ensure the security of the site and the safety of the public. Staff efforts and quarry features include security fencing and lockable gates, high visibility line and signage, CCTV, safe batter requirements, trespass procedures, and operating. There is no evidence to suggest that the proposed operations under the project would materially increase or decrease the level of risk to the safety of the very small element of the public who might access the site without authorisation.

ii Impacts on the broader social locality

The project would provide socio-economic benefits to local communities. It would support direct and indirect commercial activity and employment. This in turn supports the households of these employees and in some instance business operators. The further consumption and investment activities of these households then supports additional economic benefits.

15 Aboriginal heritage

An Aboriginal cultural heritage assessment report (CHAR) prepared by Kelleher Nightingale Consulting Pty Ltd (KNC, 2023) to accompany this EIS, is provided in Appendix M.

Table 15.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the CHAR.

Table 15.1 SEARs (Aboriginal heritage)

Relevant SEARs	Where addressed in EIS
DPE – Planning (Engagement)	
During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners In particular you must consult with: • affected landowners • community groups • Aboriginal stakeholders • Port Stephens Council • The Biodiversity Conservation Division within the Department of Planning and Environment (the Department) • The Water Division within the Department • Heritage NSW • NSW Environment Protection Authority • Regional NSW – Mining, Exploration & Geoscience Division • Department of Primary Industries (including Agriculture and Fisheries) within the Department • Hunter Water Corporation • NSW Rural Fire Service • Transport for NSW	Section 15.1.2 – Aboriginal consultation
Heritage NSW	
Provide an Aboriginal Cultural Heritage Assessment Report (ACHAR) prepared in accordance with relevant guidelines, identifying, describing and assessing any impacts to Aboriginal cultural heritage sites or values associated with the site	Appendix M

15.1 Assessment methodology

The following assessment methods were used to inform the preparation of the CHAR, consistent with that undertaken for the CHAR for the current dredge application.

15.1.1 Desktop study

The NSW Aboriginal Heritage Information Management System (AHIMS) database was searched (March 2023) to identify any registered Aboriginal sites or places in the project site or surrounds.

Environmental features which could influence historic Aboriginal occupation of the locality were characterised, for example landscape, drainage, geology, soils, vegetation, fauna and climate.

Literature such as previous heritage assessments of the quarry and local area were reviewed to understand historical Aboriginal use of the area and customs.

Information gathered from the desktop study was used to develop a predictive model of what types of Aboriginal sites are likely to occur in the project site and the landforms they may be associated with.

The search of AHIMS and review of background information revealed there were no known Aboriginal archaeological sites in the project site. The potential for subsurface Aboriginal archaeological material in the project site is considered low and potential has not been indicated by previous archaeological investigations. The project site is generally highly disturbed due to previous disturbance associated with sand extraction.

15.1.2 Aboriginal consultation

Aboriginal stakeholders were consulted in accordance with OEH's *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH, 2010).

Information regarding the project was provided in a letter dated 9 February 2023. Information included an outline of the project, location of the study area, development approval context and relationship to the current dredge application.

Sixteen groups or individuals previously registered an interest in the current application assessment process, and three new stakeholders were identified as a result of the updated consultation. The new round of consultation also resulted in the identification of updated contact details for previously registered groups and in some cases a change in contact person.

The following 16 registered Aboriginal parties (RAPs) were consulted:

- Worimi Local Aboriginal Land Council (LALC);
- Murra Bidgee Mullangari Aboriginal Corporation;
- Didge Ngunawal Clan;
- Merrigarn Indigenous Corporation;
- Muragadi Heritage Indigenous Corporation;
- Nur-Run-Gee Pty Ltd;
- Lower Hunter Wonnarua Cultural Services;
- Worimi Traditional Owners Indigenous Corporation;
- A1 Indigenous Services;
- Murrooma Incorporated;
- Karuah Indigenous Company Pty Ltd;
- Widescope Indigenous Group;
- Worimi Conservation Lands Board of Management;
- Amanda Hickey Cultural Services;
- x3 Aboriginal stakeholders (details withheld);
- Kamilaroi Yankuntjatjara Working Group; and
- Steve Talbot (individual).

Responses relating to the proposed assessment methodology were received from three stakeholder groups: A1 Indigenous Services (A1), Amanda Hickey Cultural Services (AHCS), and Murra Bidgee Mullangari Aboriginal Corporation (MBMAC).

A1 stated that they had reviewed the project information and supported the proposed CHAR assessment methodology (email dated 6 March 2023).

AHCS expressed support for the proposed assessment methodology (email dated 6 March 2023).

MBMAC stated that they had read the project information and proposed assessment methodology and endorsed the recommended approach to the assessment (email dated 1 March 2023).

Several other responses were received from stakeholders who expressed interest in a potential on-site meeting to further discuss the project. It was considered that an on-site meeting was not required as the previous CHAR assessment for the current dredge application included a site visit and there was no change in the boundary for the new CHAR.

15.1.3 Archaeological survey

The project site was surveyed by an archaeologist and the RAPs as part of the current dredge application, which targeted ground exposures. The site inspection aimed to identify Aboriginal objects or sites (if present), assess the archaeological potential and sensitivity of the project site, and confirm the nature and extent of previous disturbance associated with the former inland extraction area. Any potential Aboriginal sites were to be photographed, and their locations recorded using global positioning system units.

Visual inspection of the project site confirmed the extent and nature of previous disturbance. Previously disturbed areas had little to no archaeological potential given the previous removal of the dune mass. Ground surface exposure varied from high to low, with archaeological visibility obscured by vegetation and disturbed sands.

Large sections of the former dunes are absent, with the expansion of the central low-lying basin landform following extraction. The adjoining slopes to the west have also been modified as part of rehabilitation. The reinstated higher elevation slopes and crests to the south and west are heavily vegetated with native regrowth. Aerial imagery from 2004 shows the widespread disturbance prior to the rehabilitated landform.

Topsoil has been reintroduced to a number of areas and surface exposures were infrequent, and where present the visibility was generally low. No shell midden material or Aboriginal objects were observed in these areas. Scattered introduced fill and other rubble was also present on the surface in some of the larger exposures.

Ground disturbance from tracks and the former haul roads was evident in the central basin formed by the previous inland extraction area. Areas of lower disturbance along the southern margin of the project site were closely inspected but no archaeological sites or areas of potential were identified.

Other areas of lower disturbance associated with the remnant slope/crest landforms on the edges of the former inland extraction area were closely inspected, but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

In summary, no archaeological sites, Aboriginal objects or areas of Aboriginal archaeological potential (such as shell material) were identified within the project site. The archaeological potential for subsurface archaeological deposits was assessed as very low to nil given the extent of previous disturbance and the findings of previous archaeological assessments.

Therefore, further detailed investigation (test excavation) was not warranted to determine the nature, extent and significance of any archaeological sites and potential archaeological deposits in the project site.

15.2 Impact assessment

A review of background information revealed there were no known Aboriginal archaeological sites in the project site. The potential for Aboriginal archaeological material in the project site is low and has not been indicated by previous archaeological investigations.

The potential for subsurface midden sites has consistently been assessed as low and extensive previous investigations across the quarry have not detect any subsurface shell deposits or archaeological material.

Previous extraction for the inland extraction area is likely to have removed any once present archaeological material associated with the earlier Holocene foredune ridge plain at 5-10 m AHD. Given the indications from previous studies that midden material within the Phase I and II dune field occurs within the top 50 cm of the soil profile, the potential for deposit associated with these geomorphological elements has also been removed. The project site is therefore unlikely to contain any buried deposits associated with Aboriginal occupation.

The archaeological survey confirmed the extent and nature of previous disturbance, and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Areas of lower apparent disturbance (remnant slope/crest landforms on the edges of the former inland extraction area) were closely inspected but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

The project site does not display any scientific/archaeological significance as it does not contain any identified Aboriginal archaeological sites or areas of potential. The wider landscape encompassing the quarry retains Aboriginal cultural value and significance, including nearby traditional areas, movement routes, flora and fauna communities, natural landscape values and the linkages the landscape provides to ancestors and storylines.

The configuration of the project has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the project and the extent of the known resource. The project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider quarry site.

Impact to intrinsic Aboriginal cultural values of the surrounding landscape would also be minimal.

15.3 Management and mitigation measures

The following Aboriginal heritage management measures shall be implemented:

Heritage training and induction processes:

- Aboriginal heritage management procedures shall be included in quarry personnel training and induction processes.
- Aboriginal heritage management procedures and responsibilities for compliance shall form part of the project induction for quarry personnel (employees, contractors, subcontractors and/or agents). This shall include site identification (including heritage site map) to ensure all personnel are aware of Aboriginal heritage management responsibilities, issues affecting their activities and procedures for dealing with unexpected finds including human remains.

Avoiding impact to adjacent areas

- All works associated with the project shall be contained within the study area. Additional archaeological or Aboriginal heritage assessment shall be required for any proposed impacts outside the current study area.
- Aboriginal objects are known to occur in adjacent landforms and these shall be avoided by all proposed extraction activities. Management measures to be implemented shall include clear delineation of the boundary of the approved impact zone and the inclusion of Aboriginal heritage in the existing environmental management strategy for the quarry.
- Documented toolbox talks shall be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

Unexpected Finds Procedure

- Any unexpected Aboriginal heritage items (Aboriginal objects) shall be managed appropriately. In the event that an unexpected find (Aboriginal object) is encountered the following procedure shall apply:

- stop work and protect find area and report to environmental manager;
- contact heritage advisor for identification:
  - no further action if the find is not an Aboriginal object; and
  - if the find is an Aboriginal object proceed to next step;
- undertake relevant regulatory requirements and contact with DPE where required;
- implement conservation or mitigation strategy;
- obtain approval if required and comply with conditions; and
- recommence work.

Procedures for Handling Human Remains

- In the event that project operations reveal possible human skeletal material (remains), the following procedure shall be followed:
  - as soon as remains are exposed, all work shall halt at that location immediately and the quarry manager on site shall be immediately notified to allow assessment and management:
    - stop all activities;
    - secure the site; and
    - not further harm the remains.
  - contact police: the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic;
  - DPE, as the approval authority, shall be notified when human remains are found;
  - once the police process is complete and if remains are not associated with a contemporary crime, DPE shall determine the process:
    - if the remains are identified as Aboriginal, the site shall be secured and all Aboriginal stakeholders are to be notified in writing; or
    - if the remains are identified as non-Aboriginal (historical) remains then DPE heritage division shall be contacted as appropriate;
  - once the police process is complete and/or if the remains are identified as not being human work can recommence once the appropriate clearances have been given.

16 Economics

A surface water assessment, prepared by Southeast Engineering and Environmental (Southeast) (Southeast, 2023) to accompany this EIS, is provided in Appendix N.

Table 16.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the surface water assessment.

Table 16.1 SEARs (surface water)

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
A detailed site water balance for the life of the development, including a description of site water demands, water take from any water source, water disposal methods (inclusive of anticipated volumes, quality and frequency of any water discharges), water supply infrastructure and water storage structures as defined by the relevant Water Sharing Plan and in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012)	Section 16.2.1 – Site water balance Appendix N, Section 6
Identification of any licensing requirements or other approvals under the Water Act 1912 and/or the Water Management Act 2000	Section 16.2.1 vi and Section 5.3
Demonstration that water required for the construction and operation of the development can be obtained and maintained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP)	Section 16.1.3 – Existing water use and management
A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo with consideration to any water supply restrictions or water entitlement limitations	Appendix N, Section 1.4.1 and Section 5.0
An assessment of any likely flooding impacts of the development	Section 16.1.2 – Flooding
An assessment of the likely impacts (including cumulative impacts) on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	No surface water discharge
An assessment of the likely impacts (including cumulative impacts) of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users. This assessment must include a strategy for managing potential impacts during the life of the development and identify any conservation outcomes	No surface water discharge
DPE Planning (water and soils)	
• The EIS must describe background conditions for any water resource likely to be affected by the development, including: • existing surface and groundwater	Appendix N, Section 6.2.1
• hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	Section 16.2.1 – Site water balance
• water quality objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters	No surface water discharge

Table 16.1 SEARs (surface water)

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
• indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government	No surface water discharge
The EIS must assess the impact of the development on hydrology, including: • water balance including quantity, quality and source	Section 16.2.1 – Site water balance
• effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas	No surface water discharge
• effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems	No surface water discharge
• impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)	No surface water discharge
• changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water	Appendix N, Section 1.4.1 and Section 3.1.2
• mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and reuse options	No surface water discharge
• identification of proposed monitoring of hydrological attributes	No surface water discharge
The EIS must map the following features relevant to flooding as described in the *Floodplain Development Manual 2005* (NSW Government 2005) including: • flood prone land	
• flood planning area, the area below the flood planning level	Section 16.1.2 - Flooding
• hydraulic categorisation (floodways and flood storage areas)	Project external to floodplain
The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event	N/A
The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: • current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change	Site beyond the PMF extents – refer Section 16.1.2 - Flooding
Modelling in the EIS must consider and document: • the impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood	N/A
• impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments	N/A

Table 16.1 SEARs (surface water)

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories	
• relevant provisions of the NSW Floodplain Development Manual 2005	N/A
The EIS must assess the impacts on the proposed development on flood behaviour, including: • whether there will be detrimental increases in the potential flood affectation of other properties assets and infrastructure	N/A
• consistency with Council floodplain risk management plans	N/A
• compatibility with the flood hazard of the land	N/A
• compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land	N/A
• whether there will be adverse effect to beneficial inundation of the floodplain environment, on adjacent to or downstream of the site	N/A
• whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses	N/A
• any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council	N/A
• whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council	N/A
• emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES	N/A
• any impacts the development may have on the social and economic costs to the community as consequence of flooding	N/A
The EIS must describe the potential effects of coastal processes and hazards (within the meaning of the Coastal Management Act 2016), including sea level rise and climate change: • on the proposed development • arising from the proposed development	Section 5.3 – Other approvals Appendix N, Section 4.4
The EIS must consider have regard to any certified Coastal Management Program (or Coastal Zone Management Plan) and be consistent with the management objectives described in the Coastal Management Act 2016 and development controls for coastal management areas mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021*	Section 5.3 – Other approvals

16.1 Assessment methodology

The objectives of the surface water assessment are to address the SEARs by:

- describing the existing catchment conditions and flow regime and water quality of water resources in and adjacent to the project site;
- describing the proposed water management system, including water supply and demand requirements;
- assessing the potential impacts of changes to potential surface water flow and water quality from the project and identifying measures to prevent or manage these impacts;
- identifying a system to monitor project impacts on surface water and initiate additional management measures if required; and
- identify water licensing and approval requirements for the project.

16.1.1 Drainage and interaction with groundwater

As detailed in Section 2.3.2 of this EIS, the project site is a formed basin and has no surface flow connection to adjacent areas. There are no springs or permanent streams within the project site. Local hydrology is characterised by high infiltration rates associated with the porous sands over the quarry and the subsequent interaction with the unconfined aquifer below.

Surface runoff is limited to periods where the aquifer reaches surface levels. This predominantly occurs when rainfall intensity exceeds infiltration rates, resulting in complete saturation of the soil.

As identified in the groundwater assessment (refer Chapter 7, Appendix E of this EIS) and as considered further in Section 7.2.1 of this EIS, the maximum height of the water table across the site is approximately 3 m AHD. To ensure that the project does not intercept groundwater a minimum 0.7 m buffer would be maintained between the water table and the level of extraction, with no extraction to occur below 3.7 m AHD.

16.1.2 Flooding

Flooding in the vicinity of the project site is influenced by floodwaters from the Hunter River that overtop the Fullerton Cove levee, and the severity is a function of the magnitude of flooding in the Hunter River, which in turn is influenced by a combination of sea level impacts and catchment runoff.

The project site is beyond Port Stephens Council's mapped flood hazard extents, which also include allowance for climate change impacts. Estimates of the 1% annual exceedance probability (AEP) flood level and probable maximum flood (PMF) level in the vicinity of the quarry are 1.5 m and 5.2 m AHD, respectively. Direct surface flood impacts from the Hunter River on the project site for the PMF or more frequent events are not expected; however, floodwaters for the PMF would impact on access to and from the quarry.

As outlined in the section above, potential water ponding within the site is primarily due to raised groundwater levels which can be exacerbated by ocean inundation and localised heavy rainfall. The relatively recent Pasha Bulker storm in 2007 produced groundwater levels of about 3.5 m AHD, an approximate 100-year average recurrence interval (ARI) event.

16.1.3 Existing water use and management

i Water access licence and allocation

a Stockton Groundwater Source allocation

The site is located over the Stockton Groundwater Source (SGS) which is regulated by the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016.

The WSP specifies the planned environmental water provisions, water for basic landholder rights, share components of existing aquifer access licenses and long term average annual extraction limits for this water source. As of April 2023, 1,827.5 shares have been allocated, leaving approximately 11,919 ML/yr unassigned, which may be made available as controlled allocations.

b Site allocation

As detailed in Table 16.2, Boral has obtained a number of Water Access Licences (WAL) with a range of allocations, the most recent of which is still to be registered. The total allocated share volume is 524 mega litres per year (ML/yr).

Table 16.2 Current water allocations

Site name	WAL No.	WAL Reference No.	Extraction/ category	Nominated works	Shares / volume (ML/yr)
Stockton Quarry	37223	20AL213136	Aquifer	No WSW nominated	0
Stockton Quarry	43827	20AL220991	Aquifer	20WA221084	100
Stockton Quarry	44499	20AL221243	Aquifer	No WSW nominated	320
Stockton Quarry	-	20AL221416	Aquifer	No WSW nominated	104*
Total					**524**

**Allocation made, but WAL No. currently not known.*

ii Haul roads

Dust suppression using water carts is carried out on the existing unpaved haul roads from the site office through to Stockton Beach. Water is currently purchased directly from mains supply and applied onsite with a Boral owned/operated Water cart. Dust suppression water use in 2018 was 15.2 ML over an area of approximately 3ha, equating to about 5 ML per hectare (ML/ha). The historical average water usage for dust suppression is approximately 12 ML/yr varying according to adjustments to haul roads, and climatic variations.

iii Office facilities

Apart from drinking water, which is supplied in 20 litre containers from a bottled water contractor, the remainder of water use for the office buildings and toilet facilities is supplied from a 10,000 litre rainwater tank, collecting office and shed roof water. Since installation in 2017, the tank has not required supplementary filling from a water contractor, although this is possible, if required.

Wastewater is treated via a septic system and collected in pump out tanks which are regularly emptied by a contractor and disposed off-site. Currently, approximately 5,000 litres are collected every seven weeks.

16.2 Impact assessment

16.2.1 Site water balance

The water balance for the site has the following three separate components:

1. water use and wastewater generation associated with the office and weighbridge facility;
2. water use associated with dust suppression as required over the site; and
3. water use associated with sand processing and losses associated with the moisture content of extracted material leaving the site.

ii Office and weighbridge facilities

Water demand at the office and weighbridge facility are not expected to change significantly for the project, Any changes to water demand or wastewater generation associated with the office and weighbridge area can be managed through purchase of additional mains water from water contractors if required and additional wastewater removal contractors. Currently, rainfall is sufficient for site demands and approximately 37,000 litres of collected wastewater is removed each year.

The project would increase staff numbers to up to six full time staff and two casual staff. The existing wastewater system can accommodate this additional load and pump out frequency can be increased when required.

iii Fire fighting

As considered further in Section 19.1.10, to accommodate fire fighting demands at the site, a 20,000 litre static rainwater tank is proposed adjacent to the existing maintenance shed. Roof water from the maintenance shed would be diverted into the storage tank and retained for firefighting purposes. An onsite bore would be used to maintain this supply (refer Table 16.2 - WAL: 43827. WSW: 20AL220991).

iv Dust suppression

Water is currently sourced from mains supply. However, given the significant allocations that Boral have available, this would shift to supply from the SGS.

As detailed in Section 3.2.5 of this EIS, dust suppression would be required for the new access servicing Stages 1 to 5 and operational/laydown area, where an area 200 m x 200 m (4 ha) has been assumed. Although the windblown haul road is unlikely to be in use when the full length of haul roads are created for the project, this has been included in the total dust suppression area to present a 'worst case' scenario for dust suppression.

Table 16.3 provides a summary of areas potentially requiring dust suppression.

Table 16.3 Dust suppression areas

Location	Area (ha)
Windblown access, including through Stage 1	3
Stages 2 to 5 access	0.85
Operational/laydown area	4
Total	**7.85**

Using a demand of 5 ML/ha/y based on existing records, suggests a potential maximum demand for dust suppression of 39.25 ML/y. This area would reduce at the end of 2028 when the windblown access is no longer in use, reducing the potential area by approximately 2 ha to 5.85 ha, and associated water use for dust suppression to 29.25 ML/yr.

v Sand extraction and processing

As the project proposes to only extract sand from above the water table, water use associated with extraction would be limited to:

- moisture content associated with dry screened material leaving the site; and
- process water within the wash and separation plant for washed sand at the site.

For dry extracted material, moisture content is estimated to be 3% for material excavated from above the water table, based on laboratory testing carried out by Coffey Partners and provided by Boral.

For processed sand passing through the wash plant, sand would leave the wash plant with a moisture content of approximately 12% based on processing flows as provided by Boral and the process machinery company. This water needs to be added to the plant to continue the process. Washed sand would be stockpiled on the site and some of the accumulated moisture would either infiltrate into the sand profile or evaporate. For the purpose of the site water balance assessment, it has been assumed that all 12% leaves the site and must be replaced.

The average annual extraction over the project would be approximately 413,000 tpa (i.e. 3.1 million tonnes over 7.5 years), the maximum dispatch of 750,000 tpa has been conservatively assumed for the site water balance assessment. Further, to present maximum use, it has been assumed that all extracted sand would be screened, washed and separated, not just directly exported

as a dry product. Therefore, maximum water use associated with processing would be 12% of 750,000 tpa, equating to 90 ML/yr. This could only occur until 2028, after which the windblown consent would lapse and extraction and dispatch would reduce to 500,000 tpa, with the associated maximum water use in processing reducing to 60 ML/yr.

Sand would be transported from the site after the stockpiles reach a moisture content of 3-5%, dependent on climactic conditions, with the water lost through evaporation or infiltration to groundwater. For the purpose of the water balance assessment, infiltrated water has been assumed to have left the system.

vi Results

Maximum water use from the SGS for the project is the total of dust suppression water use (39.25 ML/yr) and sand processing water use (90 ML/yr), a total of 129.25ML/y. This is a worst-case water use estimate as it includes a maximum area requiring dust suppression, and maximum extraction with all sand being washed.

Boral's current allocations of 524 share from the SGS are well in excess of the maximum water demand required for the project. As considered in Section 5.3 (Table 5.2) of this EIS, the water extraction from the SGS necessitate an aquifer interference approval under Section 91 of the WM Act.

Should the current dredge application be approved and dredging commences, then the additional losses associated with evaporation would need to be accounted for. As has been clarified by DPE - Water, immediate returns from the dredge could be credited back to the water source. In summary, should the dredge operation commence, water use would be a function of:

- evaporation as a function of dredge pond surface area;
- water used within the screen and wash plant, similar to the project; and
- dust suppression, similar to this project.

16.3 Management and mitigation measures

The following management and mitigation measures shall be implemented to manage surface water risks from the project:

Refuelling, hydrocarbon and chemical spills

- Standard hydrocarbon and chemical storage, handling and management techniques shall be implemented for the proposed diesel generator and wash plant areas, along with the existing maintenance shed and the existing Environmental Management Strategy for the site updated accordingly.

Sediment and erosion control

- Erosion prevention and sediment controls shall be implemented through the design of the haul roads and hardstand areas to limit concentrated flow paths and through the use of erosion and sediment controls during construction and operation.
- Haul road design/construction shall be undertaken in accordance with the following guidelines:
  - *Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries* (DECC, 2008);
  - *Managing Stormwater: Soils and Construction, Volume 1* (Landcom 2004); and
  - *Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction* (DECC 2008).

Flooding and inundation

- All fixed infrastructure such as the weighbridge, offices, diesel generators and wash plant shall be located above the maximum flood level of 3.5 m AHD.

- During surface extraction processes, machinery and portable screens shall be moved prior to increased groundwater levels. To predict these periods, rainfall and ocean level conditions shall be monitored through the BoM, including storm warnings for heavy rain and high seas.
- Groundwater levels shall be monitored and rates of movement noted - based on this information the quarry manager shall decide on precautionary measures to remove machinery from areas where groundwater flooding may occur.
- Mobile plant shall be stored in the maintenance depot when not in use.
- A groundwater inundation management plan shall be prepared that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.

Water quality and quantity monitoring

- Monitoring of water extraction and water use on site shall be undertaken to gather an accurate understanding of extractions from the groundwater source, monitoring of extractions for use on site, and the measurement of moisture content of sand material and sand material export.
- The following monitoring shall be undertaken:
    - metering of all extraction bores on site;
    - metering of water inputs to the sand processing wash plant;
    - fortnightly measurements of moisture content in exported material through stockpile measurements; and
    - records of material leaving the site.

17 Economics

An economic assessment, prepared by Gillespie Economics (Gillespie, 2023) to accompany this EIS, is provided in Appendix O.

Table 17.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the economic assessment, including the cost benefit analysis (CBA), local effects analysis (LEA) and supplementary local effects analysis of the project.

Table 17.1 SEARs (economic)

Relevant SEARs	Where addressed in EIS
DPE – Planning (economic)	
including a detailed assessment of the likely economic impacts of the development, paying particular attention to: • the significance of the resource	Chapter 17 – Economics Appendix O – Economic assessment
• the costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates	Section 17.1 – Cost benefit analysis
• the demand on local infrastructure and services	Section 17.1 – Cost benefit analysis

17.1 Cost benefit analysis

CBA is concerned with whether the incremental benefits of the project exceed the incremental costs and, therefore, whether the community would, in aggregate, be better off 'with' the project compared to 'without' it.

Under the base case, Boral would operate under the current approval until 2028, which permits extraction of up to 500,000 tpa. However, the current available resources under this consent are expected to run out in December 2023 and hence the base case is for no extraction of sand from the end of 2023 onwards.

In contrast, with the project, Boral proposes to extract approximately 3.1 Mt of sand from above the water table and seeks a site wide extraction limit of 750,000 tpa, until either the current dredge application is approved and dredging commences or the existing windblown project consent lapses in 2028, after which time the extraction limit would reduce to 500,000 tpa.

Relative to the base case, the project may have incremental economic benefits and costs as described in Table 17.2 below.

The main potential economic benefit is the producer surplus (net production benefits) generated from sand extraction, producer surplus generated from ex-quarry transportation to customers, and any wage benefits to employment. The main potential economic costs relate to any environmental, social and cultural costs of quarrying and product transportation.

The environmental, social and cultural costs are only economic costs to the extent that they affect individual and community well-being through direct use or non-use of the environmental factors. Unless community wellbeing is significantly affected by these, only mitigation, compensation or offsetting costs are included in the CBA.

The analysis period was eight years and was in real values with 7% discounting. Where available, competitive market prices were used as indicators of economic values.

17.1.1 Production cost

Production costs were applied as follows:

- Opportunity cost of land – the quarry is owned by Boral and the opportunity cost is equivalent to its undeveloped value, estimate in the order of $0.4 M for the approximately 38 ha project site.
- Development cost – incremental development costs of the project are largely associated with site infrastructure, estimated at 18 M and assumed to occur in 2024. Additional costs included in the development costs of the project, include:
  - an allowance for staged purchase of biodiversity credits ($4.7 M); and
  - opportunity cost of groundwater water access licences (WALs) ($0.6 M) included in 2024; and
- Annual operating costs – operating costs of $3.52 M per year include those associated with project operations progressive rehabilitation and administration (including labour) – operating costs do not include royalties or depreciation.
- Rehabilitation and decommissioning costs – the cost to decommission and rehabilitate the project site would be approximately $100,000.

17.1.2 Production benefits

Production benefits were applied as follows:

- Value of sand – the main economic benefit of the project would be the market value of the annual sand extracted for external and internal sale – an average unit price has been applied to the output of the quarry based on advice from Boral, but has not been reported for reasons of commercial confidentiality.
- Residual value at end of evaluation period – it is assumed that rehabilitated land (not including the biodiversity offsets) has a residual value of $0.24 M in accordance with its current land value, and that capital equipment has no residual value.

As product transport externalities are a consideration of the EIS, economic benefits associated with transportation of sand product to customers were considered.

17.1.3 Environmental, social and cultural impacts

Costs or benefits were not attributed to environmental, social or cultural impacts as:

- the opportunity costs of any foregone rural production were incorporated in the CBA by inclusion of the full value of land required for the project (including land already owned by Boral);
- there would be no material noise, air quality, historic heritage or visual impacts;
- the opportunity cost of extracting up to 129.25 ML/year from the Stockton Groundwater Source was included in the operating costs by applying an assumed market value of water of $5,000/ML;
- no private registered bores would be impacted by the project and hence no material impacts from an aggregate economic efficiency perspective were identified for inclusion in the CBA; and
- the capital and operating costs of providing biodiversity offsets and installation of a water storage tank for firefighting purposes were included in the capital and operating costs of the project.

17.1.4 Employment

The project would result in all five existing jobs at the quarry being retained together with an additional two new full-time jobs and one new casual job. In addition, jobs associated with the transportation of quarry material would also be retained and additional transport jobs generated.

The wages associated with employment are considered in the CBA as an economic cost of production, with this cost included in the calculation of net production benefits (producer surplus).

17.1.5 Adjoining land values

All land required for the project is owned by Boral. No benefits to other landholders via land prices in excess of the opportunity cost of the land would occur.

17.1.6 Public infrastructure

No net infrastructure costs to the NSW Government are envisaged as a result of the project. Given that additional employment would likely be sourced from existing residents of NSW, no additional demand for community infrastructure is envisaged.

17.2 Consolidated value estimate

17.2.1 Australia costs and benefits

The present value of costs and benefits for the project, using a 7% discount rate, are presented in Table 17.2.

The project is estimated to have total net production benefits (quarrying and product transportation) of $22 M. Assuming 75% Australian ownership of Boral and 100% Australian ownership of transport providers, $19 M of these net production benefits would accrue to Australia.

For the project to be questionable from an economic efficiency perspective, all incremental residual environmental impacts from the project would need to be valued by the community at greater than $19 M. However, as shown in Table 17.2, it there are few external environmental, social or cultural impacts of the project, and those that do exist (e.g. ecological impacts and surface water impacts) are internalised into the capital costs via payment for ecological offsets and water access licences, and hence are incorporated into the estimate of net production benefits. Residual impacts are immaterial, including GHG emissions, which using a price reflective of the global social cost of carbon (SCC), rather than the SCC of carbon emissions to Australia, amounts to $1M present value.

Consequently, the project is estimated to have net social benefits to Australia of approximately $19 M present value and hence is desirable and justified from an economic efficiency perspective.

Table 17.2 Australia CBA results of the project

	Costs		Benefits	
	Description	Value ($M)	Description	Value ($M)
Net production benefits from quarrying	Opportunity cost of land	$0	Value of sand	$58
	Opportunity cost of capital	$0	Residual value of land	$0
	Development costs	$23	Residual value of capital	$0
	Operating costs	$18		
	Decommissioning and rehabilitation costs	$0		
	Sub-total	$42	Sub-total	$58
	Net Production Benefits			$16 ($13)
Net production benefits from ex-quarry transport	Transport costs	$63	Transport revenue	$69
	Net Production Benefits			$6 ($6)
	Total Net Production Benefits			**$22 M ($19 M)**

Table 17.2 Australia CBA results of the project

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M)**
Environmental, social and cultural impacts	Noise impacts	No properties impacted by exceedances	Market values of employment	NQ
	Air quality impacts	No properties impacted by exceedances	Economic benefits to existing landholders	NA
	Surface water and groundwater	Cost of WALs included in capital costs	Economic benefits to suppliers	NQ
	Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs		
	Road transport impacts	No material network, level of service or safety impacts.		
	Aboriginal heritage	No material impacts		
	Bushfire hazard	Additional cost of water storage and fire fighting equipment included in capital costs		
	Historic heritage	No material impacts		
	Visual	No material impacts		
	Greenhouse gas	$1 ($0.002)		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Residual non-market impacts sub-total	**$1 ($0.002)**		**$0**
Net social benefits				**$21 M ($19 M)**

17.2.2 NSW costs and benefits

The costs and benefits of the project to NSW are summarised in Table 17.3. The potential impacts were apportioned to NSW as follows:

- 32% of the estimated company tax generated from the project (quarrying and product transport) is attributed to NSW (DPE, 2015);
- 32% of the residual net producer surplus from the quarry is apportioned to NSW i.e. Australian share ownership assumed to be distributed in line with the population; and
- 100% of residual net producer surplus of transport provision is apportioned to NSW i.e. ownership is NSW based.

All other potential environmental, social, and cultural impacts would accrue to NSW households. However, these impacts are largely mitigated, compensated or offset by Boral.

The estimated net social benefits of the project to NSW are estimated at $9 M, present value at 7% discount. Consequently, as well as resulting in net benefits to Australia, the project would also result in net benefits to NSW.

Any unquantified residual impacts of the project after mitigation, offset and compensation would need to be valued at greater than $9 M, present value for the project to be questionable from an NSW economic efficiency perspective.

Table 17.3 NSW CBA results of the project

Costs	Value ($M)	Benefits	Value ($M)
Environmental, social and cultural impacts		Net Production Benefits of Quarrying	
Noise impacts	No properties impacted by exceedances	Direct company tax	$1
Air quality impacts	No properties impacted by exceedances	Residual net production benefits	$3
Surface water and groundwater	Cost of WALs included in capital costs	Sub-total	$4
Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs	Net Production Benefits of Product Transport	
Road transport impacts	No material network, level of service or safety impacts.	Direct company tax	$1
Aboriginal heritage	No material impacts	Residual net production benefits	$4
Bushfire hazard	Additional cost of water storage and firefighting equipment included in capital costs	Sub-total	$5
Historic heritage	No material impacts	Market values of employment	NQ
Visual	No material impacts	Economic benefits to existing landholders	NA
Greenhouse gas	No material impacts ($0.0005)	Economic benefits to suppliers	NQ
Net public infrastructure costs	No material impacts		
Loss of surplus to other industries	No material impacts		
Sub-total	**$0**	**Sub-total**	**$9**
Net social benefits			**$9 M**

17.3 Local effects analysis

The local effects analysis (LEA) assesses the effects of the project in terms of benefits to the local area, being the Port Stephens, Newcastle and Maitland LGAs.

The project would have a direct effect by continuing to employ a minimum of five people on-site. Assuming the project did not proceed, these employment opportunities would gradually reduce in line with reduced production and cease following 2028.

The project is estimated to provide continued transport employment for 13 people from the local area. Based on estimated wages for quarry workers and average wage from the input-output table for the road transport sector, the project is estimated to provide

incremental net income to the local area of up to $1.6M. Incremental net income to the region would be lower in years of lower levels of production.

Non-labour expenditure to the local area would be $15.5 M per year, when production associated with the project is at its peak of 750,000 tpa.

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment.

17.4 Supplementary local effects analysis

The supplementary LEA uses input-output (IO) analysis to identify the gross economic activity associated with the project on the local economy. It involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.

The IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of indicators of economic activity – output, income, value-added and employment. Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

Quarry production at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $26 M in annual direct and indirect regional output or business turnover;
- $17 M in annual direct and indirect regional value added;
- $2 M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

Transportation of quarry product at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $48 M in annual direct and indirect regional output or business turnover;
- $18 M in annual direct and indirect regional value added;
- $7 M in annual direct and indirect household income; and
- 127 direct and indirect jobs.

The above figures are a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

18 Rehabilitation

A rehabilitation strategy, prepared by Environmental Earth Sciences (EES) (EES, 2023) to accompany this EIS, is provided in Appendix P.

Table 18.1 identifies the relevant requirements of the SEARs and the sections of this EIS in which they have been addressed.

This chapter summarises the outcomes of the rehabilitation strategy.

Table 18.1 SEARs (rehabilitation)

Relevant SEARs	Where addressed in EIS
DPE – Planning	
General requirements:	
The EIS must include a rehabilitation strategy to apply during, and after completion of, extraction operations, and proposed final use of the site	Appendix P - Rehabilitation strategy Section 18.2 - Rehabilitation strategy
Rehabilitation:	
Including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including: - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria	Section 18.2 - Rehabilitation strategy
Nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies	Section 18.2.3 - Final landform - terrestrial areas
The potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region	Section 18.2 - Rehabilitation strategy
A detailed description of the measures that would be put into place to ensure sufficient resources are available to implement the proposed rehabilitation measures, and the ongoing management of the site following the cessation of quarrying activities	Section 18.2.6 - Management and mitigation measures

18.1 Assessment methodology

To assess the efficacy of the rehabilitation activities completed (and currently ongoing) at the site, identify areas of potential improvement, and inform future rehabilitation strategies the following activities were undertaken:

- Site inspection to assess the status of rehabilitation works undertaken in the former inland extraction area. The inspection aimed to assess the efficiency of rehabilitation strategies used to date, with consideration of time since rehabilitation and any localised site conditions which may have influenced vegetation establishment. The findings of the inspection were then used to inform recommendations for rehabilitation of the project site.
- Review of existing, available rehabilitation and landscape management plans with respect to site observations and success (or otherwise) of rehabilitation activities completed at the site to date.

18.1.1 Site inspection observations

Site inspection observation indicated that rehabilitation activities have generally been successful at the quarry to date. The degree of vegetation establishment largely depends on the duration since sand extraction activities ceased, with the western portion of the former inland extraction area having well established tree cover, while the eastern portion of the former inland extraction area had smaller trees and shrubs. The following observations were made at the time of the site inspection:

- The successful species in rehabilitated areas consisted predominantly of:

- trees – Swamp Mahogany (*Eucalyptus robusta*);
- shrubs – Coastal Wattle (*Acacia sophorae*);
- grasses – Beach Fescue (*Austrofestuca littoralis*); and
- ground cover – Pig Face (*Carpobrotus glaucescens*).

- Poor vegetation establishment has occurred in some areas. This has been attributed to:
  - areas exposed to high winds which disturb surface soil, particularly on elevated slopes;
  - areas where nutrient deficiency limits plant growth – this has been observed due to utilisation of coal by-product (chitta) for construction of the haul road resulting in depleting the landscape of nitrogen and other nutrients; and
  - limited water availability, observed on high exposed dunes, and potentially the cause of poor vegetation establishment over former haul roads due to soil compaction.

Table 18.2 presents a summary of the inspected areas.

Table 18.2 Rehabilitation areas summary

Rehabilitation area	Observations
Stage 1	Successful revegetation across a large portion of the area, establishment of a variety of tree species and grass understory Small area of exposed sand east of the haul road Poor establishment due to windblown sand
Stage 2	Areas of poor tree establishment and patchy soil cover Windblown sand Rehabilitation more recent in this area
Stage 3-4	Large areas of successful revegetation with young trees and dense shrubs Successful revegetation across the majority of the area Patchy regrowth in some areas, particularly along a former haul road – attributed to nitrogen deficiency related to use of coal by-product for road construction
Stage 5	Established trees with shrub understory Leaf litter layer on ground surface Patchy understory and lack of soil cover in small areas within Stage 5

18.1.2 Review of current rehabilitation methodology

Based on the findings of the rehabilitation review, and the rehabilitation requirements of the project, the following recommendations were made:

- Aspects of the existing rehabilitation process that are considered successful and should continue, include:
  - species selection has facilitated establishment of a diverse and robust ecological environment which is representative of local native vegetation; and
  - weed management has been successful in removing targeted species and preventing infestation.
- Aspects of the existing rehabilitation process that could be improved for future works:
  - areas subject to high winds, such as elevated dunes, require additional stabilisation to allow vegetation establishment - these areas may also require use of more robust species, such as spinifex to stabilise soil;

- areas subject to compaction and heavy impact, such as haul roads, may require deep ripping prior to rehabilitation to improve soil water availability and allow root penetration of soil;
- targeted application of suitable fertilizer, and/or use of nitrogen fixing plant species may improve plant establishment in some areas; and
- species selection should facilitate development of understorey vegetation adjacent to retained coastal woodland community, with low ongoing maintenance.

18.2 Rehabilitation strategy

The following sections detail proposed additions and/or updates to the existing rehabilitation management/landscape management actions to ensure an appropriate rehabilitation strategy is maintained and managed for the progressive rehabilitation of terrestrial areas at the site.

18.2.1 Integration with existing rehabilitation

The post-quarrying landscapes associated with the former inland extraction area have been rehabilitated in accordance with the *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry* (ERM, 2007a).

While the rehabilitation of these areas has been largely successful, some aspects of the rehabilitation indicate areas where improvements and efficiencies can be made. These findings have been incorporated into the rehabilitation strategy.

The rehabilitation strategy aims to integrate the successful aspects of the previous strategies in the ongoing works to provide the benefit of consistency in approach for site operators, the consistent use of rehabilitation species and continuity for site suppliers.

18.2.2 Rehabilitation timeline

Table 18.3 presents a summary and timeline for mitigation, rehabilitation, monitoring and maintenance works for the project.

Table 18.3 Proposed rehabilitation and management timeline

Site section	Mitigation / rehabilitation measure	Timeframe
Entire site	Topographical survey of current landform levels to inform rehabilitation, vegetation and monitoring	Prior to site establishment
Site periphery	Topographical survey of current landform levels to inform rehabilitation, vegetation and monitoring	Ongoing
	Monitor vegetative screen to ensure it remains intact and sufficient to provide screening function for operations	During sand extraction and ongoing
	Removal of undesirable weed species and vegetation not consistent with the local vegetative succession	Ongoing maintenance
	Revegetation of any disturbed areas by way of selective planting with species native to the locality	Ongoing

18.2.3 Final landform – terrestrial areas

The proposed final land use of the project site once extraction operations cease is to re-plant species endemic to coastal woodland. It is noted that, should the current dredge application commence, then the previous Rehabilitation Plan (EES, 2019a) would be referred to in place of the proposed rehabilitation strategy.

As the land would be cleared for the purposes of quarrying, there would be a requirement to revegetate post completion.

The following terrestrial areas would require specific rehabilitation/ revegetation:

- where native vegetation has been cleared across the entire inland dry sand extraction area; and
- where native vegetation has been cleared for project-specific infrastructure (e.g., haul road corridors/ accessways).

Rehabilitation activities in these areas would comprise soil preparation (i.e. deep ripping haul road corridors) and establishment of native vegetation in disturbed areas to minimise soil erosion and establish slope stability.

18.2.4 Vegetation management

An offset zone of 10 m is proposed along the northern perimeter of the proposed extraction area and a 20 m offset zone is proposed to the east, south and south-west of the proposed extraction area.

This offset zone would provide for a buffer of native trees remaining on site between the project site and the quarry property boundaries, to ensure minimal adverse amenity impacts to the greater community, including in relation to visual, noise and dust.

The offset zones would require routine management and maintenance throughout the life of the project.

18.2.5 Species selection for landscape position

Within the project site, species selection should consider landscape position in relation to beach dune vegetation zones. The beach dune vegetation zones are specifically relevant to high exposed dunes, whereby relatively high winds impact soil stabilisation. A summary of suitable revegetation species is presented in Table 4 of the rehabilitation strategy (Appendix P of this EIS).

18.2.6 Management and mitigation measures

As part of the rehabilitation management strategy, the following management and mitigation measures shall be implemented:

Stabilisation and revegetation of disturbed areas:

A project-specific rehabilitation and landscape management plan (RLMP) shall be prepared for the project as a post-approval requirement. The RLMP shall address:

- the landscape units within each rehabilitation area;
- species and numbers of plants required for each rehabilitation area;
- site preparation requirements – including earthworks and deep ripping;
- soil stabilisation, erosion control and plant protection requirements for each stabilisation area; and
- watering and maintenance requirements until plants are established.

Pest and weed management:

The following procedures shall be considered for continued pest/weeds management:

- regular inspections shall be conducted to assess the presence of pests and weeds;
- targeted spraying or removal may be required during the project; and
- potential for animal or insect pest infestation should be monitored and managed as required.

Erosion and sediment control:

In the event of surface water movement and/or formation of drainage pathways, erosion and sediment controls shall be implemented and maintained, which could include mechanisms such as:

- diversion of 'clean' overland flow to the project site away from 'dirty' areas;
- vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- corrective actions, relating specifically to:
    - maintaining, repairing and cleaning out sediment control structures in order to maintain compliance with the erosion and sediment control plan for the project (i.e. vegetated bund); and
    - repairing eroded areas.

Dust control:

Dust suppression methods shall be used on the existing and proposed haul roads for the project and, except for Stage 1, progressive sand extraction within Stages 2-5 shall seek to limit exposed ground surfaces to a maximum of 200-300m at any one time, to ensure that resource is not lost through exposure to prevailing winds.

Monthly site monitoring:

Monthly monitoring shall commence from the establishment of revegetation and continue for a minimum of three years.

Annual site inspection:

An independent inspection of the rehabilitation process from Stage 1 shall be conducted by a suitably experienced ecologist or environmental restoration consultant annually, from the commencement of rehabilitation activities.

19 Hazards and risks

This chapter provides an assessment of the potential hazards and risk associate with the project to address the relevant SEARs, as detailed in Table 19.1

A bushfire assessment prepared by Newcastle Bushfire Consulting (NBC) (NBC, 2023) to accompany EIS is provided in Appendix Q.

Table 19.1 SEARs (hazards)

Relevant SEARs	Section of EIS addressed
DPE Planning (hazards)	
Including an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks and the transport, handling and use of any hazardous or dangerous goods	Section 19.1.1 - Hazardous substance and dangerous goods management Section 19.1.5 - Public safety Section 19.1.8 - Bushfire
EPA	
Impacts related to the following environmental issues need to be assessed, quantified and reported on: • waste including hazardous materials and radiation. Consideration needs to be given to disposal options for general waste, sanitary waste as well as hazardous materials and radiation, where relevant	Section 19.1.1 - Hazardous substance and dangerous goods management
The EIS must demonstrate that appropriate spill containment will be provided for storage, filling and loading of all fuels and other chemicals to be used on site, in accordance with the relevant Australian Standard	Section 19.1.1 - Hazardous substance and dangerous goods management

19.1 Assessment of impacts

Potential impacts in relation to the management of hazardous substances and dangerous goods were assessed as part of the EIS (Element, 2020) for the current dredge application, including in relation to hydrocarbons, such as fuels (diesel), oils and greases. Other potential hazards, including in relation to unexploded explosive ordinance, soil and water contamination, risks to works, public safety and cumulative impacts were also assessed. Given that the project proposes the same rate of production and transportation as the current dredge application, and generally the use of the same plant and machinery (excluding for the dredge), the assessment in the previous EIS (Element, 2020) remains relevant and conservative, with the findings considered below.

19.1.1 Hazardous substance and dangerous goods management

i Diesel

Diesel is classified as a combustible liquid by Australian Standard (AS) 1940:2004 *The Storage and Handling of Flammable and Combustible Liquids* (AS 1940:2004) (Class C1) for the purpose of storage and handling but is not classified as a dangerous good by the Australian Dangerous Goods (ADG) Code (National Transport Commission, 2007).

Approximately 105,160 litres of diesel was used by the existing operations in 2018, a decrease of approximately 11,840 litres from 2017 due to reduced production levels in 2018.

The project would require the continued use of diesel. The quarry has an above ground 4,200 litre diesel storage tank in a bunded area of the maintenance shed. Heavy vehicles would be fuelled offsite, with the front-end loader, generators, and excavators to be re-fuelled on-site with a mobile fuel tanker. Diesel would be transported, stored, handled, and managed in accordance with regulations and industry standards. The tanker would be on an impermeable surface while re-fuelling, and spills in the collection area would be contained and managed in accordance with emergency response procedures. Any incidental

contamination would be classified and disposed of in accordance with waste legislation. A sealed system would transfer fuel from the mobile tanker to the required plant and equipment.

The storage and use of diesel is not potentially hazardous under Chapter 3 of the Resilience and Hazards SEPP as the tank would be bunded and stored away from other flammable materials.

ii Oils and greases

Oil is classified as a combustible liquid (Class C2) by AS 1940:2004. Boral would need to store small quantities of hydrocarbons, typically oils and greases for maintaining plant and equipment. These would be stored in 20 litre and 205 litre containers within the bunded areas of the existing workshop. Recovered oil and grease material would be collected for removal by a licensed recycling contractor.

Oils and greases would not be stored within the same bund as other flammable liquids, and as such would not be subject to the relevant screening thresholds under the NSW Government guideline's *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (DPE, 2011). As a result, the storage of these materials is not considered potentially hazardous under Chapter 3 of the Resilience and Hazards SEPP.

19.1.2 Unexploded explosive ordinance

The project site was historically part of the Stockton Beach Artillery Proof Range from 1942 to 1944 (ERM, 2005). The Artillery Proof Range extended from just south of Boral's property to Lavis Lane. Most of the firing was from Snake Battery Gun Position (to the south of Boral's land holding), with the projectiles impacting on the beach and adjoining sand dunes. Artillery (18 pounder) was also fired from the Ypres observation post (near the depot) towards the beach with the main impact area expected to be at the northern end of Boral's property.

ERM (2005) mapped the project site as having no risk for unexploded explosive ordinance, as it has been previously disturbed by quarrying activities from 1996 to 2008.

19.1.3 Soil and water contamination

Hydrocarbon spills could cause localised contamination of soil and water and impact health and safety.

Uncontrolled releases of hydrocarbons to the environment may damage soils and aquatic ecosystems, and fires can occur if these materials are ignited. Potentially hazardous materials such as hydrocarbons would be contained in bunded areas in accordance with relevant Australian Standards, codes and regulations.

Refuelling and maintenance activities would be restricted to bunded hardstand areas within the site depot. Therefore, the risk of soil, surface water and groundwater contamination from spills would be low.

19.1.4 Risk to workers

As with any extractive industry operations, daily operations have inherent risk to workers and contractors and have the potential to result in injury or fatality if workers are ill informed of the hazards involved, or risks associated with plant and machinery, are not properly managed. Examples of activities which could result in injury or fatality include crush injuries by moving plant and equipment, motor accidents or crush by heavy vehicles, exposure to hazardous materials, heat exhaustion, working from heights or confined spaces, and exposure to airborne dust and industrial noise.

Boral has a rigorous workplace health and safety regime, as required by the NSW *Work Health and Safety Act 2011* (WHS Act). All workers, contractors and visitors would be inducted on safety protocols and procedures before entering active parts of the site. All personnel working on the site would be required to wear personal protective equipment such as hard hats, high visibility clothing and enclosed footwear. Regular communication of safety requirements and initiatives would also be undertaken on a regular basis.

Provided the implementation of workplace health and safety protocols during construction and operation of the project, as required by the WHS Act and other relevant regulations or standards, the potential for injuries or fatalities to workers, contractors or visitors to the site would be minimised.

19.1.5 Public safety

Risks to public safety may arise where members of the public gain unauthorised access to the site. This is particularly hazardous as it could result in potential fatality for members of the public associated with movement of heavy vehicles and moving plant.

There were nine incidents during 2018, predominantly associated with recreational vehicles and pedestrians entering the quarry either unintentionally or deliberately to access the beach. There is a security gate at the quarry entrance on Coxs Lane. This gate is closed and locked overnight when the site is unoccupied but left open during operation hours to permit the entry and exit of heavy and light vehicles from the site office and weighbridge.

There is a high visibility line and bunting on the fencing along the Stockton Bight windblown extraction area, which demarcates the Boral property boundary, and includes warning signage.

Security fencing and high visibility line and signage are inspected regularly by quarry personnel, with posts for signage and high visibility line made of flexible shatterproof plastic to prevent injury during possible collision.

The following management measures are implemented:

- **Operation and maintenance of safe batters** – a working extraction face that does not produce a grade of greater than 1:3 (V:H) is maintained to blend the extraction area with the surrounding dune system to limit risks to recreational vehicles.
- **Equipment requirements** – heavy earthmoving equipment operates with safety equipment including flashing beacons for visibility in all weather conditions, radio communication and rear cameras for reversing movements.
- **Operating hours** – operations are limited on Saturdays, unless there is increased supply demand. Although operations are approved on Saturdays between the hours of 6:15 am and 12 pm (extended to 3 pm during major supply contracts), Boral reduces these hours of operation wherever possible to minimise the potential for contact with recreational users of the beach.
- **Trespassing or emergency assistance procedures** – personnel are trained to inform site management if members of the public are observed on the site in either a trespassing capacity or seeking emergency assistance. In response, the operation of all heavy machinery is ceased until the party is removed from site and it is safe to resume operations.

To address the risks to public safety, Boral continuously reviews and improve security at the site, including new fencing, security cameras, gates and signage.

All visitors to the site are required to report to the site administration office and register prior to gaining entry to the active areas of the site.

With these security initiatives in place, coupled with a regular review and inspection of the integrity and effectiveness of these measures, the potential for members of the public to gain unauthorised access to the quarry would be minimised.

19.1.6 Road safety

Heavy vehicles associated with dispatch of sand product, importation of VENM to the site and deliveries of consumables would frequently travel along Nelson Bay Road and the wider road network. Potential hazards associated with product transportation may occur in the event of a motor vehicle accident, or tip over resulting in the spill of materials across the roadway. Such events could result in injury, fatality, or general inconvenience (e.g. road closures) to the general public who utilise these roadways.

Overall, it is considered that the project would not result in negative impacts to other road users and the safety of the public road network and Boral would implement driver awareness training for all staff at the site, with a focus on the correct protocols when entering and exiting the site and driving on public roads.

19.1.7 Cumulative impacts

Despite the project being in proximity to other extractive land uses (including the windblown sand extraction area), there would be no significant cumulative risks as a result of the proximity of the project to these operations. All technical assessments of the potential impacts of the project, have where relevant, considered the cumulative impacts of the development combined with existing activities in the area thereby assessing the cumulative impacts of the project.

Other land uses near the quarry, including other extractive industries, would be subject to hazard related consent and EPL conditions. As such, hazards and risks associated with these facilities are likely to be managed in an environmentally responsible manner and in accordance with relevant legislation, thereby minimising the potential for cumulative impacts from the project combined with nearby facilities.

19.1.8 Soil and water contamination

Plant and equipment would be maintained to minimise the potential for leakages, while appropriately sized and stocked spill response kits would be provided in strategic areas of the site, and in vehicles.

A pollution incident response plan (PIRMP) has been developed by Boral as part of the approved windblown sand extraction project to manage any potential chemical or hydrocarbon spills. The PIRMP would be updated to incorporate the project.

19.1.9 Risk to workers

Designated first aid and emergency response equipment would be available during construction and operation phases of the project. Appropriately trained personnel would be on site throughout the life of the operations to provide first aid and respond to site emergencies.

Any injuries incurred at the quarry would be reported and investigated in consultation with NSW Resource Regulator and other relevant authorities. Any recommendations or findings of investigation reports would be implemented by Boral where feasible and practical.

19.1.10 Bushfire

The site is on land that is mapped as bushfire prone. The bushfire assessment prepared for the current dredge application was updated for the project, to reflect the revised RFS document *Planning for Bushfire Protection 2019* (PBP 2019), and is provided in Appendix Q of this EIS.

Bushfire hazards were assessed in relation to the aims and objectives of PBP 2019, summarised as follows.

i Afford occupants of any building adequate protection from exposure to a bush fire

Following the establishment of an asset protection zone, the buildings within the existing site depot would have a reduced exposure to bushfire. Evacuation planning in the event of bushfire should clearly indicate to workers to evacuate early in a direction away from the fire.

ii Provide for a defendable space to be located around buildings

Defendable space is available around the buildings in the existing site depot. In the event of bush fire, firefighters would have direct access to the bushland via the internal road network of the quarry, which would support firefighting efforts. In the event a fire front impacts on the buildings, defendable space is available surrounding the buildings from where the fire would be fought. A minimum 24 m asset protection zone (APZ) shall be provided around the buildings.

iii Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition

PBP 2019 provides for the required APZs, as the required buffer between the bushfire hazard and buildings. The 24 m APZ for the site depot was determined in accordance with the relevant requirements of PBP 2019.

iv Ensure that safe operational access and egress for emergency service personnel and building users is available

The property access to the buildings offers compliance with PBP 2019 access requirements. The road shall be designed for the movements of large vehicles which exceeds the minimum widths of PBP 2019.

v Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the APZ

Landscaping and fuel management shall be managed in accordance with Appendix 4 of PBP 2019 and the RFS's document *Standards for Asset Protection Zones*.

vi Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting)

A 20,000 litre static water supply is required for the project, which shall be equipped with firefighting fittings, with all electrical supplies to be located underground.

19.2 Management and mitigation measures

To minimise potential hazard risks, the following management measures shall be implemented:

Hazardous substances:

A pollution and incident response management plan (PIRMP) has been prepared to manage potential chemical or hydrocarbon spills at the quarry. The PIRMP shall be updated as follows to incorporate the project:

- all personnel shall be trained in hazardous substance management, emergency response and the use of spill kits;
- appropriately sized and stocked spill response kits shall be provided in strategic areas of the quarry and in vehicles used to transport hazardous materials to and from the site;
- spill response kits shall be maintained, clearly identified and readily accessible for use in case of accidental spillages. Key staff would be trained in their use, application and disposal of contaminated material;
- potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) shall be stored in appropriate containers in bunded areas in vehicles or designated storage areas to minimise the risk of spillages and mobilisation of pollutants into the soil or stormwater drains;
- equipment shall not be used if there are signs of fuel, oil or hydraulic leaks;
- leaks shall be repaired immediately, or the equipment would be removed from site and replaced with a leak free item; and
- soil contaminated by spills shall be excavated, classified in accordance with Waste Classification Guidelines, and disposed of at a licensed waste management facility, or remediated on site in accordance with a contaminated land management action plan to be prepared by a contaminated land specialist.

Soil and water contamination:

Plant and equipment shall be maintained to minimise the potential for leakages, while appropriately sized and stocked spill response kits would be provided in strategic areas of the site, and in vehicles.

Risk to workers:

Designated first aid and emergency response equipment shall be available during construction and operation phases of the project. Appropriately trained personnel shall be on site throughout the life of the operations to provide first aid and respond to site emergencies.

Any injuries incurred at the quarry shall be reported and investigated in consultation with NSW Resource Regulator and other relevant authorities. Any recommendations or findings of investigation reports shall be implemented by Boral where feasible and practical.

Bushfire:

- A 24 m APZ shall be provided around buildings and maintained as an inner protection area (IPA) as outlined within Appendix 4 of the NSW RFS documents *Planning for Bush Fire Protection 2019* (PBP 2019) and *Standards for Asset Protection Zones*.
- The polycarbonate roofing on the workshop shall be replaced with metal roof sheeting.
- The new haul roads shall comply with Section 7 of PBP 2019, with the roads being a minimum 6.5 m in width with a turning bay at the termination of the road, having a minimum 12 m outer radius.
- Water, electricity and gas shall comply with Section 7 of PBP 2019.
- A 20,000 litre static water supply with firefighting fittings shall be provided.
- Landscaping for the site depot shall be undertaken in accordance with Appendix 4 of PBP 2019 and managed and maintained in perpetuity.
- New buildings shall be incorporated into the site's existing emergency management plans with specific consideration of bushfire evacuation planning.

20 Waste management

This chapter addresses the requirements of the SEARs in relation to waste management as presented in Table 20.1.

The approach to managing waste is consistent with the approach provided in the EIS (Element, 2020) for the current dredge application.

Table 20.1 SEARs (waste)

Relevant SEARs	Section of EIS addressed
DPE – Planning (waste)	
Identification, classification and quantification of the likely waste streams that would be handled / stored / disposed of at the site in accordance with the EPA's Waste Classification Guidelines (2014)	Section 20.1 – Existing waste management system Table 20.2 – Waste streams
Details of how waste would be treated, stored, used, disposed and handled on site, and transported to and from the site and the potential impacts associated with these issues	Section 20.2.1 - Construction waste Section 20.2.2 - Operational waste
A description of all reasonable and feasible measures that would be implemented to maximise resource recovery from the waste streams and reduce the disposal of waste to landfill in line with the aim, objectives and guidance in the NSW Waste Avoidance and Resource Recovery Strategy 2014-21 and other relevant government policy.	Section 20.3 – Management and mitigation measures

20.1 Existing waste management system

As detailed in Table 20.2, the main waste streams generated by the quarry comprise general solid wastes and hazardous and liquid wastes from operations and servicing of equipment.

Table 20.2 Waste streams

Waste stream	Details
General solid waste	The quarry generates building and demolition waste, glass, plastic, rubber, garden waste, wood, paper and cardboard. Additionally, general solid waste (putrescible), such as food waste, is generated by site personnel.
Hazardous waste	Contaminated materials generated at the maintenance shed, such as recovered oil and grease, is collected and stored in a 400 litre tank for removal by a licensed recycling contractor. Approximately 800 litres of oil and grease waste is generated per year.
Liquid waste	The septic system is inspected and pumped out regularly by a licenced disposal contractor.
On site resource recovery	Cleared vegetation is mulched or stockpiled on-site for later use in rehabilitation. Following clearing of vegetation, topsoil is stripped using a dozer and stored in stockpiles. When an extraction area is exhausted, topsoil and previously felled vegetation or mulch is respread over finished areas and the area is actively rehabilitated and managed. Felled timber is evenly distributed to act as a wind break for emerging seedlings and provide habitat opportunities for small fauna.

All waste generated at the quarry is separated, collected in designated waste disposal bins, reused where possible, or disposed of at an appropriately licenced waste facility.

Boral has developed a waste management system for the quarry that ensures all waste generated on site is classified and managed in accordance with EPA's *Waste Classification Guidelines* (EPA, 2014) and relevant regulatory requirements of the NSW *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) and the NSW *Protection of Environment and Operations Act 1997* (POEO Act).

In accordance with the WARR Act, Boral adopts the principles of the waste management hierarchy.

These principles would continue to be upheld during the project, and be achieved by:

- purchasing recycled products where appropriate;
- developing and implementing waste management procedures to minimise the generation of waste and where unavoidable, re-use waste on-site;
- recycling as many wastes as practically possible through appropriate handling, separation, storage, and collection; and
- where waste cannot be re-used or recycled, transportation and disposal of waste off-site at an appropriately licenced facility.

20.2 Impact assessment

20.2.1 Construction waste

The following waste sources are likely to be generated during construction/establishment of the project:

- removed native and exotic vegetation;
- general solid wastes (non-putrescible), including building and demolition waste;
- excavated material (e.g. spoil) unsuitable and/or not required for backfilling and restoration;
- maintenance waste – waste generated from construction plant and machinery maintenance, such as oil and fuel; and
- general solid wastes (putrescible) and liquid waste from construction personnel.

The nature and volume of waste generated during construction would predominantly be non-hazardous and relatively minor. However, there is potential for adverse impacts on the local environment if waste is not managed appropriately.

Inappropriately managed waste has the potential to adversely impact on the following:

- visual amenity and aesthetic quality of the surrounding area;
- health and safety of residents, workers and visitors;
- landfill space, through potentially reusable and/or recyclable materials contributing to landfill waste;
- native fauna through ingestion of fugitive waste materials (e.g. plastic bags); and
- hazardous waste, particularly fuels or oils, leaching into local drainage lines and watercourses, leading to subsequent water quality degradation.

Construction wastes would be classified and disposed of in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and the NSW *Protection of the Environment Operations (Waste) Regulation 2014*.

20.2.2 Operational waste

As detailed in Table 20.3, waste generated during operation of the project would be the same as that currently generated by existing quarry operations.

Table 20.3 Operational waste

Waste description	Waste classification	Source	Quantity	Recycled	Disposed of on-site / off-site
Sewerage	Liquid	Main office facilities	5,500 litres / 7 weeks	Yes	Off-site
Oil and grease	Liquid	Maintenance of mobile equipment	800 litres / year	No	Off-site
Maintenance / production waste	Solid	Workshop waste, packaging, waste from quarry processes	6 m^3 / month	No	Off-site
Office	Solid	General office waste	5 m^3 / month	No	Off-site
Paper	Solid	Office	54 kg / year	Yes	Off-site
Scrap steel	Solid	Machinery, plant waste	5 t / year	Yes	Off-site
Timber	Solid	Felled vegetation	20 t / year	Yes	On-site

These wastes would continue to be managed in accordance with waste management systems and practices, including for topsoils and felled native vegetation.

All wastes generated by operations would be classified in accordance with the EPA's Waste Classification Guidelines (NSW (EPA, 2014), and disposed of in accordance with the resource management hierarchy principles and associated requirements of the WARR Act and NSW *Protection of the Environment Operations (Waste) Regulation 2014.*

20.2.3 Cumulative impacts

General solid wastes, liquid and hazardous wastes would continue to be generated by quarry operations. However, waste quantities would be minimal, and licenced waste contractors would collect and dispose of these wastes to ensure recycling or disposal in a legislatively compliant manner.

Other land uses near the quarry, including other extractive industries, would be subject to waste related consent and EPL conditions. As such, waste at these facilities is likely to be managed in an environmentally responsible manner and in accordance with legislation, thereby minimising the potential for cumulative impacts from the project combined with other nearby facilities.

20.3 Management and mitigation measures

Waste shall be managed in accordance with the WARR Act by adopting the resource management hierarchy (in order of priority) of avoidance, re-use, recycling / re-processing / treatment and disposal.

The existing environmental management strategy for the quarry shall be updated as follows:

- wastes shall be quantified and classified;
- disposal/reuse strategies for each type of material;
- details of how waste shall be stored and treated on site;
- identification of non-recyclable waste;
- identification of measures and initiatives to reduce, reuse and recycle; and

- procedures and disposal arrangements for potentially hazardous material.

Waste shall be managed in accordance with relevant regulatory requirements, including:

- its classification prior to leaving the site;
- recording (via an appropriate waste tracking system) its legal off site transportation for re-use, recycling or disposal.
- waste (excluding toilet waste) shall be stored in a suitable container with a lid, and transported to an appropriate facility;
- enough receptacles for general waste, hazardous waste and recyclable materials shall be provided, including sufficient bins to allow separation of wastes for recycling;
- wastes shall only be disposed at a licenced waste disposal depot;
- wastes shall be securely stored so that pollutants are prevented from escaping;
- fuel, lubricant or hydraulic fluid spillages shall be collected using absorbent material and the contaminated material disposed of at a licensed waste facility;
- hazardous or contaminated wastes (if identified) shall be removed and disposed in accordance with the State and national regulations and guidelines and best practice for the removal of these materials;
- hazardous materials shall only be removed by suitably qualified, licensed and experienced contractors;
- personnel shall be required to notify the quarry manager, and follow approved SafeWork NSW procedures for the handling and transport of any asbestos containing material wastes to an EPA approved facility;
- documents and records of the transport and fates of all materials removed from the project site shall be kept as proof of correct disposal and for environmental auditing purposes;
- waste streams shall be sorted to maximise the reuse/recycling potential and minimise disposal costs; and
- waste shall be covered, stored and removed in a timely manner so as not to attract native animals or vermin.

21 Other matters

Commensurate with the project level of impacts, a desktop assessment of other environmental aspects, including visual, historic heritage and potential cumulative impacts has been undertaken in Table 21.1, although noting the consideration of potential cumulative impacts relates to the findings of the relevant assessments considered in the preceding chapters.

Table 21.1 Other matters

Environmental aspect	SEARs requirement	Response
Visual	Including a detailed assessment of the likely visual impacts of the development (before, during and post-mining) on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to any new landforms.	The project site remains the same as the project site for the current dredge application, although noting that there would be no requirement for a pond in the final landform, given that the project does not involve dredging. As detailed in the EIS (Element, 2020) for the current dredge application, the project site would not be visible from Nelson Bay Road or surrounding residential areas. The project may be partially visible to recreational users accessing the top of the remnant hind dune directly adjacent to Boral's consent boundary. However, the project would only be partially visible from this viewpoint during the initial stages of sand extraction. With the above considered, the only likely viewpoint of the project for the public would be along a discrete section of Stockton Bight beach immediately adjacent to the quarry boundary, with temporary views confined to the highest elevation of the project site. As this area is quarried, the remainder of the project would be entirely concealed from public view. Business operators who utilise this section of Stockton Bight for recreational ventures were consulted during the SIA process for the current dredge application and provided feedback, which generally indicated that they had grown accustomed to Boral operations associated with the windblown sand extraction area and did not envisage that the project would have any negative implications for their business. Given the very limited potential for visual impacts, a further detailed visual assessment of the project is not considered warranted.
Historic heritage	Identification of historic heritage in the vicinity of the development and an assessment of the likelihood and significance of impacts on heritage items having regard to the relevant policies and guidelines.	As identified in Section 2.5.2, the only listed heritage item within 500 m of the project site is the 'Stockton Beach Dune System', which is listed on the PSLEP 2013 and is directly adjacent (north-east and south-east) to the quarry boundary. As detailed in Section 9.3.1 of this EIS, the project would not impact the beach, foredune, deflation basin and mobile transverse dunes of Stockton Bight as the project site is physically removed from, and downwind of these environments. As such, the project would not impact upon the natural landscape features comprising the listing. The project site has been subject to previous surface disturbance and is unlikely to contain any unknown historic heritage items. Notwithstanding, should an item of potential historic heritage be identified during project operations, works would cease, and the quarry manager would be contacted immediately. Appropriate measures would then be taken to minimise the potential for harm to the object. Further advice would be sought from a qualified archaeologist, and subsequently DPE - BCD would be notified of the proposed course of action, as required.
Cumulative impacts	An assessment of likely cumulative impacts of the proposed quarry operating in combination with other established quarries in the locality, paying particular attention to likely impacts on road safety, water resources, land capability and shared infrastructure.	Despite the project being in proximity to other extractive land uses (including the windblown sand extraction area), this EIS (and the accompanying technical studies) has assessed that there would be no significant cumulative risks as a result of the proximity of the project to these operations, including for: • biodiversity (Section 10.2.3); • air (Section 11.1.1); • noise (Section 12.2.4); • traffic (Section 13.3.5); • hazards (Section 19.1.7); and

Table 21.1 Other matters

Environmental aspect	SEARs requirement	Response
		• waste (Section 20.2.3).

22 Project justification and conclusion

Boral seeks State significant development (SSD) consent for the Stockton Dry Sand Extraction Project (the project), to extract approximately 3.1 million tonnes of sand from within the inland dunes of the Stockton Sand Quarry (the quarry). The project involves the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) to 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

Due to delays with the assessment and approval of the current dredge application (SSD Ref: 9490), Boral has identified that, to keep the quarry operating, the project is required as an interim measure, and seeks to extract only the remaining sand from above the water table and within the same extraction footprint.

The five stages of the project mirror the first five stages of the current dredge application, which has been designed so that, should the current dredge application be approved and dredging commences, dry sand extraction could transition into dredging, irrespective of what stage the project is at. There is no alternative project design option that would allow for this.

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit of no more than 750,000 tonnes per annum (tpa), until either:

- the current dredge application is approved and commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the current dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

The project would provide the following benefits:

- It would enable the continued operation of the existing quarry and the provision of a high demand sand resource, maximising the re-use of existing plant and infrastructure and with minimal environmental impacts.
- It would supply essential natural sand to major infrastructure and associated development projects in the Hunter and greater Sydney regions.
- It would provide continued employment of five employees, with an additional two full time and one causal employee.
- It would have net social and economic benefits to Australia of $19 M and to NSW of $9 M, including employment benefits.

The project would not have significant adverse environmental impacts and would provide significant socio-economic benefits.

A detailed groundwater assessment and conceptual ecohydrological model have been prepared to accurately predict the maximum height of the water table, to ensure that an appropriate buffer between the level of extraction and the water table is maintained.

Potential amenity impacts from air and noise have been predicted to meet all relevant government criteria at the closest residential receivers and the local road network has adequate capacity to accommodate the additional traffic generated by the project. The residual impacts on terrestrial biodiversity as a result of clearing would be offset in accordance with NSW policy with the benefit of protecting areas of similar native vegetation communities in perpetuity.

Overall, it is considered that the project is justified on economic, social and environmental grounds, as demonstrated with its consistency with the objects of the EP&A Act and ecologically sustainable development.

Abbreviations

Abbreviations	Definitions
AEMR	Annual environmental management report
AHD	Australian height datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal heritage impact permit
AIP NSW	*Aquifer Interference Policy*
APZ	Asset protection zone
ASS	Acid sulfate soils
ANZECC	Australian and New Zealand Environment and Conservation Council
AQIA	Air quality impact assessment
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method Credit Calculator
BC Act	NSW *Biodiversity Conservation Act 2016*
BCT	Biodiversity Conservation Trust
BDAR	Biodiversity development assessment report
BGS	Below ground surface
Boral	Boral Resources (NSW) Pty Ltd
BoM	Bureau of Meteorology
BSAL	Biophysical strategic agricultural land
CBA	Cost benefits analysis
CHAR	Cultural heritage assessment report
CLM Act	*Contaminated Land Management Act 1997*
CBD	Central business district
CEM	Conceptual ecohydrological model
cm	Centimetre
CM Act	*Coastal Management Act 2016*
CRD	Cumulative rainfall departure
DA	Development application
dBA	Decibels
DECCW	Department of Environment Climate Change and Water
DP	Deposited plan
DoEE	Commonwealth Department of Environment and Energy
DPE	Department of Planning and Environment

Abbreviations	Definitions
DPIE	Department of Planning, Industry and Environment
DRE	Department of Resources and Energy
EEC	Endangered ecological community
EIS	Environmental impact statement
Element	Element Environment Pty Ltd
EMP	Environmental management plan
EMS	Environmental management strategy
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999*
EPI	Environmental planning instrument
EPL	Environment protection licence
ESD	Ecologically sustainable development
GDE	Groundwater dependent ecosystem
GHG	Greenhouse gas
GSR	Greater Sydney region
ha	Hectare
HW Act	NSW *Hunter Water Act 1991*
ICNG	*Interim Construction Noise Guideline* (DECC 2009)
IPC	Independent planning commission
kl	Kilolitre
km	Kilometre
L	Litre
LALC	Local Aboriginal Land Council
LEA	Local effects analysis
LFA	Landscape function analysis
LEP	Local environmental plan
LGA	Local government area
m	Metre
mm	Millimetre
ML	Megalitre
MNES	Matters of National Environmental Significance

Abbreviations	Definitions
M	Million
Mt	Million tonnes
NGA	The National Greenhouse Accounts
NGER	*National Greenhouse and Energy Reporting Act 2007*
NIA	Noise impact assessment
NPI	*Noise Policy for Industry*
NPW Act	*National Parks & Wildlife Act 1974*
NPWS	National Parks and Wildlife Services
NSW	New South Wales
NT Act	*Native Title Act 1993*
NMLs	Noise management levels
OA	Output analysis
OEH	Office of Environment and Heritage
PCT	Plant community type
PEA	Preliminary environmental assessment
PFAS	Per- and poly-fluoroalkyl substances
PFOA	Perfluorooctanoic acid
PIRMP	Pollution and incident response management plan
PM2.5	Particulate matter less than or equal to 2.5 micrometres in aerodynamic diameter
PM10	Particulate matter less than or equal to 10 micrometres in aerodynamic diameter
PMST	Protected matters search tool
PNTLs	Project noise trigger levels
POEO Act	*Protection of Environment Operations Act 1997*
Quarry	Stockton Sand Quarry
RAAF	Royal Australian Air Force
RBL	Rating background level
RAP	Remediation action plan
RAPs	Registered Aboriginal party
Regional Plan	*Hunter Regional Plan 2041*
RFS	NSW Rural Fire Service
RMS	NSW Roads and Maritime Services
RNP	*NSW Road Noise Policy*
SEARs	Secretary's environmental assessment requirements

Abbreviations	Definitions
SEPP	State Environmental Planning Policy
SIA	Social impact assessment
SIDRA	Signalised and Unsignalised Intersection Design and Research Aid
SILO	Scientific Information for Landowners Database
SRLUP	*Strategic Regional Land Use Policy*
SSD	State significant development
SWL	Sound power level
t	Tonne
TAS	Todoroski Air Sciences
TEC	Threatened ecological community
TfNSW	Transport For NSW
TIA	Traffic impact assessment
tpa	Tonnes per annum
TSP	Total suspended particulate
VENM	Virgin excavated natural material
VLAMP	*Voluntary Land Acquisition and Mitigation Policy*
WAL	Water Access Licence
Water Act	*Water Act 1912*
WM Act	*Water Management Act 2000*
WSP	Water sharing plan

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Appendix A

SEARs/agency requirements

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
DPE Planning	**General requirements**	
	The Environmental Impact Statement (EIS) must meet the minimum form and content requirements as prescribed by Part 8 of the Environmental Planning and Assessment Regulation 2021 (EP&A Regulation) and must have regard to the State Significant Development Guidelines.In particular, the EIS must include: • a stand-alone executive summary	Page iii – Executive summary
	• a full description of the development, including the resource to be extracted, including the amount, type and composition	Chapter 3 – Project description
	• the site layout and extraction plan, including cross-sectional plans	Figure 3.1 – The project Figure 3.2 – Extraction staging plan
	• the production process and processing activities, including the in-flow and out-flow of materials and points of discharge to the environment	Section 3.2.3 – Sand extraction, staging and processing
	• surface infrastructure and facilities (including any infrastructure that would be required for the development, but the subject of a separate approvals process)	Section 1.5.3 – Plant and equipment Chapter 3 – Project description
	• a waste (overburden, rejects, tailings etc) management strategy	Section 3.2.3 – Sand extraction, staging and processing Chapter 20 – Waste management
	• a water management strategy	Chapter 16 – Surface water
	• a rehabilitation strategy to apply during, and after completion of, extraction operations, and proposed final use of site	Section 18.2 – Rehabilitation strategy
	• the likely interactions between the development and any existing, approved or proposed development in the vicinity of the site	Cumulative assessments for air (Section 11.1.1), noise (Section 12.2.4 and 12.2.7), traffic (Section 13.3.5), hazards (Section 19.1.7) and waste (Section 20.2.3) Table 21.1 – Other matters
	• a strategic justification of the development focusing on site selection and the suitability of the proposed site	Section 2.2 – Strategic project justification
	• a list of any approvals that must be obtained before the development may commence	Table 5.2 – Other approvals required

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• an assessment of the likely impacts of the development on the environment, focussing on the key issues identified below, including:	Impact assessments (Chapters 7-21) and accompanying technical studies
	• a description of the existing environment likely to be affected by the development, using sufficient baseline/background data	Section 2.3 – Biophysical factors Section 2.4 – Cultural factors Impact assessments (Chapters 7-21) and accompanying technical studies
	• an assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant laws, environmental planning instruments, guidelines, policies, plans and industry codes of practice	Impact assessments (Chapters 7-21) and accompanying technical studies
	• a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the likely impacts of the development, and an assessment of:	Impact assessments (Chapters 7-21) and accompanying technical studies Appendix D – Management and mitigation measures
	• whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented	As above
	• the likely effectiveness of these measure	As above
	• whether contingency measures would be necessary to manage any residual risks	As above
	• a description of the measures that would be implemented to monitor and report on the environmental performance of the development	As above
	• a consolidated summary of all the proposed environmental management and monitoring measures, identifying all the commitments in the EIS	Appendix D – Management and mitigation measures
	• consideration of the development against all relevant environmental planning instruments (including Part 2 of the State Environmental Planning Policy (Resources and Energy) 2021)	Table 5.3 – Matters for consideration
	• the reasons why the development should be approved, having regard to: - relevant matters for consideration under the Environmental Planning and Assessment Act 1979, including the objects of the Act	Table 5.3 – Matters for consideration
	- the biophysical, economic and social impacts of the development including the principles of ecologically sustainable development	Chapter 22 – Project justification and conclusion

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	- the suitability of the site with respect to potential land use conflicts with existing and future surrounding land uses	Table 5.3 – Matters for consideration
	- feasible alternatives to the development (and its key components), including the consequences of not carrying out the development	Section 2.2 – Strategic project justification
	- a signed declaration from the author of the EIS, certifying that the information contained within the document is neither false nor misleading	Page ii – Environmental Impact Statement Certification
	Notwithstanding the key issues specified below, the EIS must include an environmental risk assessment to identify the potential environmental impacts associated with the development	As considered further in Chapter 6, the project is proposed as an interim solution, while issues associated with the current dredge application are being resolved, proposing only dry sand extraction from above the water table. All other components of the project, in terms of the rate of extraction and dispatch, and the extraction and disturbance area, remain the same as originally proposed for the dredge application. Potential issues associated with the project are well understood, and therefore, a further environmental risk assessment to that undertaken for the dredge application is not considered warranted for the project.
	While not exhaustive, Attachment A contains a list of some of the environmental planning instruments, guidelines, policies, and plans that may be relevant to the environmental assessment of this development	Noted
	The EIS must also be accompanied by a Quantity Surveyor Report for Capital Investment Value and Employment, providing: • a detailed calculation of the estimated capital investment value (CIV) of the development, prepared by a AIQS Certified Quantity Surveyor; or • RICS Chartered Quantity Surveyor in accordance with Planning Circular PS 21-020: Calculation of capital investment value The calculation of the estimated CIV is to be accurate at the date of application and include details of all components and assumptions from which it is derived	A quantity surveyor report has been prepared for the project and will be submitted with the SSD application.
	An estimate of the retained and new jobs that would be created during the construction and operational phases, including details of the methodology to determine the figures provided	Section 3.2.12 - Employment
	Statutory and strategic context	

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• Address the statutory provisions applying to the development contained in all relevant environmental planning instruments, including: • SEPP (Resources and Energy) 2021) • SEPP (Planning Systems 2021 • SEPP (Transport and Infrastructure) 2021 • SEPP (Biodiversity and Conservation) 2021 • SEPP (Resilience and Hazards) 2021 • Port Stephens Local Environmental Plan 2013	Table 5.3 – Matters for consideration
	• Address the relevant planning provisions, goals and strategic planning objectives in the following: • Hunter Regional Plan 2041; and • Port Stephens Local Infrastructure Contributions Plan	Section 2.1 – Strategic planning policies
	Noise	
	A detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy	Chapter 12 – Noise assessment Appendix J – Noise impact assessment
	If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely noise impacts of those activities under the Interim Noise Construction Noise Guideline	N/A
	Include reasonable and feasible mitigation measures to minimise noise emissions	Section 12.3 – Management and mitigation measures (noise) Appendix D – Management and mitigation measures
	Include consideration of monitoring and management measures, in particular, real-time and attended noise monitoring	Section 12.3 – Management measures (noise) Appendix D – Management and mitigation measures
	Air quality and odour	
	A detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including PM2.5 and PM10, and having regard to the Voluntary Land Acquisition and Mitigation Policy	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	An assessment of potential dust and other emissions generated from processing, operational activities and transportation of quarry products	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment
	Reasonable and feasible mitigation measures to minimise dust and emissions	Section 11.1.3 – Management and mitigation measures (air) Appendix D – Management and mitigation measures
	Monitoring and management measures, in particular, real-time air quality monitoring	Section 11.1.3 – Management and mitigation measures (air) Appendix D – Management and mitigation measures
	A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant EPA guidelines	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment
	A greenhouse gas assessment of the operation of the development	Section 11.2 – Greenhouse gas Appendix I – Air quality and greenhouse gas assessment
	Water	
	A detailed site water balance for the life of the development, including a description of site water demands, water take from any water source, water disposal methods (inclusive of anticipated volumes, quality and frequency of any water discharges), water supply infrastructure and water storage structures as defined by the relevant Water Sharing Plan and in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012)	Section 16.2.1 – Site water balance Appendix N – Surface water assessment
	A conceptual groundwater model that assesses the potential groundwater hazards and impacts associated with the development in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012) having regard to the NSW Aquifer Interference Policy (2012)	Chapter 7 – Groundwater assessment Appendix E – Groundwater assessment (including conceptual groundwater model)
	Identification of any licensing requirements or other approvals under the Water Act 1912 and/or the Water Management Act 2000	Table 5.2 - Other approval required
	Demonstration that water required for the construction and operation of the development can be obtained and maintained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP)	Section 16.1.3 – Existing water use and management

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo with consideration to any water supply restrictions or water entitlement limitations	Appendix N – Surface water assessment – Section 1.4.1 and Section 5.0
	An assessment of any likely flooding impacts of the development	Section 16.1.2 - Flooding
	A detailed assessment of any need to maintain an adequate buffer between excavations and the highest predicted or recorded regional groundwater table	Section 7.2.1 – Maximum operating depth
	An assessment of the likely impacts (including cumulative impacts) on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	No surface water discharge
	An assessment of the likely impacts (including cumulative impacts) of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users. This assessment must include a strategy for managing potential impacts during the life of the development and identify any conservation outcomes	No surface water discharge
	An assessment of the potential water quality hazards surrounding the site including acidity, metals, salinity and contaminants including poly-fluoroalkyl substances (PFAS). This assessment must include: measures proposed to reduce or manage the hazards and potential	Appendix E – Groundwater assessment – Section 4.6 and Section 6.0
	interactions on the development and surrounding water users	No surface water discharge
	Detailed description of the proposed water management system (including sewage), surface and ground water monitoring program and other measures to mitigate surface and groundwater impacts	Section 7.6 – Groundwater monitoring and management measures Section 16.3 – Surface water management and monitoring measures
	Biodiversity	
	Accurate predictions of any vegetation clearing on site	Section 10.1.4 – Native vegetation and flora assessment
	A detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report	Chapter 10 – Biodiversity Appendix H – Biodiversity development assessment report
	A detailed consideration of the potential for off-site and in-direct impacts on local biodiversity and surrounding ecological corridors or habitat	Section 10.2.2 – Indirect impacts

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	A strategy to offset any residual impacts of the development in accordance with the Biodiversity Offsets Scheme	Section 10.2.4 – Biodiversity offset strategy
	Heritage	
	An assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage	Section 15.1.2 – Aboriginal consultation
	Identification of historic heritage in the vicinity of the development and an assessment of the likelihood and significance of impacts on heritage items having regard to the relevant policies and guidelines listed in Attachment A.	Section 2.4.2 – Historic heritage Table 21.1 – Other matters
	Traffic and transport	
	Accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products	Chapter 13 – Traffic and transport Appendix K – Traffic and transport impact assessment
	A road safety audit	Section 13.3.4 – Road safety
	A detailed assessment of potential traffic impacts on the capacity, condition, safety and efficiency of the local and State road network, having regard to the cumulative impacts of the development in relation to the proposed, approved and existing developments in the vicinity of the site in accordance with the Roads and Maritime Services NSW's Guide to Traffic Generating Developments (2002). This assessment must include a strategy to manage and/or minimise traffic impacts over the life of the development	Section 13.2 - Assessment methodology Section 13.3 - Impact assessment Section 13.3.5 - Cumulative traffic impacts Appendix – K – Traffic and transport impact assessment
	A description of the measures that would be implemented to mitigate and/or manage any impacts	Potential project traffic and transport issues were not considered significant enough to warrant specific management or mitigation measures
	Land resources	
	Potential impacts on soils and land capability (including potential erosion and land contamination) and the proposed mitigation, management and remedial measures (as appropriate)	Chapter 8 – Acid sulfate soils Appendix F – Acid sulfate soils advice letter Chapter 18 – Rehabilitation Appendix P – Rehabilitation strategy Section 18.2.6 – Management measures (rehabilitation)

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	Potential impacts on landforms (topography), paying particular attention to the long-term geotechnical stability of any new landforms (such as overburden dumps, bunds etc)	Section 3.2.3 – Sand extraction, staging and processing
	The compatibility of the development with other land uses in the vicinity of the development in accordance with the requirements in Clauses 2.17 and 2.18 of *State Environmental Planning Policy (Resources and Energy) 2021*	Table 5.3 – Matters for consideration
	Waste	
	Identification, classification and quantification of the likely waste streams that would be handled/stored/disposed of at the site in accordance with the EPA's Waste Classification Guidelines (2014)	Chapter 20 – Waste management
	Details of how waste would be treated, stored, used, disposed and handled on site, and transported to and from the site and the potential impacts associated with these issues	Chapter 20 – Waste management
	A description of all reasonable and feasible measures that would be implemented to maximise resource recovery from the waste streams and reduce the disposal of waste to landfill in line with the aim, objectives and guidance in the NSW Waste Avoidance and Resource Recovery Strategy 2014-21 and other relevant government policy	Section 20.3 – Waste management and mitigation measures
	Hazards	
	Including an assessment of the likely risks to public safety, paying particular attention to potential bushfire risks and the transport, handling and use of any hazardous or dangerous goods	Chapter 19 – Hazards and risks
	Visual	
	Including a detailed assessment of the likely visual impacts of the development (before, during and post-mining) on private landowners in the vicinity of the development and key vantage points in the public domain, paying particular attention to any new landforms	Table 21.1 – Other matters
	Social	
	Provide a Social Impact Assessment prepared in accordance with the Social Impact Assessment Guideline for State Significant Projects, paying particular consideration to: • how the development might affect people's way of life, community, access to and use of infrastructure, services and facilities, culture, health and wellbeing, surroundings, personal and property rights, decision-making systems, and fears and aspirations	Chapter 14 – Social Appendix L – Social impact assessment
	• the principles in Section 1.2 of the guideline	Appendix L, Annexure 2 (SIA principles matrix)

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• the review questions in Appendix C of the guideline	Appendix L, Annexure 2 (DPE Guidelines compliance matrix)
	Economic	
	including a detailed assessment of the likely economic impacts of the development, paying particular attention to: • the significance of the resource	Chapter 17 – Economics Appendix O – Economic assessment
	• the costs and benefits of the project; identifying whether the development as a whole would result in a net benefit to NSW, including consideration of fluctuation in commodity markets and exchange rates	Chapter 17 – Economics Appendix O – Economic assessment
	• the demand on local infrastructure and services	Chapter 17 – Economics Appendix O – Economic assessment
	Cumulative impacts	
	Including an assessment of likely cumulative impacts of the proposed quarry operating in combination with other established quarries in the locality, paying particular attention to likely impacts on road safety, water resources, land capability and shared infrastructure	Cumulative assessments for air (Section 11.1.1), noise (Section 12.2.4 and 12.2.7), traffic (Section 13.3.5), hazards (Section 19.1.7) and waste (Section 20.2.3) Table 21.1 – Other matters
	Rehabilitation	
	Including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including: - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria	Chapter 18 – Rehabilitation Appendix P – Rehabilitation strategy
	Nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies	Section 18.2.3 – Final landform – terrestrial areas
	The potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region	Appendix P, Section 4.2
	A detailed description of the measures that would be put into place to ensure sufficient resources are available to implement the proposed rehabilitation measures, and the ongoing management of the site following the cessation of quarrying activities	Section 18.2.6 – Rehabilitation management and mitigation measures
	Plans and documents	
	The EIS must include all relevant plans, architectural drawings, diagrams and relevant documentation required under Part 8 of the Regulation. Provide these as part of the EIS rather than as separate documents	Accompanying EIS figures

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	Engagement	
	• During the preparation of the EIS, you must consult with the relevant local, State or Commonwealth Government authorities, service providers, community groups and affected landowners. In particular you must consult with: • affected landowners • community groups • Aboriginal stakeholders • Port Stephens Council • The Biodiversity Conservation Division within the Department of Planning and Environment (the Department) • The Water Division within the Department • Heritage NSW • NSW Environment Protection Authority • Regional NSW – Mining, Exploration & Geoscience Division • Department of Primary Industries (including Agriculture and Fisheries) within the Department • Hunter Water Corporation • NSW Rural Fire Service • Transport for NSW	Section 4.1.1 - Community engagement Section 4.1.2 - Government agency engagement Section 4.1.3 - Aboriginal engagement
	Establish a Community Consultative Committee for the project in accordance with the Community Consultative Committee Guidelines for State Significant Projects, and consult with the committee during the preparation of the EIS	As part of the response to submissions report (Boral, 2020) for the dredge application, Boral queried the need for a community consultative committee, due to the 'perpetually low engagement response from the local community with many unaware of or unconcerned by Boral's operation'. This was noted by the DPE assessment team and requirement for a CCC removed. For these reasons and given that the project reflects a reduced scale of development to the dredge application, Boral requests the requirement for a CCC also be removed for the project.

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	The EIS must detail the engagement undertaken and demonstrate how it was consistent with the Undertaking Engagement Guidelines for State Significant Projects. The EIS must detail how issues raised and feedback provided have been considered and responded to in the project	Chapter 4 - Engagement
DPE BCD	**General**	
	For this project an important consideration will be the potential impacts on the nearby Worimi State Conservation Area and the Worimi Regional Park, which are within one kilometre of the site	Noted
	Biodiversity	
	Biodiversity impacts related to the proposed development (SSD-52984213) are to be assessed in accordance with the Biodiversity Assessment Method 2020 and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method 2020	Chapter 10 – Biodiversity Appendix H – Biodiversity development assessment report
	The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method 2020	Chapter 10 – Biodiversity Appendix H – Biodiversity development assessment report
	The BDAR must include details of the measures proposed to address the offset obligation as follows: • the total number and classes of biodiversity credits required to be retired for the development/project	Appendix H, Section 5.1 and Section 5.2
	• the number and classes of like-for-like biodiversity credits proposed to be retired	Section 10.2.4 – Biodiversity offset strategy
	• the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules	Section 10.2.4 – Biodiversity offset strategy
	• any proposal to fund a biodiversity conservation action	Section 10.2.4 – Biodiversity offset strategy
	• any proposal to conduct ecological rehabilitation (if a mining project)	N/A
	• any proposal to make a payment to the Biodiversity Conservation Fund	Section 10.2.4 – Biodiversity offset strategy
	If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits	N/A
	The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016	Appendix H – Biodiversity development assessment report – Section 1.7

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	The Department now has a template guideline for the production of BDARs titled 'Guidance for the Biodiversity Development Assessment Report Template', available at: • https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-andplants/ • Biodiversity/biodiversity-development-assessment-report-template-guide-220209.pdf	Template considered in the preparation of the BDAR (Appendix H)
	Water and soils	
	The EIS must map the following features relevant to water and soils including: • acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map)	Appendix F – Acid sulfate soils advice letter – Figure 7
	• rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method)	N/A
	• wetlands as described in s4.2 of the Biodiversity Assessment Method	N/A
	• groundwater	Chapter 7 – Groundwater Appendix E – Groundwater assessment
	• groundwater dependent ecosystems	Appendix E – Groundwater assessment – Section 4.2 and Section 4.7.2
	• proposed intake and discharge locations	No surface water discharge
	The EIS must describe background conditions for any water resource likely to be affected by the development, including: • existing surface and groundwater	Appendix E – Groundwater assessment – Section 4.0
	• hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	No surface water discharge
	• water quality objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters	No surface water discharge
	• indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government	No surface water discharge
	The EIS must assess the impacts of the development on water quality, including: • the nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction	No surface water discharge

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• identification of proposed monitoring of water quality	Section 16.3 – Surface water management and mitigation measures
	The EIS must assess the impact of the development on hydrology, including: • water balance including quantity, quality and source	Section 16.2.1 – Site water balance
	• effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas	No surface water discharge
	• effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems	Appendix E – Groundwater assessment – Section 4.2 and Section 4.7.2
	• impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)	No surface water discharge
	• changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water	Appendix N – Surface water assessment – Section 1.4.1 and Section 3.1.2
	• mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and reuse options	No surface water discharge
	• identification of proposed monitoring of hydrological attributes	Section 16.3 – Surface water management and mitigation measures
	The EIS must map the following features relevant to flooding as described in the *Floodplain Development Manual 2005* (NSW Government 2005) including: • flood prone land	Section 16.1.2 - Flooding
	• flood planning area, the area below the flood planning level	Section 16.1.2 - Flooding
	• hydraulic categorisation (floodways and flood storage areas)	Project external to floodplain
	The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event	N/A
	The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: • current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change	Site beyond the PMF extents – refer Section 16.1.2 – Flooding

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	Modelling in the EIS must consider and document: • the impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood	N/A
	• impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories	N/A
	• relevant provisions of the NSW Floodplain Development Manual 2005	N/A
	The EIS must assess the impacts on the proposed development on flood behaviour, including: • whether there will be detrimental increases in the potential flood affectation of other properties assets and infrastructure	N/A
	• consistency with Council floodplain risk management plans	N/A
	• compatibility with the flood hazard of the land	N/A
	• compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land	N/A
	• whether there will be adverse effect to beneficial inundation of the floodplain environment, on adjacent to or downstream of the site	N/A
	• whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses	N/A
	• any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council	N/A
	• whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council	N/A
	• emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES	N/A
	• any impacts the development may have on the social and economic costs to the community as consequence of flooding	N/A
	The EIS must describe the potential effects of coastal processes and hazards (within the meaning of the Coastal Management Act 2016), including sea level rise and climate change: • on the proposed development	Chapter 9 – Coastal processes Table 5.3 – Matters for consideration

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• arising from the proposed development	
	The EIS must consider have regard to any certified Coastal Management Program (or Coastal Zone Management Plan) and be consistent with the management objectives described in the Coastal Management Act 2016 and development controls for coastal management areas mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021*	Table 5.3 – Matters for consideration
	Environmentally sensitive areas	
	The EIS must include an assessment of the potential impacts (direct and indirect) of the development on the Worimi State Conservation Area and the Worimi Regional Park, as per the guideline '*Developments adjacent to National Parks and Wildlife Service lands'* (NPWS, 2020)	Section 9.3.2 – Impact on the Worimi areas
DPE - Water	**Water take and licensing**	
	A detailed and consolidated site water balance	Chapter 16 – Surface water Appendix N – Surface water assessment
	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent	Sand extraction would occur above the water table Section 16.1.3 of this EIS – Existing water use and management
	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained	Section 16.1.3 of this EIS – Existing water use and management
	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the *Water Management Act 2000* should be detailed by the proponent	Section 16.1.3 of this EIS – Existing water use and management
	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions	Appendix E – Groundwater assessment – Section 4.3 and Section 4.8
	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts	Appendix E – Groundwater assessment – Section 6.0
	Proposed surface and groundwater monitoring activities and methodologies	Section 7.3 – Groundwater monitoring and mitigation measures

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
		Section 16.3 – Surface water management and mitigation measures
	Assessment against policy and guidelines	
	Identification and impact assessment of all works/activities located on waterfront land including an assessment against Guidelines for Controlled Activities on Waterfront Land (NRAR 2018)	N/A
	Assessment of project against relevant policies and guidelines	EIS and accompanying technical studies
EPA	**General**	
	The Proponent will need to apply separately to the EPA to vary the existing environment protection licence (EPL 10132) to permit and incorporate expanded operations should the Proposal be approved	Noted
	The EIS must address the requirements of Section 45 of the Protection of the Environment Operations Act 1997 (POEO Act) by determining the extent of each impact and providing sufficient information to enable the EPA to determine appropriate conditions, limits and monitoring requirements for an Environment Protection Licence (EPL)	Noted
	Impacts related to the following environmental issues need to be assessed, quantified and reported on: • air Issues, including odour: air quality including dust and odour generation from the operation on the surrounding landscape and/or community	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment
	• noise impacts associated with operational noise particularly machinery and plant movements	Chapter 12 – Noise Appendix J – Noise impact assessment
	• waste including hazardous materials and radiation. Consideration needs to be given to disposal options for general waste, sanitary waste as well as hazardous materials and radiation, where relevant	Chapter 20 – Waste management
	• water and soils including site water balance and sediment and erosion controls during construction and operation phases	Chapter 16 – Surface water Appendix N – Surface water assessment Chapter 18 – Rehabilitation Appendix P – Rehabilitation strategy Section 18.2.6 – Management measures (rehabilitation)
	List of approvals and licences	

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	The development is a scheduled activity under the *Protection of the Environment Operations Act 1997* (POEO Act) and will therefore require an Environment Protection Licence (EPL) if approval is granted	Table 5.2 – Other approvals
	Should project approval be granted, the proponent will need to make an application to the EPA for its EPL for the proposed facility prior to undertaking any on site works. Additional information is available through the EPA Guide to Licensing document (www.epa.nsw.gov.au/licensing/licenceguide.htm)	Noted
	Water	
	The EIS must demonstrate how the proposed development will meet the requirements of section 120 of the POEO Act. The EIS must include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater disposal, including type, volumes, proposed treatment and management methods and re-use options	Chapter 16 – Surface water Appendix N – Surface water assessment
	If the proposed development intends to discharge waters to the environment, the EIS must demonstrate how the discharge(s) will be managed in terms of water quantity, quality and frequency of discharge and include an impact assessment of the discharge on the receiving environment. This should include: • description of the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges	No surface water discharge
	• description of the receiving waters including upstream and downstream water quality as well as any other water users	No surface water discharge
	• demonstration that all practical options to avoid discharge have been implemented and environmental impact minimised where discharge is necessary	No surface water discharge
	The EIS must refer to Water Quality Objectives for the receiving waters and indicators and associated trigger values or criteria for the identified environmental values of the receiving environment. This information should be sourced from the ANZECC (2018) Guidelines for Fresh and Marine Water Quality, available at: https://www.waterquality.gov.au/anzguidelines	No surface water discharge
	The EIS must describe how stormwater will be managed in all phases of the project, including details of how stormwater and runoff will be managed to minimise pollution. Information should include measures to be implemented to minimise erosion, leachate and sediment mobilisation at the site. The EIS should consider the guidelines *Managing urban stormwater: soils and construction, vol. 1* (Landcom 2004) and vol. 2 (A. Installation of services; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC, 2008)	No surface water discharge
	The EIS must describe any water quality monitoring programs to be carried out at the project site. Water quality monitoring should be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (2004) which is available at: • https://www.epa.nsw.gov.au/-/media/epa/corporatesite/	Section 7.3 – Groundwater monitoring and mitigation measures Section 16.3 – Surface water management and mitigation measures

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• resources/water/approvedmethodswater.pdf	
	Noise and vibration	
	Construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC, 2009). These are available at: https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interimconstructionnoise-guideline	Section 12.1.6 - Sources of construction noise and assessment scenarios Section 12.2.6 - Construction noise levels
	Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the Assessing Vibration: a technical guideline (DEC, 2006). These are available at: https://www.epa.nsw.gov.au/yourenvironment/noise/industrial-noise/assessing-vibration	No significant sources of vibration have been identified for the project. Additionally, the distance between the quarry and the closest receivers is over 500 m). Therefore, a detailed assessment of potential vibration impacts is not considered warranted
	If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990).These are available at: https://www.epa.nsw.gov.au/yourenvironment/noise/industrial-noise/interim-constructionnoise-guideline	No blasting is required for the project and has therefore note been assessed
	Operational noise from all industrial activities (including private haul roads and private railway lines) to be undertaken on the premises should be assessed using the guidelines contained in the *NSW Noise Policy for Industry* (EPA, 2017). https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/noise-policyforindustry-(2017)	Section 12.1 - Assessment methodology Section 12.2 - Impact assessment Appendix J - Noise impact assessment
	Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the *NSW Road Noise Policy* and associated application notes (EPA, 2011). https://www.epa.nsw.gov.au/yourenvironment/noise/transport-noise	Section 12.1.7 - Road traffic noise criteria Section 12.2.8 - Road traffic noise
	Air	
	The EIS must demonstrate the proposal’ s ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997*) and the POEO (*Clean Air) Regulation* (*2002*). Particular consideration should be given to section 129 of the POEO Act concerning control of “offensive odour”	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment
	The EIS must include an air quality impact assessment (AQIA). The AQIA must be carried out in accordance with the document, *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2016), available at:	Section 11.1 – Air Appendix I – Air quality and greenhouse gas assessment

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	https://www.epa.nsw.gov.au//media/epa/corporate-site/resources/air/approvedmethods-for-modelling-and-assessmentof-air-pollutants-in-nsw-160666.pdf	
	The EIS must detail emission control techniques/practices that will be employed at the site and identify how the proposed control techniques/practices will meet the requirements of the POEO Act, POEO (Clean Air) Regulation and associated air quality limits or guideline criteria	Section 11.1.3 – Management measures (air) Appendix D – Management and mitigation measures
	Waste, chemicals and hazardous materials and radiation	
	The EIS must assess all aspects of waste generation, management and disposal associated with the proposed development	Chapter 20 – Waste management
	The EIS must demonstrate compliance with all regulatory requirements outlined in the POEO Act and associated waste regulations	Chapter 20 – Waste management
	• The EIS must identify, characterise and classify the following in accordance with the EPA's Waste Classification Guidelines (2014) and associated addendums: • all waste that will be generated onsite through excavation, demolition or construction activities, including proposed quantities of the waste • all waste that is proposed to be disposed of to an offsite location, including proposed quantities of the waste and the disposal locations for the waste. This includes waste that is intended for re-use or recycling	Chapter 20 – Waste management
	The EIS must outline contingency plans for any event that may result in environmental harm, such as excessive stockpiling of material, or dirty water volumes exceeding the storage capacity available on-site	Chapter 20 – Waste management
	The EIS must demonstrate that appropriate spill containment will be provided for storage, filling and loading of all fuels and other chemicals to be used on site, in accordance with the relevant Australian Standard	Chapter 19 – Hazards and risks Section 19.1.1 – Hazardous substances tand and dangerous goods management
	Land	
	Identify if the soils in the area of the Proposal are contaminated or are acid forming (i.e. acid sulphate soils) and if so, identify best practice mitigation measures (pollution control) and strategies or remedial and/or disposal actions that will be required/undertaken if applicable in accordance with relevant guidance/standards	Chapter 8 – Acid sulfate soils Appendix F – Acid sulfate soils advice letter
Heritage NSW	**General**	
	Provide an Aboriginal Cultural Heritage Assessment Report (ACHAR) prepared in accordance with relevant guidelines, identifying, describing and assessing any impacts to Aboriginal cultural heritage sites or values associated with the site	Chapter 15 – Aboriginal heritage Appendix M – Aboriginal cultural heritage assessment report

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
GSNSW	**General**	
	All environmental reports (EISs, EAs, SoEEs or similar) accompanying development applications for extractive industry lodged under the Environmental Planning and Assessment Act 1979 should include a resource assessment which: • documents the size and quality of the resource and demonstrates that both have been adequately assessed • documents the methods used to assess the resource and its suitability for the intended applications	Section 2.2.2 – The resource
Transport for NSW	**General**	
	TfNSW requests that a Traffic Impact Assessment (TIA) be prepared by suitably qualified person/s in accordance with the Austroads Guide to Traffic Management Part 12, the complementary TfNSW Supplement and RTA Guide to Traffic Generating Developments. The TIA should include, but not necessarily be limited to, an assessment of the considerations outlined below:	Chapter 12 – Traffic and transport Appendix K – Traffic and transport impact assessment
	• a map of the proposed transport route/s identifying all public roads proposed to obtain access from the classified (State) road/s to the development site	Appendix K – Traffic and transport impact assessment – Figure 13
	• the total impact of existing and proposed development on the road network with consideration for a 10 year horizon. This should include: - identify Annual Average Daily Traffic (AADT) volumes with percentage heavy vehicles along the transport route/s and diagrammatically demonstrate AM and PM peak hour movements at key intersections - background traffic data from published sources and/or recent survey data. The source of data and any assumptions are to be clearly explained and justified, including the growth rate applied to the future horizon - the volume and distribution of existing and proposed trips to be generated by the construction, operational and decommission phases of the development. This should identify the maximum daily and hourly demands generated by the development, particularly where they coincide with the network peak hour the type and frequency of design vehicles accessing the development site	Appendix K – Traffic and transport impact assessment – Sections 5 and 9
	• details of the road geometry and alignment along the identified transport route/s, including existing formations, crossings, intersection treatments and any identified hazards. This should include: - an assessment of turn treatment warrants in accordance with the Austroads Guide to Traffic Management Part 6 and Austroads Guide to Road Design Part 4A for intersections along the identified transport route/s, identifying the existence of the minimum basic turn treatments and addressing the need for any warranted higher order treatments • swept path analysis demonstrating the largest design vehicle entering and leaving the development, and moving in each direction through intersections along the proposed transport route/s	Appendix K – Traffic and transport impact assessment – Sections 5, 7.3 and 11

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	• capacity analysis using SIDRA or other relevant application, to identify an acceptable Level of Service (LOS) at intersections with the classified (State) road/s, and where relevant, analysis of any other intersections along the proposed transport route/s.	Appendix K – Traffic and transport impact assessment – Section 9
	• a review of crash data along the identified transport route/s for the most recent 5 year reporting period and an assessment of road safety along the proposed transport route/s considering the safe systems principles adopted under Future Transport 2056	Appendix K – Traffic and transport impact assessment – Section 10
	• strategic (2D) design drawings of all proposed road works and the site access demonstrating scope, estimated cost and constructability of works required to mitigate the impacts of the development on road safety, traffic efficiency and the integrity of transport infrastructure. Works must be appropriately designed for the existing posted speed limit	Appendix K – Traffic and transport impact assessment - Section 9.9.2, noting no external works considered necessary
	• site plan demonstrating site access, internal manoeuvring, servicing and parking areas consistent with the relevant parts of AS2890 and Council requirements	Appendix K – Traffic and transport impact assessment Appendix A
	• details of measures to address impacts and/or provide connections for public transport services and active transport modes, such as, public and school bus services, walking and cycling	Appendix K – Traffic and transport impact assessment – Section 9.12
	• details of measures to ameliorate the impacts of road traffic noise, dust, and/or glare generated along the proposed transport route/s	Appendix K – Traffic and transport impact assessment – Section 9.13
	• details of any Traffic Management Plan (TMP) proposed to address the construction and operation phases of the proposed development. The TMP should be prepared and implemented in accordance with Australian Standard 1742.3 and the Work Health and Safety Regulation 2017. It is recommended that any TMP include, but not necessarily limited to, the following: - a map of the primary transport route/s highlighting critical locations - an induction process for vehicle operators and regular toolbox meetings - procedures for travel through residential areas, school zones and/or bus route/s - any proposed temporary measures such a Traffic Guidance Scheme (TGS) - a Driver Code of Conduct for heavy vehicle operators - a complaint resolution and disciplinary procedure	Appendix K – Traffic and transport impact assessment – Section 9.15
	Community consultation measures proposed for peak periods. Where road safety concerns are identified at a specific location along the proposed haulage routes, TfNSW suggests that the TIA be supported by a targeted Road Safety Audit undertaken by suitably qualified persons in accordance with the Austroads Guidelines	Appendix K – Traffic and transport impact assessment – Section 9.14
	Where road safety concerns are identified at a specific location along the proposed haulage routes, TfNSW suggests that the TIA be supported by a targeted Road Safety Audit undertaken by suitably qualified persons in accordance with the Austroads Guidelines	Appendix K – Traffic and transport impact assessment – Section 10.3

Table A1 SEARs/agency requirements

Stakeholder	Requirement	EIS/appendix reference
	Any roadwork on classified State Road/s is to be designed and constructed in accordance with the current Austroads Guidelines, Australian Standards and TfNSW Supplements	Noted
Crown Lands	**General**	
	The Department offers no objections to the development proposal but notes that the Department is currently in discussions with the proponent to resolve current inconsistencies between the conditions of licence 196915 and the proponents use of R170039	Noted

Appendix B

Statutory compliance table

Table B1 Statutory compliance

Relevant statute	Section of EIS addressed	Compliance
Commonwealth legislation		
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Table 5.2 - Other approvals required	Yes
Native Title Act 1993 (NT Act)	Table 5.2 - Other approvals required	Yes
National Greenhouse and Energy Reporting Act 2007 (NGER Act)	Table 5.2 - Other approvals required	Yes
NSW legislation		
Environmental Planning and Assessment Act 1979 (EP&A Act)	Section 5.1 - Power to grant approval	Yes
Protection of the Environment Operations Act 1997 (POEO Act)	Table 5.2 - Other approvals required	Yes
Biodiversity Conservation Act 2016 (BC Act)	Table 5.2 - Other approvals required	Yes
NSW *Contaminated Land Management Act 1997* (CLM Act)	Table 5.2 - Other approvals required	Yes
NSW *Hunter Water Act 1991* (HW Act)	Table 5.2 - Other approvals required	Yes
NSW *Waste Avoidance and Resource Recovery Act 2001* (WARR Act)	Table 5.2 - Other approvals required	Yes
NSW *Coastal Management Act 2016* (CM Act)	Table 5.2 - Other approvals required	Yes
National Parks and Wildlife Act 1974 (NPW Act)	Table 5.2 - Other approvals required	Yes
Heritage Act 1977 (Heritage Act)	Table 5.2 - Other approvals required	Yes
Water Management Act 2000 (WM Act)	Table 5.2 - Other approvals required	Yes
Water Act 1912 (Water Act)	Table 5.2 - Other approvals required	Yes
Roads Act 1993 (Roads Act)	Table 5.2 - Other approvals required	Yes
Rural Fires Act 1997 (RF Act)	Table 5.2 - Other approvals required	Yes
Fisheries Management Act 1994 (FM Act)	Table 5.2 - Other approvals required	Yes
NSW environmental planning instruments		
State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP)		Yes
State Environmental Planning Policy (Transport and Infrastructure) 2021 (Infrastructure SEPP)	Table 5.3 - Matters for consideration	Yes
State Environmental Planning Policy (Resilience and Hazards) 2021 (Resilience and Hazards SEPP)	Table 5.3 - Matters for consideration	Yes
State Environmental Planning Policy (Resources and Energy) 2021 (Resources SEPP)	Table 5.3 - Matters for consideration	Yes
State Environmental Planning Policy (Biodiversity and Conservation 2021 (BCD SEPP)	Table 5.3 - Matters for consideration	Yes
Port Stephens Local Environmental Plan 2013 (PSLEP 2013)	Table 5.3 - Matters for consideration	Yes

Appendix C

Government agency consultation letter

ARNOLD
PLANNING

23 February 2023

XXX
XXX

Via email to: *XXX*

Re: Stockton Quarry Dry Sand Extraction Project – Government Agency Consultation for SSD-52984213

Dear XX

Boral Resources (NSW) Pty Ltd owns and operates the Stockton Sand Quarry (the site or the quarry), located on Coxs Lane, Fullerton Cove, a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

The site has an area of approximately 246 hectares (ha) and has been used for the purposes of extractive industries (sand quarrying) since the 1970s. At present, there is an existing quarry located on the windblown (transgressive) sand dunes of Stockton Bight, which transports up to 500,000 tonnes per annum (tpa) of product (the existing windblown project).

The existing windblown project was granted consent in 1996, with the consent is due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to the NSW Department of Planning and Environment (DPE) in 2020, seeking consent to extract and dredge up to 9 million tonnes of sand from the inland dunes area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source combined with water availability, Boral has determined that to keep the quarry operating, an interim application would be required, seeking consent to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the current dredge application, the project seeks a site-wide dispatch limit of up to 750,000 tonnes per annum (tpa) (i.e. the existing windblown sand extraction area and the project operations combined) until either:

- the current dredge application is approved, after which extraction under the project would cease and be replaced with the approved dredging proposal (noting that the staging of the project and the current dredge application have been aligned to allow for this); or
- the current dredge application is not approved and the existing windblow consent lapses in 2028, after which the site-wide dispatch limit would reduce to no more than 500,000 tpa.

Details of the project are provided in the *Stockton Dry Sand Extraction Project: Scoping Report* (Arnold Planning, December 2022), which is available on the NSW Government's Major Project website at the following link. A figure showing the extent of the project is attached to this letter.

Suite 607, 310 George Street
SYDNEY NSW 2001
info@arnoldplanning.com.au
www.arnoldplanning.com.au

https://www.planningportal.nsw.gov.au/major-projects/projects/stockton-dry-sand-extraction-project

Boral has engaged Arnold Planning Pty Ltd to coordinate the preparation of the technical studies and prepare an environmental impacts statement (EIS) for the project. In accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the project (also available at the above link), Boral is required to consult with government agencies and ensure that any issues raised are adequately considered and responded to in the project. Details of the consultation undertaken and how issues have been considered will be provided in the EIS.

You are invited to provide comments on the project by **10 March 2023** via email at info@arnoldplanning.com.au

If you have any questions or would like to discuss the project in more detail, please feel free to contact me via the contact details below.

We look forward to receiving your response.

Yours sincerely

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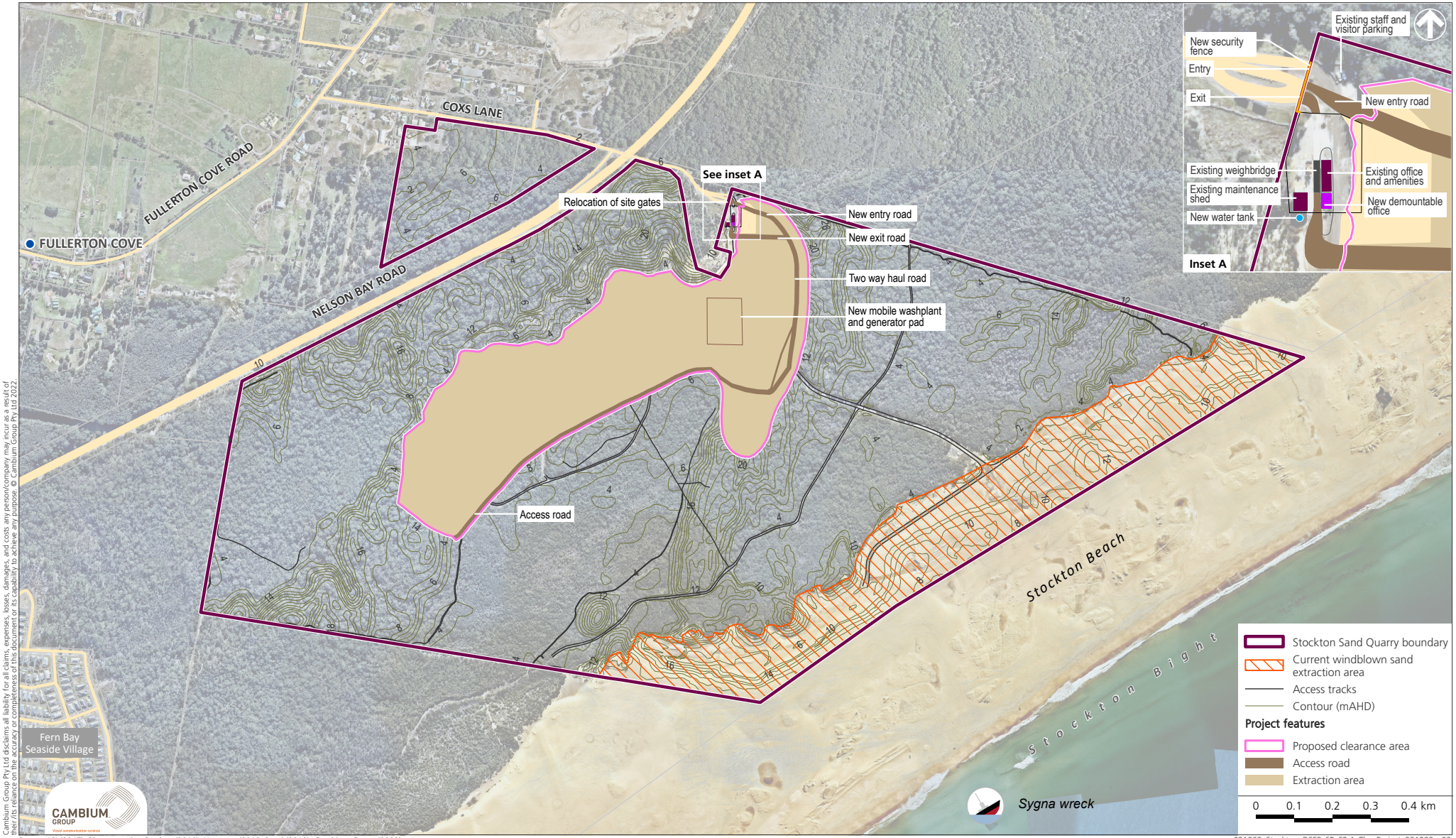
The Project

STOCKTON DRY SAND EXTRACTION PROJECT



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Appendix D

Management and mitigation measures

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
Groundwater	Groundwater monitoring network: • Ongoing groundwater monitoring shall be conducted at the site in accordance with the existing groundwater monitoring program. • Additional monitoring locations shall be installed to provide additional baseline data to characterise the groundwater regime and for ongoing monitoring over the life of the project, given that several of the existing bores are within the disturbance footprint (Note: the proposed groundwater monitoring network is presented in Table 7.1 and additional monitoring locations are shown in Figure 7-1 of the groundwater assessment (refer Appendix E of this EIS)) Groundwater monitoring program: • Groundwater level monitoring shall be conducted at the frequency outline in Table 7.1 of the groundwater assessment (refer Appendix E of this EIS). • Logger data shall be recorded at hourly intervals with data downloaded on a monthly basis at the same time as the water levels are dipped. • Groundwater quality monitoring shall be conducted at the frequency outlined in Table 7.1 of the groundwater assessment (refer Appendix E of this EIS). • The existing site groundwater management plan shall be updated to reflect the updated monitoring locations and approach. • Groundwater monitoring shall be undertaken in accordance with industry standards, with data stored within a central database and routine QA/QC conducted to verify data input. • Groundwater sampling shall include collection of field parameters for pH, temperature and EC, as well as observations on the colour and odour of the sample noted. • Samples shall be collected in laboratory supplied bottles for analysis. • Field filtering for metals analysis shall be undertaken. Samples will be stored in a chilled esky and submitted to a National Association of Testing Authorities (NATA) accredited laboratory with a chain of custody (CoC) form for water quality analysis. • The samples shall be analysed for: - turbidity; - total dissolved solids (TDS); - chloride and fluoride; - major ions: sulphate, calcium, potassium, sodium, magnesium, hardness as CaCO3, bicarbonate (HCO3); - alkalinity; - nutrients: filtrable phosphorous and nitrate as N; - total and dissolved metals: aluminium, arsenic, barium, cadmium, chromium, copper, iron, manganese, nickel, lead, selenium, zinc and mercury; and - PFAS, PFOA. Groundwater triggers and reporting:	Section 7.3

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• The groundwater data shall be compared to relevant triggers following each sampling event. • Trigger levels shall be applied for groundwater levels, pH and EC. Trigger levels are proposed as: - 95th percentile of groundwater levels recorded during low rainfall periods (less than 80 mm per month); - 95th percentile of groundwater levels recorded during high rainfall periods (more than 80 mm per month); - EC based on 95th percentile of baseline groundwater data; and - pH based on 5th and 95th percentile of baseline groundwater data. The groundwater trends shall be reviewed on an annual basis and reported on in the AEMR.	
Biodiversity	<u>General</u> • A project specific landscape and rehabilitation management plan shall be prepared to reflect biodiversity management measures associated with the project and having regard to the rehabilitation management requirements and controls.	Section 10.3
	<u>Fencing and signposting</u> • Fencing and/or the use of highly visible rope or tape boundaries shall be used to delineate the boundary of vegetation clearing at the edge of the proposed extraction area. • Signposting shall be used to inform project personnel and site visitors of areas of conservation value, to restrict entry or inform behaviour that will reduce incidental interactions with threatened species (e.g speed limits along access roads to reduce potential for fauna vehicle strikes).	
	<u>Employee education and general environmental controls</u> • Employees and contractors shall be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the project: - dust generation shall be minimised by minimising the extent and time that bare sand is exposed and by appropriate sand suppression; - procedures for the management of hydrocarbon and/or chemical spills throughout the project site shall be undertaken, including the requirements for vehicles to carry spill kits; and - vehicles shall remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going project discussions.	
	<u>Vegetation clearance protocol</u>	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• Boral has an established vegetation clearing protocol provided in the existing Project Landscape and Rehabilitation Management Plan (ERM 2007). This protocol shall be adopted under a project specific landscape and rehabilitation management plan, including the following key protocols: - prior to clearing of native vegetation, ecologists shall survey for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed; - prior to clearing of remnant hollow-bearing trees or habitat trees, ecologists shall be be engaged to supervise felling; - all hollow-bearing trees that are accessible safely from the ground shall be checked and identified fauna relocated; and - hollows bearing trees not accessible from the ground shall be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate. • Any fauna displaced during clearing are to be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so). • In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) will be contacted to handle and collect for appropriate care and rehabilitation.	
	<u>Pest and weed management</u> • A project specific pest and weed management plan shall be developed and implemented. It is envisaged that this plan would adopted protocols and strategies similar to those implemented under the existing management plan adopted for the existing windblown project (ERM 2007) with the following additional matters to be included: - management protocols for feral animals such as dogs, rabbits and foxes within the rehabilitation area; and - management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the site).	
Air quality	<u>General</u> • Activities shall be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means). • Weather forecast shall be checked prior to undertaking material handling or processing. • Engines of on-site vehicles and plant shall be switched off when not in use. • Vehicles and plant shall be fitted with pollution reduction devices where practicable. • Vehicles shall be maintained and serviced according to manufacturer's specifications. • Visual monitoring of activities shall be undertaken to identify dust generation.	Section 11.1.3
	<u>Exposed areas / stockpiles</u> • The extent of exposed surfaces and stockpiles shall be kept to a minimum. • Exposed areas and stockpiles shall either be covered or shall be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours. • Dust generation shall be minimised by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	Material handling • Drop heights shall be reduced from loading and handling equipment where practical. • Material shall be dampened during handling when excessively dusty.	
	Hauling activities • Haul roads shall be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur. • Regularly inspection of haul road haul roads and maintenance of surfaces shall be undertaken to remove potholes or depressions. • Driveways and hardstand areas shall be swept/cleaned regularly as required. • Vehicle traffic shall be restricted to designated routes. • Speed limits shall be enforced. • Vehicle loads shall be covered when travelling off-site.	
Greenhouse gas	General • The project shall utilise various management and mitigation measures to minimise the overall generation of GHG emissions. Some examples of GHG management practices that could be applied during construction and operation of the project include: - Investigating ways to reduce energy consumption throughout the life of the project and reviewing energy efficient alternatives. - Ensuring regular maintenance of plant and equipment. - Ensuring plant and equipment are switched off when not in use. - Monitoring the consumption of fuel and regularly maintaining diesel powered equipment to ensure operational efficiency. - Monitoring the total site electricity and investigating avenues to minimise consumption. - Sourcing consumable materials from environmentally sustainable sources.	Section 11.2.3
Noise	During construction • Prior to commencement of works a construction noise management plan (CNMP) shall be prepared and implemented in accordance with the requirements of the ICNG. • Consultation with the local community shall continue to be undertaken to ensure potential construction noise impacts are adequately managed. • If complaints of excessive noise occur, measures shall be undertaken to investigate the complaint, the cause of the complaint identified and changes. to work practices implemented accordingly. • Documentation and training of site staff shall occur to ensure the practices that produced the complaints are not repeated. • A permanent 'register of complaints' shall be held and alll complaints received shall be fully investigated and reported to management.	Section 12.3
	During operation	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• All engines would be turned off when not required. • Training of staff and employers would be undertaken and would include a noise awareness component, community consultation and response to complaints. • The use of reversing alarms shall be minimised or alternatively "squawkers" would be installed. • Plant and processes with reduced noise emissions would be selected. • A complaints handling process and noise monitoring procedures would be undertaken in response to any complaints.	
Aboriginal heritage	<u>Heritage training and induction processes</u> • Aboriginal heritage management procedures shall be included in quarry personnel training and induction processes. • Aboriginal heritage management procedures and responsibilities for compliance shall form part of the project induction for quarry personnel (employees, contractors, subcontractors and/or agents). This shall include site identification (including heritage site map) to ensure all personnel are aware of Aboriginal heritage management responsibilities, issues affecting their activities and procedures for dealing with unexpected finds including human remains.	Section 15.3
	<u>Avoiding impact to adjacent areas</u> • All works associated with the project shall be contained within the study area. Additional archaeological or Aboriginal heritage assessment shall be required for any proposed impacts outside the current study area. • Aboriginal objects are known to occur in adjacent landforms and these shall be avoided by all proposed extraction activities. Management measures to be implemented shall include clear delineation of the boundary of the approved impact zone and the inclusion of Aboriginal heritage in the existing environmental management strategy for the quarry. • Documented toolbox talks shall be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.	
	<u>Unexpected finds procedure</u> • Any unexpected Aboriginal heritage items (Aboriginal objects) shall be managed appropriately. • In the event that an unexpected find (Aboriginal object) is encountered the following procedure shall apply: - stop work and protect find area and report to environmental manager; - contact heritage advisor for identification (no further action if the find is not an Aboriginal object and if the find is an Aboriginal object proceed to next step); - undertake relevant regulatory requirements and contact with DPE where required; - implement conservation or mitigation strategy; - obtain approval if required and comply with conditions; and - recommence work.	
	<u>Procedures for handling human remains</u>	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• In the event that project operations reveal possible human skeletal material (remains), the following procedure shall be followed: - as soon as remains are exposed, all work shall halt at that location immediately and the quarry manager on site shall be immediately notified to allow assessment and management (stop all activities, secure the site and not further harm the remains); - contact police: the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic; - DPE, as the approval authority, shall be notified when human remains are found; - once the police process is complete and if remains are not associated with a contemporary crime, DPE will determine the process (if the remains are identified as Aboriginal, the site shall be secured and all Aboriginal stakeholders are to be notified in writing; or if the remains are identified as non-Aboriginal (historical) remains then DPE heritage division shall be contacted as appropriate); and - once the police process is complete and/or if the remains are identified as not being human work can recommence once the appropriate clearances have been given.	
Surface water	<u>Refuelling, hydrocarbon and chemical spills</u> • Standard hydrocarbon and chemical storage, handling and management techniques shall be implemented for the proposed diesel generator and wash plant areas, along with the existing maintenance shed and the existing Environmental Management Strategy for the site updated accordingly.	Section 16.3
	<u>Sediment and erosion control</u> • Erosion prevention and sediment controls shall be implemented through the design of the haul roads and hardstand areas to limit concentrated flow paths and through the use of erosion and sediment controls during construction and operation. • Haul road design/construction shall be undertaken in accordance with the following guidelines: - Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) - Managing Stormwater: Soils and Construction, Volume 1 (Landcom 2004); and - Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction (DECC 2008).	
	<u>Flooding and inundation</u> • All fixed infrastructure such as the weighbridge, offices, diesel generators and wash plant are located above the maximum flood level of 3.5 m AHD. • During surface extraction processes, machinery and portable screens can be moved prior to increased groundwater levels. To predict these periods, rainfall and ocean level conditions shall be monitored through the BoM, including storm warnings for heavy rain and high seas. • Groundwater levels shall be monitored and rates of movement noted - based on this information the quarry manager shall decide on precautionary measures to remove machinery from areas where groundwater flooding may occur. • Mobile plant shall be stored in the maintenance depot when not in use. • A groundwater inundation management plan shall be prepared that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.	
	<u>Water quality and quantity monitoring</u>	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• Monitoring of water extraction and water use on site shall be undertaken to gather an accurate understanding of extractions from the groundwater source, monitoring of extractions for use on site, and the measurement of moisture content of sand material and sand material export. • The following monitoring shall be undertake: - metering of all extraction bores on site; - metering of water inputs to the sand processing wash plant; - fortnightly measurements of moisture content in exported material through stockpile measurements; and records of material leaving site.	
Rehabilitation	<u>Erosion and sediment control</u> In the event of surface water movement and/or formation of drainage pathways, erosion and sediment controls shall be implemented and maintained, which could include mechanisms such as: • Diversion of 'clean' overland flow to the project site away from 'dirty' areas. • Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water. • Corrective actions, relating specifically to: - maintaining, repairing and cleaning out sediment control structures in order to maintain compliance with the erosion and sediment control plan for the project (i.e. vegetated bund); and - repairing eroded areas.	Section 18.2.6
	<u>Dust control</u> • Dust suppression methods shall be used on the existing and proposed haul roads for the project and except for Stage 1, progressive sand extraction within Stages 2 - 5 shall seek to limit exposed ground surfaces to a maximum of 200 - 300 m at any one time, to ensure that resource is not lost through exposure to prevailing winds.	
	<u>Monthly site monitoring</u> • Monthly monitoring shall commence form the establishment of revegetation and continue for a minimum of three years.	
	<u>Annual site inspection</u> • An independent inspection of the rehabilitation process from Stage 1 shall be conducted by a suitably experienced ecologist or environmental restoration consultant annually, from the commencement of rehabilitation activities.	
Hazards and risks	<u>Hazardous substances</u>	Section 19.2

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
	• A pollution and incident response management plan (PIRMP) has been prepared to manage potential chemical or hydrocarbon spills. The PIRMP shall be updated as follows to incorporate the project: - All personnel shall be trained in hazardous substance management, emergency response and the use of spill kits. - Appropriately sized and stocked spill response kits shall be provided in strategic areas of the quarry and in vehicles used to transport hazardous materials to and from the site. - Spill response kits shall be maintained, clearly identified and readily accessible for use in case of accidental spillages. Key staff would be trained in their use, application and disposal of contaminated material. - Potential chemical pollutants (e.g. fuels, oils, lubricants, paints, etc.) shall be stored in appropriate containers in bunded areas in vehicles or designated storage areas to minimise the risk of spillages and mobilisation of pollutants into the soil or stormwater drains. - Equipment shall not be used if there are signs of fuel, oil or hydraulic leaks. - Leaks shall be repaired immediately, or the equipment would be removed from site and replaced with a leakfree item. • Soil contaminated by spills shall be excavated, classified in accordance with Waste Classification Guidelines, and disposed of at a licensed waste management facility, or remediated on site in accordance with a contaminated land management action plan to be prepared by a contaminated land specialist.	
	<u>Soil and water contamination</u> • Plant and equipment shall be maintained to minimise the potential for leakages, while appropriately sized and stocked spill response kits would be provided in strategic areas of the site, and in vehicles.	
	<u>Risk to workers</u> • Designated first aid and emergency response equipment shall be available during construction and operation phases of the project. Appropriately trained personnel shall be on site throughout the life of the operations to provide first aid and respond to site emergencies. • Any injuries incurred at the quarry shall be reported and investigated in consultation with NSW Resource Regulator and other relevant authorities. Any recommendations or findings of investigation reports shall be implemented by Boral where feasible and practical.	
	<u>Bushfire</u> • A 24 m asset protection zone (APZ) shall be provided around buildings and maintained as an inner protection area (IPA) as outlined within Appendix 4 of the NSW RFS documents *Planning for Bush Fire Protection 2019* (PBP 2019) and *Standards for Asset Protection Zones.* • The workshop polycarbonate roofing on the workshop shall be replaced with metal roof sheeting. • The new haul roads shall comply with Section 7 of Planning for PBP 2019, with the roads being a minimum 6.5 m in width with a turning bay at the termination of the road, having a minimum 12 m outer radius. • Water, electricity and gas shall comply with Section 7 of PBP 2019. • A 20,000 litre static water supply with firefighting fittings shall be provided. • Landscaping for the site depot shall be undertaken in accordance with Appendix 4 of PBP 2019 and managed and maintained in perpetuity. • New buildings shall be incorporated into the site's existing emergency management plans with specific consideration of bushfire evacuation planning.	

Table D1 Management and mitigation measures

Environmental aspect	Management / mitigation measures	EIS section reference
Waste management	• The existing environmental management strategy for the quarry shall be updated as follows: - Wastes shall be quantified and classified. - Disposal/reuse strategies for each type of material. - Details of how waste shall be stored and treated on site. - Identification of non-recyclable waste. - Identification of measures and initiatives to reduce, reuse and recycle. - Procedures and disposal arrangements for potentially hazardous material. • Waste shall be managed in accordance with (NSW Environment Protection Authority, 2014) and relevant regulatory requirements and shall include: - Its classification prior to leaving the site. - Recording (via an appropriate waste tracking system) its legal off site transportation for re-use, recycling or disposal. - Waste (excluding toilet waste) shall be stored in a suitable container with a lid, and transported to an appropriate facility. - Enough receptacles for general waste, hazardous waste and recyclable materials shall be provided, including sufficient bins to allow separation of wastes for recycling. - Wastes shall only be disposed at a licenced waste disposal depot. - Wastes shall be securely stored so that pollutants are prevented from escaping. - Fuel, lubricant or hydraulic fluid spillages shall be collected using absorbent material and the contaminated material disposed of at a licensed waste facility. - Hazardous or contaminated wastes (if identified) shall be removed and disposed in accordance with the State and national regulations and guidelines and best practice for the removal of these materials. - Hazardous materials shall only be removed by suitably qualified, licensed and experienced contractors. - Personnel shall be required to notify the Quarry Manager, and follow approved SafeWork NSW procedures for the handling and transport of any asbestos containing material wastes to an EPA approved facility. - Documents and records of the transport and fates of all materials removed from the project site shall be kept as proof of correct disposal and for environmental auditing purposes. - Waste streams shall be sorted to maximise the reuse/recycling potential and minimise disposal costs. • Waste shall be covered, stored and removed in a timely manner so as not to attract native animals or vermin.	Section 20.3
Historic heritage	Should an item of potential non-Aboriginal heritage be identified during project operations, works would cease, and the quarry manager would be contacted immediately. Appropriate measures would then be taken to minimise the potential for harm to the object. Further advice would be sought from a qualified archaeologist, and subsequently DPE - BCD would be notified of the proposed course of action, as required.	Table 21.1

Appendix E

Groundwater assessment

umwelt
Environmental & Social Consultants

STOCKTON DRY SAND EXTRACTION PROJECT

Groundwater Assessment

FINAL

August 2023

STOCKTON DRY SAND EXTRACTION PROJECT

Groundwater Assessment

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
Boral Resources (NSW) Pty Ltd

Project Director: Claire Stephenson
Project Manager: Ian Unsworth
Report No. 22557/R02
Date: August 2023

Environmental & Social Consultants

This report was prepared using Umwelt's ISO 9001 certified Quality Management System.

Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

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1.0 Introduction

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Boral Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets. The quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle Central Business District (CBD). The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the New South Wales (NSW) Department of Planning and Environment (DPE) – Crown Lands (**Figure 1-1**).

Figure 1-1 Stockton Sand Quarry (Provided by Boral)

At present, there is an existing quarry located on the windblown sand extraction area under DA 140-6-2005 approved in 2006 and due to lapse in 2028. The site is located on the transgressive dunes adjoining Stockton Beach. Boral are seeking State Significant Development (SSD) consent (Ref: SSD 52984213) to extract the remaining dry sand resource from within the same footprint as the previously submitted Dredge Application (SSD 9490).

Umwelt Australia Pty Ltd (Umwelt) were engaged on behalf of Boral to undertake the groundwater assessment to support the Stockton Dry Sand Project (project), as presented in this report.

1.1 Project Description

The project site is in the central portion of the quarry and covers an area of approximately 37 ha. The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations, as well as new entry/exit roads, a two-way haul road and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table, from approximately 26.5 m Australian height datum (AHD) (in Stage 1) down to approximately 3.7 m AHD. Extraction would be achieved using dozer, excavator, haul trucks and front-end loader. Vegetation within the project area is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in **Figure 1-2,** sand would be extracted from five stages, starting in Stage 1. The five stages of the project (shown in **Figure 1-2**). Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

There are an estimated 3.1 million tonnes (Mt) of dry sand resource within the project site and above the water table. The project seeks a project life of 10 years.

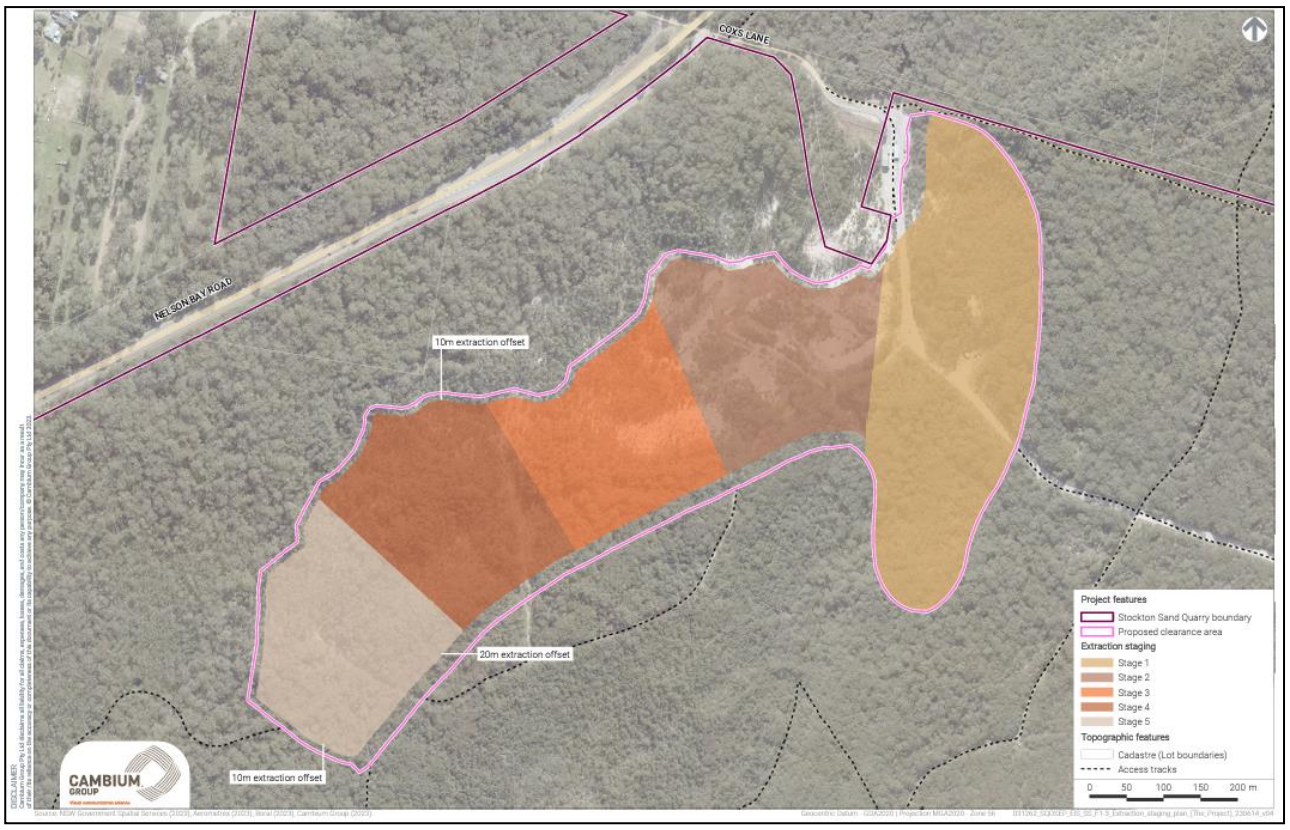

Figure 1-2 Extraction Staging Plan

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. The site layout is shown in **Figure 1-3** and overall project area and surrounds are shown in **Figure 1-4** Where new or augmented infrastructure is required, this would be delivered as part of Stage 1 and would generally include:

- Construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge.
- Construction of a new two-way haul road, which would wrap around the north, east and southern perimeter of Stage 1, linking to the existing haul road and enabling continued access to the existing windblown project.
- Construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press.
- Relocation of the parking area to the south, relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in **Figure 1-3**, the existing site depot would also be reconfigured for the project and would include the following:

- Installation of a new prefabricated office building.
- Relocation of onsite materials storage.
- Replacement of roofing for the workshop.
- Installation of a 20,000 L water storage tank for potential firefighting efforts.

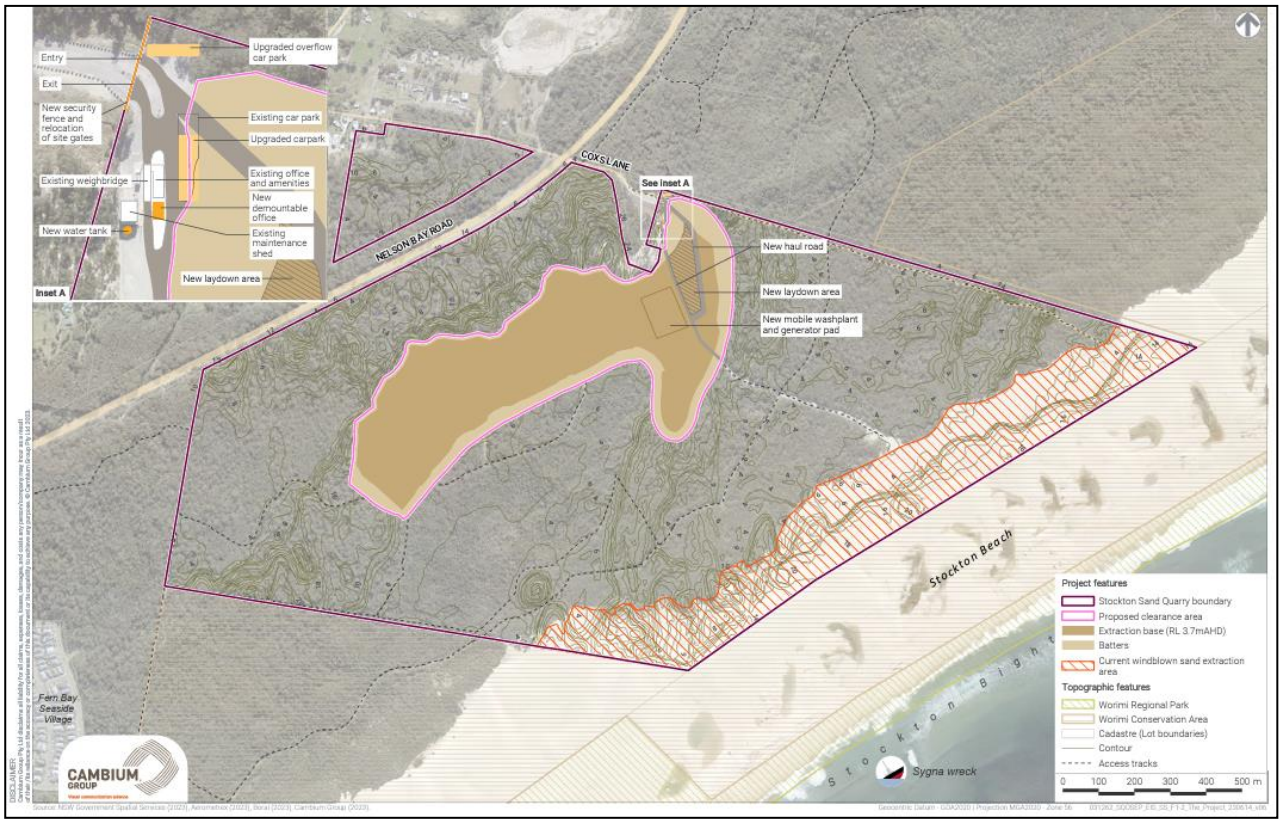

Figure 1-3 The Project Layout

1.2 Water Licensing

Four Water Access Licences (WAL) are held by Boral for abstraction of groundwater at the project site. The available licenses are summarised in **Table 1-1**. The abstraction licences were obtained for use at site during construction and operations, such as supply to the washery and dust suppression, with the total water requirement from supply bores being 129.25 ML/year. Boral holds adequate WALs for this requirement. Though the only currently available nominated works (20WA221084) to drill a supply bore is under WAL 20AL220991 and this nominated works (supply bore) has an annual extraction approval of 16 ML/year (see **Table 1-1**). Therefore, additional nominated works will need to be applied for under the relevant WALs to drill additional bores to meet the operational requirements. Applications for additional nominated works are not a part of this current assessment.

It is understood that while Boral holds licences, there are currently no abstraction bores on site and no take of groundwater. It is understood that bores will be installed later in 2023 under the currently held WAL and the bores are planned to be positioned:

- Near the existing workshop, adjacent to the bushfire water supply tank to be constructed.
- In the vicinity of the proposed new wash plant.

Though the final number is yet to be finalised (pers. comm. Rod Johnson, Boral Quarry Manager – email, June 2023).

The currently unassigned water volume for the Stockton Groundwater Source is over 12,500 ML/year (DPIE, 2016). Therefore, the planned extraction volumes under the existing licenses held for the project are unlikely to affect the overall source volume. It is not anticipated that any water will be required post-closure.

Table 1-1 Water Licenses

WAL	WAL Ref. No.	Water Source	Type	WAL Volume (ML)	Nominated Works	NW Volume (ML)
37223	20AL213136	Stockton Groundwater Source	Aquifer	0	None	n/a
43827	20AL220991	Stockton Groundwater Source	Aquifer	100	20WA221084	16
44499	20AL221243	Stockton Groundwater Source	Aquifer	320	None	n/a
n/a[1]	20AL221416	Stockton Groundwater Source	Aquifer	104	None	n/a

[1] Note that while the approval for WAL Reference 20AL221416 is available, the WAL is not found in the WAL register and may not have been uploaded yet.

1.3 Scope of Work

Umwelt have been engaged to undertake the groundwater assessment scope of works, which included:

- Review and consolidation of the site groundwater monitoring network and available groundwater data.
- Site visit to inspect the project area and a selection of the existing site groundwater bores.
- Review of site specific and publicly available data to characterise the existing environment, including the climatic conditions and surface water (consistent with the surface water consultants), groundwater regime and groundwater users. Including mapping to show existing landholder bores and potential groundwater dependent ecosystems.
- Statistical analysis of site baseline groundwater level data and climatic trends to inform the assessment of water table levels within the Project area. Presentation of groundwater level trends and a map illustrating groundwater levels relative to the Project.
- A conceptual ecohydrological model, including cross sections to present the groundwater processes and Project design.
- Undertake a qualitative risk assessment to identify and discuss potential impacts to groundwater resources and users, relevant to the Project design and site characterisation.
- Recommendations for ongoing monitoring and mitigation measures to address potential risks.

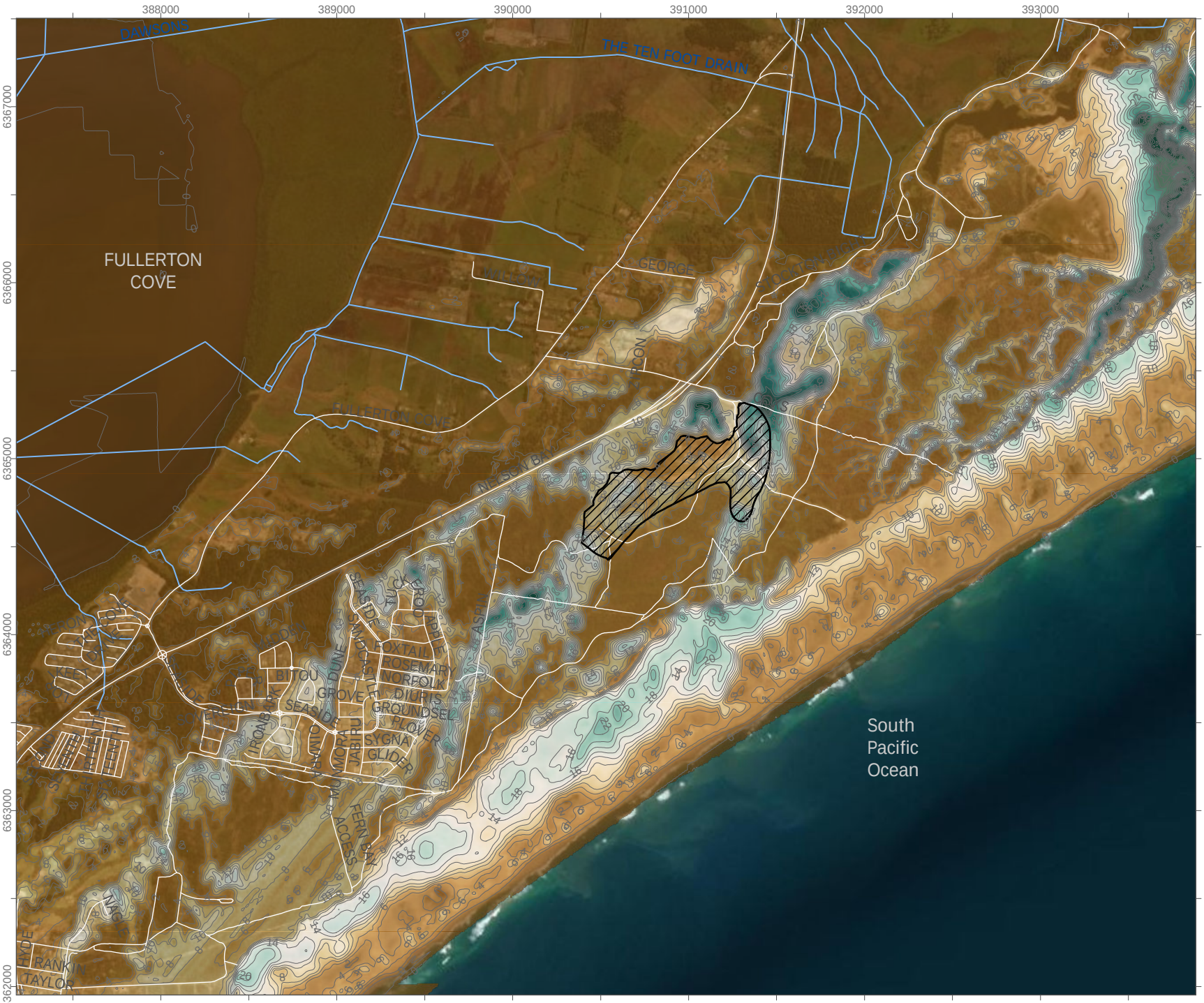

Figure 1.4

Site Location and Topography

Legend

- Extent of clearance

Elevation (m)

- 30
- -2
- Contours
- Road
- Watercourse

0 500 1,000

Metres

Scale: 1:30,000 at A4
GDA2020 MGA Zone 56

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2.0 Regulatory Setting

This section presents a summary of relevant NSW and Commonwealth legislation, policy and guidelines relevant to groundwater.

2.1 NSW Environmental Planning and Assessment Act 1979

Under Section 4.12(8) of the EP&A Act, a development application for SSD is to be accompanied by an EIS prepared by or on behalf of the applicant in the form prescribed by the regulations. The Project is classified as a SSD and requires a development consent under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act).

An SSD application (SSD-52984213) has been submitted and this Groundwater Assessment will be used in support of the environmental assessment for the Project. The Planning Secretary's (Secretary) environmental assessment requirements (SEARS) for the SSD application are summarised in **Table 2-1**, including details on where the requirements have been addressed.

Table 2-1 Project SEARs

Source	SEARs	Where Addressed
DPE – Planning (water)	A conceptual groundwater model that assesses the potential groundwater hazards and impacts associated with the development in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012) having regard to the NSW Aquifer Interference Policy (2012).	**Section 4.8**
	A detailed assessment of any need to maintain an adequate buffer between excavations and the highest predicted or recorded regional groundwater table.	**Section 5.2**
	An assessment of the likely impacts (including cumulative impacts) on the quality and quantity of existing surface and groundwater resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives.	Refer to Surface Water Assessment. No offsite discharge proposed. Assessment of groundwater quality impacts refer **Section 6.0**
	An assessment of the likely impacts (including cumulative impacts) of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users. This assessment must include a strategy for managing potential impacts during the life of the development and identify any conservation outcomes.	**Section 6.0**
	An assessment of the potential water quality hazards surrounding the site including acidity, metals, salinity and contaminants including poly-fluoroalkyl substances (PFAS). This assessment must include: • Measures proposed to reduce or manage the hazards and • Potential interactions on the development and surrounding water users.	**Section 4.6** **Section 6.0**

Source	SEARs	Where Addressed
DPE – Planning (water and soils)	The EIS must map the following features: • Groundwater • Groundwater dependent ecosystems.	**Section 4.2** **Section 4.7.2**
	The EIS must describe background conditions for any water resource likely to be affected by the development, including existing surface and groundwater.	**Section 4.0**
DPE – Water (water take and licensing)	Description of all works/activities that may intercept, extract, use, divert or receive surface water and/or groundwater. This includes the description of any development, activities or structures that will intercept, interfere with or remove groundwater, both temporary and permanent.	Details on the project in **Section 1.0** Project is proposed to extract sand **above** the water table, with no direct interception of groundwater.
	Details of all water take for the life of the project and post closure where applicable. This is to include water taken directly and indirectly, and the relevant water source where water entitlements are required to account for the water take. If the water is to be taken from an alternative source confirmation should be provided by the supplier that the appropriate volumes can be obtained**.**	Details on the project in **Section 1.0** Project is proposed to extract sand **above** the water table, with no direct interception of groundwater.
	Details of Water Access Licences (WALs) held to account for any take of water where required, or demonstration that WALs can be obtained prior to take of water occurring. This should include an assessment of the current market depth where water entitlement is required to be purchased. Any exemptions or exclusions to requiring approvals or licenses under the Water Management Act 2000 should be detailed by the proponent.	Details on the water licenses held in **Section 1.2**
	A description of groundwater conditions that provides an understanding of groundwater level across the site under a range of wet and dry conditions.	**Section 4.3** **Section 4.8**
	Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, groundwater dependent ecosystems, and ground water levels; including measures proposed to reduce and mitigate these impacts.	**Section 6.0**
	Proposed surface and groundwater monitoring activities and methodologies.	**Section 6.2**
EPA (land)	Identify if the soils in the area of the Proposal are contaminated or are acid forming (i.e., acid sulphate soils) and if so, identify best practice mitigation measures (pollution control) and strategies or remedial and/or disposal actions that will be required/undertaken if applicable in accordance with relevant guidance/standards.	Summary provided in **Section 3.4** Refer to Acid Sulfate Soil Assessment
DPE – BCD (water and soils)	The EIS must map the following features: • Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map)	Summary provided in **Section 3.4** Refer to Acid Sulfate Soil Assessment

2.2 NSW Water Management Act 2000

The Water Management (WM) Act 2000 regulates the use and interference with groundwater in NSW. Under the WM Act, Water Sharing Plans (WSP) have been established to manage water resources in NSW.

The project occurs within the Stockton Groundwater Source (SGS) under the North Coast Coastal Sands Groundwater Sources 2016 WSP. This includes many sources including the adjacent Hawkesbury to Hunter, Tomago and Tomaree sources (see **Figure 2-1**). The background document to the sources describes the Stockton source as follows (DPIE, 2016):

> *The Stockton Groundwater Source is located on the Lower North Coast between the villages of Stockton and Anna Bay. It consists of a series of parallel small dune ridges with intervening lowland swales tending to swamps. The Stockton Groundwater Source is located between the coastline and Tilligerry Creek. It extends from the Hunter River at Stockton in the south, to the drainage complex of Bobs Farm Creek, Fenninghams Island Creek, and Murrumburrimbah Swamp near Anna Bay in the north. The area of the Stockton Groundwater Source has been updated since the plan was first developed as a result of improved mapping methods. The area now totals approximately 113 km².*
>
> *Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. Some entitlement is also used for irrigation and commercial purposes.*
>
> *Located within the groundwater source are the Worimi Conservation Lands which cover the Worimi National Park, Worimi State Conservation Area, and Worimi Regional Park.*

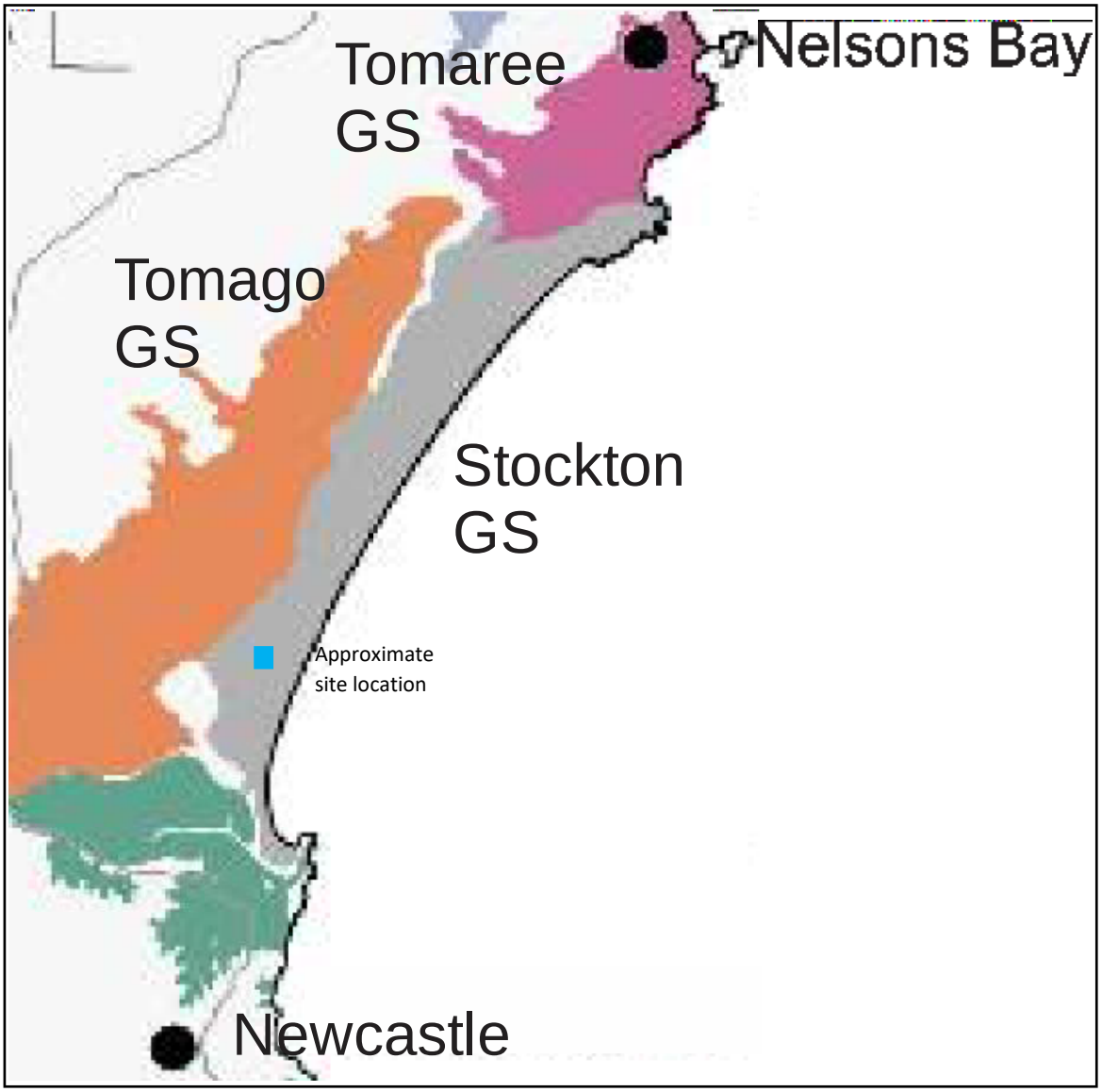


Figure 2-1 Location of the Stockton Groundwater Source.

2.2.1 Aquifer Interference Policy

Any water extraction (take) from water sources regulated by a WSP will require licensing under the WM Act. Interference with groundwater within a regulated area requires assessment in accordance with the NSW Aquifer Interference Policy 2012 (AIP).

The AIP clarifies the requirements for obtaining water licences for aquifer interference activities under NSW water legislation and establishes and objectively defines considerations in assessing and providing advice on whether more than minimal impacts might occur to a key water dependent asset. The sand extraction is proposed above the groundwater table and is unlikely to directly intersect or take groundwater. Regardless, this report has been prepared to address the AIP assessment requirements of the sand extraction. Discussion on the potential impacts of the sand extraction with regards to the AIP are presented in **Section 6.2**.

As noted in **Section 1.2,** bores are planned to extract groundwater for processing and dust suppression and adequate licenses for this are listed in **Table 1-1.**

2.2.2 SSD Groundwater Documentation Guidelines

The Department of Planning and Environment (DPE) released the *Guidelines for Groundwater Documentation for SSD / SSI Projects. Technical guideline* (DPE 2022). The groundwater assessment has been conducted in accordance with the guidelines, and information relevant to the guideline SSD Requirements relevant to a Quarry project is outlined in **Table 2-2**.

Table 2-2 SSD / SSI Requirement by Project Type - Quarries

Source	Guideline Inclusion	Relevant Section
Groundwater investigations (baseline data) requirements	Water table elevation data (reported both as depth (in metres) below a reference level such as ground surface and elevation as metres above Australian Height Datum (mAHD)) at a minimum of three monitoring bores (drilled and constructed as per the requirements for the Minimum Construction Requirements for Water Bores in Australia (NUDLC 2020)) located around the proposed quarry to assess hydraulic gradients.	**Section 4.3** **Appendix B**
	Monitoring of groundwater elevations with time, ideally providing two years of monitoring.	**Appendix B**
	Estimates of hydraulic properties (hydraulic conductivity as a minimum) for lithology to be encountered by and adjacent to quarry.	**Section 4.1**
	Use of geological and structural mapping to interpret potential controls on groundwater flow directions (including recharge and discharge).	**Section 4.4**
	Groundwater quality sampling from monitoring bores, analysed preferably by National Association of Testing Authorities (NATA) certified laboratory for major ions, dissolved metals, salinity (as electrical conductivity) with sufficient frequency to establish potential seasonal variation (for example, quarterly). Presentation of QA/QC is also required.	**Section 4.5** **Appendix C**
Source	**Guideline Inclusion**	**Relevant Section**
Groundwater impact assessments requirements	Description of the site geology including stratigraphic column.	**Section 3.3**
	Conceptual hydrogeological model(s) including description and conceptual illustration of:	
	• The water table elevation and groundwater flow directions prior to and during quarry operations (at greatest depth);	**Section 4.34.2**
	• Mapped groundwater dependent ecosystems and/or culturally significant sites (using information presented in the relevant Water Sharing Plan(s) and BoM GDE Atlas);	**Section 4.7.2**
	• Bore census of existing bore users within appropriate distance of the quarry site (as agreed with the department's Water division); and,	**Section 4.7.1**
	• Hydrostratigraphic cross-section orientated through the quarry and perpendicular to the strike of any mapped major geological structures.	**Section 4.8**
	Maps and diagrams showing the planned quarry design (deepest quarry elevation).	**Section 5.2**

Source	Guideline Inclusion	Relevant Section
	Use of modelling (analytical methods may be sufficient) to estimate maximum water table drawdown within the predicted area of influence of the quarry.	Not applicable, project planned to remain above the water table with no direct take of groundwater.
	Calculated groundwater intercepted by the quarry, presented on an annual basis, per water source.	
	Reporting of all assumptions used to predict water table drawdown (including extent) and take (direct and indirect).	
	Demonstrate a pathway to secure adequate water access licence entitlement for the maximum predicted take for each water source.	
	Assessment of potential water quality effects related to blasting, sewage, vehicle wash facilities, fuel storage, or leachates from disturbed rocks and soil (for example acid sulfate soils).	**Section 6.0**
	Consideration of the construction, operation and closure stages of the development.	**Section 6.0**
	Assessment of cumulative impacts (for example, other quarries, mines, etc in the area).	**Section 6.0** No potential cumulative groundwater flow impacts as project planned to remain above the water table with no direct take of groundwater.

2.3 Hunter Water Act 1991

The Hunter Water Act 1991 established a State-owned corporation to supply water services in the Hunter region. Under the Hunter Water Act, the North Stockton Catchment Area was declared to be a special area by the Hunter Water (North Stockton Catchment Area) Order 1999 and subsequent Hunter Water (Special Areas) Regulation 2003. Activities within the special area are regulated under the Hunter Water Regulation 2015. The project area is located at the southern edge, just outside of the North Stockton Catchment Area.

While the project area is not in the special area, groundwater flow has the potential to interact with groundwater to the north under the North Stockton Catchment Area. No direct take of groundwater is proposed with the sand extraction. However, consideration of management of site facilities to prevent potential impacts to water quality is required. This is discussed within **Section 6.0**.

2.4 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is Commonwealth legislation relating to matters of national environmental significance (MNES). The EPBC Act covers animals, plants, habitats and places, and any potential negative impacts on them are carefully considered before changes in land use or new developments are approved.

The project area was previously used for inland sand extraction and rehabilitation completed at the site. The rehabilitated vegetation is well established in the older parts of the extraction area, and less so where extraction was more recently completed.

As outlined in the Biodiversity Assessment (Niche, 2023), there are no known threatened flora within the project footprint. However, three threatened faunae were identified within the project area, the Greater Broad-nosed Bat, Eastern Bentwing Bat and White-bellied Sea Eagle. The assessment also concluded that the Squirrel Glider is likely to be present within the area, but that the site does not contain potential Koala habitat (Niche, 2023).

Direct impacts to flora and fauna species associated with ground disturbance and clearing within the project footprint are captured within the Biodiversity Assessment (Niche, 2023). The sand extraction does not involve intersection or take of groundwater, therefore indirect impact to flora and fauna habitat is unlikely. This is further discussed and presented in **Section 4.7** and **Section 6.0**.

3.0 Existing Environment

3.1 Climate

Rainfall and climate data is publicly available from the Scientific Information for Landowners (SILO) database. The SILO database provides the most complete long-term dataset and is therefore the most useful for assessing long term rainfall trends. SILO data has been obtained from the Williamtown RAAF site (Latitude -32.7939, Longitude 151.8364) and used to calculate longer term data trends from 1957 to 2023, as summarised in **Table 3-1**. **Table 3-1** also includes the long-term average pan evaporation (combined) and Morton's areal actual evapotranspiration, which represents actual evapotranspiration over a large area under prevailing soil-water conditions based on (Wang, et al., 2021).

Average rainfall data (1957 to present) taken from the SILO database (Williamtown RAAF Base) show that monthly rainfall varies between 60 mm and 132 mm with a yearly average of 1133 mm (SILO, 2023).

Table 3-1 shows that monthly rainfall varies (on average) between 61 mm and 131 mm, with a yearly average of 1,130 mm (SILO, 2023). Rainfall is higher in late summer and winter and lower in spring and early summer. The SILO database also shows that the total actual evapotranspiration (Morton) of 949 mm per year is exceeded by the yearly rainfall total. Evapotranspiration is much lower in winter than summer and on average is exceeded by rainfall from March through to August. **Figure 3-1** presents the average rainfall and evapotranspiration graphs.

Table 3-1 SILO Climate Data Summary

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Site Data Average Rainfall* (mm)	97	114	131	114	107	124	74	66	61	77	84	81	1130
SILO Average Rainfall (mm)	203	163	142	106	79	68	77	104	135	165	182	211	1637
SILO Average Pan Evaporation (mm)	198	160	140	106	78	68	78	103	133	162	179	204	1610
SILO Average Actual EVT Morton(mm)	139	117	101	62	33	21	23	39	65	96	117	135	949

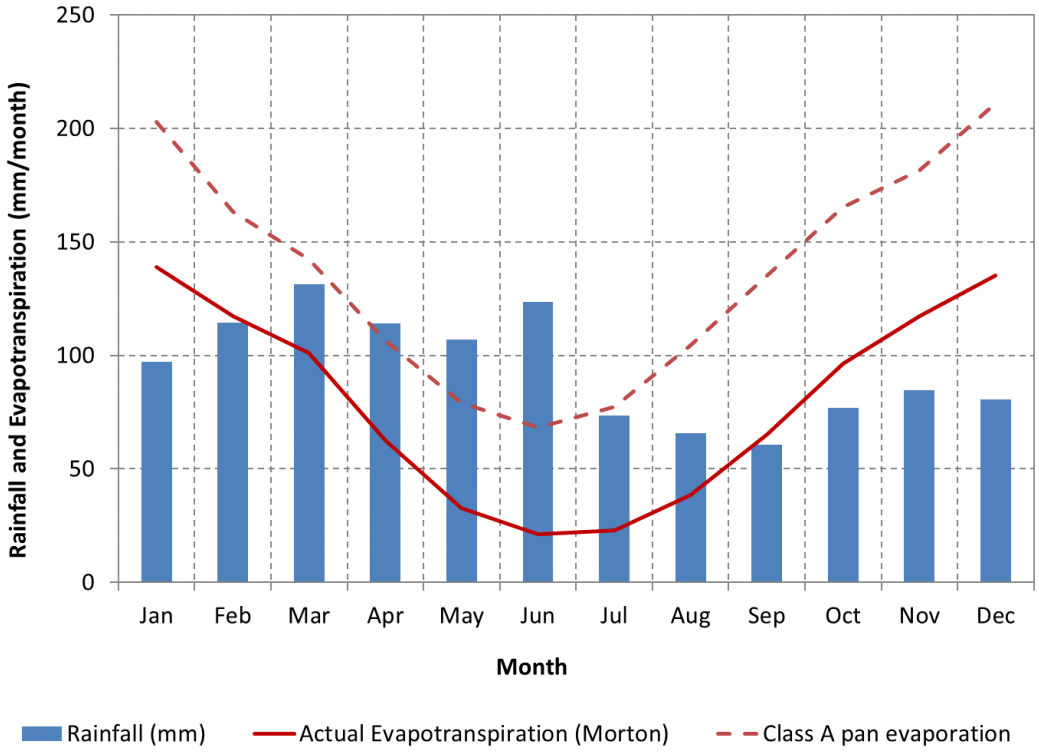


Figure 3-1 Average monthly rainfall and evapotranspiration.

The Cumulative Rainfall Departure (CRD) graphically represents monthly rainfall trends based on the long-term average monthly rainfall. A rising trend in the CRD indicates periods of above average rainfall (for the dataset period), whilst a falling slope indicates periods of below average rainfall (for the dataset period). **Figure 3-2** presents monthly rainfall from the SILO dataset, compared to the CRD calculated from SILO data from 1957 to 2023. The graph shows the region experiences cyclical periods of above average and below average rainfall.

As shown in **Figure 3-2** the region experienced below average rainfall from 1990 to 1998, above average rainfall from 1998 to around 2001, with another period of below average rainfall from 2001 to 2007 (Millennium Drought). From 2007 the rainfall trends were more variable, until 2016 when a period of sustained below average rainfall occurred until 2020. More recently the region experienced above average rainfall, from 2020 to the end of 2022.

The long-term climate trends and monthly rainfall has been considered when reviewing the site groundwater level trends in **Section 4.0**.

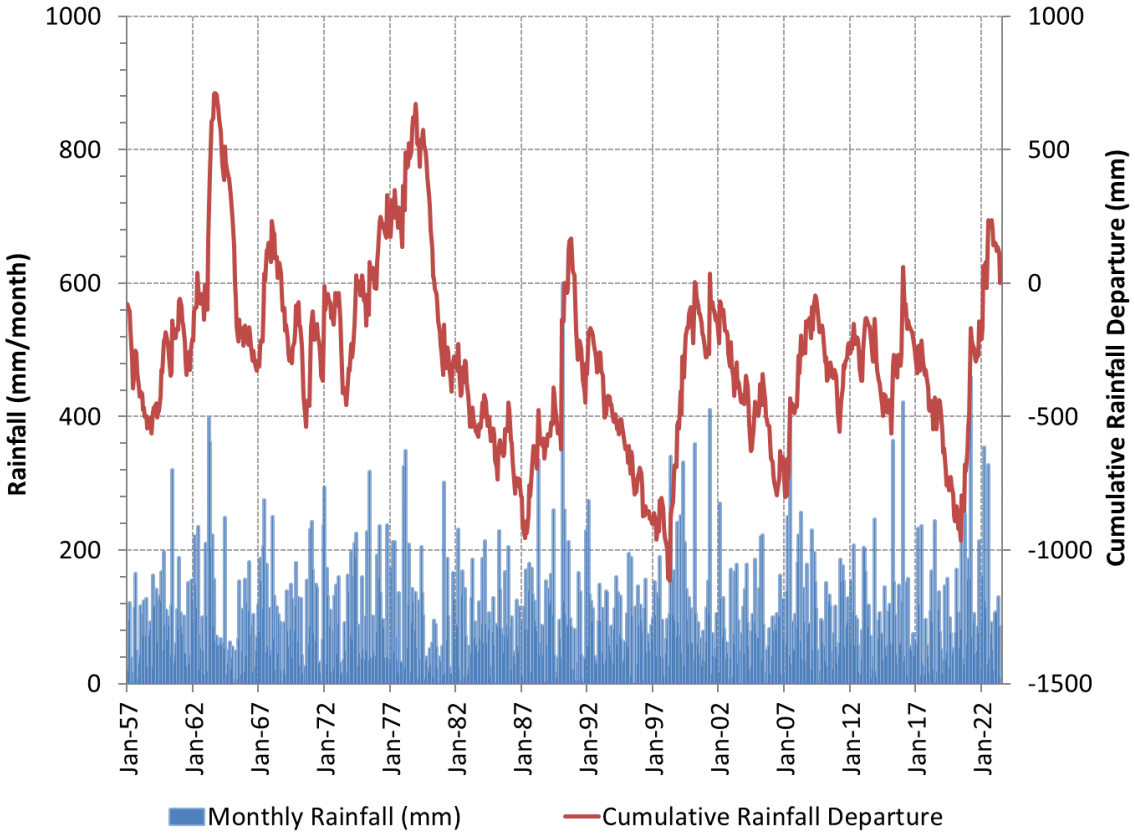


Figure 3-2 Monthly rainfall and cumulative rainfall departure

3.2 Hydrology

There are no mapped watercourses within the project area or immediate surrounds (refer **Figure 1-4**). The South Pacific Ocean is present approximately 900 m east of the project area, and Fullerton Cove approximately 2 km to the west and the Hunter River approximately 4 km to the south-west and Tilligerry Creek approximately 3 km north to north-east.

Following high intensity rainfall water can pond at surface; however, there is no surface flow from site (Southeast Engineering and Environmental, 2023). This is due to the high infiltration rates of the sands and influence of vegetation on evapotranspiration.

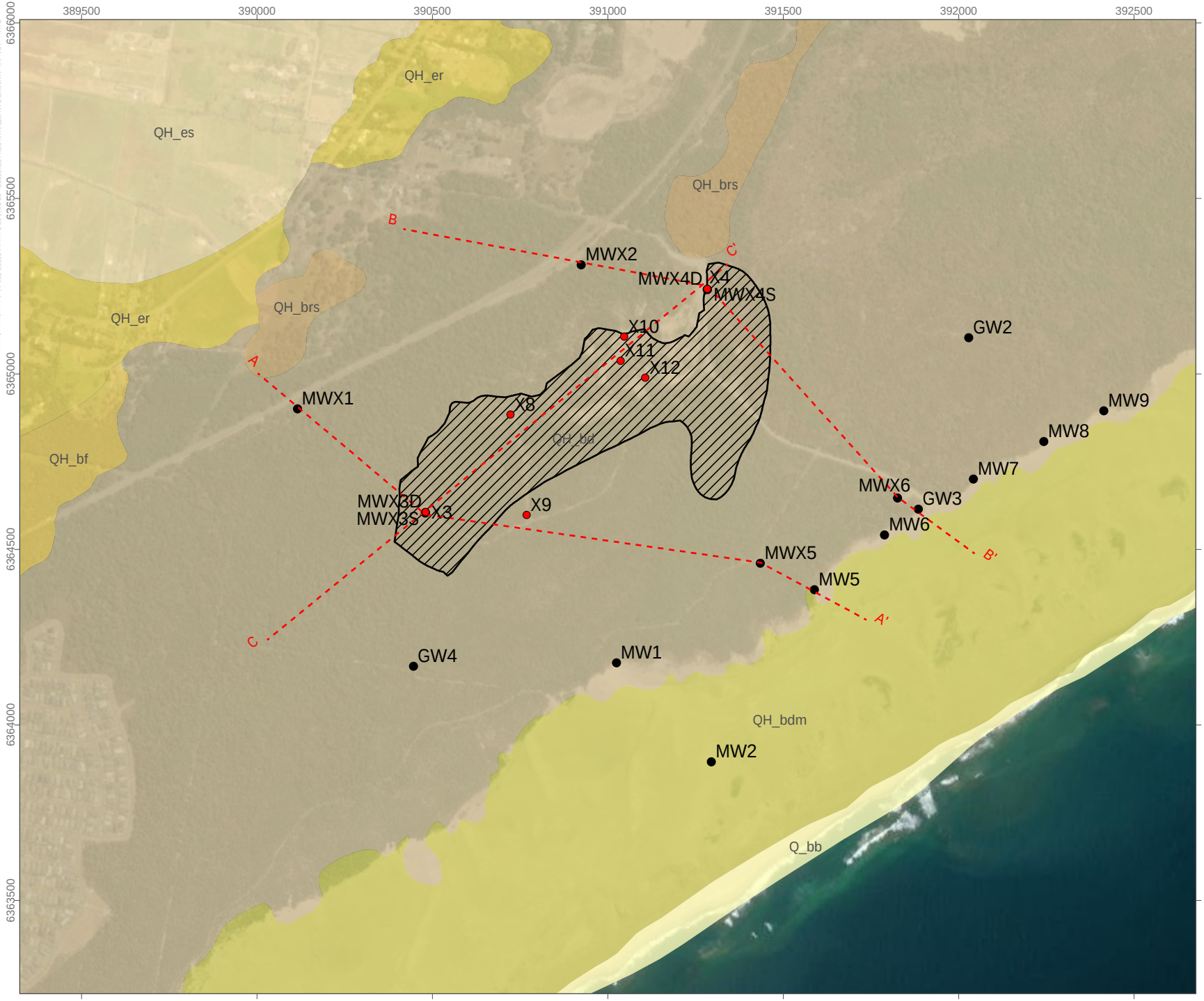
3.3 Geology

Referring to **Figure 3-3**, the New South Wales Seamless Geology map shows that the geology within the site is mainly composed of coastal dune deposits (QH_bd) with mobile coastal dunes (QH_bdm) along the south-eastern edge. The difference between the two being that the mobile deposits are free of vegetation. The proposed excavation area is entirely within the area of vegetated, non-mobile deposits.

The dune sands and beach deposits correspond to the Stockton Sand Beds within the project area and are part of a 32 km long and up to 10 km wide dune system of Quaternary age. The unvegetated, active dunes close to the coast are younger (500 years) than the older, vegetated dunes which are 5,200 to 4,000 years old. The dunes have largely developed perpendicular to the predominant south-westerly winds which is evident from the elevation contours on Figure 3-3. The sand within the site is of light brown to dark brown, fine-grained quartz. Some minor zones of fine to medium grained sand are noted as well as shell fragments being described in some of the exploration holes at depth. Analysis of the sand shows that it is made up of 95% quartz grains (Boral, 2019).

The Holocene age Tilligerry Mud Member is present to the north-west of site, associated with shallow estuarine and swamp deposits. Underlying the dunes are the Tomago Sand Beds that form an 'inner barrier' dune system. The formations Tomago Sand Beds are not penetrated by any bores at site. The Tomago Sand Beds overlie the Pleistocene age Medowie Clay Member that comprises low permeability clays and silts.

Figure 3.3
Map of Surficial Geology



Legend

- Extent of Clearance

Geology (NSW Seamless Geology)

- QH_bf - Coastal deposits - backbarrier flat facies
- Q_bb - Coastal deposits - beach facies
- QH_brs - Coastal deposits - beach-ridge swale and dune-deflation hollow
- QH_bd - Coastal deposits - dune facies
- QH_bdm - Coastal deposits - mobile dune facies
- QH_er - Estuarine shoreline ridge and dune
- QH_es - Estuarine swamp
- Cross Section Lines
- Bores
- Boral Drill holes

0 200 400

Metres

Scale: 1:15,000 at A4
GDA2020 MGA Zone 56

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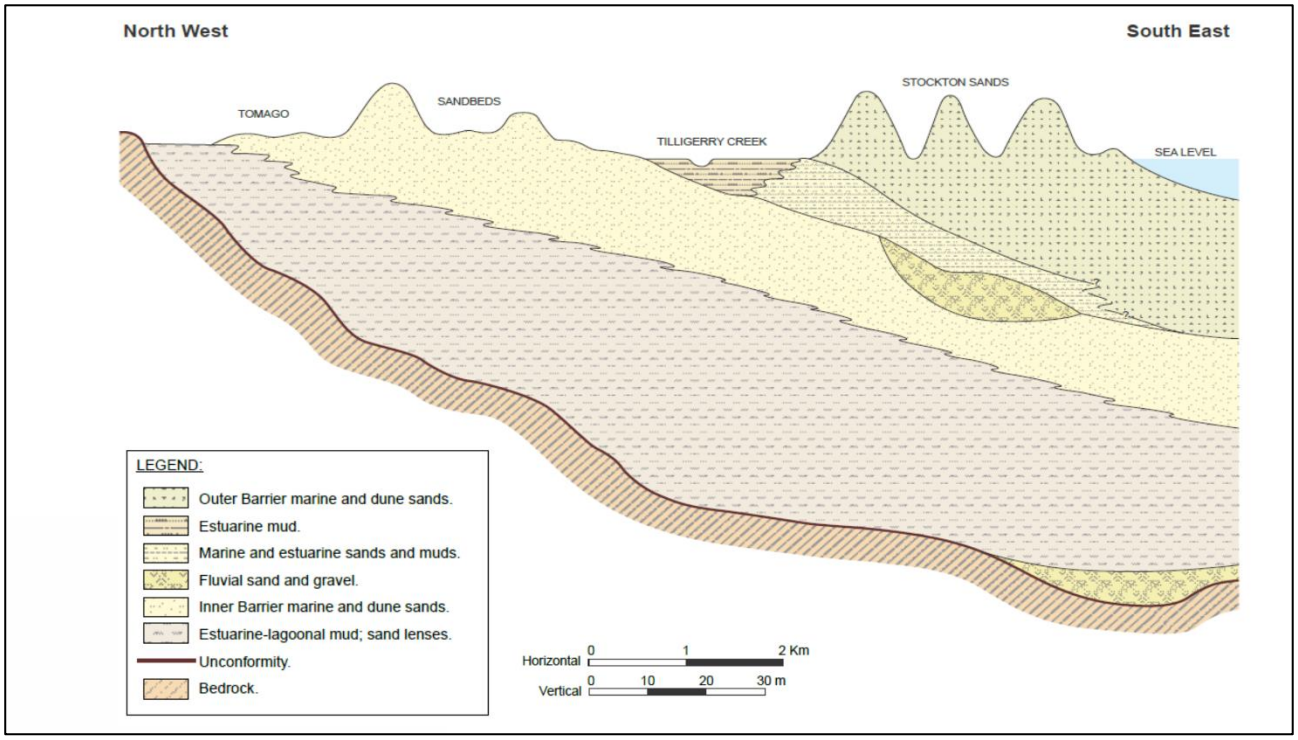

Figure 3-4 General Geological Cross Section (Source: EES 2021, Figure 7)

3.4 Acid Sulphate Soils

Environmental Earth Sciences (EES) carried out an acid sulphate soils (ASS) assessment in 2018 (EES, 2019) and (EES, 2021). A review of the Port Stephens 1:50,000 ASS Map (1996) was conducted and the site found to have a low probability for ASS. Those boreholes that were tested had "*high alkalinity and acid buffering capacity*" (EES, 2021). Of the 25 samples tested, only one (BH2 at 2m depth) showed a moderate risk for potential ASS. The assessment also recommended regular monitoring as part of a proactive ASS Management Plan (EES, 2019) and (EES, 2021).

4.0 Hydrogeology

4.1 Aquifer Type and Properties

The sand lithologies at site and in the surrounding area are unconsolidated and likely to have high primary porosities in the range of 26% to 53% (Domenico & Schwartz, 1998). The groundwater is present in and moves through the pore spaces between the sand grains. The aquifer is largely unconfined, at least within the depths of interest for this investigation. No evidence of potential confining layers (clays etc) has been noted in any the bores drilled at site (Boral, 2019).

Environmental Earth Sciences carried out two slug tests in March 2018 at the same location: MW X3 deep and shallow, though only the data for MW X3 shallow are reported (EES, 2021). The reported hydraulic conductivities range from 4.05 x 10^{-5} m/s to 4.67 x 10^{-4} m/s varying between table and text in the report and the results in the appendices. It is difficult to QC these results (there seem to be only four data points), however they do fall within the ranges reported in the published literature for such lithology: 1 x 10^{-7} m/s to 1 x 10^{-2} m/s (Freeze & Cherry, 1979) and (Domenico & Schwartz, 1998).

4.2 Groundwater Monitoring

This section presents a summary of the groundwater monitoring network, monitoring program and data management.

4.2.1 Monitoring Network

The site groundwater monitoring network currently comprises 24 bores, of which eleven are currently included in the site monitoring program. The bore locations are shown in **Figure 3-3**. Groundwater levels have been monitored in these, in some cases with data as far back as 1997. The GW series bores were installed in 1997, the MW series in 2013 and the MW X series in 2017.

Details on the site groundwater bore network was collated based on previous field reporting information. A census of the existing bore network was also undertaken by Boral, with the total bore depth measured, height of casing measured, location photographed and location of the bores obtained from handheld GPS. A summary of the monitoring bore details is included in **Table 4-1**. Details from this census are included in **Appendix A**, along with available site bore logs for GW X3, GW X4, GWX8 to GW X12.

It should be noted that the site provides a difficult environment for the maintenance of monitoring bores. This is due to public accessibility of the site, with some destroyed/damaged by trespassers. As well as the inherent challenge of monitoring within mobile sand dune system. In some cases, lengths of casing have been added or removed from the bores as the shifting sands cause changes in elevation. The ground elevations in **Table 4-1** were derived from top of casing elevations recorded by VGT Laboratories Pty Ltd (VGT). It is noted that three bores (MW6, MW7 and MW8) have recorded up to 1 m change in the top of casing elevations in 2022, the most recent top of casing is presented in **Table 4-1**.

Table 4-1 Monitoring Bore Details

ID	Easting	Northing	Ground Elevation (mAHD)*	Year Installed	Screen Top mbgl	Screen Bottom (mbgl)	Comments
GW1†	391407	6364885	9.60	1997	6.2	6.9	Logger installed – not used
GW2†	392029	6365103	2.67	1997	2.9	3.6	Logger installed – data used
GW3†	391885	6364615	3.02	1997	3.5	4.2	Logger installed – data used
GW4†	390446	6364167	3.24	1997	4.1	4.8	Logger installed – data used
MW X1	390115	6364901	6.10	2017	12.2	9.2	Logger installed – data used
MW X2	390924	6365311	5.74	2017	n/a	n/a	Logger installed – data used
MW X3 Deep	390480	6364605	6.43	2017	26.0	5.3	Logger installed – data used
MW X3 Shallow	390480	6364604	6.39	2017	11.4	8.4	Logger installed – data used
MW X4 Deep	391283	6365241	9.90	2017	24.5	8.7	Logger installed – data used
MW X4 Shallow	391284	6365241	10.21	2017	12.1	8.9	Logger installed – data used
MW X5	391435	6364461	3.82	2017	24.2	21.2	Logger installed – data used
MW X6	391826	6364647	3.15	2017	27.6	24.6	Logger installed – data used
MW X7	391159	6365084	4.61	2017	-	11.24	-
MW1†	391024	6364177	4.20	2013	19.0	25.0	Dipper data used
MW2†	391295	6363895	9.86	2013	19.0	25.0	Dipper data used
MW3	390480	6364598	19.5	2013	2.0	8.0	Little data – uncertain location
MW4	392243	6364808	9.5	2013	2.0	8.0	Little data – uncertain location
MW5†	391588	6364385	4.98	2013	2.0	8.0	Reliable dipper data from 2013
MW6†	391788	6364541	3.82	2013	2.0	8.0	Reliable dipper data from 2013
MW7†	392042	6364701	4.05	2013	2.0	8.0	Reliable dipper data from 2013
MW8†	392242	6364807	3.27	2013	19.0	25.0	Reliable dipper data from 2013
MW9†	392413	6364895	5.90	2013	19.0	25.0	Reliable dipper data from 2013
MW10	391352	6363951	-	2013	19.0	25.0	Little data
MW11	n/a	n/a	-	n/a	n/a	n/a	Little data

Note: *Coordinates in GDA2020 Zone 56, derived from handheld GPS*
**Elevation derived from VGT field data records of top of casing elevations and converted for ground elevation*
† bore currently in the site groundwater monitoring program
mbgl – meters below ground level
n/a – not available

4.2.2 Monitoring Program

Groundwater monitoring is required to be conducted at the site under the Development Consent 140-6-2005 (Mod 2) Condition 3(12). Groundwater monitoring is conducted by external contractors, with monitoring currently undertaken on a monthly basis by VGT. In 2017 water level loggers were installed in the GW and MW X series bores, but not the MW series.

The groundwater monitoring program includes measuring groundwater levels with a manual dip meter, as well as download of the logger data. Groundwater quality sampling is also undertaken on a quarterly basis for the MW Series bores, with field measurements of electrical conductivity (EC) and pH recorded. The samples are collected within laboratory supplied bottles and submitted to a laboratory for analysis of:

- Turbidity
- Total dissolved solids (TDS)
- Chloride and fluoride
- Major ions: sulphate, calcium, potassium, sodium, magnesium, hardness as $CaCO_3$, bicarbonate (HCO_3)
- Alkalinity
- Nutrients: Filtrable phosphorous and nitrate as N
- Metals: aluminium, arsenic, barium, cadmium, chromium, copper, iron, manganese, nickel, lead, selenium, zinc and mercury.

Review of groundwater monitoring results is undertaken on an annual basis and included within the Annual Environmental Management Report.

4.2.3 Groundwater Database

A consolidated site groundwater level database was developed to inform this assessment. The original groundwater level data was provided to Umwelt in various forms, including:

- An Excel file of depths to water level below top of casing (mbTOC) for the water level loggers – data recorded at one hour intervals.
- A number of Excel files provided by both Boral and VGT of the monthly dipmeter monitoring. Some as depth to groundwater table below reference point (mbTOC) and some as groundwater elevation referenced to Australian Height Datum (mAHD) or both.
- Monthly reports submitted to Boral by VGT (and previous sub-contractors) of the groundwater levels taken by dipmeter.

A quality control (QC) check has been conducted by Umwelt on the various data, and where identified, spurious data have been removed. Part of the QC process has involved determining whether the data is reported as mbTOC or mAHD and in the former case whether the elevation of the top of casing is reliable.

4.3 Groundwater Elevation and Flow Direction

The available site groundwater level data was analysed and graphed temporally in **Appendix B**, and shown spatially in **Figure 4-1** and **Figure 4-2.** The data have been analysed in two ways:

- To assist with the site hydrogeological conceptualisation, groundwater flow directions and determine groundwater elevation highs and lows.
- To determine a suitable elevation below which the extraction activities should not lower the ground level. This is discussed in more detail in **Section 5.2**.

The graphs in **Appendix B** show the change in groundwater levels over time, compared to rainfall. The graphs highlight groundwater level response to rainfall events. The hydrographs show that the groundwater levels were relatively low prior to 2021 and there is a general increase occurring in late 2020. The response to rainfall is rapid indicating rapid infiltration. Seasonally the groundwater levels are higher in the summer months corresponding to the higher rainfall in summer.

To spatially present groundwater conditions, two points in time have been taken, gridded and contoured (see **Figure 4-1** and **Figure 4-2**). The levels do not represent the lowest and highest recorded levels, but the lowest and highest levels for which reliable data is available for most bores (16 January 2020 for the low point and 24 March 2021 for the high point). Some bores were excluded from this analysis due to their location and/or elevation being uncertain, paucity of data or the fact that they became unusable as a monitoring point. For those bores not used in the analysis, reasons are expanded on below:

- GW1 – reported reference elevations are variable. Data is periodic and groundwater elevations appear to be unreliable. A logger is installed, but the recording period is short compared to other logger data. In addition, later data appears flat (the water level may have fallen below the level of the logger).
- GW2 – the low level is used, but no data is available for the high point – the area around the bore may have been flooded.
- MW3 – data is available in the period 2007 to 2009. The bore may have been destroyed. Its location is uncertain.
- MW4 – data is available in the period 2007 to 2009. The bore may have been destroyed. Its location is uncertain.
- MW8 – the low level is used, but no data is available for the high point.
- MW10 – data is not available for the chosen times.
- MW11 – only three data points are available and those are in 2013.

The groundwater elevation ranges from 0.9 mAHD to 1.1 mAHD for the low level and 2.9 mAHD to 3.1 mAHD for the high level. Reported depths to groundwater range from 0.2 m (GW2) to 17 m (MW1).

Both contour maps indicate that the local groundwater flow direction is from south-east to north-west, away from the coast and towards Fullerton Cove and Tilligerry Creek. It is noted that the gradient for both low and high levels is approximately 0.2 m per 800 m in the area of the planned excavation. This is a very slight gradient, though this steepens to the far north-west of the area near to bore MW X1. It is interpreted that this gradient is very localised and that the main regional groundwater flow direction is towards the coast (refer to **Section 4.7** for a more detailed discussion).

The development will not intercept the groundwater table and will therefore not affect the groundwater levels or flow.

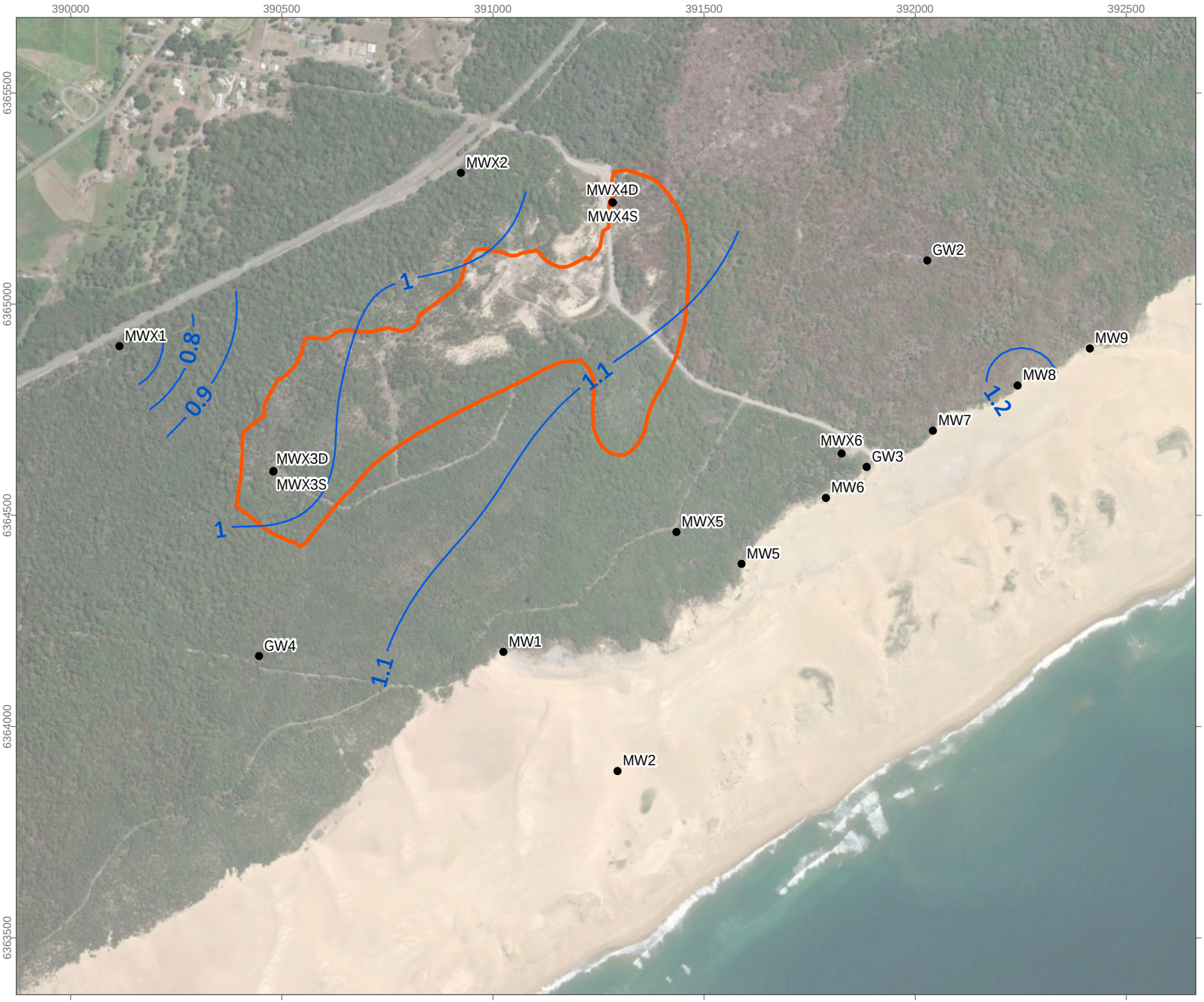

Figure 4.1
Groundwater Elevation Contours at Low Level

Legend

- Extent of clearance
- Interpolated Low Water Level Contours
- Bore

0 200 400
Metres

Scale: 1:12,500 at A4
GDA2020 MGA Zone 56

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Image Source: ESRI Basemap (2023) | Data Source: Umwelt (2023)

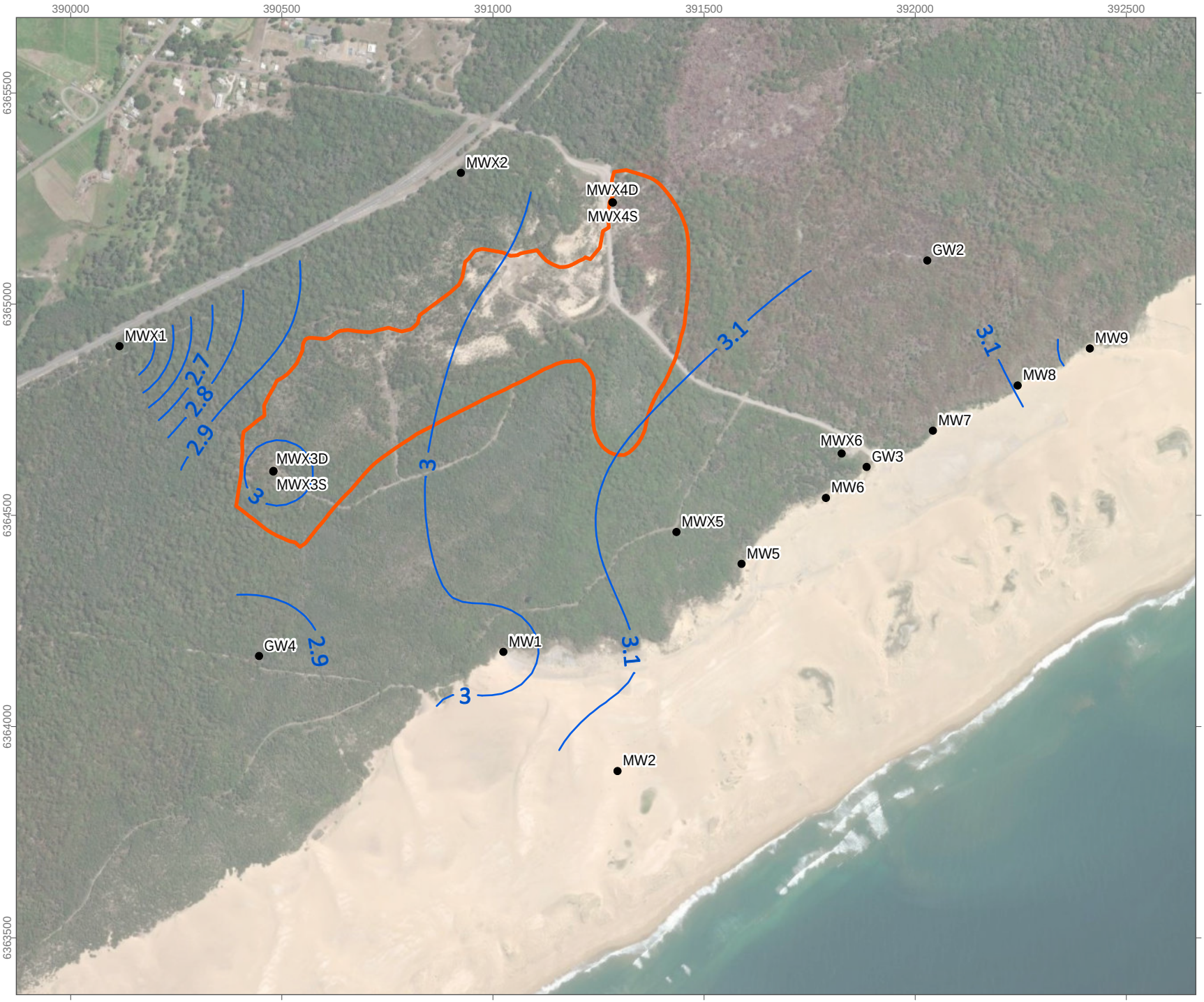

Figure 4.2

Groundwater Elevation Contours at High Level

Legend

- Extent of clearance
- Interpolated High Water Level Contours
- Bore

Scale: 1:12,500 at A4
GDA2020 MGA Zone 56

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4.4 Groundwater Recharge and Discharge

Recharge to the aquifer is expected to occur primarily through infiltration of rainfall. Due to the high porosity and hydraulic conductivity of the sand, little rainfall is expected to go to surface runoff. That which is not returned to the atmosphere by evapotranspiration, is expected to infiltrate into the ground. Hydrographs are presented in **Appendix B**. These show that the groundwater levels respond very quickly to rainfall events indicating that rainfall infiltrates the ground quickly.

Rainfall exceeds evapotranspiration; therefore recharge rates are expected to be relatively high. Hydrologic soil mapping shows that the site is within an area of soil Group A (EES, 2021), which have high infiltration rates. The WSP for the North Coast sand groundwater sources gives an overall estimated infiltration figure of 22% based on studies carried out for the adjacent Tomago and Tomaree Groundwater Sources (DPIE, 2016).

On a local scale the site recharge is interpreted to be much higher where there is no vegetation cover, along the narrow strip of mobile dunes to the south-east, compared to the majority of the site that is covered by vegetation. Rain falling on the bare sand is expected to infiltrate quickly into the subsurface and so not be available for evaporation processes. Whereas rain falling on vegetated areas will be delayed or prevented from falling directly on the ground and affected by evapotranspiration from the vegetation to a higher degree.

It is interpreted that this enhanced recharge along the dunes near the coast causes the groundwater elevation to be slightly higher than below the vegetated areas. Also, that this causes a slight (near-surface) reversal of the overall groundwater flow direction, which is expected to be towards the sea. Therefore, overall discharge is expected to be at depth and towards the sea. There are no rivers in the area.

4.5 Groundwater Quality/Chemistry

Groundwater samples are collected on a quarterly basis, with field analysis of pH and EC and laboratory analysis of major ions, TDS, total alkalinity, nitrate, total phosphorus and metals. Reporting on groundwater quality results and trends since 2007 is included as part of annual reporting by Jacobs (2023). The latest of these is provided as an example in **Appendix C**.

The trends in EC are shown in **Figure 4-3**, pH in **Figure 4-4** and iron in **Figure 4-5**. As shown in **Figure 4-3**, since 2007 the site bores have recorded relatively freshwater quality generally ranges between 200 µS/cm and 1,000 µS/cm. The rise in EC generally corresponds with a period of above average rainfall and may indicate flushing of soil stored salts within the coastal dunes following peak rainfall periods. **Figure 4-4** shows pH for most bores is slightly acidic to neutral, with pH between 6 and 7.6. Bores MW5 and MW1 have recorded a general decline in pH compared to results from 2007, with bore MW1 recording the lowest pH of between 5 and 6.5 since 2019. The low pH corresponds with surface water quality monitoring by Jacobs (2023), which indicates a pH for site surface water monitoring locations of between 4.3 to 5 at site SW1, which is near bore MW1 and MW5.

Figure 4-5 shows most bores record iron concentrations of less than 4 mg/L, with the exception of bores MW7 and MW8. Bore MW8 records the highest concentration of iron, or up to around 21 mg/L; however, this has reduced since 2020 to around 6 mg/L in 2023. Bore MW7 records similar trends in iron to bore MW8 but at lower concentrations, with a peak concentration of around 12 mg/L recorded in 2019 that has reduced to around 5 mg/L in 2023. It is also noted that in 2007 bore MW9 recorded higher iron concentrations of up to 8 mg/L, which has reduced to less than 1 mg/L.

Prior to commencement of quarry operations at the site it was noted that some bores recorded elevated iron concentrations (Boral, 2000).

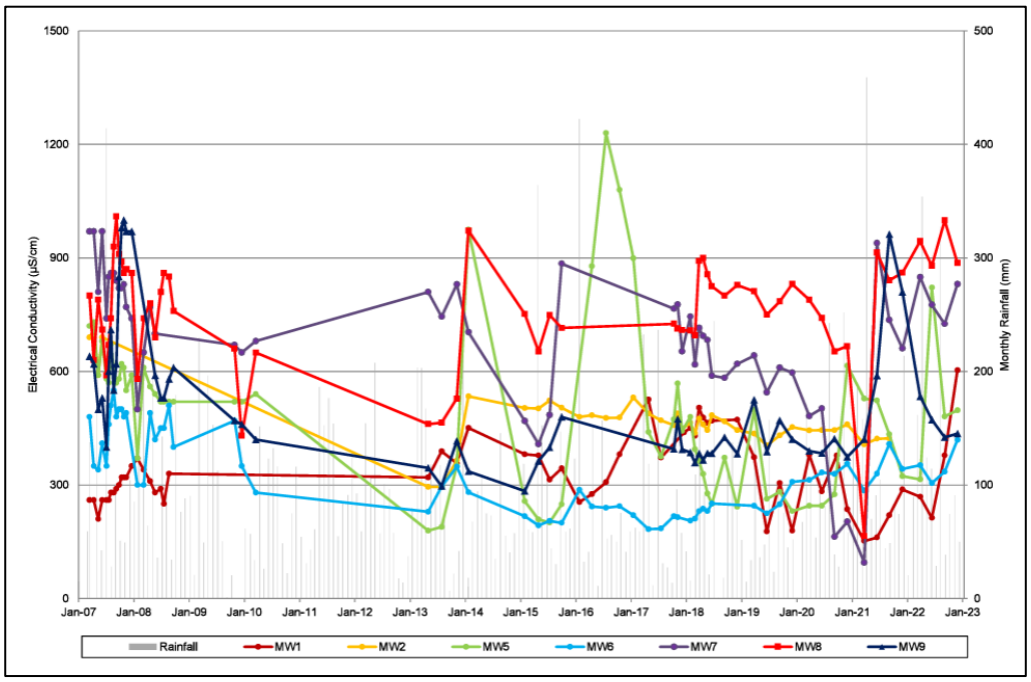

Figure 4-3 Graph showing Electrical Conductivity Trends (Source: (Jacobs, 2023))

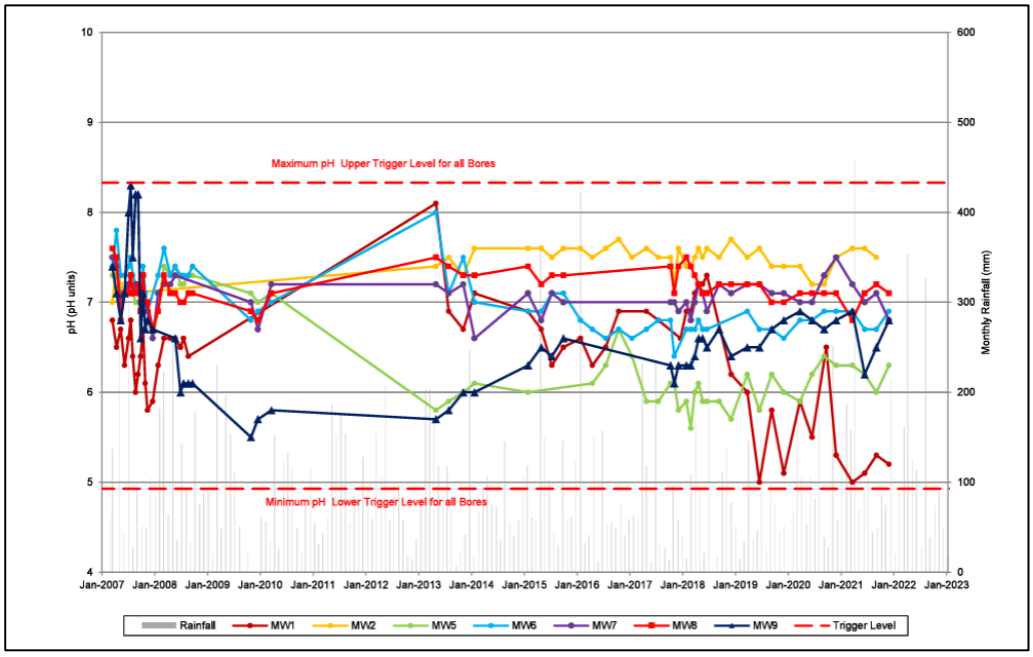

Figure 4-4 Graph showing pH Trends (Source: (Jacobs, 2023))

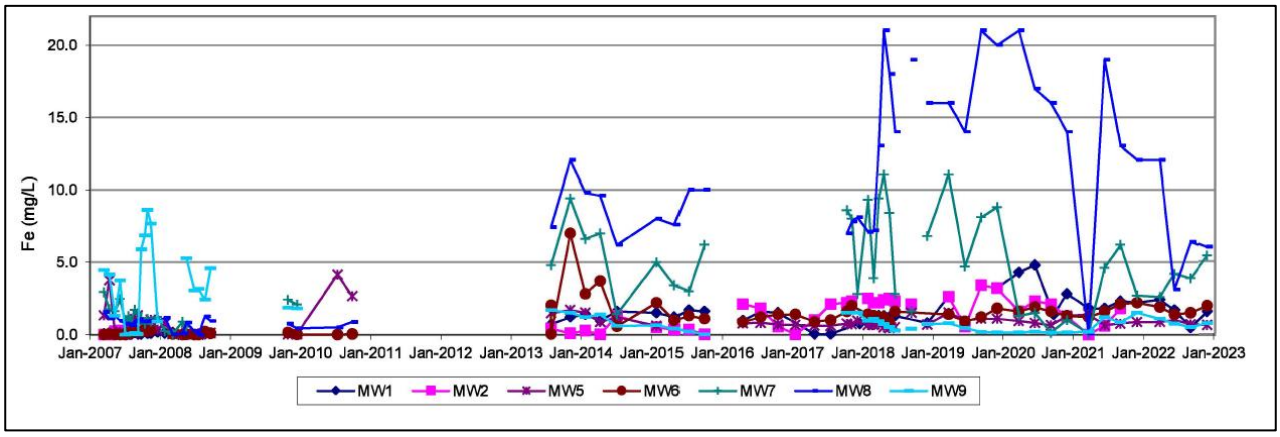

Figure 4-5 Graph showing Trends in Iron Concentrations (Source: (Jacobs, 2023))

4.6 Potential Water Quality Hazards

Royal Australian Airforce (RAAF) Base Williamtown is located approximately 10 km to the north of the Boral site. It is known that there is currently existing per- and polyfluoroalkyl (PFAs) contamination associated with the base. PFAs contaminants have been detected in both groundwater and sediments to the south of the base. The contaminant plume is monitored and reported on annually (AECOM, 2016) and (AECOM, 2020).

Hydraulic connection between the Tomago Sand Beds and Stockton Sand Beds is limited by the presence of low permeability estuarine clay deposits associated with Tilligerry Creek (refer **Figure 3-4**), and the local flow gradient from site towards the creek to the north. While these will act to impede flow and spread of contaminated water into the Stockton Sand Beds, it is noted that PFAs has been detected just to the south of the Tilligerry Creek (AECOM, 2016) and even further to the south in 2020 (AECOM, 2020).

It is noted that there is a dense monitoring network, and that the detected PFAs locations are in isolated areas and at low concentrations of <10 µg/L, and often <0.07 µg/L (AECOM, 2020). It is also noted that potential exposure to off-site users is managed by NSW Government Precautionary Advice (AECOM, 2020). However, the Boral site is currently just outside the southern margin of the Williamtown Management Area, though the Department of Defence is working with the relevant NSW Government departments to redefine the Management Zone (AECOM, 2020).

4.7 Groundwater Use

4.7.1 Anthropogenic

A search of the Bureau of Meteorology's National Groundwater Information System (NGIS) was carried out to identify possible private groundwater use around the project area. The search identified around 63 registered bores within 5 km of the project area. The location of registered bores outside of the extent of Boral owned land are shown in **Figure 4-6**.

Available details on the bores from the NGIS database indicate they are largely constructed into sand at shallow depths of around 2 m to 35 m depth. Thirty-five of the bores are noted as being for water supply, four for irrigation, four for dewatering and the remaining 20 bores have an unknown use.

There are water supply bores associated with the Fern Bay residential development to the south-west of the site. The closest of these is approximately 1 km away from the planned excavation area. There are also others approximately 2 km to the north-east (**Figure 4-6**).

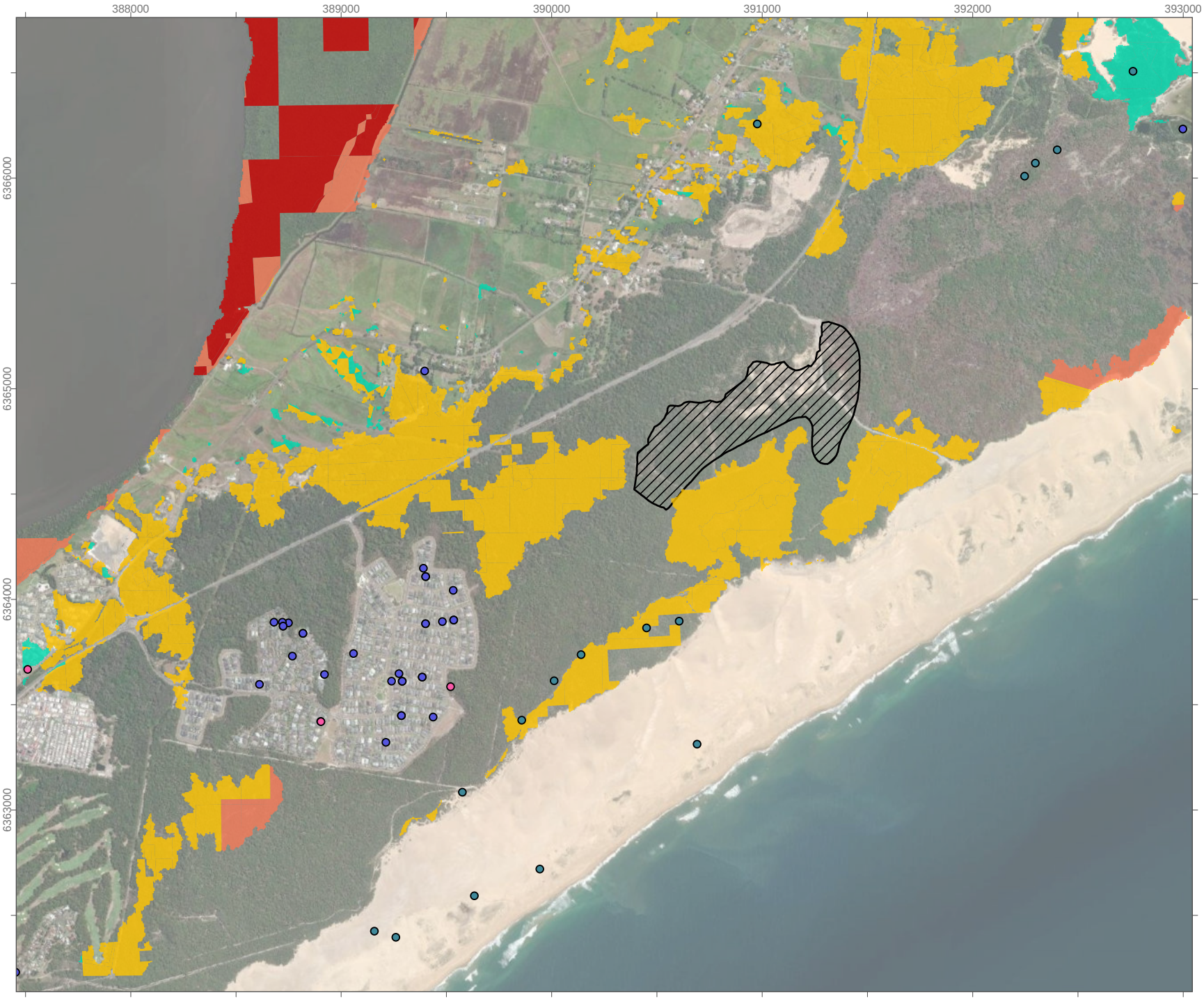

Figure 4.6
Existing Bores and Groundwater Dependent Ecosystems

Legend

- Extent of clearance

HEVAE

- High
- Low
- Medium
- Very High

Registered Bore Types

- Dewatering
- Irrigation
- Unknown
- Water Supply

0 500 1,000

Metres

Scale: 1:25,000 at A4
GDA2020 MGA Zone 56

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Image Source: ESRI Basemap (2023) | Data Source: Umwelt (2023), BoM NGIS (2023)

4.7.2 Groundwater Dependant Ecosystems (GDEs)

A map of the High Ecological Value Aquatic Ecosystems (HEVAE) is displayed in **Figure 4-6**. This mapping methodology includes four criteria: diversity, distinctiveness, naturalness and vital habitat and assigns a score to each which determines the probability of an area being a GDE (NSW_Govt, 2023).

A high probability HEVAE is located approximately 1.5 km to the east of the excavation area. The excavation area is bounded on the southern margins by medium probability HEVAEs and these zones correlate well with the areas of low topography (**Figure 1-4**.). The groundwater table will be close to surface in these areas and this is evident on the ecohydrological models in **Figure 4-7** to **Figure 4-9**. Therefore, if the groundwater table is lowered, either by natural or anthropogenic causes, then the ecosystem could be adversely affected. However, the project does not propose to intersect groundwater.

The closest known listed GDEs to site are the Tilligerry Creek Wetlands and Hunter River Wetlands, located over 10 km to the north-east and south-west of the site, respectively (DPIE, 2016).

4.8 Conceptual Ecohydrological Model

Conceptual ecohydrological models (CEM) have been developed to describe the aquifer and groundwater conditions at the site and identify possible impacts on receptors. The CEM has been developed from long term monitoring of groundwater levels and chemistry, along with borehole logs. Based on available information, the following CEM is proposed for the site:

- There is a single hydrogeological stratigraphical unit (HSU) at the site, which is composed of porous, unconsolidated sand to depth of at least 30m. The porosity of the sand is expected to be high. Therefore, the groundwater is present in and transmitted through the pores between the sand grains.
- Groundwater elevations range from 0.5 mAHD to 3.5 mAHD. The elevation contours suggest that the groundwater flows from the south-east to the north-west away from the coast and towards Fullerton Cove. It is interpreted that the groundwater gradient is reversed from that expected by preferential rainfall recharge along the unvegetated belt close to the coast. It is thought that the main groundwater flow direction will be towards the sea. If the main groundwater flow direction was truly from the coast to inland, then it would be expected that the groundwater salinity would be much higher than recorded.
- The main recharge mechanism is expected to be from direct rainfall infiltration, which is thought to be higher where there is a lack of vegetation cover.
- No surface water bodies are present within the extraction area. Therefore, there is no groundwater interaction with surface water.
- The groundwater is recorded as fresh in all the monitoring bores at site. There is little seasonal or long-term variation in groundwater quality/chemistry.
- Hydraulic conductivity tests (slug tests) have been carried out at MW X3 (in both deep and shallow bores). The analyses provide a high hydraulic conductivity value that is in keeping with the published literature.

Schematic representations (cross sections) of the CEM are presented in **Figure 4-7** to **Figure 4-9**. Cross section locations are shown in **Figure 3-3**. The figures show the proposed extraction area, which is maintained above the water table. The sand extraction is unlikely to directly intercept groundwater.

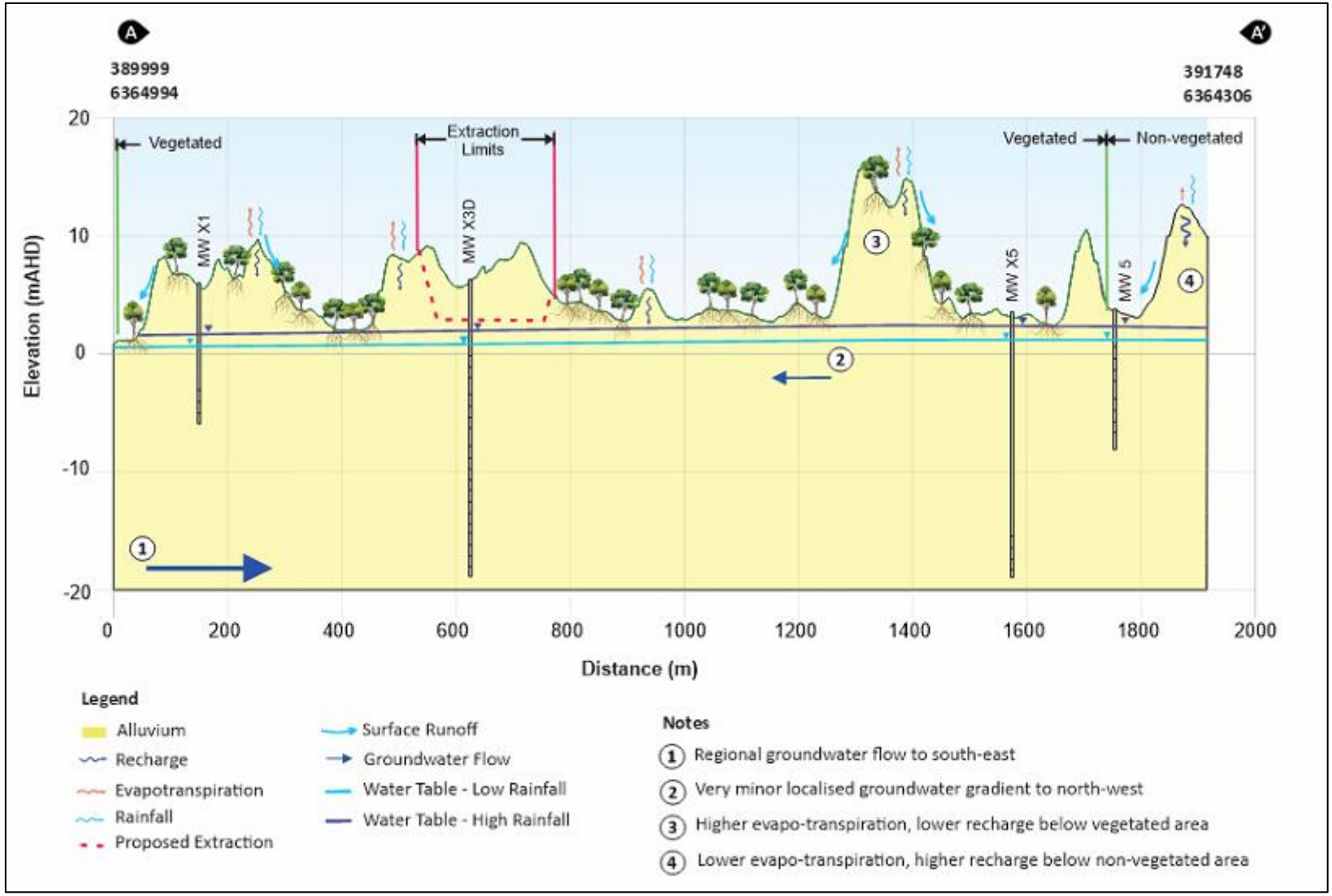

Figure 4-7 Conceptual Ecohydrological Model – Section A

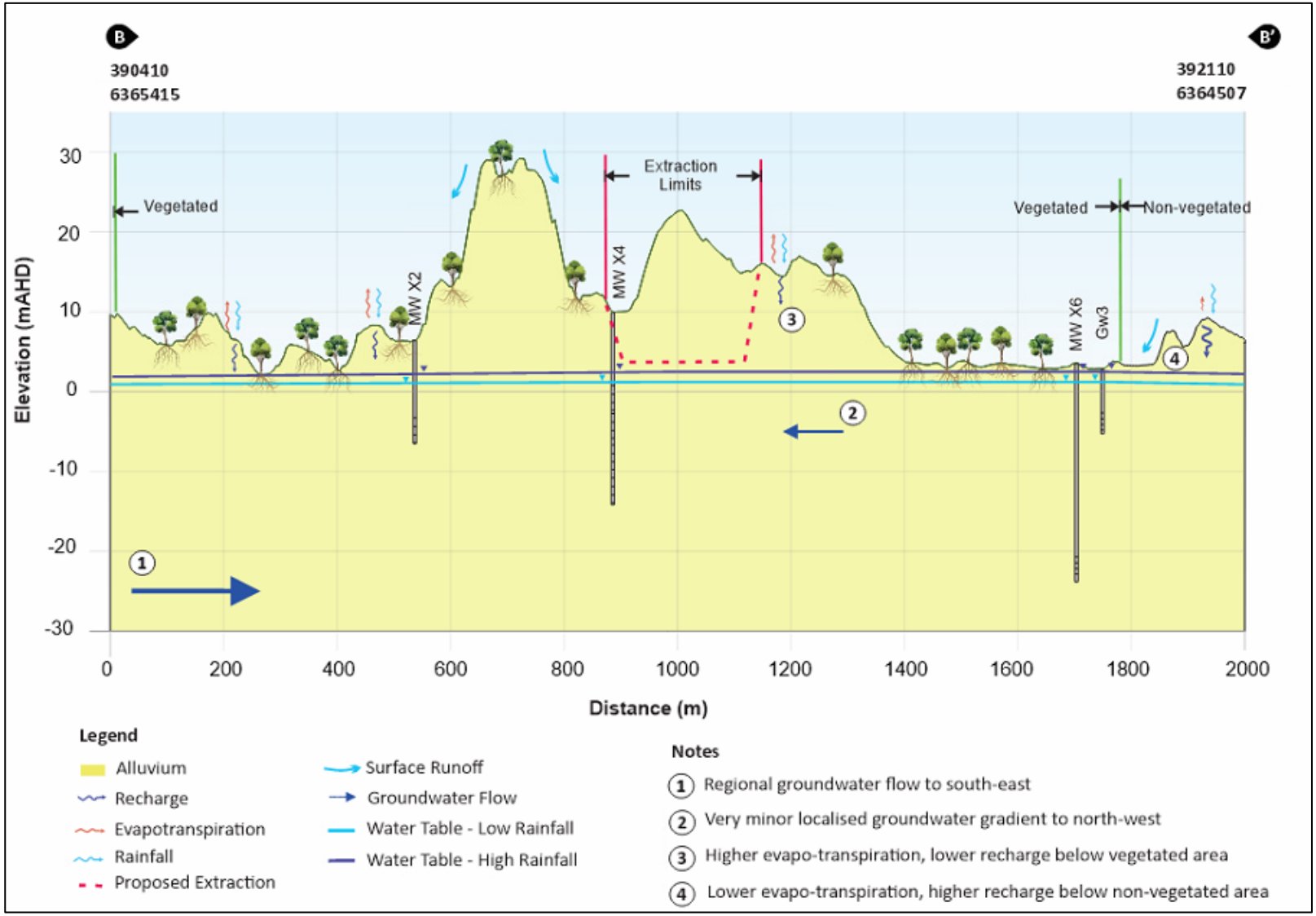

Figure 4-8 Conceptual Ecohydrological Model – Section B

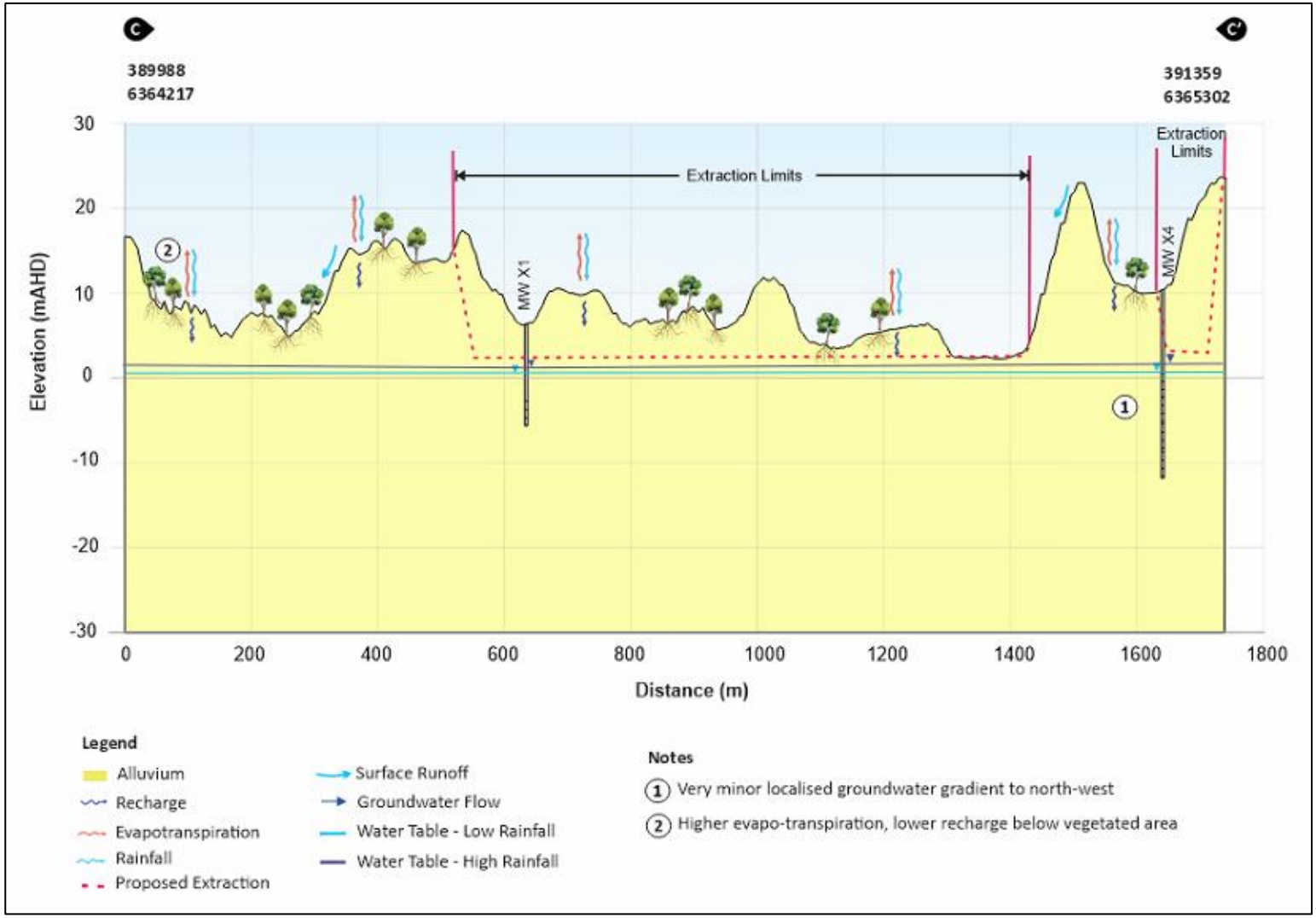

Figure 4-9 Conceptual Ecohydrological Model – Section C

5.0 Maximum Operating Depth

5.1 Introduction

As part of the planning approvals, an elevation below which sand is not to be excavated needs to be provided. This elevation has been set at 0.7 m above the groundwater elevation determined as part of this analysis (DPE, 2022).

5.2 Analysis

Following the QC process carried out on the groundwater level data, box and whiskers plots were created. The 95th and 99th percentiles were also calculated. The results are presented in **Table 5-1** and the plot in **Figure 5-1**.

Table 5-1 Statistical Results of the Groundwater Elevation Data (mAHD)

	Min	Max	Mean	StdDev	Median	Q1	Q3	95th %ile	99th %ile
MW1	0.85	3.61	1.80	0.46	1.76	1.46	2.04	2.63	2.97
MW2	1.14	3.55	1.72	0.47	1.61	1.41	1.80	2.75	3.25
MW3	1.12	3.54	1.89	0.51	1.80	1.66	2.03	2.46	3.31
MW4	1.17	3.38	1.82	0.48	1.73	1.57	1.90	2.35	3.18
MW5	1.17	3.58	1.82	0.40	1.75	1.52	2.02	2.50	3.10
MW6	0.76	3.17	1.80	0.49	1.76	1.44	2.13	2.68	3.05
MW7	1.08	3.63	1.88	0.41	1.80	1.58	2.13	2.58	3.06
MW8	1.08	3.33	1.86	0.38	1.80	1.58	2.10	2.56	2.85
MW9	1.20	2.98	1.86	0.37	1.82	1.56	2.11	2.55	2.86
MW10	1.24	2.47	1.90	0.31	1.91	1.69	2.04	2.39	2.45
MW11	1.60	2.10	1.93	0.29	2.10	1.85	2.10	2.10	2.10
GW1	1.26	3.09	2.53	0.35	2.57	2.41	2.74	3.03	3.08
GW2	1.15	3.09	1.92	0.51	1.85	1.47	2.33	2.92	3.03
GW3	1.12	3.15	1.84	0.44	1.76	1.50	2.18	2.66	2.90
GW4	1.05	3.01	1.70	0.44	1.61	1.35	1.98	2.63	2.89
MWX1	0.61	2.34	1.33	0.39	1.32	1.00	1.62	2.00	2.23
MWX2	0.89	2.95	1.70	0.52	1.66	1.24	2.09	2.69	2.86
MWX3D	0.94	3.01	1.66	0.49	1.60	1.24	1.98	2.66	2.89
MWX3S	0.95	3.01	1.63	0.46	1.57	1.22	1.94	2.56	2.90
MWX4D	0.99	3.08	1.80	0.54	1.76	1.32	2.18	2.82	3.00
MWX4S	1.00	3.09	1.83	0.52	1.79	1.36	2.19	2.77	3.00
MWX5	1.14	3.14	1.82	0.46	1.71	1.44	2.15	2.72	2.92
MWX6	1.16	3.20	1.89	0.46	1.81	1.51	2.24	2.74	2.97

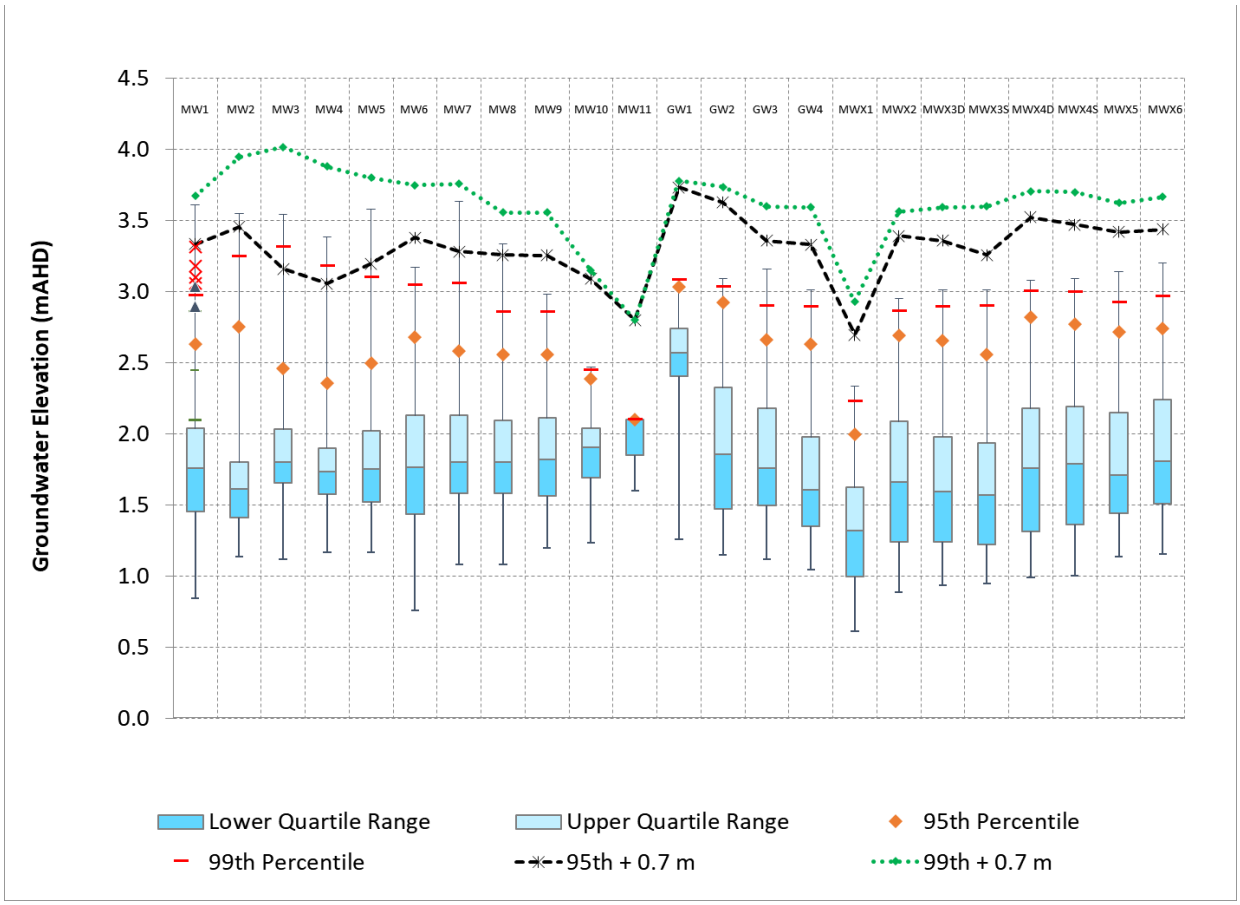

Figure 5-1 Box and Whiskers Plot for Groundwater Elevation.

Figure 5-1 boxplots present the maximum and minimum by the whiskers, the median value (50th percentile) and the upper and lower quartiles that represent the 25th and 75th percentiles and are annotated with the 95th and 99th percentiles. Outliers are also noted as crosses, which represent values over three times the standard deviation from the mean.

The 95th and 99th percentile groundwater elevation data were gridded and contoured. Based on a comparison of these contours and the maximum contours displayed in **Figure 4-2**, it was decided to use the 99th percentile groundwater elevation contours as the basis for determining the lowest excavation level (see **Figure 5-2**). The MW series bores and GW1 were not used in the contouring process:

- The MW series are not equipped with loggers and so there is much less data available. This causes a wider range of values in the statistical analysis which resulted in “bull’s eyes” in the contours.
- GW1 has a logger, however, the installation date is much later than the other bores. In addition, the later data is unreliable (flat) and the groundwater level may have fallen below the sensor.
- Therefore, only those bores with the longer periods of logger data were used in the contouring. Referring to **Figure 5-2**, it can be seen that those bores not used are furthest away from the planned area of excavation. In addition, the area is surrounded by bores equipped with loggers. Therefore, it is expected that the exclusion of these bores from the process will have had little effect on final contours.

A value of 0.7 m has been added onto the 95th and 99th percentile groundwater levels and are shown in **Figure 5-1**. As demonstrated in **Figure 5-1** the 99th percentile plus 0.7 m exceeds the maximum observed water levels for all site bores. Therefore, it is proposed that the depth of excavation be limited to the 99th percentile plus 0.7 m to ensure no interaction with the water table, referred to as the maximum operating depth. The spatial distribution of maximum operating depth is presented in **Figure 5-2**. These contours range from 3.5 mAHD to ~3.65 mAHD being lower to the west and higher to the east.

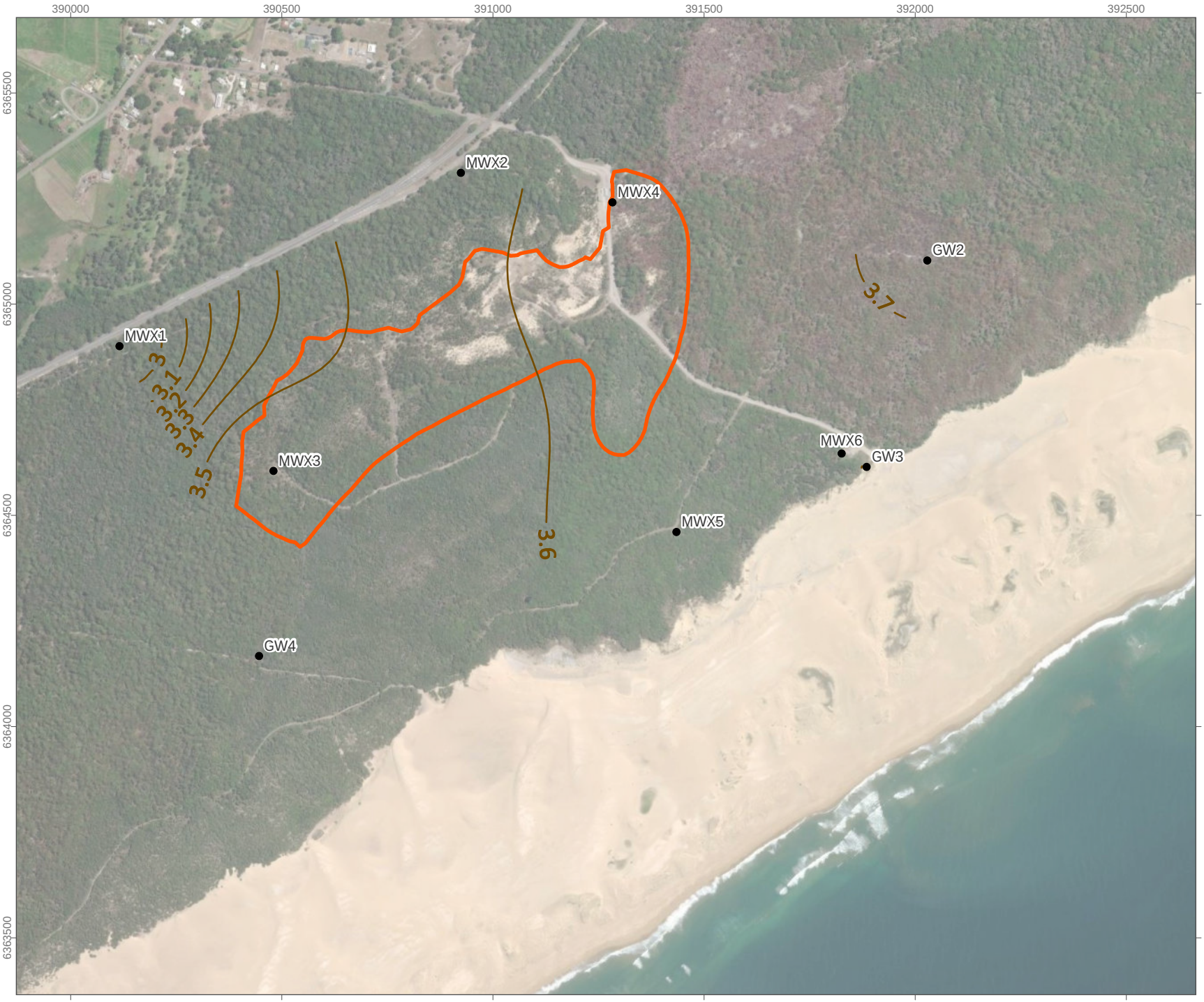

Figure 5.2
Maximum Excavation Contours (mAHD)

Legend

- Extent of clearance
- Lowest Mining Elevation (mAHD)
- Bores Used

0 200 400
Metres

Scale: 1:12,500 at A4
GDA2020 MGA Zone 56

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6.0 Impact Assessment

6.1 Risk Assessment

It is important to note that the actual sand excavation process will remain above the groundwater table by at least 0.7 m. Lowering of the groundwater table will not occur, except as associated with previously licensed groundwater extraction to support the operations. Therefore, any impacts on the groundwater would have to be caused by the associated operations or extraction of groundwater rather than the excavation process itself.

A risk assessment using likelihood and consequence criteria has been used for the potential impacts identified in the operational and post-operational phases of the sand excavation. The result of the risk assessment is shown in **Table 6-1**. The risk rating for the operational phase was determined to have a low risk to groundwater, which is reduced to very low once the management/mitigation measures are implemented.

PFAs contaminants are not included in the risk assessment table as the site may be a receptor (of contaminant from the RAAF base) rather than a source. As discussed above, the contaminant is reported on annually.

Further discussion on the proposed management and mitigation measures is included in **Section 7.0** along with a proposed monitoring program to enable early detection of adverse or unforeseen impacts.

Table 6-1 Groundwater Impact Risk Assessment

		CONSEQUENCE				
		Insignificant (F)	**Minor (I)**	**Moderate (D)**	**Major (J)**	**Catastrophic / Significant (S)**
LIKELIHOOD	**Remote (R)**	Negligible (N)	Negligible (N)	Very Low (L)	Low (W)	Medium (M)
	Unlikely (U)	Negligible (N)	Very Low (L)	Low (W)	Medium (M)	High (H)
	Possible (P)	Very Low (L)	Low (W)	Medium (M)	High (H)	Very High (V)
	Likely (L)	Low (W)	Medium (M)	High (H)	Very High (V)	Extreme (E)
	Almost Certain (C)	Medium (M)	High (H)	Very High (V)	Extreme (E)	Extreme (E)

Phase	Potential Area of Impact	Effects Without the application of mitigation or management measures	Risk Rating			Mitigation/Management Measures	Residual (Mitigated) Risk Rating		
			Likelihood	Consequence	Risk Rating		Likelihood	Consequence	Risk Rating
Operation	Groundwater Quality	Fuel or chemical spills, fire management systems or inappropriate material storage, leads to contamination of groundwater and/or nearby waterways, resulting in environmental degradation and fines under the EP Act.	P	I	W	• Industry best practice Environmental Management Plan (EMP) to be implemented that includes a Waste Management Plan that addresses the storage and stockpiling of raw materials, transport of materials to site, and disposal of materials. • Location of site sheds/storage areas and vehicle parking to be identified in EMP away from sensitive areas. • Spill Management Protocol to be implemented if any spills occur at the site.	U	I	L
Operation	Groundwater Quality	Spills of wash water leads to contamination of groundwater and/or nearby waterways, resulting in environmental degradation and fines under the EP Act.	P	I	W	• Industry best practice EMP to be implemented that includes a Waste Management Plan that addresses the and disposal of materials. • Wash water to be recycled.	U	I	L
Operation	Groundwater Quality	Intersection of Acid Sulfate Soils with potential localised impacts to water quality.	P	I	W	• Site within the area mapped as mostly having a low probability of ASS. • The ASS assessment conducted indicates a single localised occurrence of moderate risk potential ASS. An ASS Management Plan was recommended as part of the report.	U	I	L
Operation	Groundwater Level	No lowering of the groundwater table will occur as part of the sand excavation. Groundwater table will be lowered as part of the licensed groundwater extraction (sand washing and dust suppression on haul roads).	P	I	W	• Installation of monitoring bores around the planned excavation area to be equipped with level loggers. Continued monitoring of existing bores with loggers (MW X and GW series) that are away from the extraction area. • Supply bores to be located and designed by suitably qualified hydrogeologist. • Installation of flowmeters on the headworks of the groundwater supply bores. • Regular reporting of groundwater levels and extraction volumes	U	I	L
Operation	GDEs	No lowering of the groundwater table will occur as part of the sand excavation. Groundwater table will be potentially be lowered in localised areas as part of the licensed groundwater extraction, which is understood to have been previously approved.	P	I	W	• Consideration of the location of the approved extraction to minimise potential drawdown to key receptors and installation of flowmeters on the headworks of the groundwater supply bores.	U	I	L
Operation	Other Bore Users	No lowering of the groundwater table will occur as part of the sand excavation. Groundwater table could be lowered in localised areas as part of the licensed groundwater extraction, which is understood to have been previously approved.	P	I	W	• Installation of monitoring bores around the planned excavation area to be equipped with level loggers. Continued monitoring of existing bores. • Consideration of the location of the approved extraction to minimise potential drawdown to key receptors and installation of flowmeters on the headworks of the groundwater supply bores. • Regular reporting of groundwater levels and extraction volumes	U	I	L

6.2 Aquifer Interference Policy

6.2.1 AIP Assessment Framework

Groundwater within the Project Area is regulated by the Stockton Groundwater Source (SGS) under the North Coast Coastal Sands Groundwater Sources 2016 WSP and is classified as 'Highly Productive' under the AIP. The unassigned water volume of the Stockton Groundwater Source is over 12,500 ML/year and Boral currently hold licenses for consumptive use at the site (DPIE, 2016).

The sand extraction is proposed to be maintained above the water table, therefore, no incidental take of groundwater during the extraction is proposed. Responses to requirements stipulated under Section 2 of the NSW AIP (NOW, 2012) and the AIP Assessment Framework for the extraction are included in **Table 6-2** based on the groundwater assessment.

As discussed in **Section 1.2**, approximately 192 ML/year will be extracted from bores for operations to support the sand extraction and Boral holds adequate licenses for this.

Table 6-2 AIP Assessment Framework Considerations

No.	Requirement	Findings
1	Described the water source (s) the activity will take water from?	Groundwater system at site is the Stockton Groundwater Source under the North Coast Coastal Sands Groundwater Sources 2016 WSP. No take of groundwater is proposed as part of the sand excavation.
2	Predicted the total amount of water that will be taken from each connected groundwater or surface water source on an annual basis as a result of the activity?	No groundwater or surface water take proposed as part of the excavation.
3	Predicted the total amount of water that will be taken from each connected groundwater or surface water source after the closure of the activity?	No groundwater or surface water take proposed as part of the excavation.
4	Made these predictions in accordance with Section 3.2.3 of the AIP? (Page 27)	Qualitative assessment undertaken, with conceptual ecohydrological models presented in **Section 4.8** and risk assessment in **Section 6.1**
5	Described how and in what proportions this take will be assigned to the affected aquifers and connected surface water sources?	No groundwater or surface water take proposed as part of the excavation.
6	Described how any licence exemptions might apply?	Not applicable
7	Described the characteristics of the water requirements?	No groundwater or surface water take proposed as part of the excavation.

No.	Requirement	Findings
8	Determined if there are sufficient water entitlements and water allocations that are able to be obtained for the activity?	No groundwater or surface water take proposed as part of the excavation.
9	Considered the rules of the relevant water sharing plan and if it can meet these rules?	Not applicable
10	Determined how it will obtain the required water?	Not applicable
11	Considered the effect that activation of existing entitlement may have on future available water determinations?	No groundwater or surface water take proposed as part of the excavation.
12	Considered actions required both during and post-closure to minimise the risk of inflows to a mine void as a result of flooding?	No watercourses within the vicinity of the project area and no predicted flood inundation, refer to Surface Water Assessment report.
13	Developed a strategy to account for any water taken beyond the life of the operation of the Project?	No groundwater or surface water take proposed as part of the excavation. Following construction final landform will be above the water table. Being a natural wind-blown dune system, the environment will continue to experience sand deposition within the project area.
14	Will uncertainty in the predicted inflows have a significant impact on the environment or other authorised water users? Items 14-16 must be addressed if so.	No groundwater or surface water take proposed as part of the excavation.

6.2.2 Minimal Impact Considerations

This section provides discussion of potential impacts of the Project in terms of the AIP minimal impact considerations for the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources Highly Productive Coastal Sands.

As outlined in **Table 6-3**, the predicted impacts are less than the Level 1 minimal impact considerations; therefore, these impacts will be considered as acceptable under the AIP framework.

Table 6-3 Minimal Impact Considerations – Highly Productive Coastal Sands

Level 1 Minimal Impact Considerations	Assessment
Water Table: Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic post-water sharing plan variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	Level 1 – Acceptable. The proposed extraction is planned to be maintained above the maximum water table level and will not interfere with surface catchment extent or impede throughflow. Therefore, changes to the local water table at site or in the immediate surrounds during operations or post closure are considered unlikely. The project is considered to adequately satisfy the water pressure minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.
Water Pressure: A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Level 1 – Acceptable. The proposed extraction is planned to be maintained above the maximum water table level and will not interfere with surface catchment extent or impede throughflow. Therefore, changes to the local water table at site or in the immediate surrounds during operations or post closure are considered unlikely. The project is considered to adequately satisfy the water pressure minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.
Water Quality: Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Level 1 – Acceptable. A single sample of the 25 soil samples tested for ASS showed a moderate risk for potential ASS at 2 m. This was a localised occurrence. An ASS Management Plan was recommended based on these findings. Therefore, changes to the local water quality at site or in the immediate surrounds during operations or post closure are considered unlikely. The project is considered to adequately satisfy the water pressure minimal impact considerations relating to highly productive coastal sands water sources defined in the AIP.

7.0 Groundwater Monitoring and Mitigation Measures

This section presents the proposed monitoring and mitigation measures to be put in place to manage the potential risk to groundwater identified in **Table 6-1**.

7.1 Groundwater Monitoring Network

The groundwater levels need to be monitored around the excavation area to ensure that levels remain consistent with the analysis in this report. Ongoing groundwater monitoring will be conducted at site in accordance with the existing groundwater monitoring program. Additional monitoring locations are also proposed to be installed to provide additional baseline data to characterise the groundwater regime and for ongoing monitoring over the life of the project, as several of the existing bores are within the disturbance footprint. The proposed bores would be installed within the site lease in accordance with WAL Reference 20AL213136, in consultation with DPE Water and the NSW National Resources Access Regulator (NRAR).The proposed groundwater monitoring network is presented in **Table 7-1** and additional monitoring locations are shown in **Figure 7-1**. However, the finalised locations and construction for any proposed sites will be dependent on land accessibility, ground conditions and safety considerations.

The locations and numbering convention can be discussed and adjusted as required. The monitoring bores should be installed by a minimum Class I certified driller and the installation designed and supervised by a suitably qualified hydrogeologist. The bores should have level loggers installed and the data should be downloaded and checked on a monthly basis.

Works will also be undertaken to survey the ground elevation at each bore and check the condition of the bores and (where required) clear any blockages or sediment build up.

Table 7-1 Proposed Monitoring Program

ID	Easting	Northing	Ground Elevation (Mahd)*	Year Installed	Screen Top mbgl	Screen Bottom (mbgl)	Water Level	Water Quality
GW1⁺	391407	6364885	9.60	1997	6.2	6.9	Hourly (L) - Short term	Quarterly -Short term
GW2⁺	392029	6365103	2.67	1997	2.9	3.6	Hourly (L)	Quarterly
GW3⁺	391885	6364615	3.02	1997	3.5	4.2	Hourly (L)	Quarterly
GW4⁺	390446	6364167	3.24	1997	4.1	4.8	Hourly (L)	Quarterly
MW X1⁺	390115	6364901	6.10	2017	12.2	9.2	Hourly (L)	Quarterly
MW X2⁺	390924	6365311	5.74	2017	n/a	n/a	Hourly (L)	Quarterly
MW X3⁺ Deep	390480	6364605	6.43	2017	26.0	5.3	Hourly (L) - Short term	Quarterly- Short term
MW X3⁺ Shallow	390480	6364604	6.39	2017	11.4	8.4	Hourly (L) - Short term	Quarterly -Short term

ID	Easting	Northing	Ground Elevation (Mahd)*	Year Installed	Screen Top mbgl	Screen Bottom (mbgl)	Water Level	Water Quality
MW X4+ Deep	391283	6365241	9.90	2017	24.5	8.7	Hourly (L) - Short term	Quarterly -Short term
MW X4+ Shallow	391284	6365241	10.21	2017	12.1	8.9	Hourly (L) - Short term	Quarterly -Short term
MW X5+	391435	6364461	3.82	2017	24.2	21.2	Hourly (L)	Quarterly
MW X6+	391826	6364647	3.15	2017	27.6	24.6	Hourly (L)	Quarterly
MW1+	391024	6364177	4.20	2013	19.0	25.0	Monthly	Quarterly
MW2+	391295	6363895	9.86	2013	19.0	25.0	Monthly	Quarterly
MW5+	391588	6364385	4.98	2013	2.0	8.0	Monthly	Quarterly
MW6+	391788	6364541	3.82	2013	2.0	8.0	Monthly	Quarterly
MW7+	392042	6364701	4.05	2013	2.0	8.0	Monthly	Quarterly
MW8+	392242	6364807	3.27	2013	19.0	25.0	Monthly	Quarterly
MW9+	392413	6364895	5.90	2013	19.0	25.0	Monthly	Quarterly
GW6	*391490*	*6365250*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*
GW7	*391465*	*6364840*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*
GW8	*391030*	*6364735*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*
GW9	*390715*	*6364550*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*
GW10	*390360*	*6364460*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*
GW11	*390625*	*6364980*	*TBC*	*Proposed*	*TBC*	*TBC*	*Hourly (L)*	*Quarterly*

Note: *Coordinates in GDA2020 Zone 56 – final locations to be surveyed*
**Elevation derived from VGT field data records of top of casing elevations and converted for ground elevation*
mbgl – meters below ground level
+Bores within current groundwater monitoring program
(L) Bores with loggers.
Short term – refers to bores within the excavation footprint that will be removed with progression of the proposed quarry operations.

The design of the proposed monitoring bores will be based on their elevation and so will finalised once the final locations are determined.

7.2 Groundwater Monitoring Program

Groundwater level monitoring will be conducted at the frequency outline in **Table 7-1**. Logger data should be recorded at hourly intervals with data downloaded on a monthly basis at the same time as the water levels are dipped.

Groundwater quality monitoring will be conducted at the frequency outlined in **Table 7-1**. The GWMP will be updated to reflect the updated monitoring locations and approach. Groundwater monitoring will be undertaken in accordance with industry standards, with data stored within a central database and routine QA/QC conducted to verify data input.

Groundwater sampling includes collection of field parameters for pH, temperature and EC, as well as observations on the colour and odour of the sample noted.

Samples will be collected in laboratory supplied bottles for analysis. Field filtering for metals analysis will be undertaken. Samples will be stored in a chilled esky and submitted to a National Association of Testing Authorities (NATA) accredited laboratory with a chain of custody (CoC) form for water quality analysis.

The samples will be analysed for:

- Turbidity
- Total dissolved solids (TDS)
- Chloride and fluoride
- Major ions: sulphate, calcium, potassium, sodium, magnesium, hardness as CaCO3, bicarbonate (HCO3)
- Alkalinity
- Nutrients: Filtrable phosphorous and nitrate as N
- Total and dissolved metals: aluminium, arsenic, barium, cadmium, chromium, copper, iron, manganese, nickel, lead, selenium, zinc and mercury.
- PFAS, PFOA.

7.3 Groundwater Triggers and Reporting

The groundwater data should be compared to relevant triggers following each sampling event. Trigger levels should be applied for groundwater levels, pH and EC. Trigger levels are proposed as:

- 95th percentile of groundwater levels recorded during low rainfall periods (less than 80 mm per month).
- 95th percentile of groundwater levels recorded during high rainfall periods (more than 80 mm per month).
- EC based on 95th percentile of baseline groundwater data.
- pH based on 5th and 95th percentile of baseline groundwater data.

The trigger criteria relevant to the trigger levels is summarised in **Table 7-2**. The groundwater trends will be reviewed on an annual basis and reported on in the AEMR.

Table 7-2 Proposed Groundwater Trigger Criteria

ID	Trigger Exceedance Criteria	Response Action
Groundwater Level	Two consecutive monthly readings outside of the trigger level for the relevant monthly rainfall conditions. Or (whichever comes first) An adverse trend of declining groundwater levels that does not correspond to climatic conditions.	Repeat monitoring of bore with exceedance to verify accuracy of the result and refer the matter to a suitably qualified person to review. Inform relevant regulatory agencies within 7 days of being notified of the exceedance with an exceedance notification letter. Exceedance investigation report to be issued within 60 days of the initial notification to authorities.
EC	Two consecutive readings outside of the trigger level for EC.	
pH	Two consecutive readings outside of the trigger level for pH.	

7.4 Groundwater Abstraction Bores

While not part of the sand extraction, consideration will be made regarding installation of the previously approved abstraction bores for consumptive use on site (i.e., dust suppression and processing). Water supply bores will be installed by a minimum Class I driller, and the installation designed and supervised by a suitably qualified hydrogeologist.

The supply bores will be equipped with suitable flowmeters to record groundwater volumes extracted. Reporting of these volumes is a requirement of the WALs.

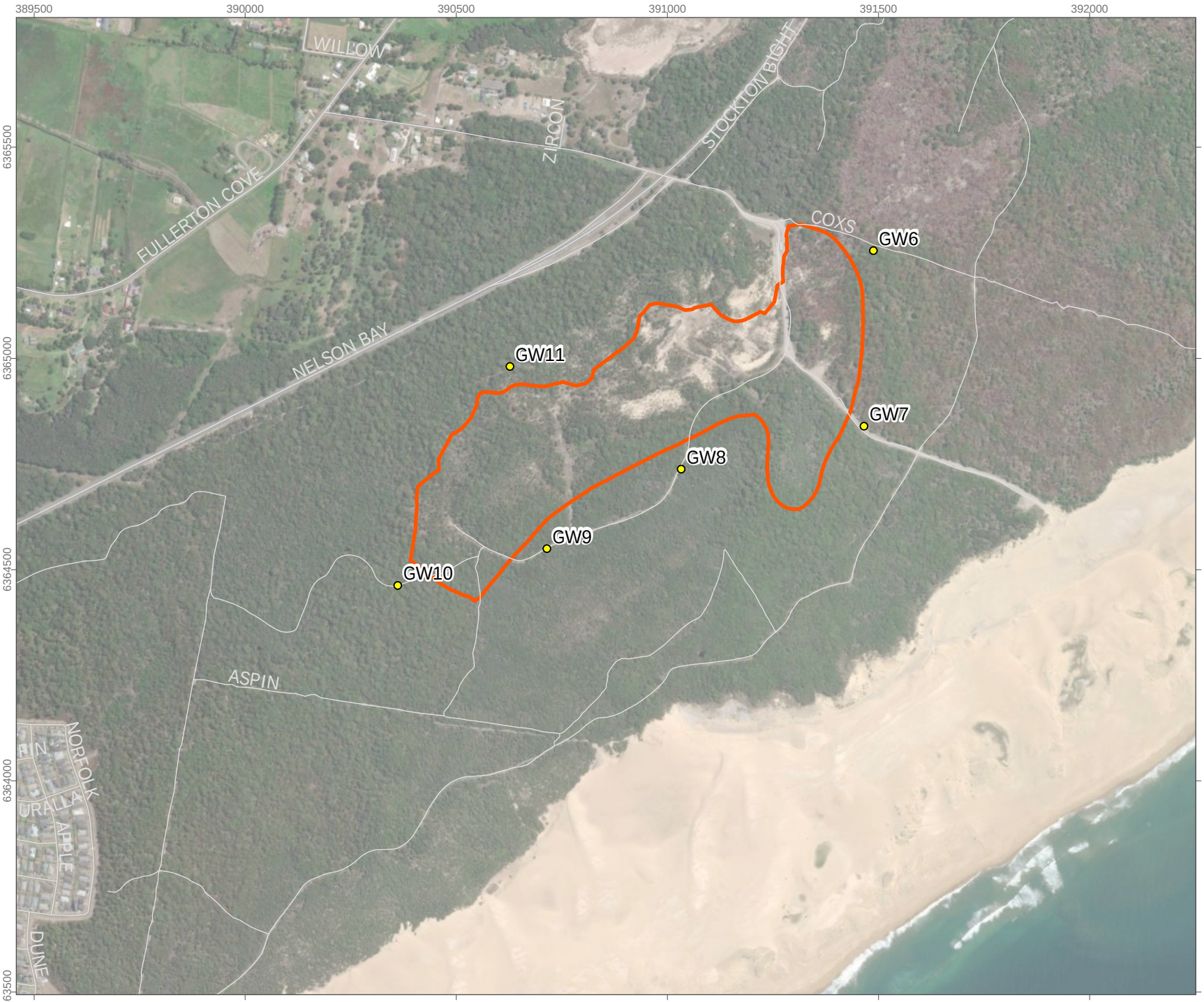

Figure 7.1
Recommended Additional Monitoring Bores

Legend

- Extent of clearance
- Road
- Proposed Monitoring Bores

0 200 400

Metres

Scale: 1:12,500 at A4
GDA2020 MGA Zone 56

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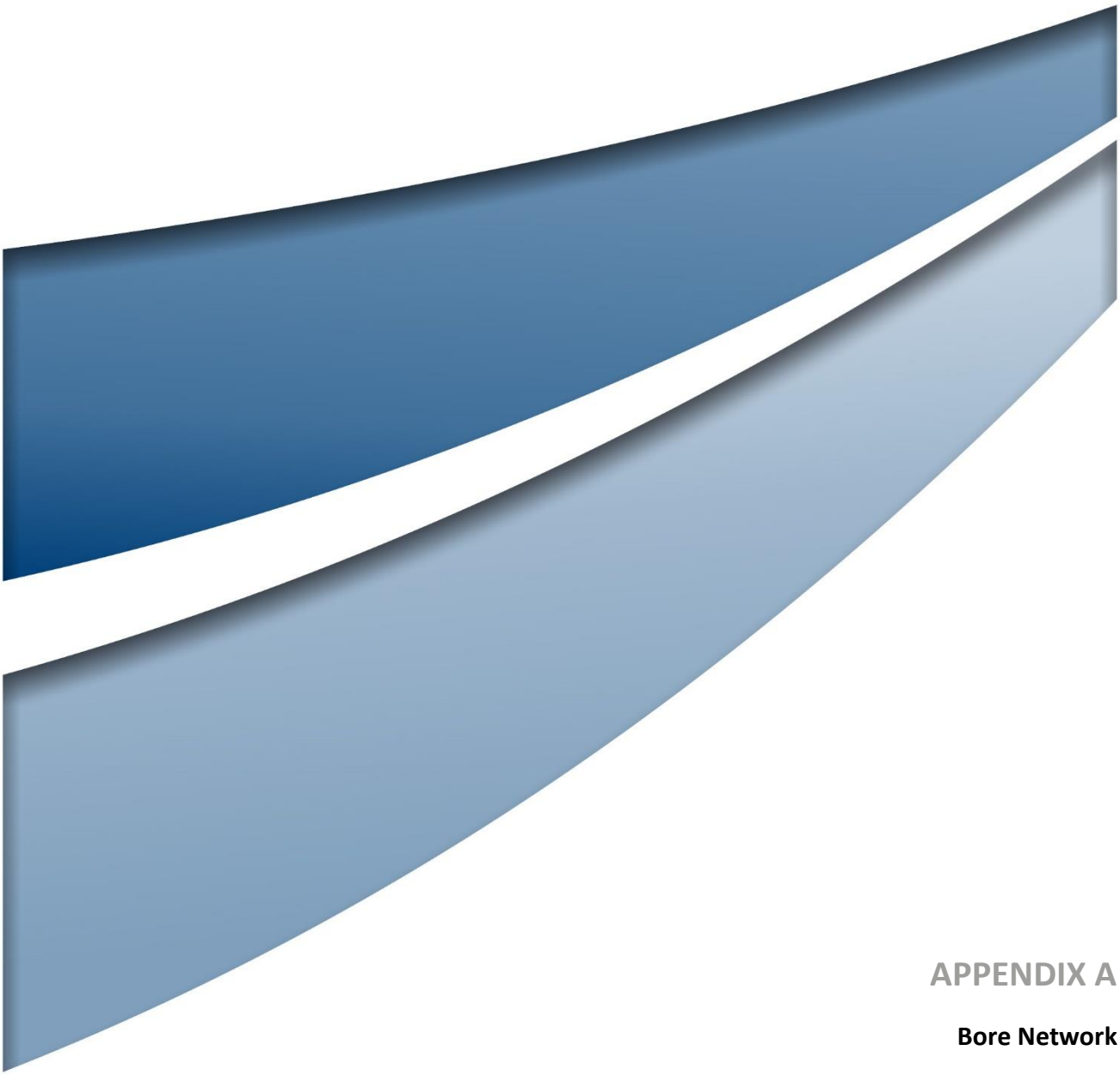


APPENDIX A

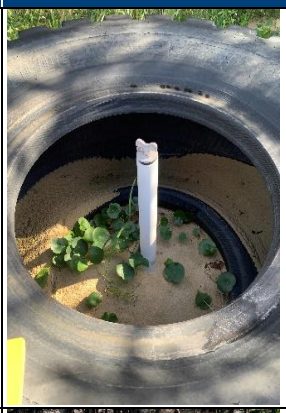
Bore Network

ID	Easting	Northing	Ground Elevation (mAHD)	Year Installed	Bore Depth (mbgl)	Screen Top (mbgl)	Screen Bottom (mbgl)	Top of Casing (magl)	Photograph
GW1	391407	6364885	9.60	1999	8.73	6.2	6.9	0.5	
GW2	392029	6365103	2.67	1999	3.48	2.9	3.6	0.32	
GW3	391885	6364615	3.02	1999	9.02	3.5	4.2	0.98	
GW4	390446	6364167	3.24	1999	4.93	4.1	4.8	0.62	

ID	Easting	Northing	Ground Elevation (mAHD)	Year Installed	Bore Depth (mbgl)	Screen Top (mbgl)	Screen Bottom (mbgl)	Top of Casing (magl)	Photograph
MW X1	390115	6364901	6.10	2017	12.03	12.2	9.2	0.7	
MW X2	390924	6365311	5.74	2017	11.63	n/a	n/a	0.6	
MW X3 Deep	390480	6364605	6.43	2017	25.5	26.0	5.3	0.54	
MW X3 Shallow	390480	6364604	6.39	2017	11.21	11.4	8.4	0.19	

ID	Easting	Northing	Ground Elevation (mAHD)	Year Installed	Bore Depth (mbgl)	Screen Top (mbgl)	Screen Bottom (mbgl)	Top of Casing (magl)	Photograph
MW X4 Deep	391283	6365241	9.90	2017	23.98	24.5	8.7	0.62	
MW X4 Shallow	391284	6365241	10.21	2017	11.88	12.1	8.9	0.48	
MW X5	391435	6364461	3.82	2017	23.86	24.2	21.2	0.35	
MW X6	391826	6364647	3.15	2017	27.29	27.6	24.6	0.68	

ID	Easting	Northing	Ground Elevation (mAHD)	Year Installed	Bore Depth (mbgl)	Screen Top (mbgl)	Screen Bottom (mbgl)	Top of Casing (magl)	Photograph
MW X7	391159	6365085	4.61		11.24			0.5	
MW1	391024	6364177	4.20	2013	11.22	19.0	25.0	0.21	
MW2	391295	6363895	-	2013		19.0	25.0		
MW3	390480	6364598	-	2013		2.0	8.0		
MW4	392243	6364808	-	2013		2.0	8.0		
MW5	391588	6364385	4.98	2013	8.98	2.0	8.0	0	
MW6	391788	6364541	3.82	2013	6.97	2.0	8.0	0.73	

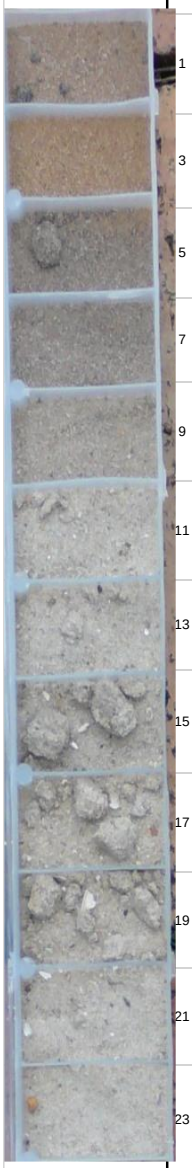
ID	Easting	Northing	Ground Elevation (mAHD)	Year Installed	Bore Depth (mbgl)	Screen Top (mbgl)	Screen Bottom (mbgl)	Top of Casing (magl)	Photograph
MW7	392042	6364701	4.05	2013	9.6	2.0	8.0	0.5	
MW8	392242	6364807	3.27	2013	9.75	19.0	25.0	0.73	
MW9	392413	6364895	5.90	2013	8.7	19.0	25.0	0.6	
MW10	391352	6363951	-	2013		19.0	25.0		
MW11	n/a	n/a	-	n/a		n/a	n/a		

Note: *Coordinates in GDA2020 Zone 56, derived from handheld GPS*
Elevation derived from VGT field data records
mbgl – meters below ground level

BORE LOG – GW X3

Stockton Quarry Drilling

BHID		Easting:	390480		Drilling Company:	Terratest
X3		Northing:	6364605		Drilled by:	
		RL:	5.9		Date Drilled:	
			(MGA)		Logged by:	DJC



	ROCK TYPE	SIZE	COLOUR	CLAY CONTENT	ROCK CHIP HARDNESS	ROCK CHIP MORPHOLOGY	Comments
0 - 1	Soil/Sand						
1 - 3	FG Sand		Light Grey				Rehab Sand
3 - 5	FG Sand		Light Brown				Rehab Sand
5 - 7	FG Sand		Light Grey				
7 - 9							
9 - 11							
11 - 13	FG Sand		White				Shell Fragments
13 - 15							Shell Fragments
15 - 17							Shell Fragments
17 - 19							Shell Fragments
19 - 21							Shell Fragments
21 - 23							Shell Fragments
23 - 25							Shell Fragments

NOTES:			Rod	Pen rate
OVB to		Drilling:	1	
SW to			2	
			3	
COMMENTS:			4	
			5	
			6	

BORE LOG GW X4

Stockton Quarry Drilling

BHID		Easting:	391283	Drilling Company:	
X4		Northing:	6365241	Drilled by:	
		RL:	10.0	Date Drilled:	
			(MGA)	Logged by:	DJC

			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP ORPHOLOGY	Comments
0	-	1	**Soil/Sand**						
1	-	3	**FG Sand**			White			
3	-	5							
5	-	7							
7	-	9							
9	-	11							
11	-	13	**FG Sand**			Dark Grey			
13	-	15							
15	-	17	**FG Sand**			White			Shell Fragments
17	-	19							Shell Fragments
19	-	21							Shell Fragments
21	-	23							Shell Fragments
23	-	25							Shell Fragments

NOTES:			Rod	Pen rate
OVB to		**Drilling:**	1	
SW to			2	
			3	
COMMENTS:			4	
			5	
			6	

Exploration Hole X8

Stockton Quarry Drilling

BHID		Easting:	390722	Drilling Company:	
X8		Northing:	6364883	Drilled by:	
		RL:	6.8	Date Drilled:	
			(MGA)	Logged by:	DJC

			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP ORPHOLOGY	Comments
0	-	1	**Soil/Sand**						
1	-	3	**FG Sand**			Light Grey			Rehab Sand
3	-	5							Rehab Sand
5	-	7							
7	-	9							
9	-	11							
11	-	13							
13	-	15	**FG Sand**			White			Shell Fragments
15	-	17							Shell Fragments
17	-	19							Shell Fragments
19	-	21							Shell Fragments
21	-	23							Shell Fragments
23	-	25							Shell Fragments

NOTES:								Rod	Pen rate
			OVB to				**Drilling:**	1	
			SW to					2	
								3	
COMMENTS:								4	
								5	
								6	

Exploration Hole X9

Stockton Quarry Drilling

BHID		Easting:	390768	Drilling Company:	Terratest
X9		Northing:	6364597	Drilled by:	
		RL:	4.8	Date Drilled:	
			(MGA)	Logged by:	DJC

			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP MORPHOLOGY	Comments
0	-	1.5	**FG Sand**			White			Shell Fragments
1.5	-	3							Shell Fragments
3	-	4.5							Shell Fragments
4.5	-	6							Shell Fragments
6	-	7.5							Shell Fragments
7.5	-	9							
9	-	11							
10.5	-	12							Shell Fragments
12	-	14							Shell Fragments
13.5	-	15							Shell Fragments
15	-	17							Shell Fragments
16.5	-	18							Shell Fragments

NOTES:

OVB to
SW to

COMMENTS:

Drilling:	Rod	Pen rate
	1	
	2	
	3	
	4	
	5	
	6	

Exploration Hole X10

Stockton Quarry Drilling

BHID		Easting:	391046		Drilling Company:	Terratest
X10		Northing:	6365105		Drilled by:	
		RL:	2.2		Date Drilled:	
			(MGA)		Logged by:	DJC

			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP MORPHOLOGY	Comments
0	-	2	**FG Sand**			Light Grey			Rehab Sand
1.5	-	3							Rehab Sand
3	-	5							Rehab Sand
4.5	-	6							
6	-	8	**FG Sand**			Light Brown			
7.5	-	9							
9	-	11	**FG Sand**			Grey/ Brown			
11	-	12							
12	-	14							
14	-	15							
15	-	17							
17	-	18							

NOTES:			Rod	Pen rate
OVB to		**Drilling:**	1	
SW to			2	
			3	
COMMENTS:			4	
			5	
			6	

Exploration Hole X11

Stockton Quarry Drilling

BHID		Easting:	391036	Drilling Company:	Terratest
X11		Northing:	6365036	Drilled by:	
		RL:	1.9	Date Drilled:	
			(MGA)	Logged by:	DJC

			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP ORPHOLOGY	Comments
0	-	1.5	**F G Sand**			Light Grey			
1.5	-	3							
3	-	4.5							
4.5	-	6	**F G Sand**			Light Brow n			
6	-	7.5							
7.5	-	9							
9	-	11							
10.5	-	12							
12	-	14							
13.5	-	15							
15	-	17							
16.5	-	18							

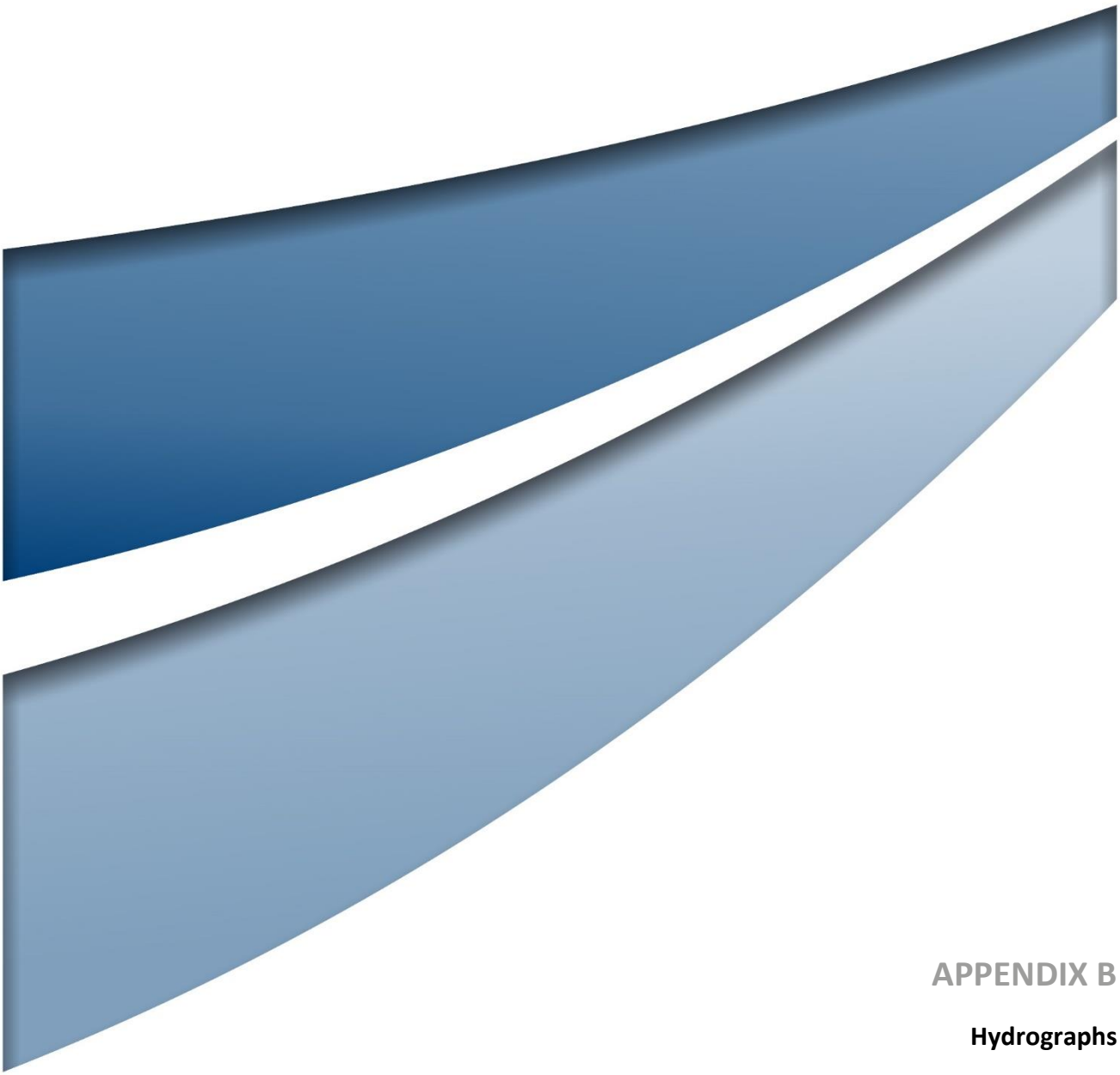
NOTES:				Rod	Pen rate
OVB to			**Drilling:**	1	
SW to				2	
				3	
COMMENTS:				4	
				5	
				6	

Exploration Hole X12

X12				Northing:	6364988		Drilled by:	
				RL:	6.8		Date Drilled:	
					(MGA)		Logged by:	DJC

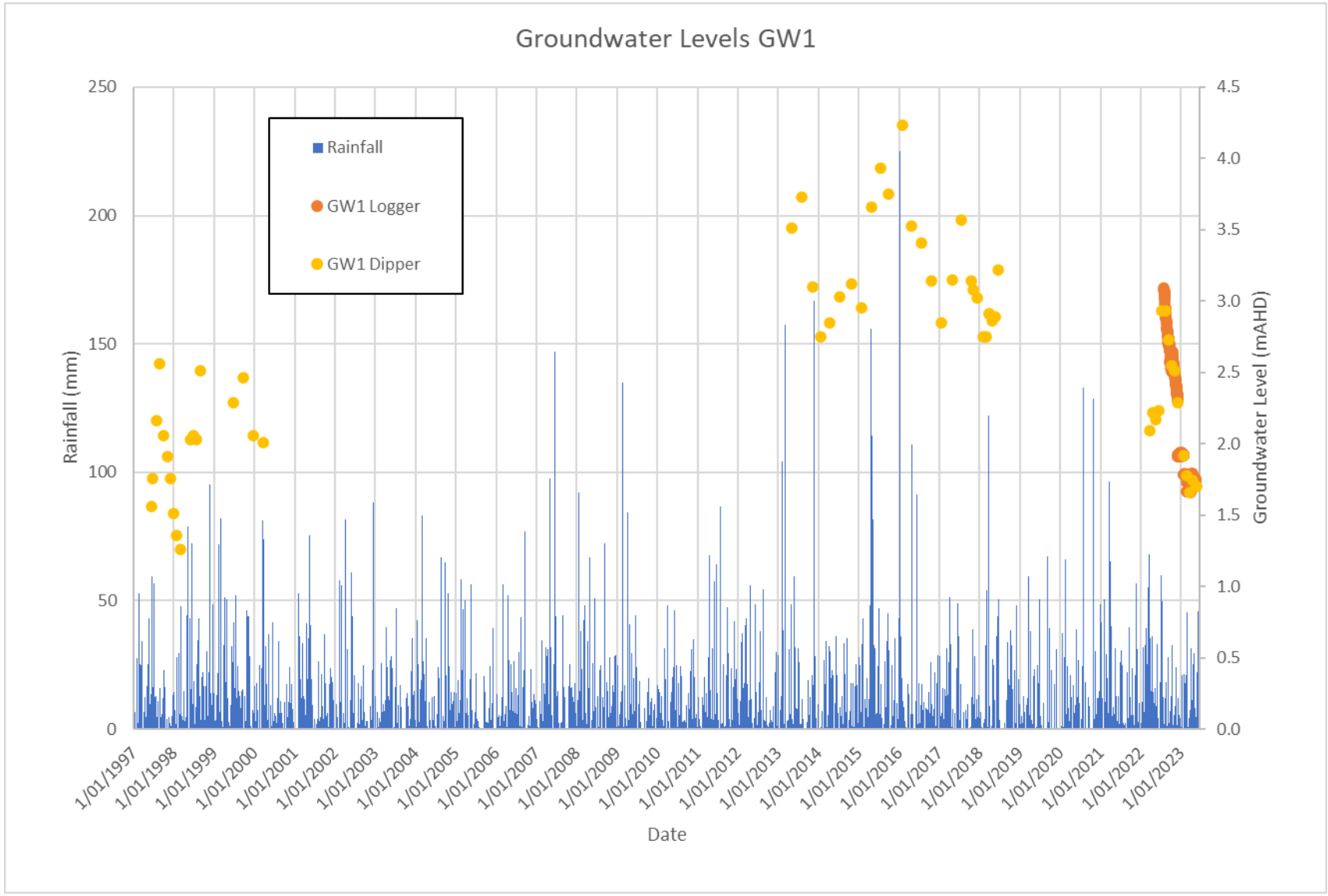
			ROCK TYPE	WEATHERING	CLAY CONTENT	COLOUR	ROCK CHIP HARDNESS	ROCK CHIP ORPHOLOGY	Comments
0	-	1.5	**F G Sand**			Light Grey			
1.5	-	3	**F G Sand**			Grey			
3	-	4.5	**F G Sand**			Light Grey			
4.5	-	6	**F G Sand**			Light Brow n			
6	-	7.5							
7.5	-	9							
9	-	11							
10.5	-	12							
12	-	14							
13.5	-	15	**F G Sand**			White			Shell Fragments
15	-	17							Shell Fragments
16.5	-	18							Shell Fragments

NOTES:								Rod	Pen rate
			OVB to				**Drilling:**	1	
			SW to					2	
								3	
COMMENTS:								4	
								5	
								6	



APPENDIX B

Hydrographs


Groundwater Levels GW1
Rainfall
GW1 Logger
GW1 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/01/1997
1/01/1998
1/01/1999
1/01/2000
1/01/2001
1/01/2002
1/01/2003
1/01/2004
1/01/2005
1/01/2006
1/01/2007
1/01/2008
1/01/2009
1/01/2010
1/01/2011
1/01/2012
1/01/2013
1/01/2014
1/01/2015
1/01/2016
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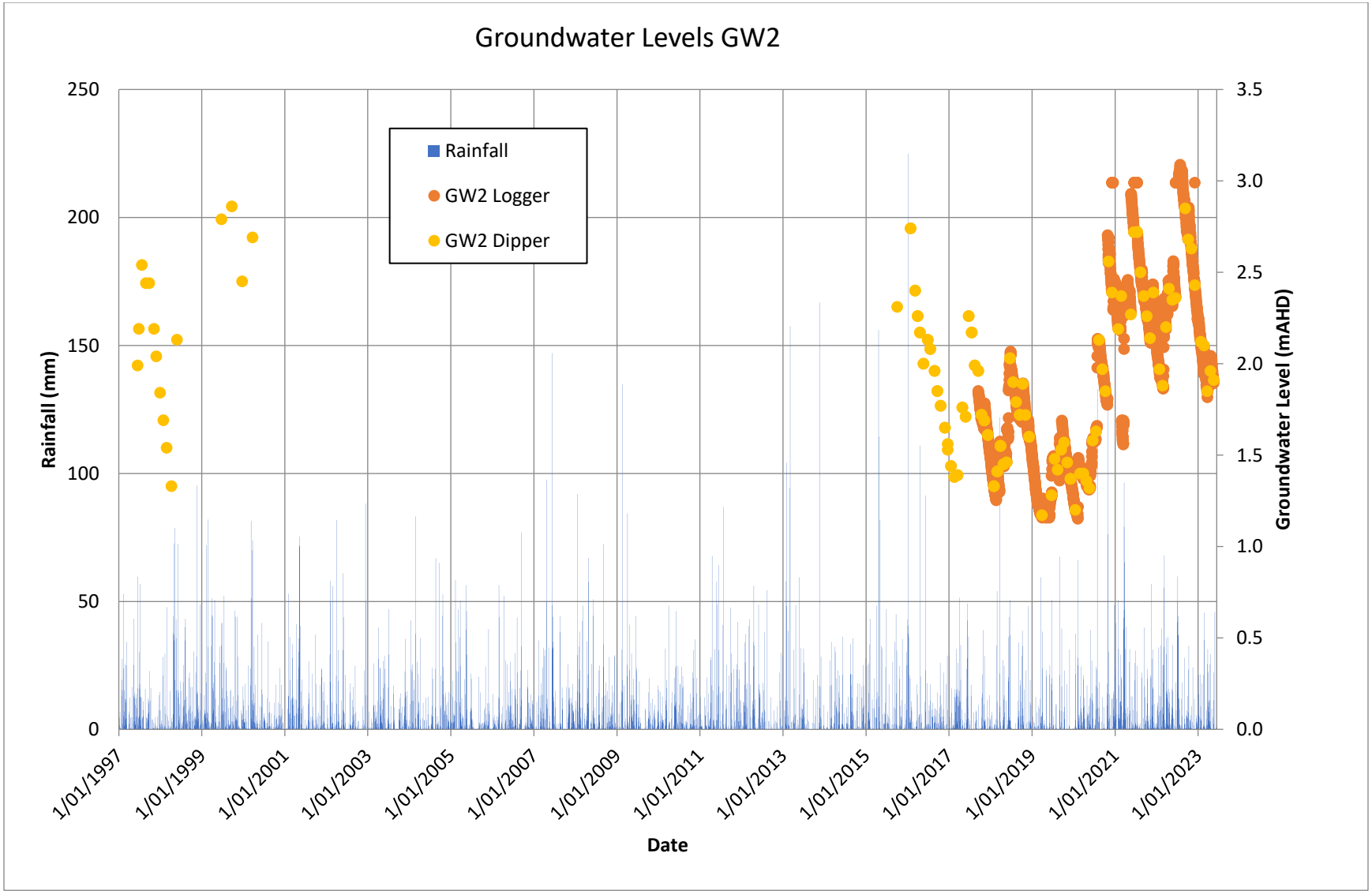
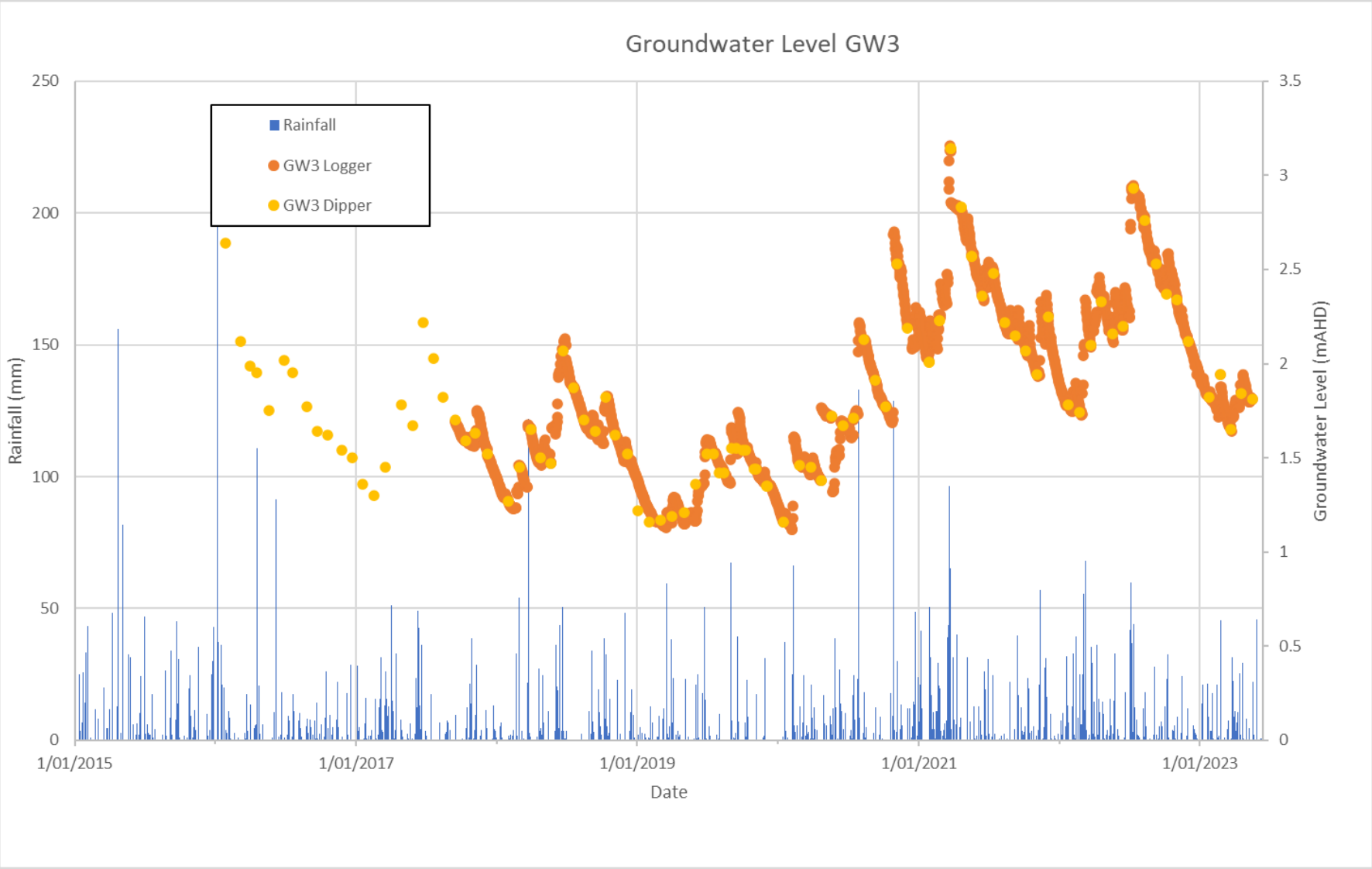
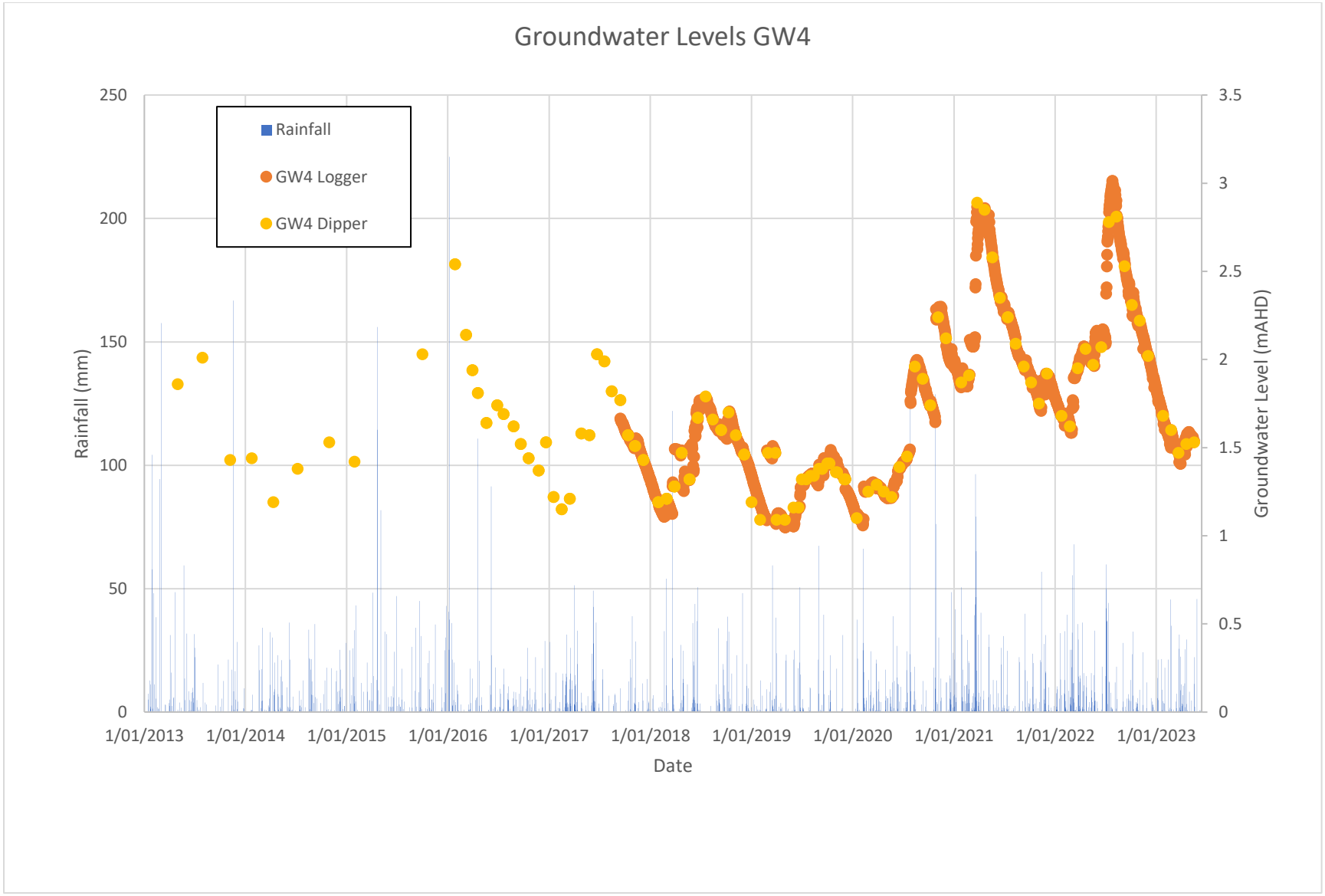
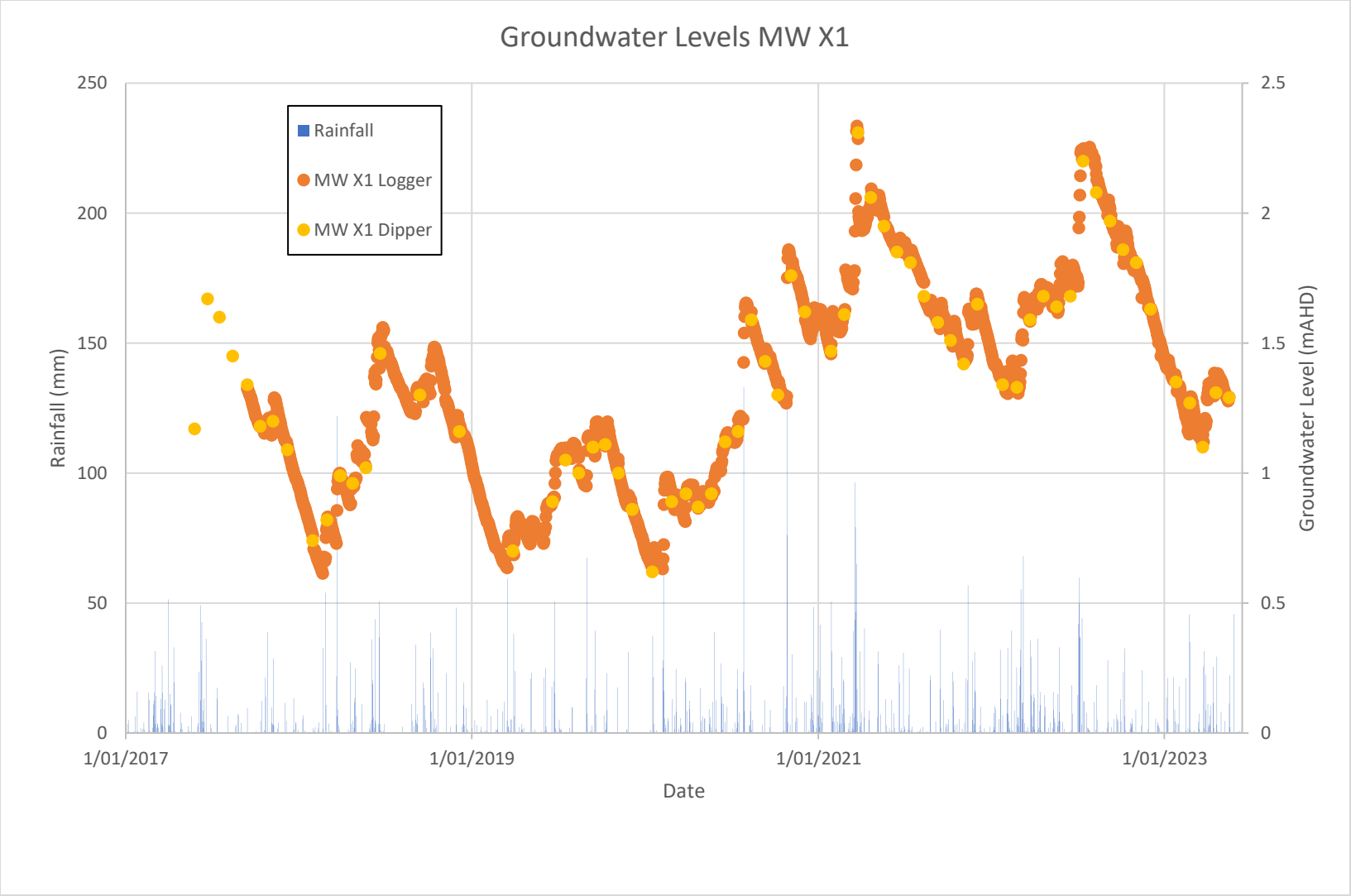
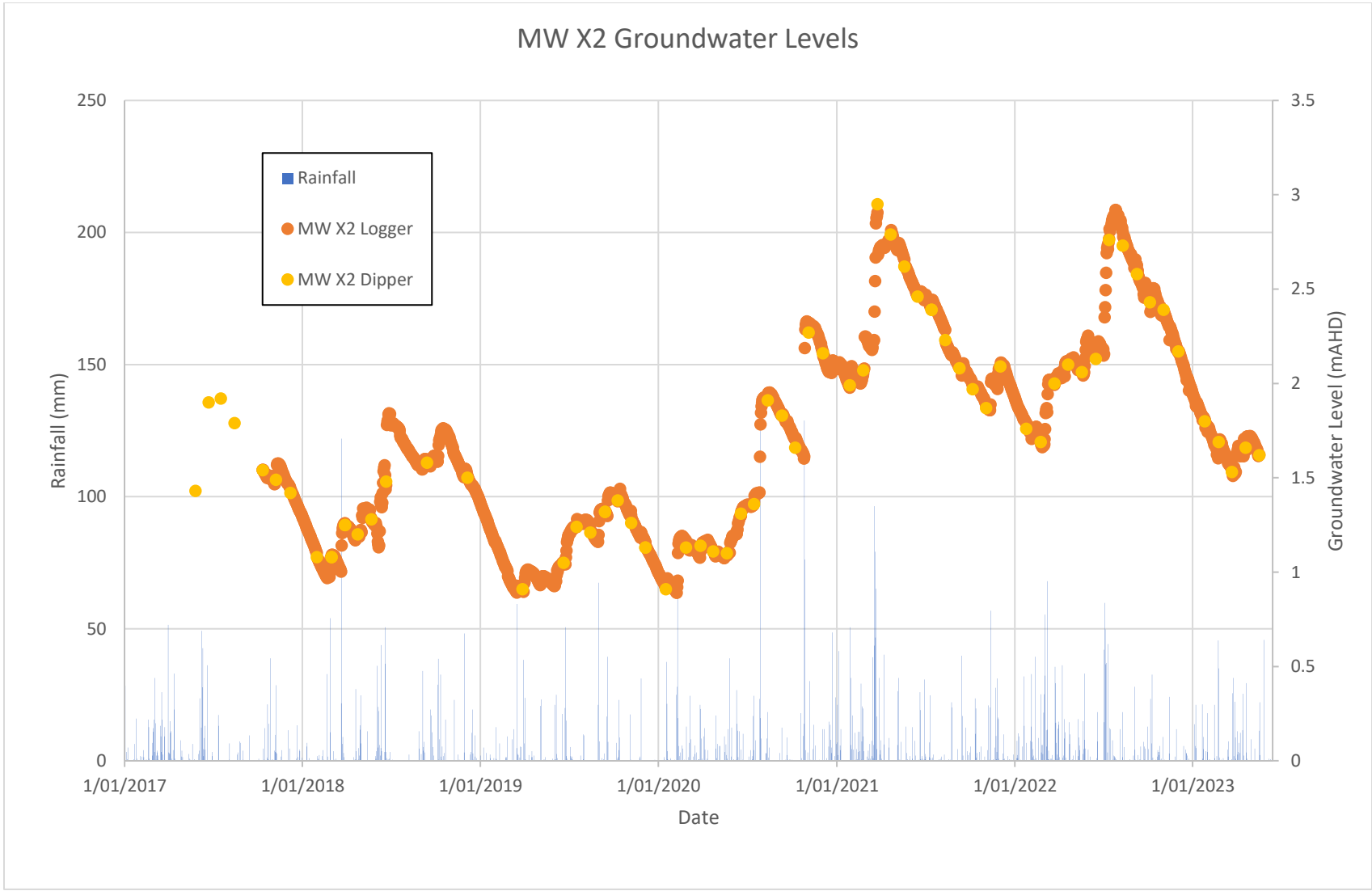
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023

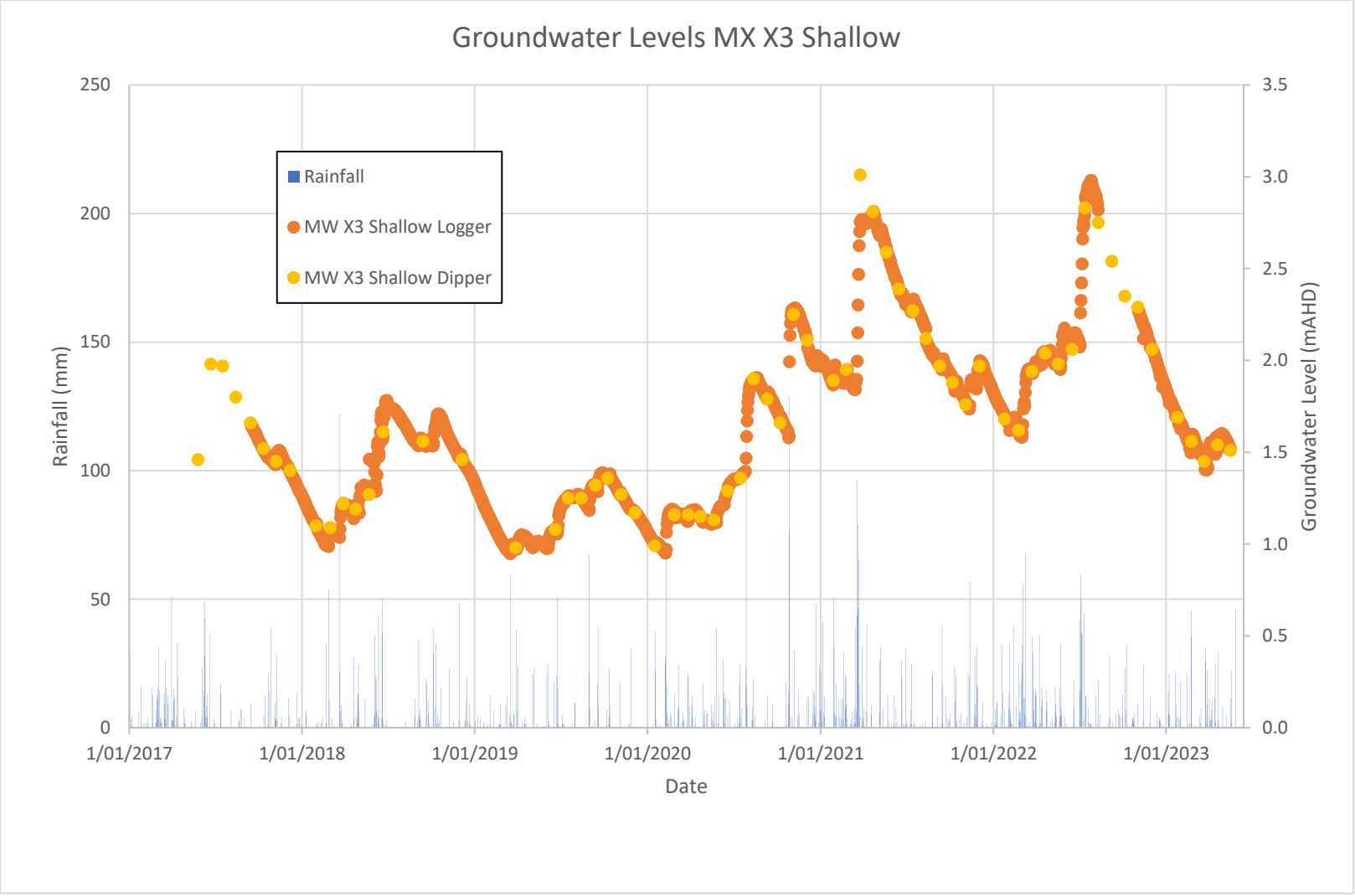

Groundwater Levels GW2
Rainfall
GW2 Logger
GW2 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/01/1997
1/01/1999
1/01/2001
1/01/2003
1/01/2005
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023

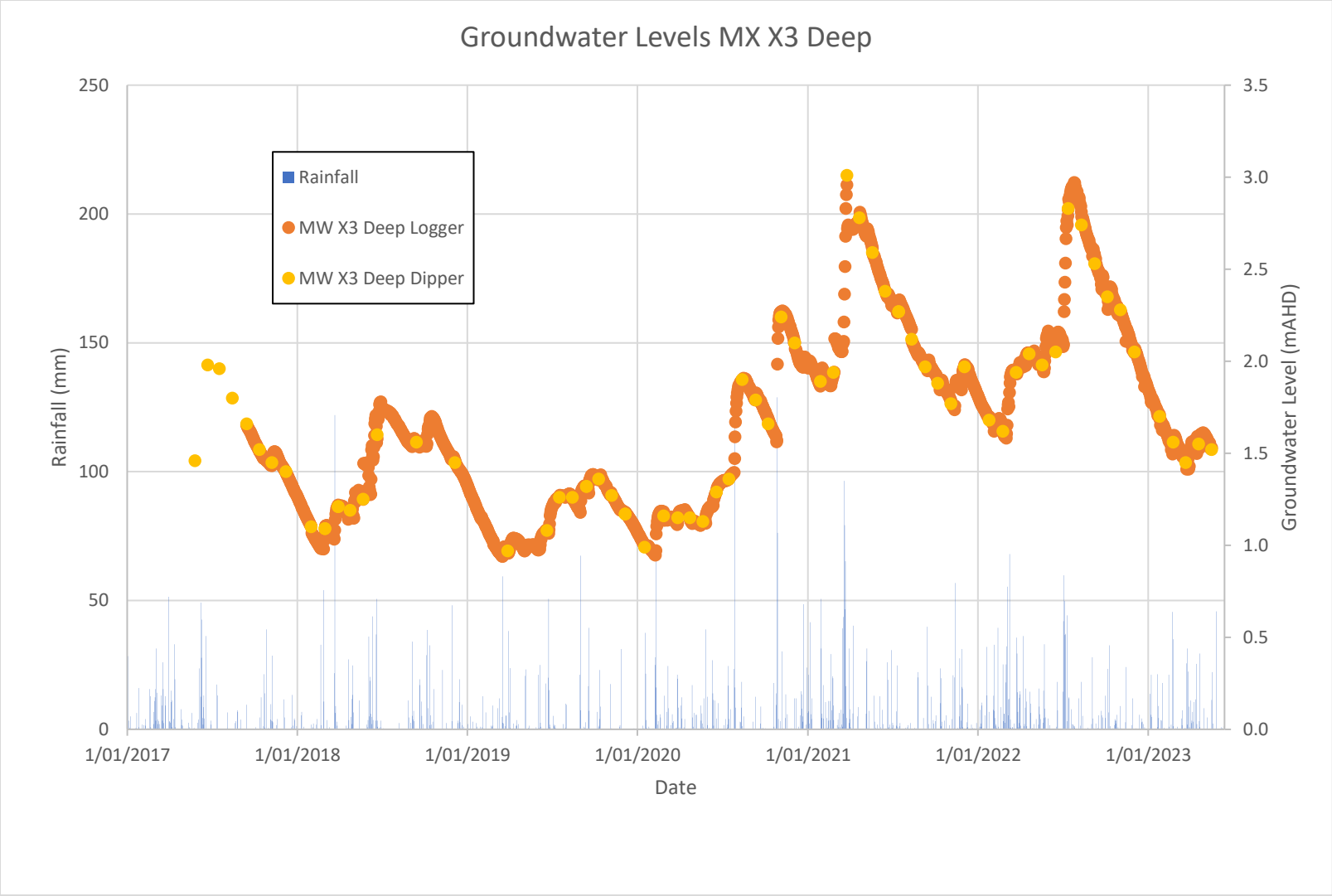

Groundwater Level GW3
Rainfall
GW3 Logger
GW3 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023

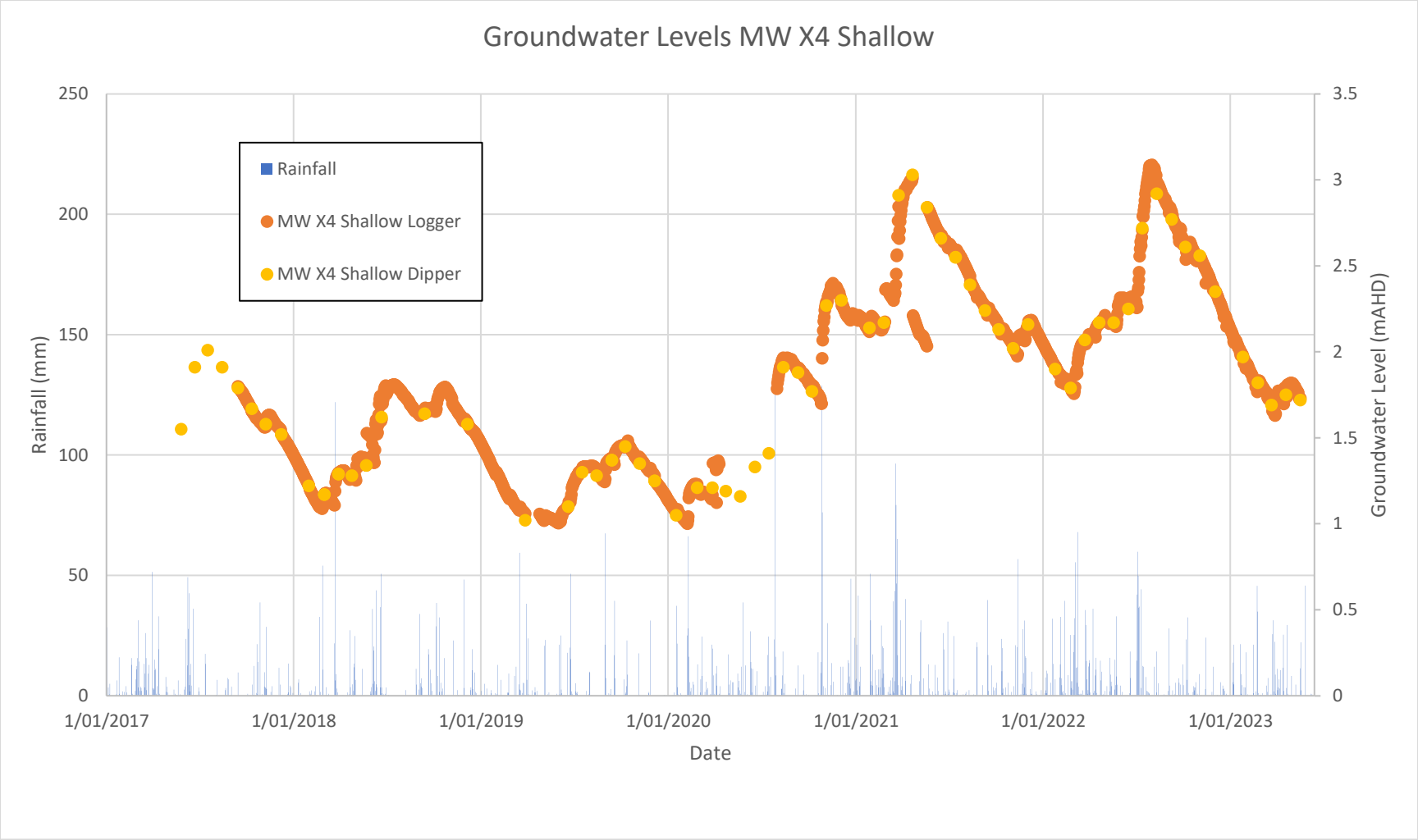

Groundwater Levels GW4
Rainfall
GW4 Logger
GW4 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2013
1/01/2014
1/01/2015
1/01/2016
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023


Groundwater Levels MW X1
Rainfall
MW X1 Logger
MW X1 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
2.5
2
1.5
1
0.5
0
1/01/2017
1/01/2019
1/01/2021
1/01/2023


MW X2 Groundwater Levels
Rainfall
MW X2 Logger
MW X2 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023


Groundwater Levels MX X3 Shallow
Rainfall
MW X3 Shallow Logger
MW X3 Shallow Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023


Groundwater Levels MX X3 Deep
Rainfall
MW X3 Deep Logger
MW X3 Deep Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023


Groundwater Levels MW X4 Shallow
Rainfall
MW X4 Shallow Logger
MW X4 Shallow Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
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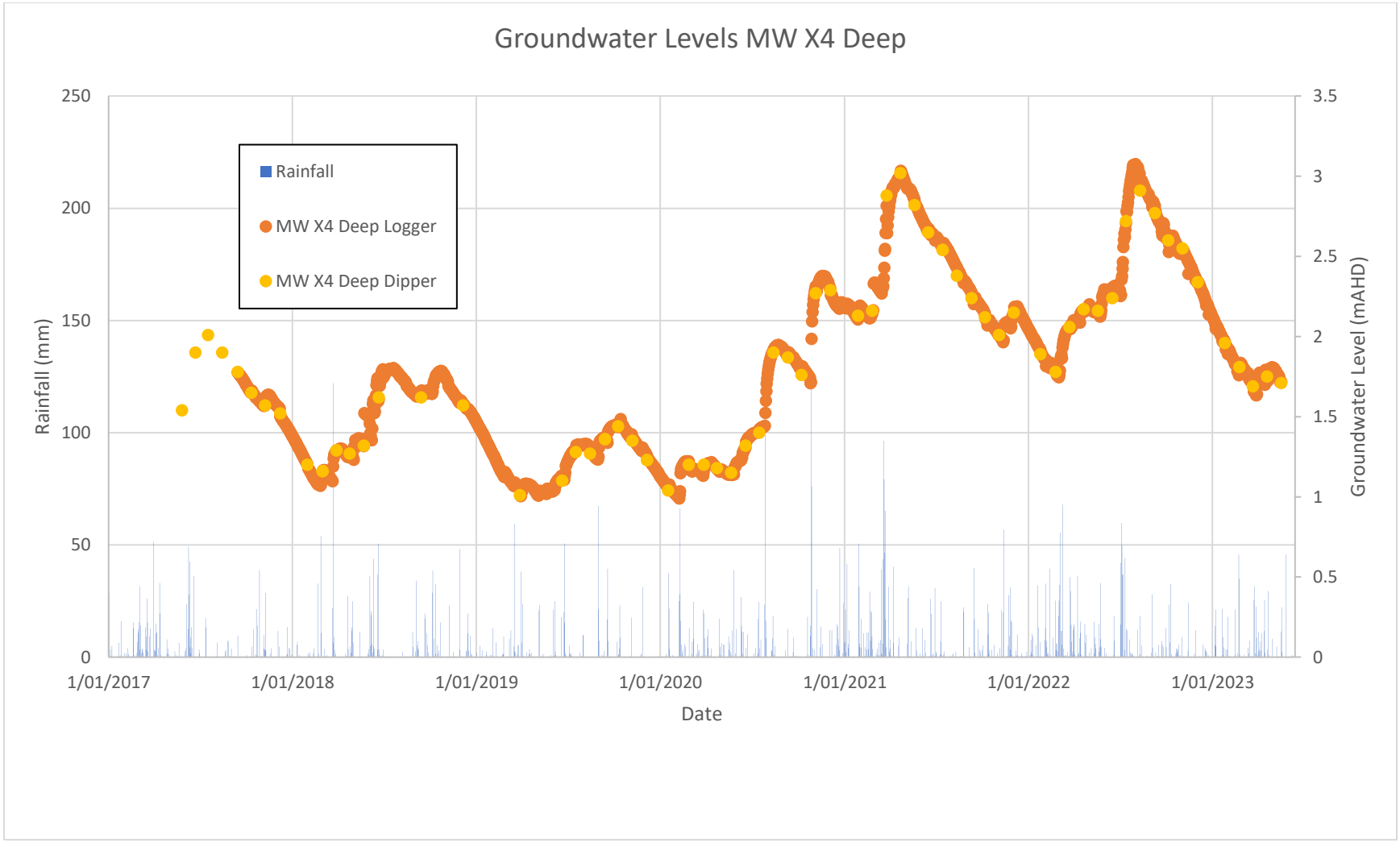
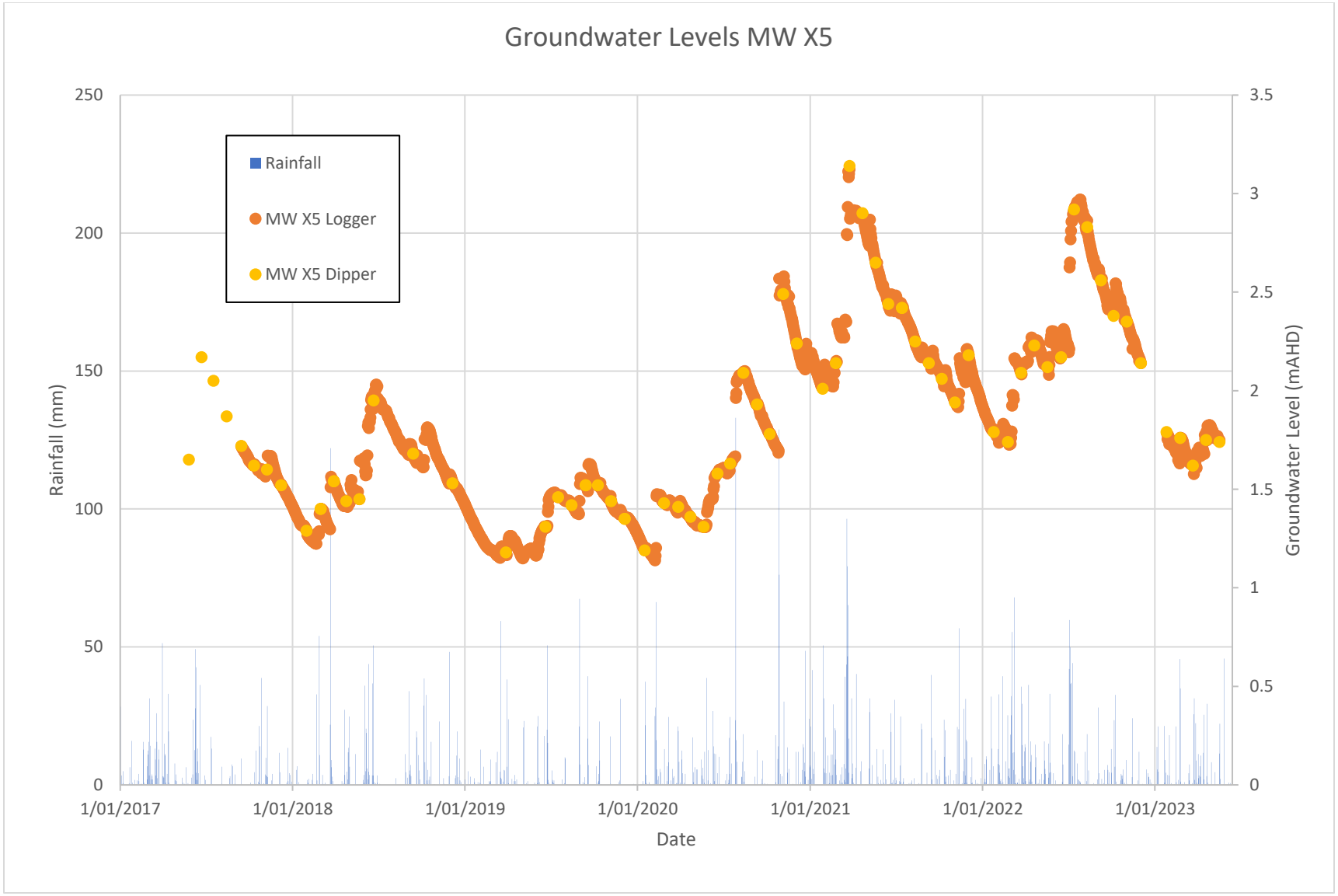
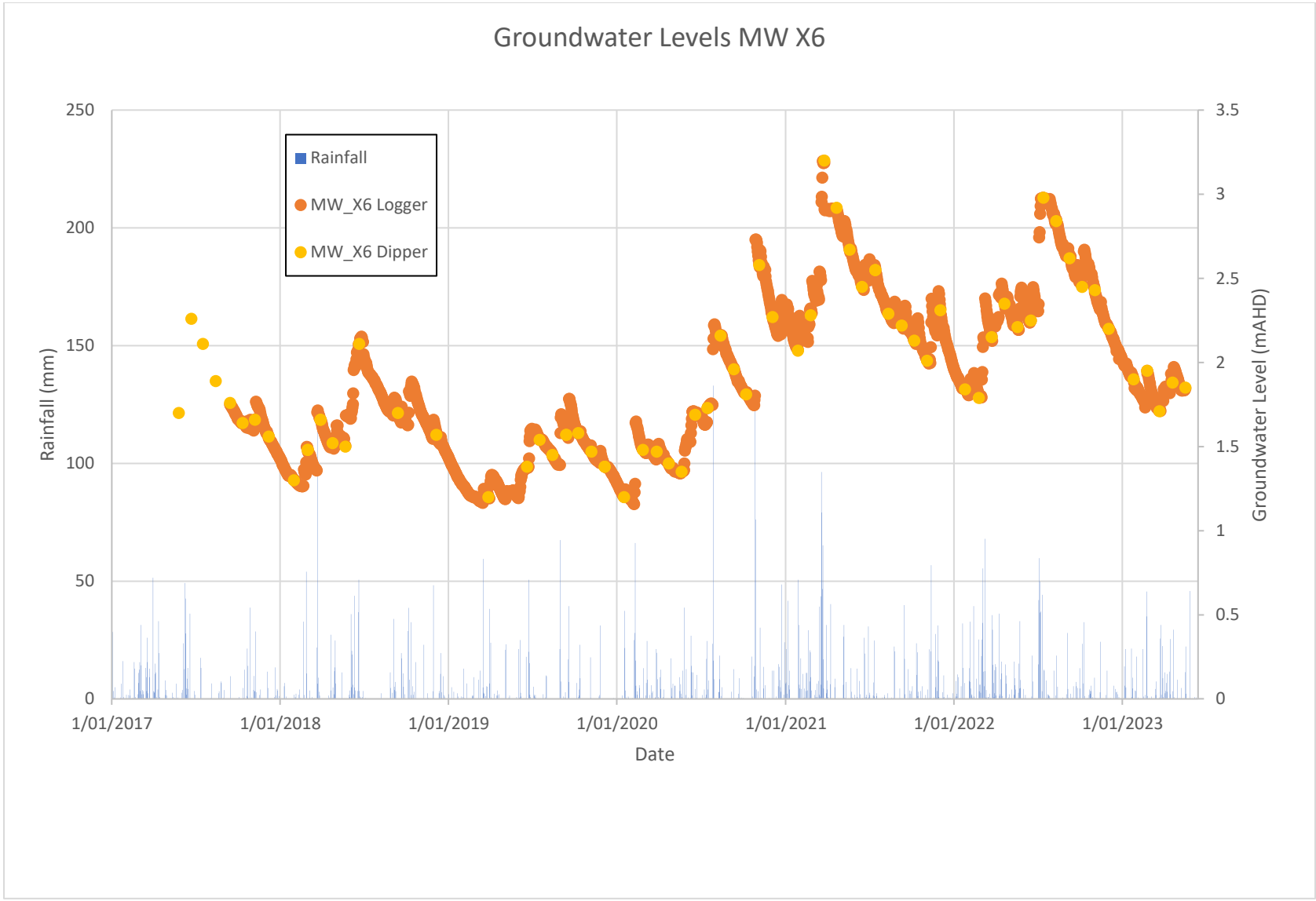
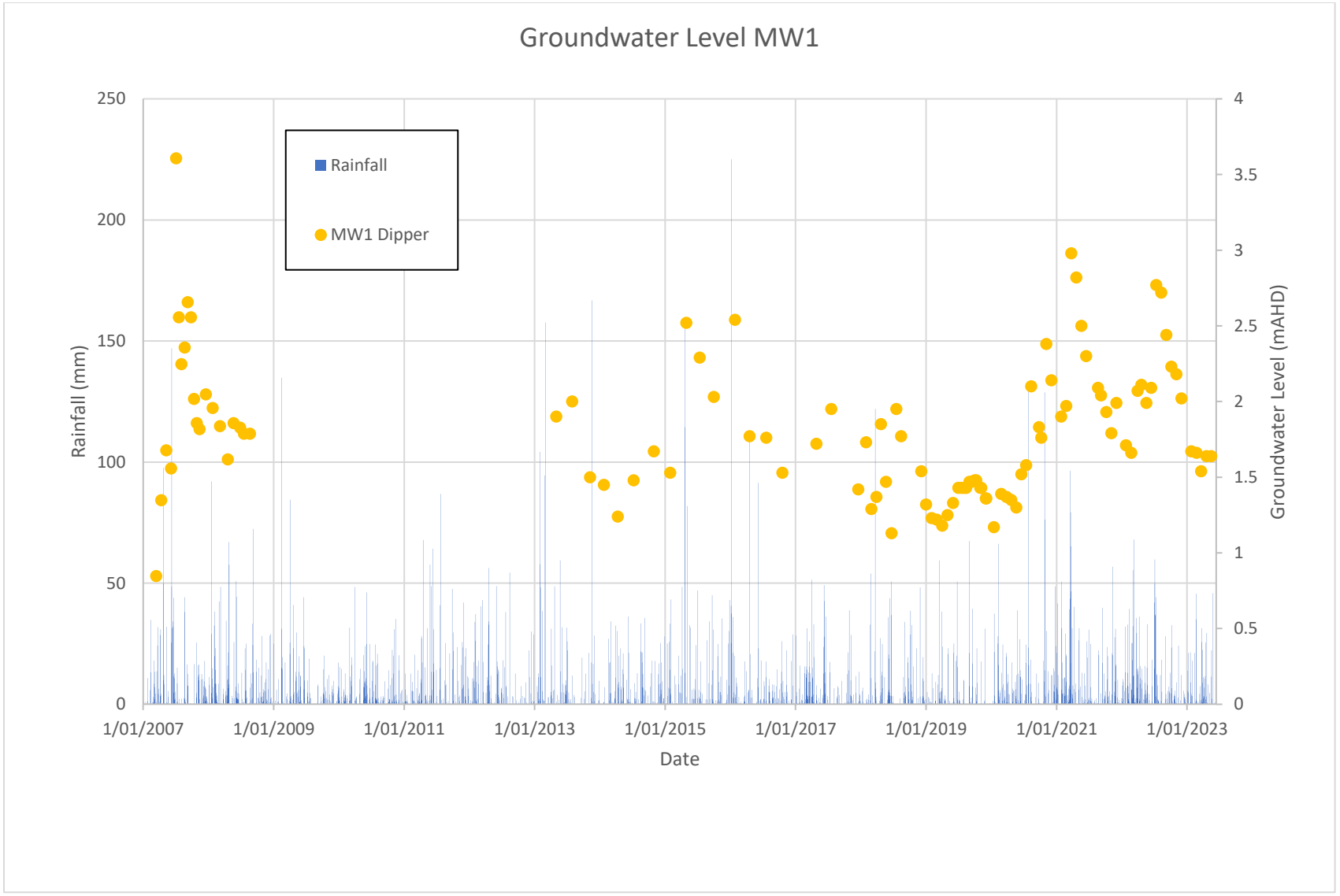
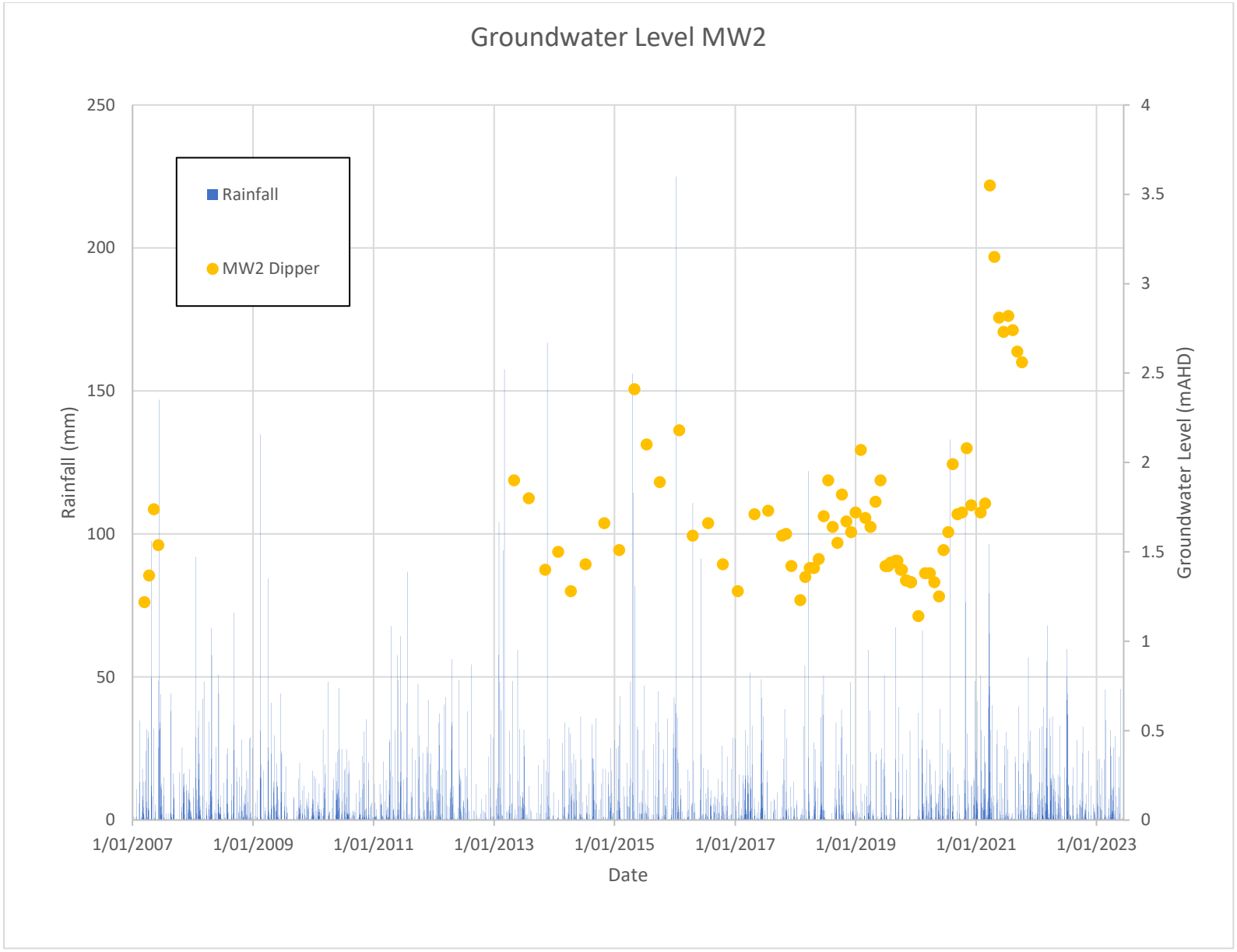
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023

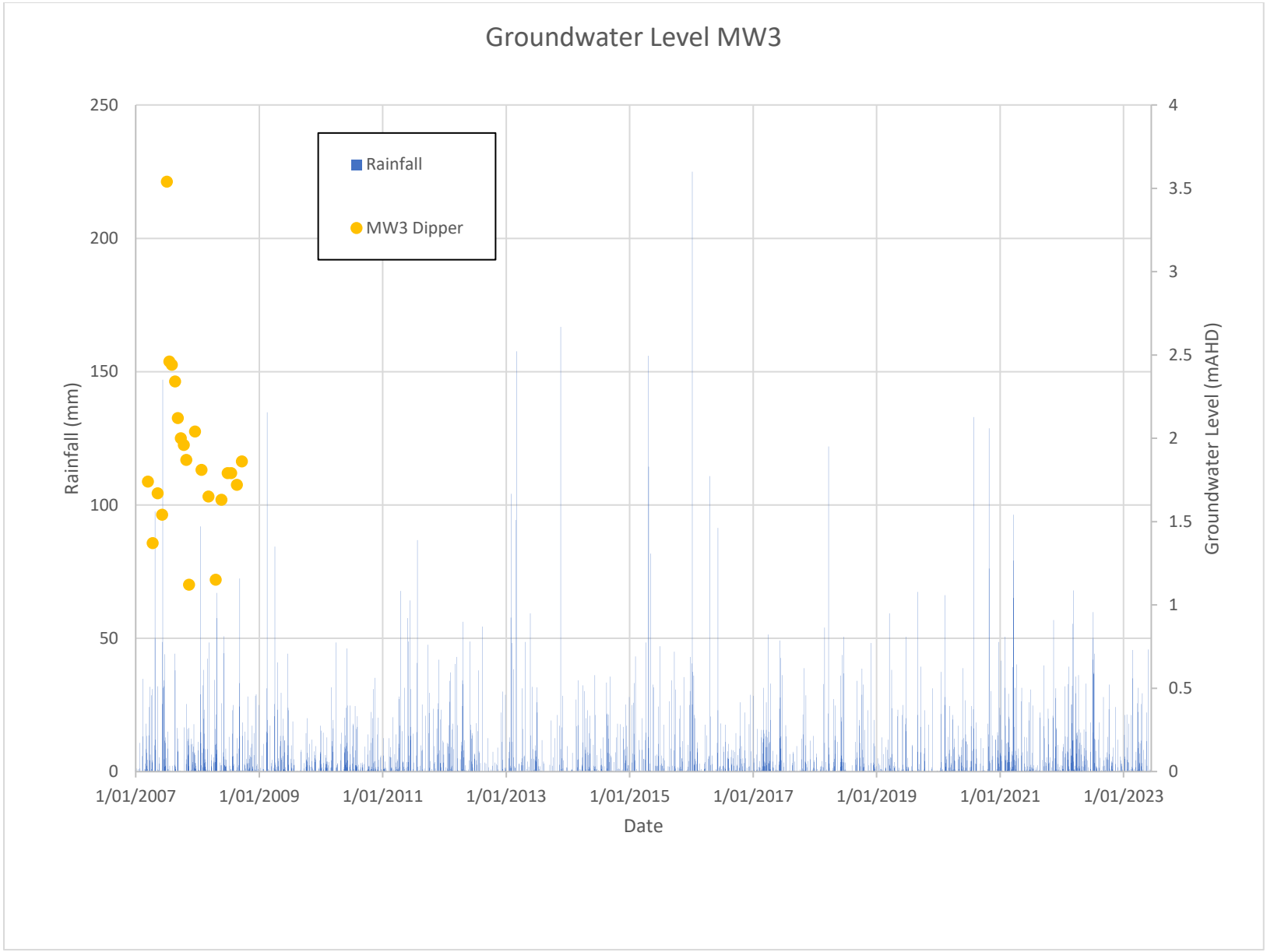

Groundwater Levels MW X4 Deep
Rainfall
MW X4 Deep Logger
MW X4 Deep Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023

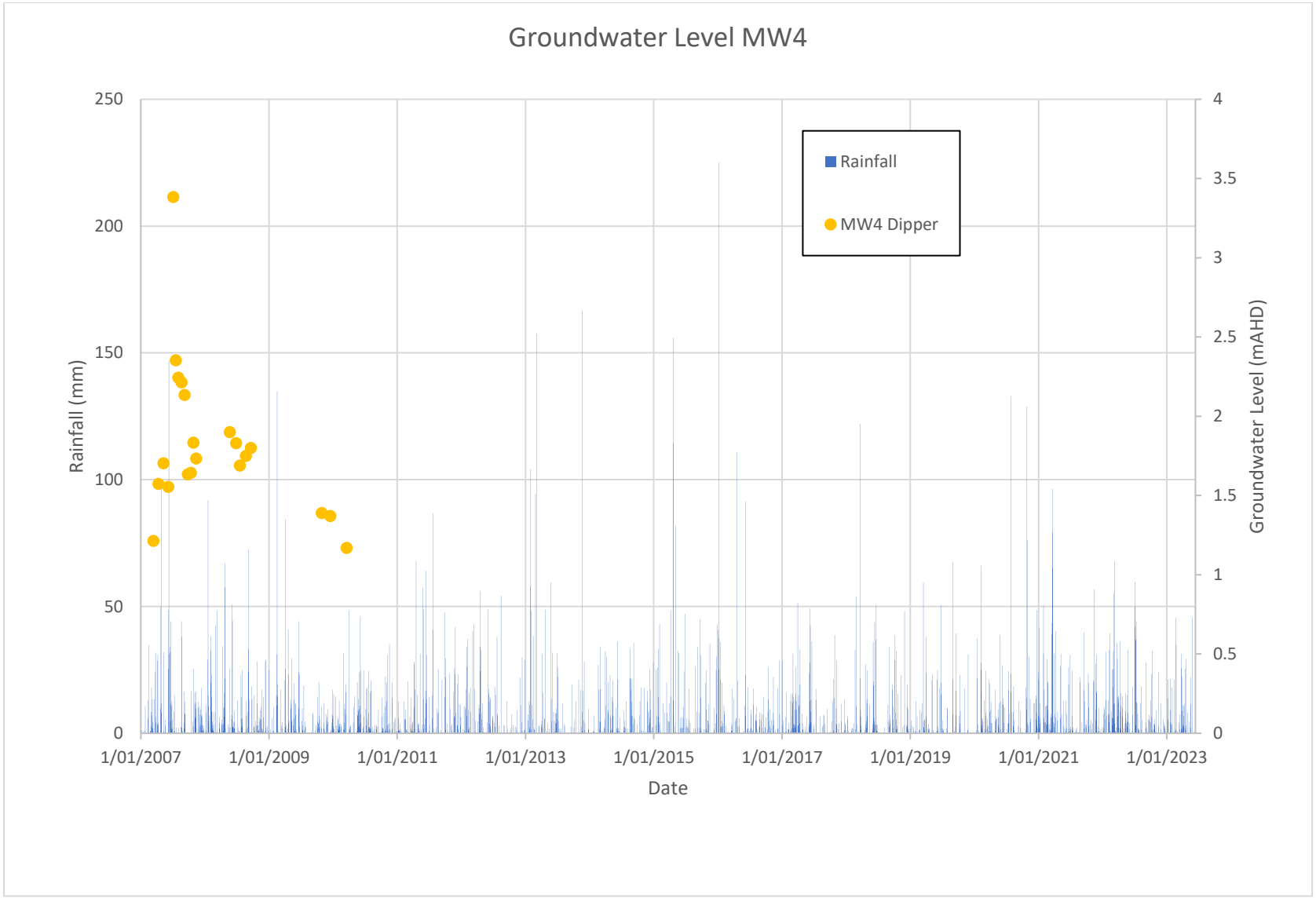

Groundwater Levels MW X5
Rainfall
MW X5 Logger
MW X5 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023

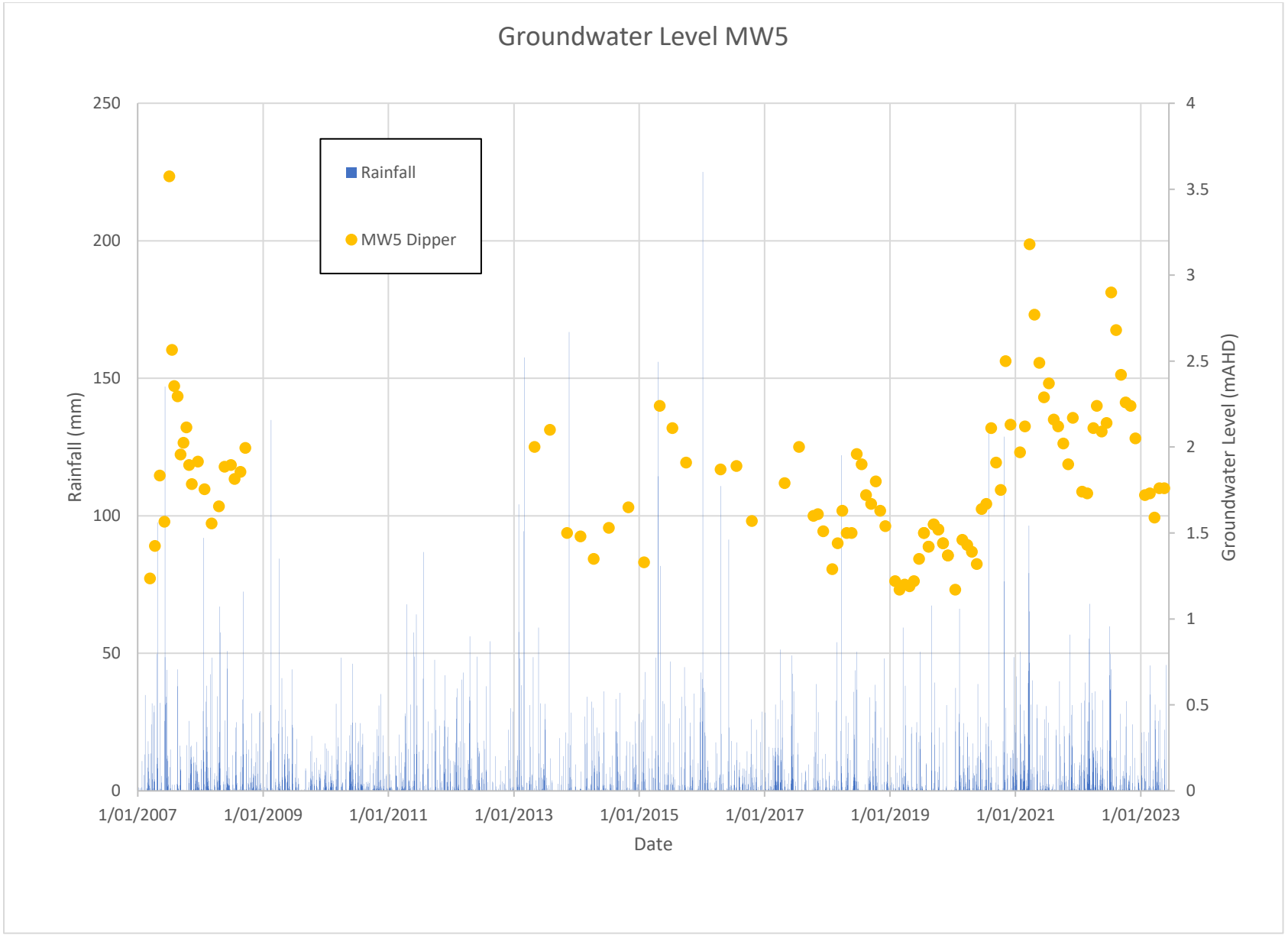

Groundwater Levels MW X6
Rainfall
MW_X6 Logger
MW_X6 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2017
1/01/2018
1/01/2019
1/01/2020
1/01/2021
1/01/2022
1/01/2023

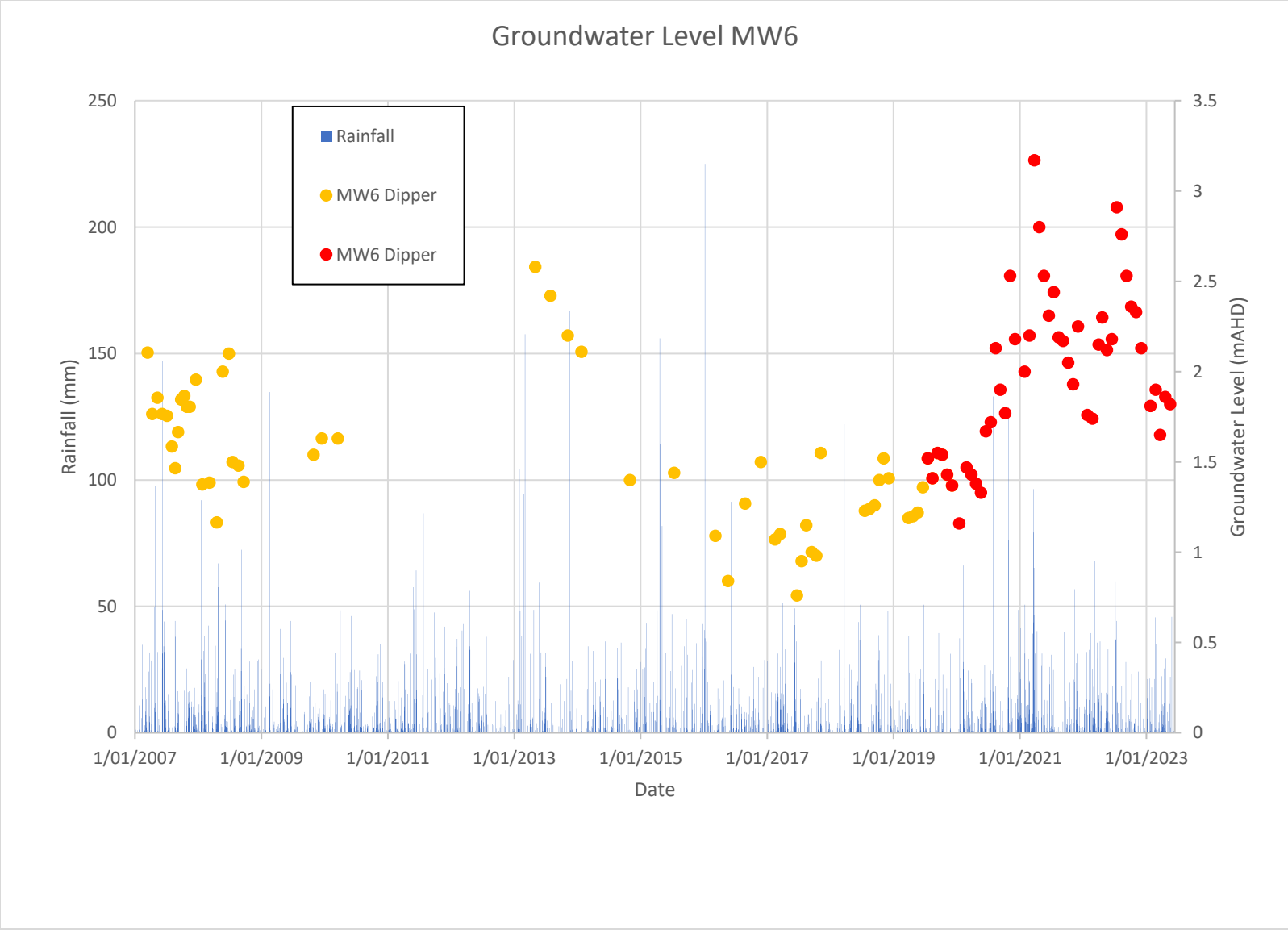

Groundwater Level MW1
Rainfall
MW1 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023

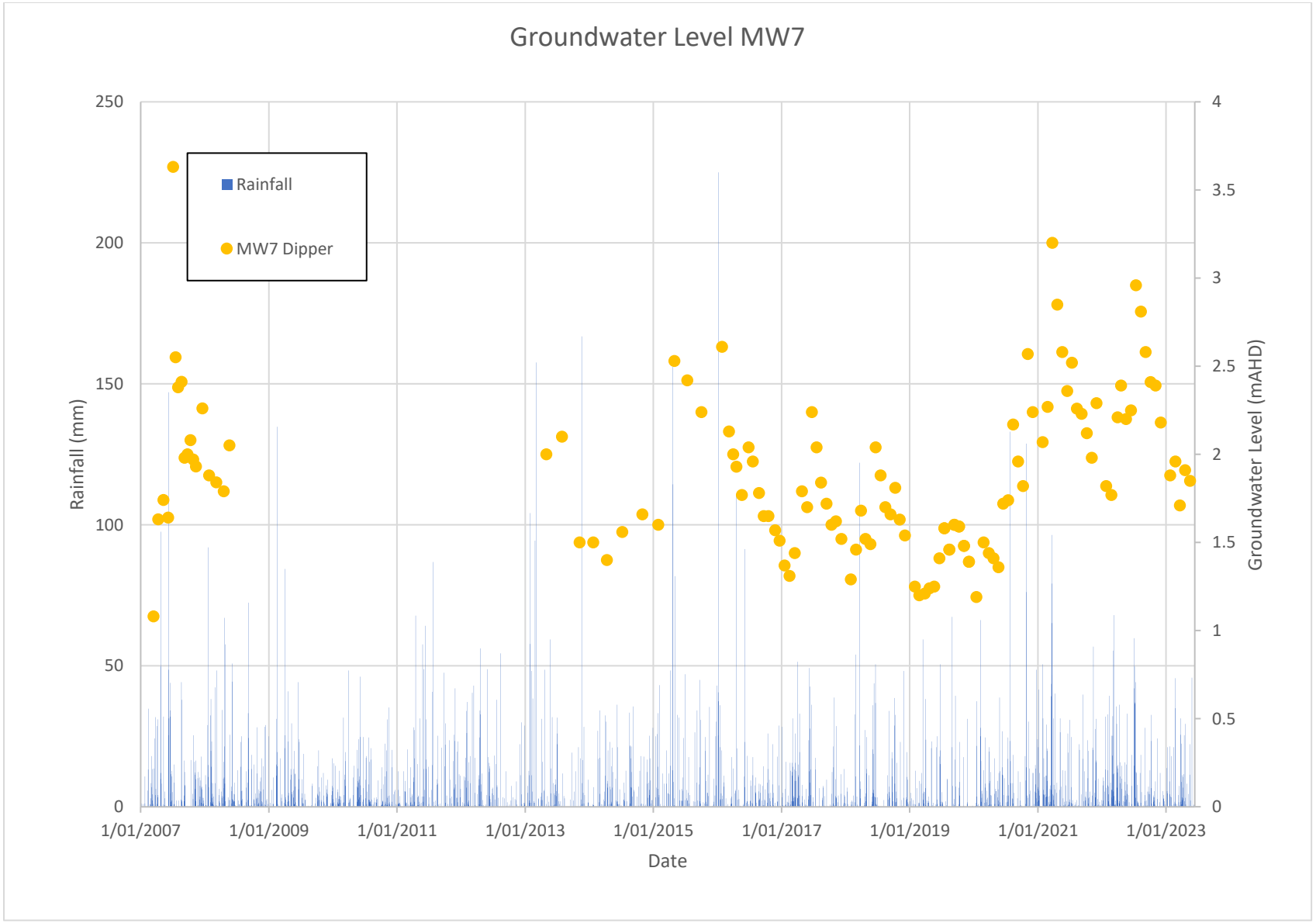

Groundwater Level MW2
Rainfall
MW2 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023

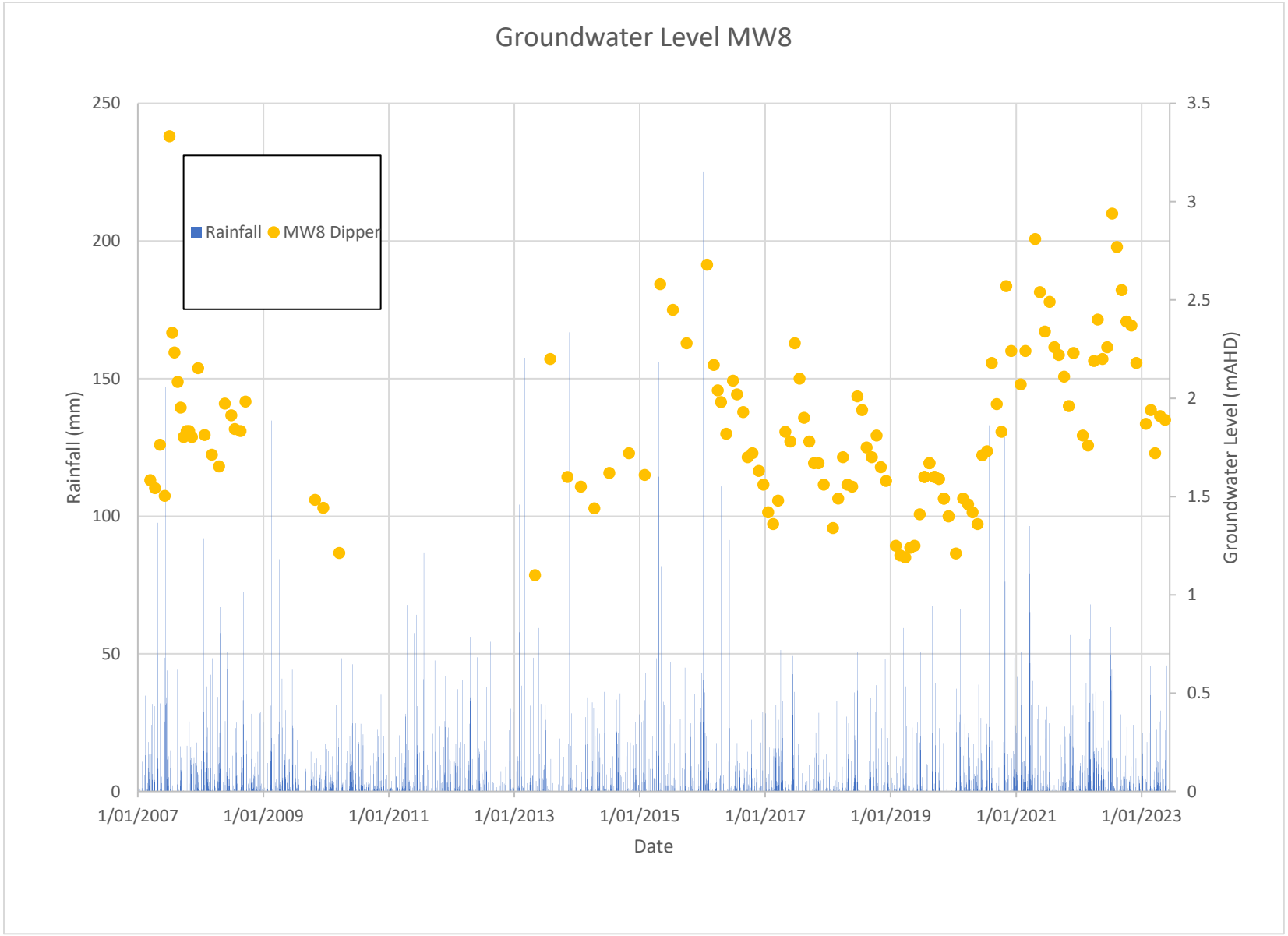

Groundwater Level MW3
Rainfall
MW3 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023


Groundwater Level MW4
Rainfall
MW4 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023


Groundwater Level MW5
Rainfall
MW5 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023


Groundwater Level MW6
Rainfall
MW6 Dipper
MW6 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023


Groundwater Level MW7
Rainfall
MW7 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
250
200
150
100
50
0
4
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023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Rainfall
MW8 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
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200
150
100
50
0
3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
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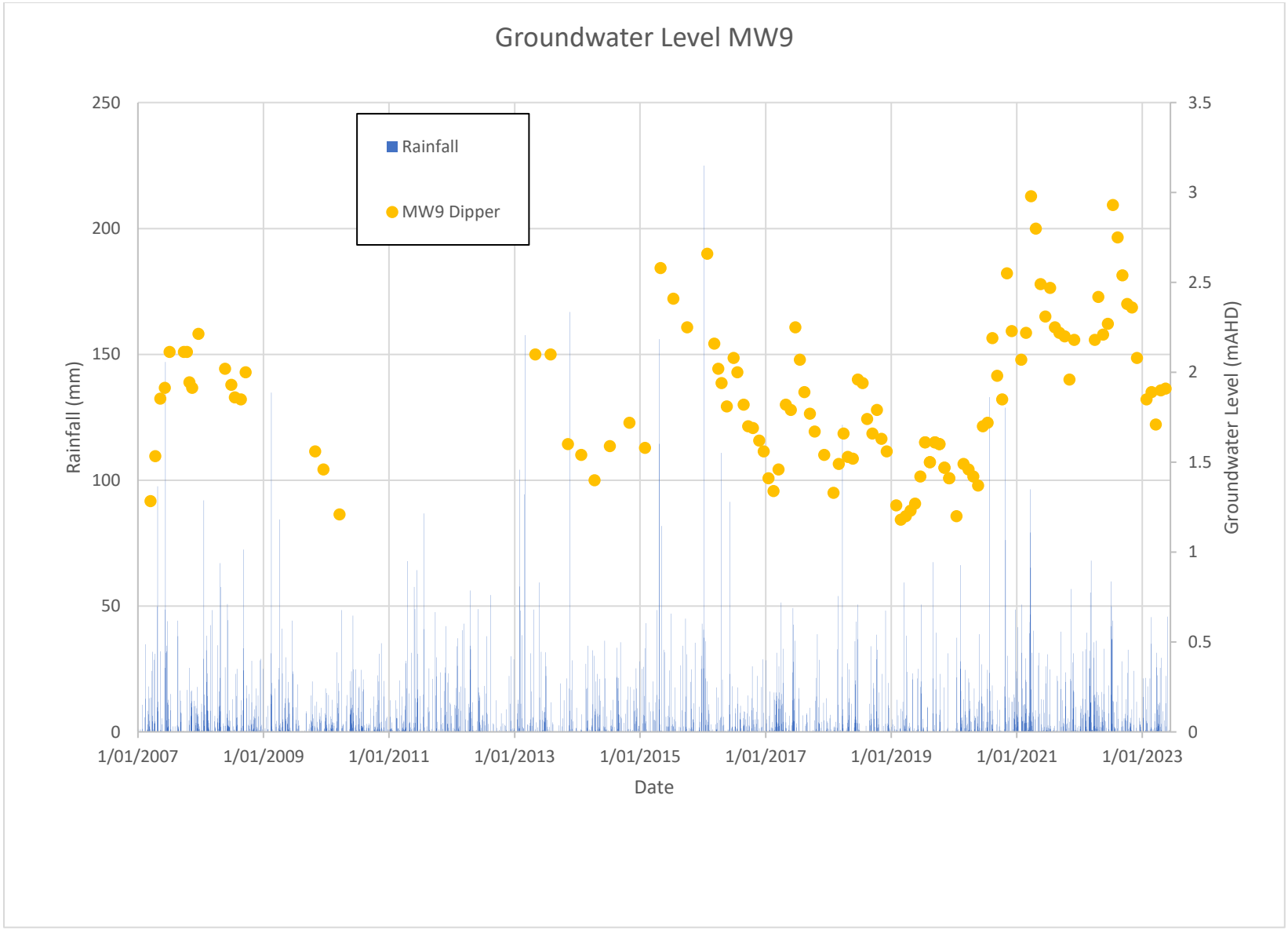
1/01/2023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Rainfall
MW9 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
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200
150
100
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3.5
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
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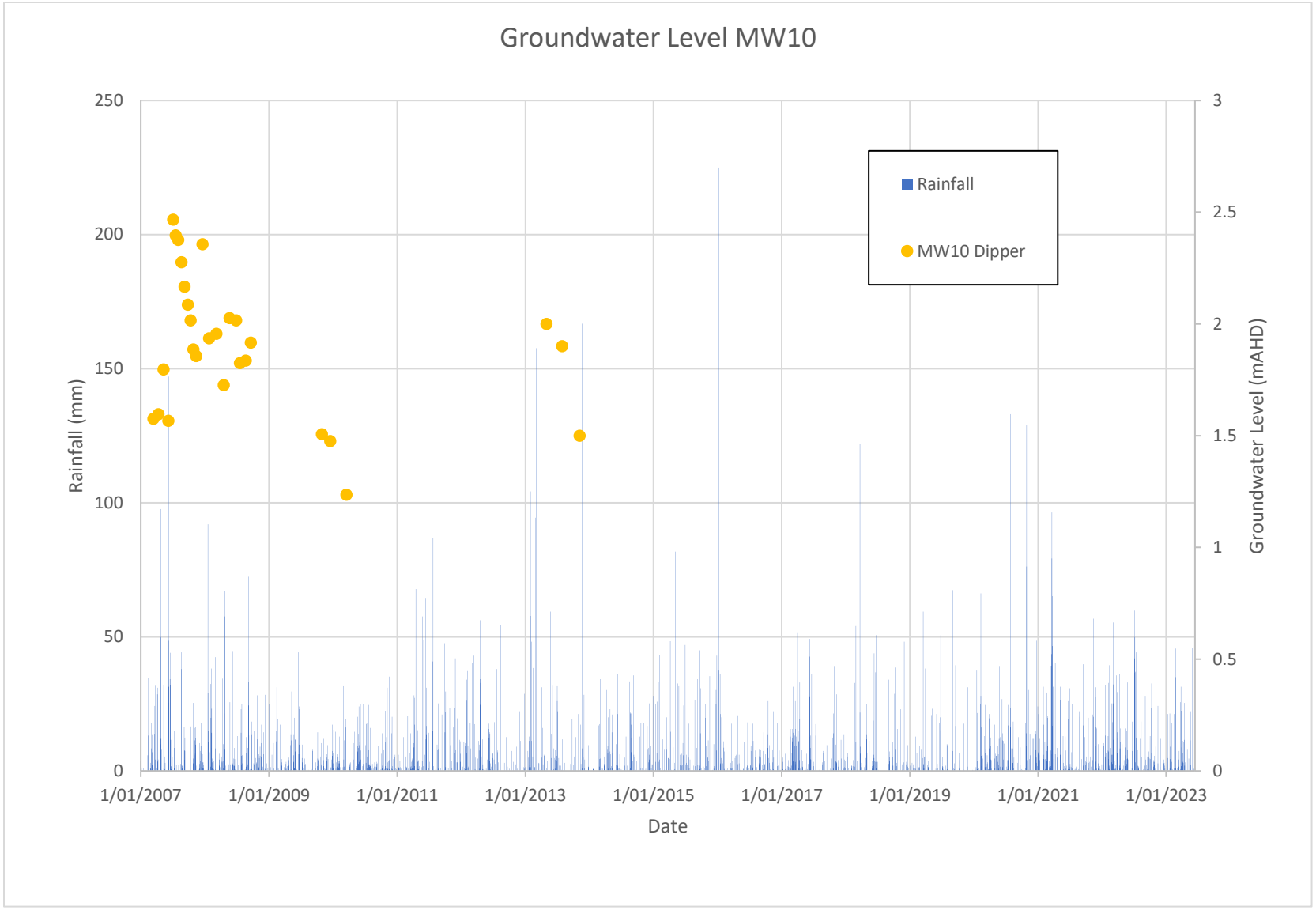
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023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Rainfall
MW10 Dipper
Rainfall (mm)
Groundwater Level (mAHD)
Date
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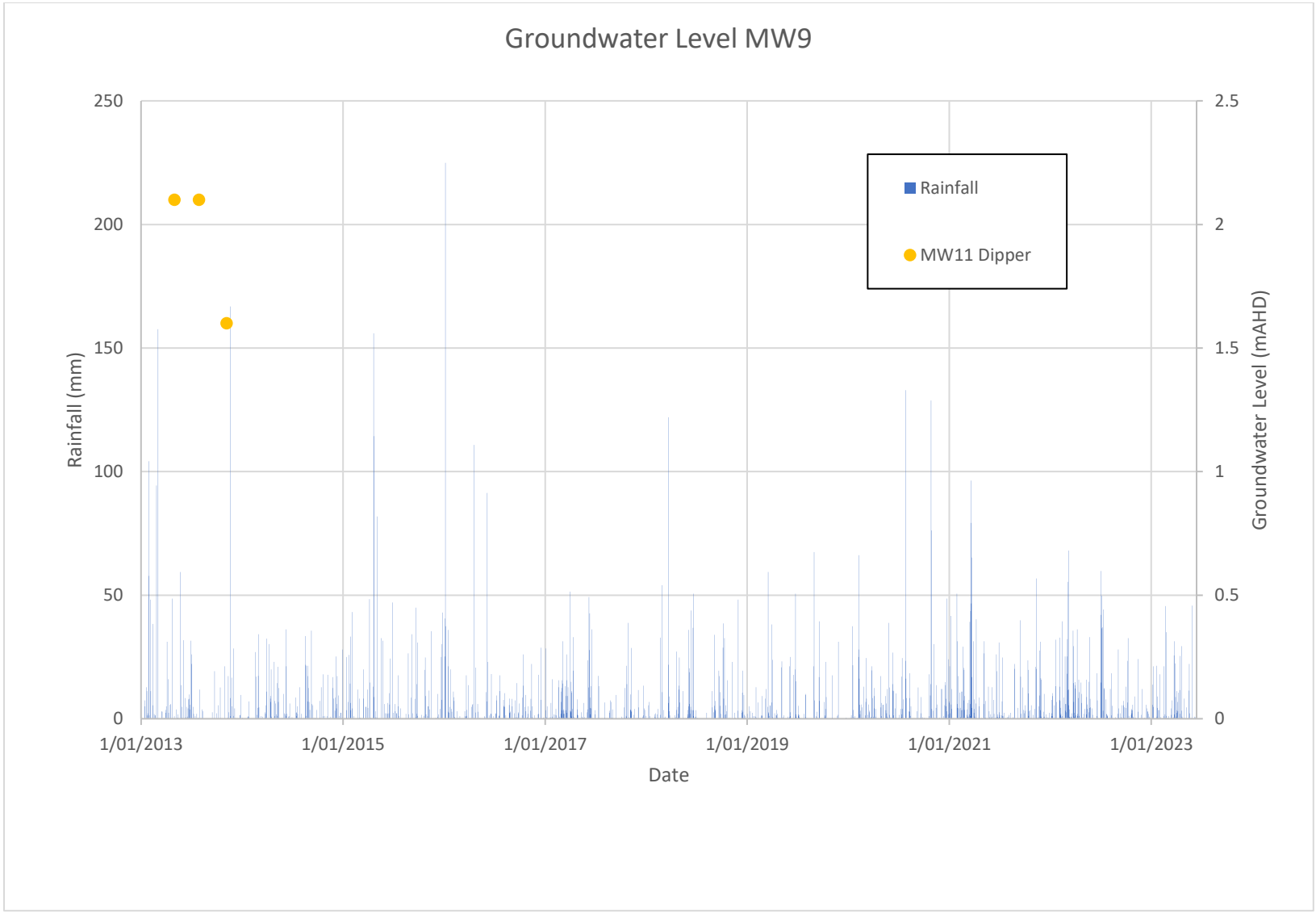
200
150
100
50
0
3
2.5
2
1.5
1
0.5
0
1/01/2007
1/01/2009
1/01/2011
1/01/2013
1/01/2015
1/01/2017
1/01/2019
1/01/2021
1/01/2023


Groundwater Level MW9
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200
150
100
50
0
Rainfall (mm)
2.5
2
1.5
1
0.5
0
Groundwater Level (mAHD)
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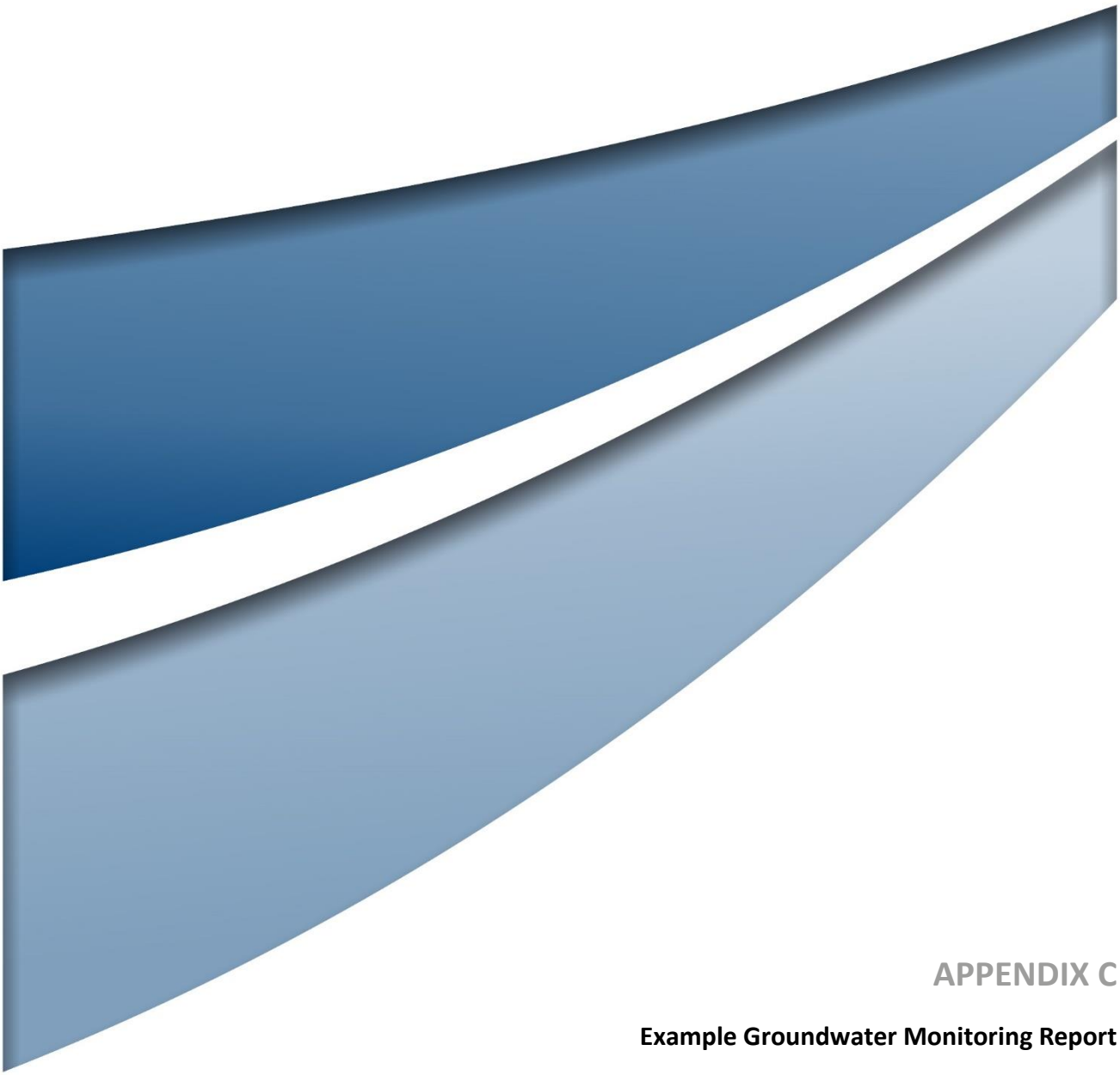
Date
Rainfall
MW11 Dipper



APPENDIX C

Example Groundwater Monitoring Report

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30 March 2023

Attention: Caiden O'Connor
RW Corkery & Co
By email

Project Name: Stockton Sand Quarry
Project Number: IA133802

Subject: Groundwater assessment for 2022 AEMR

Dear Caiden,

This letter report has been prepared on behalf of Boral Resources (NSW) Pty Ltd ("Boral") to provide a review of the results of groundwater and surface water monitoring at Boral's NSW Stockton Sand Quarry (the Quarry) between 1 January 2022 and 31 December 2022 (the "reporting period").

The report is intended to support the Annual Environmental Management Report (AEMR) for the Quarry, prepared in accordance with Development Consent DA No. 140-6-2005 ("DA 140-6-2005") *Condition 4 (3).*

1. Quarry background

The development consent for the Quarry was granted on 24 January 2006 and was amended in May 2006 and again in June 2011. The Quarry commenced operations on 15 October 2008 and involves the extraction of windblown sand from the unsaturated zone of the Stockton sand dunes.

Historic heavy mineral sand extraction operations have previously occurred in the area dating back to 1976, including within the backdune and foredune areas.

The Quarry area is located within the Stockton Groundwater Source of the Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016. The Quarry activities are not regulated under this Water Sharing Plan as the Quarry does not intercept or extract groundwater.

2. Relevant development consent conditions

Groundwater within the Quarry is monitored in accordance with the approved groundwater monitoring program (see Section 3) and utilises the current groundwater monitoring network (Figure 1, Appendix A) to collect data for analysis and subsequent inclusion within the AEMR.

DA 140-6-2005, *Condition 3 (12)* states:

The Groundwater Monitoring Program shall include:

a) Detailed baseline data on groundwater levels, flows and quality, based on statistical analysis, to benchmark the pre-quarrying natural variation in groundwater levels and quality;

b) Groundwater impact assessment criteria; and

c) A program to monitor groundwater levels and quality

The Environment Protection Licence (No. 10132) for the Quarry does not specify any groundwater monitoring but outlines in *Condition L1.1* that the licensee must comply with Section 120 of the *Protection of the Environment Operations Act (1997)* (based upon no specific water quality limit conditions).

3. Groundwater monitoring program

3.1 Overview

A groundwater monitoring program (GWMP) was first prepared for the Quarry in 2008 (ERM, 2008). Numerous subsequent revisions have been undertaken (ERM, 2010, RPS Aquaterra, 2011, RPS, 2014, and RPS, 2015). However, up until March 2020, the original 2008 GWMP remained the only document to have been formally approved by the NSW Department of Planning, Industry and Environment (DoPIE) or its predecessor departments. In March 2020, the NSW DoPIE approved an updated GWMP prepared by Jacobs (2019) (the 2019 GWMP).

The 2022 groundwater monitoring data has been assessed in accordance with the 2019 GWMP.

The 2019 GWMP documents baseline groundwater data and trigger levels based on a ten year data period (2007 to 2017). The purpose of the baseline data was to represent groundwater level and quality conditions which have not been altered due to quarrying. The purpose of the trigger levels was to provide quantitative limits, that if exceeded during future groundwater monitoring rounds, would prompt the results to be confirmed and reported to agencies and be assessed by an independent hydrogeologist / environmental scientist.

The baseline data period included data collected after commencement of quarrying in 2008 as at the time of the 2019 GWMP, no groundwater impacts due to quarrying had been identified. It was therefore considered that groundwater data collected throughout the entire ten year period was representative of baseline conditions.

It is noted that the 2019 GWMP outlines water quality monitoring for four surface water sites to monitor conditions in the vicinity of groundwater dependent ecosystems (GDEs). This surface water quality monitoring was adopted from a Surface Water Management Plan prepared by Boral (2018).

3.2 Groundwater monitoring network

With the exception of MW2 and MW11, the groundwater monitoring network, as documented in the 2019 GWMP, is summarised in Table 1. MW11 was reported as destroyed in the 2020 review of groundwater data (Jacobs, 2020). MW2 was found to have been destroyed by a vehicle sometime during October 2021. The current monitoring network is shown in Figure 1, Appendix A. The historic groundwater monitoring network is also included in Table 1 and is shown in Figure 2, Appendix A.

Despite MW2 and MW11 being destroyed, the current monitoring network is considered suitable. It is noted that there is now a substantial monitoring gap between MW1 and MW5, however with the lack of historical impacts due to quarrying and the low risk of future impacts, reduced monitoring bore frequency is not considered to pose a significant risk.

Table 1: Stockton Sand Quarry groundwater monitoring network

Location ID	Easting (MGA94)	Northing (MGA94)	Elevation (m AHD)	Depth (mBGL)	Screened Interval (mBGL)	Status
Current groundwater monitoring network – Figure 1, Appendix A						
MW1	391032.68	6364177.29	4.41	25	19 – 25	Active
MW5	391588.87	6364388.10	4.89	8	2 – 8	Active
MW6	391781.34	6364527.27	3.51	8	2 – 8	Active
MW7	392042.74	6364700.52	4.03	8	2 – 8	Active
MW8	392242.75	6364807.46	2.98	8	2 – 8	Active
MW9	392413.71	6364895.09	5.50	8	2 – 8	Active
GW1	391421	6364854	3.0	N/A	N/A	Active
GW2	392028.71	6365103.30	2.99	N/A	N/A	Active
GW3	391884.98	6364614.76	4.00	N/A	N/A	Active
GW4	390446.05	6364167.1/	3.86	N/A	N/A	Active
Historical groundwater monitoring network - Figure 2, Appendix A						
MW1	391128	6364095	21.7	22.7	19.7 – 22.7	Destroyed
MW2 (most recent, included in 2019 GWMP)	391351.81	6363950.74	9.86	25	19 – 25	Destroyed
MW2	391331	6364058	23.8	25	22 – 25	Destroyed
MW3 (old)	391457	6364185	21.0	23.5	20.5 – 23	Destroyed
MW3	391428	6364225	19.5	25	19 – 25	Destroyed
MW4	391699	6364229	9.5	10	7 – 10	Destroyed
MW5 (old)	391670	6364404	14.2	NA	NA	Destroyed
MW5A	391677	3634494	6.0	15.8	12.8 – 15.8	Destroyed
MW6	391864	6364375	11.8	14.7	11.7 – 14.7	Destroyed
MW7	392080	6364628	14.1	17.5	14.5 – 17.5	Destroyed
MW8	392274	6364633	14.2	17.5	14.5 – 17.5	Destroyed
MW9	392338	6364846	2.6	5	2-5 – 0	Destroyed
MW10 (old)	392629	6364845	9.4	11.5	8.5 – 11.5	Destroyed
MW10	392604	6364757	11	21	15 – 21	Destroyed
MW11	392600	6364951	15.5	18	12 – 18	Destroyed

Location ID	Easting (MGA94)	Northing (MGA94)	Elevation (m AHD)	Depth (mBGL)	Screened Interval (mBGL)	Status
GW5	390705	6365182	na	na	na	Destroyed

3.3 Surface water monitoring network

Surface water monitoring sites, SW1, SW2, SW3 and SW4 are included in the 2019 GWMP to monitor Groundwater Dependent Ecosystems (GDEs) within close vicinity of the operational area. These sites are shown in Figure 3, Appendix A.

SW1 and SW2 are located inland of the current extraction area and intermittently contain surface water. GDEs near these sites comprise swamp forests in the dune swales and low lying heath.

SW3 and SW4 are located seaward of the extraction area. GDEs in the vicinity of SW3 and SW4 comprise small ephemeral and mobile shallow deflation basins, vegetated with a variety of grasses, sedges and reeds. Due to the variable nature of the foredune system, the locations of the two GDE monitoring sites may change between sampling programs.

3.4 Groundwater and surface water monitoring

3.4.1 Ongoing monitoring

Ongoing groundwater and surface water monitoring as outlined in the 2019 GWMP is summarised in Table 2 and Table 3, respectively.

Table 2: Groundwater monitoring program

Parameter	Frequency	Location
Water level	Monthly	All groundwater monitoring bores
Field water Quality Parameters • pH • EC	Quarterly	MW Series Groundwater Monitoring Bores
Laboratory Chemical Analysis • Na, K, Ca, Mg, HCO3, CO3, Cl, SO4 • Al, As, B, Cd, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Se, Zn • Alkalinity, Hardness, Phosphorous, Nitrate-N, Sulphate	Quarterly	MW Series Groundwater Monitoring Bores

Table 3: Surface water monitoring program

Parameter	Frequency	Location
Field water quality parameters • pH • EC	Quarterly	All surface water monitoring sites
Laboratory Analysis • Na, K, Ca, Mg, HCO3, CO3, Cl, SO4 • Al, As, B, Cd, Cr, Cu, F, Fe, Hg, Mn, Ni, Pb, Se, Zn • Alkalinity, Hardness, Phosphorous, Nitrate-N, Sulphate	Quarterly	All surface water monitoring sites
Laboratory Analysis • BTEX, Benzene, Toluene, Ethylbenzene, TRH	Annually	All surface water monitoring sites

3.4.2 Trigger levels

Groundwater trigger levels, as defined in the 2019 GWMP, for groundwater levels, pH, EC and laboratory analytes are shown in Table 4, Table 6, Table 5 and Table 7, respectively.

With respect to the surface water monitoring sites, the 2019 GWMP did not provide trigger levels for these sites due to insufficient baseline data. The 2019 GWMP required that these surface water sites be assessed against the ANZECC 2000 guidelines as shown Table 8 until sufficient data is collected to enable development of site specific trigger levels.

Based on ANZG (2018) a minimum of 18 samples per surface water monitoring location is recommended to define surface water trigger levels. Since surface water monitoring has been undertaken monthly for three consecutive years (2020, 2021 and 2022), and a total number of 36 samples have been analysed for most analytes it is recommended that trigger levels be defined for the 2023 reporting period and 2023 AEMR. It is noted that monthly sampling exceeds the recommended quarterly sampling frequency as defined in the 2019 GWMP. It is acknowledged that as the 2019 GWMP TRH and BTEX sample frequency is annual, definition of triggers levels for TRH, BTEX, Benzene, Toluene and Ethylbenzene based on statistical sampling results is not appropriate. The definition of these triggers levels is therefore outside the scope of this report. ANZG (2018) notes that increases in water hardness reduce the toxicity of some metals (cadmium, chromium, lead, nickel, zinc), and concentrations of these metals are compared to their hardness modified trigger levels.

Updated guidance on guideline-value derivation by Batley et al. (2018) and Warne et al. (2018) advised that no hardness adjustment should be undertaken for copper for chronic toxicity, but that hardness adjustments should still be incorporated for other hardness-sensitive metals until otherwise advised.

Table 4: Groundwater level trigger levels

Monitoring Location	Units	Upper Limit	Lower Limit
MW1	mAHD	2.92	0.98
MW2	mAHD	2.33	1.09
MW5	mAHD	2.51	0.77
MW6	mAHD	2.66	0.60
MW7	mAHD	2.52	1.17
MW8	mAHD	2.57	1.23
MW9	mAHD	2.56	1.22
GW1	mBGL	7.42	9.04
GW2	mBGL	0.27	2.00
GW3	mBGL	1.40	2.87
GW4	mBGL	1.58	2.86

mAHD – meters Australian Height Datum; mBGL – meters below ground level

Table 5: Groundwater pH trigger levels

Monitoring Location	Upper Threshold Limit (pH Units)	Lower Threshold Limit (pH Units)
MW1	7.47	5.67
MW2	7.86	7.05
MW5	7.68	5.88
MW6	7.65	6.60
MW7	7.53	6.64
MW8	7.59	6.71
MW9	8.33	4.93

Table 6: Groundwater EC trigger levels

Monitoring Location	Upper Threshold Limit (µS/cm)	Lower Threshold Limit (µS/cm)
MW1	444	195
MW2	719	287
MW5	1015	105
MW6	584	115
MW7	1037	470
MW8	1021	453

Monitoring Location	Upper Threshold Limit (µS/cm)	Lower Threshold Limit (µS/cm)
MW9	965	155

µS/cm: Micro Siemens per centimetre

Table 7: Groundwater trigger levels for laboratory analytes

Analyte	MW1		MW2		MW5		MW6		MW7		MW8		MW9	
	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit
Turbidity (NTU)	145.4	na	103	na	39.4	na	33.2	na	187	na	25.7	na	74.7	na
Chloride (mg/L)	47	15.8	42.0	13.8	200.5	na	44	3.8	134	na	190.2	na	136.3	na
Sulphate as SO4	48.8	na	60.9	0.12	76.18	na	56.6	na	191.7	na	196	na	41.7	na
Aluminium (mg/l)	0.251	na	0.074	na	1.861	na	0.158	na	0.391	na	0.077	na	1.515	na
Arsenic (mg/L)	0.02	na	0.018	na	0.024	na	0.026	na	0.067	na	0.029	na	0.111	na
Boron (mg/L)	0.089	na	0.182	na	0.090	na	0.078	na	0.091	na	0.085	na	0.095	na
Calcium (mg/L)	76.2	na	121.0	28.4	141.1	na	102.9	1.86	196.5	5.1	197.2	18.7	140.2	na
Cadmium (mg/L)	0.003	na	0.002	na	0.003	na	0.002	na	0.002	na	0.002	na	0.004	na
Chromium (mg/L)	0.009	na	0.002	na	0.01	na	0.006	na	0.005	na	0.006	na	0.007	na
Copper (mg/L)	0.011	na	0.008	na	0.011	na	0.012	na	0.007	na	0.01	na	0.004	na
Iron (mg/L)	1.78	na	1.81	na	2.68	na	3.44	na	8.23	na	10.69	na	7.21	na
Potassium (mg/L)	4.6	na	3	na	5.7	na	2.8	na	5.2	0.4	4.6	0.3	7.1	na
Magnesium (mg/L)	9.7	na	8.5	5.3	20	na	7.6	na	14.3	1.8	14.1	1.1	12.1	2.8
Manganese (mg/L)	0.03	na	0.43	na	0.32	na	0.06	na	0.82	na	0.32	na	1.32	na

Nitrogen (mg/L)	0.001	na	0.001	na	0.001	na	0.001	na	0.001	na	0.001	na	0.001	na
Sodium (mg/L)	38.6	na	24.9	5.2	173.3	na	26.8	na	99.2	na	127.4	na	78.7	na
Nickel (mg/L)	0.026	na	0.01	na	0.076	na	0.074	na	0.012	na	0.064	na	0.022	na
Lead (mg/L)	0.008	na	0.0028	na	0.022	na	0.010	na	0.009	na	0.014	na	0.008	na
Selenium (mg/L)	0.009	na	0.01	na	0.011	na	0.011	na	0.009	na	0.009	na	0.009	na
Zinc (mg/L)	0.124	na	0.032	na	0.03	na	0.027	na	0.028	na	0.022	na	0.061	na
Filterable Reactive P (mg/L)	0.03	na	0.09	na	0.07	na	0.37	na	0.21	na	0.38	na	0.30	na
Nitrate -N (mg/L)	10.57	na	2.11	0.75	4.74	na	2.38	0.01	1.36	na	0.91	na	1.04	na
Alkalinity (mg CaCO3/L)	157.4	6.2	294.1	47.4	293.3	18.0	246	22.8	313.3	74.6	317.8	71.7	360.32	na
Hardness as CaCO3	170.5	66.4	374.46	278.6	431.2	117.7	274.4	144.2	487.1	274.8	501.1	283.8	484.7	11.1
Mercury (mg/L)	0.0016	na	0.0012	na	0.0016	na	0.0015	na	0.0016	na	0.0016	na	0.0016	na
Fluoride (mg/L)	0.755	0.002	0.183	0.042	0.753	na	0.726	na	0.732	na	0.746	na	0.736	na

Note: na – method results in negative value or value below limit of reporting.
nd – insufficient data

Table 8: Surface water quality interim assessment criteria

Surface water monitoring point I.D	Location	Analyte	Guideline for assessment	Trigger Value
SW1	Eastern Inland Basin	Analytes as shown in Table 3	▪ ANZECC 2000 Freshwater aquatic ecosystem (slightly to moderately disturbed) 95% species protection ▪ ANZECC 2000 Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems, lowland rivers ▪ ANZECC 2000 Ranges of default trigger values for conductivity (EC, salinity), turbidity and suspended particulate matter (SPM) indicative of slightly disturbed ecosystems in south-east Australia, lowland rivers	To be confirmed once sufficient data available to develop site specific trigger levels
SW2	Western Inland Basin			
SW3	Eastern Seaward GDE		▪ ANZECC 2000 Marine aquatic ecosystem (slightly to moderately disturbed) 95% species protection ▪ ANZECC 2000 Default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems, lowland rivers ▪ ANZECC 2000 Ranges of default trigger values for conductivity (EC, salinity), turbidity and suspended particulate matter (SPM) indicative of slightly disturbed ecosystems in south-east Australia, lowland rivers	
SW4	Western Seaward GDE			

3.4.3 Trigger action response plan (TARP)

The 2019 GWMP outlines a Trigger Action Response Plan (TARP) which details the required responses in the case of groundwater trigger levels being exceeded. The TARP is shown in Table 9.

Table 9: Trigger Action Response Plan (TARP)

Aspect	Parameter	Frequency	Purpose	Trigger	Trigger Action	Purpose	Trigger Response Action	Responsibility
Groundwater level monitoring	Groundwater level	Monthly	To identify any impacts to the groundwater level due to quarry operations.	Two consecutive monthly observations indicating a steady decline in groundwater levels below the designated lower trigger level threshold (Table 4).	Repeat water level monitoring to confirm exceedance. Review data for accuracy. Refer the matter to an independent hydrogeologist / environmental scientist (or similar) to review.	Identify, investigate and report on impacts to groundwater levels. Inform agencies of baseline assessment and monitoring.	Inform relevant regulatory agencies within 7 days of being notified of the exceedance with an exceedance notification letter. Exceedance investigation report to be issued within 60-days of initial notification to authorities.	Boral Resources (NSW) Pty Limited Environmental Officer
Groundwater quality in monitoring bores	EC	Quarterly	To identify any impacts to the groundwater level due to quarry operations.	Two consecutive quarterly EC observations above the designated upper trigger level threshold values (Table 6).	Repeat sampling of monitoring bore exceeding trigger. Review data for accuracy. Refer the matter to an independent hydrogeologist / environmental scientist (or similar) to review.	Identify, investigate and report on impacts to groundwater quality. Potentially prompt further investigation and sampling for analytes. Confirm and review trigger levels.		
	pH			Two consecutive quarterly pH observations outside of the designated trigger level threshold values (Table 5).				
	Major Ions and Metals			Two consecutive quarterly observations above the designated upper trigger level threshold values (Table 7).				

4. Monitoring results

4.1 2022 groundwater monitoring network status

As reported in the review of 2020 and 2021 groundwater data (Jacobs, 2020), bores MW2 and MW11 which are both included in the 2019 GWMP groundwater monitoring network have been destroyed.

Boral have reported the loss of MW2 to NSW DPIE and advised that they are no longer able to carry out monitoring at the bore. Additionally, Boral have advised that they do not propose to replace the bore due to its location on Worimi lands under the control of National Parks (Boral do not have permission to carry out any works on Worimi/National Parks land), and having no way of protecting the bore from vandalism.

Jacobs has reviewed the current groundwater monitoring network in light of the loss of MW2 and MW11. Despite the loss of MW2 and MW11, the current monitoring network is considered appropriate and replacing MW2 and MW11 is not considered necessary.

4.2 2022 groundwater and surface water monitoring

Groundwater and surface water sampling were generally completed in accordance with the 2019 GWMP with the exception of the following:

- MW2 water quality was not monitored in 2022 as the bore was destroyed sometime in October 2021.
- MW9 was not monitored for groundwater level in January 2022.
- GW1 was not monitored for groundwater level in January or February 2022.
- GW2 was not monitored for groundwater level in July or August 2022.
- Consecutive groundwater quality quarterly trigger level exceedances were not actioned (i.e. repeat sampled, reported and investigated) as per the 2019 GWMP TARP. There were consecutive quarterly trigger level exceedances at all groundwater monitoring locations. The associated analytes comprised aluminium, chromium, iron, potassium, sodium, chloride, phosphorus and hardness. At MW8, turbidity also exceeded trigger levels in two consecutive quarterly monitoring rounds.
- At surface water monitoring sites, total recoverable hydrocarbons (TRH) have been monitored instead of total petroleum hydrocarbons (TPH), however results for TRH and TPH are more or less interchangeable.
- Surface water monitoring was undertaken generally monthly, which is beyond the quarterly frequency requirement for all analytes except TPH/TRH and BTEX (annual frequency).

4.3 Groundwater levels

Groundwater levels measured in 2022 are shown in Table 10 and are plotted with rainfall (source: BOM Williamtown RAAF station) in Figure 4, Appendix A, which includes the entire historical data record.

During 2022, monthly rainfall was mostly consistent with long-term average values. Significant above average rainfall occurred in March and July, with rainfall 225.7 mm and 251.8 mm above

long-term monthly averages respectively. Groundwater levels consequently peaked in July and remained elevated in August. Following July, rainfall substantially decreased to at or below monthly long-term averages. In November and December of 2022 rainfall was 32.9 mm and 57.9 mm below the average value for these months. The decrease in rainfall was reflected in groundwater levels which also decreased fairly uniformly across all monitoring wells between July and December 2022.

Groundwater levels between July and September approximately equalled or exceeded the quarry's limit of extraction level of 2.5 mAHD at all monitoring locations. Groundwater levels peaked in July at all monitoring wells with the exception of GW2 where the maximum value occurred in August. During July and August 2022, all monitoring locations except MW1 exceeded upper groundwater level trigger values. Maximum values ranged from 2.68 mAHD reported in August at MW5 to 2.96 mAHD at MW7 in July.

Following the peak in July, groundwater levels display a decreasing trend, corresponding to a decline in the cumulative rainfall deviation (CRD), where a climbing CRD line slope represents above average rainfall whilst a declining slope represents below average rainfall. The CRD is calculated from the cumulative sum of observed rainfall minus long-term average rainfall and often displays correlation to groundwater levels, particularly where rainfall recharge is an important process. The difference in rainfall between July and August 2022 was 285.4 mm due to the extreme above average rainfall in July and slight below average rainfall in August.

Quarrying does not appear to be impacting groundwater levels throughout the reporting period.

Table 10: 2022 groundwater levels

	Groundwater level (mAHD)									
	GW1	GW2	GW3	GW4	MW1	MW5	MW6	MW7	MW8	MW9
Upper trigger	2.92	2.72	2.60	2.28	2.92	2.51	2.66	2.52	2.57	2.56
Lower trigger	0.98	0.99	1.13	1.00	0.98	0.77	0.60	1.17	1.23	1.22
	Date									
24/01/2022	NR[#1]	1.97	1.78	1.68	1.71	1.74	1.76	1.82	1.81	NR[#3]
23/02/2022	NR[#1]	1.88	1.74	1.62	1.66	1.73	1.74	1.77	1.76	1.75
23/03/2022	-	2.20	2.10	1.95	-	-	-	-	-	-
30/03/2022	2.00	-	-	-	2.07	2.11	2.15	2.21	2.19	2.18
20/04/2022	2.22	2.41	2.33	2.06	2.11	2.24	2.30	2.39	2.40	2.42
18/05/2022	2.17	2.35	2.16	1.97	1.99	2.09	2.12	2.20	2.20	2.21
15/06/2022	-	-	-	-	2.09	2.14	2.18	2.25	2.26	2.27
16/06/2022	2.23	2.36	2.20	2.07	-	-	-	-	-	-
13/07/2022	2.93	NR[#2]	2.93	2.78	2.77	2.90	2.91	2.96	2.94	2.93
10/08/2022	2.93	NR[#2]	2.76	2.81	2.72	2.68	2.76	2.81	2.77	2.75
07/09/2022	-	-	-	-	2.44	2.42	2.53	2.58	2.55	2.54
08/09/2022	2.73	2.85	2.53	2.53	-	-	2.17	-	-	-
05/10/2022	2.55	2.68	2.37	2.31	2.23	2.26	2.36	2.41	2.39	2.38

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	Groundwater level (mAHD)									
	GW1	GW2	GW3	GW4	MW1	MW5	MW6	MW7	MW8	MW9
02/11/2022	2.51	2.63	2.34	2.22	2.18	2.24	2.33	2.39	2.37	2.36
01/12/2022	-	-	-	-	2.02	2.05	2.13	2.18	2.18	2.08
2/12/2022	2.29	2.43	2.12	2.02	-	-	-	-	-	-
Long term average	3.16[1]	1.86[2]	1.87[2]	1.70[2]	1.88[3]	1.80[4]	1.92[4]	1.88[4]	1.90[4]	1.89[4]
Long term median	3.30[1]	1.82[2]	1.77[2]	1.62[2]	1.83[3]	1.74[4]	1.93[4]	1.79[4]	1.82[4]	1.81[4]

Notes: [1] 2013-2018, 2022. [2] 2009 – 2022. [3] 2007 – 2022. [4] 2013 – 2022.

NR – Not Recorded. [#1] Well not tested since 2017. [#2] Flooding impeded access. [#3] Borehole casing buried, unable to locate.

4.4 Groundwater quality

4.4.1 pH

Quarterly pH sampling results are summarised in Table 11 and plotted in Figure 5, Appendix A, with the plot including historical data.

During the reporting period, pH values for all monitored bores ranged from 5.10 to 7.30, with an average of 6.46.

At MW1, all quarterly samples of 5.20, 5.10, 5.40 and 5.20, were below the lower trigger of 5.67.

At all other locations, the observed pH values in 2022 were within the lower and upper trigger level range.

Whilst pH observations at MW1 were below the lower trigger level for that location, the relatively lower pH values are considered unlikely to be due to quarrying and are instead attributed to natural variability. A similar pH trend was not observed at other monitoring bores. Also, the relatively low pH values observed in 2022 at MW1 do not correlate well with groundwater levels at MW1. Observed groundwater levels at MW1 are relatively high in 2022 and do not appear to have been drawn down by quarrying, which is the primary mechanism that could lead to a lowering of pH due to quarrying.

Table 11: Groundwater pH monitoring results

Monitoring Location	Lower / upper triggers	2022 range (pH units)	2022 average (pH units)	Long term average (2007 to 2022)
MW1	5.67 / 7.47	5.10 to 5.40	5.23	6.31
MW5	5.88 / 7.68	5.90 - 6.20	6.05	6.48
MW6	6.60 / 7.65	6.70 - 6.90	6.80	7.00
MW7	6.64 / 7.53	6.90 – 7.00	6.95	7.07
MW8	6.71 / 7.59	7.30 - 7.30	7.30	7.17
MW9	4.93 / 8.33	6.10 - 6.70	6.45	6.60

4.4.2 Electrical conductivity

Quarterly electrical conductivity (EC) sampling results are available for the reporting period and are summarised in Table 12 and plotted in Figure 6, Appendix A, with the plot including historical data.

During the reporting period, EC values for all monitored bores ranged from 213 to 999 µS/cm, with an average of 573 µS/cm.

At MW1, the December EC value of 603 µS/cm is above the upper trigger of 444 µS/cm. There were no other observed exceedances of either upper or lower trigger levels at the other monitoring locations.

There are no deleterious trends apparent and the observed EC values during the monitoring period are consistent with historical variation and are considered to lie within natural variability. Considering the below average rainfall in November and December, and relatively low rainfall in September and October, the high EC observation value at MW1 is reasonable.

Table 12: Electrical conductivity monitoring results

Monitoring Location	Lower / upper triggers	2022 range (µS/cm)	2022 average (µS/cm)	Long term average (2007 to 2022) (µS/cm)
MW1	195 / 444	213 - 603	366	330
MW5	105 / 1015	315 - 822	529	495
MW6	115 / 584	305 - 419	353	331
MW7	470 / 1037	726 - 849	796	689
MW8	453 / 1021	879 - 999	927	759
MW9	155 / 965	426 - 534	467	516

4.4.3 Laboratory results

Groundwater quality results from comprehensive laboratory analysis are presented in graphs in Figures 7 to 18, Appendix A, with raw results provided in Appendix B. Trigger level exceedances are discussed below.

- **Aluminium (Figure 7, Appendix A):** Trigger exceedances for aluminium were as follows:
  - **MW1:** four samples above trigger of 0.251 mg/L. Maximum observation of 1.30 mg/L.
  - **MW5**: two samples above trigger of 1.861 mg/L. Maximum observation of 3.30 mg/L.
  - **MW6**: three samples above trigger of 0.158 mg/L. Maximum observation of 0.21 mg/L.
  - **MW7**: two samples above trigger of 0.391 mg/L. Maximum observation of 0.72 mg/L.

    MW9: two samples above trigger of 1.515 mg/L. Maximum observation of 1.90 mg/L.

  Aluminium exceeded trigger levels at five of the six monitoring bores in 2022. Historical observations show similar exceedances for aluminium across multiple locations, suggesting there is a large range of natural variability at the site. For example, an aluminium concentration of 3.1 mg/L was reported at MW5 in 2014 which is consistent with the maximum observation at MW5 in 2022. Likewise, elevated levels of aluminium were observed at MW1 in 2020 and 2021, with 2022 observations continuing to exceed trigger levels.

  The observed trends are therefore considered to fall within the range of natural variability and are not interpreted to be attributable to quarrying.

- **Arsenic (Figure 7, Appendix A):** MW6 had one observation of 0.029 mg/L, above its trigger level of 0.026 mg/L. Samples from other bores were below their respective trigger values.

  At MW6, historical observations show similar arsenic concentrations. Arsenic concentrations of 0.036 mg/L and 0.029 mg/L were reported in 2010 and 2014 respectively. The observed exceedance at MW6 is therefore attributed to natural variability and is not considered a result of quarrying.

- **Chromium (Figure 9, Appendix A):** MW9 had two observations either at or above its upper trigger level of 0.007 mg/L, recording 0.009 mg/L in June and 0.007 mg/L in September.

  The MW9 are consistent with site wide baseline data. For example, in 2010 chromium concentrations were observed at 0.023 mg/L at MW5 and 0.013 mg/L at MW8. Trends are therefore unlikely to have resulted from quarrying.

- **Iron (Figure 10, Appendix A):** Trigger exceedances for iron were as follows:
  - **MW1:** one sample above trigger of 1.78 mg/L. Maximum observation of 2.40 mg/L.
  - **MW8:** one sample above trigger of 10.69 mg/L. Maximum observation of 12 mg/L.

  Reviewing the entire dataset for all locations, there are numerous locations (e.g., MW5, MW7 and MW9) where iron concentrations during the baseline period are similar to the 2022 iron concentrations at MW1 and MW8. 2022 iron concentrations at MW1 and MW8 are also lower than those reported in 2021, indicating a declining trend. Thus 2022 iron concentrations at the former locations are in keeping with pre-quarrying concentrations for the broader site-wide baseline and are therefore unlikely to be elevated due to quarrying.

- **Potassium (Figure 13, Appendix A):**
  - **MW1:** three samples above trigger of 4.6 mg/L. Maximum observation of 9.30 mg/L.
  - **MW5:** one sample above trigger of 5.7 mg/L. Maximum observation of 6.20 mg/L.
  - **MW8:** three samples above trigger of 4.6 mg/L. Maximum observation of 5.40 mg/L.

  While potassium concentrations at MW1, MW5 and MW8 in 2022 appear to be increasing when compared to previous years, historical observations show similar exceedances, such as 6.802 mg/L measured at MW1 in 2007. Furthermore, the 2022 observations are fairly consistent with values observed in 2021 and lie within the site wide range of historical potassium concentrations. 2021 observations at MW1, MW5 and MW8 are therefore within the range of natural variability at the site and are not considered attributable to quarrying.

- **Sodium (Figure 14, Appendix A):**
  - **MW1:** one sample above trigger of 38.6 mg/L. Maximum observation of 83 mg/L.
  - **MW6:** two samples above trigger of 26.8 mg/L. Maximum observation of 28 mg/L.

  While sodium concentrations appear to be increasing at MW1 and MW6, historical observations have noted similar levels at MW1 and MW6. Other monitoring bores on site also show higher concentrations of sodium than those recorded at MW1 and MW6, even

though trigger levels were not exceeded at these locations. For example, sodium was reported at 130 mg/L at MW5 during the 2022 monitoring period, which was below the trigger level for MW5 (173.3 mg/L).

The 2022 observations at MW1 and MW6 are consistent with the site wide range of historical sodium concentrations. The observations at MW1 and MW6 are therefore within the range of natural variability at the site and are not considered attributable to quarrying.

- **Zinc (Figure 15, Appendix A):** MW5 had one observation of 0.05 mg/L, above its trigger level of 0.03 mg/L. Samples from other bores were below their respective trigger values.

  Zinc concentrations reflect an apparent declining trend since 2021 observations and site wide historical data values. Zinc levels have been historically as high as 0.115 mg/L and have been considered as occurring naturally. The 2022 exceedance at MW5 is therefore not attributable to quarrying.

- **Chloride (Figure 16, Appendix A):** Trigger exceedances for chloride were as follows:
  - **MW1:** three samples above trigger of 47 mg/L. Maximum observation of 130 mg/L.
  - **MW7:** one sample (160 mg/L) above trigger of 134 mg/L.
  - **MW8:** one sample (200 mg/L) above trigger of 190.2 mg/L.

  Although elevated when compared to preceding data, the 2022 observations at MW1, MW7 and MW8 are in line with historical site wide variation. For example, in 2014 bores MW5, MW7 and MW8 recorded chloride concentrations of greater than 170 mg/L. 2022 observations are therefore considered not a result of quarrying.

- **Hardness (as CaCO3) (Figure 16, Appendix A):** All monitored locations in 2022 except for MW9 had instances of observations which were below their lower trigger levels:
  - All observations at MW1, MW5, MW7 and MW8 were below their lower trigger levels.
  - Three observations at MW6 were below the lower trigger level.

  The 2022 hardness observations are in the range of site-wide baseline observations and considered unlikely to have been influenced by quarrying.

- **Phosphorus (Figure 17, Appendix A):**
  - **MW5:** four samples above trigger of 0.07 mg/L. Maximum observation of 0.3 mg/L.
  - **MW6:** two samples above trigger of 0.37 mg/L. Maximum observation of 0.5 mg/L.
  - **MW9:** one sample at trigger of 0.3 mg/L.

  It is noted that the laboratory limit of reporting (0.05 mg/L) was above the MW1 lower trigger level of 0.03 mg/L.

  Historical site wide phosphorous concentrations appear highly variable, with 2022 observations falling within the range of historical values. Trends are therefore not considered attributable to quarrying.

- **Turbidity (Figure 18, Appendix A):** MW8 had two observations above the trigger of 25.7 NTU for turbidity. The maximum value was 40 NTU.

The observed turbidity exceedances at MW8 occurred in June and September 2022, corresponding to a period of significant rainfall. Historical data from MW8 and other monitoring bores on site show similar turbidity readings over time.

The 2022 turbidity observations are therefore considered within the range of site-wide baseline observations and are unlikely to have been influenced by quarrying.

4.5 Surface water quality

4.5.1 pH

pH results for surface water are summarised in Table 13.

2022 SW1 results were all below the lower pH guideline value of pH 6.50. The SW1 pH values are generally lower than the site's typical groundwater pH values, consistent with the findings of 2020 and 2021 data.

SW2 pH values during 2022 were all at or within the guideline value range of pH 6.50 to 8.50.

SW3 pH values during 2022 were all within the guideline value range of pH 6.50 to 8.50 with the exception of pH measurements taken in January, February and April which were 9.50, 9.20 and 8.60 respectively.

SW4 pH values showed a similar trend to monitoring location SW3, with all pH values in 2022 falling within guideline values except for samples taken in January and February. pH readings taken in January and February were 8.80 for both months.

Table 13: Surface water pH monitoring results

Monitoring Location	Lower / upper guideline level [1]	2022 range (pH units)	2022 average (pH units)
SW1	6.50 / 8.50	4.30 to 5.00	4.69
SW2		6.50 to 7.80	7.08
SW3		7.90 to 9.50	8.34
SW4		8.30 to 8.80	8.47

Notes: [1] ANZECC 2000 default trigger value for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems, lowland rivers.

4.5.2 Electrical conductivity

EC surface water sampling results are summarised in Table 14. All results at the four surface water monitoring locations were within the guideline value range of 125 to 2200 µS/cm.

Table 14: Surface water EC monitoring results

Monitoring Location	Lower / upper guideline level [1]	2022 range (µS/cm)	2022 average (µS/cm)
SW1	125 / 2200	191 to 354	266

Monitoring Location	Lower / upper guideline level [1]	2022 range (µS/cm)	2022 average (µS/cm)
SW2		217 to 422	307
SW3		206 to 401	321
SW4		225 to 369	313

Notes: [1] ANZECC 2000 default trigger value for conductivity for slightly disturbed ecosystems (lowland rivers) in south-east Australia.

4.5.3 Laboratory results

Surface water laboratory results for SW1, SW2, SW3 and SW4 were compared against ANZECC 2000 freshwater trigger values for 95% species protection and ANZECC 2000 default trigger values for physical and chemical stressors for south-east Australia for slightly disturbed ecosystems, lowland rivers.

The following observations were outside of the guideline ranges:

- **Aluminium:** SW2 had six observed exceedances of guideline levels for Aluminium during the 2022 monitoring period. The values of these exceedances ranged from 0.13 mg/L to 0.53 mg/L, above the guideline level of 0.055 mg/L.

  Exceedances of Aluminium guideline levels have been previously reported. All samples at SW1 and approximately 50% of samples at SW2 recorded Aluminium concentrations above guideline levels in 2021. The SW2 aluminium concentrations are therefore consistent with observed typical groundwater concentrations.
- **Arsenic:** SW1 had one observation at the guideline level for Arsenic. A concentration of 0.013 mg/L was reporting in the December 2022 monitoring round.
- **Chromium:** One observation at SW1 recorded 0.002 mg/L, above the guideline level of 0.001 mg/L for water with a hardness of between 0 and 59 mg/L. Four observations at SW1 were equivalent to the guideline value. All other observations were below the guideline value.

  The SW1 Chromium concentrations are consistent with observed typical groundwater concentrations.
- **Copper:** One observation at SW2 recorded a Copper concentration of 0.009 mg/L, above the guideline level of 0.0035 mg/L adjusted for freshwater of hardness between 60 and 119 mg $CaCO_3$/L.

  One observation at SW3 recorded a Copper concentration of 0.07 mg/L, above the guideline level of 0.00546 mg/L for freshwater with hardness between 120 and 179 mg $CaCO_3$/L.

  The SW2 and SW3 Copper concentrations are consistent with observed typical groundwater concentrations.
- **Zinc:** Three observations at SW2 were above the guideline level for Zinc of 0.02 mg/L for freshwater of hardness between 60 and 119 mg $CaCO_3$/L. The observed exceedances at SW2 ranged from 0.022 mg/L to 0.15 mg/L.

  Zinc concentrations are consistent with observed typical groundwater concentrations.

- **Phosphorus:** All surface water monitoring sites reported concentrations of Phosphorus at or above the Phosphorus guideline level of 0.05 mg/L during the 2022 annual monitoring period.

  SW1 had one observation at the guideline level of 0.05 mg/L which was reported in December 2022.

  SW2 had three observations ranging between 0.06 mg/L and 0.09 mg/L which exceeded the guideline level for Phosphorus.

  SW3 had two observed exceedances of Phosphorus guideline levels, with concentrations of 0.3 mg/L and 0.06 mg/L reported in January and February of 2022 respectively.

  SW4 had four observations above the guideline level of 0.05 mg/L. The exceedances ranged from 0.06 mg/L to 0.08 mg/L.

  Phosphorus concentrations are consistent with observed typical groundwater concentrations.

Surface water sites have been consistently monitored since 2020, however long term baseline data does not exist. Based on data obtained during the 2020, 2021 and 2022 monitoring rounds there appear to be no significant trends indicating that surface water quality has been impacted by quarrying operations. It is also noted that SW1, SW2, SW3 and SW4 analyte concentrations are similar to typical groundwater concentrations for a given analyte, suggesting that quarrying activities are unlikely to have had an impact on surface water quality. The exception is pH at SW1, which is lower than typical groundwater pH but is similar to nearby MW01.

5. 2022 monitoring results compared to EIS predictions

5.1 Groundwater levels

The EIS (ERM, 2005) predicts minimal impacts to groundwater levels when sand extraction is restricted to 2.5 m AHD, limiting potential impacts to changes in local groundwater recharge characteristics. Quarry activities are not predicted to influence local or regional groundwater supply.

2022 groundwater level data does not indicate that the quarry has impacted groundwater supply and results are therefore consistent with the EIS (ERM, 2005).

5.2 Groundwater quality

Extraction limits proposed in the EIS (ERM, 2005) were to ensure quarry operation had no direct impact on local or regional groundwater quality. Following review of the 2022 groundwater laboratory results, quarry activity has not impacted groundwater quality as exceedances lie within historical ranges and can be attributed to natural variability. 2022 groundwater quality results are therefore in-line with EIS (ERM, 2005) predictions.

5.3 Surface water quality

Due to the lack of topsoil and vegetation cover, the EIS (ERM, 2005) concludes that the consequent high groundwater recharge and negligible surface runoff will result in insignificant impacts to surface water quality. Despite lacking baseline data, review of 2022 surface water

results cannot attribute any exceedances to quarry operation. Results are therefore consistent with the EIS (ERM, 2005).

6. Conclusions and recommendations

A review of the groundwater monitoring results over the reporting period suggests that the quarry operations are not impacting groundwater resources, with natural variability accounting for a number of trigger exceedances noted during the year.

Based on data obtained during the 2020, 2021 and 2022 monitoring rounds there appear to be no significant trends indicating that surface water quality has been impacted by quarrying operations. It is also noted that SW1, SW2, SW3 and SW4 analyte concentrations are similar to typical groundwater concentrations for a given analyte, suggesting that quarrying activities are unlikely to have had an impact on surface water quality. The exception is pH at SW1, which is lower than typical groundwater pH but is still similar to nearby MW01. While a number of exceedances of ANZECC 2000 default trigger values are noted, there is no reason to believe that the results are indicative of an influence from quarrying.

The following conclusions and recommendations are made:

- In 2023 and beyond, with the exception of destroyed locations MW2 and MW11, groundwater level and quality monitoring frequency should remain consistent and at a minimum, as per that specified by the 2019 GWMP, including ongoing monitoring at GW1.
- Several groundwater quality triggers, defined in the 2019 GWMP, were exceeded during the reporting period. Exceedances against the site-specific trigger levels are attributed to natural background conditions, not Quarry operations.
- Based on 2022 surface water monitoring results, there appears to be no significant trends indicating that surface water quality has been impacted by quarrying operations. As per ANZG (2018) it is recommended that since 18 consecutive surface water samples have now been collected, surface water trigger levels should be defined for the 2023 AEMR. With continued data collection, the understanding of surface water quality is expected to improve.
- For 2023 and beyond, consecutive quarterly groundwater trigger level exceedances should be actioned as per the TARP within the 2019 GWMP.
- At surface water monitoring sites, total recoverable hydrocarbons (TRH) have been monitored instead of total petroleum hydrocarbons (TPH), however results for TRH and TPH are more or less interchangeable.
- The monitoring results are in-line with the EIS predictions.

Yours sincerely

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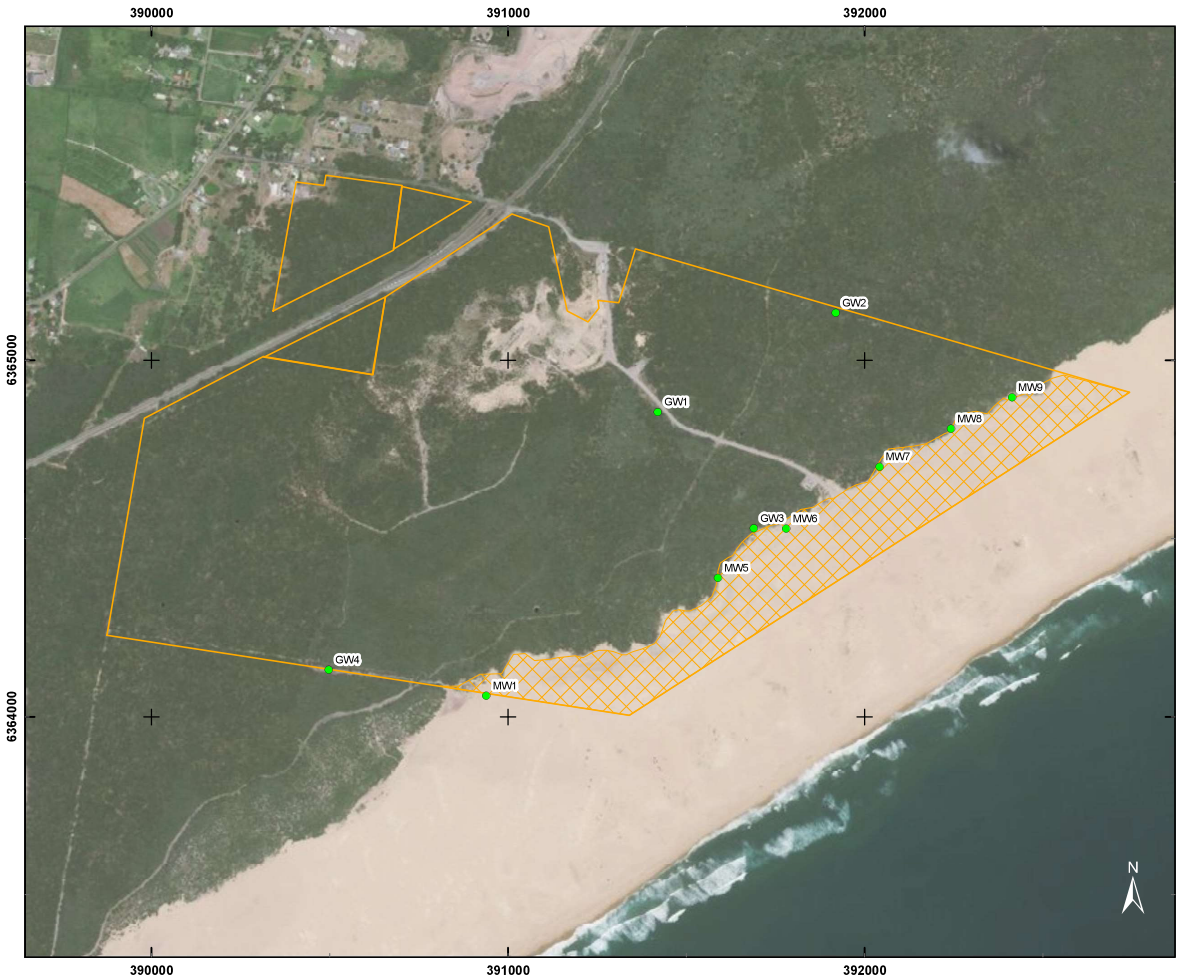
Appendix A – Figures



LEGEND

- Active Tenement
- Current Extraction Area
- Existing Piezometers

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FIGURE 1
Boral Stockton Sand Quarry
Existing Groundwater Monitoring Network

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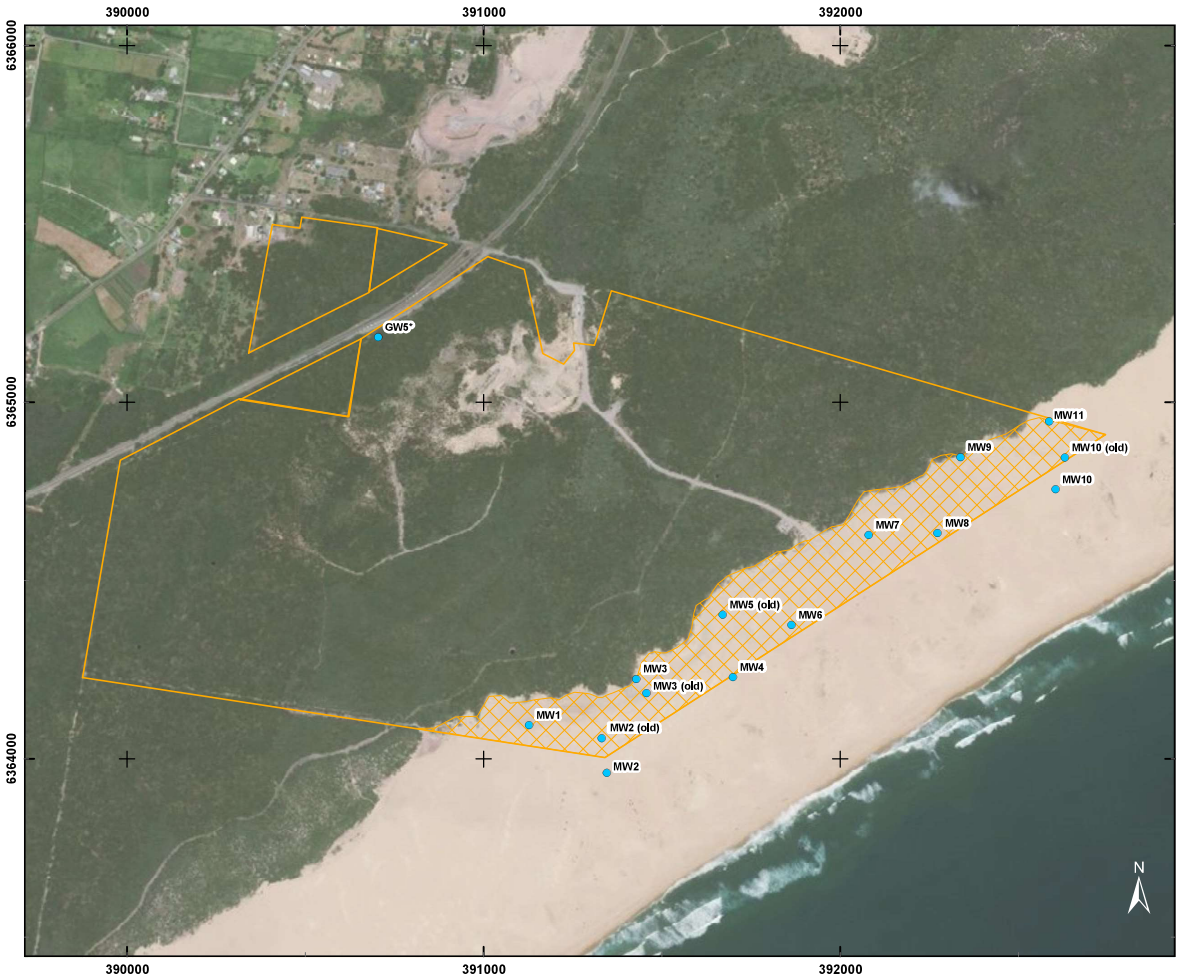

LEGEND

- Active Tenement
- Current Extraction Area
- Historic Piezometers

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FIGURE 2
Boral Stockton Sand Quarry
Historic Groundwater Monitoring Network

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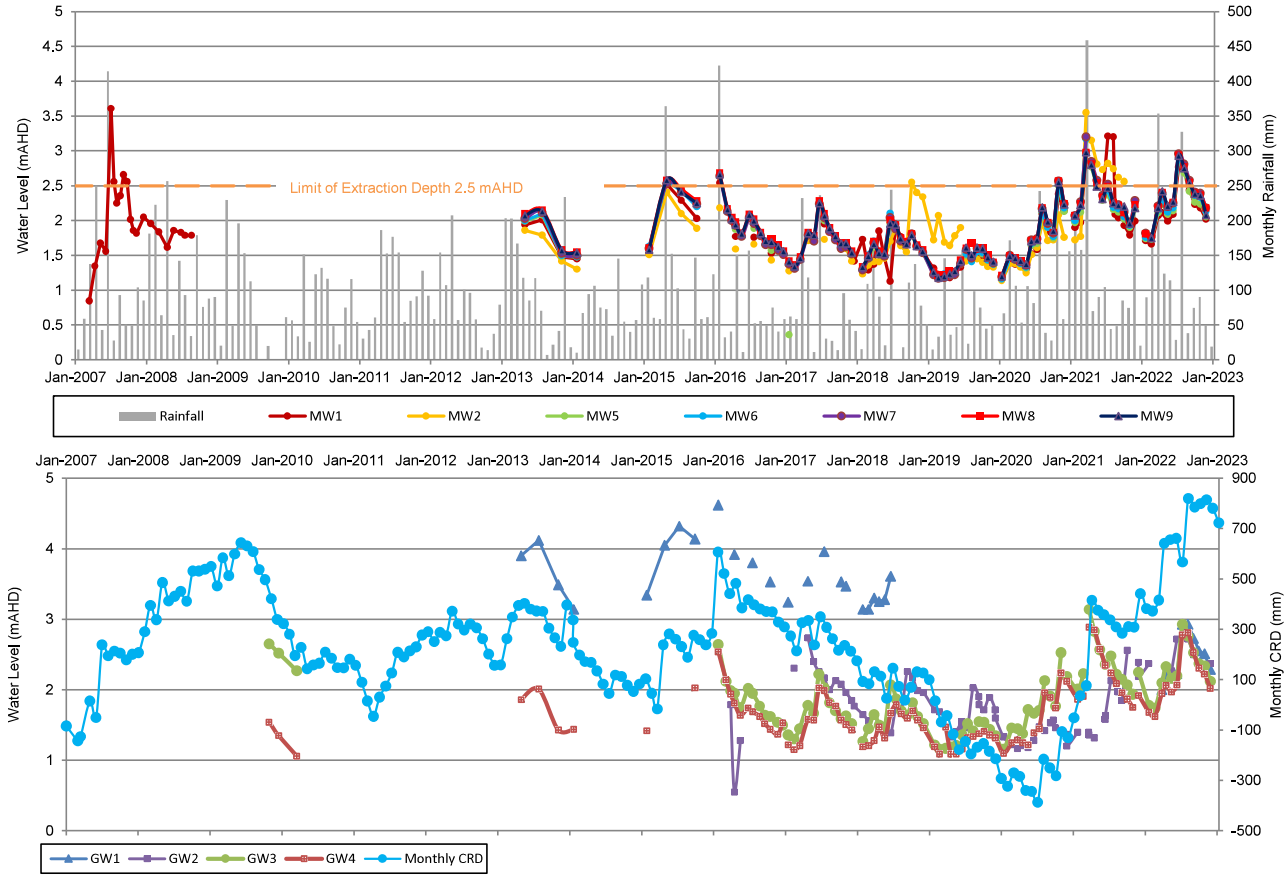

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GROUNDWATER LEVELS FIGURE 4

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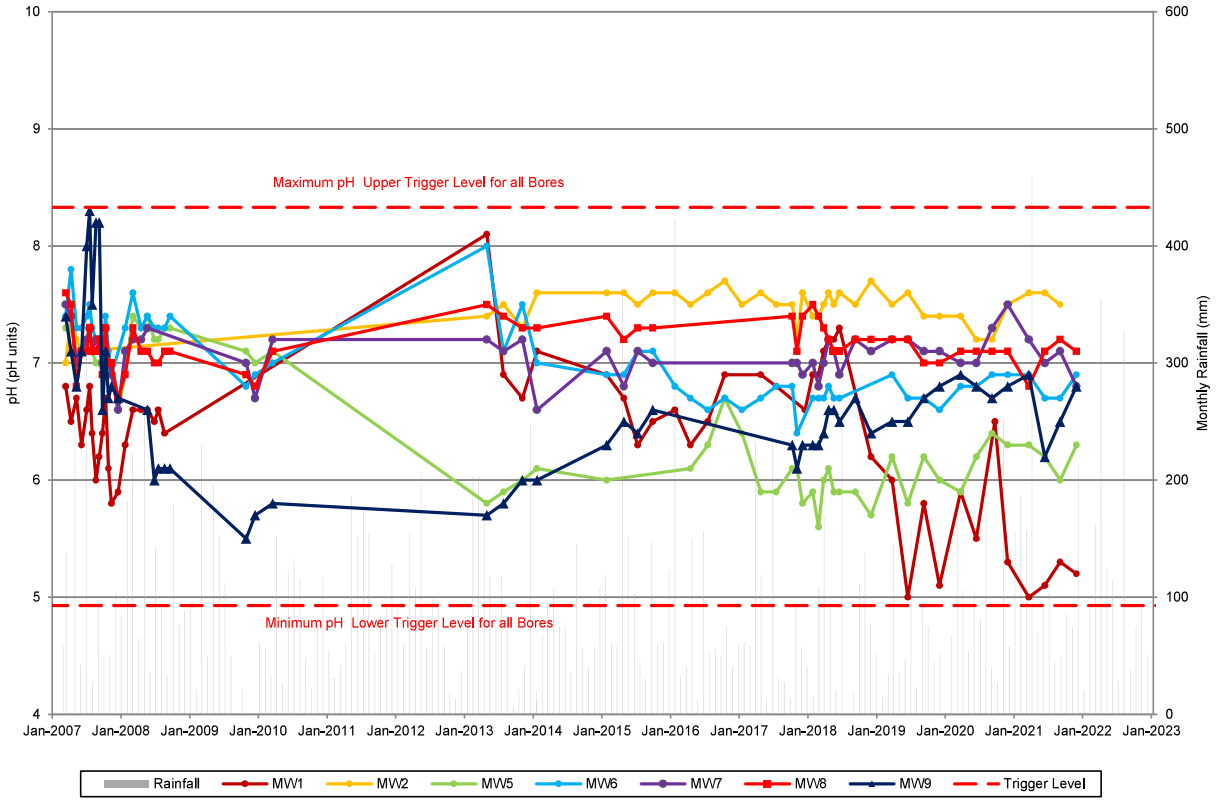

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pH Groundwater Quality FIGURE 5

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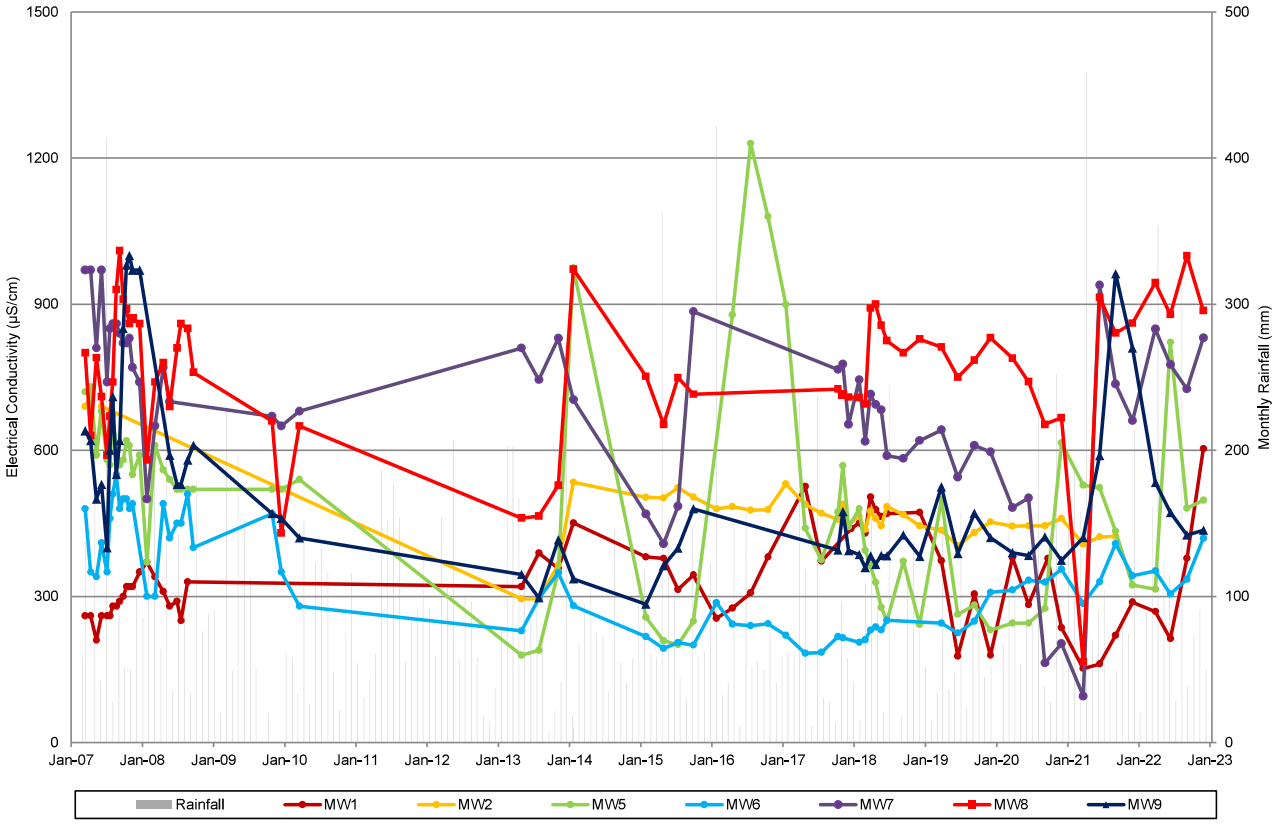

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Electrical Conductivity Groundwater Quality FIGURE 6

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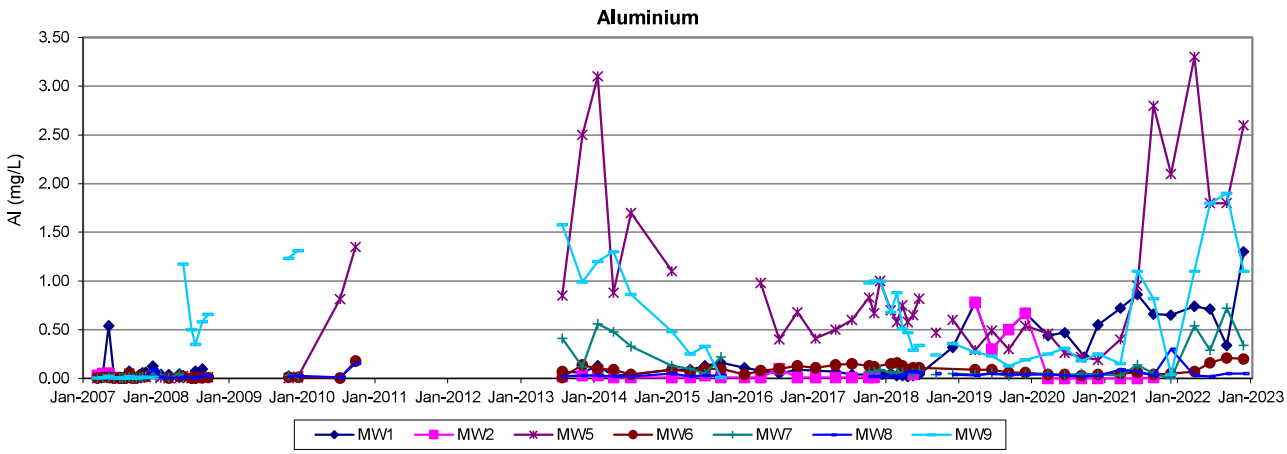

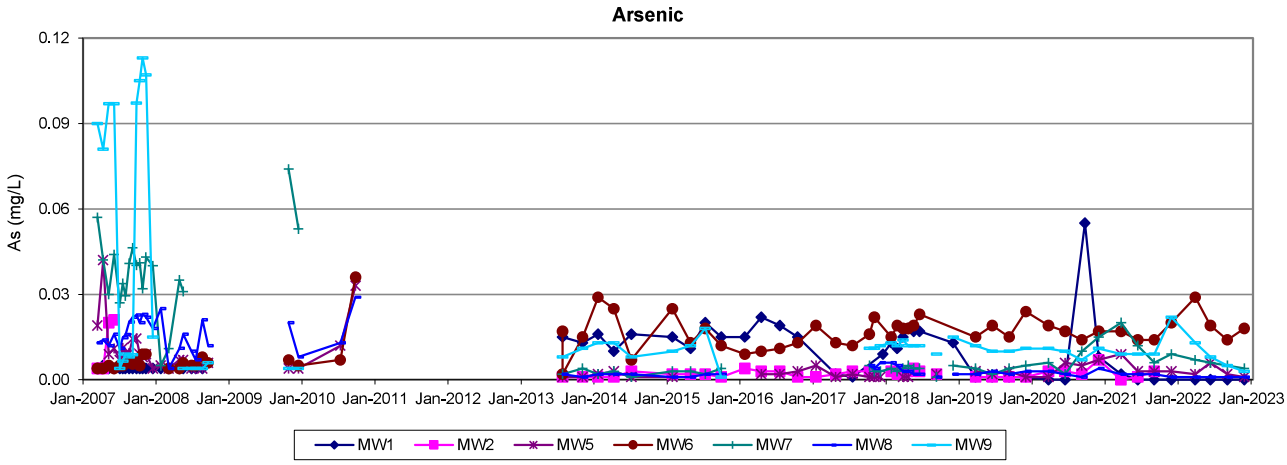

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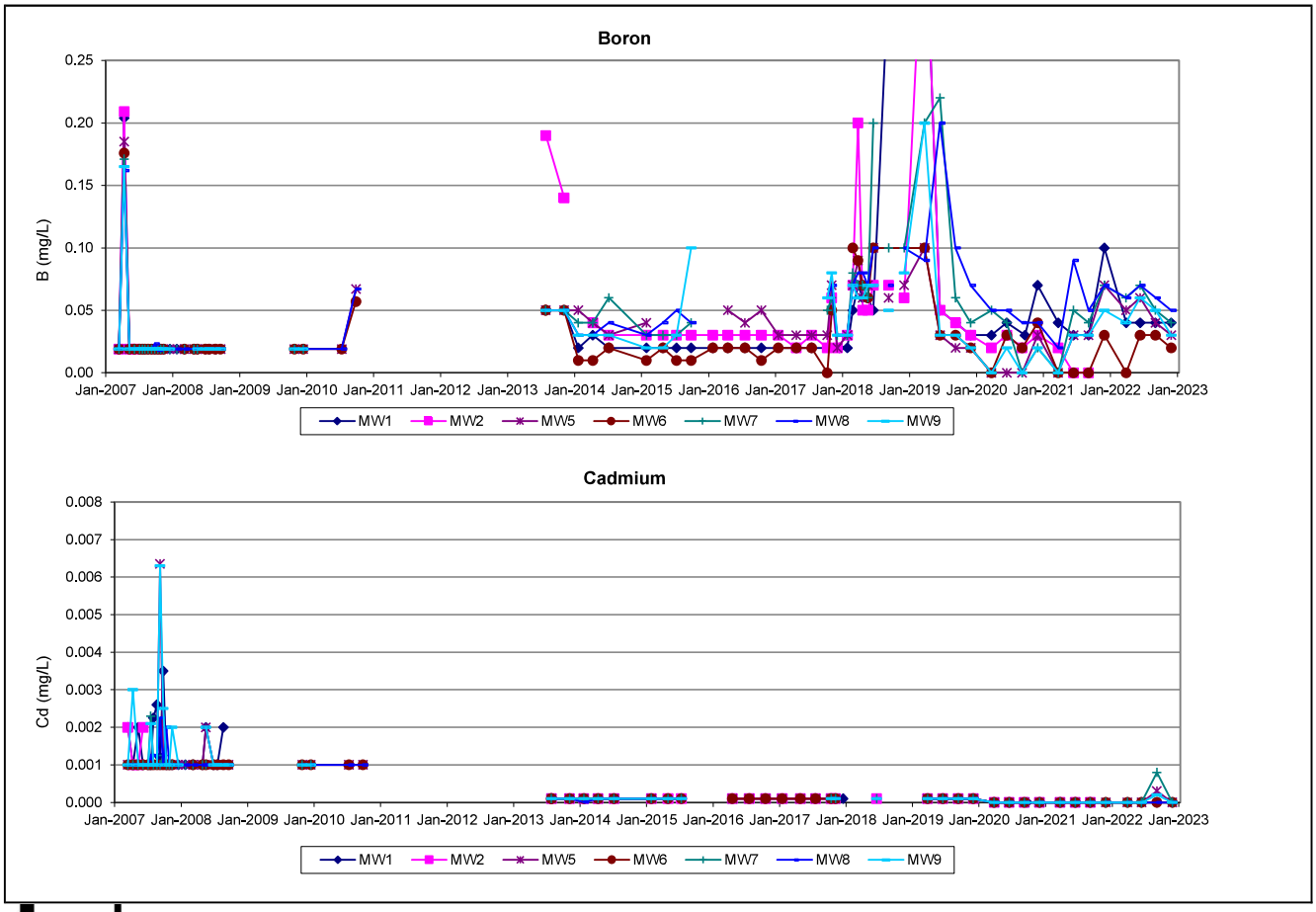
BASELINE GROUNDWATER QUALITY [ALUMINIUM ARSENIC] FIGURE 7

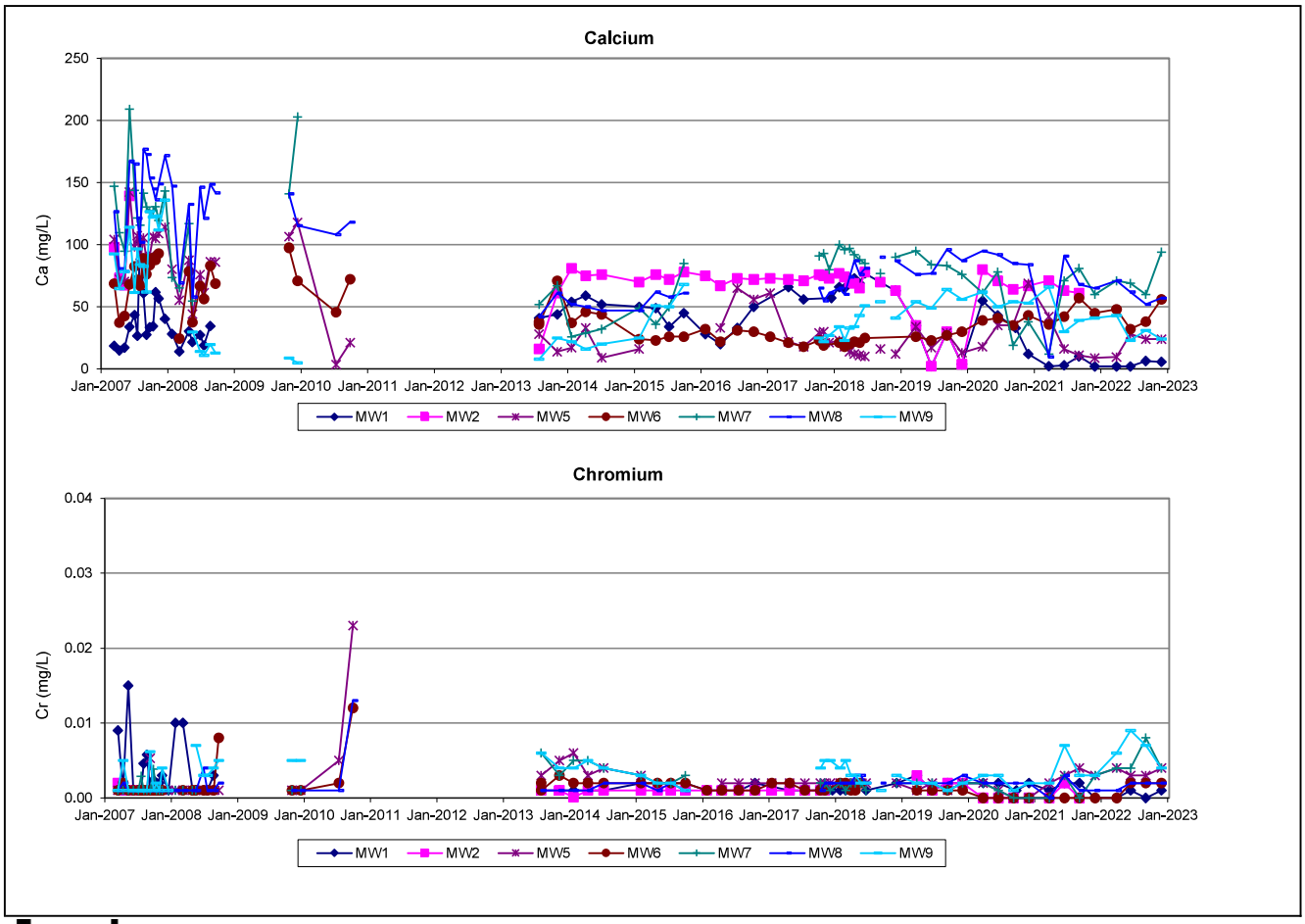
J:\IE\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Al As



Jacobs

BASELINE GROUNDWATER QUALITY [BORON CADMIUM] FIGURE 8

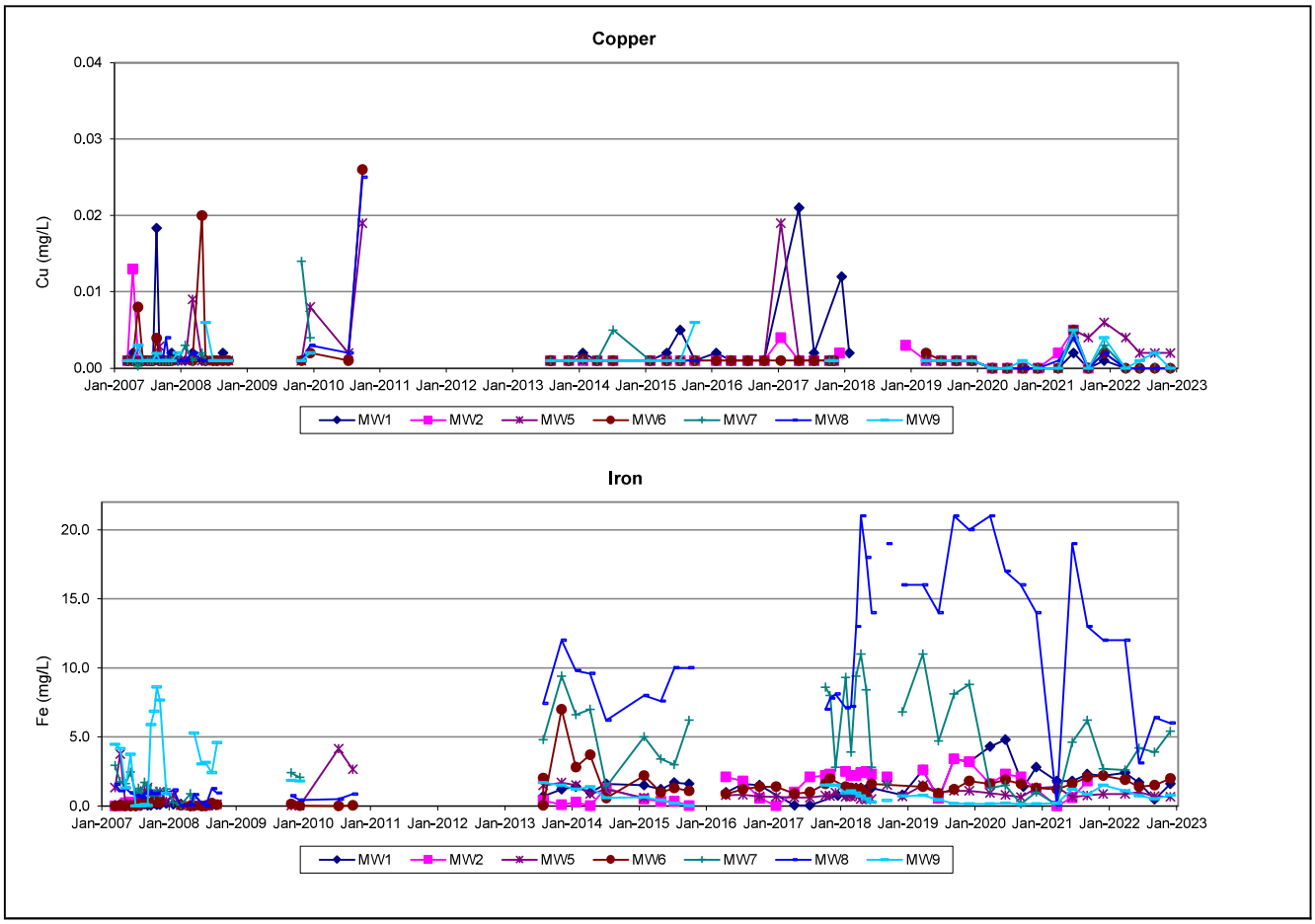
J:\IE\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]B Cd



Jacobs

BASELINE GROUNDWATER QUALITY [CALCIUM CHROMIUM] FIGURE 9

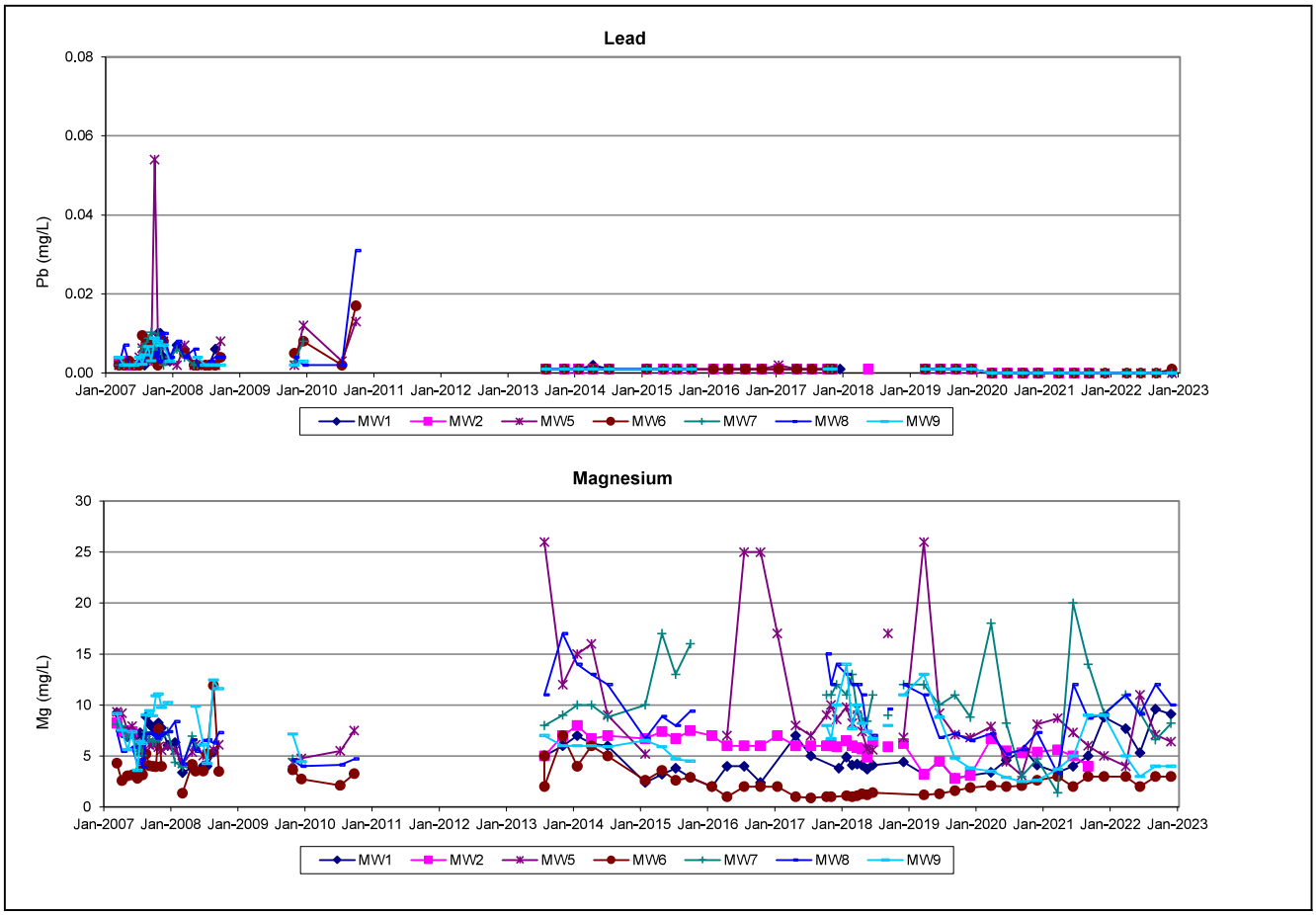
J:\E\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Ca Cr



Jacobs

BASELINE GROUNDWATER QUALITY [COPPER IRON] FIGURE 10

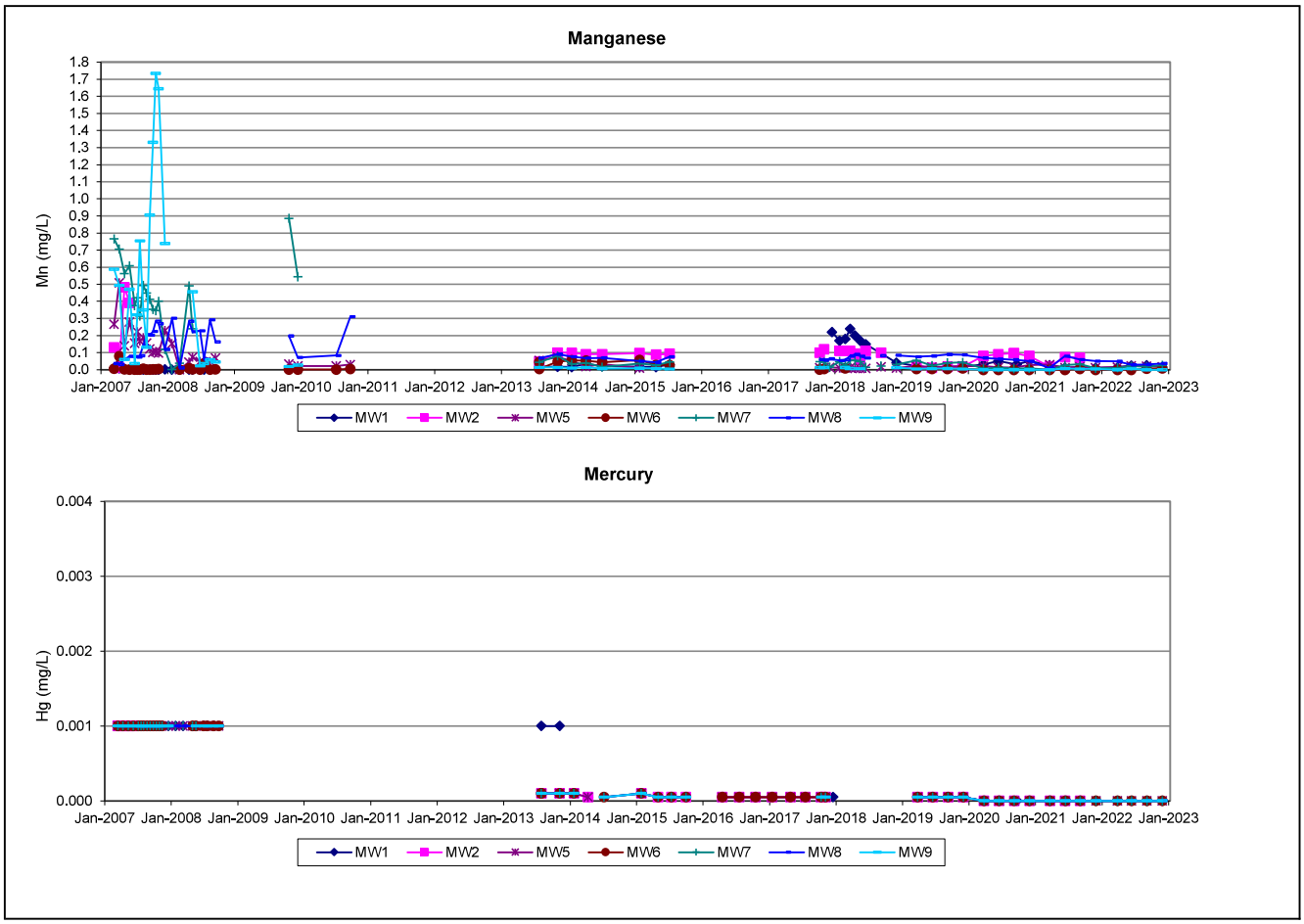
J:\E\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Fe Cu



Jacobs

BASELINE GROUNDWATER QUALITY [LEAD MAGNESIUM] FIGURE 11

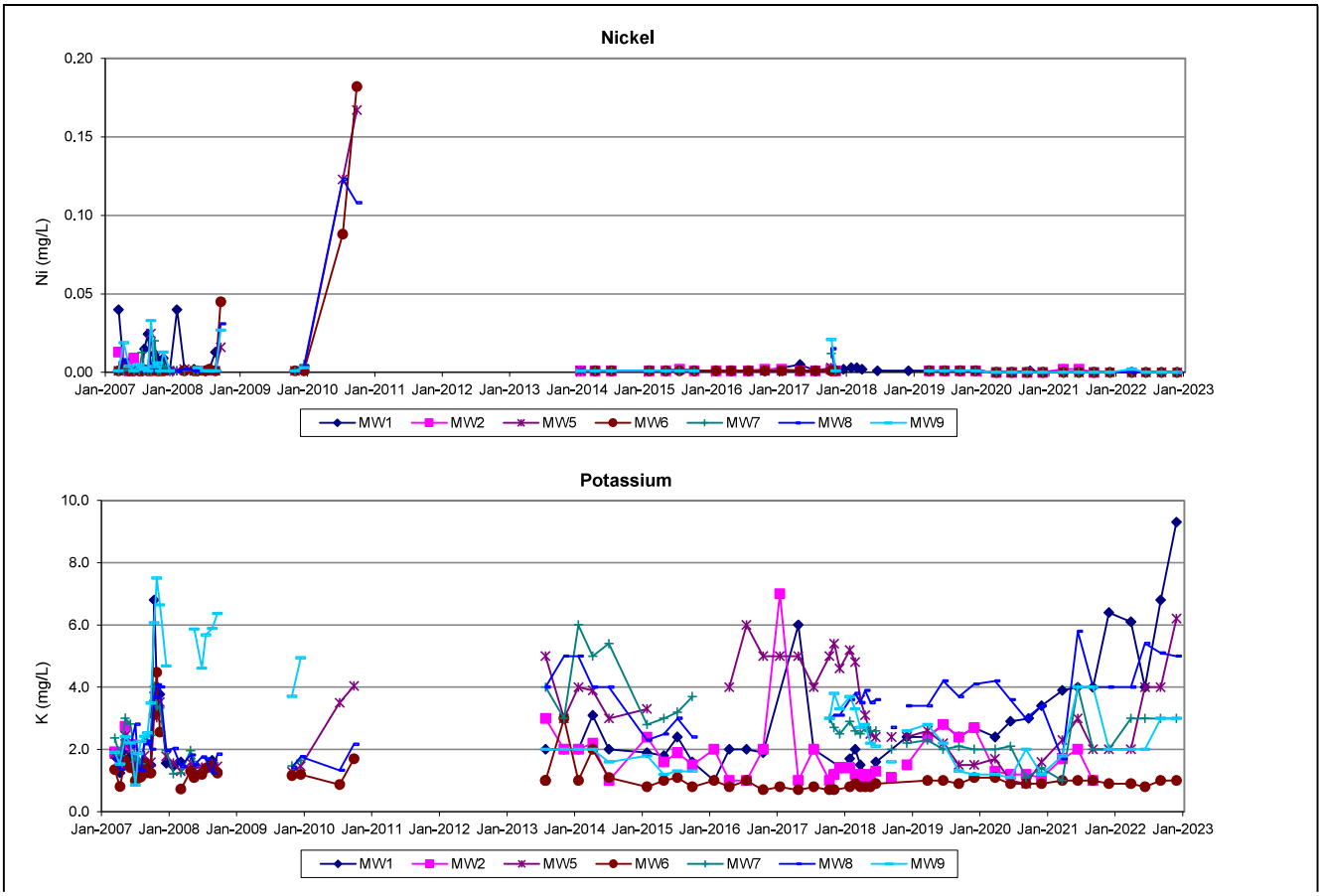
J:\E\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Mg Pb



Jacobs

BASELINE GROUNDWATER QUALITY [MANGANESE MERCURY] FIGURE 12

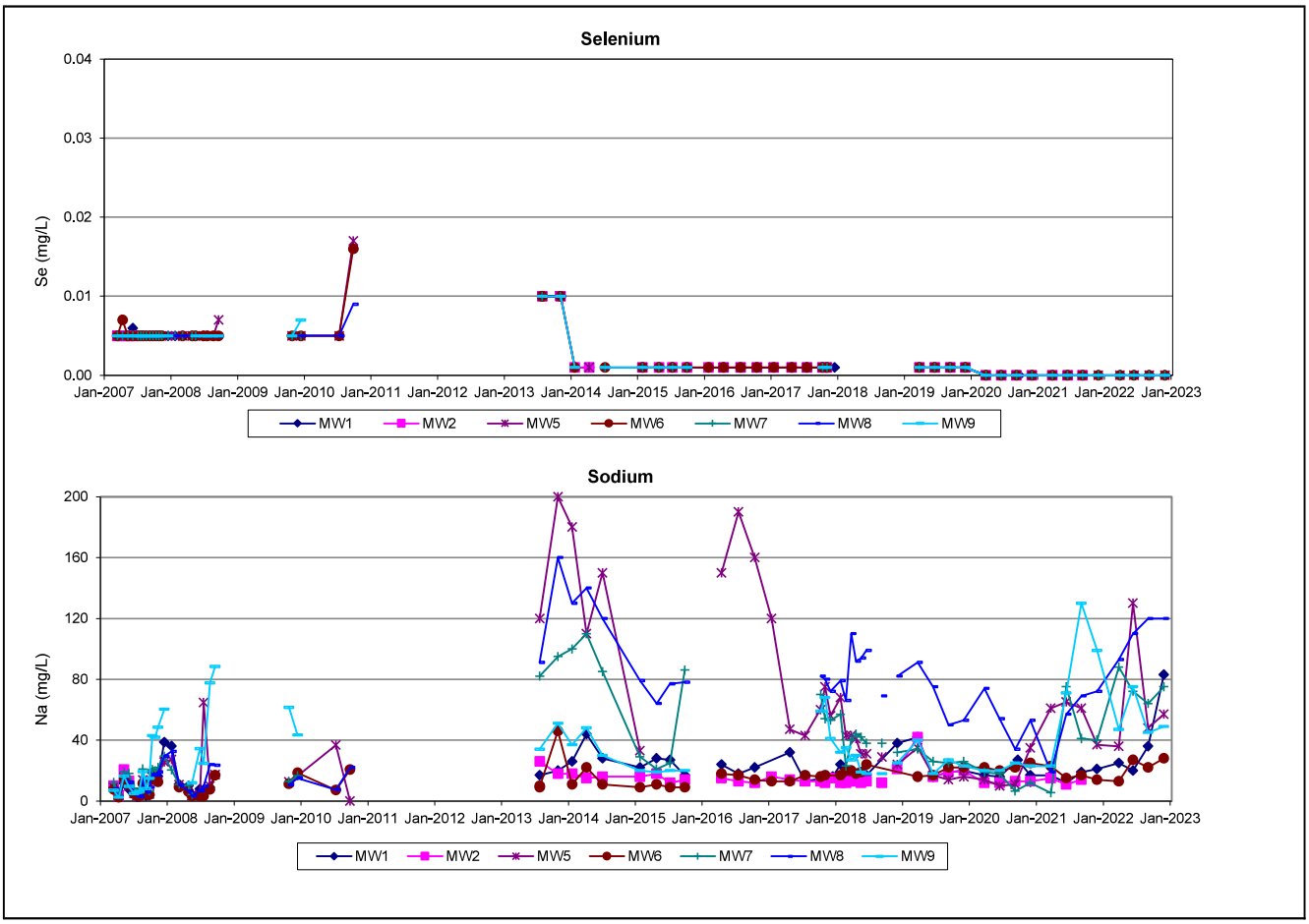
J:\E\Projects\04_Eastern\IA133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Hg Mn



Jacobs

BASELINE GROUNDWATER QUALITY [NICKEL POTASSIUM] FIGURE 13

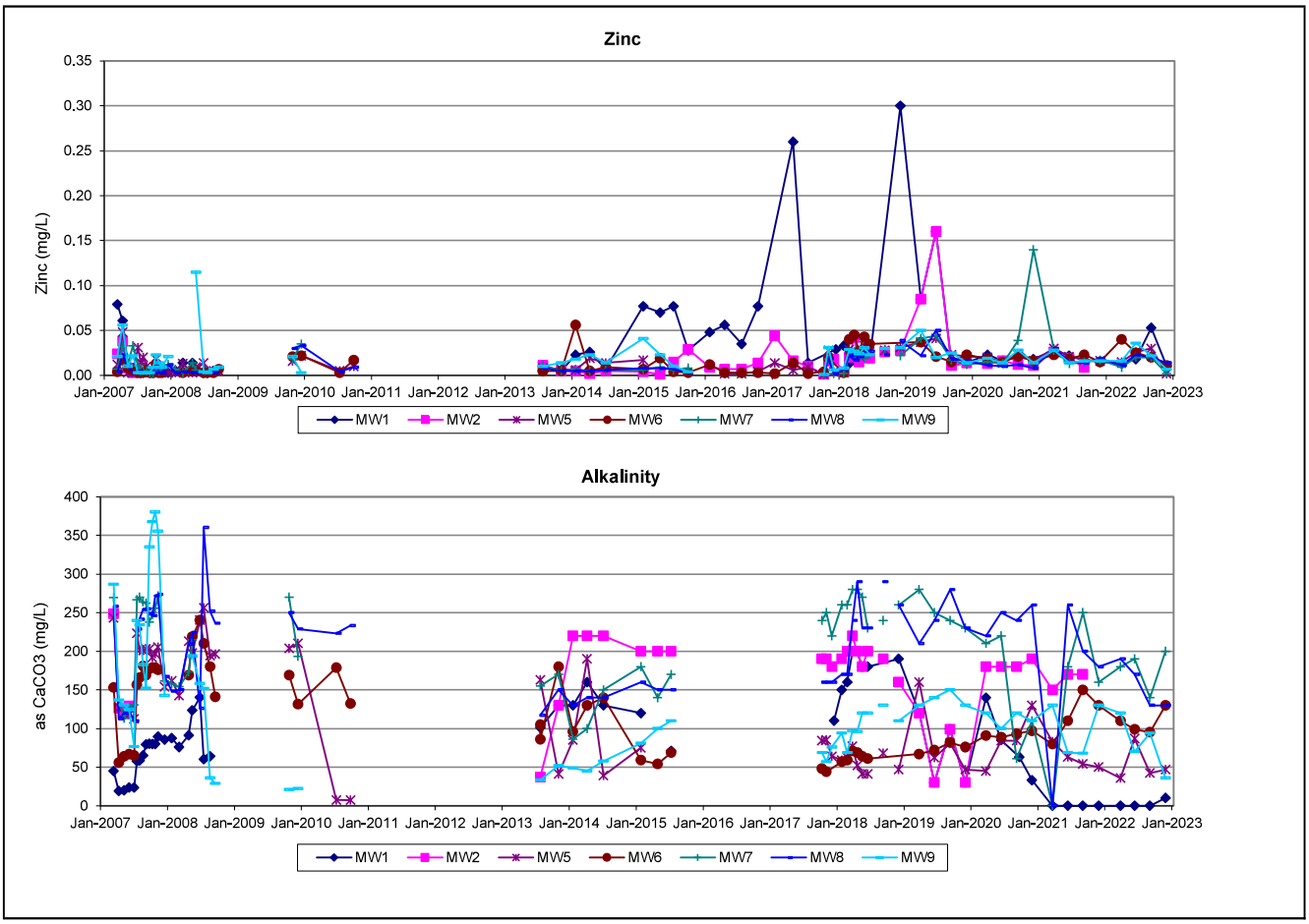
J:\IE\Projects\04_Eastern\IA133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]K Ni



Jacobs

BASELINE GROUNDWATER QUALITY [SELENIUM SODIUM] FIGURE 14

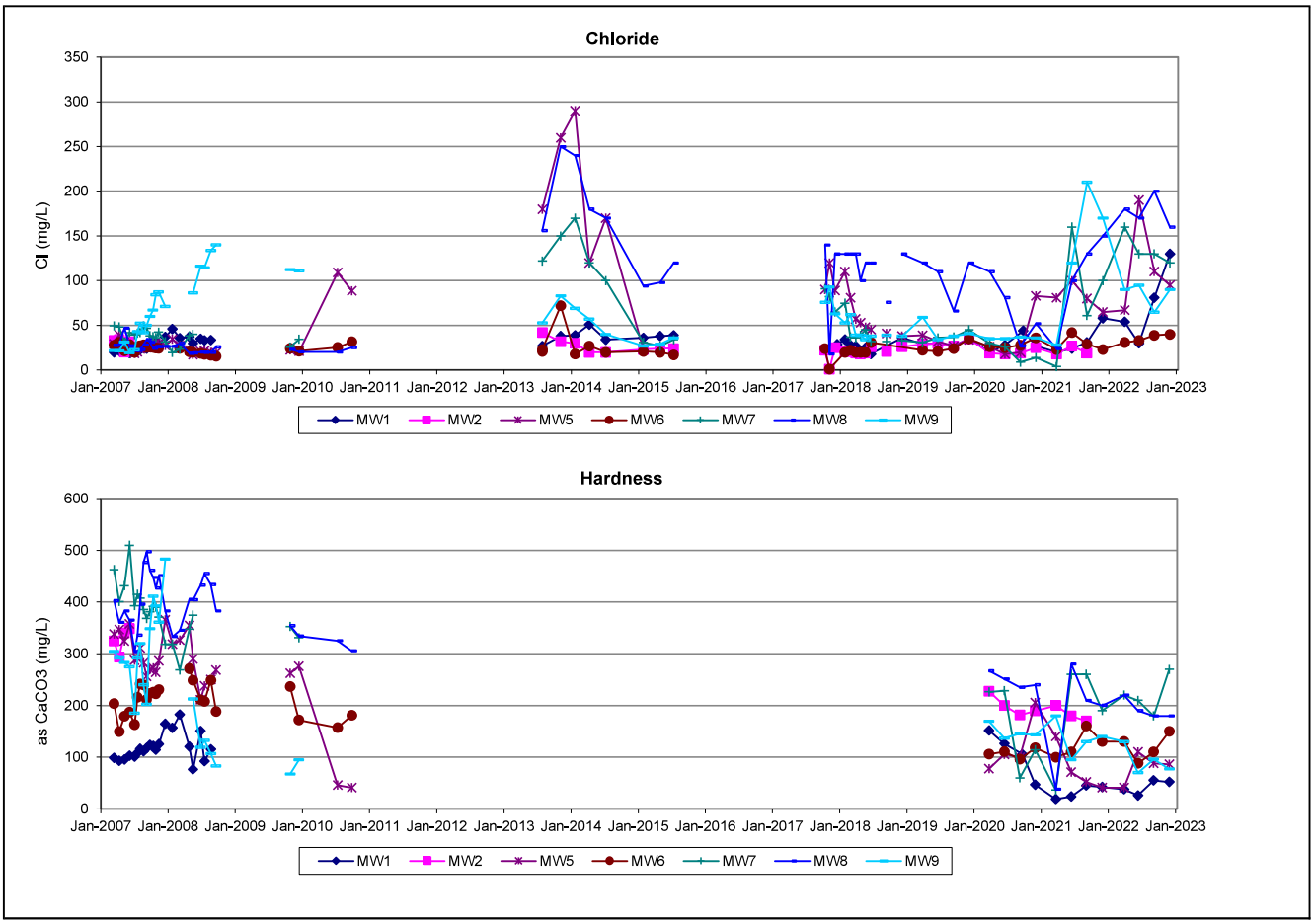
J:\E\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Na Se



Jacobs

BASELINE GROUNDWATER QUALITY [ZINC ALKALINITY] FIGURE 15

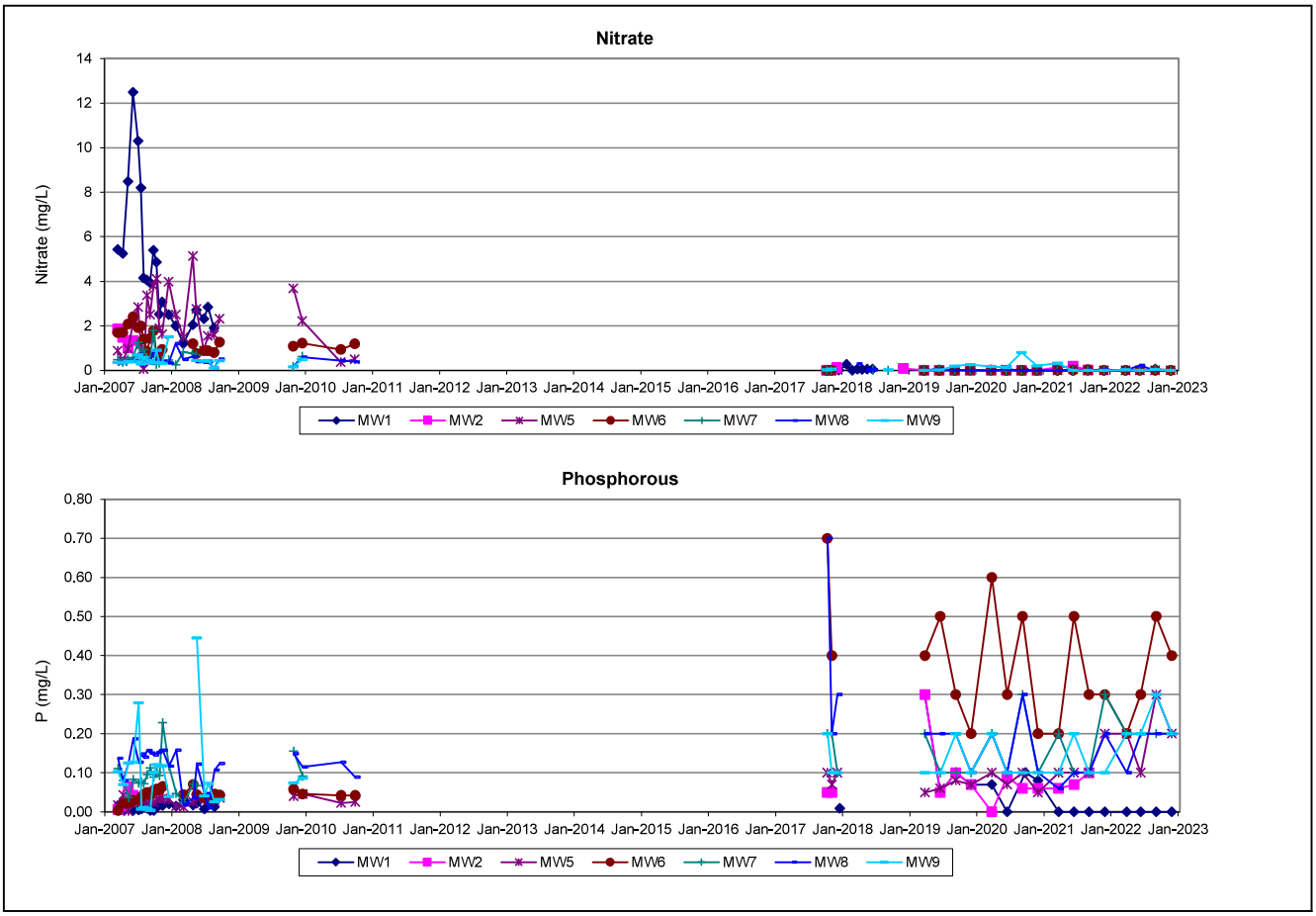
J:\IE\Projects\04_Eastern\IA133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]CaCO3 Zn



Jacobs

BASELINE GROUNDWATER QUALITY [CHLORIDE HARDNESS] FIGURE 16

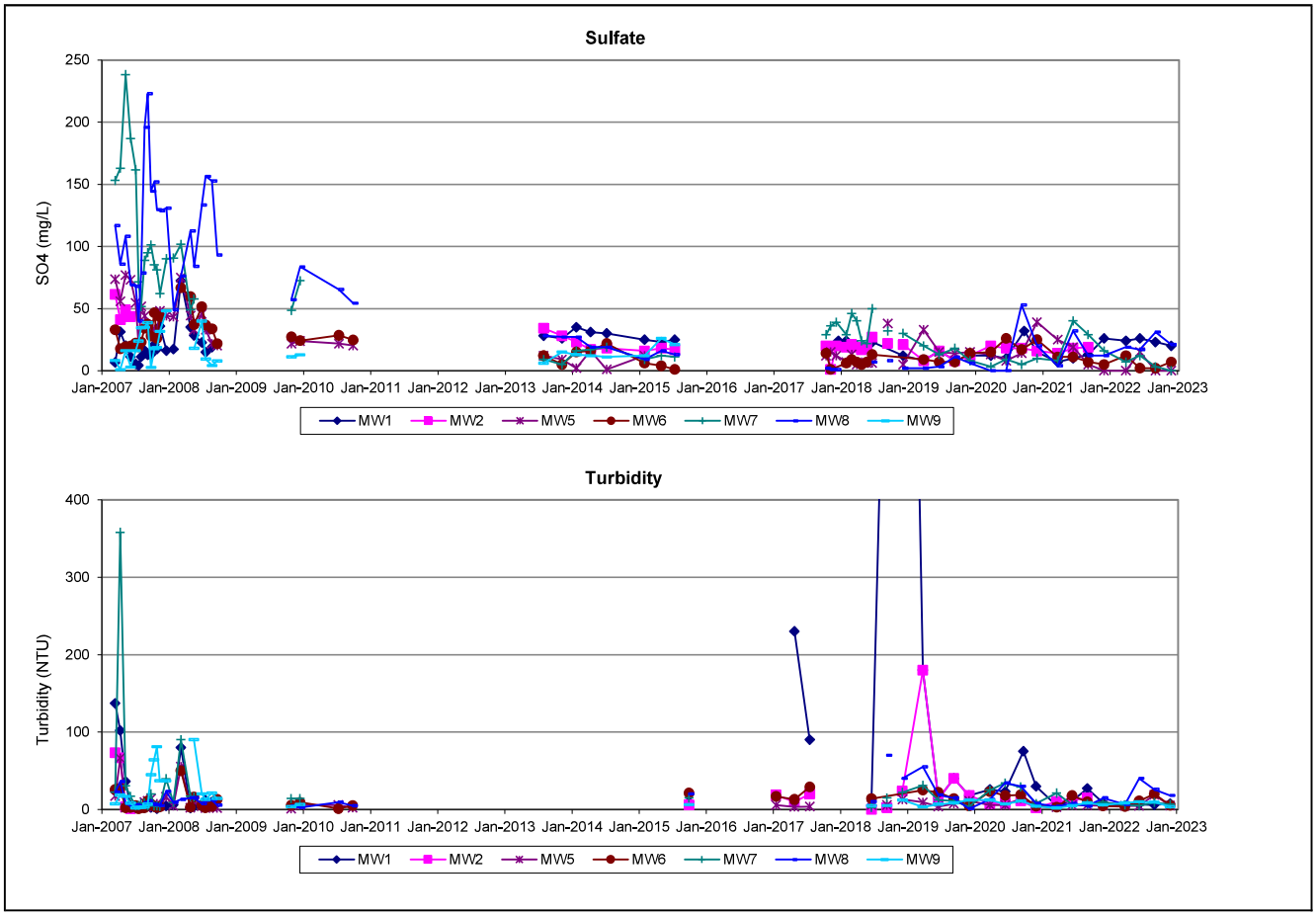
J:\E\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]Hardness Cl



Jacobs

BASELINE GROUNDWATER QUALITY [NITRATE PHOSPHOROUS] FIGURE 17

J:\IE\Projects\04_Eastern\A133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]P Nitrate



Jacobs

BASELINE GROUNDWATER QUALITY [SULPHATE TURBIDITY] FIGURE 18

J:\IE\Projects\04_Eastern\IA133800\02 Documents\Groundwater Analysis\2022 Groundwater Data\[Comprehensive Water Quality figs_2022.xlsx]NTU SO4

Jacobs

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

Appendix B – 2022 Groundwater quality monitoring results (MW series bores)

	MW1				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	5	6.6	6	7.6
[mg/L]	Chloride	54	30	81	130
[mg/L]	Sulphate as SO4	24	26	23	20
[mg/L]	Al	0.74	0.71	0.34	1.3
[mg/L]	As	<0.001	<0.001	<0.001	<0.001
[mg/L]	B	0.04	0.04	0.04	0.04
[mg/L]	Ca	2	2	6.4	5.8
[mg/L]	Cd	<0.0001	<0.0001	<0.0001	<0.0001
[mg/L]	Cr	<0.001	0.001	<0.001	0.001
[mg/L]	Cu	<0.001	<0.001	<0.001	<0.001
[mg/L]	Fe	2.4	1.7	0.47	1.6
[mg/L]	K	6.1	4	6.8	9.2
[mg/L]	Mg	7.7	5.3	9.6	9.1
[mg/L]	Mn	0.014	0.025	0.026	0.016
[mg/L]	N				
[mg/L]	Na	25	20	36	83
[mg/L]	Ni	<0.001	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	<0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.013	0.018	0.053	0.01
[mg/L]	Filtrable P	<0.05	<0.05	<0.05	<0.05
[mg/L]	Nitrate -N	<0.005	0.01	0.052	0.005
[mg CaCO3/L]	Alkalinity	<30	<30	<30	10
[mg/L]	Hardness as CaCO3	38	26	55	52
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	<0.1	<0.1	<0.1	<0.1

Note: trigger exceedances highlighted red

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

	MW5				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	4.5	4.6	19	4.9
[mg/L]	Chloride	67	190	110	95
[mg/L]	Sulphate as SO4	<1	15	<1	<1
[mg/L]	Al	3.3	1.8	1.8	2.8
[mg/L]	As	0.002	0.006	0.002	0.001
[mg/L]	B	0.05	0.06	0.04	0.03
[mg/L]	Ca	9.5	28	24	24
[mg/L]	Cd	<0.0001	<0.0001	0.0003	<0.0001
[mg/L]	Cr	0.004	0.003	0.003	0.004
[mg/L]	Cu	0.004	0.002	0.002	0.002
[mg/L]	Fe	0.85	1	0.7	0.67
[mg/L]	K	2	4	4	6.2
[mg/L]	Mg	4	11	7.1	6.4
[mg/L]	Mn	0.016	0.023	0.02	0.018
	N				
[mg/L]	Na	36	130	48	57
[mg/L]	Ni	<0.001	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	<0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.015	0.026	0.03	0.002
[mg/L]	Filtrable P	0.2	0.1	0.3	0.2
[mg/L]	Nitrate -N	<0.050	<0.050	<0.005	<0.005
[mg CaCO3/L]	Alkalinity	36	87	42	47
[mg/L]	Hardness as CaCO3	41	110	88	86
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	<0.1	<0.1	<0.1	<0.1

Note: trigger exceedances highlighted red

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

	MW6				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	4	11	20	5.3
[mg/L]	Chloride	31	33	39	40
[mg/L]	Sulphate as SO4	12	2	2	7
[mg/L]	Al	0.07	0.16	0.21	0.2
[mg/L]	As	0.029	0.019	0.014	0.018
[mg/L]	B	<0.02	0.03	0.03	0.02
[mg/L]	Ca	48	32	38	56
[mg/L]	Cd	<0.0001	<0.0001	<0.0001	<0.0001
[mg/L]	Cr	<0.001	0.002	0.002	0.002
[mg/L]	Cu	<0.001	<0.001	<0.001	<0.001
[mg/L]	Fe	1.9	1.4	1.5	2
[mg/L]	K	0.9	0.8	1	1
[mg/L]	Mg	3	2	3	3
[mg/L]	Mn	<0.005	<0.005	0.006	0.007
[mg/L]	N				
[mg/L]	Na	13	27	22	28
[mg/L]	Ni	<0.001	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.04	0.025	0.02	0.011
[mg/L]	Filtrable P	0.2	0.3	0.5	0.4
[mg/L]	Nitrate -N	<0.005	<0.005	<0.005	<0.005
[mg CaCO3/L]	Alkalinity	110	99	95	130
[mg/L]	Hardness as CaCO3	130	88	110	150
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	0.2	0.1	0.1	0.1

Note: trigger exceedances highlighted red

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

	MW7				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	6	4.9	9	6.7
[mg/L]	Chloride	160	130	130	120
[mg/L]	Sulphate as SO4	7	12	3	<1
[mg/L]	Al	0.54	0.29	0.72	0.34
[mg/L]	As	0.007	0.006	0.005	0.004
[mg/L]	B	0.06	0.07	0.05	0.04
[mg/L]	Ca	71	69	60	94
[mg/L]	Cd	<0.0001	<0.0001	0.0008	<0.0001
[mg/L]	Cr	0.004	0.004	0.008	0.004
[mg/L]	Cu	<0.001	<0.001	<0.001	<0.001
[mg/L]	Fe	2.6	4.2	3.9	5.4
[mg/L]	K	3	3	3	3
[mg/L]	Mg	11	9.3	6.6	8.2
[mg/L]	Mn	0.011	0.021	0.018	0.027
	N				
[mg/L]	Na	88	72	64	75
[mg/L]	Ni	<0.001	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	<0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.009	0.02	0.02	0.002
[mg/L]	Filtrable P	0.2	0.2	0.2	0.2
[mg/L]	Nitrate -N	<0.020	<0.005	0.04	<0.005
[mg CaCO3/L]	Alkalinity	180	190	140	200
[mg/L]	Hardness as CaCO3	220	210	180	270
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	<0.1	<0.1	<0.1	<0.1

Note: trigger exceedances highlighted red

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

	MW8				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	6.5	40	26	18
[mg/L]	Chloride	180	170	200	160
[mg/L]	Sulphate as SO4	19	17	31	21
[mg/L]	Al	0.03	0.02	0.05	0.05
[mg/L]	As	0.001	0.001	0.001	0.001
[mg/L]	B	0.06	0.07	0.06	0.05
[mg/L]	Ca	71	62	52	57
[mg/L]	Cd	<0.0001	<0.0001	<0.0001	<0.0001
[mg/L]	Cr	0.001	0.002	0.002	0.002
[mg/L]	Cu	<0.001	<0.001	<0.001	<0.001
[mg/L]	Fe	12	3.1	6.4	6
[mg/L]	K	4	5.4	5.1	5
[mg/L]	Mg	11	9.1	12	10
[mg/L]	Mn	0.049	0.029	0.032	0.036
	N				
[mg/L]	Na	93	110	120	120
[mg/L]	Ni	<0.001	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	<0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.011	0.023	0.02	0.014
[mg/L]	Filtrable P	0.1	0.2	0.2	0.2
[mg/L]	Nitrate -N	<0.005	0.22	<0.005	<0.005
[mg CaCO3/L]	Alkalinity	190	170	130	130
[mg/L]	Hardness as CaCO3	220	190	180	180
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	<0.1	<0.1	<0.1	<0.1

Note: trigger exceedances highlighted red

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

	MW9				
Units	**Date**	**30/03/2022**	**15/06/2022**	**7/09/2022**	**1/12/2022**
[NTU]	Turbidity	8.5	9.8	9.6	3.7
[mg/L]	Chloride	90	95	65	90
[mg/L]	Sulphate as SO4	14	4	3	<1
[mg/L]	Al	1.1	1.8	1.9	1.1
[mg/L]	As	0.013	0.008	0.005	0.003
[mg/L]	B	0.04	0.06	0.05	0.03
[mg/L]	Ca	43	23	31	24
[mg/L]	Cd	<0.0001	<0.0001	0.0002	<0.0001
[mg/L]	Cr	0.006	0.009	0.007	0.004
[mg/L]	Cu	<0.001	0.001	0.002	<0.001
[mg/L]	Fe	1.1	0.74	0.51	0.78
[mg/L]	K	2	2	3	3
[mg/L]	Mg	5	3	4	4
[mg/L]	Mn	<0.005	0.006	<0.005	<0.005
	N				
[mg/L]	Na	47	75	45	49
[mg/L]	Ni	0.002	<0.001	<0.001	<0.001
[mg/L]	Pb	<0.001	<0.001	<0.001	<0.001
[mg/L]	Se	<0.001	<0.001	<0.001	<0.001
[mg/L]	Zn	0.016	0.036	0.022	0.007
[mg/L]	Filtrable P	0.2	0.2	0.3	0.2
[mg/L]	Nitrate -N	0.02	<0.025	0.04	<0.005
[mg CaCO3/L]	Alkalinity	120	70	94	36
[mg/L]	Hardness as CaCO3	130	70	96	77
[mg/L]	Hg	<0.00005	<0.00005	<0.00005	<0.00005
[mg/L]	Fluoride	<0.1	<0.1	<0.1	<0.1

Note: trigger exceedances highlighted red

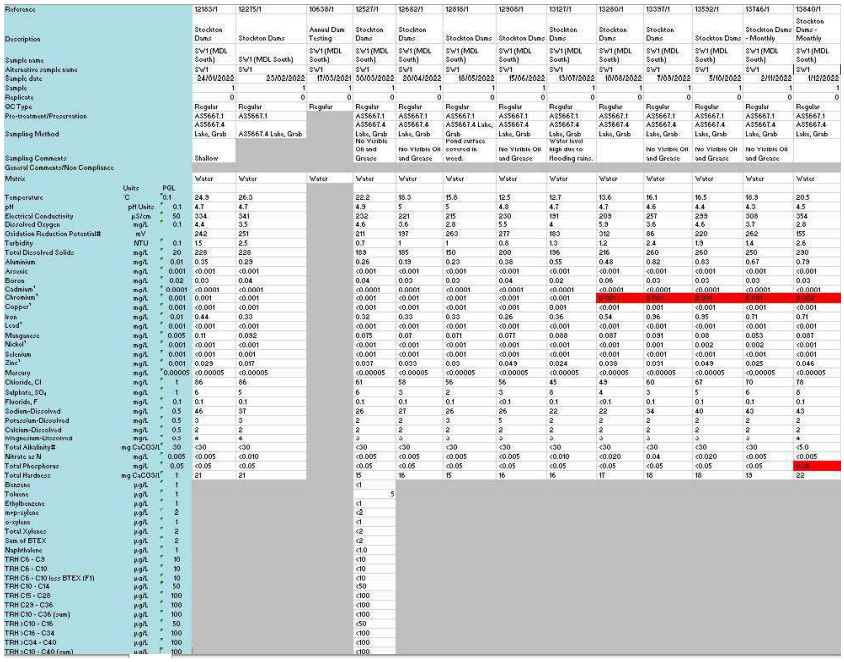
30 March 2023
Subject: Groundwater assessment for 2022 AEMR

Appendix C – 2022 Surface water quality monitoring results

Jacobs

30 March 2023

Subject: Groundwater assessment for 2022 AEMR



Reference			12183/1	12275/1	10638/1	12527/1	12682/1	12618/1	12308/1	13127/1	13280/1	13397/1	13532/1	13746/1	13449/1
Description			Stockton Dsmc	Stockton Dsmc	Annual Dsm Testing	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc	Stockton Dsmc - Monthly	Stockton Dsmc - Monthly
Sample name			SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)	SW1 (MDL South)
Alternative sample name			SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1	SW1
Sample date			24/09/2022	25/02/2022	17/05/2021	30/05/2022	20/04/2022	16/05/2022	15/06/2022	13/07/2022	10/08/2022	7/09/2022	5/10/2022	2/11/2022	1/12/2022
Sample			1	1	1	1	1	1	1	1	1	1	1	1	1
Replicate			0	0	0	0	0	0	0	0	0	0	0	0	0
QC Type			Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular
Pre-treatment/Preservation			AS5667.1	AS5667.1		AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1
Sampling Method			AS5667.4 Lake, Grab	AS5667.4 Lake, Grab		AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab
Sampling Comments			Shallow			No Visible Oil and Grease	No Visible Oil and Grease	Pond outlets connected to wood.	No Visible Oil and Grease	Water level high due to flooding rains.		No Visible Oil and Grease	No Visible Oil and Grease	No Visible Oil and Grease	
General Comments/Non Compliances															
Matrix	Units	PQL	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Temperature	°C	0.1	24.9	26.3		22.2	16.3	15.6	12.5	12.7	13.6	16.1	16.5	18.9	20.5
pH	pH Units	0.1	4.7	4.7		4.9	5	5	4.8	4.7	4.7	4.6	4.4	4.3	4.5
Electrical Conductivity	µS/cm	50	334	341		232	221	215	230	191	203	257	259	308	354
Dissolved Oxygen	mg/L	0.1	4.4	3.5		4.6	3.6	2.8	5.5	4	5.9	3.6	4.6	3.7	2.8
Oxidation Reduction Potential#	mV		242	251		211	197	263	277	183	312	86	220	262	155
Turbidity	NTU	0.1	1.5	2.5		0.7	1	1	0.8	1.3	1.2	2.4	1.9	1.4	2.6
Total Dissolved Solids	mg/L	20	228	228		159	165	150	200	136	216	260	260	250	290
Aluminium	mg/L	0.01	0.35	0.29		0.26	0.19	0.23	0.38	0.55	0.49	0.82	0.83	0.67	0.79
Arsenic	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.02	0.03	0.04		0.04	0.03	0.03	0.04	0.02	0.06	0.03	0.03	0.03	0.03
Cadmium[1]	mg/L	0.0001	<0.0001	<0.0001		<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium[1]	mg/L	0.001	0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	0.001	0.001
Copper[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.01	0.44	0.33		0.32	0.33	0.33	0.26	0.36	0.54	0.96	0.95	0.71	0.71
Lead[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.005	0.11	0.092		0.075	0.07	0.071	0.077	0.088	0.097	0.091	0.08	0.053	0.097
Nickel[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.002	<0.001
Selenium	mg/L	0.001	<0.001	0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc[1]	mg/L	0.001	0.029	0.017		0.037	0.033	0.03	0.043	0.024	0.039	0.031	0.043	0.025	0.046
Mercury	mg/L	0.00005	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Chloride, Cl	mg/L	1	86	86		61	58	55	56	45	43	60	57	70	76
Sulphate, SO_4	mg/L	1	6	5		6	3	2	3	8	4	3	5	6	8
Fluoride, F	mg/L	0.1	0.1	0.1		0.1	0.1	0.1	<0.1	0.1	<0.1	0.1	0.1	0.1	0.1
Sodium-Dissolved	mg/L	0.5	45	37		26	27	26	26	22	22	34	40	43	43
Potassium-Dissolved	mg/L	0.5	3	3		2	2	3	5	2	2	2	2	2	2
Calcium-Dissolved	mg/L	0.5	2	2		2	2	2	2	2	2	2	2	2	2
Magnesium-Dissolved	mg/L	0.3	4	4		3	3	3	3	3	3	3	3	3	4
Total Alkalinity#	mg CaCO3/L	30	<30	<30		<30	<30	<30	<30	<30	<30	<30	<30	<30	<5.0
Nitrate as N	mg/L	0.005	<0.005	<0.010		<0.005	<0.005	<0.005	<0.005	<0.010	<0.020	0.04	<0.020	<0.005	<0.005
Total Phosphorus	mg/L	0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06
Total Hardness	mg CaCO3/L	1	21	21		15	16	15	16	16	17	16	18	19	22
Benzene	µg/L	1				<1									
Toluene	µg/L	1					5								
Ethylbenzene	µg/L	1				<1									
m+p-xylene	µg/L	2				<2									
o-xylene	µg/L	1				<1									
Total Xylenes	µg/L	2				<2									
Sum of BTEX	µg/L	2				<2									
Naphthalene	µg/L	1				<1.0									
TRH C6 - C9	µg/L	10				<10									
TRH C6 - C10	µg/L	10				<10									
TRH C6 - C10 less BTEX (F1)	µg/L	10				<10									
TRH C10 - C14	µg/L	50				<50									
TRH C15 - C28	µg/L	100				<100									
TRH C29 - C36	µg/L	100				<100									
TRH C10 - C36 (sum)	µg/L	100				<100									
TRH >C10 - C16	µg/L	50				<50									
TRH >C16 - C34	µg/L	100				<100									
TRH >C34 - C40	µg/L	100				<100									
TRH >C10 - C40 (sum)	µg/L	100				<100									

Note: outside of default guideline range shown red highlighted

[1]Adjusted trigger values apply for selected metals in freshwaters of varying water hardness as per the ANZECC 2000

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

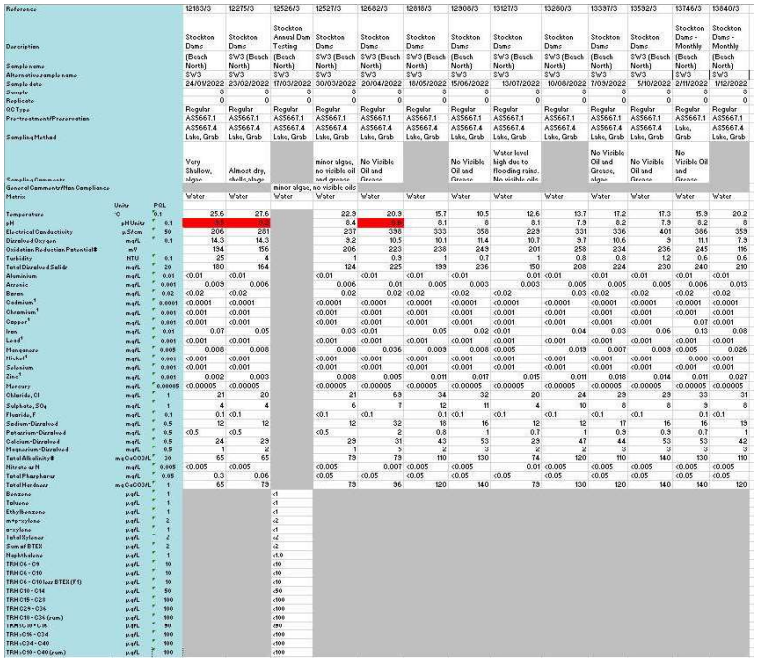
Reference			12183/2	12275/2	12526/2	12527/2	12662/2	12815/2	12906/2	13127/2	13260/2	13397/2	13532/2	13746/2	13840/2
Description			Stockton Dams	Stockton Dams	Stockton Annual Dam Testing	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams	Stockton Dams - Monthly	Stockton Dams - Monthly
Sample name			SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)	SW2 (MDL North)
Alternative sample name															
Sample date			24/01/2022	23/02/2022	17/03/2021	30/03/2022	20/04/2022	18/05/2022	15/06/2022	13/07/2022	10/08/2022	7/09/2022	5/10/2022	2/11/2022	1/12/2022
Sample			2	2	2	2	2	2	2	2	2	2	2	2	2
Replicate			0	0	0	0	0	0	0	0	0	0	0	0	0
QC Type			Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular
Pre-treatment/Preservation			AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1
Sampling Method			AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab
Sampling Comments			Shallow		No visible oils	No Visible Oil and Greases	No Visible Oil and Greas		No Visible Oil and Greas	Water level high due to flooding rains. No visible oils.		No Visible Oil and Greas	No Visible Oil and Greas	No Visible Oil and Greas	mV retested at 13:38 at 21.2C
General Comms on Plan Compliance															
Matrix			Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
	Units	PQL													
Temperature	°C	0.1	25.1	24.3		21.5	18.3	15.9	9.5	11.9	12.3	15.2	16.9	19.1	20.5
pH	pH Units	0.1	7.6	7.7		7.4	7.2	7.1	7.3	6.7	6.5	6.8	6.8	6.8	6.9
Electrical Conductivity	µS/cm	10	422	409		319	323	324	306	217	225	261	280	270	327
Dissolved Oxygen	mg/L	0.1	7.2	5.6		4.4	4.3	4.4	7.1	5.2	5.6	3.1	3.2	2.7	3.7
Oxidation Reduction Potential@	mV		234	225		256	254	252	225	188	265	251	166	259	95
Turbidity	NTU	0.1	1.5	1.5		1.5	1.5	1.5	5.8	6.4	5.4	6.7	10	5.1	1.9
Total Dissolved Solids	mg/L	10	256	238		208	202	206	200	136	224	252	270	200	250
Aluminium	mg/L	0.01	0.01	0.01		0.01	0.01	0.01	0.03	0.26	0.06	0.04	0.08	0.03	0.01
Arsenic	mg/L	0.001	0.001	0.001		0.001	<0.001	<0.001	<0.001	0.002	0.003	0.002	0.002	0.001	0.001
Boron	mg/L	0.02	0.03	0.04		0.04	0.03	0.03	0.04	0.03	0.06	0.04	0.03	0.04	0.03
Cadmium[1]	mg/L	0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.002	0.001	<0.001	<0.001
Copper[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.002	<0.001	0.001	0.002
Iron	mg/L	0.01	0.04	0.03		0.05	0.12	0.05	0.08	0.37	1.1	1.5	2	1.2	0.49
Lead[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.005	0.082	0.081		0.063	0.1	0.059	0.066	0.83	0.59	0.71	0.43	0.52	0.101
Nickel[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.003	0.002	0.002	0.002	0.002	<0.001
Selenium	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc[1]	mg/L	0.001	0.015	0.015		0.015	0.016	0.012	0.011	0.018	0.039	0.023	0.027	0.035	0.036
Mercury	mg/L	0.00005	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Chloride, Cl	mg/L	1	42	43		31	35	35	37	25	34	41	41	42	45
Sulphate, SO_4	mg/L	1	3	4		3	2	2	2	12	2	2	3	2	3
Fluoride, F	mg/L	0.1	0.3	0.3		0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
Sodium-Dissolved	mg/L	0.5	25	20		18	18	21	19	16	18	23	23	22	26
Potassium-Dissolved	mg/L	0.5	4	3		3	4	3	3	3	2	3	3	4	4
Calcium-Dissolved	mg/L	0.5	46	44		35	38	36	35	18	16	19	20	19	21
Magnesium-Dissolved	mg/L	0.5	5	5		4	4	4	4	4	3	3	3	3	4
Total Alkalinity @	mgCaCO3/L	20	140	130		110	110	100	95	47	43	52	54	50	63
Nitrate as N	mg/L	0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.010	<0.050	0.05	<0.020	<0.005	<0.005
Total Phosphorus	mg/L	0.05	<0.05	<0.05		<0.05	<0.05	<0.05	<0.05	0.06	<0.05	0.07	0.06	<0.05	<0.05
Total Hardness	mgCaCO3/L	1	140	130		100	110	110	100	61	54	61	65	60	69
Benzene	µg/L	1			<1										
Toluene	µg/L	1			<1										
Ethylbenzene	µg/L	1			<1										
m+p-xylene	µg/L	2			<2										
o-xylene	µg/L	1			<1										
Total Xylenes	µg/L	2			<2										
Sum of BTEX	µg/L	2			<2										
Naphthalene	µg/L	1			<1.0										
TRH C6 - C9	µg/L	10			<10										
TRH C6 - C10	µg/L	10			<10										
TRH C6 - C10 less BTEX (F1)	µg/L	10			<10										
TRH C10 - C16	µg/L	50			<50										
TRH C15 - C28	µg/L	100			<100										
TRH C29 - C36	µg/L	100			<100										
TRH C10 - C36 (sum)	µg/L	100			<100										
TRH >C16 - C36	µg/L	50			<50										
TRH >C16 - C34	µg/L	100			<100										
TRH >C34 - C40	µg/L	100			<100										
TRH >C16 - C40 (sum)	µg/L	100			<100										

Note: outside of default guideline range shown red highlighted

[1]Adjusted trigger values apply for selected metals in freshwaters of varying water hardness as per the ANZECC 2000

30 March 2023

Subject: Groundwater assessment for 2022 AEMR



Reference			12183/3	12275/3	12526/3	12527/3	12682/3	12818/3	12908/3	13127/3	13280/3	13397/3	13592/3	13746/3	13840/3
Description			Stockton Dams (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Annual Dam Testing SW3 (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams (Beach North)	Stockton Dams SW3 (Beach North)	Stockton Dams - Monthly SW3 (Beach North)	Stockton Dams - Monthly (Beach North)
Sample name															
Alternative sample name			SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3	SW3
Sample date			24/01/2022	23/02/2022	17/03/2022	30/03/2022	20/04/2022	18/05/2022	15/06/2022	13/07/2022	10/08/2022	7/09/2022	5/10/2022	2/11/2022	1/12/2022
Intensity			0	0	0	0	0	0	0	0	0	0	0	0	0
Replicate			0	0	0	0	0	0	0	0	0	0	0	0	0
QC Type			Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular
Pre-treatment/Preservation			AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1	AS5667.1
Sampling Method			AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	AS5667.4 Lake, Grab	Lake, Grab	AS5667.4 Lake, Grab
Sampling Comments			Very Shallow, algae	Almost dry, shells, algae		minor algae, no visible oil and grease	No Visible Oil and Grease		No Visible Oil and Grease	Water level high due to flooding rains. No visible oils		No Visible Oil and Grease, algae	No Visible Oil and Grease	No Visible Oil and Grease	
Source Comments/Wet Compliance					minor algae, no visible oils										
Metric	Units	PQL	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
Temperature	°C	0.1	25.6	27.6		22.9	20.9	15.7	10.5	12.6	13.7	17.2	17.3	15.9	20.2
pH	pH Units	0.1	8.6	8.8		8.4	8.4	8.1	8	8.1	7.9	8.2	7.9	8.2	8
Electrical Conductivity	µS/cm	50	206	231		237	330	333	356	229	331	336	401	366	359
Dissolved Oxygen	mg/L	0.1	14.3	14.3		9.2	10.5	10.1	11.4	10.7	9.7	10.6	9	11.1	7.9
Oxidation Reduction Potential#	mV		194	156		206	223	238	249	201	258	234	236	245	116
Turbidity	NTU	0.1	25	4		1	0.9	1	0.7	1	0.8	0.8	1.2	0.6	0.6
Total Dissolved Solids#	mg/L	20	180	164		124	225	199	236	150	208	224	230	240	230
Aluminium	mg/L	0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	mg/L	0.001	0.003	0.006		0.006	0.01	0.005	0.003	0.003	0.005	0.005	0.005	0.006	0.013
Boron	mg/L	0.02	<0.02	<0.02		0.02	0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Cadmium[1]	mg/L	0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	<0.001
Iron	mg/L	0.01	0.07	0.05		0.03	<0.01	0.05	0.02	<0.01	0.04	0.03	0.06	0.13	0.08
Lead[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.005	0.006	0.006		0.006	0.036	0.003	0.006	0.005	0.013	0.007	0.003	0.005	0.026
Nickel[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.009	<0.001
Selenium	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc[1]	mg/L	0.001	0.002	0.003		0.008	0.005	0.011	0.017	0.015	0.011	0.018	0.014	0.011	0.027
Mercury	mg/L	0.00005	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Chloride, Cl	mg/L	1	21	20		21	53	34	32	20	24	29	29	33	31
Sulphate, SO4	mg/L	1	4	4		6	7	12	11	4	10	8	8	9	8
Fluoride, F	mg/L	0.1	0.1	<0.1		<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Sodium-Dissolved	mg/L	0.5	12	12		12	32	18	16	12	12	17	16	16	19
Potassium-Dissolved	mg/L	0.5	<0.5	<0.5		<0.5	2	0.8	1	0.7	1	0.9	0.9	0.7	1
Calcium-Dissolved	mg/L	0.5	24	29		29	31	43	53	29	47	44	53	53	42
Magnesium-Dissolved	mg/L	0.5	1	2		1	3	2	3	2	2	3	3	3	3
Total Alkalinity#	mg CaCO3/L	20	65	65		79	79	110	130	74	120	110	140	130	110
Nitrate as N	mg/L	0.005	<0.005	<0.005		<0.005	0.007	<0.005	<0.005	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Total Phosphorus	mg/L	0.05	0.3	0.06		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total Hardness	mg CaCO3/L	1	65	79		79	96	120	140	79	130	120	140	140	120
Benzene	µg/L	1			<1										
Toluene	µg/L	1			<1										
Ethylbenzene	µg/L	1			<1										
m+p-xylene	µg/L	2			<2										
o-xylene	µg/L	1			<1										
Total Xylenes	µg/L	2			<2										
Sum of BTEX	µg/L	2			<2										
Naphthalene	µg/L	1			<1.0										
TRH C6 - C9	µg/L	10			<10										
TRH C6 - C10	µg/L	10			<10										
TRH C6 - C10 less BTEX (F1)	µg/L	10			<10										
TRH C10 - C14	µg/L	50			<50										
TRH C15 - C28	µg/L	100			<100										
TRH C29 - C36	µg/L	100			<100										
TRH C10 - C36 (sum)	µg/L	100			<100										
TRH >C6 - C10	µg/L	50			<50										
TRH >C10 - C16	µg/L	100			<100										
TRH >C16 - C34	µg/L	100			<100										
TRH >C34 - C40	µg/L	100			<100										
TRH >C10 - C40 (sum)	µg/L	100			<100										

Note: outside of default guideline range shown red highlighted

[1]Adjusted trigger values apply for selected metals in freshwaters of varying water hardness as per the ANZECC 2000

30 March 2023

Subject: Groundwater assessment for 2022 AEMR

Reference			12163/4	12215/4	12526/4	12527/4	12682/4	12819/4	12908/4	13127/4	13260/4	13397/4	13532/4	13746/4	13840/4
Description			Stockton Dump	Stockton Dump	Stockton Annual Dun Testing	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump	Stockton Dump - Monthly	Stockton Dump - Monthly
Sample name			SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)	SW4 (Beach South)
Alternative sample name			SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4	SW4
Sample date			24/01/2022	23/02/2022	30/03/2022	30/03/2022	20/04/2022	18/05/2022	15/06/2022	13/07/2022	10/08/2022	7/09/2022	5/10/2022	2/11/2022	1/12/2022
Samples			4	4	4	4	4	4	4	4	4	4	4	4	4
Replicate			0	0	0	0	0	0	0	0	0	0	0	0	0
QC Type			Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular	Regular
Pre-treatment/Preservation			AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab	AS5667.1 AS5667.4 Lake, Grab
Sampling Method			Very Shallow	Very shallow	minor algae, no visible oils	minor algae, no visible oils and grease	No Visible Oil and Grease	No Visible Oil and Grease	No Visible Oil and Grease	high due to flooding rains. No		Oil and Grease, algae	No Visible Oil and Grease	No Visible Oil and Grease	
Sampling Comments															
General Comments/Met Compliance															
Matrix			Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water	Water
	Units	PQL													
Temperature	°C	0.1	24.3	26.4		22.5	20	15.9	11.1	12.8	14.4	17	17.6	15.2	20.7
pH	pH Units	0.1	8.5	8.5		8.5	8.5	8.4	8.4	8.4	8.4	8.3	8.3	8.3	8.5
Electrical Conductivity	µS/cm	50	307	280		256	213	319	329	225	347	364	369	352	319
Dissolved Oxygen	mg/L	0.1	9.7	10.4		9.4	10.3	10.2	11.9	10.9	10.4	10.5	9.3	10.6	9.2
Oxidation Reduction Potential®	mV		160	96		121	193	212	220	197	223	232	217	91	145
Turbidity	NTU	0.1	20	5		15	8.5	6.8	4.9	2.2	2.9	3.5	6.7	6.7	4.9
Total Dissolved Solids	mg/L	20	193	146		156	159	182	213	135	208	208	190	200	160
Aluminium	mg/L	0.01	0.03	0.02		0.02	<0.01	0.01	0.02	0.02	<0.01	<0.01	0.01	<0.01	0.01
Arsenic	mg/L	0.001	0.008	0.006		0.006	0.005	0.005	0.005	0.003	0.004	0.004	0.003	0.005	0.004
Boron	mg/L	0.02	<0.02	0.02		0.02	<0.02	<0.02	0.02	<0.02	0.03	0.03	0.03	0.02	0.03
Cadmium[1]	mg/L	0.0001	<0.0001	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001
Chromium[1]	mg/L	0.001	0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.01	0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Lead[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.005	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	<0.005	<0.005	<0.005
Nickel[1]	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Selenium	mg/L	0.001	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc[1]	mg/L	0.001	0.005	0.004		0.006	0.007	0.011	0.013	0.012	0.009	0.015	0.03	0.01	0.01
Mercury	mg/L	0.00005	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Chloride, Cl	mg/L	1	47	39			25	25	24	27	20	23	23	23	31
Sulphate, SO4	mg/L	1	13	10			8	9	14	11	6	11	12	13	15	12
Fluoride, F	mg/L	0.1	<0.1	<0.1			0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium-Dissolved	mg/L	0.5	25	21			14	13	14	14	12	12	17	17	17	21
Potassium-Dissolved	mg/L	0.5	4	1			0.8	0.8	1	1	0.8	2	1	1	1	2
Calcium-Dissolved	mg/L	0.5	23	22			31	34	42	48	28	42	45	43	41	28
Magnesium-Dissolved	mg/L	0.5	4	4			2	3	4	4	2	3	4	5	5.2	5.2
Total Alkalinity®	mg CaCO3/L	20	61	62			87	87	110	120	71	120	120	120	97	85
Nitrate as N	mg/L	0.005	0.02	<0.005			<0.005	<0.005	0.007	0.18	<0.005	<0.005	<0.005	<0.005	0.003	<0.005
Total Phosphorus	mg/L	0.05	0.1	0.05			0.09	0.03	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.06
Total Hardness	mg CaCO3/L	1	75	63			88	97	120	140	80	120	130	130	120	91
Benzene	µg/L	1			<1										
Toluene	µg/L	1			<1										
Ethylbenzene	µg/L	1			<1										
m+p-xylene	µg/L	2			<2										
o-xylene	µg/L	1			<1										
Total Xylenes	µg/L	2			<2										
Sum of BTEX	µg/L	2			<2										
Naphthalene	µg/L	1			<1.0										
TRH C6 - C9	µg/L	10			<10										
TRH C6 - C10	µg/L	10			<10										
TRH C6 - C10 less BTEX (F1)	µg/L	10			<10										
TRH C10 - C14	µg/L	50			<50										
TRH C15 - C28	µg/L	100			<100										
TRH C29 - C36	µg/L	100			<100										
TRH C10 - C36 (sum)	µg/L	100			<100										
TRH >C10 - C16	µg/L	50			<50										
TRH >C16 - C34	µg/L	100			<100										
TRH >C34 - C40	µg/L	100			<100										
TRH >C10 - C40 (sum)	µg/L	100			<100										

Note: outside of default guideline range shown red highlighted

[1]Adjusted trigger values apply for selected metals in freshwaters of varying water hardness as per the ANZECC 2000

umwelt

umwelt
Environmental & Social
Consultants

Umwelt (Australia) Pty Limited

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Appendix F

Acid sulfate soils advice

SAGE Environmental Services Pty Ltd
2/3 Woomba Place
Mooloolaba, QLD, 4557

8/08/2023
Boral Land & Property Group Pty Ltd
Kelli Adair
Care of John Arnold
Suite 282
Ground Floor, 1 Market Street
Newcastle, NSW 2300

To John,

Stockton Quarry Sand Extraction Project – Acid Sulfate Soils Advice Letter

1. Introduction

1.1 Overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in Figure 1, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Figure 1 - Stockton sand quarry (provided by Boral)

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

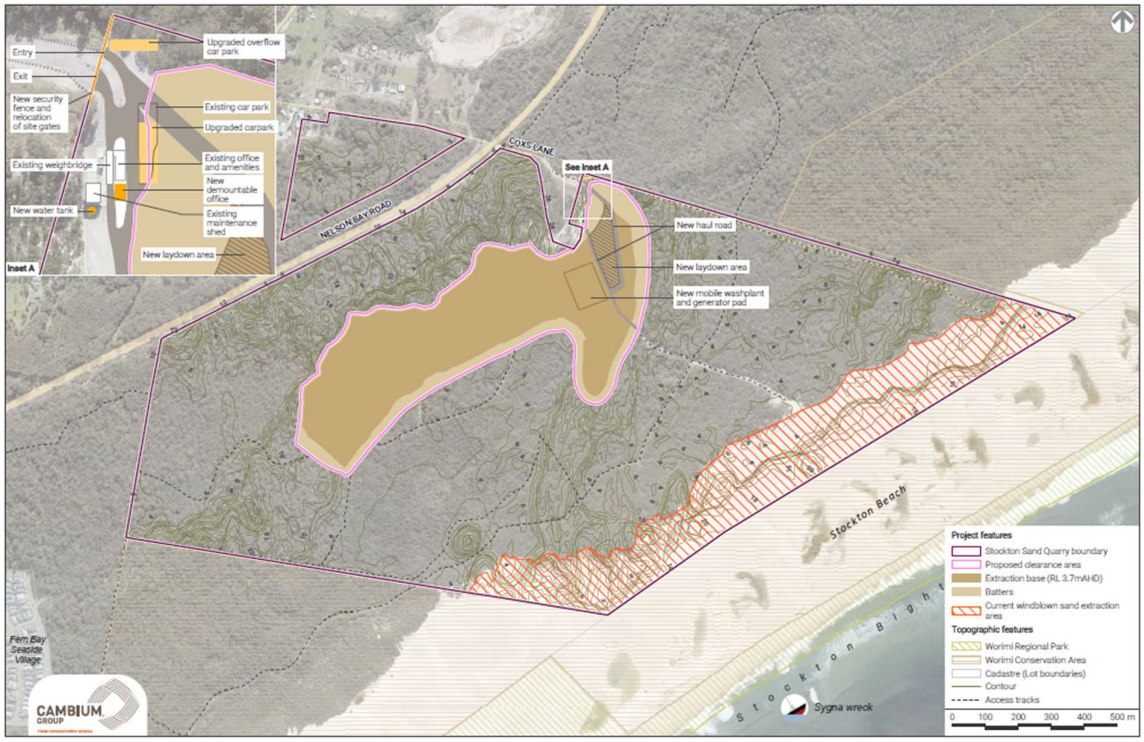
- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource located above the water table and from within the same extraction area (the project).

Figure 2 shows the quarry, the proposed dry sand extraction project, and the existing windblown project.

Figure 2 – The project (provided by Boral)



Secretary's Environmental Assessment Requirements (SEARs) were issued by the NSW Department of DPE for the project on 18 January 2023 (amended 31 March 2023). This Acid Sulfate Soils Advice Letter has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project.

This advice letter should be read in conjunction with the limitations provided in Section 10.

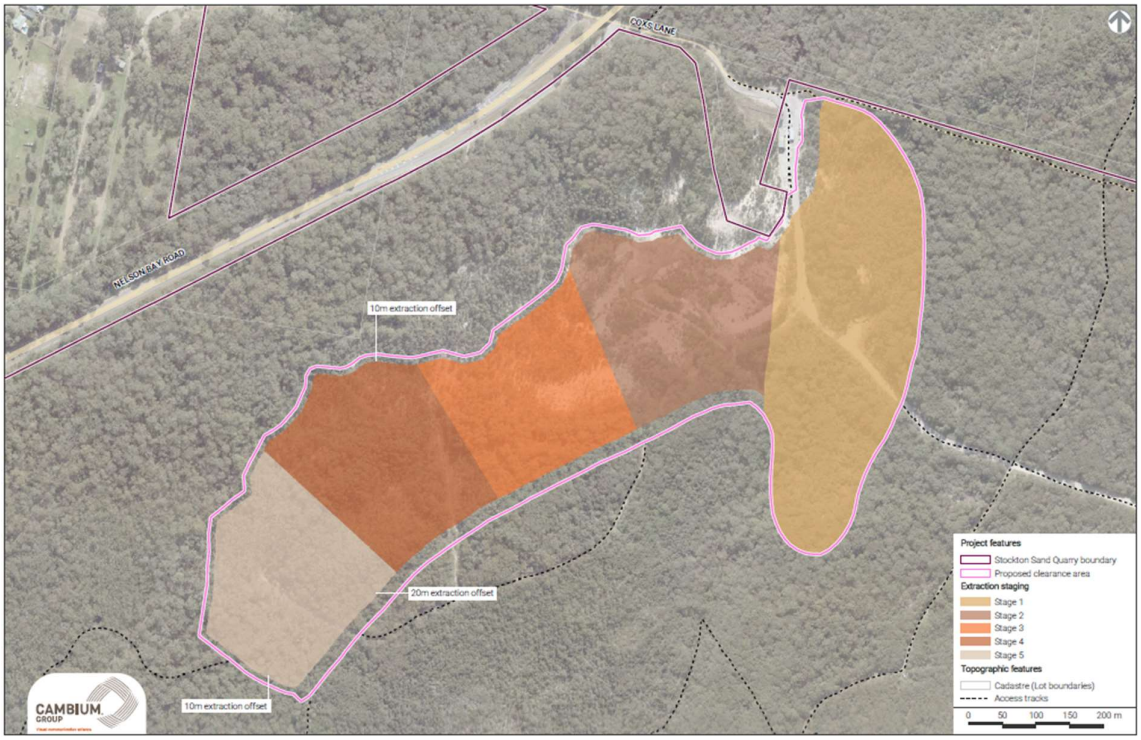
Boral has separately engaged Umwelt Pty Ltd to prepare a groundwater assessment (Umwelt 2023) to accompany the EIS for the project.

1.2 The project

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the current dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

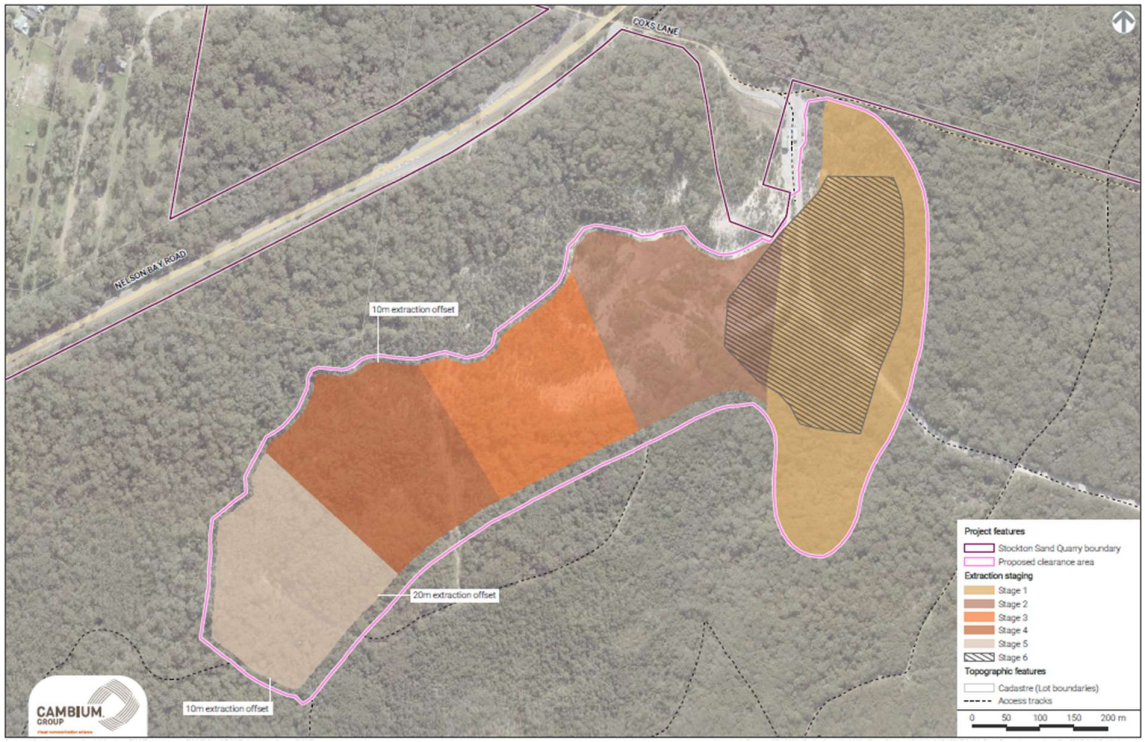
As shown in Figure 3, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

Figure 3 – Extraction staging plan – the project (provided by Boral)



The five stages of the project (shown in Figure 3) mirror the first five stages of the dredge application (shown in Figure 4). This has been designed so that, should the dredge application be approved and commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

Figure 4 – Extraction staging plan - current dredge application (provided by Boral)



There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the current dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the current dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;

- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

2. Scope of work

This letter was prepared to include the following information:

- Summary of the site setting, including topography, geology, hydrogeology and history.
- Summary of past assessments including information on soil located from the top of the water-table and above.
- Discussion on ASS / potential acid sulfate soils (PASS) risk in accordance with proposed works.
- Conclusion on suitability and recommendations (where required) regarding potential environmental risk involved with the proposed works.

3. Secretary's Environmental Assessment Requirements

Relevant SEARs requirements have been summarised in Table 1 with reference to appropriate sections of this advice letter where they have been addressed as relevant.

Table 1: Summary of SEARs requirements

Relevant SEARs	Relevant information and section reference within this letter
The EIS must map the following features relevant to water and soils including: • ASS (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) • Groundwater • Groundwater dependent ecosystems	Mapped ASS from the Acid Sulfate Soil Planning Map are presented in **Figure 7**
Identify if the soils in the area of the Proposal are contaminated or are acid forming (i.e. acid sulphate soils) and if so, identify best practice mitigation measures (pollution control) and strategies or remedial and/or disposal actions that will be required/undertaken if applicable in accordance with relevant guidance/standards.	Discussion in **Sections 4.6.2, 5 and 6.1** risk for soil contamination and ASS are very low.

4. Site Location and Setting

4.1 The site

The site is in Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD and is located in the Port Stephens local government area (LGA).

The regional site context is shown in Figure 1.

The site is approximately 246 ha in size and is legally described as comprising:

- Lot 1 DP 1006399 - comprising 234 ha and located predominantly on the eastern side of Nelson Bay Road, with a small portion also situated on the western side of Nelson Bay Road;
- Lot 2 DP 1006399 - comprising 10.4 ha and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road; and
- Lot 3 DP 664552 - comprising 1.62 ha and located wholly on the eastern side of Nelson Bay Road.

The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the New South Wales (NSW) Department of Planning and Environment (DPE) – Crown Lands.

Table 2 below presents key identification features of site.

Table 2: Site identification

Item	Details
Site owner	Boral
Address	Cox's Lane, Fullerton Cove, NSW 2318
Lot & plan number	Part Lot 1 DP1006399 Part Lot 2 DP1006399 Lot 3 DP664552 Lot 7300 DP1130730 (Crown Land) NOTE: This application proposes no works on Crown Land
Area	~ 246 hectares (ha)
Size of IEA	~ 37 ha
Zoning	RU2 – Rural Landscape
Proposed land use	Extractive Industry (sand)
Local government authority	Port Stephens Council
Site location and layout	**Figure 1** and **Figure 2**

4.2 The project site

As shown in Figure 2, the project site is in the central portion of the quarry and covers an area of approximately 38 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road and a pad for a wash plant and water recycling and filter press.

4.3 Regional Meteorology

Rainfall and climate data is publicly available from the Scientific Information for Landowners (SILO) database. The SILO database provides the most complete long-term dataset and is therefore the most useful for assessing long term rainfall trends. SILO data has been obtained from the Williamtown RAAF site (Latitude -32.7939, Longitude 151.8364) and used to calculate longer term data trends from 1957 to 2023. Table 3 also includes the long-term average pan evaporation (combined) and Morton's areal actual evapotranspiration, which represents actual evapotranspiration over a large area under prevailing soil-water conditions based on (Wang, et al., 2021).

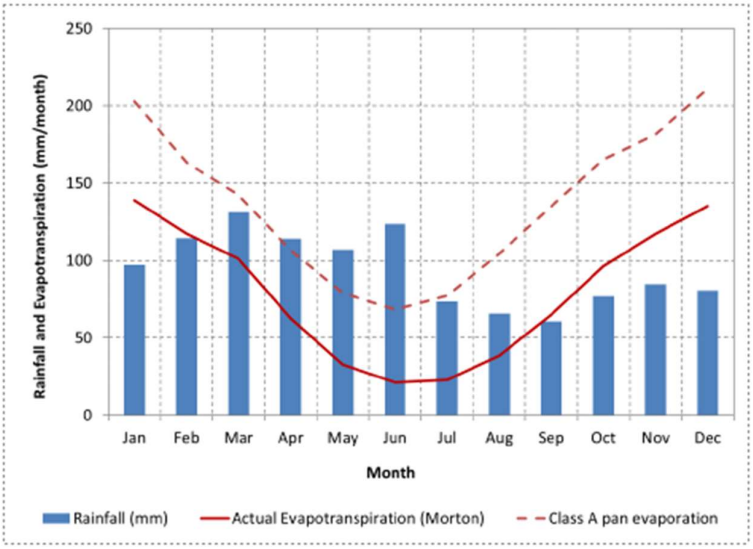
Average rainfall data (1957 to present) taken from the SILO database (Williamtown RAAF Base) (and presented in Umwelt, 2023 and reproduced in Table 3) show that monthly rainfall varies between 60 mm and 132 mm with a yearly average of 1,133 mm (SILO, 2023).

Table 3 shows that monthly rainfall varies (on average) between 61 mm and 131 mm, with a yearly average of 1,130 mm (SILO, 2023). Rainfall is higher in late summer and winter and lower in spring and early summer. The SILO database also shows that the total actual evapotranspiration (Morton) of 949 mm per year is exceeded by the yearly rainfall total. Evapotranspiration is much lower in winter than summer and on average is exceeded by rainfall from March through to August. Figure 5 presents the average rainfall and evapotranspiration graphs.

Table 3: SILO Monthly Climate Data Summary (Umwelt, 2023)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Site Data Average Rainfall	97	114	131	114	107	124	74	66	61	77	84	81	1130
SILO Average Rainfall (mm)	203	163	142	106	79	68	77	104	135	165	182	211	1637
SILO Average Pan Evaporation (mm)	198	160	140	106	78	68	78	103	133	162	179	204	1610
SILO Average Actual EVT Morton	139	117	101	62	33	21	23	39	65	96	117	135	949

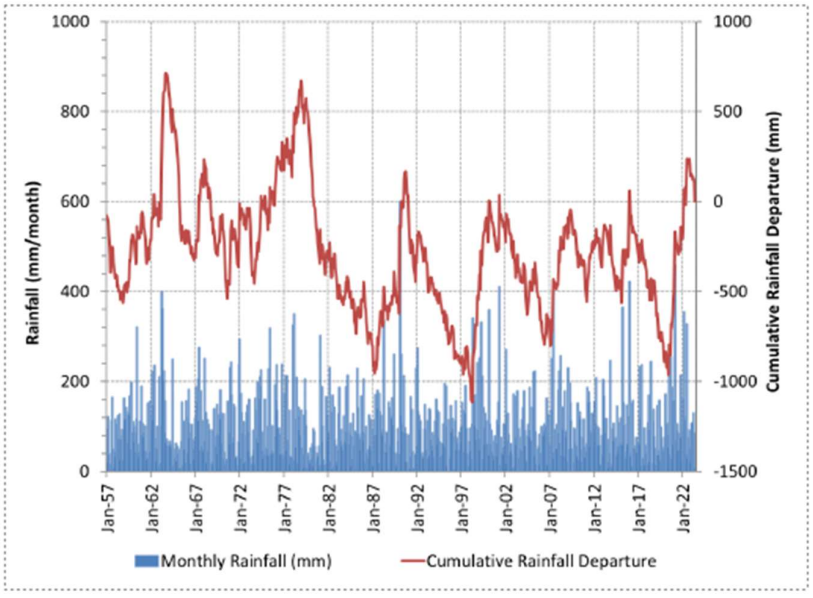
Figure 5 Average monthly rainfall and evapotranspiration (Umwelt, 2023)



The Cumulative Rainfall Departure (CRD) graphically represents monthly rainfall trends based on the long-term average monthly rainfall. A rising trend in the CRD indicates periods of above average rainfall (for the dataset period), whilst a falling slope indicates periods of below average rainfall (for the dataset period). Figure 6 presents monthly rainfall from the SILO dataset, compared to the CRD calculated from SILO data from 1957 to 2023. The graph shows the region experiences cyclical periods of above average and below average rainfall.

As shown in Figure 6 the region experienced below average rainfall from 1990 to 1998, above average rainfall from 1998 to around 2001, with another period of below average rainfall from 2001 to 2007 (Millennium Drought). From 2007 the rainfall trends were more variable, until 2016 when a period of sustained below average rainfall occurred until 2020. More recently the region experienced above average rainfall, from 2020 to the end of 2022.

Figure 6 Monthly and cumulative rainfall departure (Umwelt, 2023)



4.4 Topography

The project site is part of the Stockton Sand Dunes, which are aeolian sand deposits extending 32 km from Stockton to Anna Bay. Due to their mobile nature, the dunes' topography can change based on wind and weather conditions. Historically, the project site has been utilised for sand extraction, primarily from the foredunes. As part of a previous effort, a revegetation initiative has been undertaken, contributing to some stability of the underlying sands. The proposed dry sand extraction area generally lies at elevations between approximately 4 m AHD and 26.5 m AHD.

4.5 Soil and geology

The New South Wales Seamless Geology map shows that the geology within the site is mainly composed of coastal dune deposits (QH_bd) with mobile coastal dunes (QH_bdm) along the south-eastern edge (Umwelt, 2023). The difference between the two being that the mobile deposits are free of vegetation. The proposed excavation area is entirely within the area of vegetated, non-mobile deposits (Umwelt, 2023).

The dune sands and beach deposits found in the project site correspond to the Stockton Sand Beds. These sands are part of a larger dune system that spans 32 km in length and can be up to 10 km wide, of Quaternary age.

Active dunes close to the coast are younger (500 years) than the older, vegetated dunes which are 5,200 to 4,000 years ago (Umwelt, 2023). The formation of these dunes is closely linked to the predominant south-westerly winds, which have influenced their development.

The sand found within the project site varies in colour from light brown to dark brown and consists of fine-grained quartz. Some minor zones of fine to medium-grained sand are also present, along with shell fragments identified in certain exploration holes at deeper levels. An analysis of the sand composition reveals that 95% comprises quartz grains (Boral in 2019).

To the north-west of the site lies the Tilligerry Mud Member, associated with shallow estuarine and swamp deposits. Underlying the dunes are the Tomago Sand Beds that form an ‘inner barrier’ dune system. The Tomago Sand Beds overlie the Pleistocene age Medowie Clay Member that comprises low permeability clays and silts (Umwelt, 2023).

4.6Hydrogeology

The sand lithologies at site and in the surrounding area are unconsolidated and likely to have high primary porosities in the range of 26% to 53% (Domenico & Schwartz, 1998). The aquifer is largely unconfined, at least within the depths relevant to the project (Umwelt, 2023). No evidence of potential confining layers (clays etc) has been noted in any the bores drilled at site (Boral, 2019).

4.7 Acid sulfate soils

4.7.1 General

The term "ASS" encompasses two types of acid sulfate soils: Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS). Actual ASS refers to soils with highly acidic horizons, generating an excess of hydrogen ions beyond the sediment's ability to neutralise the acidity. This results in a soil pH of 4 or less during when measured in dry season

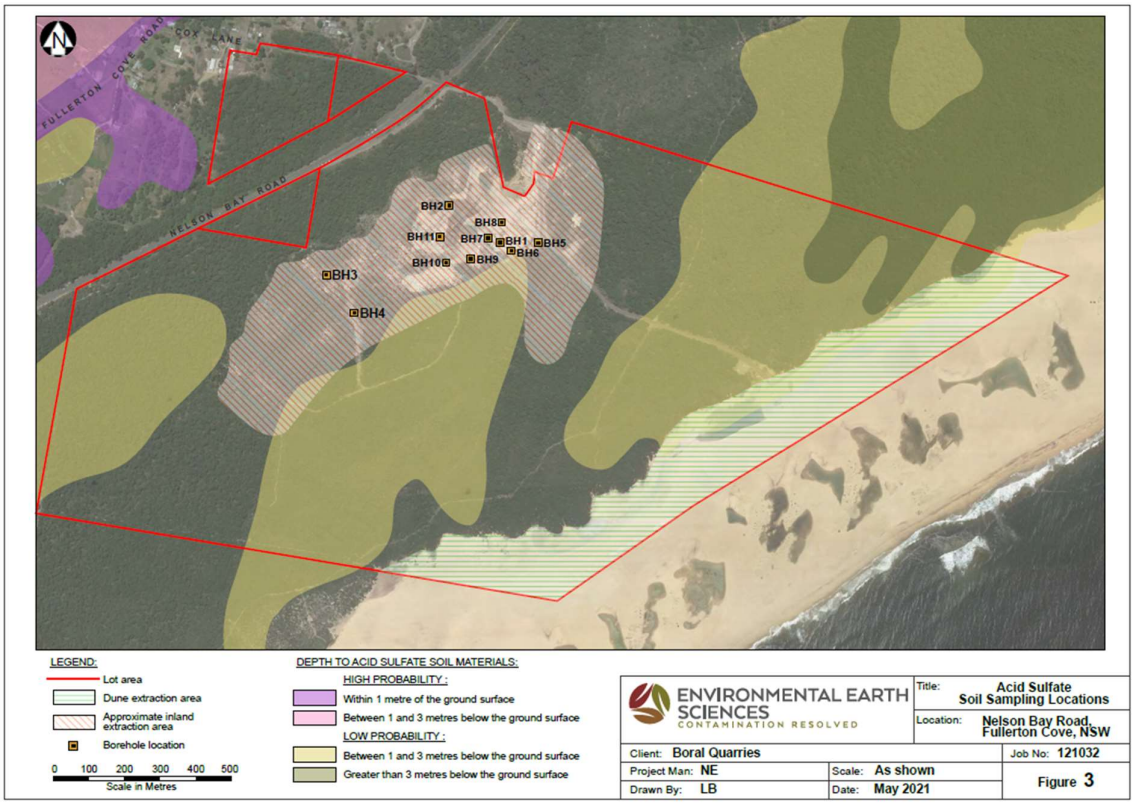
conditions. PASS refers to soils containing sulfidic material that remains unoxidised and pose an environmental risk. When exposed to air and oxidized, these soils become acidic.

4.7.2 Project specific

The project site was reviewed against the *Port Stephens Local Environmental Plan 2013* (LEP) with the Acid Sulfate Soils Risk Map – Sheet ASS_004 provided in Figure 7 (prepared by EES, 2021) has been reviewed.

It has been identified that the project site is considered low probability for ASS in general. The southern boundary of the project site is considered low probability between 1 – 3 m BGS beneath dunes, whilst the remainder and majority of the project site is considered low probability for ASS >3 m BGS on sandplains.

Figure 7 – Mapped probability of ASS (EES, 2021)



A summary of information regarding the low probability of ASS in the project site is provided in **Table 4** below.

Table 4: Summary of ASS in proposed extraction area

Low probability of ASS[1]	
ASS MAP class description[1]	The depositional environment has generally not been suitable for ASS formation. ASS, if present, is sporadic and may be buried by windblown sediments.
Environmental risk[1]	Majority of these landforms are not expected to contain ASS. Land management is generally not affected by ASS.

Low probability of ASS[1]		
	Highly localised occurrences may be found, especially near boundaries with environments with a high probability for ASS (not present within project site). Environmental risk will vary with elevation and depth of disturbance.	
Typical landform types[1]	Wa2 – Aeolian sandplain >2-4m AHD	Wd4 – Aeolian dunes >4m AHD
Depth to sulfidic soil[1]	Between 1 – 3 m BGS	>3 m BGS
Port Stephens LEP (2013) class of land[2]	**Class 3** Development consent required for: Works >1 m BGS. Works by which the water table is likely to be lowered >1 m BGS.	**Class 4** Development consent required for: Works >2 m BGS. Works by which the water table is likely to be lowered >2 m BGS.
Soil landscape[3]	Hawks Nest	Boyces Track

Notes:
1. Sourced from the Williamtown 1:50 000 Acid Sulfate Soils Map (DLWC, 1997).
2. Sourced from Port Stephens Local Environmental Plan 2013, Part 7 Clause 7.1 – Acid Sulfate Soils.
3. Sourced from eSPADE v2.0 published by the NSW Office of Environment & Heritage (2018) (https://www.environment.nsw.gov.au/eSpade2Webapp, verified 23 March 2023)

The occurrence of PASS in the region is linked to the depositional environments of Tilligerry Creek and Fullerton Cove to the north of the site, rather than the Stockton (or Tomago) Sandbeds. Additionally, there is no evident risk of oxidation of mineral sands containing heavy minerals such as rutile, zircon, ilmenite, and monazite, which are associated with specific portions of the Tomago Sandbeds. These sandbeds are located well to the north, approximately 10 km inland, forming part of the Rutile and Zirconium Mine (RZM).

5. Past assessments

The following assessments have been reviewed and summarised in the below sub-sections, noting that they were prepared in consideration of the current dredge application within the project site:

- Environmental Earth Sciences (2021a) – Acid Sulfate Soil Impact Assessment, Stockton Sand Quarry, Cox's Lane, Fullerton Cove, NSW (ref: 121032_V3, dated: 11 November 2021).

The findings of the ASS impact assessment were as follows:

- Desktop review of both regional and state government investigations and mapping confirmed that PASS risk is low in the proposed extraction area.
- Ground conditions assessed in the proposed extraction area typically comprised medium-grained sand that extend past the base of the dredging area, to the final depth of investigation (18 to 24 m BGS). Sediments such as estuarine muds, clays or silts were not typically observed.
- Based on the results of the investigation, which collected 632 samples from 11 borehole locations over two campaigns (March 2018 and April 2021), two samples (0.3%) had a pH field oxidation (pH_{FOX}) <2.5, and 32 samples (5%) had a pH_{FOX} ≤3.0,

while the minimum pH field (pH_F) was 4.5 and the normally distributed mean pH_F was 6.6:

    - Consequently, 51 samples were analysed for the Chromium Reducible Sulfur (CRS) Suite (37 including Acid Neutralising Capacity [ANC]), with the minimum pH_{KCl} being 5.1 (BH2_2.0) with a normally distributed mean pH_{KCl} of 7.0.
    - As such, it can be concluded that no actual acid sulfate soil (AASS) was observed at within the project site, as no pH_F or pH_{KCl} value was <4 and the titratable actual acidity (TAA) laboratory data can be discounted.

- All metal concentrations in 22 samples analysed were within background ranges. Iron concentrations ranged between 90 and 8,940 mg/kg (mean and median of 981 and 565 mg/kg respectively), which is significantly lower than the range of 900-9,000 mg/kg with a mean of 3,550 mg/kg reported for the RZM sediments (after Thom and Jones 1999).
- The acid-base account (ABA) for the laboratory data shows a maximum Net Acidity (NA) of 1.96 kg H_2SO_4 per tonne of soil (0.06%S and 40 mol H^+/T) at borehole BH2_2.0, with ANC present at all 37 samples analysed and alkalinity exceeding acid generation potential such that the mean NA of all 51 samples is -7 kg H_2SO_4 per tonne of soil (equating to 0.7% $CaCO_3$).
- All soils analysed were classified as “not acid sulfate soils” (NASS) or “no risk – non-reactive” (NRNR).
    - Given the above, it is reasonable to extrapolate that a natural buffering capacity exists across the project site due to the presence of shell grit ($CaCO_3$) within sand deposits.
    - It is also reasonable to conclude, based on the data collected from the incubation assessment in particular, that the natural buffering capacity measured in the laboratory can be replicated at field-scale and therefore can be relied upon.

6. Discussion

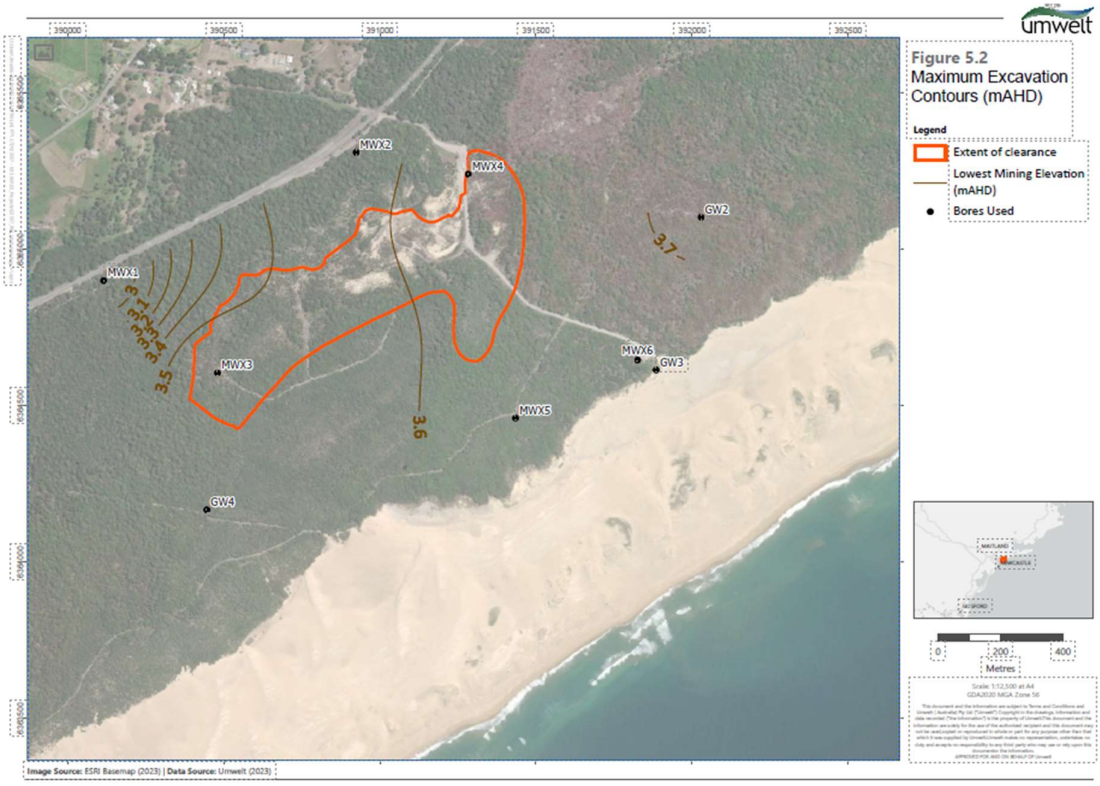
In relation to the SEARs requirements outlined and discussed in Table 2 and comments for the above water-table sands extraction, the below discuss potential for PASS risk.

6.1 Maximum operating depth

As part of the planning approvals, an elevation below which sand is not to be extracted needs to be provided (DPE: Water, 2022). This elevation has been set at 0.7 m above the 99th percentile groundwater elevation, referred to as maximum operating depth (consistent with Department of Planning and Environment (DPE): Water advice [DPE: Water, 2022]).

The spatial distribution of the maximum operating depth is presented in Figure 8 these contours range in elevation from 3.5 m AHD to approximately 3.65 m AHD, being lower in the west and higher in the east (Umwelt, 2023).

Figure 8 Maximum operating depth (Umwelt, 2023)



6.2 PASS risk

Through the completion of desktop research, field testing, and laboratory analysis, it has been determined that there is a low risk of Actual ASS occurring onsite within the sands above the water-table (the maximum operating depth has been confirmed to be 0.7m above the 99th percentile groundwater level [Umwelt, 2023]). Additionally, since the sands above the water table have already been exposed to air and are not submerged, it is reasonable to conclude that no PASS are capable of existing.

Overall, the PASS risk for dry sand extraction activities within the project site is considered very low and therefore acceptable without any need for further assessment or management regarding PASS. A summary of laboratory results for above water-table sands is provided in Table 1 in Appendix A of this document (as compiled by EES, 2023). The ABA for this data shows a maximum NA of 1.96 kg H_2SO_4 per tonne of soil (0.06%S and 40 mol H^+/T) at borehole BH2_2.0, with ANC present at six of 11 samples analysed and alkalinity exceeding acid generation potential such that the mean NA of all 11 samples is -21.5 kg H_2SO_4 per tonne of soil (equating to 2.2% $CaCO_3$).

7. Conclusion and recommendations

It is reasonably concluded through the preparation of the EIS and in response to the SEARs comments that the design and implementation of dry sand extraction from above the water table at 3.7 m AHD has very low potential to impact to the environment with respect to ASS or PASS.

The dry sand extraction activities are not expected to inhibit progression of the original dredging application, in fact, it should aid in the progression of the submission due to more information/ data being accessible for collection.

Should you have any queries, please do not hesitate to contact me using the details below.

Yours faithfully,

Ben Hunter

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9. Glossary of terms

The following descriptions are of terms used in the text of this report.

Acid neutralising capacity (ANC) is the soils natural resistance to acid generation. It is the number of moles of protons per unit mass of soil required to raise the pH of the soil by one pH unit. ANC is measured as percentage $CaCO_3$.

Acid Sulfate Soil (ASS) are all those soils in which sulfuric acid may be produced, is being produced, or has been produced in amounts that have a lasting effect on main soil characteristics (Pons 1973). This general definition includes: (i) potential, (ii) actual (or active), and (iii) post-active ASS, three broad genetic soil types that continue to be recognized (e.g. Fanning 2002). Soil horizons that contain sulfides are called **sulfidic material** (Isbell 1996; Soil Survey Staff 2003) and can be environmentally damaging if exposed to air by disturbance. Exposure results in the oxidation of pyrite, with each mole of pyrite yielding 4 moles of acidity (i.e. 2 moles of sulfuric acid). This process transforms sulfidic material to **sulfuric material** when, on oxidation, the material develops a pH of 4 or less (Isbell 1996). ASS may be deposited during either the Pleistocene or Holocene geological epochs (Quaternary period) as sea levels rose and fell.

Actual Acid Sulfate Soil (AASS) soil in which soil sulfides are undergoing oxidation and producing more acid than the soils ANC, leading to a net acid generation (see Sulfuric material below).

Buffer ionic compound, usually a salt of a weak acid or base added to a solution to resist changes in its acidity or alkalinity and thus stabilise its pH.

Clay Soil material composed of particles finer than 0.002 mm. When used as a soil texture group such soils contain at least 35% clay.

Groundwater water held in the pores of an aquifer.

Net acidity (NA) total acid generation potential based on acid-base account (ABA) of reduced inorganic sulfides (RIS) measured as chromium reducible sulfur (CRS) plus actual acidity measured as TAA and retained (jarositic) acidity, less neutralising (acid buffering) capacity based on ANC, reported in units of kilogram H_2SO_4 production per tonne of soil.

Oxidation originally referred only to the addition of oxygen to elements, however now encompasses the broader concept of the loss of electrons by electron transfer to other ions. The gain of electrons is called reduction.

pH logarithmic index for the concentration of hydrogen ions in an aqueous solution, which is used as a measure of acidity.

Potential Acid Sulfate Soil (PASS) soil that contains sulfidic material that has not been oxidised but poses a considerable environmental risk should oxidation occur (see Sulfidic material below).

Reduction can be simply expressed as the absence of oxygen, though chemically the meaning is more complex as it involves the gain of electrons by transfer from other ions.

Sulfidic material contains oxidizable sulfur compounds. They may be mineral or organic soil materials, have a natural pH value >4, and when incubated or aged as a layer 1 cm thick under moist conditions, while maintaining contact with the air at room temperature, they show a drop in pH to a value of 4.0 or less within 8 weeks (Isbell 1996). If disturbed, the time required for the transition from sulfidic material to a sulfuric material ranges from weeks to years and decades.

Sulfuric material must be >15 cm thick and be composed of either mineral or organic soil material; have a pH value <4, plus show evidence of jarosite (Isbell 1996). When sulfidic material is drained and exposed to air, it will oxidize and produce sulfuric acid (e.g. Dent and Pons 1993). If the amount of acidity produced exceeds the buffering capacity of water and sediments, acidification occurs. Prior to draining, materials that can cause acidification are called sulfidic material (i.e. potential acid sulfate soil material or PASS). Once sulfidic material is drained it may transform to sulfuric material (i.e. actual acid sulfate soil or AASS).

10. Limitations

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Attachments

Attachment A **- Tables**

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Attachment A
Tables

TABLE A Stockton laboratory results summary - acidity above the water-table

Sample (depth m BGS)	Date	Texture	pHKCl (1:5)	pHF (1:5)	pHFOX (H2O2)	Incubation pH Week 8	Potential Acidity (CRS)	Actual Acidity (TAA)	Buffering Capacity (ANC)	Net acidity (NA)	Risk Level
Units		-	pH	pH	pH	pH	kg H2SO4 / t	kg H2SO4 / t	kg H2SO4 / t	kg H2SO4 / t	-
Criteria		-	<4	<4	<2.5	<4	>1	>1	-	>3	-
BH1_1.5	12/03/2018	Sand	5.6	6.8	3.7	-	0.79	0.098	-	0.79	NASS
BH2_0.5	13/03/2018	Sand	10.0	8.7	6.6	-	0.31	<0.049	32.14	-31.83	NASS
BH2_2.0	13/03/2018	Sand	5.1	5.0	1.3	-	3.04	2.058	1.08	1.96	NRNR
BH2_2.5	13/03/2018	Sand	6.0	6.5	2.8	-	0.79	<0.049	-	0.79	NASS
BH2_3.0	13/03/2018	Sand	6.2	6.4	5.2	-	0.28	<0.049	-	0.28	NASS
BH3_3.5	13/03/2018	Sand	6.1	7.7	5.9	-	0.21	<0.049	-	0.21	NASS
BH3_4.0	13/03/2018	Sand	6.0	7.4	5.7	-	0.24	<0.049	-	0.24	NASS
BH4_2.0	14/03/2018	Sand	10.2	7.3	5.1	-	1.53	<0.049	80.95	-79.42	NRNR
BH4_3.5	14/03/2018	Sand	6.6	7.5	4.8	-	0.21	<0.049	2.65	-2.44	NASS
BH5_0.75	12/04/2021	Sand	9.6	9.9	6.7	6	1.96	<0.049	123.48	-121.52	NRNR
BH5_1.75	12/04/2021	Sand	6.8	8.9	7.4	6	0.49	<0.049	6.08	-5.59	NASS

Notes:

mBGS	metres below ground surface
CRS	Chromium Reducible Sulfur
ANC	Acid Neutralising Capacity
TAA	Tritratable actual acidity
kg H2SO4/t	kilograms of sulfuric acid per tonne
NASS	Not Acid Sulfate Soil
NRNR	No Risk-Non Reactive

Appendix G

Coastal assessment

Boral Stockton Dry Sand Extraction: coastal processes, hazards and impacts

Report prepared for Arnold Planning on behalf of Boral

by Coastal Studies

30 June 2023

Boral Stockton Dry Sand Extraction: coastal processes, hazards and impacts

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Executive Summary

This report addresses the potential effects of coastal processes and hazards, including sea level rise on the proposed Boral Stockton Quarry Dry Sand Extraction Project (the project) and any potential impact on these coastal processes arising from the project. It also assesses the potential impacts (direct and indirect) of the project on the Worimi State Conservation Area and the Worimi Regional and National Parks.

The existing Boral Stockton quarry is located in the vegetated dune systems of Stockton Bight. The dunes are part of a 6,500-year-old coastal sand barrier that has seen four phases of beach and dune building, with the present phase actively moving the dunes inland. It is important to note that the project site is located 1.2 to 1.8 km inland from Stockton Beach, and as such, is physically remote from the coastal processes and hazards, including beach erosion, storm surge, beach rotation and beach recession, which at the most can impact 100 m inland. As a result, the project site is not impacted by nor has any impact on these processes. Whilst it is acknowledged that the project site is exposed to coastal winds, winds which are moving the dunes inland, at their present rate of advancement it will take between 120 to 200 years for the moving dunes to reach the project site.

The project site is presently above 2020 highest tide inundation levels and will be more than 2 m above the projected 2100 highest inundation level based on excavation to 3.7 m AHD and on a forecast 84 cm rise in sea level.

The quarry is bordered on three sides by the Worimi Conservation Area and beyond that the Worimi Regional and National Parks. The Worimi areas are separated from the quarry by at least 400 m of vegetated dunes and consequently the project can have no impact on the Worimi areas including the bare mobile dunes. Dune movement and exposure of cultural sites within the Worimi areas is a consequence of long-term natural dune movement and surface deflation, exacerbated in recent decades by ongoing off-road vehicle activity.

1 Introduction

The Boral Stockton sand quarry (the quarry) has an area of 246 ha and has been operated by Boral since 1992. Between 1996 and 2008, sand was extracted from the middle of the site to an elevation of 5 m Australian Height Datum (AHD), following which it was progressively landscaped and rehabilitated. The present project proposes to extract sand from a 37 ha area within this site, to an elevation of 3.7 m AHD, this level being above the water table. This 37 ha area, the focus of the proposed development, is referred to as the "project site" herewith.

Based on predicted market demands, the project site would yield approximately 3.1 Mt/10 years of dry sand, excavated at a rate of no more than 750,000 tpa until either a dredge application is approved after which the project would transition to a dredging at approved rates; or the dredge application is not approved and the

existing windblown consent lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa. Boral is seeking consent to operate for 10 years.

The site is surrounded by at least 500 m of densely vegetated dunes and is located at least 500 m and downwind from the nearest mobile dunes and at least 1 km from the Stockton Beach shoreline. It is also bordered by the Worimi State Conservation Area on three sides, with the Worimi Regional and National Parks located beyond the Worimi State Conservation Area (Worimi areas).

This report assesses the potential impacts of coastal processes, hazards and climate change on the excavation site and the potential impacts the site could have on both coastal processes and the surrounding Worimi areas.

2 Coastal processes and the evolution of Stockton Bight sand barrier

The Stockton (Newcastle) Bight sand barrier extends for 32 km from Birubi Point to Newcastle and is up to 8 km wide, the largest such system in NSW. It is a product of coastal processes delivering sand to the shoreline and building the beaches and dunes that comprise the barrier. This section will briefly review the geomorphological evolution and nature of the barrier.

The beach and backing dune systems of Stockton Bight have evolved during two episodes of beach-dune (barrier) building, one approximately 120,000 years ago and the other over the past several thousand years, both occurring during periods of high global sea level, as at present. This period is geologically known as the Quaternary and the Quaternary geology of Stockton Bight is illustrated in Figure 1.

A *barrier* refers to the entire beach and the backing sand dunes, with Stockton Bight containing an inner and outer barrier. The inner barrier, which contains the Tomago Sands, formed approximately 120,000 years ago when sea level was at least as high as present and probably up to 2 m higher. It is separated from the modern outer barrier by a low flat partly water-filled inter-barrier depression (that is a shore parallel depression between the inner and outer barriers) occupied by Fullerton Cove, Salt Ash and Tilligerry Creek. The outer barrier, which includes the modern beach and dunes, was initiated by waves and wind once sea level stabilised at its present level about 6,500 years ago.

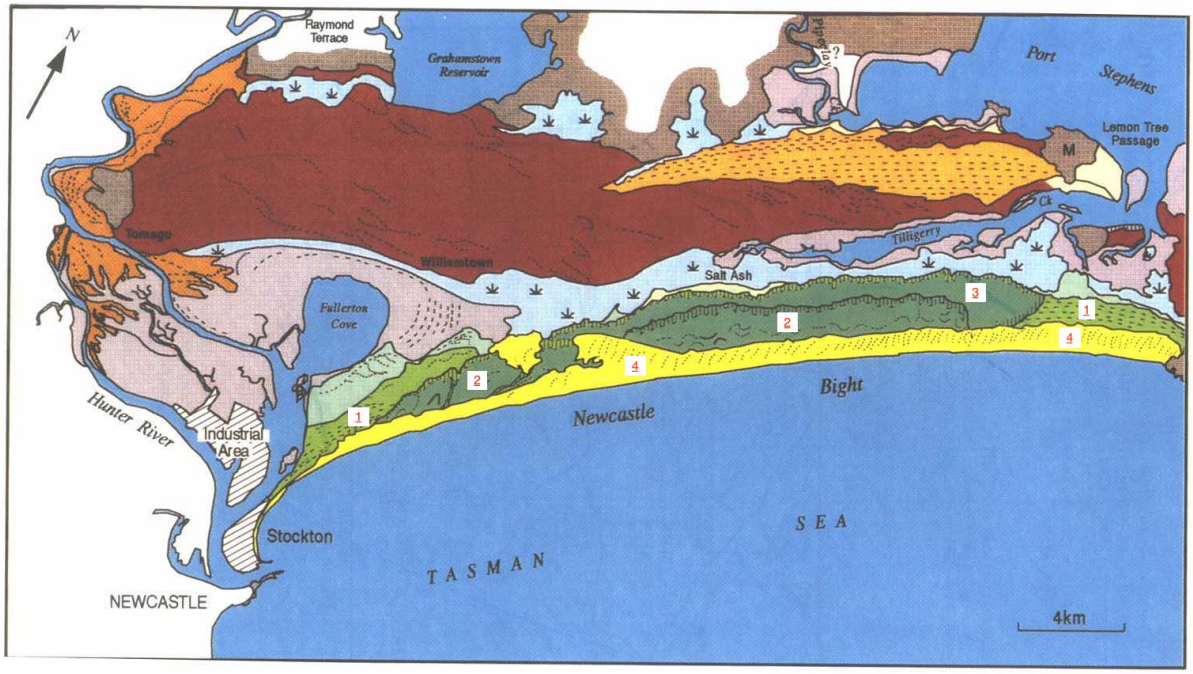

Figure 1 Stockton (Newcastle) Bight inner barrier (brown and orange), inter-barrier depression containing backbarrier flats (light blue) and intertidal wetlands (purple) and outer barrier (green and yellow) systems. Numbers 1-4 refer to stages in the development of the outer barrier. Note a 'barrier' refers to the entire beach and dune system (from: Thom, et al., 1992). Combined these two barrier systems have filled in the embayment and prograded the shoreline by up to 8 km seaward.

The modern outer barrier has undergone four phases of development labelled 1 to 4 in Figure 1:

1. Between 6,500-5,000 years ago waves delivered sand to the shore depositing gently landward sloping backbarrier overwash flats (the Salt Ash flats), which are up to 1 km wide. Following this tonging delivery of sand moved the shoreline up to 3 km seaward depositing in its lee a series of 5-10 m high undulating shore-parallel foredune ridges. The ridges extended the length of the Bight and were fully vegetated when formed. The only ridges visible today are located at the southern and northeastern ends of the Bight (Figure 1, #1). The dashed lines are indicative of the parallel crests of the ridges that extend the length of the Bight. Most are however buried under dunes along most of the Bight and some are presently being buried by active dunes in the east (Figure 2).

2. The initial burial took place between 5,200-4,000 years ago when phase #2 dunes migrated up 3 km inland (Figure 1, #2). The phase #2 dunes were then vegetated and stabilised.

3. Approximately 2,000 years ago phase #3 dunes migrated approximately 2 km inland, burying in turn much of the phase #2 dunes, and were then vegetated and stabilised (Figure 1, #3).

4. Approximately 500 years ago the present phase #4 dunes started moving inland as bare sand, excavating the outer foredune ridges to form a deflation

basin and burying phase #3 dunes along most of the Bight and the phase #1 ridges in the far south and the northeast. The phase #4 dunes have now moved several hundred metres inland producing the present situation. The dashed diagonal lines shown on phase #4 (Figure 1) indicate the orientation of the transverse dune ridges that dominate the morphology of the active dunes, also shown in Figure 2.

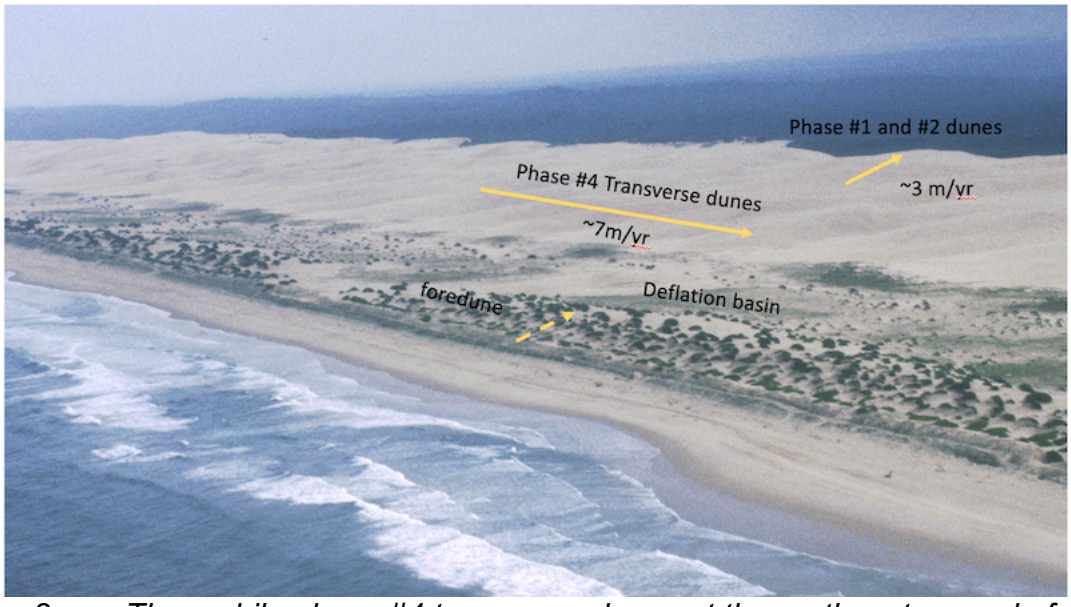

Figure 2 The mobile phase #4 transverse dunes at the northeastern end of Stockton Bight are migrating both longshore (northeast) and onshore (northwest) over the original 6,500-5,000year old phase #1 foredune ridges, which are eroded down to the water tables and blown inland leaving the deflation basin.

Each phase of dune activity has excavated sand from the outer foredune ridge plain and blown it inland, together with some sand moving directly from the beach, likely leading to some recession of the shoreline. As it does so, it excavates a deflation area, which when continuous alongshore is called a 'deflation basin'. The surface is deflated down to the groundwater level, where vegetation and more cohesive wet sand prevent further excavation.

Phase #4 is continuing the excavation of the exposed foredune ridges. As the buried foredune ridges are eroded along the western side of the advancing deflation basin, the dark soil horizon, that represent the original surface of the buried foredunes, is exposed as a dark linear undulating line in the yellow sand. This layer represents the soil horizon and often contains remnants of vegetation that grew on the ridges as well as cultural sites from when the ridges were occupied. The buried vegetation debris can be used to carbon date when the ridges and cultural sites were originally buried by the phase #2 dunes.

3 Stockton sand dune dynamics

The Stockton Bight dune system is part of the largest unstable barrier in NSW with a total area of 70 km^2, including 26 km^2 of bare sand. It is typical of similar transgressive (mobile) barriers that occur around Australia. Australia has 12,000 km of coastal sand barriers which occupy 40% of the coast. While most are vegetated

and stable, 12% (3000 km^2) are unstable with bare sand moving inland (Short, 2020). The vast majority of the presently mobile dunes, like the Stockton dunes, were activated by natural causes a few hundred years ago (Short and Hesp, 1982).

Figure 3 shows a typical cross-section of the Stockton dunes in the vicinity of the Boral Stockton Quarry. It shows the initial undulating surface of the phase #1 foredune ridge plain (~6500-5000 years old), which is buried beneath the phase #2, #3 and #4 dunes, and is presently being eroded to supply sand to the phase #4 dunes in the process forming the deflation basin (swale) area.

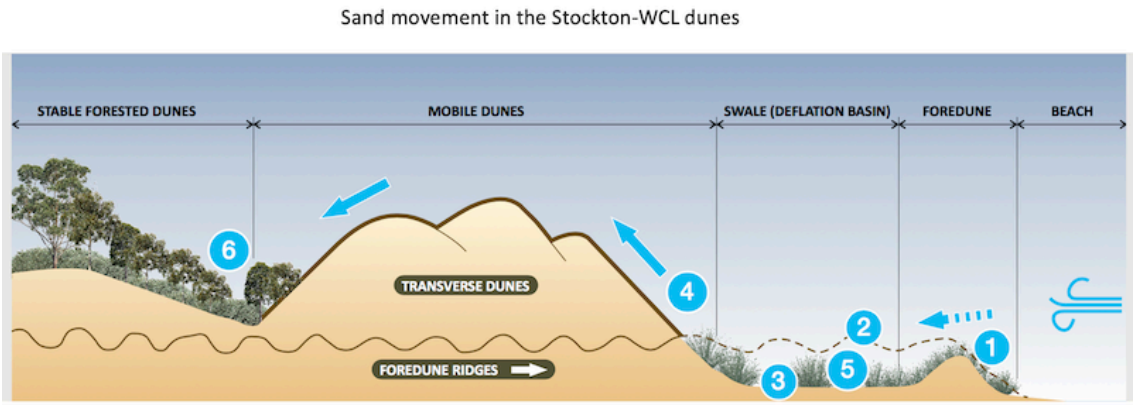

Figure 3 Schematic cross-section of Stockton barrier in the southern Stockton Bight region showing the undulating surface of the original now buried phase #1 foredune ridge plain which has been eroded (dashed line) in the swale (deflation basin) region. From left to right are the beach and foredune, deflation basin (swale), the mobile phase #4 (transverse) dunes, vegetated phase #2 and #3. The entire barrier has been deposited in the past 6,500 years. The white arrows indicate former direction of sand movement and the blue active sand movement.

The Stockton dunes are a highly dynamic system with sand moving from the beach into the dune system in the following manner:

1. Sand is blown from beach to foredune by strong onshore (south to southeast winds) where it is either trapped by vegetation in the foredune or blown through gaps in the foredune into the deflation basin;
2. Sand is also blown from the unstable and/or unvegetated foredune areas into the deflation basin;
3. During storms, like the June 2016 storm, waves can wash across the beach and through gaps in the foredune to flood parts of the deflation basin. As some of this water returns seaward it can scour channels down the beach. The channels will be filled in during periods of calmer waves.

4. Sand is then blown from the deflation basin and its western side into mobile transverse phase #4 dunes, eroding and exposing the dark soil horizon which marks the crest of the buried foredune ridges;
5. Deflation basin is lowered/deflated until a cohesive surface is reached usually close to the groundwater table where coarser shell lag, wet sand, reeds, etc. prevent further deflation;
6. The strong onshore southeast winds move the transverse dunes towards the northwest where they are burying the vegetated phase #3 dunes, while strong west to northwest winds also move them to the northeast, parallel to the shore arranged as a series of approximately 150 transverse dunes spaced on average 160 m apart and 10-15 m high.
7. All the above are natural processes that have been occurring for hundreds of years, though more recent off-road vehicle movement through and over the foredune, deflation basin and active dunes is helping to maintain their instability.

The present barrier therefore is composed of the beach and surf zone, foredune, foredune ridges, deflation basin, transgressive dunes (bare and vegetated) and the backbarrier flats, the dynamics of each is described below.

The *beach and surf zone* is a highly dynamic double bar system responding to waves and tides (Short, 2007) and is the source of fine to medium sand for the backing dunes. High waves and elevated sea level can causes erosion of the beach and foredune and inundation of the deflation basin.

The *foredune* is the first vegetated dune behind the beach. Along Stockton Bight, it is unstable with a mix of low bare unstable sections and higher vegetated more stable sections. Where bare and unstable sand can blow from the foredune into the deflation basin; while the low areas allow wind and occasionally waves to move sand directly from the beach through the foredune into the deflation basin;

The foredune is usually stabilised with primary vegetation (grasses, succulents, creepers) grading landward into secondary shrubs (coastal acacia, banksia and tea tree) particularly behind the dune. Foredune heights range from 5 to 20 m and width up to 50 m. The foredune is regularly exposed to winds and sand movement and during storms the foredune can be exposed to both to wave attack and inundation. Along Stockton Bight the foredune is usually only vegetated with primary species and only moderately vegetated rendering it more susceptible to wind and wave erosion.

The *deflation basin* is a low-lying depression located between the beach-foredune and the transgressive dunes (Figures 2 and 3). It receives sand from the beach and foredune and loses sand to the transverse dunes and represents an eroded basin from which sand has been blown inland into the mobile transgressive dunes. The base of the basin is usually around the groundwater table (approximately 4 metre AHD), which prevents further sand erosion. In Stockton Bight, the basin extends for 28 km between Birubi Point and the Stockton Bridge area and varies between 200-500 m in width. It is exposed to wind-blown sand transport and inundation by storm surges. While generally bare of vegetation some primary species will grow including reeds (e.g. Juncus) in wetter areas.

Foredune ridges are shore-parallel foredunes developed in lee of the active beach. As the beach builds seaward, it leaves a series of well vegetated foredunes in lee of the advancing beach. At Stockton Bight, the phase #1 foredune ridge plain was up to 3 km wide and contained approximately 40 ridges and intervening swales spaced ~80 m apart with ridge elevations of a few metres. These ridges are now largely buried under the mobile dunes (phases #2, 3 and 4) with their exposed eastern ends being eroded in the deflation basin, with the sand used to supply the active dunes.

Transgressive dunes are dunes that have migrated or are migrating (transgressing) inland. Along Stockton Bight, they include the stable and vegetated phase #2 and #3 dunes and the bare and mobile phase #4 dunes, which are presently moving inland between 3-5 metres per year (m/yr). At their present rate of inland migration, the dunes would take between 120-200 years to reach the excavation site.

The *transverse dunes* are bare transgressive sand dunes that are aligned perpendicular to the prevailing (dominant) wind direction (Figures 2 and 3). They usually occur in series of dune ridges and swales with spacing between 100-250 m and dune height between 10-20 m. Along Stockton Bight, there are 150 transverse dunes all aligned perpendicular to the strong westerly winds with spacing averaging 160 m and height averaging 15 m. The westerlies drive them alongshore to the northeast at about 7 m/yr, while onshore southeast winds are also causing them to migrate inland to the northwest at between 3-5 m/yr, while

The inner edge of the 10-20 m high vegetated transgressive dunes terminates abruptly at the backbarrier flats, which are part of the interbarrier depression shown in Figure 1. The depression is a low, gently landward sloping (<1^{o}) plain that was deposited by storm waves when sea level first reached its present level, as wide low gradient sand flats. It extends longshore from Fullerton Cove to Bobs Farm Creek and cross-shore from the rear of the transgressive dunes to Tilligerry Creek, ranging in width for several hundred metres to over a kilometre.

4 The Boral Stockton quarry site

The Boral Stockton sand quarry (the site) is located at Fullerton Cove Bay approximately 10 km north of the Hunter River. The site covers 246 ha and includes an eastern section containing active phase #4 bare dunes, while the bulk of the site contains the well vegetated phase #2 and #3 dunes. The site was previously quarried to an elevation of 5 m AHD, then reshaped and rehabilitated with soil and native vegetation.

The proposed excavation site is located in the area of #2 and #3 phase dunes and has an area of 37 ha. It is located between 1 to 1.7 km landward of the Stockton beach shoreline and between 500 m and 1 km landward of the bare mobile Stockton sand dunes. It is surrounded by a buffer of densely vegetated coastal sand dunes at least 500 m wide between 5 and 20 m in height (Figure 4).

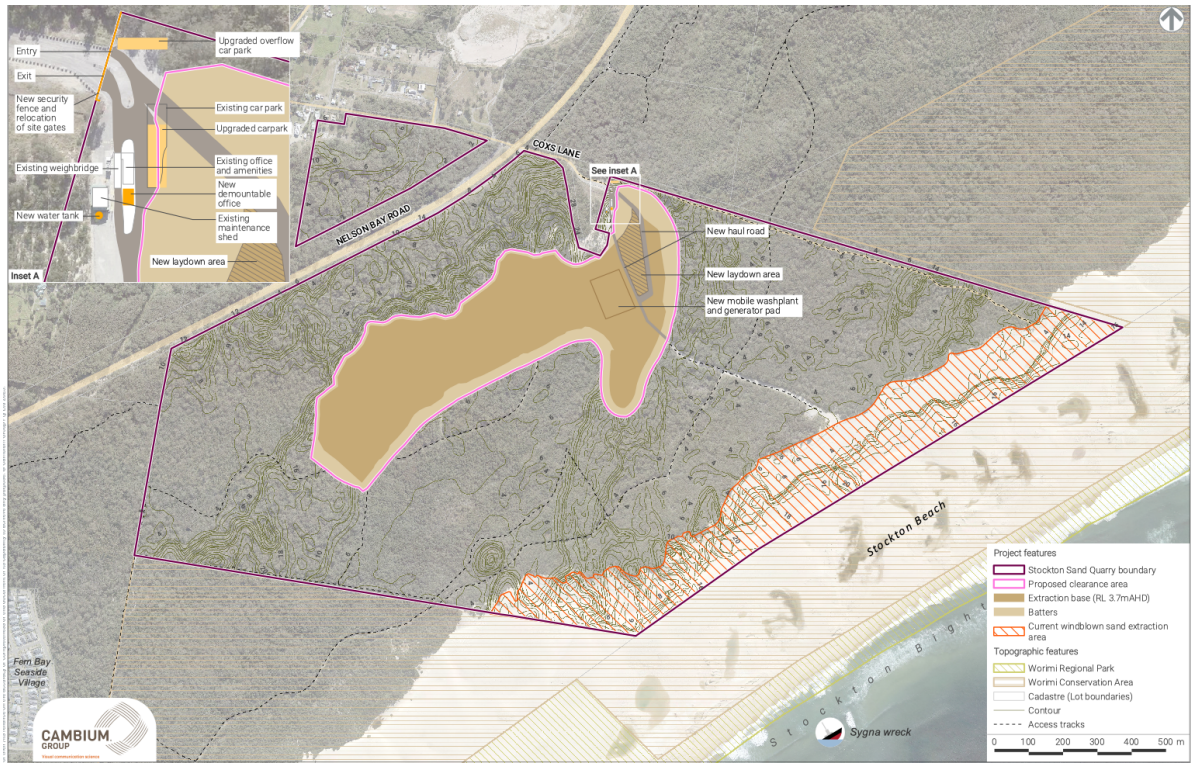

Figure 4 The Boral Stockton quarry boundary and location and topography of the proposed extraction site (light brown) (source: Boral)

5 Potential effects of coastal processes and hazards on the quarry

Coastal processes refer to marine and atmospheric processes that dominate the coastal zone including backing sand dune systems. These include waves, tides, storm surges and ocean currents together with wind, temperature and precipitation and the future impacts climate change, which include rising sea level, changing waves climate and enhanced extreme events. *Coastal hazards* relate to the adverse impacts of these processes on the coastal zone, and *coastal vulnerability* the likelihood of coastal hazard impacting a given area. This section will review these processes and their potential impact on and vulnerability of the excavation site starting with the short-term beach erosion and moving towards the longer-term climate change impacts.

5.1 Coastal processes and vulnerability assessment of the site

5.1.1 Beach erosion

The excavation site is located between 1.2 to 1.7 km inland from the Stockton Bight beach system. The area between the quarry and the shoreline is occupied by the beach, foredune, deflation basin, transverse dunes (phase #4), and the densely vegetated phase #2 and #3 transgressive dunes covered in dry sclerophyll forest as shown in Figure 4.

The beach, foredune and deflation basin are the areas most exposed and vulnerable to coastal processes, particularly wave erosion and marine inundation. During storm events the beach can erode tens of metres and permit waves to reach and erode the

front of the foredune (Table 1). Erosion events are however usually part of an erosion-recovery cycle, with calmer post-storm conditions allowing the beach to recover and return to its pre-storm position and the foredune to slowly rebuild. If the beach does not recover, then it will experience net recession.

Table 1. Maximum landward extend of coastal processes impacts to 2100

Process	Distance	Comment
Beach erosion	100 m	followed by 100 m recovery
Storm surge	300 m	can flood deflation basin then recede
Beach rotation	0-30 m	cyclical
Beach recession	200 m^3/m	net recession of entire beach
	~100 m	assuming maximum rate
Wind & salt spray	~100 m	to rear of foredune
Inundation*	+84 cm	extreme scenario
Hazard line*	180m	rare scenario (e.g. 1 in 100 year event)

* *to 2100*

5.1.2 Storm surges

Storm events are often accompanied by extreme water levels (a storm surge) generated by wave set up, infragravity waves, high tide, wind stress and inverse barometric pressure. At Stockton Bight a storm surge can result in water moving over the beach and though low points in the foredune to reach and fill the deflation basin with shallow ponds of sea water. When some of this water returns to the shore it can also scour the beach and dune. However, marine processes (wave, tides and surges) cannot and do not impact the barrier beyond the deflation basin, with storm surges reaching at most 300 m inland form the shoreline, following which the surge recedes or soaks into the basin (Table 1). These processes cannot and do not impact the mobile sand dunes (phase #4), nor the backing vegetated dunes (phases #3 and #2).

The extraction site is located at least 1 km inland of the coastal processes with a 10-20 m high buffer of bare and vegetated dunes. It cannot therefore be exposed to beach erosion and marine inundation and is therefore not vulnerable to their impacts.

5.1.3 Beach rotation

Beach rotation refers to the opposing shoreline movement at either end of embayed beaches, with one end eroding while the other accretes and vice versa owing to slight changes in wave direction related to climate indices, in particular the Southern Oscillation. Rotation was first identified on the east coast at Narrabeen Beach (Short and Trembanis, 2004) and has since been identified at many sites along the NSW coast (Short, 2020).

A study by Bluecoast (2020) found that along Stockton Bight, the entire Bight has been undergoing a clockwise rotation since at least 1990, with northern Birubi end accreting, while the southern Stockton end has eroded. In the south erosion reaches a maximum at Stockton Beach decreasing northwards and reaching zero by the Boral quarry area. The central section has remained stable with accretion beginning around the Salt Ash area and increasing northward to a maximum at Birubi Point.

Bluecoast (2020) attribute the rotation to a long-term climate signal. They also found that while the northern end had accreted up to 30 m and the southern end eroded up to 20 m, the fulcrum of the rotation, located along the central section had remained essentially 'stable', as is typical of rotating beaches (Table 1). The beach adjacent to the Boral quarry area appears to have been slightly impacted by the rotation in recent decades.

5.1.4 Beach recession

While beach erosion refers to the short-term cycle of erosion and recovery of a beach, beach recession refers to the longer term (decades-centuries) net movement of the shoreline landward, from which it does not recover. Beach recession is usually caused by a negative sediment budget. However, accurate shoreline mapping along Stockton Bight only goes back to the 1980's restricting estimate of shoreline behaviour to the past few decades.

Bluecoast (2020) developed a contemporary sand budget for Stockton Bight, including longshore, offshore and aeolian sand transport, based on data between 2010 and 2018. They found considerable variation in longshore beach behaviour owing to beach rotation. However, for the entire Stockton Bight, they estimated a net loss of ~70 000 m^3/yr, the losses being primarily to the sand dunes and bypassing around Birubi Point. When divided by the length of the beach, this equates to a loss of ~2.2 m^3/m/yr for each metre of beach, which would equate to a shoreline recession in the order of a few centimetres per year (Table 2).

More recent mapping by Geoscience Australia undertaken as part of their Digital Earth Australia Coastline project (DEAC) (https://maps.dea.ga.gov.au/#share=s-DEACoastlines&playStory=1) has shown that:

- the average annual position of the shoreline along the northern 7 km of Stockton Bight has prograded seaward between 0.5 to 1 m/yr between 1988 and 2019;
- the southernmost Stockton Beach has receded between 0.5-0.9 m/yr, the latter in agreement with RH DHV (2018); and
- the amount of recession decreases northward and is between 0.3 and 0.8 m/yr in the site area, decreasing to zero between Salt Ash and Bobs Farm. (Figure 5).

Both the rotation and areas of erosion are in agreement with the recent Coastsat data. Coastsat plots shoreline position from satellite images recorded between 1988 and 2022, which clearly show the rotation signal in Figure 6. In front of the site, the transects indicate a -0.4 m/yr recession over this period (Table 2, Figure 6). These finding agree with the beach rotation impact identified by Bluecoast (2020) and discussed above.

Consequently, the shoreline behaviour is presently dominated by the rotation signal and contemporary data is too short (~ 35 years) to identify the longer-term recession rates within the Stockton Bight, apart from the overall recession of -2.2 m^3/m/yr identified by Bluecoast (2020).

Table 2. Summary of general shoreline behaviour between ~1990 and 2020

Source	Buribi (N)	Centre	Stockton (S)
Bluecoast (2020)	30 m		-20 m
Bluecoast (2020)		-2.2 m^3/m/yr (all beach)	
Geoscience Aust	0.5-1 m/yr	-0.3-0.8 m/yr	-0.5-0.09 m/yr
Coastsat	0.5-1 m/yr	0 to -0.5 m/yr	-0.5-1 m/yr

Bluecoast (2020) estimate the overall rate of recession is -2.2 m^3/m/yr which equates to a few centimetres per year. Even if at a maximum rate of 1 m/yr along the entire Stockton Bight, including the site, by 2100 this would equate to a potential recession of 80 m. This is less than that predicted by the NCC (2018) 2100 hazard line, which as discussed below, would have no impact of the proposed extraction site.

Figure 5. Satellite image of Stockton Bight plotting the DEAC estimate of shoreline behaviour (1988-2020) along the bight. Blue indicate accretion, red recession. Numbers are mean rates of shoreline change over that period. Source: https://maps.dea.ga.gov.au/#share=s-DEACoastlines&playStory=1

5.1.5 Wind

Wind is another major coastal process along Stockton Bight, particularly the dominant southwest and sub-dominate southeast winds (Figure 7). Onshore winds blow salt spray across the beach and onto the foredune. This allows only salt tolerant primary and secondary dune vegetation to cover the foredune, which extend about ~100 m inland (Table 1). Salt intolerant tertiary vegetation (shrubs and trees) can grow in the hind dunes in lee of the foredune, where they are sheltered from strong winds and the spray. In the case of Stockton Bight, the deflation basin has replaced the hind dunes and does not permit most secondary and no tertiary

vegetation to take hold. The spray does not impact the well vegetated dune in lee of the active (phase #4) dunes and cannot impact the quarry site, which lies landward of these dunes.

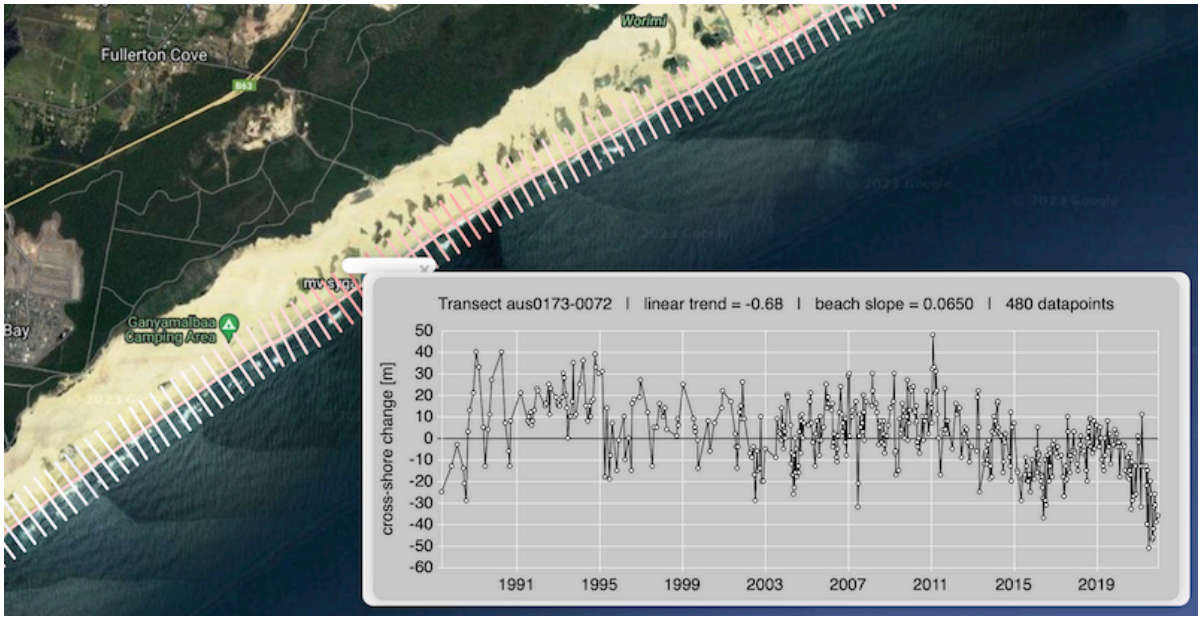

Figure 6. Coastsat transects along Stockton Bight in the Boral site area. Insert shows plot of shoreline position obtained from satellite images between 1988 and 2021, which show considerable oscillation, but overall a -0.4 m/yr trend. Source http://coastsat.wrl.unsw.edu.au

Over several millennium, the winds have also mobilised millions of cubic metres of beach sand and blown it inland to form the present massive dune systems, with an estimate volume of 1,000 million m^3. These winds continue to mobilise sand and move the active transgressive dunes (phase #4) both longshore to the northeast and inland to the northwest. The northwest movement of the dunes is occurring at a rate of 3-5 m/yr, and at this rate will take approximately 120-200 years to reach the proposed extraction site. The proposed extraction site is therefore not vulnerable to sand inundation for at least 120 years. The proposed extraction site in turn has no impact on these winds, other than causing a decrease in wind velocity when the wind moves over the lower elevation excavation depression.

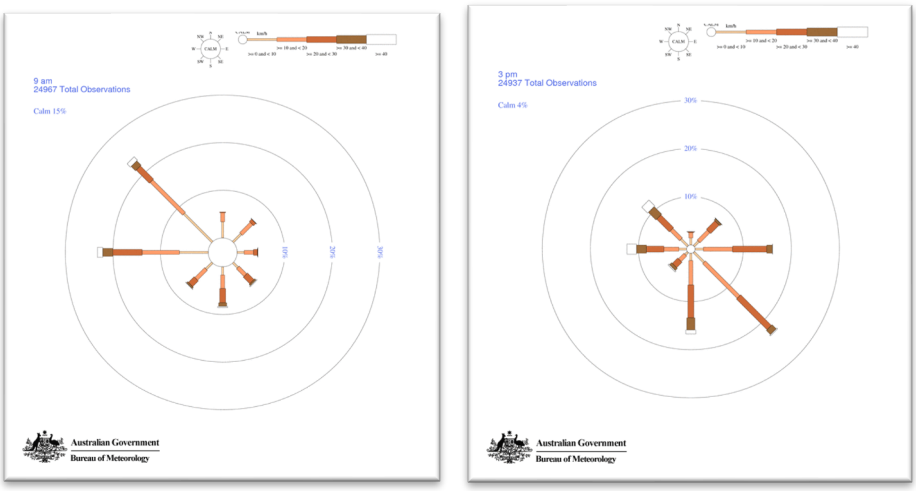

Figure 7. The 9am and 3pm wind roses at Williamstown, 5 km north of the project site. Note the dominate morning west to northwest winds and afternoon onshore southeast winds. These are the two main drivers of the sand dune movement and direction (source: Bureau of Meteorology)

5.2 Climate change impacts

Warming global climate is inducing sea level rise and is forecast to generate more severe tropical and east coast cyclones, which in turn could cause an anticlockwise shift in wave direction. Sea level along the NSW coast has risen 25 cm since 1880, with half of this rise occurring since 1970 and at present is rising about 3.5 cm per decade (BOM, 2020 and http://www.bom.gov.au/state-of-the-climate/oceans.shtml). Figure 8 presents a range of sea level projections to 2100.

While the scenarios range between 15-65 cm by 2100, the mid-range projections is ~40 cm.

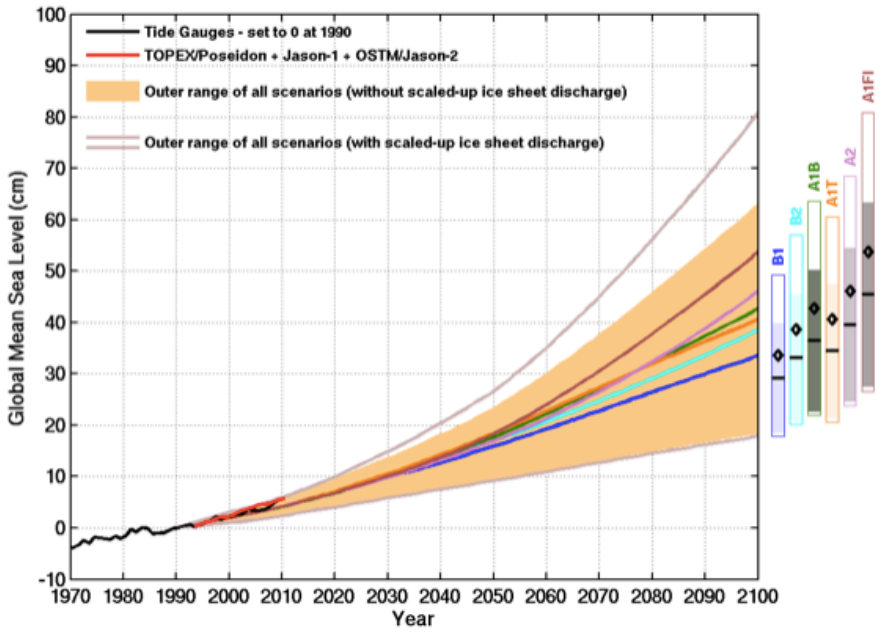

Figure 8 Sea level rise projections based of a range of warming scenarios. Source: Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4).

Sea level rise has two major impacts on beaches, that of shoreline recession and inundation. Geoscience Australia has mapped the entire Australian coast and assuming an 84 cm sea level rise by 2100, which based on Figure 8 is an outer range scenario, has plotted present and projected 2100 highest tides inundation lines.

The backbarrier flats at Fullerton Cove are presently prone to inundation and by 2100 the entire flats from Fullerton Cove to Tilligerry Creek will be prone to inundation during the highest tides. The project site is free of inundation at present and an excavation to 3.7 m AHD will also remain above the proposed 2100 inundation level of 1.84 m AHD (i.e. 1 m high tide plus 84 cm) (Table 1 and Figure 9). Therefore, during the highest tides predicted to occur in 2100, marine inundation would not flood the excavation site. Also Figure 8 indicates a rise of 84 cm is towards the outer range of projections with a lower level more likely.

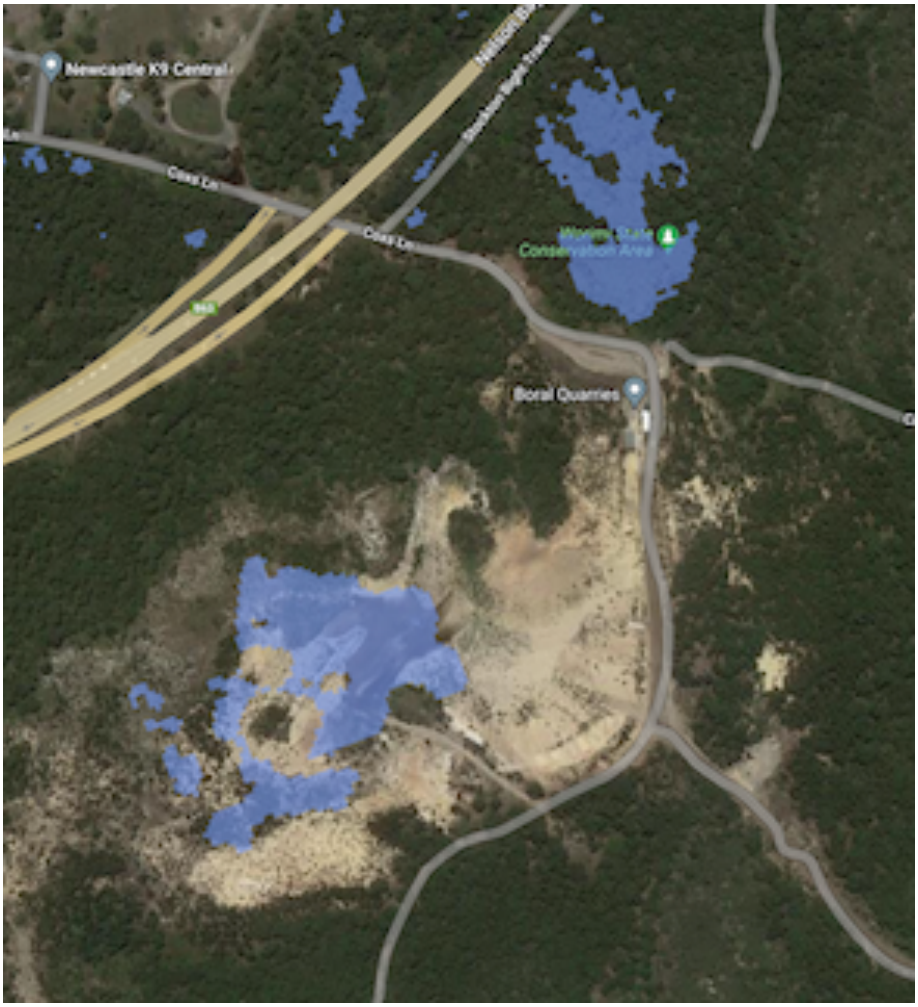

Figure 9. Satellite image of the Stockton Bight centred on the Boral Stockton quarry (the site) showing the present (dark blue) and potential 2100 (light blue) highest tide inundation level, assuming an 84 cm sea level rise (Source: https://coastalrisk.com.au/viewer). While the image indicates some inundation now and in 2100, if the project site is excavated/levelled to 3.7 m AHD it should be at least 2 m above the 2100 highest inundation level.

5.3.2 *Recession*

Sea level induced shoreline recession over the coming decades can only be modelled. These models use existing shoreline behaviour (stable, receding or accreting) and sea level rise to predict the exposure of future shoreline to erosion and inundation during extreme events, which are mapped as hazard lines. NCC (2018) modelled hazard lines along the southern Stockton Beach up to Fort Wallace, located approximately 3.5 km to the southwest of the site. At Fort Wallace the existing 'rare' immediate hazard line reaches 50 m inland, with the 2050 'rare' hazard line reaching 100 m and the 2100 line reaching 180 m inland (NCC, 2018) (Table 1), with the latter two also accounting for rising sea level rise. If we assume the same lines apply to the site, then by 2100 marine processes, in particular beach erosion and storm surge could extend this far inland on 'rare' occasions, that is, during major storm erosion and surge events. This would still lie within the deflation basin area and have no impact on the mobile dunes, vegetated dunes or the quarry area.

5.3.3 *Cyclones*

The forecast of more intense cyclones off the NSW coast (Goodwin, et al., 2016) will lead to greater for beach erosion, higher storm surges and stronger onshore winds, each of which will increase the impact of these hazards along the coast. Along Stockton Bight such events would result in greater beach erosion, slower beach recovery, and greater storm surge inundation of the deflation basin, together with increased onshore aeolian sand transport. The June 2016 storm event which inundated the Stockton deflation basin, provides an indication of the type of impacts along the NSW coast (Harley, et al., 2017; Mortlock, et al., 2016).

While these impacts will be felt across the beach, foredune and deflation basin area, they will not impact beyond the deflation basin, and consequently will have no impact on the site or proposed extraction area apart from a slight increase in mobile sand movement.

5.3.4 *Wave direction*

The forecast anticlockwise shift in wave direction will generate a rotation of beaches to the south and reduce the rate of northerly longshore sand transport (Goodwin, et al., 2016; Mortlock, 2016). Along Stockton Bight this would result in slight retreat of the northern Birubi end of the beach and accretion along the southern Stockton Beach, with little impact along the central section, including the site.

The reduction in longshore sand transport would decrease the amount of sand bypassed around Birubi Point, thereby reducing the net loss of sand from the Bight.

5.3 Potential effects of the project on coastal processes, hazards and the surrounding environment

As demonstrated above the proposed extraction area and more broadly the site is located too far inland to have any impact on marine processes (waves, tide, storm surges and coastal currents).

The only coastal processes that could be impacted are wind flow across the site. The lowering of the existing topography to 3.7 m AHD will form a deeper hollow causing wind velocities to decrease as they flow over and into the excavation site. This will lessen any potential windblown sand movement.

Providing the quarry boundaries continued to be buffered (i.e., graded and stabilised with vegetation), which is part by the project design, the proposed extraction area would have no geotechnical impacts, including any erosion, disturbance or contamination to the surrounding landforms, in particular the vegetated transgressive dunes or the Fullerton Cove flats.

5.3.1 Impact on Worimi areas

The quarry is bordered on three sides by the Worimi Conservation Area (Figures 10 and 11). In addition, the Worimi Regional Park incorporates much of Stockton beach and the mobile dunes and the Worimi National Park much of the vegetated transgressive dunes (Figure 10). As shown in Figure 11, the Worimi areas are separated from the excavation site by at least 400 m of vegetated dunes and to the south by an additional 200 m wide strip of mobile dunes. While one point of the regional park lies within 700 m of the proposed excavation site, most of the regional park and national park are located several kilometres from the proposed excavation site and the site more broadly.

The proposed extraction site can have no direct or indirect impact on any of the Worimi areas. This is because:

- the site is located at least a few hundred meters and in most cases kilometres from the Worimi areas;
- much of the 400 m buffer is densely vegetated with littoral forest; and
- where the Conservation Area is adjacent to the site, it is located downwind and can therefore not physically impact movement of the mobile dunes.

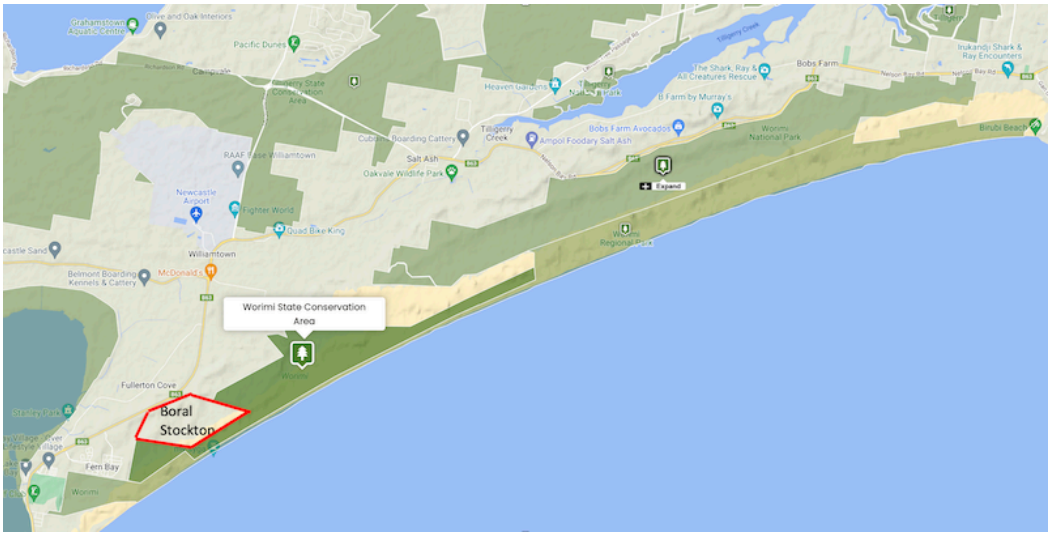

Figure 10. Map showing the approximate location of the site (red box) and the Worimi Conservation Area, Worimi Regional Park and Worimi National Park (source: https://www.nationalparks.nsw.gov.au/visit-a-park/parks/worimi-state-conservation-area).

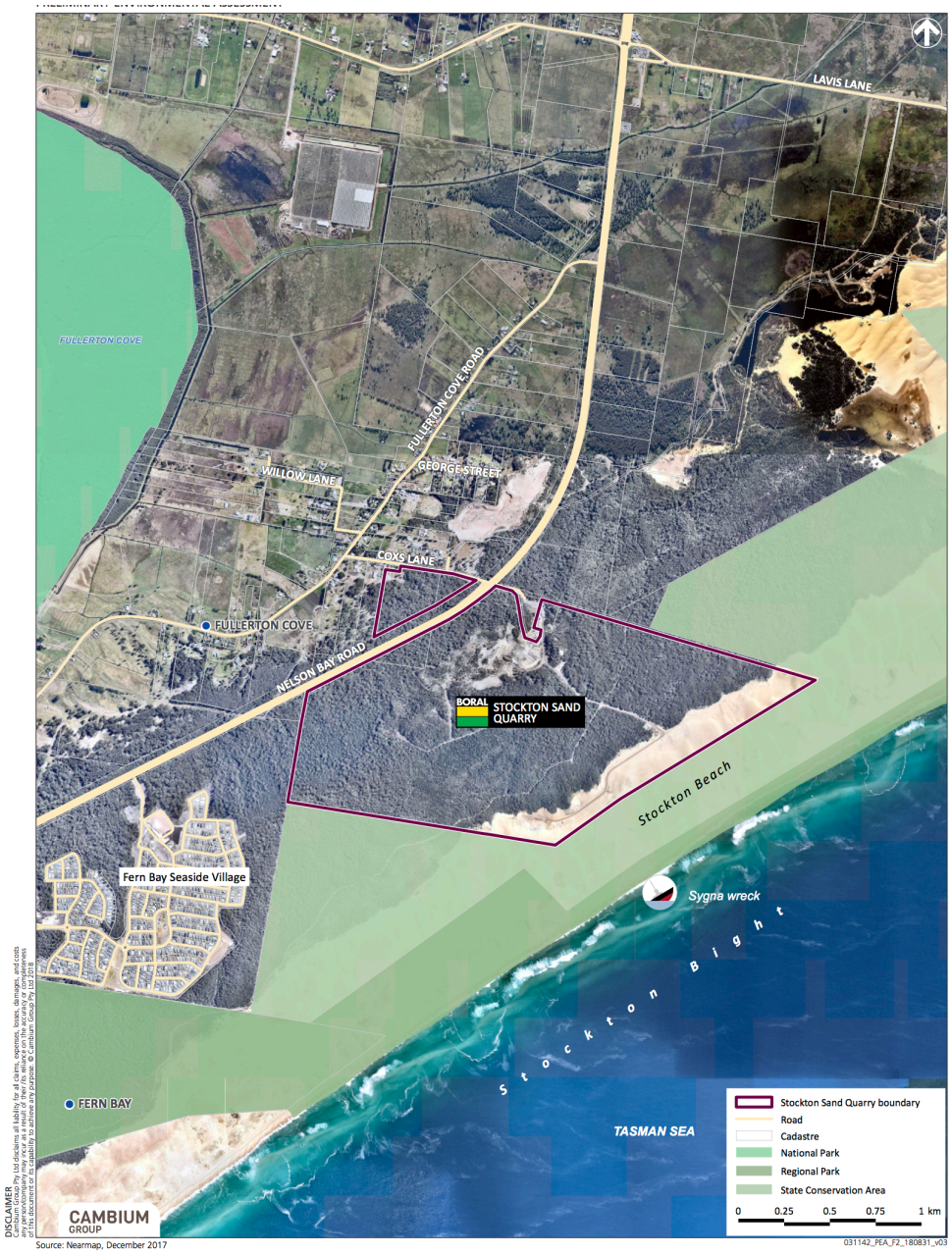

Figure 11. Satellite image of quarry site and overlain with adjacent Worimi Conservation Area (light green) and Worimi Regional Park (darker green).

Mobile sand and dune activity within the Conservation Area is a result of long-term natural processes occurring on the beach, foredune, deflation basin and mobile dunes, processes that have ultimately formed the entire barrier system. The present phase #4 of dune mobility was initiated by natural causes a few hundred years ago. It has however been exacerbated in recent decades by considerable and ongoing off-road vehicle activity. Vehicle traffic damages vegetation in the deflation basin and foredune and hinders the establishment or re-establishment of sand binding vegetation. The result is an increase in areas of bare and disturbed which permits greater aeolian sand transport, leading to ongoing erosion of the foredune and deflation basin. In places, this erosion exposes cultural sites in the deflation basin. These exposed sites are located at least 1 km from the excavation site.

6 Summary

Given the size and nature of the buffer zone surrounding the proposed excavation site and its distance from active coastal processes (Table 1) and the Worimi areas it cannot and will not have any direct or indirect physical interaction with or impact on these systems, namely beach processes or the movement of sand from the beach into the mobile dunes and their encroachment on the vegetated hind dunes.

The mobile dunes, at their present rate of movement, will require 120-200 years to reach the proposed excavation site. The site is above both present levels of coastal inundation and the projected 2100 inundation levels. Once the site is landscaped and rehabilitated it should remain vegetated and stable. Likewise, owing to the vegetation buffer and distances and the fact it is downwind of the Worimi areas the site cannot directly or indirectly impact any of the Worimi areas.

The following points can be made about Stockton Bight and the dune field in the vicinity of the site and the proposed extraction site:

6.1 Geology

- The Stockton dune field is a natural dune system (a coastal sand barrier) that has evolved over the last approximately 6,500 years with four phases of barrier-dune development.
- The backbarrier flats were deposited and the barrier built seaward (phase #1) between 6,500 and 5,000 years ago as a series of low foredune ridges.
- This was followed by three phases of active transgressive (mobile) dunes: phase #2 5,200-4,000 years ago, phase #3 approximately 2,000 years ago and the present phase #4 during the past 500 years.
- The present barrier consists of the active beach and surf zone, backed by an unstable foredune, then a long deflation basin. Sand is blowing from the beach and foredune into the deflation basin and then into the mobile transverse dunes which extend up to 600 m inland. The vegetated phase #2 and #3 dunes extend another 2 km inland.
- The proposed excavation site is located in the inner portion of the phase #2 dunes and at least 500 m landward of the mobile phase #4 dunes, which at their present rate of migration (3-5 m/yr) would take 120-200 years to reach the excavation site.

6.2 Costal Processes, Hazards and Vulnerability

- The proposed development will have no additional physical impact on the surrounding environment, outside of the immediate buffer zone. It is located too distant from active coastal processes including waves, tides, ocean currents and longer-term processes including beach rotation, periodic storm erosion and sea level rise to 2100 (Table 1). The predicted 2100 erosion hazard line lies more than 1 km southeast of the site. Present and projected 2100 highest tide inundation levels will not impact the proposed excavation site, particularly as the project is only planned to operate for 10 years.
- Impacts that have already occurred at the site and include increased exposure of the fringing forest located along its southern boundary. As the

excavation will stop at 3.7 m AHD, which is above the water table it should have no impact on the elevation of the water table. So long as the buffer zone is stabilised, vegetated and maintained there would be no erosion or disturbance of the adjacent areas.

- The project is not exposed to nor vulnerable to coastal processes and cannot impact any of the marine processes. It will however decrease wind velocity over the site.

6.3 Worimi Conservation Area, Worimi Regional Park & Worimi National Park (Worimi Areas)

The following points can be made about Stockton Bight and the dune field in the vicinity of the Worimi areas:

- The Stockton-Worimi dune field is a natural dune system that has evolved over the last ~6000 years with three episodes of dune migration. The most recent commenced about 500 years ago.
- In recent decades this natural dune movement has been adversely impacted by off-road vehicle traffic over the dunes. This has led to a more unstable foredune and deflation basin, both of which have increased sand mobility, with the net result being an increase in the amount of deflation and an expansion of the deflation basin.
- Ongoing deflation in parts of the Conservation Area can be attributed to the above natural dune migration, aggravated by the vehicle activity, leading to the ongoing deflation and northwest expansion of the deflation basin.
- The present fencing of the foredune and removal of vehicles from the beach will increase the vegetation and stability of the foredune and ultimately prevent beach and foredune sand from reaching the deflation basin. The deflation basin will however continue to lose sand to the transverse dunes.
- The excavation site is located downwind of these activities and cannot impact the above dune dynamics east and upwind of the site boundary. Transverse dunes within the boundary have been partly truncated, and are now moving both northwest along the beach, as well as moving into the Boral Stockton site.

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UNSW Coastsat: Worldwide shoreline mapping using satellite images
http://coastsat.wrl.unsw.edu.au

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Appendix H

Biodiversity development assessment report

Excellence in your environment

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Stockton Dry Sand Extraction Project

Biodiversity Development Assessment Report

Prepared for Boral Resources (NSW) Pty Ltd 13 August 2023

niche-eh.com

Excellence in your environment

Project number	Client	Project manager	LGA
3706	Boral Resources NSW Pty Ltd	Luke Baker (Accreditation no. BAAS17033)	Port Stephens

Declaration

This Biodiversity Development Assessment Report has been approved for submission by Niche Environment and Heritage.
Niche Assessors and staff involved in this Project include:

Luke Baker - BAM Accredited Assessor (BAAS17033); Alex Christie - BAM Accredited Assessor (BAAS18131)

Amanda Griffiths - BAM Accredited Assessor (BAAS19016); Radika Michniewicz - Senior Ecologist

Declaration:

This Biodiversity Development Assessment Report has been prepared on the basis of the requirements of (and information provided under) the Biodiversity Assessment Method and advice provided by the BAM Support Team, as certified by BAM Accredited Assessor: Luke Baker (BAAS #BAAS17033)

Version	Author	Review	Status	Date
Rev 1	Baker, L	Boral Resources (NSW)	Final	8 August 2023

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Executive summary

Context

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource located above the water table and from within the same extraction area (the Stockton Dry Sand Extraction Project (the Project)).

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral to prepare a Biodiversity Development Assessment Report (BDAR) for the Stockton Dry Sand Extraction Project (the Project), which addresses the requirements of the NSW *Biodiversity Conservation Act 2016* (BC Act) and NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

Survey overview

An ecological assessment in accordance with the BAM was undertaken for the Project and consisted of:

- Site survey to determine the extent and occurrence of native vegetation and determine habitat for threatened biodiversity.
- Collection of data from 16 BAM plots.
- Targeted surveys for threatened flora during the months of May to September.
- Targeted surveys for a range of threatened fauna species, including: Wallum Froglet, Bush-stone Curlew, Koala, Powerful Owl, Barking Owl, Masked Owl, Brush-tailed Phascogale, Gang-gang Cockatoo, Glossy-black Cockatoo, and threatened microbats (Little Bentwing-bat, Southern Myotis, Eastern Cave Bat, Greater Broad-nosed Bat, Eastern Bentwing Bat).
- Surveys for breeding resources associated with threatened fauna.

Results

The subject site is approximately 38.16 ha and contains all areas proposed for ground disturbance. The subject site is located within the footprint of former inland extraction areas that were cleared over the past two decades and have since been rehabilitated with native plantings.

Native Vegetation

Native vegetation on the subject site was identified and mapped in accordance with the BAM and BioNet Vegetation Classification. In total the subject site includes:

- 35.67 ha of vegetation which meets the definition of native vegetation; and

- 2.49 ha non-native vegetation.

Of the above, preliminary clearing of approximately 0.5 ha of preliminary vegetation is proposed across the project site prior to extraction, to facilitate a widespread drilling program, which would enable Boral to:

- monitor the level of the water table over the life of the project; and
- provide an accurate representation of the quality of the sand resource across the site.

Two Plant Community Types (PCTs) were mapped within the subject site:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast: recorded in five different condition classes that are representative of the age of the former quarry pit rehabilitation.
- PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast: recorded in one condition class which is representative of historic plantings.

None of the PCTs recorded align to Threatened Ecological Communities (TECs) listed on the BC Act or *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).

Threatened Species

No threatened flora were recorded within the subject site during targeted field surveys.

Three threatened fauna were recorded within the subject site during the field survey: Greater Broad-nosed Bat, Eastern Bentwing Bat and White-bellied Sea Eagle. All are regarded as 'ecosystem credit' species for this assessment given the absence of breeding habitat within the subject site.

The assessment concluded that the Squirrel Glider (species credit) is likely to occur within the subject site due to a historic record within the subject site.

All ecosystem credit species as generated by the BAM database searches and calculator outputs, were assumed to be present.

Impact

The impact of the Project on ecological values are summarised as follows:

- Direct removal of 35.67 ha of native vegetation, noting that 5.12 ha has a site integrity score below that requiring a credit offset.
- Indirect impacts to immediately surrounding vegetation/habitat will be prevented via a series of mitigation measures.
- Removal of fauna habitat, consisting of a mix of rehabilitation land and remnant vegetation.
- Removal of micro habitat features such as hollow-bearing trees and logs.

Commonwealth Assessment

The Project is to be assessed under the EPBC Act pursuant to the assessment bilateral agreement with the NSW Government. Therefore, this BDAR provides an assessment of potential impacts to EPBC Act listed threatened species and communities, applying the Biodiversity Assessment Method (BAM).

Our assessment concluded that seven threatened biodiversity listed on the EPBC Act have a moderate to high likelihood to utilise the subject site: Black-faced Monarch, White-throated Needletail, Spotted-tail

Quoll, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox. Many of these species were determined to potentially use the subject site given the absence of detection during the field survey. Formal Assessment of Significance were completed for the Commonwealth listed threatened species, which concluded that that Project is unlikely to have a significant impact on any MNES.

Measures to Avoid, Minimise and Mitigate Impacts

As detailed in the Environmental Impact Statement (EIS), throughout the process of site planning Boral has considered alternative locations and processes. The current site utilises the former rehabilitated inland extraction area for most of the impact rather than remnant vegetation that occupies the remaining portion of the site.

The Project has been designed to avoid or minimise impacts to vegetation and habitat and include:

- Undertaking vegetation clearing in accordance with the Vegetation Clearance Protocol described in section 5.1.4 (impacts arising from the construction will primarily relate to vegetation clearing).
- Fencing and signposting erected as close as possible to the edge of the subject site as described in section 5.1.4.
- Educating employees and/or contractors involved in the construction and operation of the Project.
- The preparation and implementation of a suitable Landscape and Rehabilitation Management Plan.
- Dust suppression.
- Procedures for the management of spills throughout the subject including the requirements for vehicles to carry spill kits.
- Management and removal of all rubbish from the subject site.
- Maintain current quarry speed limits to minimise the potential for fauna collision.

Offset Strategy

The result of running the Biodiversity Assessment Method Credit Calculator (BAM-C) is that the Project requires a total of 571 ecosystem credits and 700 species credits:

- Ecosystem credits:
    - PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast – 540 credits
    - PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast – 31 credits.
- Species credits:
    - Squirrel Glider – 700 credits

Boral commits to satisfying the credit requirements using offset mechanisms allowed by the NSW Biodiversity Offset Scheme (i.e. retirement of biodiversity credits and/or contribution to the Biodiversity Conservation Fund).

Boral propose to implement a staged-offset approach to reflect the progressive native vegetation disturbance. The staged-offset would involve the retirement of the required credits over a period of approximately 10 years prior to progressing vegetation/habitat removal.

No Commonwealth biodiversity offset is required given that there is no significant impact to any EPBC Act listed threatened biodiversity.

Conclusion

The impact avoidance, mitigation and offset hierarchy has been applied to the Project resulting in some unavoidable impacts. The credit calculation has determined the offset requirement for clearance of native vegetation (ecosystem credit requirement) and the offset requirement for Squirrel Glider. It is anticipated that the offset requirements would be met through retirement of biodiversity credits and/or contribution to the Biodiversity Conservation Fund.

Glossary and list of abbreviations

Term or abbreviation	Definition
BAM	Biodiversity Assessment Method
BAM-C	Biodiversity Assessment Method Credit Calculator
BC Act	NSW *Biodiversity Conservation Act 2016*
BC Reg	NSW *Biodiversity Conservation Regulation 2017*
BCF	Biodiversity Conservation Fund
BDAR	Biodiversity Development Assessment Report
BMP	Biodiversity Management Plan
BOS	NSW Biodiversity Offsets Scheme
BSA	Biodiversity Stewardship Agreement
BSSAR	Biodiversity Stewardship Site Assessment Report
CEEC	Critically Endangered Ecological Community
cm	Centimetre/s
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DBH	Diameter at Breast Height
DCP	Development Control Plan
DPIE	NSW Department of Planning, Industry and Environment (formerly DECCW, DECC, DEC, OEH)
EEC	Endangered Ecological Community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FM Act	NSW *Fisheries Management Act 1994*
ha	Hectare/s
IBRA	Interim Biogeographic Regionalisation for Australia
km	Kilometre/s
LEP	Local Environment Plan
LGA	Local Government Area
Locality	The subject site and surrounds, nominally a 10 km radius from the subject site
m	Metre/s
MNES	Matters of National Environmental Significance (from the EPBC Act).
PCT	Plant Community Type
RDP	Rapid Data Point
SAII	Serious and Irreversible Impacts
SEARS	Secretary Environment Assessment Requirements
SSD	State Significant Development
TBDC	Threatened Biodiversity Database Collection
TEC	Threatened Ecological Community
VI	Vegetation Integrity as calculated by the BAM Calculator

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1. Introduction

1.1 Context

Boral Resources (NSW) Pty Ltd owns and operates the Stockton Sand Quarry (the site or the quarry), located on Coxs Lane, Fullerton Cove, a long standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

The existing windblown project was granted consent in 2006, with the consent is due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to the NSW Department of Planning and Environment (DPE) in 2020, seeking consent to extract and dredge up to 9 million tonnes of sand from the inland dunes area (the current dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that, to keep the quarry operating, an interim application is required, and is seeking SSD approval (Ref: SSD 52984213) to extract only the remaining dry sand resource located above the water table and from within the same extraction area (the Stockton Dry Sand Extraction Project (the Project)).

Consistent with the current dredge application, the project seeks a site-wide dispatch limit of up to 750,000 tonnes per annum (tpa) (i.e. the existing windblown sand extraction area and the project operations combined) until either:

- the current dredge application is commenced, after which extraction under the project would cease and be replaced with the approved dredging proposal (noting that the staging of the project and the current dredge application have been aligned to allow for this); or
- the current dredge application is not approved and the existing windblow consent lapses in 2028, after which the site-wide dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the current dredge application not be approved, as well as allowing for fluctuations in market demand.

Niche Environment and Heritage Pty Ltd (Niche) was commissioned by Boral Resources (NSW) Pty Ltd (Boral) to prepare a Biodiversity Development Assessment Report (BDAR) for the Project, which addresses the requirements of the NSW *Biodiversity Conservation Act 2016* (BC Act). The report was prepared in accordance with the Biodiversity Assessment Method (BAM) (OEH 2020a) and the Secretary Environmental Assessment Requirements (SEARs) for the Project, and also assesses the impacts of the Project on Matters of National Environmental Significance (MNES) under the EPBC Act.

1.2 The Project

The Stockton Sand Quarry is located in Fullerton Cove, approximately 9.8 kilometres (km) north-northeast of the Newcastle Central Business District (CBD), within the Port Stephens Local Government Area (LGA) (Figure 1 and Figure 2).

The site is owned and operated by Boral and covers an approximate area of 246 hectares, comprising of:

- Lot 1 DP 1006399, comprising 234.0 hectares located on the eastern side of Nelson Bay Road.
- Lot 2 DP 1006399 comprising 10.4 hectares and located predominantly on the western side of Nelson Bay Road, with a small portion also positioned on the eastern side of Nelson Bay Road (formerly Part Lot 167, Part Portion 167).
- Lot 3 DP 664552 comprising 1.6 hectares and located wholly on the eastern side of Nelson Bay Road, within which the existing depot and weighbridge are located (formerly within Part Lot 3, Part Portion 3).

  The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the New South Wales (NSW) Department of Planning and Environment (DPE) – Crown Lands

The subject site is in the central portion of Boral's landholdings and covers an area of approximately 378ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010/4 and is the same as the project site for the current dredge application.

The subject site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

Sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project mirror the first five stages of the dredge application. This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or

- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand. Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

The existing site depot would also be reconfigured for the Project as part of Stage 1, including:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

1.3 The Subject site

The subject site is approximately 38.16 ha and contains all areas proposed for ground disturbance (Figure 3). The subject site is located within the footprint of former inland extraction areas that were cleared over the past two decades and have since been rehabilitated with native plantings.

The extent of disturbance associated with the subject site will result in the clearing of:

- 35.67 ha of vegetation which meets the definition of ‘native vegetation’ as per the BAM; and
- 2.49 ha non-native vegetation.

Biodiversity values have been avoided as much as practical as detailed in section 5.1, and details of the mitigation measures proposed to reduce or prevent indirect impacts from the Project are detailed in section 5.1.4.

1.4 Approval and Assessment Process

The following legislation or planning instruments are relevant to the works associated with the Project.

1.4.1 State Approval and Assessment Process – Application of the BAM

For NSW State approval, the Project is to be assessed as State Significant Development (SSD) under Part 4 of the EP&A Act, which requires proponents to use the Biodiversity Offset Scheme (BOS) BAM to prepare a Biodiversity Development Assessment Report (BDAR) under the BC Act.

This BDAR describes the biodiversity values present within the subject site and identifies impacts from the Project on these values. This assessment has used the BAM Calculator (BAM-C) (version 1.2.7.2) to determine the biodiversity credits required to offset the Project.

1.4.2 Commonwealth Approval and Assessment Process

Matters of National Environmental Significance (MNES) are protected under the EPBC Act. The BAM requires proponents to identify and assess the impacts on all nationally listed threatened species and threatened ecological communities that may be present on or near the development site. Therefore, the BAM has partly been used to perform assessment of impacts under the EPBC Act. Further assessment of impacts under the EPBC Act has been undertaken via assessments of significance for EPBC Act listed species with the potential to be affected by the Project (Annex 8).

Under the EPBC Act, activities that have potential to result in significant impacts on MNES must be referred to the Commonwealth Minister for the Environment and Energy for assessment.

This report assesses the impact of the project on MNES.

1.4.3 Secretary Environmental Assessment Requirements (SEARs)

In addition to requirements under the BAM and Commonwealth environmental approvals process, this BDAR addresses specific requirements provided in the Project SEARs relating to biodiversity, issued in January 2023 (amended March 2023) by the DPE. Table 1 below cross-references this report with the relevant SEARs.

Table 1. SEARs addressed in this BDAR

Requirement	Section addressed in report
Biodiversity – including: - accurate predictions of any vegetation to be cleared on site; - a detailed assessment of the likely biodiversity impacts of the development, paying particular attention to threatened species, populations and ecological communities and groundwater dependent ecosystems, undertaken in accordance with the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report; -a detailed consideration of the potential for off-site and in-direct impacts on local biodiversity and surrounding ecological corridors or habitat.	This report follows the BAM. It provides an assessment of the impacts as per the BAM and assesses the Commonwealth EPBC Act Matters in relation to biodiversity.
- a strategy to offset any residual impacts of the development in accordance with the Biodiversity Offsets Scheme.	Section 7.
Attachment A	
1. Biodiversity impacts related to the proposed development (SSD-52984213) are to be assessed in accordance with the Biodiversity Assessment Method 2020 and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the Biodiversity Conservation Act 2016 (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method 2020.	This document is a BDAR and follows the BAM.

Requirement	Section addressed in report
2. The BDAR must document the application of the avoid, minimise and offset framework including assessing all direct, indirect and prescribed impacts in accordance with the Biodiversity Assessment Method 2020.	Section 5.1 details avoidance and minimisation. Section 5.2 details impacts (direct, indirect, prescribed). Section 6 details offsets.
3. The BDAR must include details of the measures proposed to address the offset obligation as follows: The total number and classes of biodiversity credits required to be retired for the development/project The number and classes of like-for-like biodiversity credits proposed to be retired; The number and classes of biodiversity credits proposed to be retired in accordance with the variation rules; Any proposal to fund a biodiversity conservation action; Any proposal to conduct ecological rehabilitation (if a mining project); Any proposal to make a payment to the Biodiversity Conservation Fund. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	The offset strategy is detailed in section 7. Rehabilitation of the site is discussed in detail in the EES (2019) Landscape and Rehabilitation Strategy.
4. If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits.	Boral are not seeking variation rules.
5. The BDAR must be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016.	This assessment and field survey has been completed by Accredited Assessors (section 1.7)
6. The Department now has a template guideline for the production of BDARs titled 'Guidance for the Biodiversity Development Assessment Report Template', available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-andplants/Biodiversity/biodiversity-development-assessment-report-template-guide-220209.pdf	Template considered. This BDAR has been reviewed by OEH/DPE twice based on the dredging Assessment. This BDAR has been updated to reflect prescribed impacts and an updated of the BAM-C.

1.5 Consultation

As part of the project planning for the current dredge application, Element Environment/Boral submitted correspondence to the Department of Planning, Industry and Environment (DPIE) - Biodiversity and

Conservation Division (BCD) on the 17th July 2019 requesting to provide comments for the preparation of the Environmental Impact Statement.

A response was provided by DPIE on the 2nd August 2019, stating that the BCD has provided input into SEARs (reference DOC18/691590-1) which outline assessment requirements for Aboriginal cultural heritage, threatened biodiversity, impacts to National Parks and Wildlife Estate, soils and water, flooding, floodplain management and coastal erosion. BCD had no further assessment requirements at this stage of the project.

Boral, Niche and Arnold Planning met with the BCD on the 9 December 2022 to discuss the BDAR for the Project. Niche discussed that the BDAR would essentially be identical to that submitted as part of the current dredge application, which had been reviewed and approved by the BCD. Niche discussed that this BDAR would only be required to be updated to reflect:

- Changes to benchmarks within the BAM-C, requiring a new run of the calculator.
- Updates of BAM plot data that is older than 5 years.
- Updates in sections of the report to adhere to guidance material that has been released since the original BDAR was submitted.
- Updates to Project descriptions, SEARs, plot data lists, vegetation integrity scores, and tables depicting biodiversity credits.

1.6 Assessment Objectives and Format

The primary objective of this assessment is to use the guidelines and methodology provided in the BAM to determine the impact the project would have on biodiversity, avoid and mitigate these impacts and then calculate the Project's biodiversity offset requirement.

This BDAR has two broad stages consistent with the BAM methodology:

Stage 1 – Biodiversity Assessment

- assessment of landscape features
- assessment of native vegetation
- assessment of threatened species and populations.

Stage 2 – Impact Assessment

- avoid and minimise impacts on biodiversity values
- consider impact and offset thresholds
- determine and calculate offset (credit) requirements.

1.7 Assessment Resources and Assessor Qualifications

This BDAR has been prepared by the accredited personnel and support staff identified in Table 2. Resources and survey guidelines used in the development of this BDAR are detailed in 3.1 and 4.1.

Table 2: Assessor qualifications and resources

Personnel	Qualifications	Tasks carried out
Luke Baker	Team Leader Ecology Accredited Biodiversity Assessor (BAAS 18088)	Flora and fauna field survey, data management, data entry, credit calculations, report preparation.
Rhidian Harrington	Ecologist and former Director of Niche. Accredited Biodiversity Assessor (BAAS 17095)	Quality assurance, report review, review of threatened bird and amphibian habitat.

Alex Christie	Ecologist Accredited Biodiversity Assessor (BAAS 18144)	Flora and fauna field survey and report preparation
Amanda Griffith	Senior Ecologist Accredited Biodiversity Assessor (BAAS 17066)	Flora and fauna field survey
Radika Michniewicz	Senior Ecologist Extensive fauna trapping experience, including project management and field assessment of long-term targeted Fauna Monitoring Projects for NSW Roads and Maritime Services.	Flora and fauna field survey, including trapping and spotlighting, and Wallum Toadlet transects after 20 mm of rain.
Jodie Danvers	Ecologist Extensive fauna trapping experience, including field assessment and reporting associated with long-term targeted Fauna Monitoring Projects for NSW Roads and Maritime Services.	Flora and fauna field survey, including trapping, spotlighting and Wallum Toadlet transects after 20 mm of rain.
Sophia Dunn	Ecologist BAM plot collection in 2023 Extensive botanical experience, including field assessment and reporting associated with biodiversity stewardship sites for the ARTC Inland Rail Project.	BAM plot collection in 2023
Isabel Lyons	Ecologist Accredited Biodiversity Assessor (BAAS22002)	BAM plot collection in 2023

Table 3: Assessment resources and guidelines used

Assessment resources/guideline	
Survey guidelines	NSW • Surveying threatened plants and their habitats NSW survey guide for the Biodiversity Assessment Method (DPIE 2020c). • 'Species credit' threatened bats and their habitats, NSW survey guide for the Biodiversity Assessment Method (OEH 2018a). • Field survey methods for amphibians, Threatened species survey and assessment guidelines (DECC 2009). • 2004 Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft) (DECC 2004). • Lake Macquarie City Council (LMCC 2014a) Flora and Fauna Survey Guidelines Version 4.2. Commonwealth • Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010a) • Survey Guidelines for Australia's Threatened Bats (DEWHA 2010b) • Survey Guidelines for Australia's Threatened Birds (DEWHA 2010c) • Draft Survey Guidelines for Australia's Threatened Orchids (Commonwealth of Australia 2013)

2. Landscape Features

2.1 Methods

As detailed in Section 4 of the BAM (OEH 2017a), a landscape assessment for the Project is required, which was conducted within the BAM Calculator. Landscape value is an assessment of factors including:

- Native vegetation cover
- Rivers, streams and estuaries
- Areas of geological significance
- Habitat connectivity.

For each factor the current state of the landscape is assessed then compared with the state of the landscape if the Project were to proceed.

2.2 Landscape Features and Scoring

The inputs into the landscape features component of the BAM Calculator, along with the associated Figure reference, has been detailed in Table 4 below.

Table 4: Landscape features and scoring under the NSW BAM

Landscape features	Description	Figure reference
subject site size	38.16 ha	
IBRA bioregion/subregion	NSW North Coast IBRA region, and within Karuah Manning IBRA subregion.	Figure 4
NSW (Mitchell) Landscapes	One Mitchell landscape occurs across the subject site: Sydney - Newcastle Barrier and Beaches.	Figure 4
Rivers, streams and estuaries and Strahler stream order	No rivers, streams of estuaries occur within the subject site.	None occur within the subject site
Wetlands within and adjacent to development	No wetlands occur within or adjacent to the development. The closest mapped wetlands include Long Bight Swamp located approximately 2.3 km to the southwest of the subject site.	-
Cleared areas	The native vegetation proposed to be directly impacted for the Project has largely been subject to clearing due to historic quarrying operations. Rehabilitation of the former quarry pits have occurred over the past decade. The rehabilitation has been undertaken as per a series of rehabilitation management plans (section 3.1.2), which has entailed large-scale tubestock planting and seeding. Areas of 'cleared areas' (devoid of native vegetation) within the subject site, comprise portions of the former inland extraction area and associated infrastructure (Figure 6). These cleared areas total 2.49 ha.	'Cleared Areas' or 'non-native' areas is shown on Figure 6
Connectivity features	The subject site adjoins a native vegetation corridor which extends to the north and south along Stockton beach encompassing Worimi Regional Park and Worimi State Conservation Area. The corridor also adjoins the	Figure 1

Landscape features	Description	Figure reference
	wetlands (Long Bight Swamp) and riparian vegetation of Fullerton Cove approximately 2.3 km to the south-west.	
Buffer area (percent native vegetation cover)	A 1,500 m buffer was applied to the subject site resulting in an overall buffer area of 1,220 ha. Aerial interpretation was used to map the area of native vegetation, and non-native vegetation within the locality. In total 596 ha is non-native (consisting of quarry pit, existing emplacement, infrastructure, rural residential and roads/rail links) and 624 ha is native vegetation. ***Total native vegetation cover*** Combining the estimated native vegetation cover resulted in 51% of the buffer area supporting native vegetation. This falls into the 30-70% category within the BAM Calculator.	Figure 4
Site context	Site based assessment.	-
Geological significance	There are no karst, caves, crevices, cliffs or other areas of geological significance within the subject site. Such geographic significant features are located greater than 2 km away from the subject site one would be impacted by the Project.	-

3. Native Vegetation and Flora Assessment

3.1 Native Vegetation

3.1.1 Methods – Data Review

A review of relevant literature, databases and existing vegetation mapping was undertaken to identify vegetation, threatened flora and Threatened Ecological Communities (TECs) with potential to occur at the subject site. The literature review was undertaken prior to the field survey to inform field survey requirements. A likelihood of occurrence analysis (Annex 1) was then undertaken for each species/TEC, based on suitability of habitat present within the subject site.

Resources reviewed included the following:

- Database searches:
  - *NSW BioNet Atlas Database* (DPIE 2020d) for spatial records of threatened flora listed under the BC Act within a 10 kilometre (km) radius of the subject site.
  - *EPBC Act Protected Matters Search Tool* (PMST) (DAWE 2020) for list of flora and ecological communities identified as MNES known or with potential habitat within a 10 km radius of the subject site.
  - BAM Calculator candidate and predicted species list.
- Vegetation mapping: Greater Hunter Native Vegetation Mapping v4.0. VIS ID 3855 (OEH 2017b)
- Previous relevant studies including:
  - Eastcoast Flora Survey (2010) Vegetation of the Worimi Conservation Lands, Port Stephens, New South Wales: Worimi NP, Worimi SCA & Worimi RP - Final Report, November 2010, Stephen Bell & Colin Driscoll.
  - ERM (2005a) Fern Bay Estate, Species Impact Statement, Prepared for Winten Property Group and Continenal Venture Capital Limited.
  - ERM (2005b) Stockton Sandpit Windblown Sand Extraction, Environmental Impact Statement, Prepared for Boral Resources (Country) Pty Limited.

3.1.2 Methods – Vegetation Validation

Prior to field validation, the subject site was stratified using aerial photographic interpretation (API), and through reference of rehabilitation management zones specified in management plans of the former quarry pit (Plate 1). The series of relevant management plans and monitoring reports for the site include:

- ERM (2007) Boral Resources (Country) Pty Ltd, Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan December 2007.
- ERM (2010) Boral Resources (Country) Pty Ltd, Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan August 2010.
- Environmental Compliance Services (2017) Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan, Prepared for Boral Resources, March 2017.
- Hunter Land Management (2015) Rehabilitation Assessment Boral Fullerton Cove, Prepared for Boral Resources, August 2015.

Plate 1. Approximate former quarry pit locations subject to native vegetation rehabilitation

Through the API process some of the rehabilitation areas were clearly defined. BAM plot location and an approach to survey transects were then plotted on field maps to guide survey effort.

A field survey was carried out on the following dates to stratify the vegetation as per the BAM:

- 27-29th September 2017
- 20th August 2018
- 26th May 2020
- 30th July 2020
- 1st July 2020
- 7th February 2023
- 8th February 2023

The surveys completed in 2020 involved a comprehensive hollow-bearing tree assessment which allowed Niche to refine the vegetation zones of the site to reflect similar plot condition scores within each PCT, and stratify the site based on relevant mapping guidelines provided by the BCT in March 2020.

In total, 16 BAM plots were completed within the subject site to meet the minimum plot requirement as per the BAM (Table 5 and Figure 5). A significant number of transects were also completed which assisted in vegetation zone delineation (Figure 5).

3.1.3 Results – Vegetation Validation

The field survey confirmed that the subject site consisted predominately of native vegetation. For the most part, the subject site consists of large portions of planted tubestock at varying ages and in-fill planting within patches of remnant vegetation, which was conducted over the past two decades to rehabilitate the former quarry pits.

As detailed in the OEH (2018b) Biodiversity Assessment Method Operational Manual, '*Planted native vegetation is treated in the same way as native vegetation if it meets the definition of native vegetation in Section 5A of the Local Land Services Act 2013. Where the vegetation is a mix of local and non-local planted species the assessor should consider the best matching PCT based on the local species present*'.

As such, the zones that have been rehabilitated have been attributed to two Plant Community Types (PCTs) which likely occurred within the subject site prior to clearing or contain a structure and composition similar to that of the rehabilitated land.

Different condition classes were assigned to vegetation where obvious differences in structure and quality occurred, resulting in two PCTs and six vegetation categories (zones) as shown in Table 5. The vegetation zones generally reflected the age of the rehabilitation and areas of remnant vegetation.

Descriptions for those communities which occur within the subject site are provided in Annex 2 and the distribution is shown in Figure 6.

Table 5: Plant Community Types present across the subject site

Vegetation zone	Plant Community Type (PCT)	Vegetation formation	Vegetation class	Threatened Ecological Community (TEC)*	PCT % cleared[1]	Condition identifier input used in Calculator	Total (ha)	Plots required	Plots completed[2]
1	PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests	-	45	Zone 1	14.14	3	4
2						Zone 2	3.83	2	2
4						Zone 4	5.12	3	3
5						Zone 5	1.70	1	1
6						Zone 6	8.21	3	4
3	PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Dry Sclerophyll Forests (Shrubby sub-formation)	South Coast Sands Dry Sclerophyll Forests	-	86	Zone 3	2.67	2	2
-	Non-native	-	-	-	-	Non-native	2.49	-	-
	Total						**38.16**	**14**	**16**
	Total native vegetation						**35.67**		

3.1.4 Plant Community Descriptions

Refer to Annex 2 for plant community descriptions and diagnostic species for each plant community.

[1] The BAM defines 'Percent Cleared Value' as the percentage of a PCT that has been cleared as a proportion of its pre-1750 extent, as identified in the BioNet Vegetation Classification

[2] An additional plot located outside of subject site was also completed.

3.1.5 Site Values

Flora

Floristic data recorded from floristic plots performed throughout the identified vegetation zones is included within Annex 3.

Plot and transect values

The results of the plot data and species list obtained during the field assessment is provided in Annex 4.

Site integrity scores

The site value assessment was carried out by entering plot data into the BAM Calculator. The data provides quantitative measures of composition, structure and function for each vegetation zone (Annex 4). The BAM Calculator compares the values recorded with the benchmark for the vegetation class to provide the site value score. This score represents the overall condition of the vegetation compared against the benchmark.

The vegetation scores for each zone in the subject site have been provided in Table 6. The score from these inputs, coupled with data in the following section of this report, is used to determine the number of ecosystem credits that are required for development.

Vegetation zones that have a site integrity score of less than 17 out of 100 for a non-threatened ecological community do not need to be offset.

As shown in Table 6, vegetation zone 'Zone 4' had a score of 15.7 and, as such, does not require to be offset. The remainder of the vegetation zones had a site integrity score greater than 17 and therefore require biodiversity offsetting (section 6.1.1).

Table 6. Vegetation zones and site integrity scores

Vegetation zone	Plant Community Type (PCT)	Condition identifier input used in Calculator	Total (ha)	Site integrity	Offset required
1	PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Zone 1	14.14	54.4	Yes
2		Zone 2	3.83	27	Yes
4		Zone 4	5.12	15.7	No
5		Zone 5	1.70	65.8	Yes
6		Zone 6	8.21	55.7	Yes
3	1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Zone 3	2.67	23.1	Yes

3.1.6 High Threat and Priority Weeds

The BCD has a list of 'High threat weeds' (HTW) which need to be taken into consideration in the BDAR.

During the field surveys, three high threat weeds were recorded within BAM plots: *Bidens pilosa* (Farmers Friend), *Ehrharta erecta* (Panic Veldtgrass) and *Eragrostis curvula* (Africa Lovegrass). Although the three high threat weeds were located across all vegetation zones, they were concentrated adjacent to existing disturbance areas. The cover of 'high threatened weeds' are considered in the site value scores for each BAM plot (Annex 4). Other HTW recorded outside of the BAM plots include *Chrysanthemoides monilifera* (Bitou bush), *Ageratina adenophora* (Crofton Weed) and *Senecio madagascariensis* (Fire weed).

3.1.7 Threatened Ecological Communities (TECs)

A list of TECs occurring or potentially occurring within the locality as generated from the database searches is detailed in section 3.1.1 and Annex 1. The database searches identified 25 TECs that have been identified as potentially occurring within the locality.

Based on the results of the detailed vegetation validation, and review of the Conservation Advice of the TECs, no TECs were recorded on the subject site or are considered likely to occur.

3.2 Threatened Flora

3.2.1 Methods - Threatened Flora

A total of 21 threatened flora with the potential to occur within the locality, or as generated by the BAM Calculator, are presented in Annex 1.

In total, approximately 112.5 hours of threatened flora survey was conducted across the site (Table 7 and Figure 5). Furthermore, the visibility of the landscape, particularly in the relatively younger rehabilitation areas (Zone 1, Zone 2, Zone 4), was relatively open resulting in limited observer obstruction during the transect walks.

A survey was also conducted in 2018 by Dr Amanda Griffiths during the recommended survey month (August) to determine the presence of *Diuris praecox*. The survey was considered necessary as *Diuris praecox* has been recorded within the locality and on total of 208 individual *Diuris praecox* were recorded within Boral's landholding in September 2003 (ERM 2005b).

The population recorded by ERM in 2003 was adjacent to walking tracks and roads where it was noted there was reduced competition for light (ERM 2005b). Follow up site visits in 2004 noted that half the population was not flowering, which may have been attributed to increased shrub density and competition for light (ERM 2005b). The August 2018 survey did not include transect lines as per the DPIE (2020c) plant survey guide as this guideline was only publicly available in April 2020 after the lodgement of the application in March 2020.

A follow-up targeted survey was therefore completed for *D. praecox* in August 2020 as per the DPIE (2020c) guidelines. The survey was completed after confirming with the BCD that the *Diuris praecox* was flowering in August. The survey entailed a series of transects as per the DPIE (2020c) guidelines, which was walked by ecologists Luke Baker and Jodie Danvers. Given the relatively open ground layer throughout much of the site, visibility to detect the species during the traverses was generally unimpeded.

Similarly, a targeted survey was completed for *Cyptostylis hunteriana* during early November 2020. Local populations around the Newcastle area were confirmed to be flowering mid-later October by BCD Threatened Species Officer. The survey entailed a series of transects as per the DPIE (2020c) guidelines, which was walked by ecologists Luke Baker and Jodie Danvers.

Table 7. Threatened flora survey timing and effort

Dates of survey	Consultant	Hours completed (total)
26 – 27th September 2017	Luke Baker, Alex Christie	18 hours
20th August 2018	Dr Amanda Griffith	7 hours
26th May 2020	Luke Baker	3 hours
27th – 28th May 2020	Dr Radika Michniewicz, Jodie Danvers	8 hours
30th June 2020	Luke Baker, Jodie Danvers	10 hours
1st July 2020	Luke Baker, Jodie Danvers	9 hours
24th – 25th August 2020	Luke Baker, Jodie Danvers	29.5 hours
9th – 12th November 2020	Luke Baker, Jodie Danvers	28 hours
8 – 9th of February 2023	Isabel Lyons, Sophia Dunn	8 hours
Total		**112.5 hours**

3.2.2 Threatened Flora Results (BC Act)

No threatened flora listed on the BC or EPBC Acts were recorded during the field surveys.

The historic clearing events have changed the resilience across large portions of the site, particularly for vegetation in Zone 1, Zone 2 and Zone 4. These vegetation zones had relatively low recruitment of native species and were relatively open in terms of ground cover (see - Plate 5 as an example from Zone 4). We therefore consider vegetation Zone 1, Zone 2 and Zone 4 to have a low habitat preference for threatened flora.

Vegetation Zone 3 is dominated by a *Leptospermum* shrub thicket. The soil is more compacted compared to the open areas of bare sand. The ground cover within this vegetation zone is sheltered from direct sunlight due to the thicket, contains high litter cover and a protection from wind (Plate 3). Zone 3 may offer some habitat for threatened flora; however, threatened flora was absent in this area during field survey.

Vegetation Zone 5 and Zone 6 offer greater resilience and native recruitment and would be more suited to threatened flora habitat for the associated subject species; however, threatened flora was absent in this area during field survey (Plate 4).

Plate 2. Sand cover across the former quarry pit (vegetation zone 4)

Plate 3. Ground cover within former quarry pit (vegetation zone 3)

Plate 4. Native regeneration and high resilience in vegetation zone 6

In accordance with Section 6.4 of the BAM, the list of potentially occurring threatened flora species may be further refined where:

- habitat constraints listed for the species in the TBDC are absent from the subject site (or particular vegetation zones), or
- habitat constraints or microhabitats on which the species depends are sufficiently degraded such that the species is unlikely to use the subject site, or
- the species is vagrant in the IBRA subregion, or
- an expert report is prepared (in accordance with Subsection 6.5.2 of the BAM) stating that the species is unlikely to be present on the subject site.

Table 8 lists the candidate threatened flora species provides comment on the survey effort completed and justifies where a species has been removed from further consideration.

Table 8: Candidate flora species predicted by the BAM Calculator to occur

Scientific Name	Recommended survey time (BAM)												Survey completed?	Considered further
	J	F	M	A	M	J	J	A	S	O	N	D		
Allocasuarina simulans	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.	Not considered further.
Angophora inopina	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time - conspicuous species that is unlikely to remain undetected during field survey.	Not considered further.
Callistemon linearifolius	Y	Y	Y	Y					Y	Y	Y	Y	Survey was not completed during the recommended survey time, however given the relatively conspicuous nature of the species, it is highly likely the species would have been detected during the field surveys if present. The species is known to flower in spring and will not lose foliage over the winter months. As such, even without the flower present, *Callistemon* species within the current landscape would have been identified during the months that survey took place. We therefore regard our survey as suitable for detection of the species.	Not considered further.
Corybas dowlingii						Y	Y	Y					Survey was completed during recommended survey time. We did not detect the species during the field surveys. It should be noted that *Corybas dowlingii* forms clonal colonies and typically grows in gullies in tall open forest on well-drained gravelly soil at elevations of 10-200m (Jones 2004). Much of the subject site is below 10 m elevation, and the soil types across the site are not of a gravelly soil structure. As such, the habitat suitability at the site for this species is relatively low.	Not considered further.
Cryptostylis hunteriana	Y	Y									Y	Y	*Cryptostylis hunteriana* is known from the Gan Gan Hill and Tomaree Headland. The species is a saprophyte and therefore reliant on a symbiotic relationship with mycorrhizal fungus. Based on the relatively low natural regeneration evident within much of the former quarry pit, the potential for the species to occur on the rehabilitated quarry areas (Zone 1, Zone 2 and Zone 4) seems highly unlikely based on the current natural regeneration at the site and historic disturbance. Some potential may occur within Zone 5 and Zone 6 given these zones have greater soil resilience and recruitment. A survey was completed in November 2020 during the recommended survey time and when the local population was flowering (as indicated by BCD Threatened Species Officer). The field survey confirmed that the plant was not at the site.	Not considered further.
Diuris arenaria									Y				Surveys were completed during recommended survey periods. The species can utilise 'dune/sandy hills' which fits the habitat types present within the subject site. The species has been previously recorded within the Worimi Conservation Lands along a powerline easement (near Bob's Farm)	Not considered further.

Scientific Name	Recommended survey time (BAM)												Survey completed?	Considered further
	J	F	M	A	M	J	J	A	S	O	N	D		
													(Eastcoast Flora Survey 2010). The species was not recorded at the subject site (ERM 2005b), nor was the species recorded at the Fern Bay Estate (approximately 1.1 km to the southwest) in 2005 despite targeted surveys by ERM (ERM 2005a). Within the subject site, some potential habitat occurs within vegetation Zone 5 and Zone 6 given these areas have a relatively intact soil profile. However, the species was not detected during targeted flora survey, nor historically at the subject site, therefore is not required to be considered further as per the BAM.	
Diuris praecox							Y	Y					A survey was completed in August 2018 by Dr Amanda Griffiths, and again in August 2020 by Jodie Danvers and Luke Baker. The survey in August 2018 was not completed to the requirements of DPIE (2020b) survey guidelines, which were released in April 2020. The follow-up survey in accordance with DPIE (2020b) guidelines was completed in August 2020. The survey was carried out after confirming with the BCD that Diuris praecox within the Newcastle Region was flowering. The survey effort that was completed involved transects covering the entire areas as shown in Figure 5. Each transect was walked by two qualified ecologists. The survey did not record the *Diuris praecox*. Based on the relatively low natural regeneration evident within much of the former mine quarry pit, the potential for the species to occur on the rehabilitated quarry e pit encompassing areas (Zone 1, Zone 2, Zone 3 and Zone 4) seems highly unlikely. Some potential may occur within Zone 5 and Zone 6 given these areas have greater soil resilience and recruitment, however the survey confirmed that the species is not present.	Not considered further.
Eucalyptus camfieldii	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time and given it is a conspicuous species it is unlikely to remain undetected following field survey.	Not considered further.
Eucalyptus parramattensis subsp. decadens	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time and given it is a conspicuous species it is unlikely to remain undetected following field survey.	Not considered further.
Melaleuca groveana	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time and given it is a conspicuous species it is unlikely to remain undetected following field survey.	Not considered further.

Scientific Name	Recommended survey time (BAM)												Survey completed?	Considered further
	J	F	M	A	M	J	J	A	S	O	N	D		
Prostanthera densa	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time and given it is a conspicuous species it is unlikely to remain undetected following field survey.	Not considered further.
Rhizanthella slateri									Y	Y	Y		Survey completed during recommended survey period in September. We note that the species is relatively cryptic and as such the survey team looked for tips of bract breaking the surface of the sandy soil during surveys. Although the species was not detected during the surveys, we note that the LMCC (2014a) Flora and Fauna Survey Guidelines state that the species is *'difficult or impossible to detect even when flowering*'. As such, Niche has investigated the known and potential habitat associated with the species, and notes the following: - The subject site does not occur within the likely distribution range for the species as per DoE (2020a), but does occur within a 'known subregion' according to the TBCD given the known population at Bulledellah. - The population at Bulledellah is the closest known population to the subject site, approximately 50 km to the north, where the species occurs on the western slopes and base of Bulahdelah Mountain (known locally as Alum Mountain). - The species was not been recorded at the subject site by ERM, nor has the species been recorded during other investigations in the locality (e.g. ERM (2005a, 2005b); EastCoast Survey (2010)). Based on the above we therefore conclude that there is a low likelihood for the species to be present.	Not considered further.
Senecio spathulatus	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Survey completed during recommended survey time and given it is a conspicuous species it is unlikely to remain undetected following field survey. It should be noted that this species occurs on the frontal dune system, but the site does not occur on the frontal dune system complex.	Not considered further.
Tetratheca juncea							Y*	Y*	Y	Y	Y*	Y*	A targeted survey was completed during the recommended survey period in September, and also during August 2018. We note that this species has since been listed in the TBDC to have a survey period only in September/October. We did not detect the species during our survey. We note that the species is usually found in low open forest/woodland with a mixed shrub understorey and grassy groundcover. The site predominately did not have a grassy ground cover as evident in the plot cover scores provided in Annex 4. The Threatened Species Profile also states that the '*majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape*' (OEH 2018d). The Awaba soil landscape does not occur at the subject site.	Not considered further.

Scientific Name	Recommended survey time (BAM)												Survey completed?	Considered further
	J	F	M	A	M	J	J	A	S	O	N	D		
													The Lake Macquarie Habitat suitability modelling using compiled species records shows core population densities around the Central Coast and North Coast Regions on Map 1 of LMCC (2014c). The closest record to the site is approximately 8 km to the south in Newcastle. Other records throughout NSW are situated away from similar dune vegetation to the site. Map 2 provided in LMCC (2014c) contains the mapped *Tetratheca juncea* habitat and distribution of records. The site does not occur within areas mapped by LMCC as 'modelled suitable *T. juncea*' habitat. Based on the information gathered, we conclude that the species has a low likelihood to occur at the site given the following: - The species was not detected during field survey. - No modelled habitat by LMCC occurs within the subject site. - No records of the species have previously been recorded at the site, or during the current survey (we note however that the survey was completed during the correct survey times at the time of submission). - Records for the species indicates that the species may not coincide with the habitat present at the subject site. - Vegetation zones 1, Zone 2, Zone 3 and Zone 4 have low native recruitment, low resilience due to historic clearing and are unlikely to be suitable habitat for the species.	
Thesium australe	Y	Y							Y	Y	Y	Y	Survey completed during recommended survey period. It occurs on soils derived from sedimentary, igneous and metamorphic geology on a range of soils including black clay loams to yellow podzolics and peaty loams. The site contains sandy loams and as such is likely unsuitable regardless of survey.	Not considered further.

* survey time for the species as presented in the BAM calculator submitted March 2023.

3.2.3 Threatened Flora for Further Consideration

Our survey and analysis confirm that no threatened flora requiring species credits were recorded within the subject site.

3.2.4 Threatened Flora Results (EPBC Act)

No threatened flora as listed on the EPBC Act were recorded during the field survey. Threatened flora listed on the EPBC Act have been addressed in Annex 1. No threatened flora on the EPBC Act is likely to occur in the subject site based on the results of the field survey.

4. Fauna and Fauna Habitat Assessment

4.1 Fauna assessment

4.1.1 Methods – Data Review

As for the native vegetation and flora assessment, a review of relevant literature, databases and existing vegetation mapping was undertaken to identify vegetation (fauna habitat) and threatened fauna with the potential to occur on the subject site. Data reviewed included:

- Database searches:
  - *NSW BioNet Atlas Database* (DPIE 2020d) for spatial records of threatened flora listed under the BC Act within a 10 kilometre (km) radius of the subject site.
  - *EPBC Act Protected Matters Search Tool* (PMST) (DAWE 2020) for list of flora and ecological communities identified as MNES known or with potential habitat within a 10 km radius of the subject site.
  - BAM-Calculator candidate and predicted species list.
- Previous relevant studies including:
    - Ecotone (2008) Vertebrate Fauna Survey Worimi Conservation Lands prepared for the NSW Department of Environment and Climate Change.
    - ERM (2005a) Fern Bay Estate, Species Impact Statement, Prepared for Winten Property Group and Continental Venture Capital Limited.
    - ERM (2005b) Stockton Sandpit Windblown Sand Extraction, Environmental Impact Statement, Prepared for Boral Resources (Country) Pty Limited.

Results of the searches and reviews were undertaken prior to field survey to inform field survey requirements. A likelihood of occurrence analysis (Annex 1) was then undertaken for each species, based on suitability of habitat present within the subject site .

4.1.2 Methods – Field Survey

The likelihood of occurrence for threatened fauna, along with the candidate threatened fauna as per the BAM Calculator dictated the survey method approach. The fauna survey was primarily designed to target threatened fauna that are regarded as 'species credit' fauna, and those listed as threatened on the EPBC Act.

The following guidelines or documentation were consulted to assist with establishing the survey plan:

- Lake Macquarie City Council Flora and Fauna Survey Guidelines LMCC (2014a)
- Threatened Species – Field Survey Methods (OEH 2015)
- Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECC 2009)
- Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities Working Draft (Department of Environment and Conservation, 2004)
- Survey Guidelines for Australia's Threatened Frogs (DEWHA 2010a)
- Survey Guidelines for Australia's Threatened Bats (DEWHA 2010b)
- Survey Guidelines for Australia's Threatened Birds (DEWHA 2010c)
- Survey Guidelines for Australia's Threatened Mammals (DEWHA 2011a)
- Survey Guidelines for Australia's Threatened Reptiles (DEWHA 2011b)
- Relevant Significant Impact Guidelines and Referral Guidelines for EPBC Act listed species.

Survey methods were selected to detect the target species identified during desktop research (i.e. threatened species with the potential to be impacted by the Project), as well as to employ a broad range of survey techniques that allowed for detection of the variety of fauna species groups.

Survey methods and effort is summarised in Table 10 with an overview of the survey dates provided in Table 9 below. Figure 7 and Figure 8 shows the location of the fauna survey effort.

Table 9. An overview of fauna field survey dates

Dates of survey	Ecologist	Key fauna survey tasks completed during field campaign
26 – 27th September 2017	Luke Baker, Alex Christie	Habitat assessment, Bird survey, Anabat, SAT survey
20th August 2018	Dr Amanda Griffith	Opportunistic bird survey
26th – 28th May 2020	Luke Baker, Dr Radika Michniewicz, Jodie Danvers	Camera trapping, spotlighting, call playback, stag watching, hollow-bearing tree mapping, bird survey, amphibian survey
30th June 2020 - 1st July 2020	Luke Baker, Jodie Danvers	Camera trapping, spotlighting, call playback, stag watching, hollow-bearing tree mapping, bird survey, amphibian survey
9th November – 13th November 2020	Luke Baker, Jodie Danvers	Spotlighting, stag watching, hollow-bearing tree watching, bird survey, amphibian survey
8th February to 9th of February 2023	Isabel Lyons, Sophia Dunn	Habitat assessment and opportunistic bird survey.

2020 Field Survey Conditions

The field survey program was designed to detect potentially occurring threatened species and allow for an inventory of species to be compiled for the subject site. Although singular sightings of individual species were recorded during targeted surveys, repeat observations were not necessarily recorded. Incidental observations were recorded if the species had not been detected during targeted survey, was a threatened species, or was considered rare either within the subject site.

Details of the daily weather conditions have been provided in Annex 6. The mean weather conditions during the majority of the survey period (June 2020) consisted of day temperatures of 19 degrees, and at lowest temperature of approximately 12 degrees during night surveys.

During the November 2020 field campaigns, the weather conditions during the majority of the survey consisted of day temperatures of 24 degrees, and lowest temperature at night of 16 degrees.

Heavy rainfall (approximately 33.2 mm) occurred prior to the May 2020 field survey, which provided the recommended amphibian survey conditions (20 mm recommended) specified in the Amphibian Guidelines (DECC 2009) to maximise detection of the Wallum Toadlet. Heavy rainfall also occurred on the 6th of November 17mm prior to the November 2020 field campaign.

During spotlighting, call-playback and stag watching, the wind conditions were relatively calm.

2023 Field Survey Conditions

The field survey program was designed to update the BAM plots given most were older than 5 years.

Details of the daily weather conditions have been provided in Annex 6. The mean weather conditions during the majority of the survey period (February 2023) consisted of day temperatures of 27 degrees, and at lowest temperature of approximately 22 degrees.

Table 10: Fauna survey effort

Fauna Group	Survey Technique	Survey effort	Details
All	Spotlighting	26/5/20 (start: 18.15) 27/5/20 (start: 18:30) 28/5/20 (start 18.20) 30/6/20 (start 18.00) 1/7/20 (start 18:15) 9/11/20 (start 9pm) 10/11/20 (start 8.45pm) 11/11/20 (start 9pm) 12/11/20 (start 8.30pm)	Spotlighting was undertaken by two ecologists within all habitat types of the subject site using LED torches. Each spotlighting session lasted for approximately one hour, with the exception of the November 2020 surveys which were approximately two hours each.
Mammals – arboreal	Camera trapping	59 camera traps Date established: 26/5/20 Date collected: 1/7/20 Total survey effort: 49,560 hours	A total of 59 baited camera traps (combination of Moultrie model MCG-12596, Scoutguard model SG562C, Reconyx model HC500) were set across the site. The cameras were placed in areas that were likely to yield the best results for target species (e.g. not within open bare sand areas). Each of the traps were mounted onto a tree at head height secured with the camera straps and a bait canister containing honey, oats and peanut butter was placed on an opposite tree at similar height. The bait cannister was secured with a nail and wire. The cameras remained in place for four weeks and the bait was changed at two weeks. Camera trap results were checked immediately after the field survey.
Mammals – ground	Camera trapping	21 camera traps Date established: 26/5/20 Date collected: 1/7/20 Total survey effort: 18,144 hours	A total of 21 baited camera traps (Scoutguard model SG562C) were set across the site. The cameras were set in all the vegetation zones. Each of the traps were mounted onto a tree at knee height secured with the camera straps and a bait canister containing honey, oats and peanut butter was placed on the ground and secured with a peg. The cameras remained in place for four weeks and the bait was changed at two weeks.
Mammals – Koala	SAT plot	3 x survey 26/07/2017 1 x survey 27/07/2017	SAT (Koala scat) surveys were conducted across the subject site at the locations shown in Figure 7. The bases (0 to 2 m from the trunk) of twenty such trees were searched for evidence of Koala scat by first circling around the tree looking for scats without disturbing the leaf litter (approximately 1 minute), then by raking through the leaf litter for scats (approximately 1 additional minute). In addition to SAT surveys, random tree

Fauna Group	Survey Technique	Survey effort	Details
			inspections were carried out during traverses of the subject site feed trees searching for scats and characteristic bark scratches.
Birds	Diurnal survey	1 x survey 26/07/2017, (2 hours) 15:30 into dusk 1 x survey 27/07/2017 (2 hours) 6:55 1 x survey 26/5/2020 (30 mins) 16:45 1 x survey 30/6/20 (40 mins) 16:45 1 x survey 1/7/2020 (25 mins) 16.45	To date, DPE has not yet published the 'Bird Survey Guidelines' to provide guidance in relation to BDARs. We were advised by BCD in June 2020 that Niche should apply the most relevant guidelines available (ie. DECC 2004, LMCC 2014a). Two ecologists conducted 20 minute, two hectare bird surveys at the areas shown on Figure 7. These were generally lengthened in time due to relatively low bird activity in most areas and additional species being recorded after or at the end of the 20 minute period. Incidental bird sightings were made throughout surveys activities with species of note being recorded. Birds were identified with the use of 10 X 42 binoculars or from their calls.
Birds	Nocturnal survey – call playback	26/5/20 (start: 17.15) 27/5/20 (start: 17:40) 28/5/20 (start 17.30) 30/6/20 (start 5.16) 1/7/20 (start 17:20)	Calls of targeted species (Powerful Owl, Masked Owl, Barking Owl and Bush-stone Curlew) were broadcast using a loud hailer for up to five minutes followed by five minutes of listening time. This process was repeated several times for each species at each survey site. A total of seven survey sites (two additional locations for only the Bush-stone Curlew in more suitable habitat were included) were established across the subject site in locations that offered sufficient vantage points and habitat features that may suit each species. Given the volume of the loud hailer and size of the subject site, calls at each survey location could be heard from all areas of the subject site.
Birds	Nocturnal survey – stag watching	26/5/20 (start: 17.15) 27/5/20 (start: 17:40) 28/5/20 (start 17.30) 30/6/20 (start 5.16) 1/7/20 (start 17:20)	Stag watching commenced prior to and during call playback. Vantage points were established near potential roost trees. Stag watching commenced prior to call playback, at approximately to 17:00 pm (prior to dusk) and continued for approximately 30-40 minutes coinciding with the call playback surveys. Six stag survey sites were established, and each was surveyed once during the survey program.
Birds	General survey transects and tracks	Conducted in conjunction with all diurnal surveys	Opportunistic bird surveys were conducted in conjunction with all diurnal surveys. Many of the threatened fauna requiring targeted survey were relatively conspicuous (e.g. Glossy-black Cockatoo and Gang-gang Cockatoo) and therefore would likely have been heard/or observed during activities such as camera trap deployment and hollow-bearing tree mapping.

Fauna Group	Survey Technique	Survey effort	Details
			Furthermore, the extensive survey tracks completed across the area were also subsequently used to survey for nests of the Bush-stone Curlew.
Gang-gang Cockatoo hollow survey	Surveys were completed across six areas (as shown in Figure 8) by two ecologists to determine if the Gang-gang Cockatoo was utilise the tree hollows.	9/11/20 (start 5 pm) 10/11/20 (start 5.30 am) 11/11/20 (start 5.30 am) 12/11/20 (start 5.30 am) 13/11/20 (start 5.30 am)	Six areas as shown on Figure 8 were surveyed at dusk for an hour each to determine if Gang-gang cockatoos were utilising the tree hollows. Given the relatively conspicuous nature of the species, any calls or sighting throughout the site were noted. Each area was surveyed for an hour, watching the tree hollows in each area.
Microbats	Echolocation Call	2 x Anabat left for 2 x consecutive nights 26/09/2017 (5pm – 5am 10 hours); 27/09/2017(5pm – 5am 10 hours)	Anabat II bat detector and Anabat CF recorder units were deployed at two sites over two nights along potential flyways.
Amphibians	Spotlighting transects	26/5/20 (start: 18.15, 1.75 hr pp) 27/5/20 (start: 18:30, 1.25 hr pp) 28/5/20 (start 18.20, 1.5 hr pp) 9/11/20 (start 9pm, 2 hours pp) 10/11/20 (start 8.45pm, 2 hours pp) 11/11/20 (start 9pm, 2 hours pp) 12/11/20 (start 8.30pm, 2 hours pp)	Three amphibian transects were completed in conjunction with the general spotlighting transects described above. The spotlighting transects were carried out immediately after 20 mm of rainfall (as recorded on Tuesday 26th May – 33 mm). The amount of rainfall did not result in any significant pool habitat or inundation areas being created within the subject site, nor within the patch of Swamp Sclerophyll Forest close to the subject site manager confirmed that the site does not retain water following rainfall, with the exception being the Pasha Bulker storm in 2007 where a pool formed following days of heavy rainfall in the former quarry pit. The survey guidelines recommend '*a 200 m transect within watercourses or inundation areas*' (DECC 2009). Given the subject site does not contain features, our survey approach was to cover a greater distance than the 200 m transects specified in the guidelines and complete a series of transects within all habitat types within the subject site. This enabled the team greater ground during ideal conditions, and not limit the team to only 200 m transects within non-watercourse habitats. Males of the Wallum Froglet also call at any time of the year, especially after heavy rain and, as such, calls of the Wallum Froglet were listened for during the spotlighting transects and diurnal surveys.
Pale-headed Snake	Spotlighting transects	9/11/20 (start 9pm, 2 hours pp) 10/11/20 (start 8.45pm, 2 hours pp)	The Pale-headed Snake surveys were completed in conjunction with the general spotlighting transects described above. The area of the survey targeted locations where

Fauna Group	Survey Technique	Survey effort	Details
		11/11/20 (start 9pm, 2 hours pp) 12/11/20 (start 8.30pm, 2 hours pp)	tree hollows were present, including better condition habitat (that more suited the TBDC description) located outside of the subject site.
All	Survey tracks and transects		Opportunistic observations were made of fauna using binoculars and photography. Opportunistic survey included searches of micro habitat; under logs, waste piles (where limited areas of such habitat existed) or within heaped leaf litter, casual bird or mammal observations, or by listening for calls.

4.1.3 Fauna and Fauna Habitats

Fauna species recorded in the subject site are listed in Annex 5. A total 63 species were recorded during field surveys, comprising 44 birds, five amphibians, seven mammals, and seven reptiles.

Of the species recorded, the Brush-tailed Possum and Ring-tail Possum were the most commonly encountered species, detection via infrared cameras and spotlighting. The Swamp Wallaby was the most encountered mammal during the day surveys.

Three threatened fauna were recorded with the subject site; Greater Broad-nosed Bat, Eastern Bent-wing Bat and White-bellied Sea Eagle. Both the threatened microbats were recorded via Anabat, whilst the White-bellied Sea Eagle was recorded flying over the subject site during the field survey. A feather of a Glossy-black Cockatoo, and evidence of foraging on planted Allocasuarina littoralis trees (chewed cones) was also recorded at the locations shown on Figure 8.

Our assessment stratified the subject site into different habitat types, which were generally reflective of the rehabilitation efforts. The habitat types are shown on Figure 8 and are described below.

Habitat – Dune

Ground cover across much of younger rehabilitation areas (vegetation Zone 4) were generally sparse consisting of bare sand cover. The sandy substrate may provide burrowing habitat for small to medium-sized mammals, however only three small borrows were encountered during transects. The three burrows were quite old and were not deep, and no tracks were recorded outside the entrances. Two rabbits were observed during the site survey and are likely to have habitat within the open rehabilitated areas.

Plate 5. Dune habitat within former quarry pit

Habitat – Forest

Forest habitat has been grouped into three categories representing stratums and condition:

- Young open forest habitat: represents the younger rehabilitation areas. The height of the trees were approximately 3 – 5 m. Shrub and ground layer was quite open. The area would be suitable for foraging habitat during spring when many of the shrubs are flowering.
- Open forest habitat: The large-scale planting of the former quarry pits has resulted in a forest habitat type, ranging in canopy heights of 5-10 metres. Tree species mainly comprised *Eucalyptus pilularis, Cormbia gummifera* and *A. costata.* Midstorey cover comprised plantings of *Allcasuarina littoralis, Acacia species* and Leptospermums.

  The *Allocasuarina littlorlis* tubestock have created a foraging resource for the Gang-gang Cockatoo. Evidence of foraging was present with chewed cones beneath trees at the locations shown on Figure 8.
- Forest habitat: consisted of remnant vegetation or the older rehabilitated areas where occasional trees where not cleared during historical mining operations. These areas had all stratum layers intact, and a higher diversity and coverage compared to the younger areas of forest habitat. Tree hollows were present throughout the forest habitat type. Such areas are likely to provide greater breeding and foraging resources compared to the younger forest habitat types.

Plate 6. Young open forest – habitat

Plate 7. Open Forest – habitat

Plate 8. Forest habitat

Habitat – Shrub Thicket

A relatively homogenous planting of *Leptospermum laevigatum and L. trinervium* occurs within vegetation zone 3. Some scattered trees of *Angophora costata* and *Eucalyptus pilularis* have been planted in the area, however the vegetation zone is predominately a shrub thicket. Ground cover throughout this area is very sparse, consisting of a few native grass species and very few forbs.

This area during times of flower may be suitable foraging habitat for a range of bird species, and the Squirrel Glider, which is known to occur within the Worimi National Park.

Plate 9. Shrub thicket

Habitat – Tree Hollows and stags

A hollow-bearing tree survey was carried out during the May-July 2020 field survey. The location of hollow-bearing trees and stags are provided in Annex 7 and shown on Figure 8. The hollow-bearing trees were

restricted to vegetation Zone 5 and Zone 6, being the vegetation zones that consisted of remnant vegetation or rehabilitated areas that contained scattered remnant trees. All planted trees within the other vegetation zones of the subject site are not at an age where hollows have developed.

The hollow-bearing trees were typically *Angophora costata, Eucalyptus pilularis* and *Banksia serrata*, and ranged in size from 30 cm to greater than 80cm diameter at breast height. The size of the hollows ranged in size from 5 cm to over 30cm. The base of a hollow-bearing tree inspected for the presence of owl pellets or prey, to which no evidence of usage was observed during the time of the survey.

Areas of hollow-bearing trees were also observed from vantage points during stag watch and call-playback survey. No fauna was observed leaving the hollows during the survey activity.

A targeted survey of the Gang-gang cockatoo was completed during the recommended breeding season in November to determine if the species is utilise the tree hollows. The survey confirmed the species is not utilising the site for breeding.

Many of the camera traps were also placed facing the hollow-bearing trees to increase detectability of hollow-dwelling species. As previously mentioned, only the Bush-tailed Possum and Ring-tail Possums were recorded on the cameras.

Aquatic habitat

There are no water features within the subject site such as creeks, swamps, dams or pools. The subject site contains Swamp Sclerophyll Forest or wetland/swamp habitat, which would retain pools or be inundated after heavy rains.

The May-July field surveys were conducted following 20 mm of rain to target threatened amphibians, including the Wallum Froglet, during the correct conditions. Despite the rain, the amount of rainfall did not result in any pool habitat or inundation areas forming within the subject site. The Quarry Manager confirmed that the site does not retain water following rainfall, with the exception being during the Pasha Bulker storm in 2007 where many days of heavy rainfall resulted in a pool forming in the former quarry pit.

The closest area that would retain pools or be inundated following heavy rainfall is immediately north of the subject site, near the quarry carpark. This area is shown on Figure 8 as Swamp Sclerophyll Forest. However, this area was not inundated following the 33 mm of rainfall. Following extended periods of heavier rainfall it is likely this area would become inundated and provide amphibian habitat. This area is separated from the subject site by a steep slope that was once cleared for the former mine pit, and has since been sparsely rehabilitated.

4.1.4 Assessment of Threatened Fauna and Populations

Threatened species predicted or potentially occurring within the IBRA subregion as generated by the BAM Calculator were reviewed and refined post field survey on the basis of the vegetation types, condition and habitat features, as well as the results of field survey.

In accordance with Section 6.4 of the BAM the threatened fauna list of potentially occurring species may be further refined where:

- habitat constraints listed for the species in the TBDC are absent from the subject site (or particular vegetation zones), or
- habitat constraints or microhabitats on which the species depends are sufficiently degraded such that the species is unlikely to use the subject site, or

- the species is vagrant in the IBRA subregion, or
- an expert report is prepared (in accordance with Subsection 6.5.2 of the BAM) stating that the species is unlikely to be present on the subject site.

The list of predicted and candidate species generated via the BAM Calculator is presented in Table 11. A status for each species is provided which represents the basis for deciding whether a species was present or absent from the subject site. No ecosystem credit species were omitted from the BAM Calculator.

Table 11: List of Predicated and Candidate fauna species and assessment of credit requirement

Common Name	Scientific Name	Recommended survey time												Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D		
Candidate threatened species															
Regent Honeyeater (Breeding)	*Anthochaera Phrygia*									Y	Y	Y	Y	The subject site does not occur within the 'important Regent Honeyeater' map as per the BAM Important Areas Map. Therefore the 'species credit' component associated with Regent Honeyeater breeding habitat is not triggered. The Regent Honeyeater is therefore not considered further.	Not considered further
Bush Stone-curlew	*Burhinus grallarius*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	A targeted survey was completed using call playback, spotlighting and transects within the appropriate survey period. The species was not detected during targeted survey, and thus as per the BAM, the species is not required to be considered further.	Not considered further.
Gang-gang Cockatoo (Breeding)	*Callocephalon fimbriatum*	Y									Y	Y	Y	Breeding habitat as specified in TBCD (June 2020)[3] includes: *'(1) lone adult males have been identified at the site during the breeding season (October to January); or (2) an occupied nest has been found.'* As per the directions on the TBCD, hollow-bearing tree survey has been used to identify whether potential nest hollows are present (defined as hollows in forest and woodland eucalypts; (i) at least 9 m above the ground and, (ii) with hollow diameter of 10 cm or larger). Such features were recorded within the subject site and are common throughout the locality within *Eucalyptus pilularis* and *Angophora costata* trees. Given potential habitat exists, the species was surveyed during the breeding season (October to January) in November 2020 to determine whether breeding is occurring on the site. DPE is currently developing survey guidelines for threatened bird species. In the absence of guidelines, the BCD advised Niche in June 2020 to follow the best available guidelines for detecting breeding in this species, which will require surveys to be completed in October-January. Niche completed a week long survey of the hollow bearing tree areas as detailed in Table 10 which confirmed the species is not utilising the site for breeding.	Not considered further.
Glossy Black-Cockatoo (Breeding)	*Calyptorhynchus lathami*			Y	Y	Y	Y	Y	Y					Similar to the Gang-gang Cockatoo, DPE have not yet released survey guidelines for this species. Breeding habitat as specified in the TBCD (June 2020)[4] includes: *(1) begging birds of any age or sex have been identified at the site; or* *(2) lone adult males have been identified at the site during the breeding season (April to August); or* *(3) an occupied nest has been found.* As per the directions provided in the TBCD (June 2020) we have surveyed for all potential nest hollows (defined as *(i) at least 8 m above the ground and, (ii) in stems with a diameter of at least 30 cm and, (iii)*	Not considered further

[3] It should be noted that the definition of breeding habitat and hollow-bearing tree size/age have changed since the submission of the original BDAR.

[4] It should be noted that the definition of breeding habitat and hollow-bearing tree size/age have changed since the submission of the original BDAR.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
														hollow diameter is at least 15 cm and, (iv) stem angle is at least 45 degrees, and may be near-vertical or vertical). The species was surveyed using targeted bird surveys during the correct survey season. It should be noted that the species is highly recognisable and would have been observed during all the other survey activities had it been present. Evidence of the Glossy-black cockatoo was recorded at the site with a feather and chewed allocasuarina cones recorded (Figure 8). However, if the species was breeding in the subject site, it is likely we would have recorded the species during the survey. The species is relatively conspicuous, and given the amount of hours spent on-site during the correct breeding time, it is likely the species would have been detected if actively using hollow-bearing trees for breeding. Given it was not recorded during the field surveys, the habitat would not be regarded as known 'breeding habitat' as per the BAM guidelines.	
Eastern Pygmy-possum	*Cercartetus nanus*	Y	Y	Y						Y	Y	Y	Y	The subject site does not occur within a location that fits the distribution of the species as described in the Scientific Determination for the species - '*In New South Wales the species is found in coastal areas and at higher elevation in the south, but north of Newcastle at higher elevation only*'. This is supported by the closest record for the Eastern Pygmy Possum, occurring 20 km to the north of the subject site The species has also not been recorded during previous surveys of the Boral landholding by ERM (2005b), or nearby fauna surveys associated with Worimi Conservation Lands (Ecotone 2008), Fern Bay (ERM 2005a). Despite the habitat not being ideal for the species, we deployed an extensive number of camera traps across the subject site and undertook spotlighting survey across all habitat types. Our survey did not record the species. Although the timing was outside of the recommended survey time provided in the TBCD, we note that the LMCC (2014a) guidelines state that at any time of the year a survey may 'still detect the species, though the months of September to June are optimal'. Given ours and previous survey results, and that the subject site, the know distribution of the species, the species is considered to have a low likelihood of occurrence.	Not considered further.
Large-eared Pied Bat	*Chalinolobus dwyeri*	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	The habitat descriptions provided in OEH (2018a) '*Species credit' threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method'* note that the Large-eared Pied Bat breeding habitat occurs within 2 km of caves, scarps, cliffs, rock and disused quarries. The subject site does not occur within 2 km of such features. The species was also not recorded during the Anabat analysis. The use of bat call detector is the recommended method for recording this species LMCC (2014a). Given the absence of records and the distance from breeding resources, the subject site to support habitat for the Large-eared Pied Bat.	Not considered further.
Wallum Froglet	*Crinia tinnula*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	There are no drainage lines, watercourses, dams or swamp-like vegetation within the subject site. The nearest swamp sclerophyll habitat that may become inundated following rainfall occurs immediately north of the subject site Figure 8). Following over 30mm of rainfall, which is above the 20 mm specified as ideal survey conditions (LMCC 2014a), there pools or inundation within the Swamp sclerophyll Forest, nor within the subject site.	Not considered further.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
														Following 20 mm of rainfall, Dr Radika Michniewicz and Jodie Danvers completed three nights of spotlighting transects targeting the species. Given the subject site does not contain water features, our survey approach was to cover a greater distance than the 200 m transects specified in the guidelines by completing a series of transects within all habitat types of the subject site. Males of the Wallum Froglet call at any time of the year, especially after heavy rain and, as such, calls of the Wallum Froglet were listened for during the spotlighting transects. The surveys did not detect the Wallum Froglet within the subject site, and there is a lack of water bodies and suitable within the subject site.	
Emu population in the New South Wales North Coast Bioregion and Port Stephens local government area	*Dromaius novaehollandiae* - endangered population	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	The Emu was not detected during the field surveys. No Emus were recorded on the camera traps, nor have they been previously recorded within the subject site by Boral staff.	Not considered further.
White-bellied Sea-Eagle (Breeding)	*Haliaeetus leucogaster*							Y	Y	Y	Y	Y	Y	The White-bellied Sea-Eagle is a dual credit species, with breeding habitat triggering species credits. The White-bellied Sea-Eagle was recorded flying over the subject site during the September and July surveys. The TBCD states that '*Breeding habitat is live large old trees within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines AND the presence of a large stick nest within tree canopy; or an adult with nest material; or adults observed duetting within breeding period.* Our survey effort has confirmed that no large stick nests are present within the subject site . Given we have covered the entire subject site, it is highly unlikely that breeding habitat is present within the subject site.	Not considered further.
Little Eagle (Breeding)	*Hieraaetus morphnoides*								Y	Y	Y			The Little Eagle is a dual credit species, with breeding habitat triggering species credits. Little Eagle Breeding habitat is defined in the TBCD as '*live (occasionally dead) large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy*'. The survey did not record the presence of the Little Eagle, nor did it record any large stick nests. Therefore, it is conclude that the subject site does not contain breeding habitat for the Little Eagle.	Not considered further.
Pale-headed Snake	*Hoplocephalus bitorquatus*	Y	Y	Y								Y	Y	The TBDC (as at June 2020) notes that the Pale-headed Snake can be found '*within 500m of moderate to good vegetation*', and further describes habitat as '*found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest*'. Both definitions of habitat, but	Not considered further.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
														particularly '*moderate to good vegetation*', are very broad and encompass most vegetation types, including derived native grasslands. The TBDC also states that the species utilise hollows. The LMCC (2014a) survey guidelines describe habitat for the species as '*Loose bark, tree hollows in riparian habitat in dry eucalypt forest / woodland*'. The species is also described as preferring Callitris woodlands (Scientific Committee Determination). The main prey is tree frogs although lizards and small mammals are also taken. The subject site does not contain riparian habitat, and the closest record to the subject site the immediate west. Within the immediate locality, habitat for this species is likely to be within Swamp Sclerophyll Forest where there are tree hollows. Riparian habitat does not occur within the subject site. The areas containing tree hollows (Zone 5 and Zone 6) are not located in riparian habitat, nor do they contain Callitris woodlands. Based on the habitat descriptions in the LMCC (2014a) guidelines, the species is unlikely to occur, but if the broader definition of the TBCD is used, potential habitat is present. As such a targeted survey was completed in November 2020 as detailed in Table 10 which confirmed the species is not utilising the site.	
Swift Parrot (Breeding)	*Lathamus discolor*					Y	Y	Y	Y					The species is a dual credit species, with the species credit component mapped as an important area. These mapped areas do not require survey as it is presumed that the species is present. The subject site does not occur within an important area.	Not considered further.
Green and Golden Bell Frog	*Litoria aurea*	Y	Y	Y							Y	Y	Y	The BAM calculator lists the following habitat constraints in reference to potential habitat for the Green and Golden Bell Frog: *- 'Semi-permanent/ephemeral wet areas* *- Within 1km of wet areas/Swamps* *- Within 1km of swamp/Waterbodies* *- Within 1km of waterbody'* The above terms are very broad definitions (e.g. what constitutes a 'wet area'?) with little guidance provided. When referenced in relation to the specific habitat requirements for the species as detailed in BioNet, habitat for the Green and Golden Bell Frog includes: *- 'marshes, dams and stream-sides, particularly those containing bullrushes (Typha spp.) or spikerushes (Eleocharis spp.).* *- water-bodies that are unshaded, free of predatory fish such as Plague Minnow.'* The subject site does not contain any of the above features. The closest dam to the subject site is approximately 350 m north of the subject site, separated from the subject site by Nelson Bay. The Project will not impact upon this water feature, nor any other known areas of potential habitat. Given such habitat requirements are absent for the species, it is unlikely that the Green and Golden Bell Frog would be present within the subject site.	Not considered further.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
Green-thighed Frog	*Litoria brevipalmata*	Y	Y	Y								Y	Y	As stated in the TBDC, the Green-thighed Frogs '*occurs in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain*' and ' *Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred*'. The TBDC recommends that survey be undertaken after rainfall events of >75 mm in 24 hrs or 150 mm over 72 hrs as the most probable time to survey and detect the species. In relation to the LMCC (2014a) Guidelines: preferred breeding/sheltering habitat is in ephemeral pools in creeklines and soaks in flood prone vegetation. As previously discussed, the subject site does not contain watercourses or riparian habitat, is not flood prone. Although the subject site was not visited after 75 mm of rainfall, the quarry manager has confirmed that the subject site does not hold water with the exception being following the Pasha Bulker storm in 2007 where a pool formed in the former quarry pit following days of heavy rainfall. In the context of other records for the species, the subject site is within 35 km of the closest record. The species has also not been detected during a fauna surveys of the site by ERM (2005b), at the Fern Bay development (ERM 2005a) nor within the Worimi Conservation lands (Ecotone 2008). There is no suitable habitat for this species present within the subject site.	Not considered further.
Square-tailed Kite (Breeding)	*Lophoictinia isura*	Y								Y	Y	Y	Y	Breeding habitat is living large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy. Our hollow-bearing tree survey confirmed the absent of large stick nests. Therefore, it is unlikely that breeding habitat of the species occurs within the subject site.	Not considered further
Little Bentwing-bat (Breeding)	*Miniopterus australis*	Y	Y										Y	The species is regarded as a dual credit species with breeding habitat triggering species credits. Breeding habitat includes: -Caves - Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave' observation type code 'E nest-roost' with numbers of individuals >500 or from the scientific literature. None of these features occur at the subject site or immediately adjacent.	Not considered further.
Large Bentwing-bat (Breeding)	*Miniopterus schreibersii oceanensis*	Y	Y									Y	Y	The species is regarded as a dual credit species with breeding habitat triggering species credits. habitat includes: --Caves - Cave, tunnel, mine, culvert or other structure known or suspected to be used for breeding including species records in BioNet with microhabitat code 'IC – in cave' observation type code 'E nest-roost' with numbers of individuals >500 or from the scientific literature. None of these features occur at the subject site or immediately adjacent.	Not considered further.
Southern Myotis (Breeding)	Myotis macropus	Y	Y	Y							Y	Y	Y	The species is regarded as a dual credit species with breeding habitat triggering species credits. Breeding habitat as described in the TBDC includes: - *'Hollow bearing trees*	Not considered further.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
														- *Within 200 m of riparian zone|Other* - *Bridges, caves or artificial structures within 200 m of riparian zone|Waterbodies* - *This include rivers, creeks, billabongs, lagoons, dams and other waterbodies on or within 200m of the site'* The Bat survey guidelines (OEH 2018a) also state that habitat for the species is '*land within 200m of a waterbody with pools/ stretches 3m or wider including rivers, creeks, billabongs, lagoons, dams and other waterbodies on the subject site'*. The subject site contains hollow-bearing trees, but is over 200 m from waterbodies. As such, no breeding habitat would be impacted.	
Barking Owl (Breeding)	*Ninox connivens*					Y	Y	Y	Y	Y	Y	Y	Y	The species is regarded as a dual credit species with breeding habitat triggering species credits. As at June (2020), breeding can be identified by "suitable habitat AND 1. presence of male and female or 2. calling to each other (duetting) or 3. find nest or 4. existing breeding habitat identified". The subject site contains approximately 9.8 ha of suitable habitat. This is made up of the following vegetation zones: Zone 5 and Zone 6 which contain hollow-bearing trees. In order to determine the presence of breeding habitat, we completed the following survey (as detailed in section 4.1.2): - Spotlighting - Call playback - Stag watching from key vantage points. Our field survey did not record the Barking Owl on the subject site, nor any nests during the hollow-bearing tree surveys. Thus, despite the presence of potential habitat, under the BAM and available survey guidance material, breeding habitat is unlikely to be impacted.	Not considered further.
Powerful Owl (Breeding)	*Ninox strenua*					Y	Y	Y	Y					The species is regarded as a dual credit species with breeding habitat triggering species credits. As at June (2020), breeding can be identified by 'suitable habitat AND 1. presence of male and female or 2. calling to each other (duetting) or 3. find nest or 4. existing breeding habitat identified'. The subject site contains approximately 9.8 ha of suitable habitat. This is made up of the following vegetation zones: Zone 5 and Zone 6 which contain hollow-bearing trees. In order to determine the presence of breeding habitat, we completed the following survey (as detailed in section 4.1.2): - Spotlighting - Call playback - Stag watching from key vantage points. Our field survey did not record the Barking Owl on the subject site, nor any nests during the hollow-bearing tree surveys. Thus, despite the presence of potential habitat, under the BAM and available survey guidance material, breeding habitat is unlikely to be impacted.	Not considered further.

Common Name	Scientific Name	Recommended survey time												Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D		
Eastern Osprey (Breeding)	*Pandion cristatus*				Y	Y	Y	Y	Y	Y	Y	Y		The species is regarded as a dual credit species with breeding habitat triggering species credits. As at June (2020) breeding is 'Presence of stick-nests in living and dead trees (>15m) or artificial structures within 100m of a floodplain for nesting)'. The field survey confirmed the absence of stick nests. The species was also not recorded during the field survey. As such, breeding habitat for the Eastern Osprey is unlikely to be impacted.	Not considered further.
Squirrel Glider	*Petaurus norfolcensis*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	The species was detected during previous surveys within the subject site in 2003 (ERM 2005) and is known to occur in the Worimi Conservation Lands (Ecotone 2008).	Considered further.
Brush-tailed Rock-wallaby	*Petrogale penicillata*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	According to the TBDC, habitat for the species is associated '*Land within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines*'. There are no such features within 1km of the subject site, and thus no potential habitat is present.	Not considered further.
Brush-tailed Phascogale	*Phascogale tapoatafa*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	A targeted survey was completed using camera trapping following the TBDC guidelines (section 4.1.2). The survey involved extensive camera trapping (totalling 49,560 hours). The species was not detected during the targeted trapping.	Not considered further.
Koala (important habitat)	*Phascolarctos cinereus*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	The Koala was not detected during targeted field survey (spotlighting, SAT surveys) (section 4.1.2). The Koala has also not been recorded by Boral staff working at the quarry. The Koala has been recorded throughout the locality, with the closest records according to Bionet being along Nelson Bay Road approximately 100 metres to the north of the subject site. The Koala has also been recorded throughout the stretch of the vegetation corridor which encompasses Worimi Regional Park and Worimi State Conservation Area. One of the most important factors influencing the distribution and numbers of Koalas in any area is the presence and density of their food tree species (OEH 2018e). Koalas feed almost exclusively on a few preferred tree species which are of primary and secondary importance. If primary tree food species are not present or occur in low density, Koalas must rely on secondary food tree species, but the number of animals per hectare is lower. *Eucalyptus robusta* is regarded as a primary feed tree, but it is not present in the subject site in large numbers, nor was it a prominent species in the tubestock plantings. The dominant canopy species over most of the subsite site include *Eucalyptus pilularis, Corymbia gummifera* and *Angophora costata*, none of which are regarded as primary or secondary feed trees. The subject site does not contain a large proportion of important feed trees and is unlikely to be utilised by Koalas. This is supported by the absence of scratches and Koala scats observed during the field survey. This is further supported by the Recovery Plan for the Koala (DECC 2008) which notes that *arguably the most important factor influencing koala occurrence is the suite of tree species available. In any one area, koalas rely primarily on regionally specific primary and/or secondary food tree species. If primary food tree species are not present or occur in low density, koalas will rely on secondary food tree species, but the carrying capacity of the habitat (i.e. number of animals per hectare) is inevitably lower. Adequate floristic diversity is also important. Although primary and secondary food trees provide the bulk of a koala's diet,*	Not considered further as a species credit fauna.

Common Name	Scientific Name	Recommended survey time												Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D		
														leaves from other species, including non-eucalypts, may provide a seasonal or supplementary dietary resource (Smith 1992). The quality of habitat is also influenced by the presence of suitable shelter trees, particularly in harsh climates. Based on the absence of suitable food trees it has been determined that important habitat for the Koala does not occur within the subject site, and therefore the Koala should be regarded as an ecosystem credit species.	
Koala, Hawks Nest and Tea Gardens population	*Phascolarctos cinereus* - endangered population	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	As above.	Not considered further.
Common Planigale	*Planigale maculata*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	The TBDC states that the Common Planigale *'inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water'*. The subject site contains surface cover in vegetation Zone 3, Zone 5 and Zone 6, compared to the other vegetation zones which typically had low litter coverage. However, the site is located away from freshwater waterbodies. Targeted surveys for the species were conducted using baited camera traps placed at ground level to maximise the survey period for the species. A total of 18,144 hours of camera trapping was conducted. The camera traps did not record the species nor any other antechinus or mouse species. Based on the trapping results, the species has been considered unlikely to be present within the subject site.	Not considered further.
Grey-headed Flying-fox (Breeding)	*Pteropus poliocephalus*										Y	Y	Y	The species is regarded as a dual credit species with breeding habitat triggering species credits. Breeding habitat is considered present if a camp site is known to occur. The field traverses confirmed that the subject site does not contain a camp site.	Not considered further.
Masked Owl (Breeding)	*Tyto novaehollandiae*					Y	Y	Y	Y					The species is regarded as a dual credit species with breeding habitat triggering species credits. Potential breeding habitat for the species as at June 2017 on BioNet is '*Living or dead trees with hollows greater than 20cm diameter*'. Whilst the BioNet does not specify a process for confirming breeding habitat, we have assumed this it is similar to the other threatened owl species and is determined based on field survey. We have therefore completed a targeted survey for the Masked Owl during appropriate periods using a combination of call playback, spotlighting, stag watching and hollow-bearing tree mapping as detailed in section 4.1.2. Our field survey did not record the Masked Owl at the site, nor was it heard calling from a distance. Based on the result of the field survey the species is considered unlikely to breed within the subject site.	Not considered further.
Mahony's Toadlet	*Uperoleia mahonyi*	Y	Y	Y							Y	Y	Y	As at June 2020, the TBDC profile for the Mahony's Toadlet is incomplete. The BioNet describes that the '*potential for the species to be more abundant/broadly distributed than currently thought, this combined with the location of this species (coastal fringe) and lots of PCT associations means it may frequently trigger SAII. As such, it will need regular review of status/data'*. The habitat description provided in the TBDC includes:	Not considered further.

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
														- *'Inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range.* - *Known records occur in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps,* - *Mahony's Toadlet also is known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland.* - *Recent studies suggest intact vegetation adjacent to and within water bodies is an important habitat feature for this species.* - *Known records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water.* - *Aquatic vegetation at breeding sites includes sedges (Shoenoplectus spp., Baumea spp. and Lepironia articulata) and Broadleaf Cumbungi (Typha orientalis).* - *Females have been recorded up to 400m from water-bodies indicating moderate dispersal distances and use of multiple habitat types.* - *Tadpoles have been observed using leaf litter in the shallow verges of water bodies on sandy substrate. Rocks, logs and leaf litter may also be used for shelter and provide important foraging areas for invertebrate prey items.'* The subject site does not contain a water body. Survey was completed after 20 mm of rain which confirmed that the subject site does not retain pools of water following heavy rainfall. As such the subject site does not contain aquatic vegetation as described above, shallow pools, or drainage lines with limited flow. We note that the species may occur within 400 m of water and has been associated with Paperbark Forest. Paperbark Forest occurs outside of the subject site near the front entrance to the quarry from Nelson Bay Road. It did not hold water following 20 mm or rain and would likely require days of heavy rain to maintain potential habitat for the species. Given the absence of ephemeral, semi-permanent or permanent waterbodies in the subject site and within 400 m, and the absence of vegetation types that are known habitat for the species, the species is considered unlikely to occur.	
Eastern Cave Bat	*Vespadelus troughtoni*	Y										Y	Y	Habitat as per the TBDC that needs to be considered for this species includes: - *'Caves* - *Within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines, tunnels, old buildings or sheds'*. The subject site does not occur within 2 km of such features. As such, the subject site does not contain habitat for this species. Furthermore, the species was not detected during Anabat surveys	Not considered further.
Predicted threatened species														
Regent Honeyeater	*Anthochaera phrygia*	No requirement to survey as assumed to be present based on habitat present												

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
Gang-gang Cockatoo	*Callocephalon fimbriatum*													
Glossy Black-Cockatoo	*Calyptorhynchus lathami*													
Speckled Warbler	*Chthonicola sagittata*													
Spotted Harrier	*Circus assimilis*													
Varied Sittella	*Daphoenositta chrysoptera*													
Spotted-tailed Quoll	*Dasyurus maculatus*													
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*													
Little Lorikeet	*Glossopsitta pusilla*													
White-bellied Sea-Eagle	*Haliaeetus leucogaster*													
Little Eagle	*Hieraaetus morphnoides*													
Golden-tipped Bat	*Kerivoula papuensis*													
Swift Parrot	*Lathamus discolor*													
Square-tailed Kite	*Lophoictinia isura*													
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*													
Little Bentwing-bat	*Miniopterus australis*													

Common Name	Scientific Name	Recommended survey time												Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D		
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*														
Eastern Freetail-bat	*Mormopterus norfolkensis*														
Turquoise Parrot	*Neophema pulchella*														
Barking Owl	*Ninox connivens*														
Powerful Owl	*Ninox strenua*														
Eastern Osprey	*Pandion cristatus*														
Yellow-bellied Glider	*Petaurus australis*														
Koala	*Phascolarctos cinereus*														
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*														
Eastern Chestnut Mouse	*Pseudomys gracilicaudatus*														
Grey-headed Flying-fox	*Pteropus poliocephalus*														
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*														
Greater Broad-nosed Bat	*Scoteanax rueppellii*														
Diamond Firetail	*Stagonopleura guttata*														

Common Name	Scientific Name	Recommended survey time											Approach to survey	Considered further
		J	F	M	A	M	J	J	A	S	O	N	D	
Common Blossom-bat	*Syconycteris australis*													
Masked Owl	*Tyto novaehollandiae*													

4.1.5 Threatened Fauna for Further Consideration

Through consideration of the candidate species list, one threatened fauna were determined for further consideration based on:

- Assumed presence (Squirrel Glider) given previous records within the subject site, surrounds and presence of habitat.

In order to determine the offset requirement, species polygons (areas of occupied/potential habitat for the species) must be completed. We have detailed the species polygons in Table 12. The biodiversity credits associated with the Squirrel Glider species polygon is detailed further in section 6.

Table 12. Threatened Fauna Species Polygon

<table>
<tr><th>Threatened Fauna</th><th>Consideration</th><th>Details</th></tr>
<tr><td>Squirrel Glider</td><td>Assumed to be present given previous records</td><td>The Squirrel Glider has been previously recorded at the site by ERM (2005b) and is known to occur widely throughout Worimi Conservation Lands (Ecotone 2008).
The TBCD does not provide any guidance on the methods used to determine a species polygon for the Squirrel Glider. We have assumed that the area for the polygon relates to potential roosting and foraging habitat. Foraging habitat consists of eucalyptus sap, Acacias and nectar from a wide range of native flora. We have therefore assigned the vegetation zones provided in the table below to a species polygon. Foraging habitat is present within these vegetation zones. The total area is 26.72 ha as shown on Figure 10.
<table>
<tr><th>Species Polygon</th><th>Vegetation zone</th><th>Total (ha)</th></tr>
<tr><td rowspan="3">PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast</td><td>Zone 1</td><td>14.14</td></tr>
<tr><td>Zone 5</td><td>1.70</td></tr>
<tr><td>Zone 6</td><td>8.21</td></tr>
<tr><td>1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast</td><td>Zone 3</td><td>2.67</td></tr>
<tr><td colspan="2">Total</td><td>26.72</td></tr>
</table>
</td></tr>
</table>

4.1.6 Threatened Fauna (EPBC Act)

A total of 63 EPBC Act-listed fauna were considered in the assessment based on the database reviews detailed in section 4.1.1, with most species being Marine or Migratory bird species. Of the species considered, foraging habitat for seven were considered to have a moderate to high likelihood of occurring: Black-faced Monarch, White-throated Needletail, Spotted-tail Quoll, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox.

The Grey-headed Flying-fox is only likely to utilise the subject site on occasion for foraging. No roosting camp sites were observed in the subject site or immediately adjacent. The species has been recorded throughout the Worimi conservation lands (Ecotone 2008).

The Long-nosed Potoroo, Koala, Spotted-tail Quoll and New Holland Mouse have been attributed a moderate likelihood of occurrence as all species have been recorded within Worimi Regional Park and Worimi State Conservation Area and may utilise the subject site for foraging. However, none of these species were recorded during the field survey so any use of the subject site is likely be to be low.

None of the above species were detected during the field surveys and based on specific habitat requirements for each species (Appendix 1), it is likely that the subject site would only be used on an intermittent basis for foraging, if at all based on the surveyed habitat features. The extensive native vegetation that occurs throughout the land to the north and south within Worimi Regional Park and Worimi State Conservation Area are likely to offer greater habitat suitability for each of these species.

Given the likelihood of occurrence and potential use of the subject site, each of the threatened species have been considered in an EPBC Act Assessment of Significance (Annex 9).

5. Impact Assessment

The Impact Assessment forms Stage 2 of the BDAR as detailed in Section 8 of the BAM.

5.1 Avoid and Minimise Impacts

In accordance with the BAM, proponents must demonstrate the measures employed to avoid, mitigate and offset impacts of a Project on biodiversity values. This section of the report outlines the details from the Environment Impact Statement (Arnold Planning 2023) associated with avoidance planning, management and mitigation measures that Boral has incorporated into the Project design or will employ during construction, operation or completion of the Project to reduce impacts on biodiversity values.

5.1.1 Justification for the Project

As detailed in the Environmental Impact Statement (Arnold Planning 2023), Boral is a leading producer and supplier of building and construction materials in the country. Accordingly, a significant amount of development in NSW, including many of NSW's best known structures, are underpinned by Boral-supplied concrete, cement, asphalt and construction materials such as natural sand.

With the significant increase in approved infrastructure Projects in Sydney and other parts of NSW, the leading suppliers of natural sand are under pressure to meet this increased demand as natural sand has unique structural characteristics to manufactured sand and is essential to meet design specifications on many infrastructure and associated development Projects.

As Stockton Sand Quarry is one of Boral's few remaining natural sand quarries, Boral propose to meet part of this increased demand in natural sand by extracting the remaining sand from the same inland extraction area previously approved under the former 1996 development consent (DA 2010/94).

As detailed in the Environmental Impact Statement (Arnold Planning 2023), the expanded operations at Stockton Sand Quarry will provide:

- supply of essential natural sand to major infrastructure and associated development Projects;
- continued employment of four full time employees, one casual employee and truck/transportation drivers, with an additional two full time positions and two casual positions also created along with further employment benefits created through flow-on effects;
- optimal use of a regionally-significant resource; and
- economic benefits to the local community through the purchase of goods and services and local expenditure both directly and indirectly through employee wages.

Boral's operations provide substantial economic benefits at Federal, State and local levels while being committed to maintaining a good working relationship with the local community and implementing best practice environmental management across the site.

5.1.2 Justification for the Project

Resource quality

Sand suitable for use in the construction and foundry industries occurs in the Stockton Bight dunes. Although the entire sand unit possesses some potential for a particular use, there are optimum areas from which these materials can be obtained. The sand within Boral's land holding comprises a fine to medium grained sand suitable for use as a fine aggregate in concrete.

Sand suitable for concrete use must comply with Australian Standard 2758.1-1998 "Aggregates and Rock for Engineering Purposes - Concrete Aggregates". Factors such as grain shape, composition and grading of the sand must be considered. The sand must be clean, fine to medium grained, and free of deleterious materials including friable particles, organic impurities, structurally weak substances, and alkali reactive materials. The sand in Boral's land holding meets these requirements and the main use proposed for the sand is concrete production within Boral's own concrete plants in the region.

Foundry sand suitable for the use and manufacture of cores and moulds in the casting of metal products must have chemical and physical properties that allow them to withstand the high temperatures of molten metal. The sand should be a fine silica sand, even grained, and low in deleterious matter such as shell, silica and limonite, as is the case with the dune sands at Anna Bay at the northern end of Stockton Bight. Sand in the Boral land holding does not generally meet foundry requirements due to unsuitable grading, given it is too coarse grained. Conversely, the very fine grained windblown dune sands along the northern end of Stockton Bight are generally not optimal for use in concrete, being too fine grained.

Leaching of the upper layers of vegetated dune sands, by organic acids, produces white, low iron sand below the organically enriched sandy topsoil layer. The leached white sand layer on Boral's property is of variable thickness but is generally thin. Below this thin white sandy capping there is a zone of iron enrichment, the sandy material within this zone being commonly termed ‘coffee rock’ or ‘waterloo rock’. This material varies in character from a thin crusty layer of loosely bound iron coated sand grains to a thick layer of moderately iron stained amber-brown sand. ‘Coffee rock’ or ‘waterloo rock’ is unsuitable for concrete production and (where it occurs) is blended with the thin white sand layer above (where it occurs) to produce a fill sand.

Fill sand is used in numerous construction applications, including use as a support filler under house slabs, as a filter material for pipe bedding and as a drainage layer under roads. Sand used for this purpose does not have to conform to the rigid specifications outlined for specialised sands. The sand, however, needs to be reasonably 'clean' (some impurities such as charcoal, shell material, and iron-staining can be tolerated) and not too fine grained.

Sand suitable for use in glass manufacture must comply with rigid specifications. It should consist of almost pure quartz (i.e. minimum silica content of 99.5 percent), and be fine in grain size and low in shell, iron, and organic materials. Very few sand deposits, including sand on Boral's holding, meet these stringent requirements.

In the manufacture of Concrete, the fine aggregate component is achieved by blending Fine Sand with a Course Sand. In Boral’s case, the Course sand is Manufactured Sand which is a made from further processing of Quarry Dust which is a by-product of the crushing process.

Stockton Fine Sand is ideally matched to Boral’s Peppertree Manufactured Sand which supplies most of Boral’s Concrete production requirements in the Sydney and Hunter market. This means that Stockton Sand allows the greatest utilisation of manufactured sand in the Concrete blend, and therefore better utilises this scarce resource over a greater volume of total production that would otherwise have been produce with a less superior grading.

In this regard, Boral’s Stockton fine sand reduces the natural fine sand usage, and avoids the need to find and develop a more resource intensive source of fine sand.

Locational factors

In terms of weight and volume, more sand products have to be quarried and transported to construction sites than any other type of resource material. It is for these reasons that extractive sand sources need to be located as close as possible to the point of usage. The value to weight ratio is very low, making transport costs to the market highly sensitive.

Establishing sand extraction operations close to the construction market represents considerable savings in terms of construction and associated transport costs for Projects undertaken in the region that are to be serviced by the quarry. Over the life of the quarry this represents a significant benefit to the local community and the state in terms of reduced transport and associated infrastructure maintenance costs.

Adjoining operations

Existing operations providing fine to medium grained sand suitable as fine concrete aggregate in the Lower Hunter Region are principally located in the barrier dune systems between Stockton and the Port Stephens peninsula. In addition to Boral's sand extraction operation at Fullerton Cove, operations in the Stockton Bight area are located at Salt Ash, Williamtown, Bobs Farm, Anna Bay and Raymond Terrace.

Minor quantities of manufactured sand are derived from quarrying and processing of hard rock (quarry dust). Manufactured sand is assisting to prolong the life of the natural sand reserves, however manufactured sand is generally not suitable for use in concrete on its own and is typically either used in road base or blended with natural sand to produce an acceptable grade concrete sand.

As transport distance adds significantly to the delivered price of sand into the Hunter Region, very little sand is imported into the region from outside.

Future demand

The demand for construction materials in major infrastructure and construction Projects in the Lower Hunter Region and Sydney has been high in recent years and is expected to be strong for the foreseeable future.

Fine grained construction sand is a major component of concrete, particularly for domestic applications. For example, an average three bedroom brick veneer home on a concrete slab foundation, with concrete paths and driveways, consumes in the order of 50 cubic metres of concrete, which contains 17.5 tonnes of fine grained construction sand.

Boral uses sand extracted from the site as the fine sand component in concrete production. The future demand for construction sand will correlate with anticipated growth in residential development, commercial development, and major infrastructure and construction Projects in the Lower Hunter Region and Sydney during the next 15 to 20 years.

Life of operation

The Project proposes to extract approximately 3.1 million tonnes of sand resource over a potential 10 year period.

Taking into account the sites existing operation, extracting sand from the transgressive dunes, the Project is seeking to allow for maximum site transport limit of 750,000 tonnes per annum (tpa) (over the two projects) up until 2028 when the extraction on the transgressive dunes is due to cease. At this time the transport limit will reduce to 500,000 tpa.

To allow for flexibility between the two projects, the Project has been assessed on the basis of a site wide maximum extraction and transport rate of 750,000 tpa.

5.1.3 Project Alternatives

Do nothing

Sand extracted from the Stockton Sand Quarry is used within the Hunter and Sydney regions. At present, due to sustained demand across the building and construction industry, Boral's sand resource across all assets have been substantially depleted.

If the proposed extraction of additional sand is not approved, the quarry will cease to operate in approximately three years' time due to current demand trends for natural sand products. This would result in loss of employment, reduced revenue to local service providers, reduced regional expenditure in the Port Stephens and Newcastle Local Government Areas (LGA), sterilisation of a valuable resource and shortages of raw materials for essential NSW infrastructure and associated development Projects.

The sand deposit at the site is highly suitable for use in concrete, is close to markets, and environmental impacts are less than for other alternatives on Boral's land and possibly less than for other sites in the region.

As detailed in the Environmental Impact Statement (Arnold Planning 2023), given that local demand for natural construction sand is unlikely to diminish, and given that the site is ideally located at the southern end of Stockton Bight to supply the Lower Hunter and Sydney market, it is most likely that other Stockton Bight sand suppliers further to the north would take up a shortfall in Boral's production. As such, there is a possibility that sand would be purchased from elsewhere, likely further away from the end use. In this case, it is likely that road transport impacts would be compounded, and would increase the cost of sand and concrete. Additionally, Boral would be required to purchase sand from other approved or yet to be approved Stockton Bight quarries. While it is not possible to clearly compare environmental impacts in this case, the Project has a limited environmental effect as it is confined to an area which has been disturbed by quarrying operations in the past. Because of the likelihood of alternate supply being a different grading there is a greater likelihood that more fine sand will be required for extraction and transport in order to produce one cubic metre of Concrete, when compared to the combination for Stockton Sand Grading with Boral's Manufactured Sand source.

In summary, should the Project not proceed, Boral would close the quarry in due course and have to rely on other sand sources locally or further afield, depleting those resources sooner. Importantly, not proceeding would mean that the community would lose the opportunity to allow the further development of an existing quarry operation. Conversely, alternative developments may require the disturbance of greenfield land parcels with more inherent environmental risks.

Alternative locations

As outlined earlier, Stockton Sand Quarry is one of Boral's few remaining natural sand quarries. With the significant increase in demand for natural sand, all of Boral's natural sand quarries are operating at full capacity.

As the quarry has a substantial remaining natural sand resource and is relatively close to Boral's existing Hunter and Sydney supply contracts, it is an ideal site to meet current and predicted future market demand for natural sand.

Other sand resources on Stockton Bight lie within the Worimi Conservation Lands, Crown lands and, to a lesser extent, on freehold lands. Most sand deposits on freehold lands are already owned or being extracted by the construction sand industry. A few isolated sand bearing properties remain but the size of the sand deposits are generally too small for economic development.

Many millions of tonnes of sand lie within the Worimi Conservation Lands or Crown lands on Stockton Bight but are currently unavailable for extraction by virtue of environmental protection zoning. Sand on Crown lands closer to Anna Bay which have appropriate zoning for extraction is generally too fine grained for concrete, being more suited to foundry applications and glass manufacture.

The dune sands on Stockton Bight need little or no processing to produce a grain size grading suitable for concrete manufacture. The only other source of sand in the region is the processing of soft rock. Friable sandstones at Blackhill, matrix sand from conglomerates at Teralba and overburden sediments in coal mines are examples, but in each of these cases, the cost of extraction and processing to produce suitably graded sand would be considerably higher than extracting the loose, naturally graded sands of Stockton Bight.

There are millions of tonnes of remaining sand suitable for production of concrete at the site. A number of alternative development scenarios were explored for the development of this remaining sand, culminating in the conclusion that the Project represents the most environmentally, socially and economically sensible option.

The proposed extraction area has been previously disturbed and as such the recommencement of sand extraction is considered to have a reduced direct environmental impact. The location of the site is separated from sensitive receptors, with Boral's current operations largely going unnoticed by the surrounding community and visually unobtrusive due to the presence of the dune system that surrounds the extraction area.

Alternative materials

There are few alternative materials to replace natural sand in the production of concrete. Alternative materials are emerging, which represent viable supplements to natural sands, but not as replacements to natural sands. In recognition of the value of such alternatives, Boral is becoming increasingly more active in recycling and in the production of manufactured sand.

Manufactured sand is a sand product created from quarry dust generated by the crushing of hard rock. Quarry dust is mainly blended into road bases, but many quarries process some of the dust to produce coarse sand for blending with finer grained natural sands to produce acceptable grade concrete sand.

To a significant extent, therefore, the alternative manufactured sand option is already being used to extend the life of natural fine grained sand sources. The inability of manufactured sand to be a complete replacement for natural sands is due to a number of factors. Quarry dust generally has a particle shape that is angular and often elongated, making concrete flow and concrete workability very difficult. Quarry dust also tends to be deficient in the fine end of the particle range and the addition of fine grained natural sand is required to fill out the grading. The addition of fine grained natural sand also helps concrete workability as the natural sands are often rounded.

Barmac crushing can be used to produce a dust with a better particle shape, but this in turn produces greater volumes of dust. A compromise is usually made, which invariably requires the use of natural sand to even out grain shape and particle size deficiencies.

Boral is engaged in ongoing research and development into the production of manufactured sand to supplement the natural sand market. In the immediate term Boral are investigating options to utilise glass sand or recovered sand from virgin excavated natural material (VENM). However, these sources are yet to receive approvals. In the case of glass sand, commercial production levels are low (as a new recovered resource and burgeoning industry) and the planning approvals necessary to permit the importation and blending of these materials to create building products is not widely accepted by consent authorities. Additionally, recovered sand product from processing VENM does not typically yield the same high quality product as that proposed to be extracted from the Stockton Sand Quarry. Cumulatively this would impact on the production of key building materials, in particular the production of concrete which would have wider implications for the building and construction industry within the Hunter and Sydney regions.

Alternative non-naturally occurring materials exist which can substitute to some extent for the naturally occurring construction sand sources. Examples are recycled building and demolition waste, granulated blast furnace slag and fly ash from coal fired power stations. However, these alternatives generally have high handling, transport and processing costs, although they are commonly used for roadbase and other applications.

Boral is actively involved in construction and demolition recycling with a major plant at Wetherill Park in Sydney and approved operations at Somersby on the Central Coast and Kooragang Island. The products from these operations supplement the natural sand market.

Whilst new innovation in alternative materials is emerging, the need for constant supply of natural sands for concrete production remains integral.

Alternative Project Design

To ensure that potential impacts of the project would not exceed those assessed as part of the current dredge application, the project has been designed to reflect the rate of extraction and dispatch and the extraction and disturbance area originally proposed and exhibited. This would enable the existing technical studies to be updated for the project. Furthermore, the staging of the project reflects the staging of the current dredge application, which would enable the dry sand extraction to transition dredging should the current dredge application be approved and commence. There is no alternative design option that would allow for this to occur.

5.1.4 Mitigation Measures (Construction and Post Construction)

A project specific Landscape and Rehabilitation Management Plan (will be prepared to reflect biodiversity management measures associated with the Project in order to protect and manage important biodiversity values. It is envisaged that the project specific plan would be similar to the existing Landscape and Rehabilitation Management (Boral, 2010) adopted in relation to the existing Windblown Sand Project. This existing Plan discusses key commitments relating to threatened species management, pest and weed management, fire management and site hygiene practices.

Mitigation measures to be undertaken during construction and post construction include:

Fencing and signposting

Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the proposed extraction area.

Signposting will be used to inform Project personnel and site visitors of areas of conservation value to restrict entry or inform behaviour that will reduce incidental interactions with threatened species - e.g. speed limits along access roads to reduce potential for fauna vehicle strikes.

Employee Education and General Environmental Controls

Employees and contractors would be educated on and required to implement the following controls, to avoid or at least minimise potential environmental impacts associated with the Project:

- Minimise dust generation by minimising the extent and time that bare sand is exposed and by appropriate sand suppression.
- Procedures for the management of hydrocarbon and/or chemical spills throughout the Project site including the requirements for vehicles to carry spill kits.
- Ensuring vehicles remain on designated roads and tracks and abide by site speed limits, through use of signposting and driver education during the induction process and in on-going Project discussions.
- Management and removal of all rubbish from the Project site.

Vegetation Clearance Protocol

Boral has an established vegetation clearing protocol provided in the existing Windblown Project Landscape and Rehabilitation Management Plan (ERM 2010). This protocol would be adopted under a project specific Management Plan. This will include the following key protocols:

- Prior to clearing of native vegetation, ecologists are to survey for ground dwelling fauna and to remove any fauna/ fauna habitats to adjacent areas that would not be further disturbed.
- Prior to clearing of remnant hollow-bearing trees or habitat trees, ecologists are to be engaged to supervise felling. All hollow-bearing trees that are accessible safely from the ground are to be checked and identified fauna relocated. Hollows higher up and not accessible from the ground are to be identified and trees felled gently by an excavator or dozer and left overnight to allow fauna to relocate.
- Any fauna displaced during clearing are to be captured where possible and relocated to pre-planned areas (fauna to be captured and handled only by personnel trained to do so).
- In an event that fauna are injured during clearing, the NSW Wildlife Information, Rescue and Education Service (WIRES) will be contacted to handle and collect for appropriate care and rehabilitation.

5.1.5 Rehabilitation

On completion of extraction activities, the following areas would require specific rehabilitation/revegetation:

- where native vegetation has been cleared across the proposed extraction area; and
- where native vegetation has been cleared for project-specific infrastructure (i.e. haul road corridors and internal accessways).

Rehabilitation activities in these areas would comprise soil preparation (i.e. deep ripping for haul road corridors) and establishment of native vegetation in disturbed areas, utilising suitable rehabilitation species to minimise soil erosion and establish slope stability (Arnold 2023).

5.1.6 Pest and Weed Management

A project specific pest and weed management plan would be developed and implemented. It is envisaged that this plan would adopted protocols and strategies similar to those implemented under the existing management plan adopted for the Windblown Project (ERM 2010) with the following additional matters also included::

- Management protocols for feral animals such as dogs, rabbits and foxes within the rehabilitation area, and
- Management protocols for the identification of noxious or important environmental weeds within areas to be cleared (in order to avoid transporting the weeds to rehabilitation areas or other parts of the site).

5.1.7 Fire Management

Boral currently have a Bushfire Management Plan included in the Boral (2010) Stockton Transgressive Dune Quarry Environmental Management Strategy. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated where required to reflect the findings and recommendations provided in the Bushfire Hazard Assessment for the Project (BPAD 2023).

5.2 Impact summary

5.2.1 Direct Impacts

The Project would result in the unavoidable clearing of 35.67 ha of vegetation regarded as 'native vegetation,' as defined in the BAM, which comprises of:

- 33.00 ha of PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland
- 2.67 ha of PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes.

The Project would result a direct impact to 26.72 ha of Squirrel Glider habitat.

Of the above, preliminary clearing of approximately 0.5 ha of vegetation is proposed across the project site prior to extraction, to facilitate a widespread drilling program, which would enable Boral to:

- monitor the level of the water table over the life of the project; and
- provide an accurate representation of the quality of the sand resource across the site.

Figure 10 shows the location of existing and proposed boreholes and indicates the areas of proposed vegetation clearance, to allow for access tracks a maximum 2.6 m wide and with turn around areas a maximum 10 m by 4 m. A systematic grid approach has been adopted; however, preference has been given to locating the proposed boreholes in low lying areas and areas of cleared vegetation, to minimise vegetation clearing where possible.

The direct impacts associated with the project cannot be further avoided or mitigated. As per the BAM, Section 6 details the biodiversity credits required to offset the unavoidable impacts of the Project.

5.2.2 Indirect Impacts

Indirect impacts associated with the Project will largely occur during the construction and operation of the Project, resulting in a short-term impact (i.e. the construction and rehabilitation phases of the Project) and will be minimised where possible through management procedures. A range of indirect impacts are likely to or could occur as a result of the Project, including:

- Increased noise and dust
- Increased spreading of weed propagules.

The indirect impacts described above are variable in terms of the distance they may extend from the subject site, and in many cases, due to mitigation measures, indirect impacts will be completely contained within the subject site. The area of indirect impact without mitigation measures has been attributed to a 50 m area around the boundary of the site.

Indirect impacts on the biodiversity values of areas surrounding the subject site, along with recommended mitigation measures to minimise identified impacts, are discussed in Table 13. Boral would be responsible for carrying out the mitigation measures.

Furthermore, Boral would engage a suitably qualified ecologist to undertake a due diligence assessment prior to the clearing of vegetation associated with the drilling program. This will assist in the management of direct and indirect impacts to terrestrial biodiversity values prior to and during borehole and access track construction. Details of the due diligence process and due diligence checklist are provided in the EIS.

Table 13: Indirect impacts

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
Edge effects	The establishment of the new extraction area would result in the creation of new edges adjacent to areas of existing native vegetation immediately adjacent to the extraction area. The new edges could facilitate the establishment and spread of introduced plant species and increase light levels, however, appropriate monitoring and control measures would be implemented during and after construction to counteract the potential for weed occurrences.	Varying distance from subject site. Potentially occurring within 30 metres from the disturbance area throughout the active life of the Project.	Fencing and/or the use of highly visible rope or tape boundaries will be used to delineate the boundary of vegetation clearing at the edge of the extraction area. Signposting and education will also be used to inform Project personnel of no-go areas. Weed management and monitoring to be included in the project specific Landscape & Rehabilitation Management Plan.	Active weed, and pest management are anticipated to be successful at managing edge effects from the Project.
Weeds	Weeds have the opportunity to establish themselves in areas of disturbed vegetation. The greatest establishment of weeds are in areas already disturbed. The Project has the potential to increase or lead to the establishment of weed species where they do not currently exist through the operation of machinery during construction phases. New weed species can potentially be introduced as a result of the movement of construction vehicles and materials into the subject site. Areas more likely to be exposed to weed increases are areas of native vegetation that occur to the south of the subject site. However, weeds will be controlled during and after construction in accordance with the Landscape and Rehabilitation Management Plan and thus indirect impacts from weeds is likely to be negligible within the adjacent woodland areas.	Variable depending on topography. However, typically would occur within proximity to the disturbance area.	Weed management and monitoring to be implemented in accordance with the project specific Landscape and Rehabilitation Management Plan.	Active weed control methods are likely to be successful in managing the spread of weeds within adjacent areas.
Erosion and sedimentation	Erosion of sand and associated sedimentation associated with the Project may involve the following: • Alteration of sand structure beneath haul roads; and • The deposition of soil particulates in drainage lines and remnant vegetation surrounding the subject site.	Variable depending on topography and operation.	Sediment management measures will be implemented in accordance with project specific Erosion and Sedimentation Control Plan that will adopt mitigation and strategies similar to the existing recommendations in the Stockton Transgressive Dune Quarry (ERM 2010).	Sedimentation control are known to reduce sedimentation spills.

Indirect impact	Likely impact from the Project	Potential extent of the indirect impact prior to mitigation measure	Mitigation measure	Expected success of mitigation measure
Dust	Although dust will be generated from the construction and operation of the Project, it will be mitigated with dust suppression from a water truck, which is the practice with the current operations. Where feasible Boral utilise available water allocations.	Variable depending on wind conditions. Potential for dust emissions likely throughout life of Project.	Dust impacts will be mitigated through the onsite use of water suppression. Further, vegetation clearing protocols for the Project will seek to minimise exposed areas with the potential to generate dust by completing vegetation clearing as close to mining operations as practical.	Successful implementation of dust control would minimise dust. Current dust suppression mitigation works are ongoing at the Stockton Sand Quarry.
Fire	Historically, bushfires tend to be associated with a proficient growth of native grasses following large rain events. During summer, following rain events, dry swards of grasses pose a bushfire hazard when placed near a source of ignition. Vehicles driven through long grass with hot exhausts may cause a fire particularly during the hotter months of the year.	Potential to be widespread in locality, though unlikely.	A bushfire hazard assessment has been completed by BPAD (2023) as part of the Project. Boral also currently have a Bushfire Management Plan included in the Boral (2010) Stockton Transgressive Dune Quarry Environmental Management Strategy. Fire prevention and suppression are detailed within the Plan including emergency protocols should a fire occur. This Plan would be updated to reflect the recommendations of BPAD (2023) where required to reflect the Project.	Given the existing quarry operations have not resulted in any significant fires, the continued implementation of the Stockton Transgressive Dune Quarry Environmental Management Strategy and any project specific requirements would likely result in fire prevention.
Fauna vehicle strike	No fauna have been hit via a vehicle over the past decade. This is likely attributed to enforced speed limits whilst on-site, and contractor awareness. Boral will continue to maintain the slow speed limits during the operation of the Project.	Likely to be successful given no fauna have been impacted by vehicle movement at the site to date.	Continue current slow speed limits around the quarry site. Continue current contractor awareness training regarding fauna operations.	Currently successful.

5.2.3 Impacts to Commonwealth Threatened Biodiversity

Formal Assessments of Significance have been provided in Annex 9 for the following EPBC Act listed threatened species: *Cryptostylis hunteriana*Black-faced Monarch, White-throated Needletail, Spotted-tail Quoll, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox.

The Assessments conclude that a significant impact to Commonwealth listed threatened biodiversity is unlikely.

5.2.4 Potential Serious and Irreversible Impacts (SAII)

The BC Act and the *Local Land Services Act 2013* (LLS Act) imposes various obligations on decision-makers in relation to impacts on biodiversity values that are at risk of Serious and Irreversible Impacts (SAII). These obligations generally require a decision-maker to determine whether the residual impacts of a proposed development on biodiversity values (that is, the impacts that would remain after any proposed avoid or mitigate measures have been implemented) are serious and irreversible (DPIE 2019b).

No threatened biodiversity at risk of SAII (as assigned in the TBDC at March 2023) are known in the subject site or are considered to potentially be impacted by the Project.

5.2.5 Prescribed biodiversity impacts

Prescribed biodiversity impacts are impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. This can include impacts on:

- on the habitat of threatened entities including:
    - karst, caves, crevices, cliffs, rocks and other geological features of significance,
    - human-made structures, or
    - non-native vegetation
- on areas connecting threatened species habitat, such as movement corridors
- that affect water quality, water bodies and hydrological processes that sustain threatened entities (including from subsidence or upsidence from underground mining)
- on threatened and protected animals from turbine strikes from a wind farm
- on threatened species or fauna that are part of a TEC from vehicle strikes.

The BDAR must include an assessment of any prescribed impacts of the Project on threatened entities and their habitat, and describe:

- The nature, extent, frequency, duration, and timing of prescribed impacts that may occur:
    - i. during construction;
    - ii. during operation; and
    - iii. that are uncertain (predictions should be made).
- The consequences of prescribed impacts on biodiversity values.
- Any limitations to data, assumptions, and predictions about impacts on biodiversity.

An assessment for each of the relevant prescribed biodiversity impacts have been completed in the following sections:

5.2.5.1 Karst, caves, crevices, cliffs, rocks and other geological features of significance,

None of these features would be impacted by the Project.

5.2.5.2 Human made structures and non-native vegetation

The Project would not impact upon any existing human-made structures and non-native vegetation that provides habitat for threatened species.

5.2.5.3 Threatened species movement corridors

The subject site adjoins a large native vegetation corridor which extends along Stockton Beach to Anna Bay in the north and Stockton in the south (Figure 1). The stretch of the vegetation corridor encompasses Worimi Regional Park and Worimi State Conservation Area. The corridor also adjoins the wetlands (Long Bight Swamp) and riparian vegetation of Fullerton Cove approximately 2.3 kilometres to the southwest.

All predicted threatened species as identified in the BAM-C (section 3.2 and 4.1) may utilise the surrounding habitat for movement. The removal of habitat within the subject site is unlikely to reduce the amount of important habitat features within the corridor to an extent that fauna roosting and foraging habitat would be significantly impacted. The removal of the vegetation from within the subject site is unlikely to restrict fauna movement along the Stockton Beach to Anna Bay corridor given the following:

- The area to be disturbed is centred on the former quarry pit which was predominately cleared over a decade ago.
- Vegetation would be retained along Nelson Bay Road and towards Stockton Beach allowing fauna movement along the corridor (as can be seen from Figure 8).
- The haul road that is currently in operation for the quarry operations would not be widened as part of the current proposal, thus no changes to fauna movement are likely.

5.2.5.4 Water quality, water bodies and hydrological processes that sustain threatened entities (including from subsidence or upsidence from underground mining)

Water quality, waterbodies and hydrological processes would not be impacted by the Project. This is supported by the water quality specialist assessments completed for the Project.

5.2.5.5 Threatened and protected animals from turbine strikes from a wind farm

Not relevant to the Project.

5.2.5.6 Threatened species or fauna that are part of a TEC from vehicle strikes.

No TECs occur within the site or immediately adjacent to the site. As such, this is not applicable to the Project.

State Environmental Planning Policy (Biodiversity and Conservation) 2021State Environmental Planning Policy (Biodiversity and Conservation) 2021 is current in effect at the time of BDAR preparation. The SEPPaims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline:

(a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and

(b) by encouraging the identification of areas of core koala habitat, and

(c) by encouraging the inclusion of areas of core koala habitat in environment protection zones.

SEPP 44 applies to Local Government Areas (LGAs) listed in Schedule 1, and where a development has an area of more than 1 ha.

The subject site exceeds 1 ha and is located within the Port Stephens LGA which is listed in Schedule 1 of SEPP 44, and as such, the SEPP applies to the subject site.

Under SEPP 44, 'potential Koala habitat' is defined as -

'*areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component'.*

Of the tree species listed in Schedule 2, only *Eucalyptus robusta* was recorded within and near the subject site. *E. robusta* comprised less than 15 per cent of the total number of trees present in the subject site, and therefore, as per the definition of SEPP 44, the habitat present is not regarded as 'potential Koala habitat'.

'Core Koala habitat' is defined in the SEPP as -

'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'.

The Koala was not recorded on the subject site during the surveys and there are no historical records of the species in the subject site. As discussed in Table 11, the Koala has been recorded within the locality, with the closest records being along Nelson Bay Road approximately 100 metres to the north of the subject site.

If a resident population of the Koala was present within the subject site, it is highly likely that there would be extensive sightings by Boral staff and rehabilitation contractors whilst working within the subject site. Given the lack of recent sightings and/or historical records in the subject site, the site is not considered to constitute 'core Koala habitat'.

5.2.6 Port Stephens Council Comprehensive Koala Plan of Management

The Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) has been prepared by Port Stephens Council and the Australian Koala Foundation (AKF) for the Port Stephens LGA. The CKPoM has an aim to 'encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline'.

The CKPoM includes a Koala habitat map for the Port Stephens LGA (Port Stephens Council 2007), which classifies Koala habitat into different categories based off a range of attributes and survey results. The subject site has been mapped as 'Supplementary" Koala habitat, which is defined as habitat where Marginal Koala Habitat Middle-ranking Community overlap' (Port Stephens Council 2002). This habitat is regarded in the CKPoM as 'important to the long-term conservation of Koalas in Port Stephens and thus also requires protection, albeit with less restrictions on development than Preferred Koala Habitat'.

The CKPoM also includes performance criteria to assist development applications in the Port Stephens LGA demonstrate that developments are consistent with the objectives associated with the CKPoM. Given this BDAR is associated with an SSD rather than a local government development application, the performance criteria are not relevant to this Project, however Boral has considered the aims and objectives of the performance criteria to minimise potential impact to the Koala as detailed in Table 14 and Table 15.

Given the Project will largely impact upon a rehabilitated former quarry pit, and will avoid decreasing the width of a wildlife corridor along Nelson Bay Road, it is highly unlikely that the Project would result in an

impact to a Koala population in the Port Stephens LGA. The Project will also implement a series of mitigation measures (section 5.1.4) to avoid any potential indirect impacts to surrounding habitat.

Table 14. Consideration of aim and objectives of CKPoM

General Aims and Objectives of CKPoM Performance Criteria for Developments	Consideration in the Project
i) To ensure that the koala population in the Port Stephens LGA is sustainable over the long-term.	The area to be impacted is not known to contain a resident Koala population. The area to be disturbed consists predominately of native rehabilitated land, which occurs within and immediately adjacent to a former quarry pit. The Project is highly unlikely to result in any decrease in the Koala population of the Port Stephens LGA.
ii) To protect koala habitat areas from any development which would compromise habitat quality or integrity.	The vegetation disturbance associated with the Project does not occur within areas of 'important' or 'core Koala' habitat as discussed in section 4.7.1. The Project would predominately involve the clearing of rehabilitated native vegetation within a former quarry pit. As such, impacts to large tracts of native vegetation and habitat have largely been avoided. The Project will not result in an impact to a Koala corridor, core habitat, important habitat or extensive koala habitat that would decrease a population of the Koala.
iii) To ensure that any development within or adjacent to koala habitat areas occurs in an environmentally sensitive manner.	Boral will implement the mitigation measures detailed in section 5.1.4 to minimise all potential indirect impacts.
iv) To ensure that acceptable levels of investigation are undertaken, considered and accepted prior to any development in or adjacent to koala habitat areas.	This assessment has utilised the methodology of the BAM and associated threatened survey guidelines to survey for Koalas.
v) To encourage koala habitat rehabilitation and restoration.	The Project would result in the clearing of native vegetation, conservatively estimated to be 35.67 ha, of which most is predominately rehabilitated land. Given the Project is located predominately within a former quarry pit and historically impacted areas, impacts to remnant vegetation is largely avoided. Mitigation measure to reduce potential habitat impacts are detailed in section 5.1.4.
vi) Maintain interconnection between areas of Preferred and Supplementary Koala Habitat and minimise threats to safe koala movements between such areas.	The Project will impact areas mapped as 'supplementary Koala habitat' as per the CKPoM. Much of the areas to be impacted occur within the former quarry pit, and immediately adjacent areas. The removal of the vegetation would not restrict Koala movement throughout the landscape and mitigation measures (speed limits) would prevent Koala collisions, should they venture into the site during operation.
vii) To ensure that development does not further fragment habitat areas either through the removal of habitat or habitat links or through the imposition of significant threats to koalas.	As discussed in section the Project would not reduce Koala connectivity and movement through the landscape.

General Aims and Objectives of CKPoM Performance Criteria for Developments	Consideration in the Project
viii) To provide guidelines and standards to minimise impacts on koalas during and after development, including any monitoring requirements.	Boral will implement the mitigation measures detailed in section 5.1.4 to minimise all potential indirect impacts.
ix) To provide readily understandable advice to proponents preparing development applications and for Council officers involved in the assessment of those applications.	Not relevant

Table 15. Performance Criteria

Performance criteria	Response
a) Minimise the removal or degradation of native vegetation within Preferred Koala Habitat or Habitat Buffers;	The Project justification is provided in section 5.1. The subject site contains limited primary or secondary preferred feed trees. The Project minimises impacts to remnant native vegetation/habitat by focusing the majority of the subject site on the former quarry pit.
b) Maximise retention and minimise degradation of native vegetation within Supplementary Koala Habitat and Habitat Linking Areas;	As above, impacts to potential Koala habitat has been minimised as much as practical. The project is largely contained to the former inland extraction area that was cleared in accordance with the 1996 development consent (DA 2010/94). Any existing vegetation is rehabilitation in various stages of growth that was planted by Boral. The project area contains few mature primary or secondary species preferred by Koalas. Moreover, Boral has occupied the site for almost 40 years during which time no Koalas have been observed to use the site. In this regard, despite the mapping identification, the subject site does not provide Koala Habitat. The Project will not result in fragmentation or reduce Koala connectivity throughout the wider landscape. Land outside of the subject site will not be impacted by the Project.
c) Minimise the removal of any individuals of preferred koala food trees, wherever they occur on a development site. In the Port Stephens LGA these tree species are Swamp Mahogany (*Eucalyptus robusta*), Parramatta Red Gum (*Eucalyptus parramattensis*), and Forest Red Gum (*Eucalyptus tereticornis*), and hybrids of any of these species. An additional list of tree species that may be important to koalas based on anecdotal evidence is included in Appendix 8	*Eucalyptus robusta* was quite rare in the subject site, with only a few noted within vegetation zone 2. These individuals were either planted as tubestock or been in the native seed mix. The dominant eucalypts on the subject site include *E. pilularis, Corymbia gummifera* and *Angophora costata.* The Project will therefore not impact on the important trees or hybrids. *Corymbia gummifera* and *E. pilularis* are listed in Appendix 8 of the KPoM as 'tree species that may be

Performance criteria	Response
	important'. These species will be impacted as they are dominant species within PCT1646. The Project has minimised impacts by predominately using a former quarry pit and impacting largely upon planted trees.
d) Make provision, where appropriate, for restoration or rehabilitation of areas identified as Koala Habitat including Habitat Buffers and Habitat Linking Areas over Mainly Cleared Land. In instances where Council approves the removal of koala habitat (in accordance with dot points 1-4 of the above waive clause), and where circumstances permit, this is to include measures which result in a "net gain" of koala habitat on the site and/or adjacent land;	The Koala is regarded as an 'ecosystem credit' species as part of this BDAR (section 4.1.4, Table 11) that would be subsequently offset through PCT1646 and PCT1644. Both these PCTs contain 'trees that may be important' and would result in a net gain of Koala habitat.
e) Make provision for long term management and protection of koala habitat including both existing and restored habitat;	An overarching management plan will specify the mitigation measures and controls during construction and operation of the Project (see details provided in section 5.1.4). Long-term management and restoration of Koala habitat be through the provision of biodiversity credits for PCT1646 and PCT1644.
f) Not compromise the potential for safe movement of koalas across the site. This should include maximising tree retention generally and minimising the likelihood that the proposal would result in the creation of barriers to koala movement, such as would be imposed by certain types of fencing. The preferred option for minimising restrictions to safe koala movement is that there be no fencing (of a sort that would preclude koalas) associated with dog free developments within or adjacent to Preferred or Supplementary Koala Habitat, Habitat Buffers or Habitat Linking Areas.	The Project will not impeded Koala movement across the landscape. The Project will not introduce or enhance populations of feral and domestic dogs.
g) Be restricted to identified envelopes which contain all buildings and infrastructure and fire fuel reduction zone. Generally, there will be no clearing on the site outside these envelopes. In the case of applications for subdivision, such envelopes should be registered as a restriction on the title, pursuant to the Conveyancing Act 1919; and	Not applicable.
h) Include measures to effectively minimise the threat posed to koalas by dogs, motor vehicles and swimming pools by adopting the following minimum standards.	The Project will not introduce or enhance populations of feral and domestic dogs.

Performance criteria	Response
i) The development must include measures that effectively abate the threat posed to koalas by dogs through prohibitions or restrictions on dog ownership. Restrictions on title may be appropriate. ii) The development must include measures that effectively minimise the threat posed to koalas from traffic by restricting motor vehicle speeds, where appropriate, to 40 kph or less. iii) The development must reduce the risk of koala mortality by drowning in backyard swimming pools. Appropriate measures could include: trailing a length of stout rope (minimum diameter of 50mm), which is secured to a stable poolside fixture, in the swimming pool at all times; designing the pool in such a way that koalas can readily escape; or enclosing the pool with a fence that precludes koalas. This last option should include locating the fence away from any trees which koalas could use to cross the fence.	Existing vehicle speeds within the quarry site would be adhered to and staff and contractors educated about Koala interactions to prevent Koala collisions. Final land use of the subject area will be detailed in a project specific Landscape and Rehabilitation Management Plan. This plan will consider measures to protect Koalas during Project decommissioning and rehabilitation.

5.2.7 Cumulative Impacts

In relation to the Project, the cumulative impacts are considered to be the total impact on the environment that would result from the current proposal plus any additional impacts likely to occur due to subsequent Projects that are of a similar nature or that are partly or wholly contingent on the Project.

Identifiable cumulative impacts to be considered in the locality include the following quarry operations:

- Salt Ash Sand Project (Nelson Bay Road), which has approval to operate until 2030
- Cabbage Tree Road Sand Quarry, which has approval to operation until 2033
- Mackas Sand Project, Nelson Bay Road.

Each of the above quarry operations have a range of approved biodiversity impacts, and it is likely that over the next few decades, modification to existing operations may entail clearing of native vegetation and habitat. Niche is not able to quantify this as part of this BDAR, however it is likely that such impact would be within the existing operations leases. Residential, commercial and industrial development is also identified as a continuous cumulative biodiversity pressure associated with the wider Port Stephens and Newcastle LGAs. Whilst the Project will result in removal of native vegetation from within the North Coast IBRA region, the Project primarily will result in an impact to planted rehabilitation. The Project also involve an offset that will contribute to in-perpetuity managed conservation areas within the Bioregion.

6. Quantifying Offset Requirements

The BAM identifies the BAM Calculator as the appropriate tool for quantifying the offsets required, which is expressed as numbers of ecosystem and species credits. A calculation of the nature and extent of biodiversity credits required due to ecological impacts associated with the Project has been undertaken using the BAM Calculator.

No threatened biodiversity listed on the EPBC Act are required to be offset for the project, as the project does not result in a significant impact to any threatened biodiversity listed on the EPBC Act.

6.1.1 Summary of Ecosystem Credits Required

The results of the BAM Calculator, ecosystem offset credit requirements, including current, future and change in vegetation integrity scores are shown in Table 16.

Impacts to native vegetation communities within the development site generate a requirement for 571 ecosystem credits. These 571 ecosystem credits also cover the credit requirement for ecosystem credit species. The full BAM Calculator biodiversity credit report is provided in Annex 8.

Table 16. Ecosystem credit requirement

PCT	Vegetation zone	Impact area (ha)	Current Vegetation Integrity score	Future Vegetation Integrity score	Change in Vegetation Integrity Score	Biodiversity risk weighting	Required credits
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	1	14.14	54.4	0	-54.4	1.5	288
	2	3.83	27	0	-27	1.5	39
	4	5.12	15.7	0	-15.7	1.5	0*
	5	1.70	65.8	0	-65.8	1.5	42
	6	8.21	55.7	0	-55.7	1.5	171
PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	3	2.67	23.1	0	-23.1	2	31
Total							571

*Credits not required as vegetation integrity score below 17

6.1.2 Summary of Species Credits Required

The results of the BAM-C species offset credit requirements are shown in Table 17. Threatened species identified or assumed to be present within the development site and likely to be impacted by the Project generate a requirement for a total of 700 species credits. The full BAM Calculator biodiversity credit report is provided in Annex 8.

Table 17. Species credits required

Threatened species	Habitat impacted (ha)	Required credits
Squirrel Glider	26.72	700
Total		**700**

7. Offset Strategy

Under the BAM, an offset strategy is not required to be submitted with the BDAR as the credits are to be formally retired with the establishment of a Biodiversity Stewardship Site, or purchasing of credits from the market, or payment into the Biodiversity Conservation Fund (BCF). However, as noted in the SEARs for the Project, a biodiversity offset strategy is required to be included in the Biodiversity Assessment.

7.1 Offset Requirements

Under the BAM, the biodiversity offsets must provide benefits to biodiversity to compensate for the adverse impacts of an action. Biodiversity offsets assist in achieving long-term conservation outcomes while providing development proponents with the ability to undertake actions that have unavoidable impacts on biodiversity.

Unavoidable impacts to biodiversity are those impacts that are residual (i.e. impacts that remain after impact avoidance, management and mitigation measures are employed to reduce the type or magnitude of biodiversity impacts). Section 5.1 of this report outlines the planning and consideration of alternative emplacement options that Boral has considered. Section 5.1.4 to section 5.1.7 of this report outline the management and mitigation actions that Boral will employ to further reduce direct and indirect impacts to biodiversity values as a result of this Project.

This section of the report describes the approach to biodiversity offsetting proposed for the Project in order to satisfy the BAM offsetting requirements.

Based on the results of the MNES Assessments of Significance contained in this report, the Project would not result in a significant impact to any threatened biodiversity listed on the EPBC Act, and thus would not require offsets for any Commonwealth MNES.

7.2 Offset Strategy Options

To satisfy the offset requirement, Boral has identified a range of options to meet the required offsets for the Project (Table 18). As demonstrated in the table and given Boral has the option to pay into the Biodiversity Conservation Fund (BCF) to satisfy the offset requirement, there is minimal risk for Boral not to meet their offset liability.

Table 18. Options to satisfy the offset requirement

Offset requirement	Credits required	Purchase credits on market	Payment into BCF	Utilise existing Boral Landholdings	Risk of offset not met
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	540	If credits become available, Boral may pursue this option.	Yes – Boral can pay the equivalent credit cost into the BCF	The surrounding Boral landholdings may be considered as a biodiversity stewardship site. The surrounding vegetation consists of the same PCTs and would contain Squirrel Glider habitat.	No risk given the option to pay into the BCT Payment Fund.
1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	31				
Squirrel Glider	700				

7.3 Staged-Offset Approach

The proposal will result in progressive vegetation disturbance across five distinct stages spanning approximately 10 years. The area associated with each stage are indicated on Figure 12. Boral propose to progressively offset the five stages prior to vegetation disturbance.

The area of native vegetation and habitat associated with each offset stage is provided in Table 19, and the associated credits provided in Table 20.

The first offset stage is proposed in 2023, and would involve the retirement of the following credits prior to vegetation disturbance:

- PCT1644 - Coast Tea Tree/ Old Man Banksia coastal shrubland – 1 credits
- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland – 4 credits
- Squirrel Glider –12 credits

Table 19. Area of vegetation/habitat impact within each offset stage

Plant Community Type (PCT)	Vegetation zone	Staged-Offset Approach – Area (ha)						Area Total (ha)
		0 (2023)	1 (2024)	2 (2027)	3 (2028)	4 (2029)	5 (2031)	
Non-native	Non-native	0.00	1.28	0.50	0.00	0.44	0.26	2.48
PCT1644 - Coast Tea Tree/ Old Man Banksia coastal shrubland	Zone 3	0.08	2.59	0.00	0.00	0.00	0.00	2.67
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 1	0.25	4.34	0.47	1.64	4.98	2.46	14.14
	Zone 2	0.00	0.00	0.77	2.25	0.81	0.00	3.83
	Zone 4	0.00	0.34	4.10	0.68	0.00	0.00	5.12
	Zone 5	0.00	0.86	0.13	0.00	0.10	0.61	1.70
	Zone 6	0.14	2.14	1.02	1.61	0.42	2.88	8.21
Squirrel Glider								
1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Zone 3	0.08	2.59	0.00	0.00	0.00	0.00	2.67
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 1	0.25	4.34	0.47	1.64	4.98	2.46	14.14
	Zone 5	0.00	0.86	0.13	0.00	0.10	0.61	1.70
	Zone 6	0.14	2.14	1.02	1.61	0.42	2.88	8.21

Table 20. Credits per offset staging

Credit Type	Vegetation zone	Total credits required	Total Area (ha)	Credits per ha		Credits per stage (indicative year for credit retirement)				
					0 (2023)	1 (2024)	2 (2027)	3 (2028)	4 (2029)	5 (2031)
PCT1644 - Coast Tea Tree/ Old Man Banksia coastal shrubland	Zone 3	31	2.7	11.5	1	30	0	0	0	0
PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland	Zone 1	288	14.1	20.4	1	90	11	34	102	50
	Zone 2	39	3.8	10.2	0	0	8	23	8	0
	Zone 5	42	1.7	24.7	0	21	4	0	2	15
	Zone 6	171	8.2	20.9	3	45	21	34	8	60
Total ecosystem credits		**571**		-	5	186	44	91	120	125
Total Species credits (Squirrel Glider)	-	**700**	26.7	26.2	12	260	42	85	145	156

8. Summary

Boral have aimed to avoid and minimise environmental impacts from the Project through detailed design and siting of the Project, along with implementation of actions aimed at mitigating and managing potential indirect impacts from the Project as detailed in section 5.1.

The unavoidable impacts of the Project on ecological values include the clearing of 35.67 ha of vegetation regarded as 'native vegetation,' as defined in the BAM. Associated fauna habitat would also be directly impacted.

Seven Assessments of significance under the EPBC Act were required for threatened biodiversity (, Black-faced Monarch, White-throated Needletail, Spotted-tail Quoll, Long-nosed Potoroo, Koala, New Holland Mouse and Grey-headed Flying-fox), which concluded that a significant impact as a result of the Project was unlikely. As such, there is no requirement for an EPBC Act Referral regarding Commonwealth MNES, and no need to offset them.

Biodiversity offsets required for unavoidable impacts from the Project have been calculated as follows:

- PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast– 540 credits
- PCT1644- Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast – 31 credits.

One threatened species, the Squirrel Glider requires offsetting (700 credits) as a result of the Project.

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Figures

Figure 1. Local Context (Boral)

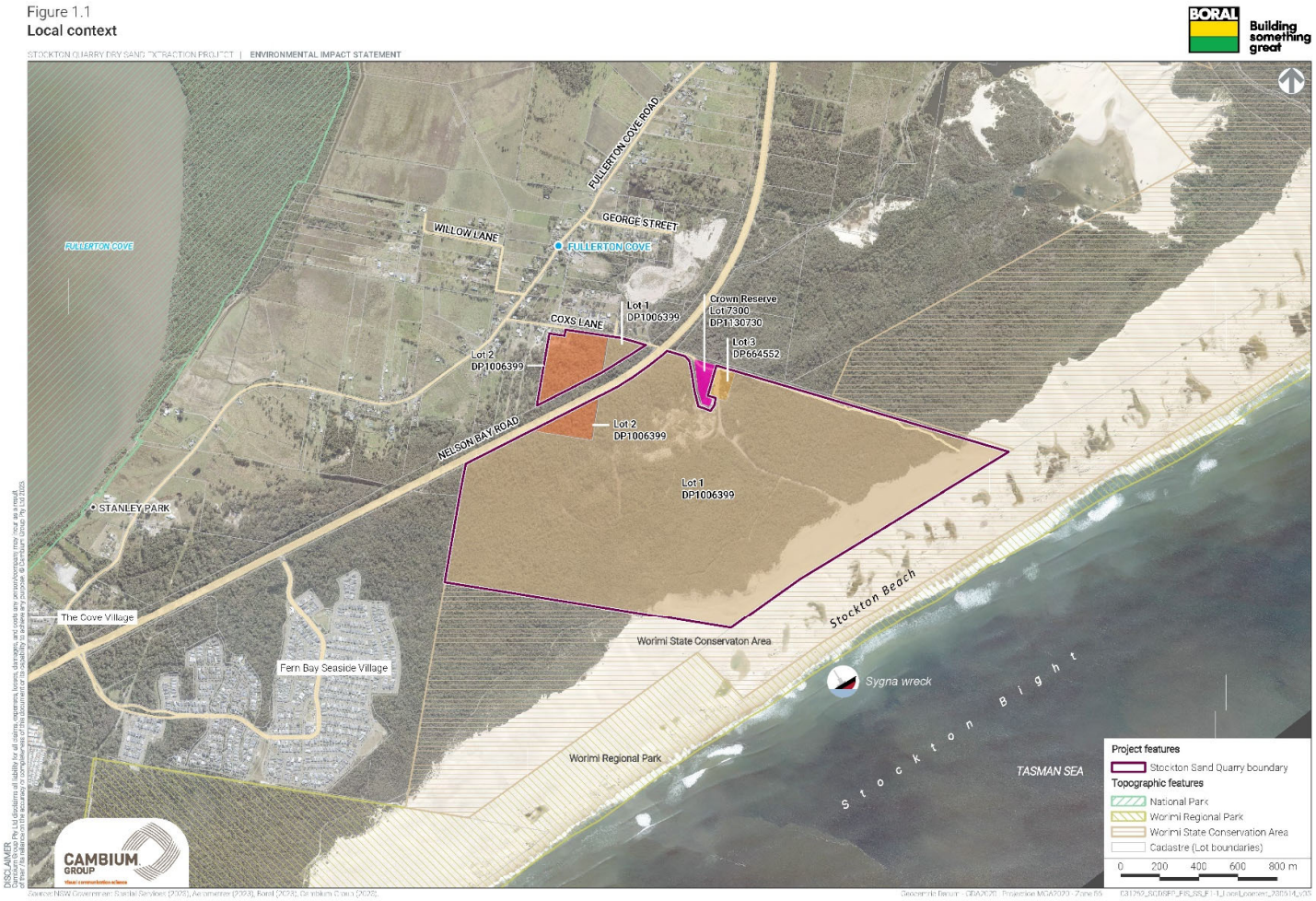
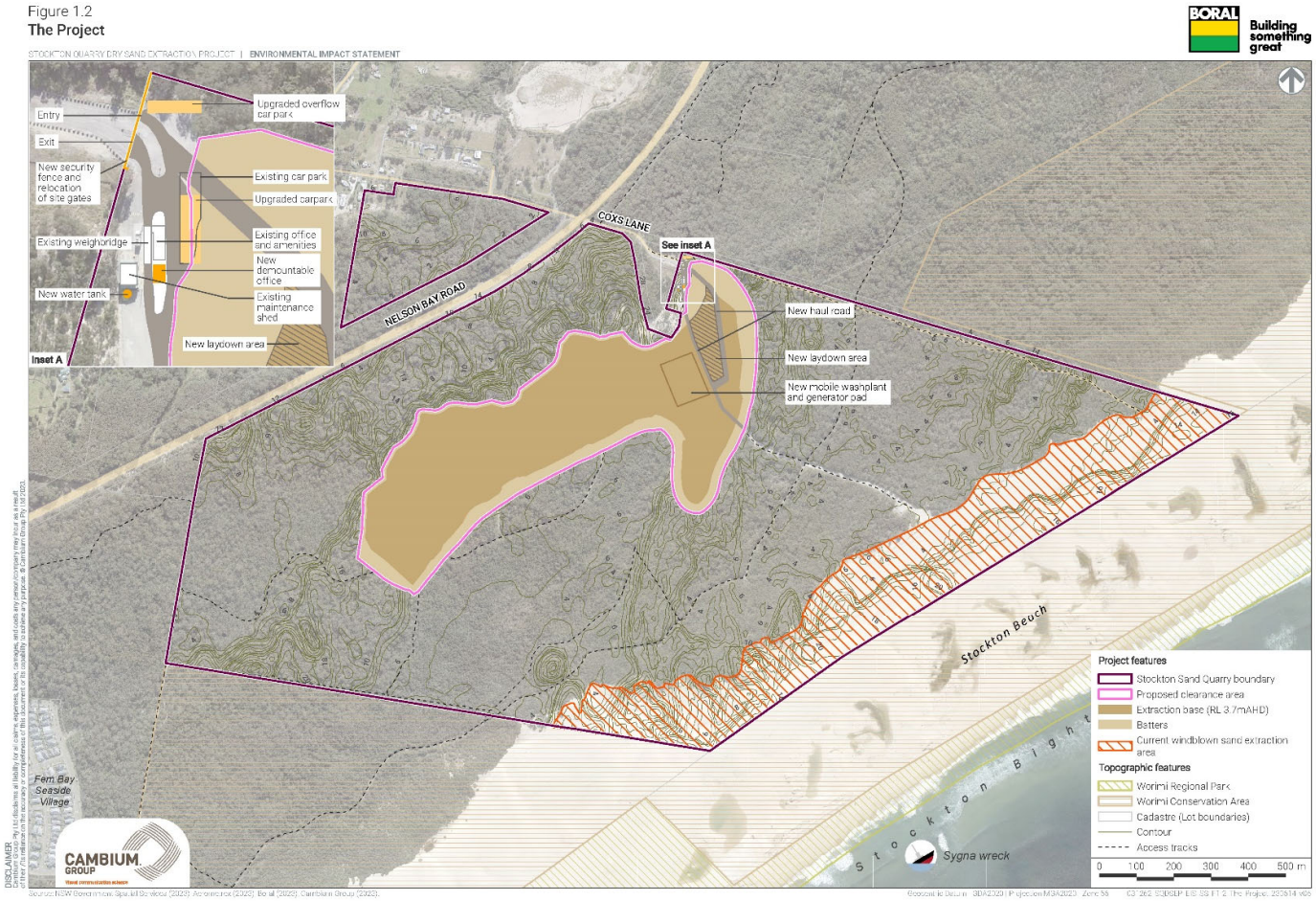
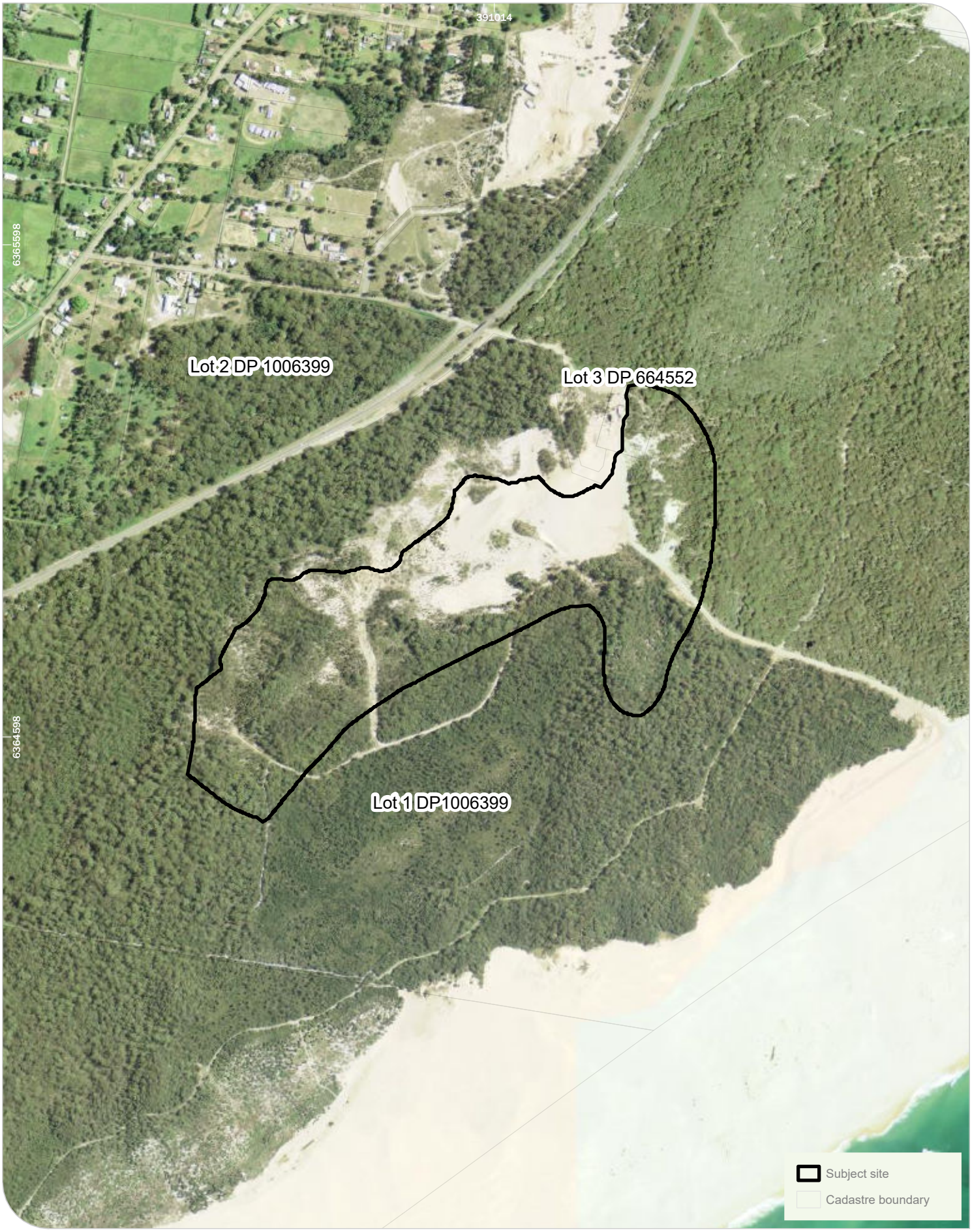


Figure 2. The Project





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Location map
Stockton Quarry Dry Sand Extraction Project

Niche PM: Luke Baker
Niche Proj. #: 7847
Client: Boral Resources (NSW) Pty

Figure 3

sixmaps/LPI_Imagery_Best: © Department of Finance, Services & Innovation 2018

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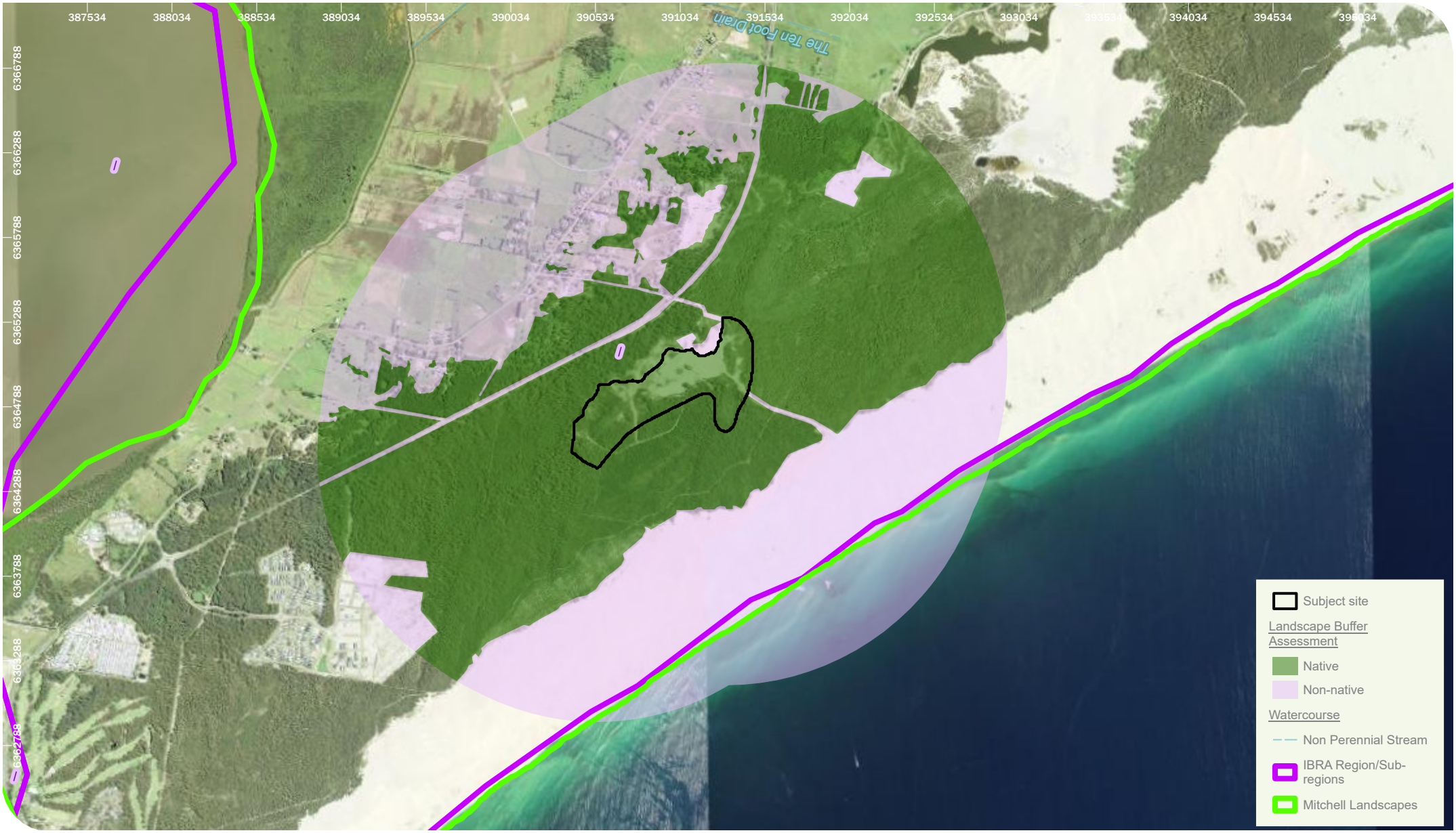

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Geographic

Stockton Quarry Dry Sand Extraction Project

Figure 4

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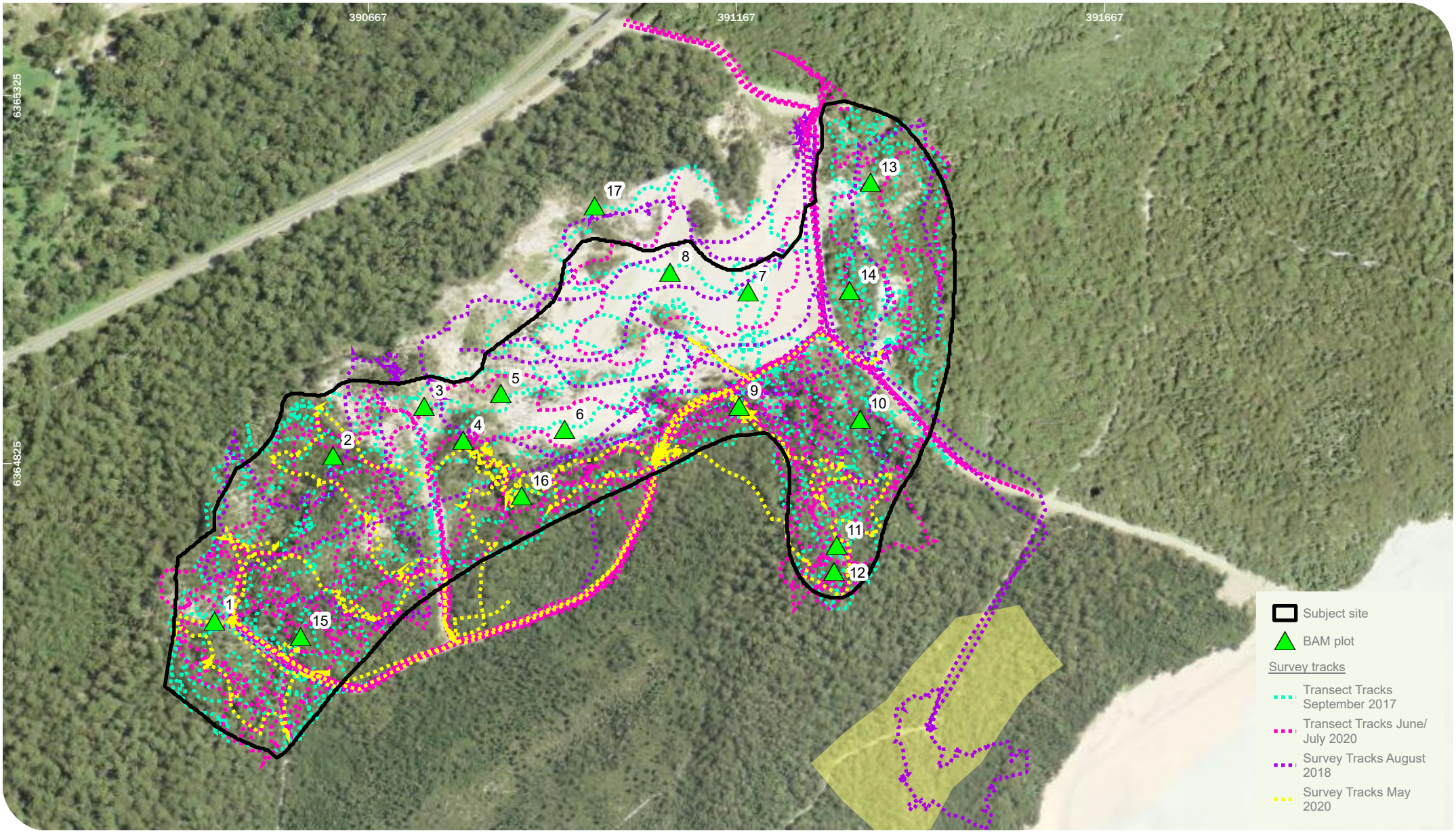

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Survey flora
Stockton Quarry Dry Sand Extraction Project

Figure 5

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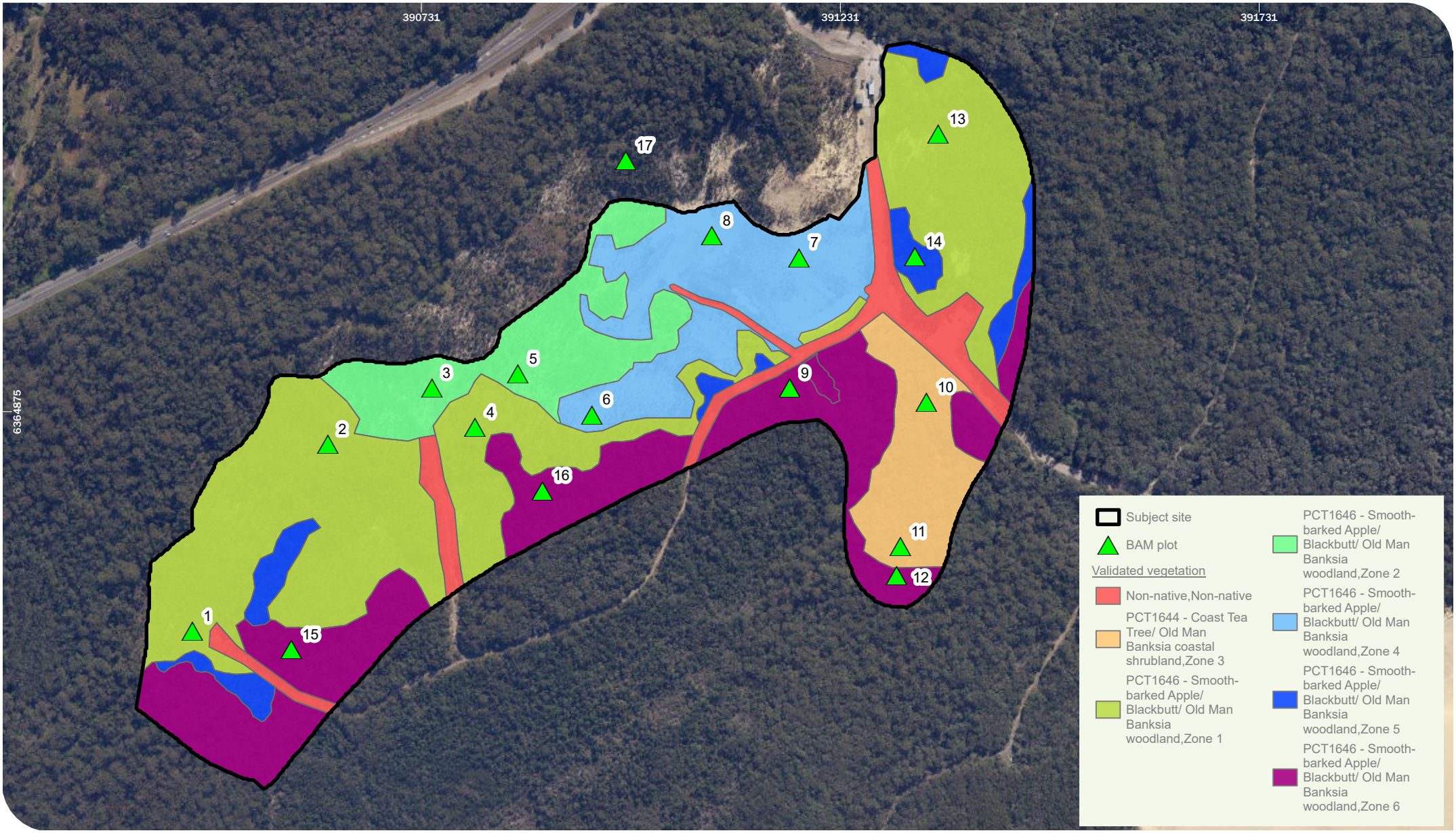

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Validated vegetation
Stockton Quarry Dry Sand Extraction Project

Figure 6

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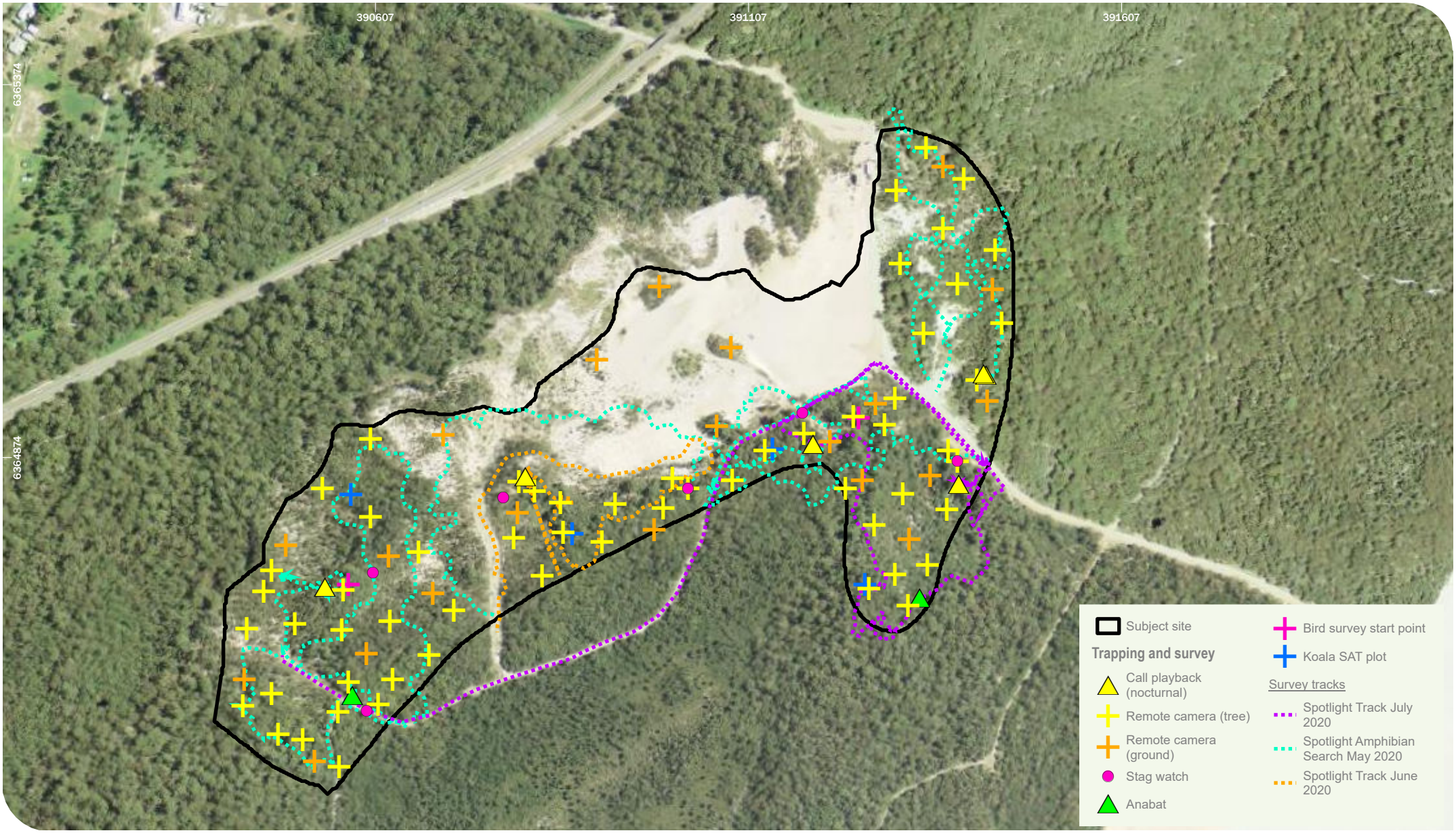

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Client: Boral Resources (NSW) Pty

Threatened fauna survey effort
Stockton Quarry Dry Sand Extraction Project

Figure 7

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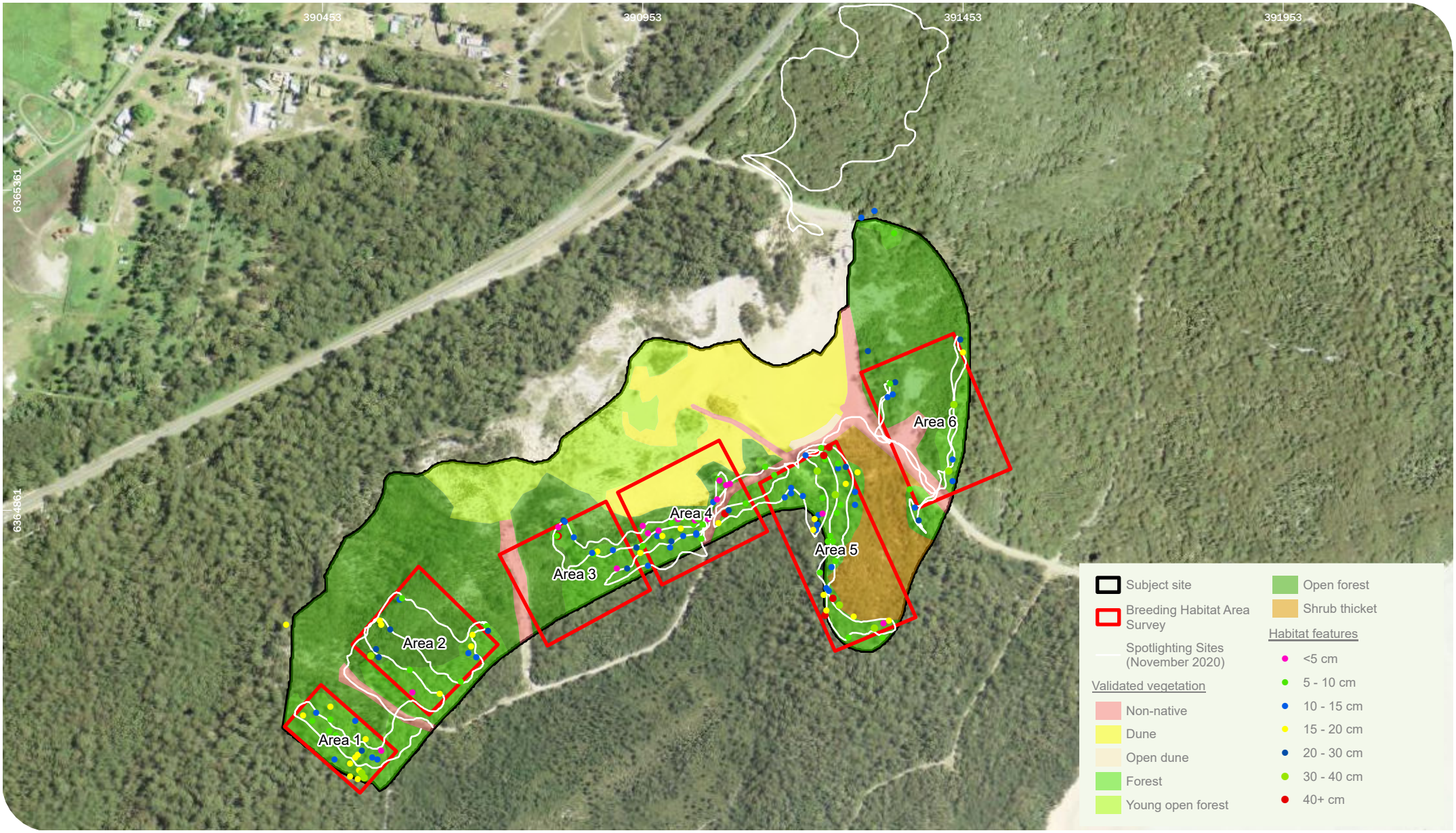

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Threatened fauna survey effort – November 2020 Survey
Stockton Quarry Dry Sand Extraction Project

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Figure 8

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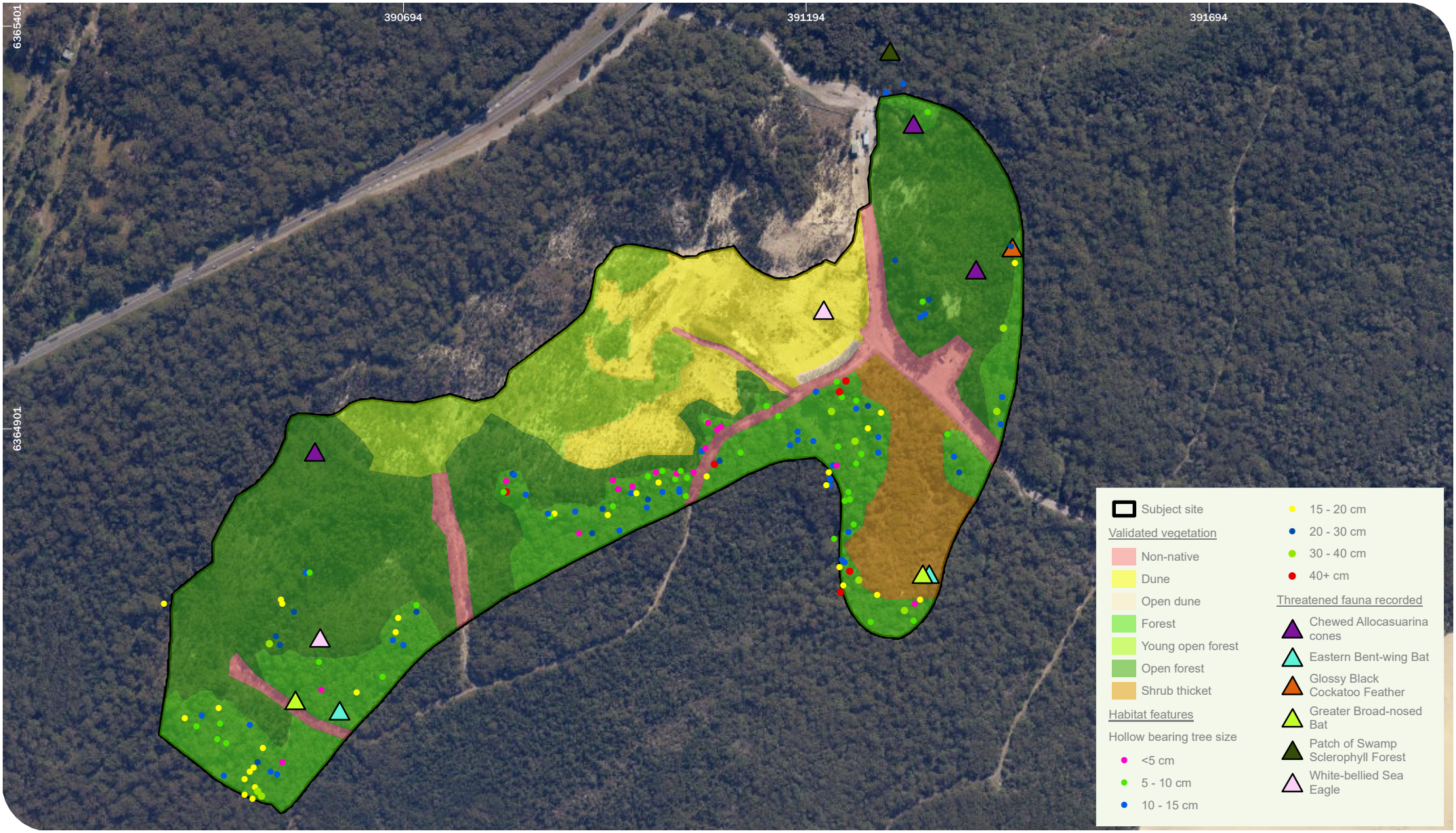

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Niche Proj. #: 7847
Client: Boral Resources (NSW) Pty

Threatened fauna habitat and records
Stockton Quarry Dry Sand Extraction Project

Figure 9

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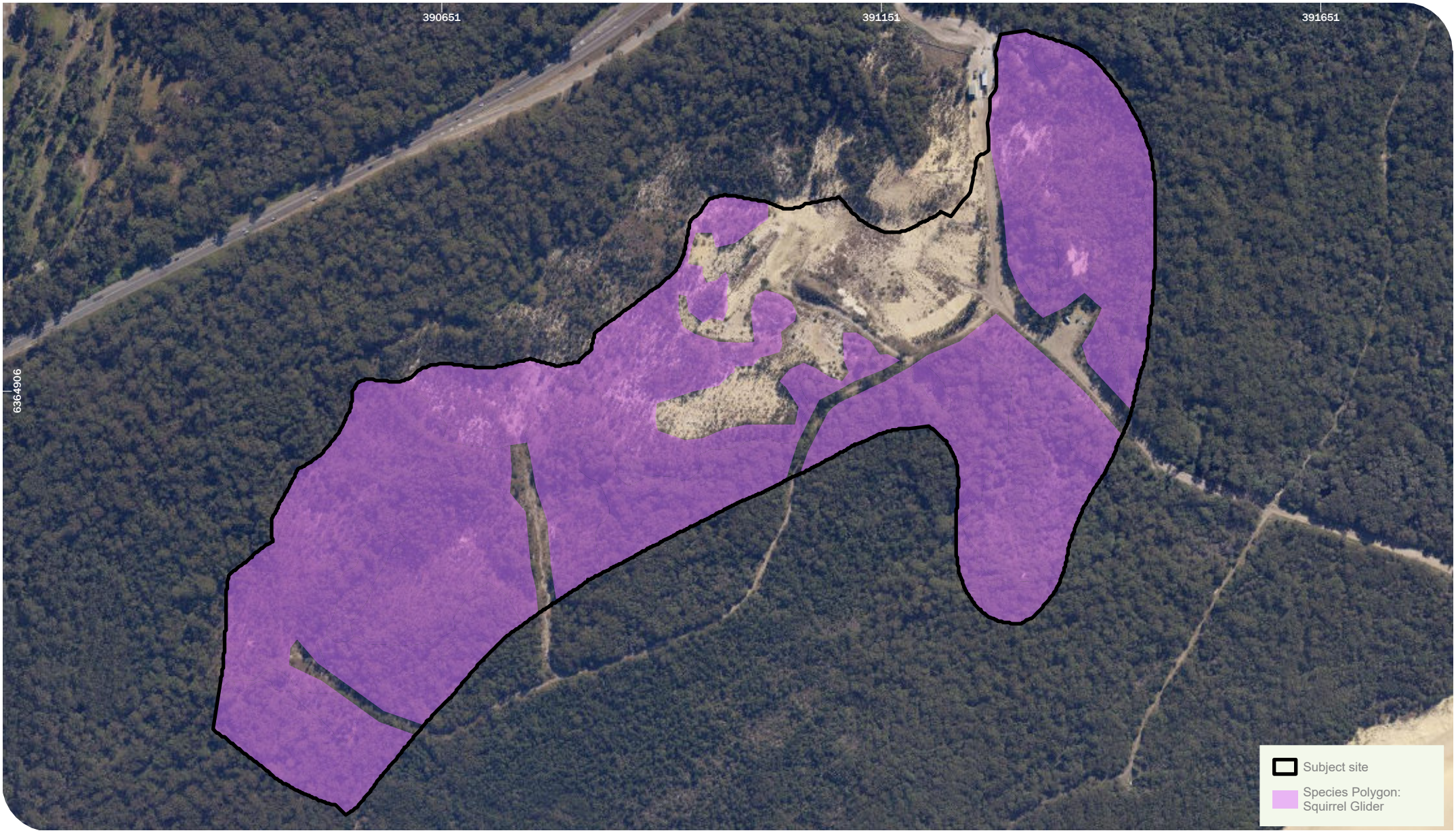

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Squirrel Glider
Stockton Quarry Dry Sand Extraction Project

Figure 10

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Disturbance
Stockton Quarry Dry Sand Extraction Project

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Figure 11

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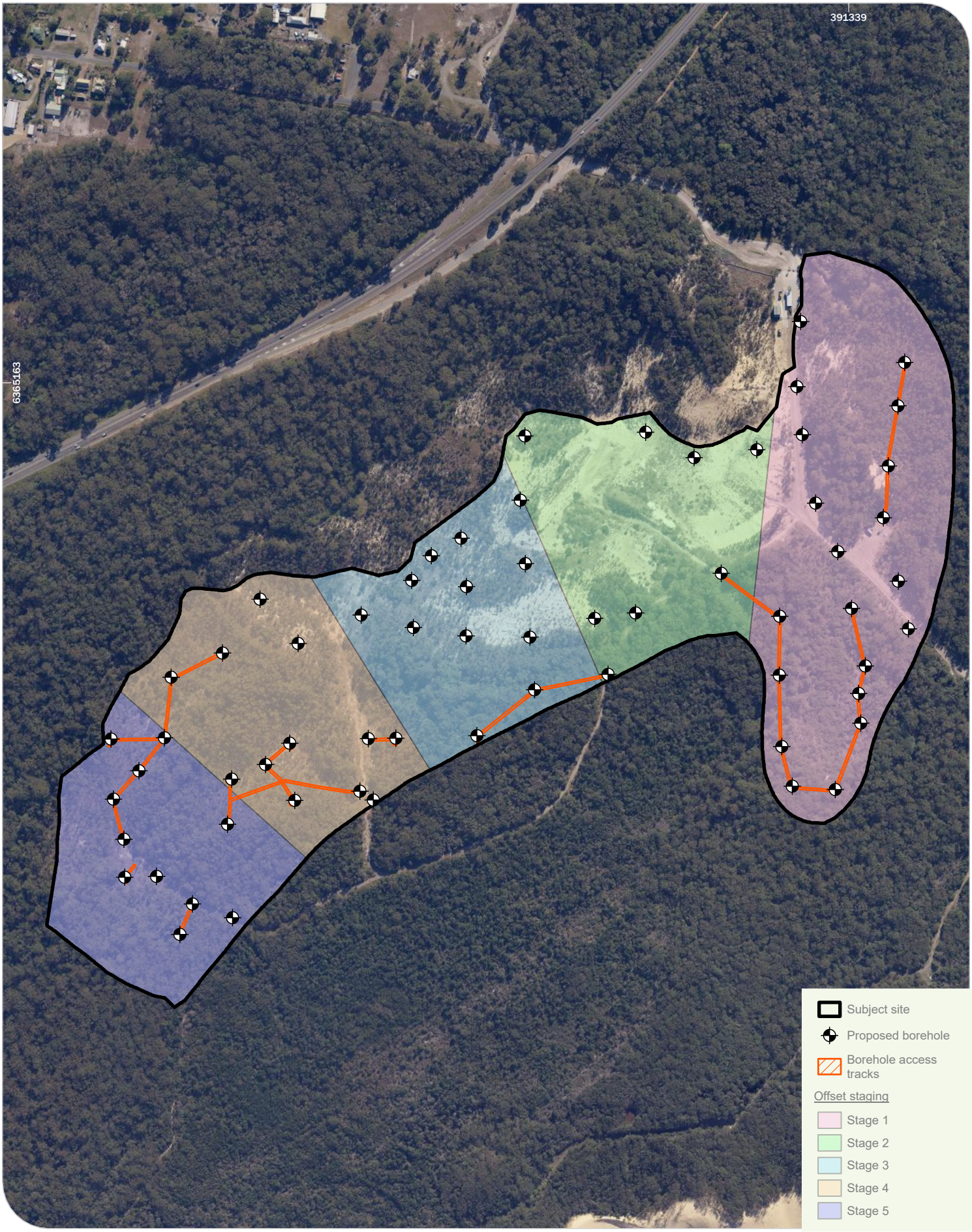

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Staged Offset
Stockton Quarry Dry Sand Extraction Project

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Figure 12

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Annex 1. Likelihood of Occurrence

Threatened biodiversity likelihood of occurrence

A list of subject threatened flora and fauna and threatened ecological communities within the locality (10 km radius) was determined from database searches. The list of potentially impacted species is determined from consideration of this list. In order to adequately determine the relevant level of assessment to apply to potentially affected species, further analysis of the likelihood of those species occurring within the subject site was completed.

Five categories for 'likelihood of occurrence' were attributed to species after consideration of criteria such as known records, presence or absence of important habitat features on the subject site, results of the field surveys and professional judgement. This process was completed on an individual species basis.

Species considered further in formal assessments of significance (EPBC Act) were those in the 'Known', 'High' or 'Moderate' categories and where adverse impacts for the species could reasonably occur from the development. Species listed as a 'Low' or 'None' likelihood of occurrence are those for which there is limited or no habitat present within the subject site.

Likelihood rating	Threatened flora criteria	Threatened and migratory fauna criteria
Known	The species was observed within the subject site.	The species was observed within the subject site.
High	It is likely that a species inhabits or utilises habitat within the subject site.	It is likely that a species inhabits or utilises habitat within the subject site.
Moderate	Potential habitat for a species occurs on the site. Adequate field survey would determine if there is a 'high' or 'low' likelihood of occurrence for the species within the subject site.	Potential habitat for a species occurs on the site and the species may occasionally utilise that habitat. Species unlikely to be wholly dependent on the habitat present within the subject site.
Low	It is unlikely that the species inhabits the subject site.	It is unlikely that the species inhabits the subject site. If present at the site the species would likely be a transient visitor. The site contains only very common habitat for this species which the species would not rely on for its on-going local existence.
None	The habitat within the subject site is unsuitable for the species.	The habitat within the subject site is unsuitable for the species.

Likelihood of Occurrence

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Amphibians						
Crinia tinnula	Wallum Froglet	V	-	Wallum Froglets are found in paperbark swamps and sedge swamps of the coastal 'wallum' country. Their tadpoles are adapted to acid conditions and may be outcompeted by the Common Froglet. Males call from the base of vegetation in and around the breeding site and are almost impossible to locate. Calling occurs from Autumn to Spring, being most strongly associated with flooding following rainfall. Its range extends from SE QLD to the Kurnell Peninsular of Sydney.	Low to moderate as discussed in section 4.1.4.	Species
Heleioporus australiacus	Giant Burrowing Frog	V	V	The Giant Burrowing Frog has been recorded breeding in a range of water bodies associated with sandy environments of the coast and adjacent ranges from the Sydney Basin south the eastern Victoria. It breeds in hanging swamps, perennial non-flooding creeks and occasionally permanent pools, but permanent water must be present to allow its large tadpoles time to reach metamorphosis.	None – no potential habitat given absence of waterbodies	Species
Litoria aurea	Green and Golden Bell Frog	E	V	Inhabits a very wide range of water bodies including marshes, dams and streams, particularly those containing emergent vegetation such as bullrushes or spikerushes. It also inhabits numerous types of man-made water bodies including quarries and sand extraction sites. Optimum habitat includes water-bodies that are un-shaded, free of predatory fish such as Plague Minnow, have a grassy area nearby and diurnal sheltering sites available. Known records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water. Aquatic vegetation at breeding sites includes sedges (Shoenoplectus spp., Baumea spp. and Lepironia articulata) and Broadleaf Cumbungi (Typha orientalis).	Low as discussed in section 4.1.4.	Species
Uperoleia mahonyi	Mahonys Toadlet	E	-	Current observations indicate Mahony's Toadlet inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range. Known records occur in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps, Mahony's Toadlet also is known to occur in wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. Recent studies suggest intact vegetation adjacent to and within water bodies is an important habitat feature for this species.	Low to moderate as discussed in section 4.1.4.	Species
Mixophyes balbus	Stuttering Frog	E	V	Associated with streams in dry sclerophyll and wet sclerophyll forests and rainforests of more upland areas of the Great Dividing Range of NSW and down into Victoria. Breeding occurs along forest streams with permanent water where eggs are deposited within nests excavated in riffle zones by the females and the tadpoles swim free into the stream when large enough to do so. Outside of	Low to moderate as discussed in section 4.1.4.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				breeding, individuals range widely across the forest floor and can be found hundreds of metres from water.		
Birds						
Actitis hypoleucos	Common Sandpiper	-	M, MA	Utilises a wide range of coastal wetlands and some inland wetlands, mostly found around muddy margins or rocky shores. Forages in shallow water and on soft mud, roosts on rocks or vegetation such as mangroves. Northern hemisphere breeding.	Low – no wetlands or mangroves within subject site.	N/A
Anthochaera phrygia	Regent Honeyeater	CE	CE	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests.	Low as discussed in section 4.1.4.	Species
Apus pacificus	Fork-tailed Swift	-	M	The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 m above ground and probably much higher.	Low – no nests found in subject site. May fly over subject site on occasion.	N/A
Arenaria interpres	Ruddy Turnstone	-	M	Mainly found in coastal regions with exposed rock coast lines or coral reefs. Also found on rock platforms with shallow tidal pools, and occasionally beaches and estuaries. Northern hemisphere breeding.	Low – no rock platforms and tidal pools.	N/A
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	Often reported in woodlands and dry open sclerophyll forests, usually dominated by eucalypts, including mallee associations. It has also been recorded in shrublands and heathlands and various modified habitats, including regenerating forests; very occasionally in moist forests or rainforests.	Moderate – can occur in range of habitats.	Ecosystem
Botaurus poiciloptilus	Australasian Bittern	E	E	The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes and spikerushes.	Low – lack of habitat in subject site.	Species
Burhinus grallarius	Bush Stone-curlew	E	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Largely nocturnal, being especially active on moonlit nights.	Low - based on survey result – discussed in section 4.1.4.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Calidris acuminata	Sharp-tailed Sandpiper	-	M	Prefers muddy edges of shallow or brackish wetlands, with inundated or emergent sedges, saltmarsh or other low vegetation. Also found foraging in sewage ponds and flooded paddocks. Northern hemisphere breeding.	Low – lack of habitat within subject site.	N/A
Calidris canutus	Red Knot	-	M, E	Usually found foraging in soft substrate near the edge of the water on intertidal mudflats. Also have been recorded at nearby lakes, sewage ponds and floodwaters. Roosts on sandy beaches, spits and islands. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Calidris ferruginea	Curlew Sandpiper	E	CE, M	It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. It generally occupies littoral and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes the inland. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Calidris melanotos	Pectoral Sandpiper	-	M	Prefers shallow fresh to saline wetlands, found at coastal lagoons, estuaries, bays, swamps, inundated grasslands, saltmarshes and artificial wetlands. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Calidris ruficollis	Red-necked Stint	-	M	Mostly found in coastal areas including inlets, bays, lagoons and estuaries with intertidal mudflats. Occasionally on exposed ocean beaches and sometimes rocky shores and reefs. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Calidris tenuirostris	Great Knot	V	M, CE	In NSW, this species has been recorded at scattered sites along the coast to about Narooma. It has also been observed inland at Tullakool, Armidale, Gilgandra and Griffith. Occurs within sheltered, coastal habitats containing large, intertidal mudflats or sand flats, including inlets, bays, harbours, estuaries and lagoons. Often recorded on sandy beaches with mudflats nearby, sandy spits and islets and sometimes on exposed reefs or rock platforms. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	The Gang-gang Cockatoo inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. This species requires tree hollows for nesting and sometimes for roosting. Eucalypt trees and acacia shrubs are used for foraging. Plantations of exotic pines are usually avoided.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. Discussed in section 4.1.4, however breeding habitat is not present.	Dual
Calyptorhynchus lathami	Glossy-black Cockatoo	V	-	The species is uncommon although widespread throughout suitable forest and woodland habitats, from the central Queensland coast to East Gippsland in Victoria, and inland to the southern tablelands and central western plains of NSW, with a small population in the Riverina. An isolated population exists on Kangaroo Island, South Australia. Inhabits open forest and woodlands of the coast and the	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. Discussed in section	Dual

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				Great Dividing Range where stands of sheoak occur. Black Sheoak (Allocasuarina littoralis) and Forest Sheoak (A. torulosa) are important foods.	4.1.4, however breeding habitat is not present.	
Charadrius bicinctus	Double-banded Plover	-	M	Found on littoral, estuarine and fresh or saline terrestrial wetlands, rocky beaches, bays and inlets. Sometimes found on exposed reefs and rock platforms. Migrates to breed in New Zealand.	Low – habitat preferences not in subject site.	N/A
Charadrius leschenaultii	Greater Sand Plover	V	M, V	Occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons. Non-breeding in Australia.	Low – habitat preferences not in subject site.	N/A
Charadrius mongolus	Lesser Sand Plover	V	M, E	Inhabits large intertidal sand flats or mudflats in sheltered bays, harbours and estuaries, and occasionally sandy ocean beaches, coral reefs, wave-cut rock platforms and rocky outcrops. Non-breeding in Australia.	Low – habitat preferences not in subject site.	N/A
Chthonicola sagittata	Speckled Warbler	V		The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Circus assimilis	Spotted Harrier	V	-	The Spotted Harrier occurs throughout the Australian mainland, except in densly forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including Acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Cuculus optatus, Cuculus saturatus	Oriental Cuckoo	-	M, MA	Mainly inhabits coniferous, deciduous and mixed forests. Breeds in northern hemisphere. Brood parasite, laying eggs in nests of other birds.	Low – habitat preferences not in subject site.	N/A
Daphoenositta chrysoptera	Varied Sittella	V	-	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. The Varied Sittella's population size in NSW is uncertain but is believed to have undergone a moderate reduction over the past several decades. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Dasyornis brachypterus	Eastern Bristlebird	E	E	Found in coastal woodlands, dense scrub and heathlands, particularly where it borders taller woodlands.	Low – not within known range of species. No records occur within locality.	Species
Diomedea antipodensis	Antipodean Albatross	V	V, M, MA	The species ranges across the southern Pacific Ocean, east to the coast of Chile and west to eastern Australia. The Antipodean Albatross breeds biennially in colonies on ridges, slopes and plateaus of isolated subantarctic islands, usually in vegetation such as grass tussocks. This species regularly occurs in small numbers off the NSW south coast from Green Cape to Newcastle during winter where they feed on cuttlefish.	None	N/A
Diomedea exulans	Wandering Albatross	E	V, M, MA	The Wandering Albatross is marine, pelagic and aerial. The Wandering Albatross visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year.	None	N/A
Diomedea gibsoni, Diomedea antipodensis gibsoni	Gibson's Albatross	V	V, M, MA	The species is regularly encountered on trans-Tasman shipping routes and at seas off Sydney, and regularly occurs off the NSW coast usually between Green Cape and Newcastle. This species is known only to breed on the Adams, Disappointment and Auckland Islands in the subantarctic Auckland Island group. Potential forage in NSW waters during the winter is considered significant for the species.	None	N/A
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sand flats, and mangrove vegetation.	Low – habitat preferences not in subject site.	Species
Epthianura albifrons	White-fronted Chat	V	-	Low vegetation in salty coastal and inland areas and crops. Runs along ground and is found in local flocks in Winter.	Moderate	Ecosystem
Erythrotriorchis radiatus	Red Goshawk	CE	V	Distributed sparsely through northern and eastern Australia, from the western Kimberley Division of northern Western Australia to north-eastern Queensland and south to far north-eastern NSW, and with scattered records in central Australia. In NSW, preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers. Very rare in NSW.	Low	Species
Gallinago hardwickii	Latham's Snipe	-	M	Latham's Snipe is a non-breeding migrant to the south east of Australia including Tasmania, passing through the north and New Guinea on passage. Latham's Snipe breed in Japan and on the east Asian mainland. Seen in small groups or singly in freshwater wetlands on or near the coast, generally among dense cover. They are found in any vegetation around wetlands, in sedges, grasses, lignum, reeds and rushes and also in saltmarsh and creek edges on migration.	Low – habitat preferences not in subject site.	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Gallinago megala	Swinhoe's Snipe	-	M	Occurs at edges of wetlands, swamps and freshwater streams. Also known to occur in grasslands, sewage ponds and drying claypans. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Gallinago stenura	Pin-tailed Snipe	-	M	Occurs at edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. Also found on more open wetlands, claypans and sewage ponds. Breeds in the northern hemisphere.	Low – habitat preferences not in subject site.	N/A
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range in NSW, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri. Mostly occur in dry, open eucalypt forests and woodlands. They feed primarily on nectar and pollen in the tree canopy. Nest hollows are located at heights of between 2 m and 15 m, mostly in living, smooth-barked eucalypts. Most breeding records come from the western slopes.	Regarded in the BAM Calculator as a 'predicted - ecosytstem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Grantiella picta	Painted Honeyeater	V	V	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of the bird and almost all breeding occurs on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits boree, brigalow and box-gum woodlands and box-ironbark forests.	None – out of range for species.	Ecosystem
Haematopus fuliginosus	Sooty Oystercatcher	V	-	In NSW the Sooty Oystercatcher occupies rocky headlands, reefs and offshore islands along the entire coast, apparently as a single continuous population.	Low – habitat preferences not in subject site.	Species
Haematopus longirostris	Pied Oystercatcher	E	-	The Pied Oystercatcher inhabits marine littoral habitats, including islands. It occupies muddy, sandy, stony or rocky estuaries, inlets and beaches, particularly intertidal mudflats and sandbanks in large marine bays.	Low – habitat preferences not in subject site.	Species
Haliaeetus leucogaster	White-bellied Sea Eagle	V	MA	Inhabits coastal and near coastal areas, building large stick nests, and feeding mostly on marine and estuarine fish and aquatic fauna.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. It was also recorded during field survey flying over the subject site. No nest is present within the subject site.	Ecosystem/species
Hieraaetus morphnoides	Little Eagle	V	-	Most abundant in lightly timbered areas with open areas nearby. Often recorded foraging in grasslands, crops, treeless dune fields, and recently logged areas. May nest in farmland, woodland and forest in tall trees.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem/species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Hirundapus caudacutus	White-throated Needletail	-	M, MA	An aerial species found in feeding concentrations over cities, hilltops and timbered ranges.	Moderate – species can occur in a range of habitat types.	N/A
Lathamus discolor	Swift Parrot	E	CE	The Swift Parrot occurs in woodlands and forests of NSW from May to August, where it feeds on eucalypt nectar, pollen and associated insects. The Swift Parrot is dependent on flowering resources across a wide range of habitats in its wintering grounds in NSW. This species is migratory, breeding in Tasmania and also nomadic, moving about in response to changing food availability.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem/species
Limicola falcinellus	Broad-billed Sandpiper	V	M	Favours sheltered parts of the coast such as estuarine sand flats and mudflats, harbours, embayments, lagoons, saltmarshes and reefs as feeding and roosting habitat. Occasionally, individuals may be recorded in sewage farms or within shallow freshwater lagoons. Broad-billed Sandpipers roost on banks on sheltered sand, shell or shingle beaches. Breeds in the northern hemisphere.	Low – habitat preferences not in subject site.	Species
Limosa lapponica baueri	Bar-tailed Godwit	-	M, V	Bar-tailed Godwit (spp baueri) is the eastern Australian / New Zealand sub species. Mainly found in coastal habitats such as intertidal sand flats, mudflats, estuaries, inlets, coastal lagoons and bays. Often found around beds of seagrass and saltmarsh. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Limosa limosa	Black-tailed Godwit	V	M	Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sand flats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	Ecosystem
Lophoictinia isura	Square-tailed Kite	V	-	The Square-tailed Kite ranges along coastal and subcoastal areas from south-western to northern Australia, Queensland, NSW and Victoria. In NSW, scattered records of the species throughout the state indicate that the species is a regular resident in the north, north-east and along the major west-flowing river systems. It is a summer breeding migrant to the south-east, including the NSW south coast, arriving in September and leaving by March. Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Macronectes giganteus	Southern Giant Petrel	E	E	The Southern Giant Petrel has a circumpolar pelagic range from Antarctica to approximately 20 S and is a common visitor off the coast of NSW. Over summer, the species nests in small colonies amongst open vegetation on antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	None	EEC/Marine
Macronectes halli	Northern Giant-petrel	V	V	Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer.	None	EEC/Marine

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Monarcha melanopsis	Black-faced Monarch	-	M	Found along the coast of eastern Australia, becoming less common further south. Inhabits rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating.	Moderate – can occur in a range of habitat types.	N/A
Melithreptus gularis gularis	Black-chinned Honeyeater	V	-	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*) and Forest Red Gum (*E. tereticornis*).	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Monarcha trivirgatus	Spectacled Monarch	-	M	Coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. Prefers thick understorey in rainforests, wet gullies and waterside vegetation, as well as mangroves.	Low – habitat preferences not in subject site.	N/A
Motacilla flava	Yellow Wagtail	-	M	Breeds in temperate Europe and Asia. The Yellow Wagtail is a regular wet season visitor to northern Australia. Increasing records in NSW suggest this species is an occasional but regular summer visitor to the Hunter River region. The species is considered a vagrant to Victoria, South Australia and southern Western Australia. Habitat requirements for the Yellow Wagtail are highly variable, but typically include open grassy flats near water. Habitats include open areas with low vegetation such as grasslands, airstrips, pastures, sports fields; damp open areas such as muddy or grassy edges of wetlands, rivers, irrigated farmland, dams, waterholes; sewage farms, sometimes utilise tidal mudflats and edges of mangroves.	Low – habitat preferences not in subject site.	N/A
Myiagra cyanoleuca	Satin Flycatcher	-	M	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low – habitat preferences not in subject site.	N/A
Neophema pulchella	Turquoise Parrot	V	-	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	Low – habitat preferences not in subject site.	Ecosystem
Ninox connivens	Barking Owl	V	-	Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey found on these fertile riparian soils.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. Field surveys did not detect the species utilising hollows.	Ecosystem / species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance.		
Ninox strenua	Powerful Owl	V	-	Occupies wet and dry eucalypt forests and rainforests. Can occupy both un-logged and lightly logged forests as well as undisturbed forests where it usually roosts on the limbs of dense trees in gully areas. It is most commonly recorded within turpentine tall open forests and black she-oak within open forests. Large mature trees with hollows at least 0.5 m deep are required for nesting. Tree hollows are particularly important for the Powerful Owl because a large proportion of the diet is made up of hollow-dependent arboreal marsupials. Nest trees for this species are usually emergent with a diameter at breast height of at least 100 cm.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. Field surveys did not detect the species utilising hollows. Species is discussed in section 4.1.4.	Ecosystem/species
Numenius madagascariensis	Eastern Curlew	-	CE, MA, M	A primarily coastal distribution. Found in all states, particularly the north, east, and south-east regions including Tasmania. Rarely recorded inland. Mainly forages on soft sheltered intertidal sand flats or mudflats, open and without vegetation or cover. Breeds in the northern hemisphere.	Low – habitat preferences not in subject site Not detected during field survey.	Ecosystem
Numenius minutus	Little Curlew	-	M	Feeds in short, dry grassland and sedgeland, including dry floodplains and black soil plains, which have scattered, shallow freshwater pools. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Numenius phaeopus	Whimbrel	-	M	Usually found on intertidal mudflats of sheltered coasts. Also found in harbours, lagoons, estuaries and river deltas, often those with mangroves. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Pandion cristatus, Pandion haliaetus	Eastern Osprey	V	M, MA	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south-eastern Australia. Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water.	No nests in subject site. May occasionally fly over the subject site.	Species
Philomachus pugnax	Ruff	-	M	Generally found in fresh, brackish to saline wetlands with exposed mudflats at the edges. Breeds in northern hemisphere.	Low – habitat preferences not in subject site.	N/A
Phoebetria fusca	Sooty Albatross	V	-	In Australian waters, this species is generally recorded in winter off the south coast from Tasmania to Western Australia, while there are occasional sightings off the NSW coast, north of Grafton. This pelagic or ocean-going species inhabits subantarctic and subtropical marine waters, spending the majority of its time at sea, and rarely occurs in continental shelf waters.	None	EEC/Marine
Pluvialis fulva	Pacific Golden Plover	-	M	Coastal habitats such as beaches, mudflats, sand flats, estuaries, lagoons and evaporation ponds in salt works. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Pluvialis squatarola	Grey Plover	-	M	Almost entirely in coastal areas including sheltered embayment's, estuaries and lagoons with mudflats and sand flats, and occasionally on rocky coasts with platforms or reef flats. Breeds in northern hemisphere.	Low – habitat preferences not in subject site.	N/A
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies	V	-	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Woodlands on fertile soils in coastal regions.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Pterodroma neglecta neglecta	Kermadec Petrel (west Pacific subspecies)	V	V	Typically nests on the surface in loose colonies among rocks and vegetation. On Ball's Pyramid it nests only on steep cliffs above 400 m. On Phillip I. it nests under stands of African Olive. This species is marine and highly pelagic, rarely approaching land except at colonies.	None	EEC/Marine
Rhipidura rufifrons	Rufous Fantail	-	M	Found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. Inhabits tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests.	Low – habitat preferences not in subject site.	Species
Rostratula australis	Australian Painted Snipe	E	E, MA	In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	Low – may fly over site	Ecosystem
Stagonopleura guttata	Diamond Firetail	V	-	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Sternula albifrons	Little Tern	E	M	In Australia, Little Terns inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches.	Low – not recorded in subject site.	Species
Thalassarche cauta (sensu stricto), Thalassarche cauta cauta	Shy Albatross, Tasmanian Shy Albatross	V	V, M, MA	The Shy Albatross is a marine species occurring in subantarctic and subtropical waters, reaching the tropics in the cool Humboldt Current off South America.	None	EEC/Marine
Thalassarche melanophris	Black-browed Albatross	V	V, M, MA	The Black-browed Albatross has a circumpolar range over the southern oceans, and are seen off the southern Australian coast mainly during winter. Inhabits Antarctic,	None	N/A

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				subantarctic, subtropical marine and coastal waters over upwellings and boundaries of currents.		
Tringa brevipes, Heteroscelus brevipes	Grey-tailed Tattler	-	M, MA	Found on sheltered coasts with reefs and rock platforms, intertidal mudflats, estuaries and coastal lagoons, especially fringed with mangroves. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Tringa nebularia	Common Greenshank	-	M	Variety of inland wetlands and sheltered coastal habitats of varying salinity. Found on mudflats, saltmarsh, mangroves in embayments, harbours, deltas and lagoons. Breeds in northern hemisphere.	Low – habitat preferences not in subject site.	N/A
Tringa stagnatilis	Marsh Sandpiper	-	M	Permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, sewage farms and salt works. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	N/A
Tyto novaehollandiae	Masked Owl	V	-	Inhabits a diverse range of wooded habitat that provide tall or dense mature trees with hollows suitable for nesting and roosting. Mostly recorded in open forest and woodlands adjacent to cleared lands. Nest in hollows, in trunks and in near vertical spouts or large trees, usually living but sometimes dead. Nest hollows are usually located within dense forests or woodlands. Masked Owls prey upon hollow-dependent arboreal marsupials, but terrestrial mammals make up the largest proportion of the diet.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present. Field surveys did not detect the species utilising hollows.	Species/Ecosystem
Xenus cinereus	Terek Sandpiper	V	M, MA	The Terek Sandpiper mostly forages in the open, on soft wet intertidal mudflats or in sheltered estuaries, embayments, harbours or lagoons. Northern hemisphere breeding.	Low – habitat preferences not in subject site.	Ecosystem
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Located in a variety of drier habitats, including the dry sclerophyll forests and woodlands to the east and west of the Great Dividing Range. Can also be found on the edges of rainforests and in wet sclerophyll forests. This species roosts in caves and mines in groups of between 3 and 37 individuals.	None – subject site not within 2 km of rocky cliff lines	Ecosystem and species
Dasyurus maculatus	Spotted-tail Quoll	V	E	The range of the Spotted-tailed Quoll has contracted considerably since European settlement. It is now found in eastern NSW, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. The species was not detected during extensive trapping. It is unlikely to use the subject site.	Ecosystem
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Inhabit sclerophyll forests, preferring wet habitats where trees are more than 20 m high. Two observations have been made of roosts in stem holes of living eucalypts. There is debate about whether or not this species moves to lower altitudes during winter, or whether they remain sedentary but enter torpor. This species also	High	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				appears to be highly mobile and records showing movements of up to 12 km between roosting and foraging sites.		
Kerivoula papuensis	Golden-tipped Bat	V	-	Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, Casuarina-dominated riparian forest and coastal Melaleuca forests.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Miniopterus australis	Little Bentwing-bat	V	-	Coastal north-eastern NSW and eastern Queensland. The Little Bentwing-bat is an insectivorous bat that roost in caves, in old mines, in tunnels, under bridges, or in similar structures. They breed in large aggregations in a small number of known caves and may travel hundreds of kilometres from feeding home ranges to breeding sites. They have a preference for moist eucalypt forest, rainforest or dense coastal banksia scrub where it forages below the canopy for insects.	Moderate – thought unlikely to have breeding habitat given lack of hollows in subject site.	Ecosystem and species
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Eastern Bentwing-bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young.	Known – recorded in subject site, though no breeding habitat.	Ecosystem and species
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Most records are from dry eucalypt forests and woodlands to the east of the Great Dividing Range. Appears to roost in trees, but little is known of this species' habits.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Myotis macropus	Southern Myotis	V	-	The Southern Myotis is found in the coastal band from the north-west of Australia, across the top-end and south to western Victoria. Generally roost in groups of 10 - 15 close to water in caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage.	Moderate – though no breeding habitat.	Ecosystem and species
Petauroides volans	Greater Glider	-	V	The Greater Glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria. It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows.	Low	Species
Petaurus norfolcensis	Squirrel Glider	V	-	Generally occurs in dry sclerophyll forests and woodlands but is absent from dense coastal ranges in the southern part of its range. Requires abundant hollow bearing trees and a mix of eucalypts, banksias and acacias. There is only limited information available on den tree use by Squirrel gliders, but it has been observed using both living and dead trees as well as hollow stumps. Within a suitable vegetation community at least one species should flower heavily in winter and one	Previously been recorded in the subject site.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				species of eucalypt should be smooth barked. Endangered population in the Wagga Wagga LGA.		
Petaurus australis	Yellow-bellied Glider	V	-	Occur in tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south. Feed primarily on plant and insect exudates, including nectar, sap, honeydew and manna with pollen and insects providing protein.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	The Brush-tailed Phascogale has a patchy distribution around the coast of Australia. In NSW it is mainly found east of the Great Dividing Range although there are occasional records west of the divide. Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest.	Low – species not recorded along Stockton beach corridor. Closest record is approximately 8km inland. The species was not detected during extensive targeted survey.	Species
Phascolarctos cinereus	Koala	V	V	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	Low likelihood to utilise the subject site on a regular basis. This is supported by the SAT and spotlighting survey which did not detect any usage of the subject site by Koalas. However it is noted that there are records throughout the locality. The Koala may move through the area, but given the site is predominately regeneration, is unlikely to use as main source of foraging habitat, and would likely utilise the surrounding bushland for movement given the protection from predators.	Species
Phascolarctos cinereus	Koala, Hawks Nest and Tea Gardens population	EP	-	Inhabits eucalypt forests and woodlands. The suitability of these forests for habitation depends on the size and species of trees present, soil nutrients, climate and rainfall.	As above	N/A
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Inhabits coastal heath and wet and dry sclerophyll forests. Generally found in areas with rainfall greater than 760 mm. Requires relatively thick ground cover where the soil is light and sandy.	Moderate	Ecosystem

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
Pseudomys novaehollandiae	New Holland Mouse	-	V	The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	Moderate	Ecosystem
Pseudomys gracilicaudatus	Eastern Chestnut Mouse	V	-	In NSW the Eastern Chestnut Mouse mainly occurs north from the Hawkesbury River area as scattered records along to coast and eastern fall of the Great Dividing Range extending north into Queensland. There are however isolated records in the Jervis bay area. In NSW the Eastern Chestnut Mouse is mostly found, in low numbers, in heathland and is most common in dense, wet heath and swamps. In the tropics it is more an animal of grassy woodlands.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	This species is a canopy-feeding frugivore and nectarivore of rainforests, open forests, woodlands, melaleuca swamps and banksia woodlands. Bats commute daily to foraging areas, usually within 15 km of the day roost although some individuals may travel up to 70 km.	High – however no breeding habitat in subject site.	Ecosystem and species
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country. Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Prefer moist gullies in mature coastal forests and rainforests, between the Great Dividing Range and the coast. They are only found at low altitudes below 500 m. In dense environments they utilise natural and human-made opening in the forest for flight paths. Creeks and small rivers are favoured foraging habitat. This species roosts in hollow tree trunks and branches.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Syconycteris australis	Common Blossom Bat	V	-	Coastal areas of eastern Australia from Hawks Nest in NSW to Cape York peninsula in Queensland. In areas, the distribution extends inland to coastal foothills. Common Blossom-bats often roost in littoral rainforest and feed on nectar and pollen from flowers in adjacent heathland and paperbark swamps. They have also been recorded in a range of other vegetation communities, such as subtropical rainforest, wet sclerophyll forest and other coastal forests.	Regarded in the BAM Calculator as a 'predicted - ecosystem credit species'. Therefore, the species is presumed to be present.	Ecosystem
Reptiles						
Hoplocephalus bitorquatus	Pale-headed Snake	V	-	The TBDC (as at June 2020) notes that the Pale-headed Snake can be found '*within 500m of moderate to good vegetation*', and further describes habitat as '*found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest*'. Both definitions of habitat, but particularly	Low – not detected during survey. Not previously recorded in subject site or surrounds.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				'*moderate to good vegetation*', are very broad and encompass most vegetation types, including derived native grasslands. The TBDC also states that the species utilise hollows. The LMCC (2014a) survey guidelines describe habitat for the species as '*Loose bark, tree hollows in riparian habitat in dry eucalypt forest / woodland*'. The species is also described as preferring Callitris woodlands (Scientific Committee Determination). The main prey is tree frogs although lizards and small mammals are also taken. The subject site does not contain riparian habitat, and the closest record to the subject site is 30 km to the immediate west. Within the immediate locality, habitat for this species is likely to be within Swamp Sclerophyll Forest where there are tree hollows. Riparian habitat does not occur within the subject site. The areas containing tree hollows (Zone 5 and Zone 6) are not located in riparian habitat, nor do they contain Callitris woodlands. Based on the habitat descriptions in the LMCC (2014a) guidelines, the species is unlikely to occur, but if the broader definition of the TBCD is used, potential habitat is present. As such a targeted survey was completed in November 2020 which confirmed the species is not utilising the site.		
Flora						
Angophora inopina	Charmhaven Apple	V	V	Endemic to the Central Coast region of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. Occurs most frequently in Red Bloodwood Scribbly Gum woodland, wet heath, Red Mahogany Paperbark Sedge woodland and Stringybark Red Bloodwood forest.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Callistemon linearifolius	Netted Bottle Brush	V	-	Recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. Recorded in 2000 at Coalcliff in the northern Illawarra. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. The species was more widespread in the past, and there are currently only 5-6 populations remaining from the 22 populations historically recorded in the Sydney area. Three of the remaining populations are reserved in Ku-ring-gai Chase National Park, Lion Island Nature Reserve and Spectacle Island Nature Reserve. The species has also been recorded from Yengo National Park.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Commersonia prostrata	Dwarf Kerrawang	E	E	Occurs on sandy, sometimes peaty soils in a wide variety of habitats: snow gum woodland at Rose Lagoon; Blue-leaved Stringybark open forest at Tallong; and in	Low – not detected during survey. Relatively conspicuous	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				Brittle Gum low open woodland at Penrose; Scribbly Gum - Swamp Mahogany ecotonal forest at Tomago.	species. Not previously recorded in subject site or surrounds.	
Corybas dowlingii	Red Helmet Orchid	E	-	*Corybas dowlingii* is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. Sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	Low – habitat not suitable as species occurs in sheltered gullies.	Species
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Does not appear to have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland. The larger populations typically occur in woodland dominated by Scribbly Gum, Silvertop Ash, Red Bloodwood and Black She-oak and appears to prefer open areas in the understorey of this community.	Low – lack of remnant habitat given the subject site is mainly rehabilitated quarry pit. Lack of associated canopy species.	Species
Diuris arenaria	Sand Doubletail	E	-	Known from the Tomaree Peninsula near Newcastle. This species occurs in coastal heath and dry grassy eucalypt forest on sandy flats. Grows in gently undulating country in eucalypt forest with a grassy understorey on clay soil.	Low – lack of clay soil. Not previously recorded in the locality of the subject site.	Species
Diuris praecox	Rough Doubletail	V	V	Occurs between Ourimbah and Nelson Bay. Grows on hills and slopes of near-coastal districts in open forests which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year. It produces leaves and flowering stems in winter.	Low – species has been recorded adjacent to the subject site in remnant coastal dry sclerophyll forest. Targeted survey during the recommended survey time did not detect the species.	Species
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges. Occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Eucalyptus parramattensis subsp. decadens		V	V	Generally occupies deep, low-nutrient sands, often those subject to periodic inundation or where water tables are relatively high. It occurs in dry sclerophyll woodland with dry heath understorey. It also occurs as an emergent in dry or wet heathland. Often where this species occurs, it is a community dominant.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Grevillea parviflora subsp. parviflora	Small-flowered Grevillea	V	V	Grows in sandy or light clay soils usually over thin shales. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. Found over a	Low – not detected during survey. Relatively conspicuous	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				range of altitudes from flat, low-lying areas to upper slopes and ridge crests. Often occurs in open, slightly disturbed sites such as along tracks.	species. Not previously recorded in subject site or surrounds.	
Maundia triglochinoides		V	-	Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Flowering occurs during warmer months. Diaspore is the seed and root tubers, which are probably dispersed by water.	None – no waterbodies	Species
Melaleuca biconvexa	Biconvex Paperbark	V	V	Grows in damp places, often near streams or low-lying areas on alluvial soils of low slopes or sheltered aspects. Scattered and dispersed populations found in the Jervis Bay area in the south and the Gosford-Wyong area in the north.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Melaleuca groveana	Groves Paperbark	V	-	Widespread, scattered populations in coastal districts north of Yengo National Park to southeast Queensland. Also found as a disjunct population near Torrington on the northern tablelands. Grove's Paperbark grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on outcopping granite, rhyolite and sandtone on rocky outcrops and cliffs.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Persicaria elatior	Tall Knotweed	V	V	This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Phaius australis	Southern Swamp Orchid	E	E	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.	Low – lack of habitat preferences. Not detected during survey. Not previously recorded in subject site or surrounds.	Species
Prostanthera densa	Villous Mint Bush	V	V	This species has been recorded from the Currarong area in Jervis Bay, Royal National Park (Marley), Cronulla, Helensburgh and Port Stephens (Nelson Bay). The Sydney and Royal National Park populations were thought possibly extinct, but the species is now known to occur at Bass and Flinders Point in Cronulla. *Prostanthera densa* generally grows in sclerophyll forest and shrubland on coastal headlands and near coastal ranges, chiefly on sandstone, and rocky slopes near the sea.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Rhizanthella slateri	Eastern Australian Undergrown Orchid	V	E	Occurs from south-east Queensland to south-east NSW. In NSW, currently known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Habitat requirements are poorly understood and no particular vegetation type has been associated with the species, although it is known to occur in sclerophyll forest.	Low – no previous records and the majority of the subject site consists of rehabilitation which has changed the natural sandy soil base.	Species

Scientific Name	Common Name	BC Act	EPBC Act	Habitat	Likelihood of occurrence	Credit type
				Highly cryptic given that it grows almost completely below the soil surface, with flowers being the only part of the plant that can occur above ground. Therefore usually located only when the soil is disturbed.		
Senecio spathulatus	Coast Groundsel	E	-	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah). In Victoria there are scattered populations from Wilsons Promontory to the NSW border. Coast Groundsel grows on primary dunes.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Found only in NSW, in a narrow, linear coastal strip from Bulahdelah to Conjola State forest. On the south coast the species occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral rainforest. On the central coast it occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities.	Low – not detected during survey. Relatively conspicuous species. Not previously recorded in subject site or surrounds.	Species
Tetratheca juncea	Black-eyed Susan	V	V	Confined to the northern portion of the Sydney Basin bioregion and the southern portion of the North Coast bioregion in the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. It is usually found in low open forest-woodland with a mixed shrub understorey and grassy groundcover. The majority of populations occur on low nutrient soils associated with the Awaba Soil Landscape. Cryptic species that requires survey in September-October.	Low – not detected during survey. Not previously recorded in subject site or surrounds. Habitat preferences absent given the subject site has been previously cleared.	Species
Thesium australe	Austral Toadlax	V	V	Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time. It may persist in some areas in the broader region. Occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Often found in association with Kangaroo Grass (*Themeda australis*).	Low – headland habitat not present.	Species

Threatened Ecological Community (TEC) Likelihood of occurrence

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Central Hunter Grey Box - Ironbark Woodland in the New South Wales North Coast and Sydney Basin Bioregions	Central Hunter Grey Box-Ironbark Woodland occurs in the Central Hunter Valley between about Singleton and Muswellbrook. It is known to occur in the Cessnock, Singleton and Muswellbrook LGAs but may occur elsewhere within the Sydney Basin Bioregion. Central Hunter Grey Box-Ironbark Woodland occurs in areas of relatively low rainfall and high temperatures. It is associated mostly with Permian lithology, and is situated on gently undulating hills, slopes and valleys, or occasionally on rocky knolls. Central Hunter Grey Box–Ironbark Woodland typically forms a woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Kurrajong (*Brachychiton populneus* subsp. *populneus*) and Grey Box (*Eucalyptus moluccana*). Other tree species such as Rough-barked Apple (*Angophora floribunda*) and Black Cypress Pine (*Callitris endlicheri*) may be present and occasionally dominate or co-dominate. A shrub layer is often present and common shrub species include Velvet Mock Olive (*Notelaea microcarpa* var. *microcarpa*), Coffee Bush (*Breynia oblongifolia*), Blackthorn (*Bursaria spinosa* subsp. *spinosa*), *Cassinia quinquefaria* and Sticky Hop-bush (*Dodonaea viscosa*). Subshrubs may also be common and include Narrawa Burr (*Solanum cinereum*), *Phyllanthus virgatus* and Small-leaf Bluebush (*Maireana microphylla*). Ground cover can be moderately dense to dense, and consist of numerous forbs and grass species as well as a small number of ferns, sedges and twiners. The more common species include Barbed Wire Grass (*Cymbopogon refractus*), Purple Wiregrass (*Aristida ramosa*), Kidney Weed (*Dichondra repens*), Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Bristly Cloak Fern (*Cheilanthes distans*), Tall Chloris (*Chloris ventricosa*), Slender Tick-trefoil (*Desmodium varians*), Yellow Burr-daisy (*Calotis lappulacea*), Many-flowered Mat-rush (*Lomandra multiflora* subsp. *multiflora*), Blue Trumpet (*Brunoniella australis*) and *Glycine tabacina*.	Endangered	Critically Endangered	None
Central Hunter Ironbark - Spotted Gum - Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions	Central Hunter Ironbark-Spotted Gum-Grey Box Forest occurs in the central Hunter Valley mainly between Maitland and Muswellbrook. It has been recorded from Singleton, Cessnock and Muswellbrook LGAs but may occur elsewhere within the North Coast and Sydney Basin Bioregions. Central Hunter Ironbark-Spotted Gum-Grey Box Forest occupies undulating country including low rises and slopes, occurring on all aspects. It may also occur on alluvial and colluvial soils in valleys. It mostly occurs on clayey soils found on Permian sediments. Central Hunter Ironbark-Spotted Gum-Grey Box Forest typically forms an open forest or woodland dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Spotted Gum (*Corymbia* maculata) and Grey Box (*Eucalyptus moluccana*). Other tree species such as Red Ironbark (*Eucalyptus fibrosa*) and Forest Red Gum (*Eucalyptus* tereticornis) may be present, and occasionally dominate or co-dominate. A sparse layer of small trees including Bulloak (*Allocasuarina* luehmannii) or Silver-stemmed Wattle (*Acacia parvipinnula*) may be present in some areas. The shrub layer varies from sparse to moderately dense. Common shrub species include Gorse Bitter Pea (*Daviesia ulicifolia* subsp. *ulicifolia*), Grey Bush-pea (*Pultenaea spinosa*), Coffee Bush (*Breynia oblongifolia*), Needlebush (*Hakea* sericea) and Blackthorn (*Bursaria spinosa* subsp. *spinosa*). Ground cover can be sparse to moderately dense and consists of numerous forbs, a few grass species and occasional ferns and sedges. Common species include Poison Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), Barbed Wire Grass (*Cymbopogon refractus*), Whiteroot (*Pratia purpurascens*), Many-flowered Mat-rush (*Lomandra multiflora* subsp. *multiflora*), *Pomax umbellata*, *Glycine tabacina*, Blue Flax-lily (*Dianella revoluta*), Slender Wire Lily (*Laxmannia gracilis*), *Vernonia cinerea* var. *cinerea*, Slender Tick-trefoil (*Desmodium varians*) and Kidney Weed (*Dichondra repens*).	Endangered	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea*, Sea Rush (*Juncus krausii* subsp. australiensis), Samphire (*Sarcocornia quinqueflora* subsp. quinqueflora), Marine Couch (*Sporobolus virginicus*), Streaked Arrowgrass (*Triglochin striata*), Knobby Club-rush (*Ficinia nodosa*), Creeping Brookweed (*Samolus repens*), Swamp Weed (*Selliera radicans*), Seablite (*Suaeda* australis) and Prickly Couch (*Zoysia macrantha*). Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans. Found in the tidal flats of estuaries and on the edges of intermittently opened coastal lagoons. Occurs in the upper limits of the tidal zone, and is frequently interspersed with bare ground and salt pans.	Endangered	Vulnerable	None
Coastal Upland Swamp in the Sydney Basin Bioregion	The Coastal Upland Swamp in the Sydney Basin Bioregion includes open graminoid heath, sedgeland and tall scrub associated with periodically waterlogged soils on the Hawkesbury sandstone plateaux. The Coastal Upland Swamp is generally associated with soils that are acidic and vary from yellow or grey mineral sandy loams with a shallow organic horizon to highly organic spongy black peat soils with pallid subsoils. The vegetation of the Coastal Upland Swamp may include tall open scrubs, tall closed scrubs, closed heaths, open graminoid heaths, sedgelands and fernlands. Larger examples may include a complex of these structural forms. The flora comprising the upland swamp is diverse there are 73 plant species listed as characterising the ecological community.	Endangered	Endangered	None
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Associated with coastal areas subject to periodic flooding and in which standing fresh water persists for at least part of the year in most years. Typically occurs on silts, muds or humic loams in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes but may also occur in backbarrier landforms where floodplains adjoin coastal sandplains. Generally occur below 20 m elevation on level areas. They are dominated by herbaceous plants and have very few woody species. The structure and composition of the community varies both spatially and temporally depending on the water regime: Those that lack standing water most of the time are usually dominated by dense grassland or sedgeland vegetation, often forming a turf less than 0.5 metre tall and dominated by amphibious plants including Paspalum distichum (water couch), Leersia hexandra (swamp rice-grass), Pseudoraphis spinescens (mud grass) and Carex appressa (tussock sedge). Where they are subject to regular inundation and drying the vegetation may include large emergent sedges over 1 metre tall, such as Baumea articulata, Eleocharis equisetina and Lepironia articulata, as well as emergent or floating herbs such as Hydrocharis dubia (frogbit), Philydrum lanuginosum(frogsmouth), Ludwigia peploides subsp. montevidensis (water primrose), Marsilea mutica (nardoo) and Myriophyllum spp. (milfoils).	Endangered		None
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions	Hunter Floodplain Red Gum Woodland generally forms a tall to very tall (18-35 m) woodland on floodplains and associated rises along the Hunter River and tributaries within the NSW North Coast and Sydney Basin Bioregions. Stands on major floodplains are generally dominated by Eucalyptus camaldulensis (River Red Gum) in combinations with Eucalyptus tereticornis (Forest Red Gum), Eucalyptus melliodora (Yellow Box) and Angophora floribunda (Rough-barked Apple). Within the community stands of Casuarina cunninghamiana subsp. cunninghamiana (River Oak) and Casuarina glauca (Swamp Oak) can form a part of this community. Dominant groundcovers include Cynodon dactylon (Couch), Alternanthera denticulata (Lesser Joyweed), Austrostipa verticillata(Slender Bamboo Grass), Dichondra repens (Kidney Weed), Lepidium pseudohyssopifolium (Peppercress), Pratia concolor (Poison Pratia), Urtica incisa (Stinging Nettle), Einadia hastata (Berry Saltbush), Amaranthus macrocarpus var. macrocarpus (Dwarf Amaranth), Cyperus fulvus (Sticky Sedge), Cynoglossum australe (Australian Hound's Tongue), Cyperus gracilis(Slender Flat-sedge), Glycine tabacina (Variable Glycine), Geranium solanderi (Native Geranium) and Microlaena stipoides var. stipoides (Weeping Rice Grass).	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	Hunter Lowland Redgum Forest is an open forest where the most common canopy tree species are *Eucalyptus tereticornis*(Forest Red Gum) and *E. punctata* (Grey Gum). Other frequently occurring canopy species are *Angophora floribunda* (Rough-barked Apple), *E. crebra* (Narrow-leaved Ironbark), *E. moluccana* (Grey Box) and *Corymbia maculata* (Spotted Gum). The shrub layer is open and common shrub species include *Breynia oblongifolia* (Coffee Bush), *Leucopogon juniperinus* (Prickly Beard-heath), *Daviesia ulicifolia* (Gorse Bitter Pea) and *Jacksonia scoparia* (Dogwood). The ground cover typically comprises grasses and herbs with common species being *Microlaena stipoides* var. *stipoides* Forest Weeping Grass, *Pratia purpurascens* (Whiteroot), *Lomandra multiflora* (Many-flowered Mat-rush), *Cymbopogon refractus* (Barbed Wire Grass), *Cheilanthes sieberi* (Poison Rock Fern) and *Dichondra repens* (Kidney Weed). Occurs between Muswellbrook, Beresfield, Mulbring and Cessnock in the Lower Hunter in the Sydney Basin and North Coast bioregions. It has been recorded from the Maitland, Cessnock, Port Stephens, Muswellbrook and Singleton LGAs, but may occur elsewhere in these bioregions. Probably less than 500 hectares of this community remains. Hunter Lowland Redgum Forest occurs on the Permian sediments of the Hunter Valley floor. Much of the remaining community is disturbed and fragmented. The floristic composition and structure of the community is influenced by both the size and disturbance history of the remaining fragments. Consequently at heavily disturbed sites only some of the species which characterise the community may be present. Occurs on gentle slopes of depressions and drainage flats on the Hunter Valley floor.	Endangered		None
Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion	Hunter Valley Footslopes Slaty Gum Woodland is a woodland, or occasionally an open forest, with a sparse to moderately dense tree layer with occasional small trees and a moderately dense to dense shrub layer. The tree canopy is typically dominated by *Eucalyptus dawsonii* (Slaty Gum) and/or *Eucalyptus moluccana* (Grey Box). *Acacia salicina*(Cooba) and *Allocasuarina luehmannii* (Bulloak) may form a small tree layer or be part of the upper-most canopy. Other trees which may be present include *Brachychiton populneus* subsp. *populneus* (Kurrajong), *Callitris endlicheri*(Black Cypress Pine), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus punctata* (Grey Gum). The shrub layer includes species such as *Olearia elliptica* (Sticky Daisy Bush), *Acacia cultriformis* (Knife-leaved Wattle), *Canthium odoratum* (Shiny-leaved Canthium), *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Dodonaea viscosa* subsp. *cuneata* (Wedge-leaf Hopbush), *Acacia decora* (Western Golden Wattle) and *Solanum brownii* (Violet Nightshade). The groundcover is typically sparse to very sparse and is relatively species poor. The most frequently occurring species include *Dichondra repens*(Kidney Weed), *Lomandra multiflora* subsp. *multiflora* (Many-flowered Mat-rush), *Aristida ramosa* (Wire Grass), *Brunoniella australis* (Blue Trumpet), *Cymbopogon refractus* (Barbed Wire Grass), *Desmodium brachypodum* (Large Tick-trefoil), *Fimbristylis dichotoma* (Common Fringe-rush) and *Sida corrugata*(Corrugated Sida).	Vulnerable	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Hunter Valley Vine Thicket in the NSW North Coast and Sydney Basin Bioregions	Hunter Valley Vine Thicket typically forms a low forest, usually less than 10 m tall, with a closed canopy dominated by small trees. The canopy may include *Elaeodendron australe*(Red Olive Plum), *Geijera parviflora* (Wilga), *Notelaea microcarpa* var. *microcarpa* (Native Olive), *Alectryon oleifolius* subsp. *elongatus*(Western Rosewood), *Melia azedarach* (White Cedar) and *Brachychiton populneus* subsp. *populneus* (Kurrajong). Emergent eucalypts are common and include *Eucalyptus albens* (White Box), *E. dawsonii* (Slaty Box) and *E. crebra*(Narrow-leaved Ironbark). A shrub stratum is usually present and includes *Olearia elliptica* subsp. *elliptica* (Sticky Daisy Bush) and *Rhagodia parabolica*(Mealy Saltbush). Vines are common and include *Cissus opaca* (Small-leaved Water Vine), *Marsdenia flavescens* (Hairy Milk Vine), *Parsonsia eucalyptophylla*(Gargaloo) and *Pandorea pandorana* subsp. *pandorana* (Wonga Vine). Ground cover is generally sparse and includes *Urtica incisa* (Stinging Nettle) and *Austrostipa verticillata* (Slender Bamboo Grass). Hunter Valley Vine Thicket has a highly restricted geographic distribution in the central Hunter Valley. The community occurs mostly as patches of less than 10 ha, with a few larger patches exceeding 100 ha. Approximately 85% of the pre-European distribution of the community remains. The largest occurrence is at Brushy Hill adjacent to Glenbawn Dam, north east of Scone. The only stand known to occur in a conservation reserve is at Mt Dangar within the Goulburn River National Park. Hunter Valley Vine Thicket has been recorded from the local government areas of Muswellbrook, Singleton, and Upper Hunter but may occur elsewhere within the Sydney Basin Bioregion and NSW North Coast Bioregion.	Endangered		None
Hunter Valley Weeping Myall Woodland in the Sydney Basin Bioregion	Hunter Valley Weeping Myall Woodland of the Sydney Basin bioregion typically has a dense to open tree canopy up to about 15 m tall, depending on disturbance and regrowth history. The most common tree is *Acacia pendula* (Weeping Myall), which may occur with *Eucalyptus crebra* (Narrow-leaved Ironbark), *A. salicina* (Cooba) and/or trees within the *A. homalophylla - A. melvillei* complex. Understorey shrubs may include *Canthium buxifolium* (Stiff Canthium), *Dodonaea viscosa* (Sticky Hopbush), *Geijera parviflora* (Wilga), *Notelaea microphylla* var. *microphylla*(Native Olive) and *Senna zygophylla* (Silver Cassia). However, these shrubs are absent from some stands. The groundcover varies from dense to sparse, and is comprised of grasses such as *Austrodanthonia fulva* (a wallaby grass) and *Themeda australis* (Kangaroo Grass), and low shrubs and herbs such as *Chrysocephalum apiculatum* (Common Everlasting), *Einadia nutans* subsp. *nutans* (Climbing Saltbush), *Enchylaena tomentosa* (Ruby Saltbush), *Maireana microphylla* (Eastern Cotton Bush) and *Ptilotus semilanatus*.	Critically Endangered	Critically Endangered	None
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Littoral Rainforest is generally a closed forest, the structure and composition of which is strongly influenced by its proximity to the ocean. The plant species of this community are predominantly rainforest species. Several species have compound leaves, and vines may be a major component of the canopy. Littoral Rainforest occurs only on the coast and is found at locations in the NSW North Coast Bioregion, Sydney Basin Bioregion and South East Corner Bioregion. Littoral Rainforest is very rare and occurs in many small stands. In total, it comprises less than one percent of the total area of rainforest in NSW. The largest known stand occurs in Iluka Nature Reserve, which is about 136 hectares in size. Not all stands of this community have been included in mapping for the Environmental Planning Policy 26, Littoral rainforest. Occurs on sand dunes and on soil derived from underlying rocks. Stands on headlands exposed to strong wind-action may take the form of dense, wind-pruned thickets. Stands are generally taller in sheltered sites such as hind dunes, although wind-pruning may still occur on their windward sides. Most stands occur within two kilometres of the sea, though are occasionally found further inland within reach of the maritime influence.	Endangered	Critically Endangered	Low

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	Restricted to a range of approximately 65 km by 35 km centred on the Cessnock - Beresfield area in the Central and Lower Hunter Valley. Within this range, the community was once widespread. A fragmented core of the community still occurs between Cessnock and Beresfield. Remnants occur within the Local Government Areas of Cessnock, Maitland, Singleton, Lake Macquarie, Newcastle and Port Stephens but may also occur elsewhere within the bioregion. Outliers are also present on the eastern escarpment of Pokolbin and Corrabare State Forests on Narrabeen Sandstone.	Endangered		None
Lower Hunter Valley Dry Rainforest in the Sydney Basin and NSW North Coast Bioregions	Lower Hunter Valley Dry Rainforest mainly occurs on the Barrington footslopes along the northern rim of the Hunter Valley Floor, where it occupies gullies and steep hillslopes with south facing aspects. It is also known from south of the Hunter River at Mt Bright and Mt View. Lower Hunter Valley Dry Rainforest has been recorded from the local government areas of Cessnock, Maitland and Port Stephens, and is also likely to occur or have occurred in Muswellbrook, Singleton, Upper Hunter and Dungog LGAs. Lower Hunter Valley Dry Rainforest typically occurs on Carboniferous sediments in gullies and on steep hillslopes with south facing aspects. It is generally found at elevations less than 300 m ASL with a mean annual rainfall less than 900 mm	Vulnerable		None
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions is an ecological community of subtropical rainforest and some related, structurally complex forms of dry rainforest. Lowland Rainforest, in a relatively undisturbed state, has a closed canopy, characterised by a high diversity of trees whose leaves may be mesophyllous and encompass a wide variety of shapes and sizes. Typically, the trees form three major strata: emergents, canopy and sub-canopy which, combined with variations in crown shapes and sizes results in an irregular canopy appearance. The trees are taxonomically diverse at the genus and family levels, and some may have buttressed roots. A range of plant growth forms are present in Lowland Rainforest, including palms, vines and vascular epiphytes. In disturbed stands of this community the canopy cover may be broken, or the canopy may be smothered by exotic vines. The Hawkesbury River notionally marks the southern limit of Lowland Rainforest in the NSW North Coast and Sydney Basin bioregions. South of the Sydney metropolitan area, Lowland Rainforest is replaced by Illawarra Subtropical Rainforest of the Sydney Basin Bioregion, which is listed as an endangered ecological community. Milton Ulladulla Subtropical Rainforest is also a related rainforest endangered ecological community that occurs still further south in the South East Corner Bioregion.	Endangered	Critically Endangered	None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	Lowland Rainforest on Floodplain is a rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast, with less than 1000ha in total thought to remain. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include figs *(Ficus macrophylla, F. obliqua* and *F. watkinsiana),* palms *(Archontophoenix cunninghamiana* and *Livistona australis),*Silky Oak *(Grevillea robusta)*, Black Bean *(Castanospermum australe)* and Brush Cherry *(Syzygium australe).* Animals present include fruit-eating rainforest pigeons, Noisy Pitta, Brush-turkey, pademelons, flying foxes, the Land Mullet skink and rainforest snails. Lowland Rainforest on Floodplain generally occupies riverine corridors and alluvial flats with rich, moist silts often in subcatchments dominated by basic volcanic substrates. Major examples once occurred, and remnants remain, on the floodplains of the Tweed, Richmond, Clarence, Bellinger, Macleay, Hastings, Manning, and Hunter Rivers. Other minor river systems also support the community. This community occurs on fertile soils in lowland river valleys.	Endangered	Critically Endangered	None
Quorrobolong Scribbly Gum Woodland in the Sydney Basin Bioregion	Quorrobolong Scribbly Gum Woodland is a low shrubby woodland with the overstorey dominated by *Eucalyptus racemosa* (Scribbly Gum). Other tree species present include *E. piperita* (Sydney Peppermint), *E. resinifera* (Red Mahogany), *Angophora costata* (Smooth-barked Apple) and *E. punctata* (Grey Gum). There is usually a well developed shrub layer with common species being *Leptospermum trinervium* (Slender Tea-tree), *Acacia parvipinnula* (Silver-stemmed Wattle), *Persoonia linearis*(Narrow-leaved Geebung) and *Leptospermum polygalifolium* (Tantoon). The ground layer is often sparse and frequently occurring species are *Imperata cylindrica* var. *major* (Blady Grass), *Panicum simile* (Two-colour Panic), *Pratia purpuracens* (Whiteroot), *Lomandra cylindrica* (Needle Mat-rush) and *Dianella revoluta*. Currently known from only a small area between Quorrobolong and Mulbring in the Cessnock local government area, but may also occur elsewhere within the Hunter Valley. The current known extent is about 70 hectares; the pre-European extent is estimated to have been only 160 hectares, reflecting the limited area of the sand deposit on which it occurs. Not known to occur within any conservation reserves. Occupies gentle slopes and rises on a residual sand deposit overlying the Permian clay sediments of the Hunter Valley floor.	Endangered		None
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	As the name suggests, this EEC is found on the river flats of the coastal floodplains. It has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include Eucalyptus tereticornis (forest red gum), E. amplifolia (cabbage gum), Angophora floribunda (rough-barked apple) and A. subvelutina (broad-leaved apple). Eucalyptus baueriana (blue box), E. botryoides (bangalay) and E. elata (river peppermint) may be common south from Sydney, E. ovata (swamp gum) occurs on the far south coast, E. saligna (Sydney blue gum) and E. grandis (flooded gum) may occur north of Sydney, while E. benthamii is restricted to the Hawkesbury floodplain.	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion	Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion has a tall open tree layer of eucalypts, which may exceed 40 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. While the composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (forest red gum), *E. siderophloia* (grey ironbark), *Corymbia intermedia* (pink bloodwood) and, north of the Macleay floodplain, *Lophostemon suaveolens* (swamp turpentine). Other trees may be scattered throughout at low abundance or locally common at few sites, particularly where there is an influence from lithic substrates upslope. These include *Eucalyptus moluccana* (grey box), *E. propinqua* (grey gum), *E. seeana*(narrow-leaved red gum), *Angophora subvelutina* (broad-leaved apple), *E. robusta* (swamp mahogany), *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *E. acmenoides* (white mahogany), *Angophora woodsiana, A. paludosa* and rainforest trees such as *Ficus*spp. (figs) and *Cupaniopsis* spp (tuckeroos). A layer of small trees may be present, including *Allocasuarina torulosa* (forest oak), *Alphitonia excelsa* (red ash), *Glochidion ferdinandi* (cheese tree), *Callistemon* spp. (bottlebrushes), *Melaleuca* spp. (paperbarks) *andCasuarina glauca* (swamp oak). Scattered shrubs include *Breynia oblongifolia* (coffee bush), *Acacia concurrens* (curracabah), *Commersonia* spp., and *Hibiscus* spp. Occasional vines include *Eustrephus latifolius* (wombat berry), *Parsonsia straminea* (common silkpod) and *Geitonoplesium cymosum* (scrambling lily). The groundcover is composed of abundant forbs, scramblers and grasses including *Imperata cylindrica* var. *major* (blady grass), *Themeda australis* (kangaroo grass), *Vernonia cinerea, Dianella caerulea* (blue flax lily), *Pratia purpurascens* (whiteroot), *Cheilanthes sieberi* subsp. *sieberi,* and *Dichondra repens* (kidney weed). The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.	Endangered		None
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which *Casuarina glauca* (swamp oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (lilly pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui. The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica* var. *discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter. The composition of the ground stratum varies depending on levels of salinity in the groundwater. Under less saline conditions prominent ground layer plants include forbs such *Centella asiatica, Commelina cyanea, Persicaria decipiens*and *Viola banksii*; graminoids such as *Carex appressa, Gahnia clarkei, Lomandra longifolia, Oplismenus imbecillis*; and the fern *Hypolepis muelleri*. On the fringes of coastal estuaries, where soils are more saline, the ground layer may include the threatened grass species, *Alexfloydia repens*, as well as *Baumea juncea, Juncus kraussii, Phragmites australis, Selliera radicans* and other saltmarsh species. Known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes, Port Stephens, Maitland, Newcastle, Cessnock, Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Hawkesbury, Baulkham Hills, Hornsby, Lane Cove, Blacktown, Auburn, Parramatta, Canada Bay, Rockdale, Kogarah, Sutherland, Penrith, Fairfield, Liverpool, Bankstown, Wollondilly, Camden, Campbelltown, Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley but may occur elsewhere in these bioregions. Major examples once occurred on the floodplains of the Clarence, Macleay, Hastings, Manning, Hunter, Hawkesbury, Shoalhaven and Moruya Rivers.	Endangered	Endangered	Low

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	This swamp community has an open to dense tree layer of eucalypts and paperbarks although some remnants now only have scattered trees as a result of partial clearing. The trees may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality where the tree stratum is low and dense. For example, stands dominated by *Melaleuca ericifolia* typically do not exceed 8 m in height. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. The most widespread and abundant dominant trees include *Eucalyptus robusta*(swamp mahogany), *Melaleuca quinquenervia* (paperbark) and, south from Sydney, *Eucalyptus botryoides* (bangalay) and *Eucalyptus longifolia*(woollybutt). Other trees may be scattered throughout at low abundance or may be locally common at few sites, including *Callistemon salignus* (sweet willow bottlebrush), *Casuarina glauca* (swamp oak) and *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *Livistona australis* (cabbage palm) and *Lophostemon suaveolens* (swamp turpentine). A layer of small trees may be present, including *Acacia irrorata* (green wattle), *Acmena smithii* (lilly pilly), *Elaeocarpus reticulatus* (blueberry ash), *Glochidion ferdinandi* (cheese tree), *Melaleuca linariifolia* and *M. styphelioides*(paperbarks). Shrubs include *Acacia longifolia, Dodonaea triquetra, Ficus coronata, Leptospermum polygalifolium* subsp. *polygalifolium* and *Melaleuca* spp. Occasional vines include *Parsonsia straminea, Morinda jasminoides* and *Stephania japonica* var. *discolor*. The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei, Pteridium esculentum, Hypolepis muelleri, Calochlaena dubia, Dianella caerulea, Viola hederacea, Lomandra longifolia, Entolasia marginata* and *Imperata cylindrica*. On sites downslope of lithic substrates or with soils of clay-loam texture, species such as *Allocasuarina littoralis, Banksia oblongifolia, B. spinulosa, Ptilothrix deusta* and *Themeda australis*, may also be present in the understorey.	Endangered		Low
Sydney Freshwater Wetlands in the Sydney Basin Bioregion	A complex of vegetation types largely restricted to freshwater swamps in coastal areas. These also vary considerably due to fluctuating water levels and seasonal conditions. Characteristic species include sedges and aquatic plants such as *Baumea* species, *Eleocharis sphacelata*, *Gahnia* species, *Ludwigia peploides* subsp. *montevidensis* and *Persicaria* species. Occurs on sand dunes and low-nutrient sandplains along coastal areas in the Sydney Basin bioregion. It is known from the Lake Macquarie, Wyong, Gosford, Pittwater, Warringah, Woollahra, Waverley, Botany, Rockdale, Randwick, Sutherland and Wollongong local government areas, but is likely to occur elsewhere within the bioregion. Has been extensively cleared and filled and remnants are often small and disturbed. Largely restricted to freshwater swamps in swales and depressions on sand dunes and low nutrient sandplains such as those of the Warriewood and Tuggerah soil landscapes. Swampy areas on alluvium with a saline influence do not fall within this community.	Endangered		None

Threatened Ecological Community	Description	BC Act Status	EPBC Act Status	Likelihood of occurrence within subject site
Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Themeda Grassland on seacliffs and coastal headlands is found on a range of substrates in the NSW North Coast, Sydney Basin and South East Corner bioregions. Stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs, as for example at Cape Banks and Henry Head in Botany Bay National Park, and on metasedimentary headlands, as for example at McCauleys Headland in Coffs Coast Regional Park, Look-at-me-now Headland, Dammerels Head and Bare Bluff in Moonee Beach Nature Reserve and Wilson's Headland in Yuraygir National Park. Individual stands of the community are often very small, a few square metres, but at some sites larger stands of up to several hectares or tens of hectares occur. Overall, the community has a highly restricted geographic distribution comprising small, but widely scattered patches. The community is found on a range of substrates, although stands on sandstone are infrequent and small. Larger stands are found on old sand dunes above cliffs, for example at Cape Banks and Henry Head in Botany Bay National Park, and on metasedimentary are rarely adamellite headlands on the north coast. Individual stands of the community are often very small, a few square metres, but at some sites larger stands of up to several hectares or tens of hectares occur. Overall, the community therefore has a highly restricted geographic distribution comprising small, but widely scattered patches.	Endangered		None
Umina Coastal Sandplain Woodland in the Sydney Basin Bioregion	A low woodland dominated by trees of Eucalyptus botryoides and Angophora floribunda with a diverse understorey of sclerophyllous shrubs species including Banksia integrifolia, Banksia serrata, Monotoca elliptica, Macrozamia communis, Acacia ulicifolia, Platysace lanceolata, Acacia suaveolens and Allocasuarina littoralis. Eucalyptus botryoides is the dominant tree in the zone immediately behind the beach, while Angophora floribunda is dominant in the zone beyond up to 2 km from the beach. Largely restricted to coastal sands on the Umina, Woy Woy and Ettalong Sandplain, a beach ridge system within the Gosford local government area. Including ecotonal areas, less than 10% (being less than 10 hectares) of the community's estimated original cover of about 80 hectares remains. This comprises four main remnants at Umina, while a few smaller remnant patches and scattered trees around Pearl Beach and Patonga and elsewhere on the 'Peninsula' indicate its former distribution.	Endangered		None
Warkworth Sands Woodland in the Sydney Basin Bioregion	Warkworth Sands Woodland is a low woodland dominated by *Angophora floribunda* (Rough-barked Apple) and *Banksia integrifolia* subsp. *integrifolia*(Coast Banksia). Other tree species may be present such as *Eucalyptus tereticornis* (Forest Red Gum)and *E. glaucina* (Slaty Red Gum). Shrub and ground layer species commonly present include *Acacia filicifolia* (Fern-leaved Wattle), *Melaleuca thymifolia* (Thyme Honey-myrtle), *Brachyloma daphnoides* (Daphne Heath), *Pteridium esculentum* (Bracken), *Pimelea linifolia* (Slender Rice Flower), *Imperata cylindrica* var. *major* (Blady Grass), *Chrysocephalum apiculatum* (Common Everlasting) and *Glycine clandestina*. Small drainage lines within the area occuied by this community may support the presence or higher abundance of certain species (such as *Melaleuca thymifolia*) and the absence or lower abundance of others (such as *Banksia integrifolia* subsp. *integrifolia*). Such areas are included as part of this community.	Endangered	Critically Endangered	None
White Box, Yellow Box, Blakely's Red Gum Woodland and Derived Native Grassland	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: White Box Eucalyptus albens, Yellow Box E. melliodora and Blakely's Red Gum E. blakelyi. Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs. The community also includes a range of mammal, bird, reptile, frog and invertebrate fauna species. Intact stands that contain diverse upper and mid-storeys and groundlayers are rare.	Endangered	Critically Endangered	None

Annex 2. Plant Community Type

PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland on coastal sands of the Central and Lower North Coast

Habitat: PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland has been mapped as occurring throughout the majority of the subject site, in five different condition classes based on similar age of rehabilitation and natural succession:

- Zone 1 = 14.13 ha
- Zone 2 = 3.87 ha
- Zone 4 = 5.19 ha
- Zone 5 = 1.71 ha
- Zone 6 = 8.09 ha.

Whilst it is noted in this report that much of the subject site consists of planting, as per the OEH (2018) Biodiversity Assessment Method Operational Manual, '*Planted native vegetation is treated in the same way as native vegetation if it meets the definition of native vegetation in Section 5A of the Local Land Services Act 2013. Where the vegetation is a mix of local and non-local planted species the assessor should consider the best matching PCT based on the local species present*'. As such, we have aligned the areas of native rehabilitated land to PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland due to the following:

PCT1646 - Smooth-barked Apple/ Blackbutt/ Old Man Banksia woodland occupied the subject site prior to vegetation clearing for the former inland extraction area; and

- The canopy tubestock planted within the subject site (*Eucalyptus pilularis, Corymbia gummifera*, and *Angophora costata*) are the dominant species of PCT1646.
- The structure of the PCT within the subject site is highly attributed to the age of the regeneration that has taken place over the past decade. The structure associated with each of the vegetation zones have been provided in the table below.

In summary, the vegetation recorded within the subject site is consistent with the description of PCT1646 due to the following:

- The dominant canopy species recorded within the subject site comprise *Eucalyptus pilularis, Corymbia gummifera,* and *Angophora costata* which are dominants within PCT1646
- The subject site occurs on quaternary dune sands
- The structure of the remnant condition class is an open forests to woodland dominated in the canopy by Angophora's
- The structure of the remnant condition class consists of a sparse mid-stratum that is typically characterised by Banksia's
- The structure of the remnant condition class is relatively sparse and is characterised by grasses and ferns.

Conservation Status: PCT1646 does not align to any TECs under the BC or EPBC Acts.

Condition classes: Five condition classes were assigned to PCT1646 within the subject site:

Vegetation zone	Description	Photo of vegetation zone
Zone 1	Canopy: dominated by planted E*ucalyptus pilularis,* and *Corymbia gummifera.* The age of eucalypts are approximately 10 years old. None have developed hollows and are approximately 5 metres in height. Midstorey and shrub layer: Relatively sparse shrub layer consisting of planted native species: *Acacia sophorae, A. suaveolens, A. ulicifolia, Allocasuarina littoralis, Angophora costata, Aotus ericoides,* and *Leptospermum* species. Ground cover: Very sparse ground cover dominated by planted and naturally regenerating species including: *Lomandra longifolia, Pteridium esculentum, Imperata cylindrica, Hibbertia virgata,* and *Themeda australis.*	 **Plate 10. Vegetation zone – Zone 1**
Zone 2	Canopy: No large canopy present. Very sparse planted *Angophora costata* and *Corymbia gummifera*. Many of the canopy species are less than 2 metres in height and are sparsely scattered throughout the zone. Midstorey: Very sparsely scattered tubestock of *Acacia suaveolens, Allocasuarina littoralis, Banksia serrata, Bossiaea heterophylla* and *Dillwynia retorta.* Ground cover was particularly sparse in term of native vegetation cover. Some planted success of *Carpobrotus glaucescens, Lomandra longifolia, Pteridium esculentum, Imperata cylindrica, Hibbertia virgata,* and *Themeda australis.*	 **Plate 11. Vegetation zone – Area 2**
Zone 4	Canopy: No large canopy present. Very sparse planted *Angophora costata* and *Corymbia gummifera*. Many of the canopy species are less than 1 metres in height and are sparsely scattered throughout the zone. Midstorey: Very sparsely scattered tubestock of *Acacia suaveolens, Allocasuarina littoralis, Banksia serrata, Bossiaea heterophylla* and *Dillwynia retorta.* Ground cover was particularly sparse in term of native vegetation cover. Some planted success of *Carpobrotus glaucescens, Lomandra longifolia, Imperata cylindrica, a*nd *Themeda australis.*	 **Plate 12. Vegetation zone – Zone 4**
Zone 5	Canopy: dominated by *Eucalyptus pilularis, Angophora costata* and *Corymbia gummifera*. Typical height is approximately 10 metres and 20% Projected foliage cover. In-fill planting has occurred throughout the area, though has a high resilience. Midstorey and shrub layer: Relatively moderate cover of shrubs including: *Acacia sophorae, A. ulicifolia, Banksia integrifolia, B. serrata, Bossiaea rhombifolia, Leptospermum* species. Ground cover: Dominant species include: *Pteridium esculentum, Imperata cylindrica, Themeda australis.*	 **Plate 13. Vegetation zone – Zone 5**

Vegetation zone	Description	Photo of vegetation zone
Zone 6	Canopy: dominated by *Eucalyptus pilularis, Angophora costata* and *Corymbia gummifera*. Typical height is approximately 12 metres and 30% Projected foliage cover. Some in-fill planting though due to the resilience and natural succession, has been combined as one vegetation zone. Midstorey and shrub layer: Relatively moderate to dense cover of shrubs including: *Acacia sophorae, A. ulicifolia, Banksia integrifolia, B. serrata, Bossiaea rhombifolia, Leptospermum* species. Ground cover: Dominant species include: *Pteridium esculentum, Imperata cylindrica, Themeda australis, Glycine* species*, Hibbertia virgata.*	 **Plate 14. Vegetation zone – Zone 6**

PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast

Habitat: PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes has been mapped as occurring to the east of the subject site as a 2.67 ha patch. The area has been historically cleared and rehabilitated with tubestock and natural regeneration comprising predominately of *Leptospermum laevigatum* (Plate 15).

The area of rehabilitation has been aligned to PCT1646 given the following:

- Dominance of *Leptospermum laevigatum* which is a key diagnostic species of the PCT
- Occasional *Banksia serrata* and *Angophora costata* which are also key diagnostic upper stratum species
- The following species were recorded in the vegetation zone and are diagnostic species of the PCT: *Acacia longifolia, Dodonaea triquetra, Ricinocarpos pinifolius, Monotoca elliptica, Kennedia rubicunda, Pteridium esculentum, Lomandra longifolia* and *Hardenbergia violacea.*

The structure of the PCT within the subject site is described as follows:

- Canopy: Occasional presence of *Angophora costata* more towards the patch boundaries. The canopy has a projected foliage cover of approximately 5-10 percent and is approximately 15 metres in height.
- Midstorey and shrub layer: Dominated by *Leptospermum laevigatum* which forms a thicket in areas. Other shrubs include *Allocasuarina littoralis*, *Acacia longifolia, Dodonaea triquetra, Ricinocarpos pinifolius, Monotoca elliptica.*
- Ground layer: A very sparse ground layer which is likely attributed to the high amounts of leave litter and the shading from the *Leptospermum laevigatum* across the vegetation zone. Common ground cover recorded included: *Imperata cylindrica, Themeda australis, Dianella caerulea,* and *Pomax umbellata.*

Conservation Status: This PCT does not align to a TEC under the BC or EPBC Acts.

Plate 15. PCT1644 - Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes within the subject site

Non-native vegetation

Portions of the subject site where there are no native species present have been attributed to a 'non-native' vegetation type. These areas typically include existing access tracks, haul road, areas of bare sand, and existing infrastructure.

Annex 3. Floristic plot data

Note: field data was collected in electronic format, therefore raw data sheets have not been provided in this report. We can supply the raw data files in an excel format as required.

C = cover; A = Abundance; *plot outside of subject site

Plot number		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17*	
Species	Common Name	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A
Acacia longifolia		5	15	0.1	3	2	10	5	5	20	20	0.5	1	10	50	5	7			10	20	5	20	1	10	2	5							5	10
Acacia suaveolens	Sweet Wattle			0.1	2			0.2	1	0.1	1																								
Acacia ulicifolia	Prickly Moses	0.5	10	0.1	1			0.2	1					0.1	1	0.2	2							0.1	1										
Allocasuarina littoralis	Black She-Oak			2	5					1	2	0.5	1					2	3	1	3	1	1			5	5							0.5	1
Angophora costata	Sydney Red Gum	2	3	2	2	3	6	0.5	2	3	5	5	10					5	3	5	3	3	3	60	20	20	20	3	3	5		5	3	5	10
Aotus ericoides	(blank)			0.5	3							0.5	1													1	3								
Banksia integrifolia	Coast Banksia																			1	2			0.5	1	2	3								
Banksia serrata	Old-man Banksia					0.5	1	1	3	1	2	2	10					2	3			2	3	1	3					5	2	1	5		
Bidens pilosa*	Cobbler's Pegs					0.3	20	0.2	20																			0.2	20					0.1	5
Bossiaea heterophylla	Variable Bossiaea	0.2	2							0.2	2																							0.2	1
Bossiaea rhombifolia	(blank)	30	50	1	30			0.5	5					0.2	2	0.2	3			5	20			1	20	1	5			0.5	1			0.2	15
Bossiaea scolopendria	(blank)									0.5	5																							0.5	1
Breynia oblongifolia	Coffee Bush							0.1	1											1	1							0.2	2	1	2	1	3		
Caladenia catenata	(blank)																											0.1	50	0.2	50	0.5	1		
Carex spp.	(blank)							0.1	1																					0.1	5	0.1	5		
Carpobrotus glaucescens	Pigface	0.5	10			0.5	10	1	30	1	20			0.2	3	0.2	10			1	5					1	5							5	30
Cassinia arcuata	Sifton Bush							0.2	1																									0.2	1
Chrysanthemoides monilifera*	(blank)	0.1	1					0.5	5									0.1	1	2	10	5	10	2	30			1	5	1	5			0.2	1
Corybas aconitiflorus	Spurred Helmet Orchid																							0.2	10							0.1	5		
Corymbia gummifera	Red Bloodwood	2	3	10	10					2	4							3	1			3	2	5	2	3	2					1	2		
Cynodon dactylon	Common Couch																	0.2	10																
Dianella caerulea var. producta	(blank)	2	30	0.1	1			5	100	0.5	20							10	200	3	25	3	6	0.5	10			0.2	5	1	5	0.5	10	0.3	10
Dillwynia retorta	(blank)			1	10					1	20	2	10	1	5	0.5	5									2	8	0.2	5			0.1	3		
Ehrharta erecta*	Panic Veldtgrass																			1	10														
Eragrostis brownii	Brown's Lovegrass	0.5	10			0.2	3																												
Eragrostis curvula*	African Lovegrass							5	50	5	100			5	50	2	20									0.5	6	1	5						
Eucalyptus pilularis	Blackbutt	40	25	10	20			40	30									30	15			2	2			10	5	5	5	10		10			
Eustrephus latifolius	Wombat Berry																							0.1	1					0.1	1	0.1	5		
Exocarpos cupressiformis	Cherry Ballart																							1	1										
Gastrodia sesamoides	Cinnamon Bells																	0.1	1																

Glycine tabacina	Variable Glycine									0.1	1									1	3			0.5	20			0.1	5	0.1	5	0.1	5	0.1	1
Gnidia squarrosa*	(blank)					5	500			2	100			0.1	5																			0.1	2
Gonocarpus tetragynus	Poverty Raspwort																							0.5	10										
Gonocarpus teucrioides	Germander Raspwort	0.1	1	0.5	20					0.5	20											2	10							0.2	10	0.2	2	0.5	20
Hardenbergia violacea	False Sarsaparilla	0.1	1	0.1	2			0.5	5	1	20	0.1	1	0.5	2	0.5	4			1	2							0.2	3	0.1	1	0.1	3		
Heterotheca grandiflora*	Telegraph Weed					50	1000			1	50			1	100																			0.1	20
Hibbertia virgata	(blank)			0.1	1																			0.5	5					0.2	4			0.2	5
Hydrocotyle bonariensis*	(blank)													0.1	2	0.2	10																		
Hypochaeris radicata*	Catsear															0.1	5											0.1	5					0.1	2
Imperata cylindrica	Blady Grass	10	50	0.5	20	20	1000	0.1	5									10	100			3	200	1	50			5	20	5	10	5	15	40	1000
Kennedia rubicunda	Dusky Coral Pea											0.2	3					0.5	10					2	10	0.5	3							0.1	2
Leptospermum laevigatum	Coast Teatree									1	1									50	100	60	50												
Leptospermum trinervium	(blank)																													5					
Leucopogon parviflorus	Coastal Beard-heath	2	10	20	50			5	5	2	10							2	10	15	20	5	10	40	30					1	5	0.1	5	1	20
Lomandra longifolia	Spiny-headed Mat-rush	2	20	5	50			0.2	3	0.2	2							1	10	5	15			2	50			3	20			1	5	0.5	10
Melinis repens*	Red Natal Grass	0.5	5			50	1000	40	1000	40	1000			1	30	0.5	20	0.2	20	2	100													50	1000
Oenothera indecora subsp. bonariensis*	(blank)					15	500			0.5	20			5	150	1	5																		
Oxalis rubens	(blank)																	0.5	20									0.1	10			0.1	10		
Pandorea pandorana	Wonga Wonga Vine																	0.1	1			0.1	1	2	10					0.1	2				
Panicum maximum*	Guinea Grass							40	1000									1	50	3	80														
Passiflora spp.*	(blank)							0.5	1																										
Persoonia levis	Broad-leaved Geebung																							2	1										
Persoonia oblongata	(blank)	2	5	0.1	1	0.5	1	0.8	3	1	3	1	3					0.2	1			5	10			1	2							10	30
Petrorhagia dubia*	(blank)					0.1	1																												
Platysace lanceolata	Shrubby Platysace																	2	20			1	5					0.1	20						
Pomaderris elliptica	(blank)																									0.1	1								
Pomax umbellata	Pomax																													0.1	5	0.2	0.5	0.5	15
Poranthera corymbosa	(blank)			0.1	1																														
Poranthera ericifolia	(blank)																																	0.1	1
Pteridium esculentum	Bracken	0.5	5					0.1	1									1	20			3	100	70	200			3	30	15	20	10	10		
Ricinocarpos pinifolius	Wedding Bush	0.2	5	0.5	10																													0.1	1
Rytidosperma spp.	(blank)																							0.1	1					1	5	1	5		
Sonchus oleraceus*	Common Sowthistle							0.1	1																										
Themeda australis	Kangaroo Grass	0.5	30																	11	100	2	100	2	50			1	5	1	5			3	50

Wahlenbergia gracilis	Sprawling Bluebell	0.1	1			0.1	1	0.1	20	0.5	30							0.2	20									0.1	5	0.1	10	0.1	5	0.5	50

Annex 4. BAM plot transect scores

Note: field data was collected in electronic format, therefore raw data sheets have not been provided in this report. We can supply the raw data files in an excel format as required.

Key to growth form groups: TG - Tree; SG - Shrub; GG - Grass and Grass-like; FG - Forb; EG - Fern; OG – Other; **Function codes:** NLT - Number of large trees; TSSC - Tree Stem Size Class; NTH - Number of trees with hollows; FL - Course Woody Debris (fallen logs); LL - mean leaf litter cover; HTW - High Threat Weeds

* 1 m^2 litter quadrats were placed at 5 m (left), 15 m (right), 25 m (left), 35 m (right) and 45 m (left) along the central 50 m transect, all positioned 5 m from the transect centreline and alternating to the left and right from the transect centreline (as indicated).

plot	pct	area	patchsize	condition class	zone	easting	northing	bearing	compTree	compShrub	compGrass	compForbs	compFerns	compOther	strucTree	strucShrub	strucGrass	strucForbs	strucFerns	strucOther	funLargeTrees	funHollowtrees	funLitterCover	funLenFallenLogs	funTreeStem5to10	funTreeStem10to20	funTreeStem20to30	funTreeStem30to50	funTreeStem50to80	funTreeRegen
10	1644	2.67	1000	Zone3	56	391346	6364892	88	3	5	2	2	0	2	7.0	81.0	16.0	4.0	0.0	2.0	0	0	85.0	1.0	1	1	0	0	0	0
11	1644	2.67	1000	Zone3	56	391314	6364706	92	5	5	2	2	1	1	11.0	76.0	5.0	5.0	3.0	0.1	0	0	90.0	0.0	1	0	0	0	0	0
1	1646	14.13	1000	Zone1	56	390444	6364594	270	2	8	5	3	1	4	35.1	9.6	6.7	0.3	0.1	2.3	0	0	78.0	55.0	1	1	1	1	0	1
2	1646	14.13	1000	Zone1	56	390634	6364834	314	4	10	4	4	0	0	25.6	16.8	2.7	0.5	0.0	0.0	1	0	90.0	51.0	1	1	1	1	1	1
4	1646	14.13	1000	Zone1	56	390782	6364852	37	3	5	1	4	1	4	41.2	10.1	0.3	5.5	0.2	5.3	0	0	63.0	33.0	1	1	1	0	0	0
13	1646	14.13	1000	Zone1	56	390564	6364715	267	4	12	5	2	1	2	50.8	11.7	1.6	0.2	0.2	0.2	0	0	79.0	52.0	1	1	1	1	0	1
3	1646	3.87	1000	Zone2	56	390736	6364905	87	3	4	3	2	0	0	9.2	8.5	0.3	0.2	0.0	0.0	0	0	37.0	42.0	1	1	1	0	0	1
5	1646	3.87	1000	Zone2	56	390830	6364923	55	4	9	2	3	0	3	8.3	21.7	0.2	0.4	0.0	0.3	0	0	46.0	36.0	1	1	0	0	0	0
6	1646	5.19	1000	Zone4	56	390964	6364890	230	5	7	2	0	0	2	17.6	4.4	0.3	0.0	0.0	0.2	0	0	18.8	80.0	1	0	0	0	0	1
8	1646	5.19	1000	Zone4	56	391102	6365063	315	0	6	6	4	0	0	0.0	16.2	2.3	1.4	0.0	0.0	0	0	10.4	1.0	0	0	0	0	0	0
7	1646	5.19	1000	Zone4	56	391174	6365056	85	0	4	0	0	0	0	0.0	20.9	0.0	0.0	0.0	0.0	0	0	5.6	0.0	0	0	0	0	0	0
14	1646	1.71	1000	Zone5	56	390811	6364775	48	4	5	3	4	1	5	30.0	25.3	22.1	0.9	1.0	0.5	4	0	79.0	33.0	1	1	1	1	1	0
9	1646	8.09	1000	Zone6	56	391161	6364881	247	5	9	3	3	1	5	37.1	6.1	10.3	10.3	5.0	0.9	0	0	75.0	12.0	1	1	1	1	0	1
12	1646	8.09	1000	Zone6	56	391305	6364689	190	4	7	4	3	1	4	66.5	45.6	5.1	1.2	70.0	4.6	1	5	75.0	10.0	1	1	1	1	1	0
15	1646	8.09	1000	Zone6	56	390584	6364580	112	3	5	4	5	1	4	20.0	7.7	7.1	1.6	15.0	0.4	0	4	75.0	22.0	1	1	1	1	1	1
16	1646	8.09	1000	Zone6	56	390882	6364760	96	4	3	4	7	1	3	17.0	1.2	7.1	1.7	10.0	0.3	0	3	80.0	16.0	1	1	1	1	0	1

Annex 5. Fauna species list

Group	Scientific	Common name	Status	Observation	Camera trap
Amphibia	Crinia signifera	Common eastern froglet	P	H	
Amphibia	Limnodynastes peronii	Striped Marsh Frog	P	H	
Amphibia	Limnodynastes dumerilii	Eastern Banjo Frog	P	H	
Amphibia	Litoria caerulea	Green Tree Frog	P	H	
Amphibia	Litoria peronii	Perons Tree Frog	P	H	
Reptilia	Morelia spilota spilota	Diamond Python	P	O	
Reptilia	Pseudonaja textilis	Eastern Brown Snake	P	O	
Reptilia	Pseudechis porphyriacus	Red-bellied Black Snake	P	O	
Aves	Cracticus tibicen	Australian Magpie	P	H	X
Aves	Corvus coronoides	Australian Raven	P	O H	
Aves	Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	H	
Aves	Coracina novaehollandiae	Black-faced cuckoo-shrike	P	O	
Aves	Acanthiza pusilla	Brown Thornbill		O	
Aves	Anas castanea	Chestnut teal	P	O	
Aves	Platycercus elegans	Crimson Rosella	P	O H	
Aves	Artamus cyanopterus	Dusky woodswallow	P	O	
Aves	Platycercus eximius	Eastern Rossella	P	O	
Aves	Acanthorhynchus tenuirostris	Eastern Spinebill	P	O H	
Aves	Psophodes olivaceus	Eastern Whipbird	P	O H	
Aves	Eopsaltria australis	Eastern Yellow Robin	P	O H	
Aves	Cacomantis flabelliformis	Fan-tailed Cuckoo	P	O H	
Aves	Eolophus roseicapillus	Galah	P	O	
Aves	Cracticus torquatus	Grey butcherbird	P	O H	
Aves	Rhipidura albiscapa	Grey Fantail	P	H	
Aves	Welcome Swallow	Hirundo neoxena	P	O	
Aves	Dacelo novaeguineae	Laughing Kookaburra	P	O H	
Aves	Grallina cyanoleuca	Magpie Lark	P	O	
Aves	Dicaeum hirundinaceum	Mistletoebird	P	O H	
Aves	Dicaeum hirundinaceum	Mistletoebird	P	O	
Aves	Falco cenchroides	Nankeen Kestrel		O	
Aves	Phylidonyris novaehollandiae	New Holland Honeyeater	P	O H	
Aves	Philemon corniculatus	Noisy Friar Bird	P	O H	
Aves	Manorina melanocephala	Noisy Miner	P	O H	X
Aves	Rufous Whilster	Pachycephala rufiventris	P	O	
Aves	Strepera graculina	Pied Currawong	P	O H	
Aves	Trichoglossus moluccanus	Rainbow Lorikeet		O, H	
Aves	Neochmia temporalis	Red-browed finch	P	O	
Aves	Sericornis frontalis	Scrub wren		O	
Aves	Zosterops lateralis	Silvereye	P	O H	
Aves	Zosterops lateralis	Silvereye	P	O	

Group	Scientific	Common name	Status	Observation	Camera trap
Aves	Cacatua galerita	Sulphur-crested Cockatoo	P	O H	
Aves	Malurus cyaneus	Superb Fairy-wren	P	O H	
Aves	Podargus strigoides	Tawny Frogmouth	P	H	
Aves	Haliaeetus leucogaster	White-bellied Sea Eagle	V, M	O	
Aves	Sericornis frontalis	White-browed Scrubwren	P	O H	
Aves	Epthianura albifrons	White-fronted chat	P	O	
Aves	Rhipidura leucophrys	Willie Wagtail	P	O H	
Aves	Acanthiza nana	Yellow Thornbill	P	O H	
Aves	Lichenostomus chrysops	Yellow-faced honeyeater	P	O	
Aves	Calyptorhynchus funereus	Yellow-tailed black-cockatoo	P	O	
Aves	Acanthiza chrysorrhoa	Yellow-rumped Thornbill	P	O	
Mammalia	Trichosurus vulpecula	Common Brushtail Possum	P	O	X
Mammalia	Pseudocheirus peregrinus)	Common Ringtail Possum	P	O	X
Mammalia	Miniopterus schreibersii	Eastern Bentwing Bat	V	Anabat	
Mammalia	Vulpes vulpes	Fox	U	O H	
Mammalia	Scoteanax rueppellii	Greater Broad-nosed Bat	V	Anabat	Camera trap
Mammalia	Oryctolagus cuniculus	Rabbit	U	O	
Mammalia	Wallabia bicolor	Swamp Wallaby	P	O	
Reptilia	Tiliqua scincoides	Eastern Blue Tongue	P	O	
Reptilia	Physignathus lesueurii	Eastern water dragon	P	O	
Reptilia	Eulamprus quoyii	Eastern water-skink	P	O	
Reptilia	Pseudechis porphyriacus	Red-bellied black snake	P	O	
Reptilia	Ctenotus robustus	Striped Skink	P	O	

Key: W – heard; O – observed; U – ultrasonic bat call (D – definite ID, P – probable ID); V = Vulnerable.

Note: field data was collected in electronic format, therefore raw data sheets have not been provided.

Annex 6. Weather Condition

Weather conditions during survey and trapping (BoM 2020– Newcastle Nobby Station)

Date	Day	Temps		Rain	Max wind gust		9:00 AM				3:00 PM			
		Min	Max		Dir	Spd	Temp	RH	Dir	Spd	Temp	RH	Dir	Spd
		°C	°C	mm	km/h		°C	%	km/h		°C	%	km/h	
May														
20	We	10.6	23.8	0			15		N	9				
21	Th	12.6	16.8	2			13.8	96	Calm					
22	Fr	8	16.6	8.2			11	78	Calm					
23	Sa	10.5	16.2	0.8			12.5	71	NW	37				
24	Su	10.4	18	0.2			14.5	69	SW	37				
25	Mo	8.6	16.5	0			16.4	56	SW	28				
26	Tu	12.2	20.2	33.2			15.1	97	Calm					
27	We	10.7	19.8	1.4			14.5	88	Calm					
28	Th	9.8	23.2	0			11.8	99	Calm					
29	Fr	11.2	19.2	0			16.2	77	Calm					
30	Sa	8.2	20	0.4			13.8	87	Calm					
31	Su	9.7	21.2	0.2			13	94	NW	9				
June														
1	Mo	12.9	22.6	0	W	57	14.9	83	NW	6	21.9	44	NW	33
2	Tu	8.6	15.8	0	WNW	54	10.4	69	WNW	35	14.5	59	W	22
3	We	9	18.1	0.6	S	61	12.7	67	WNW	26	16.9	54	SSW	30
4	Th	12	16.5	0	SSW	54	13.8	63	SW	24	15.2	66	SW	19
5	Fr	9.6	19.4	0	NW	26	12.1	77	NW	17	18.9	51	NW	13
6	Sa	8.3	18.2	0	NW	19	11.9	80	NW	11	17.4	69	SE	7
7	Su	7.5	17.1	0	SE	41	9.8	100	WNW	11	16.4	79	SSW	11
8	Mo	9.8	18.4	9.6	SSW	50	13.8	84	SW	17	15.8	75	SW	24
9	Tu	13.6	18.7	19.6	ESE	50	17.4	84	SE	30	17.8	87	SSE	26
10	We	15.2	17.3	6.6	ENE	43	15.4	100	ENE	22	16.7	99	E	17
11	Th	14.7	19.4	10.6	S	33	15.3		NW	13	18.5	84	SSW	11
12	Fr	14.7	18.1	0.2	SW	31	16.1	89	SSW	15	17.3	89	SSW	17
13	Sa	13.3	19.4	0	NNW	19	14.2	100	WNW	7	18.6	90	ESE	4
14	Su	14.2	21.1	11.2	NW	48	14.8		NNW	17	21.1	54	NW	28
15	Mo	11	19.3	0			13.3	67	WNW	30	18.8	47	NW	17
16	Tu	11.1	20	0			13.4	76	NW	24	19.5	56	NW	19
17	We	10.2	18.7	0	SE	54	14.2	78	WNW	9	17.9	78	SSE	41
18	Th	14.2	18.2	0.6	SE	43	16.2	74	S	22	17.5	62	SSE	17
19	Fr	10.1	19.2	0.4	ENE	28	10.7		NW	9	18.9	68	ENE	11
20	Sa	8.4	20.5	0	NW	28	9.9		NW	15	20.3	58	NNW	11
21	Su	9.8	15.3	0.2	W	56	12.5	98	NW	9	12.9	86	N	6
22	Mo	10.2	16.2	7.4	NW	54	12.7	76	NW	22	15.5	57	NW	33
23	Tu	8.9	16.1	0.2	NW	46	11.4	77	WNW	30	15.3	53	NW	28
24	We	9.9	18.1	0	NW	56	12.2	71	NW	39	17.7	52	WNW	30
25	Th	10.2	17.7	0	NW	39	12.3	74	WNW	22	17.3	55	WNW	28

Date	Day	Temps		Rain	Max wind gust		9:00 AM				3:00 PM			
		Min	Max		Dir	Spd	Temp	RH	Dir	Spd	Temp	RH	Dir	Spd
		°C	°C	mm	km/h		°C	%	km/h		°C	%	km/h	
26	Fr	8.9	18.7	0	SSE	31	13	65	WNW	9	16.3	68	S	20
27	Sa	12.6	16.4	0	SSE	41	15.6	79	S	31	14.7	80	S	22
28	Su	11.6	15.7	0.4	S	39	13.8	78	WSW	11	15	75	S	26
29	Mo	9.2	18	0	ESE	20	11.7	98	NW	9	16.6	76	S	11
30	Tu	8.6	19	0	NNW	20	10.1	100	NW	11	18.7	59	N	9
July														
1	We	8.3	19.9	0.2	NW	30	10.7	83	NW	20	19.5	43	NW	20
2	Th	9.8	23.2	0	NW	44	12.9	76	NW	19	23	39	NW	24
3	Fr	12.8	20.4	0.2	S	31	15.3	73	SSW	9	20	47	W	13
November														
9	Mo	14.1	20.9	0	E	26	19.6	63	Calm		19.4	54	ESE	17
10	Tues	14.6	20.9	0	ENE	37	18.3	71	Calm		19.1	65	E	24
11	Wed	16.1	22.4	0	ENE	43	20.1	74	Calm		21.8	79	E	24
12	Thur	18.1	24.5	0	NE	41	21.2	79	N	17	22.4	83	ENE	28
13	Fri	19.3	26.4	2.8	W	81	21.9	83	NNE	11	22.8	79	ENE	24

Annex 7. Hollow-bearing tree register

Note: field data was collected in electronic format, therefore raw data sheets have not been provided in this report. We can supply the raw data files in an excel format as required.

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
97	-32.849141	151.833274	Hollow-bearing tree	2	Blackbutt	<5 cm
128	-32.852263	151.830274	Hollow-bearing tree	1	Eucalyptus pilularis	<5 cm
137	-32.851452	151.830804	Hollow-bearing tree	1	Angophora costata	<5 cm
250	-32.850558	151.838684	Hollow-bearing tree	1	Angophora	<5 cm
263	-32.849007	151.837667	Hollow-bearing tree	1	Bloodwood	<5 cm
277	-32.849143	151.834689	Hollow-bearing tree	1	Red Bloodwood	<5 cm
278	-32.849249	151.834758	Hollow-bearing tree	2	Blackbutt	<5 cm
282	-32.849217	151.834946	Hollow-bearing tree	1	Blackbutt	<5 cm
284	-32.849056	151.835259	Hollow-bearing tree	2	Angophora floribunda	<5 cm
287	-32.849077	151.835542	Hollow-bearing tree	2	Blackbutt	<5 cm
306	-32.849739	151.834242	Hollow-bearing tree	1	Angophora costata	<5 cm
337	-32.849096	151.835796	Hollow-bearing tree	1	Corymbia gummifera	<5 cm
338	-32.848783	151.835928	Hollow-bearing tree	1	Corymbia gummifera	<5 cm
340	-32.84851	151.83597	Hollow-bearing tree	1	Eucalyptus pilularis	<5 cm
342	-32.848564	151.836134	Hollow-bearing tree	1	Angophora costata	<5 cm
343	-32.848586	151.836152	Hollow-bearing tree	1	Angophora costata	<5 cm
95	-32.849067	151.833374	Hollow-bearing tree	3	Blackbutt	10 - 15 cm
96	-32.84929	151.833528	Hollow-bearing tree	8	Blackbutt	10 - 15 cm
98	-32.849486	151.834182	Hollow-bearing tree	1	Blackbutt	10 - 15 cm
101	-32.849511	151.833819	Hollow-bearing tree	2	Red bloodwood	10 - 15 cm
105	-32.851722	151.829204	Hollow-bearing tree	1	E pilularis	10 - 15 cm
112	-32.851841	151.829839	Hollow-bearing tree	1	Corymbia gummifera	10 - 15 cm
113	-32.852397	151.829489	Hollow-bearing tree	1	E pilularis	10 - 15 cm
121	-32.852369	151.830113	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
127	-32.852389	151.830201	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
151	-32.850909	151.831748	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
152	-32.850971	151.831884	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
165	-32.847322	151.838867	Hollow-bearing tree	3	Blackbutt	10 - 15 cm
166	-32.847363	151.838791	Hollow-bearing tree	3	Blackbutt	10 - 15 cm
169	-32.848563	151.83985	Hollow-bearing tree	2	Angophora costata	10 - 15 cm
170	-32.848257	151.839861	Hollow-bearing tree	3	Blackbutt	10 - 15 cm
209	-32.850082	151.837762	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
210	-32.850053	151.837726	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
215	-32.848871	151.838217	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
217	-32.848698	151.838214	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
220	-32.848372	151.837937	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
223	-32.848164	151.837343	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
225	-32.848737	151.837363	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
227	-32.849015	151.837609	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
229	-32.849157	151.837579	Hollow-bearing tree	1	Angophora floribunda	10 - 15 cm
230	-32.849221	151.837575	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
233	-32.848712	151.837152	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
234	-32.848765	151.837053	Hollow-bearing tree	1	Angophora costata	10 - 15 cm
245	-32.848927	151.839225	Hollow-bearing tree	1	Blackbutt	10 - 15 cm
253	-32.849756	151.837813	Hollow-bearing tree	6	Angophora	10 - 15 cm
267	-32.848629	151.837151	Hollow-bearing tree	10	Angophora costata	10 - 15 cm
273	-32.850138	151.830609	Hollow-bearing tree	2	Blackbutt	10 - 15 cm
280	-32.849292	151.834925	Hollow-bearing tree	3	Blackbutt	10 - 15 cm
290	-32.848828	151.835865	Hollow-bearing tree	4	Angophora costata	10 - 15 cm
316	-32.849706	151.834769	Hollow-bearing tree	1	Corymbia gummifera	10 - 15 cm
320	-32.849456	151.835137	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
327	-32.849286	151.835352	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
332	-32.849283	151.835573	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
333	-32.849258	151.835569	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
345	-32.844738	151.838607	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
347	-32.844832	151.838375	Hollow-bearing tree	1	Eucalyptus pilularis	10 - 15 cm
99	-32.849508	151.833916	Hollow-bearing tree	1	Blackbutt	15 - 20 cm
106	-32.851758	151.828972	Hollow-bearing tree	1		15 - 20 cm
111	-32.851647	151.829433	Hollow-bearing tree	1	A costata	15 - 20 cm
114	-32.852624	151.829754	Hollow-bearing tree	1	Dead	15 - 20 cm
115	-32.852453	151.829759	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
116	-32.852365	151.829829	Hollow-bearing tree	1	E pilularis	15 - 20 cm
117	-32.852312	151.829892	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
120	-32.852107	151.83001	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
123	-32.852534	151.829894	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
126	-32.852667	151.829872	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
132	-32.850445	151.830281	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
133	-32.850489	151.830294	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
140	-32.851479	151.831269	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
149	-32.850656	151.831821	Hollow-bearing tree	1	Angophora costata	15 - 20 cm
150	-32.850826	151.831792	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
159	-32.850474	151.82872	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
172	-32.846761	151.840059	Hollow-bearing tree	2	Blackbutt	15 - 20 cm
202	-32.848419	151.838265	Hollow-bearing tree	1	Angophora costata	15 - 20 cm
203	-32.85046	151.838175	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
205	-32.850518	151.838755	Hollow-bearing tree	1	Angophora costata	15 - 20 cm
207	-32.850357	151.837733	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
208	-32.850146	151.837682	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
219	-32.848585	151.83808	Hollow-bearing tree	1	Angophora costata	15 - 20 cm
228	-32.849079	151.837553	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
231	-32.849224	151.837531	Hollow-bearing tree	1	Angophora floribunda	15 - 20 cm
240	-32.849114	151.835929	Hollow-bearing tree	1	Angophora floribunda	15 - 20 cm

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
281	-32.849286	151.835006	Hollow-bearing tree	2	Pink Bloodwood	15 - 20 cm
312	-32.849528	151.834624	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
328	-32.849179	151.835305	Hollow-bearing tree	1	Eucalyptus pilularis	15 - 20 cm
94	-32.849061	151.833358	Hollow-bearing tree	1	Blackbutt	20 - 30 cm
118	-32.852259	151.829945	Hollow-bearing tree	1	Eucalyptus pilularis	20 - 30 cm
130	-32.850956	151.830248	Hollow-bearing tree	1	Eucalyptus pilularis	20 - 30 cm
131	-32.850844	151.830198	Hollow-bearing tree	1	Dead tree	20 - 30 cm
134	-32.850572	151.830453	Hollow-bearing tree	1	Eucalyptus pilularis	20 - 30 cm
148	-32.850594	151.832072	Hollow-bearing tree	1	Eucalyptus pilularis	20 - 30 cm
161	-32.84671	151.838473	Hollow-bearing tree	5	Blckbutt	20 - 30 cm
163	-32.847157	151.838921	Hollow-bearing tree	5	Blackbutt	20 - 30 cm
173	-32.846569	151.840015	Hollow-bearing tree	3	Blackbutt	20 - 30 cm
201	-32.848348	151.838087	Hollow-bearing tree	1	E pilularis	20 - 30 cm
246	-32.8491	151.839282	Hollow-bearing tree	9	Blackbutt	20 - 30 cm
271	-32.84893	151.83611	Hollow-bearing stag	0		20 - 30 cm
308	-32.849736	151.834412	Hollow-bearing tree	1	Angophora costata	20 - 30 cm
313	-32.849458	151.834555	Hollow-bearing tree	1	Angophora costata	20 - 30 cm
321	-32.849368	151.835151	Hollow-bearing tree	1	Eucalyptus pilularis	20 - 30 cm
124	-32.852577	151.829936	Hollow-bearing tree	1	Eucalyptus pilularis	30 - 40 cm
125	-32.852645	151.829982	Hollow-bearing tree	1	Eucalyptus pilularis	30 - 40 cm
129	-32.850928	151.830108	Hollow-bearing tree	1	Angophora costata	30 - 40 cm
168	-32.848413	151.8398	Hollow-bearing tree	1	Angophora costata	30 - 40 cm
171	-32.847478	151.83989	Hollow-bearing tree	7	Blackbutt	30 - 40 cm
247	-32.85063	151.838533	Hollow-bearing tree	1	Angophora	30 - 40 cm
251	-32.850294	151.837945	Hollow-bearing tree	1	Angophora	30 - 40 cm
257	-32.84873	151.837907	Hollow-bearing tree	3	Blackbutt	30 - 40 cm
261	-32.848402	151.837606	Hollow-bearing tree	1	Angophora smooth	30 - 40 cm
206	-32.85043	151.837694	Hollow-bearing tree	6	Eucalyptus pilularis	40+ cm
222	-32.848061	151.837793	Hollow-bearing tree	1	Eucalyptus pilularis	40+ cm

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
252	-32.850195	151.837827	Hollow-bearing tree	2	Angophora	40+ cm
259	-32.848181	151.837702	Hollow-bearing tree	1	Blackbutt	40+ cm
270	-32.848984	151.836041	Hollow-bearing tree	3	Angophora costata	40+ cm
275	-32.849267	151.833275	Hollow-bearing stag	0		40+ cm
93	-32.850518	151.832062	Hollow-bearing tree	6	Blackbutt	5 - 10 cm
100	-32.849542	151.833858	Hollow-bearing tree	5	Blackbutt	5 - 10 cm
107	-32.851839	151.829128	Hollow-bearing tree	1	A costata	5 - 10 cm
108	-32.851994	151.82941	Hollow-bearing tree	1	E. Pilularis	5 - 10 cm
109	-32.852034	151.829521	Hollow-bearing tree	1	E pilularis	5 - 10 cm
110	-32.851817	151.829441	Hollow-bearing tree	1	A costata	5 - 10 cm
142	-32.851319	151.831604	Hollow-bearing tree	1	Eucalyptus pilularis	5 - 10 cm
158	-32.851144	151.830759	Hollow-bearing tree	1	Dead - unsure if hollows	5 - 10 cm
160	-32.845063	151.838918	Hollow-bearing tree	4	Blackbutt	5 - 10 cm
164	-32.847181	151.83882	Hollow-bearing tree	3	Blackbutt	5 - 10 cm
211	-32.849827	151.837624	Hollow-bearing tree	1	Angophora costata	5 - 10 cm
218	-32.848883	151.837988	Hollow-bearing tree	1	Eucalyptus pilularis	5 - 10 cm
221	-32.848288	151.837941	Hollow-bearing tree	1	Angophora costata	5 - 10 cm
242	-32.848444	151.836887	Hollow-bearing tree	1	Angophora floribunda	5 - 10 cm
244	-32.848675	151.83914	Hollow-bearing tree	3	Blackbutt	5 - 10 cm
248	-32.850756	151.838098	Hollow-bearing tree	3	Angophora	5 - 10 cm
249	-32.850752	151.838657	Hollow-bearing tree	3	Angophora	5 - 10 cm
254	-32.84966	151.837887	Hollow-bearing stag	0		5 - 10 cm
255	-32.848979	151.837923	Hollow-bearing tree	2	Angophora	5 - 10 cm
258	-32.848236	151.837739	Hollow-bearing tree	1	Blackbutt	5 - 10 cm
260	-32.84802	151.837643	Hollow-bearing tree	1	Blackbutt	5 - 10 cm
262	-32.848787	151.837687	Hollow-bearing tree	3	Angophora floribunda	5 - 10 cm
264	-32.849309	151.837811	Hollow-bearing stag	0		5 - 10 cm
265	-32.849393	151.837839	Hollow-bearing tree	3	Blackbutt	5 - 10 cm
266	-32.849396	151.837756	Hollow-bearing tree	2	Angophora smooth	5 - 10 cm

ID no.	latitude	longitude	Habitat feature	No. hollows	Tree	Size category
269	-32.848846	151.836394	Hollow-bearing tree	4	Angophora costata	5 - 10 cm
274	-32.850137	151.83065	Hollow-bearing tree	2	Blackbutt	5 - 10 cm
276	-32.849266	151.833242	Hollow-bearing stag	0		5 - 10 cm
279	-32.849438	151.834686	Hollow-bearing tree	3	Bloodwood	5 - 10 cm
283	-32.849099	151.835168	Hollow-bearing tree	1	Blackbutt	5 - 10 cm
285	-32.849043	151.835357	Hollow-bearing stag	0		5 - 10 cm
286	-32.849138	151.835529	Hollow-bearing stag	0		5 - 10 cm
288	-32.849054	151.835596	Hollow-bearing tree	3	Angophora costata	5 - 10 cm
289	-32.849124	151.835677	Hollow-bearing tree	3	Angophora costata	5 - 10 cm
305	-32.849736	151.83424	Hollow-bearing tree	1	Angophora costata	5 - 10 cm
334	-32.849329	151.835655	Hollow-bearing tree	1	Corymbia gummifera	5 - 10 cm
339	-32.848497	151.835938	Hollow-bearing tree	1	Eucalyptus pilularis	5 - 10 cm
344	-32.848384	151.836739	Hollow-bearing tree	1	Eucalyptus pilularis	5 - 10 cm

Annex 8. Ecosystem and species credits required (BAM-C Credit report)

BAM Credit Summary Report

Proposal Details

Assessment Id
00038433/BAAS17033/23/00038434

Proposal Name
Stockton Sand Quarry Dredging 2023

BAM data last updated *
22/06/2023

Assessor Name
Luke Baker

Report Created
10/08/2023

BAM Data version *
61

Assessor Number
BAAS17033

BAM Case Status
Open

Date Finalised
To be finalised

Assessment Revision
0

Assessment Type
Major Projects

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

Zone	Vegetation zone name	TEC name	Current Vegetation integrity score	Change in Vegetation integrity (loss / gain)	Area (ha)	Sensitivity to loss (Justification)	Species sensitivity to gain class	BC Act Listing status	EPBC Act listing status	Biodiversity risk weighting	Potential SAII	Ecosystem credits

Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast												
1	1644_Zone3	Not a TEC	23.1	23.1	2.7	PCT Cleared - 86%	High Sensitivity to Gain			2.00		31
											Subtotal	**31**
Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast												
2	1646_Zone1	Not a TEC	54.4	54.4	14.1	PCT Cleared - 45%	High Sensitivity to Gain			1.50		288
3	1646_Zone2	Not a TEC	27	27.0	3.8	PCT Cleared - 45%	High Sensitivity to Gain			1.50		39
4	1646_Zone4	Not a TEC	15.7	15.7	5.1	PCT Cleared - 45%	High Sensitivity to Gain			1.50		0
5	1646_Zone5	Not a TEC	65.8	65.8	1.7	PCT Cleared - 45%	High Sensitivity to Gain			1.50		42
6	1646_Zone6	Not a TEC	55.7	55.7	8.2	PCT Cleared - 45%	High Sensitivity to Gain			1.50		171
											Subtotal	**540**
											Total	**571**

Species credits for threatened species

BAM Credit Summary Report

Vegetation zone name	Habitat condition (Vegetation Integrity)	Change in habitat condition	Area (ha)/Count (no. individuals)	Sensitivity to loss (Justification)	Sensitivity to gain (Justification)	BC Act Listing status	EPBC Act listing status	Potential SAII	Species credits
Petaurus norfolcensis / Squirrel Glider (Fauna)									
1644_Zone3	23.1	23.1	2.7	Biodiversity Conservation Act listing status	Species dependent on habitat attributes	Vulnerable	Not Listed	False	31
1646_Zone1	54.4	54.4	14.1	Biodiversity Conservation Act listing status	Species dependent on habitat attributes	Vulnerable	Not Listed	False	384
1646_Zone5	65.8	65.8	1.7	Biodiversity Conservation Act listing status	Species dependent on habitat attributes	Vulnerable	Not Listed	False	56
1646_Zone6	55.7	55.7	8.2	Biodiversity Conservation Act listing status	Species dependent on habitat attributes	Vulnerable	Not Listed	False	229
								Subtotal	**700**

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00038433/BAAS17033/23/00038434

Proposal Name
Stockton Sand Quarry Dredging 2023

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Assessor Name
Luke Baker

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Proponent Names

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Assessment Type
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Date Finalised
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Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1644-Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Not a TEC	2.7	0	31	31
1646-Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Not a TEC	33.0	171	369	540

1644-Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	South Coast Sands Dry Sclerophyll Forests This includes PCT's:	South Coast Sands Dry Sclerophyll Forests >=70% and <90%	1644_Zone3	No	31	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1646-Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone1	No	288	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone2	No	39	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone4	No	0	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone5	No	42	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone6	Yes	171	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Petaurus norfolcensis / Squirrel Glider	**1644_Zone3, 1646_Zone1, 1646_Zone5, 1646_Zone6**	26.7	700.00

Credit Retirement Options

Like-for-like credit retirement options

	Spp	IBRA subregion
Petaurus norfolcensis / Squirrel Glider	**Petaurus norfolcensis /** Squirrel Glider	Any in NSW

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
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Proposal Name
Stockton Sand Quarry Dredging 2023

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Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
No Changes

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1644-Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	Not a TEC	2.7	0	31	31.00
1646-Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	Not a TEC	33.0	171	369	540.00

1644-Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
South Coast Sands Dry Sclerophyll Forests This includes PCT's:	South Coast Sands Dry Sclerophyll Forests >=70% and <90%	1644_Zone 3	No	31	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 2 or higher threat status	1644_Zone 3	No	31	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1646-Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone 1	No	288	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone 2	No	39	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone 4	No	0	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone 5	No	42	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Coastal Dune Dry Sclerophyll Forests This includes PCT's: 3544, 3545, 3546, 3547, 3548, 3549, 3550, 3551, 3552, 3553, 3554, 3555, 3556	Coastal Dune Dry Sclerophyll Forests <50%	1646_Zone 6	Yes	171	Karuah Manning,Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region
Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 4 or higher threat status	1646_Zone 1	No	288	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 4 or higher threat status	1646_Zone 2	No	39	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 4 or higher threat status	1646_Zone 4	No	0	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 4 or higher threat status	1646_Zone 5	No	42	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 4 or higher threat status	1646_Zone 6	Yes (including artificial)	171	IBRA Region: NSW North Coast, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Petaurus norfolcensis / Squirrel Glider	**1644_Zone3, 1646_Zone1, 1646_Zone5, 1646_Zone6**	26.7	700.00

Credit Retirement Options

Like-for-like options

Petaurus norfolcensis/ Squirrel Glider	Spp		IBRA region
	Petaurus norfolcensis/Squirrel Glider		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Karuah Manning, Hunter, Macleay Hastings, Mummel Escarpment and Upper Hunter. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Annex 9. EPBC Act Significant Impact Criteria Assessment

Matters for Assessment

Assessments of Significance and supplementary information (where relevant) are presented for the following MNES in relation to the Project:

- Black-faced Monarch
- White-throated Needletail
- Spotted-tail Quoll
- Long-nosed Potoroo
- Koala
- New Holland Mouse
- Grey-headed Flying-fox.

Koala

In assessing the significance of the impact from the proposed action on the Koala, the '*EPBC Act referral guidelines for the vulnerable koala*' were applied to the assessment. The following information is presented prior to the Assessment of Significance for the Koala to demonstrate application of the guidelines and to assist with understanding the assessment and its conclusion.

Koala Habitat Assessment Scoring (Department of the Environment (2014). EPBC Act Referral Guidelines for the vulnerable Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory). Commonwealth of Australia, 2014.):

Attribute	Score	Habitat Appraisal
Koala occurrence	+1	Koalas have not been recorded by Boral within the subject site nor their mining lease. Koala have been encountered infrequently adjacent to the subject site as evident with the records from BioNet. The closest record is along Nelson Bay Road towards the entrance to the Quarry (record from 2013). The result of the survey indicate that the Koala is not frequently using the subject site.
Vegetation Structure and composition	0	Habitat scoring was applied across the subject site using floristic data and cover values from 400m^2 quadrats. The mapping indicated that the majority of the subject site did not contain either two or more known primary or secondary feed trees that occupied more than 50% of the quadrat.
Habitat connectivity	+2	The subject site is part of a contiguous landscape of > 500 ha.
Key existing threats	+1	There is no known documented or anecdotal evidence of Koala mortality from dog attack or vehicle collision within the subject site or surrounds. Dogs, trucks, and vehicle movements are all present within the subject site.
Recovery value	0	Uncertain whether the habitat within the subject sites will be important in achieving the interim recovery objectives. The habitat is not thought to specifically act as a habitat refuge. The subject site has already been impacted and Koalas are still occurring within the locality which demonstrates that the subject site is not of significance importance to the survival of the population.
Total	**4/10**	

Koala (vulnerable)	
Criteria (Vulnerable Species)	Likelihood
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is considered unlikely that the Project would lead to a long-term decrease in the size of an important population of the Koala. The subject site is centred around the previously cleared mine pit. The location of the subject site does not occur within an area that is frequently used by Koalas, as evident in the results of the field survey. The location of the subject site would not fragment habitat, or impeded connectivity for the species given the surrounding native vegetation would remain intact. It is highly unlikely that the Project would decrease an important population of the Koala	Unlikely
reduce the area of occupancy of an important population;	
No important population occurs within the subject site. The Project is unlikely to reduce the occupancy of an important population as the subject site is not used on a regular basis by the Koala. The Koala can utilise a range of eucalypts for foraging, and as such, any portion of the site that contain eucalypts could be used by the Koala. However, our field survey results confirmed that the Koala is not utilising the subject site frequently.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for the identified population. As previously discussed, the subject site would not result in fragmentation or obstruction of movement throughout the landscape.	Unlikely
adversely affect habitat critical to the survival of a species;	
The habitat within the subject site is not regarded as habitat critical to the survival of the Koala as determined through application of the Koala habitat assessment tool (DoE 2014), which is illustrated in the table above. The habitat within the disturbance area scores a 4/10. A score of less than 5 does not indicate critical habitat.	Unlikely
disrupt the breeding cycle of an important population	
Habitat within the subject site is not thought to be a key breeding area due to the low number of records surrounding the subject site, no signs of the Koala during field survey, and given the species has not been recorded by mine staff over the past decade. Therefore, removal of the habitat is unlikely to disrupt the breeding cycle of the population. The area constitutes a very small proportion of the overall habitat for the population as clearing evidence by the scale of the vegetation corridor along Stockton Beach.	Unlikely
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The subject site does not contain primary or secondary feed trees as defined in the DoE (2014) guideline. The surrounding locality offers a greater availability of foraging habitat for the Koala. The removal of potential habitat within the subject site is unlikely to have any impact on patterns of Koala movement, or impact foraging resources such that the species is likely to decline.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
Predatory species such as foxes and wild dogs are already established within the locality. The Project is unlikely to further encourage these threats from occurring.	Unlikely
introduce disease that may cause the species to decline, or	

The main diseases affecting Koalas are chlamydial infections. The Project would not increase exposure to such infections as Koalas from the local population would not have increased contact with other Koala populations including infected populations.	Unlikely
interfere substantially with the recovery of the species.	
The following aspects are considered in relation to the possibility of the Project to interfere with the recovery of the Koala (from DoE 2014): *Increasing koala fatalities in habitat critical to the survival of the koala due to dog attacks to a level that is likely to result in multiple, ongoing mortalities.* There is no reason to suspect that dogs would become more prevalent within the subject site or surrounds as a result of the Project; *Increasing koala fatalities in habitat critical to the survival of the koala due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities.* There have been no reported Koala fatalities due to vehicle strike within the quarry or along access roads. Additional vehicle movements are expected to occur as a result of the Project but are expected to presented a low risk to the Koala. The Project would ensure the continuation of the current regime of vehicle movements within the subject site. There are strict speed controls on the vehicles operating within the quarry and as such it is considered that the risk of increased fatalities such that multiple ongoing fatalities occur is very low; *Facilitating the introduction or spread of disease or pathogens for example Chlamydia or Phytophthora cinnamomi, to habitat critical to the survival of the koala, that are likely to significantly reduce the reproductive output of koalas or reduce the carrying capacity of the habitat*; The Project is not likely to introduce Chlamydia or Phytophthora cinnamomic to the subject site and surrounds. All works will be undertaken as per the BMP detailed in section 5 of this BDAR. *Creating a barrier to movement to, between or within habitat critical to the survival of the koala that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala.* The subject site would not create a barrier to Koala movement. As shown on Figure 8, a wildlife movement corridor would still remain. *Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term.* The Project is unlikely to alter the hydrology to the extent that it would result in the degradation of remaining habitat critical to the survival of the Koala.	Unlikely
Conclusion: It is unlikely that the Project would result in a significant impact to an important population of the Koala.	

Migratory Species - Black-faced Monarch, White-throated Needletail	
Criteria (Migratory Species)	Likelihood
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species, or	
No important habitat for any of the potentially occurring migratory species is likely to occur within the subject site.	Unlikely
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	
No invasive species of particular significance to the identified migratory species are expected to be established as a result of the Project. The subject site is already affected by invasive plants including some high threat weeds and introduced fauna such as the Rabbit which have some potential to adversely impact most fauna occurring within the subject site and surrounds. New invasive species are unlikely to become established due to the Project if mitigation measures are adhered to, including pest and weed management.	Unlikely
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	
None of the potentially occurring migratory species would have a significant proportion of their population occurring within the subject site.	Unlikely
Conclusion: The Project would remove 35.67 hectares of native vegetation, which for the most part, consists of sparsely scattered tubestock with a lack of microhabitat features such as fallen logs and hollow-bearing trees. None of the above species occur in significant numbers within the subject site and the subject site does not support significant breeding habitat such that it may be used by a significant number of individuals to conduct any aspect of their lifecycle including foraging, breeding, overwintering or sheltering. The Project is not likely to result in a significant impact on the Black-faced Monarch or the White-throated Needletail.	

Grey-headed Flying-fox (Vulnerable)	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
It is not expected that any impacts on breeding or roosting habitat for the Grey-headed Flying-fox would result from the Project as breeding/roosting camps will not be impacted and do not occur in the subject site. Impacts from the Project constitute impacts to foraging habitat of which approximately 35.67 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with areas of remnant woodland. There are a variety of different canopy species present within proposed disturbance areas, some of which may contribute to winter and spring food availability. The significance of this contribution is not expected to be high as the expanse of similar foraging habitat within the locality is high. Regardless, potential foraging habitat would remain relatively abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
No Grey-headed Flying Fox camp sites occur in the subject site or immediate surrounds. The Grey-headed Flying Fox forage opportunistically, often at distances up to 30 km from camps, and occasionally up to 60-70 km per night, in response to patchy food resources (Augee and Ford 1999; Tidemann 1999). The subject site may be used on occasion for foraging given the species feeds on a variety of eucalypts, which occur within a wide range vegetation communities. The reduction of 35.67 ha of potential habitat for the species is relatively minor compared to the availability of habitat across the locality. And furthermore, the proposed development would not restrict the Grey-headed Flying-fox from utilising foraging habitat throughout the locality. We therefore conclude that the Project would not reduce the availability of occupancy for an important population such that any significant disruption to the species would occur.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Grey-headed Flying-fox is a mobile species and the Project would not impact on areas where the species is known to breed and roost.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species has been loosely nominated within DECCW (2009) *Draft National Recovery Plan for the Grey-headed Flying-fox.* The Draft plan contains a definition for critical foraging habitat, and critical roosting habitat which have been addressed below: <u>Critical Roosting Habitat</u> DECCW (2009) states that habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Grey-headed Flying-foxes. Roosting habitat that: 1. *is used as a camp either continuously or seasonally in > 50% of years* **Response**: The subject site and immediate surrounds are not used as a camp site presently, or historically. 2. *has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 10 000 individuals, unless such habitat has been used only as a temporary refuge, and the use has been of limited duration (i.e. in the order of days rather than weeks or months)*	Unlikely

Response: As discussed above, the subject site and immediate surrounds are not used as a camp site presently, or historically. 3. *has been used as a camp at least once in 10 years (beginning in 1995) and is known to have contained > 2 500 individuals, including reproductive females during the final stages of pregnancy, during lactation, or during the period of conception (i.e. September to May).* **Response**: As above. <u>Critical Foraging Habitat</u> DECCW (2009) states that foraging habitat that meets at least one of the following criteria can be explicitly identified as habitat critical to survival, or essential habitat, for Grey-headed Flying Foxes. Natural foraging habitat that is: 1. *productive during winter and spring, when food bottlenecks have been identified (ParryJones and Augee 1991, Eby et al. 1999):* **Response:** The DECCW (2009) do not provide guidance around what constitutes a 'productive' natural foraging habitat, nor a 'food bottleneck'. As previously discussed, the subject site may be used on occasion for foraging given the species feeds on a variety of eucalypts. We have conservatively determined 30.66 ha of potential foraging habitat occurs within the Study Area. Similar potential foraging habitat is relatively available throughout the locality which would not be impacted by the Project. For the most part, the foraging habitat surrounding the subject site is likely to be in a better condition to that of the subject site, given historic vegetation clearing and grazing has not occurred. As such, whilst the site does contain potential foraging habitat, it is unlikely to be of significantly productive during both winter and spring to an extent that it is critical foraging habitat for the species. 2. *known to support populations of > 30 000 individuals within an area of 50 km radius (the maximum foraging distance of an adult)* **Response**: The subject site does not support a population of >30,000 individuals. 3. *productive during the final weeks of gestation, and during the weeks of birth, lactation and conception (September to May)* **Response:** No, the subject site is highly unlikely to be productive for the species given absence of roost sites and the distance from known camps. As discussed above, the locality contains important feed trees and foraging habitat that is not impacted by the Project. 4. *productive during the final stages of fruit development and ripening in commercial crops affected by Grey-headed Flying-foxes (months vary between regions)* **Response:** No, the subject site is highly unlikely to be productive for the species given absence of roost sites and the distance from known camps. No commercial crops or important commercial fruit trees would be impacted by the Project. 5. *known to support a continuously occupied camp* **Response:** No camp site occur within the subject site.	
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as breeding events for this species primarily take place within camps, none of which would be adversely impacted by the Project.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	

The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the subject site and the Project is not expected to increase the level of predation threat for the Grey-headed Flying-fox.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any bat diseases.	Unlikely
interfere substantially with the recovery of the species.	
The Project does not directly or substantially interfere with any of the specific recovery objectives under the draft National Recovery Plan (Commonwealth of Australia 2017). A general objective is to lessen the currently operating threats to the species which includes the removal of foraging habitat. The Project is therefore not consistent with this general objective. However, the amount and type of foraging habitat removal is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Grey-headed Flying-fox within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas.	

Spotted-tail Quoll Vulnerable)	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
The Spotted-tail Quoll was not recorded during the extensive field survey, nor has been recorded previously at the subject site and within the Boral mining lease. Impacts from the Project constitute impacts to potential foraging habitat of which approximately 35.67 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with areas of remnant woodland. Potential foraging habitat would remain abundant within the locality. It is unlikely that the subject site provides the only foraging resource for the species in the locality. The proposed removal of potential foraging habitat is therefore not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
It is unlikely that an important population of the Spotted-tail Quoll occurs in the subject site, as the species was not detected during the survey, and there is only one previous record of the species within a 10 km radius of the subject site. The Project would not impact the area of occupancy of the Spotted-tail Quoll for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • Spotted-tail Quoll would still be expected to forage within the vicinity of the subject site, given potential foraging habitat extends beyond the subject site boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Long-nosed Potoroo is a mobile species and the Project would not impact on areas where the species is known to occur.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species is not likely to include the subject site, as no known previous records occur in the subject site. Further, the majority of the subject site does not support the dense understorey that is considered important for the species, as it consists of rehabilitated areas where the understorey and ground cover is sparse. Therefore, the potential foraging habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as the habitat to be impacted by the Project is marginal and no known populations occur in the subject site.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	

The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the subject site and the Project is not expected to increase the level of predation threat for the Spotted-tail Quoll.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
Currently, there is no recovery plan for this species. The amount and type of foraging habitat removal required for the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Spotted-tail Quoll Potoroo within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas.	

Long-nosed Potoroo (Vulnerable)	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
The Long-noised Potoroo was not recorded during the extensive field survey, nor has been recorded previously at the subject site and within the Boral mining lease. Impacts from the Project constitute impacts to potential foraging habitat of which approximately 35.67 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with areas of remnant woodland. Potential foraging habitat would remain abundant within the locality. It is unlikely that the subject site provides the only foraging resource for the species in the locality. The proposed removal of potential foraging habitat is therefore not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
It is unlikely that an important population of the Long-nosed Potoroo occurs in the subject site, as the species was not detected during the survey, and there is only one previous record of the species within a 10 km radius of the subject site. The Project would not impact the area of occupancy of the Long-nosed Potoroo for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • Long-nosed Potoroo would still be expected to forage within the vicinity of the subject site, given potential foraging habitat extends beyond the subject site boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The Long-nosed Potoroo is a mobile species and the Project would not impact on areas where the species is known to occur.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species is not likely to include the subject site, as no known previous records occur in the subject site. Further, the majority of the subject site does not support the dense understorey that is considered important for the species, as it consists of rehabilitated areas where the understorey and ground cover is sparse. Therefore, the potential foraging habitat to be removed is not considered critical to the species survival.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as the habitat to be impacted by the Project is marginal and no known populations occur in the subject site.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely

result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	
The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the subject site and the Project is not expected to increase the level of predation threat for the Long-nosed Potoroo.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
Currently, there is no recovery plan for this species. The amount and type of foraging habitat removal required for the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the Long-nosed Potoroo within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution (predominately the understorey is sparse) or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas.	

New Holland Mouse (Vulnerable)	
Preamble The New Holland Mouse currently has a disjunct, fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Across the species' range the New Holland Mouse is known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes. The New Holland Mouse has been attributed a moderate likelihood of occurrence as the species has been recorded within Worimi Regional Park and Worimi State Conservation Area and may utilise the subject site for foraging.	
Criteria (Vulnerable Species)	**Likelihood**
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:	
lead to a long-term decrease in the size of an important population of a species;	
Impacts from the Project constitute impacts to foraging habitat of which approximately 35.67 hectares would be cleared. The foraging habitat is considered to be of marginal quality for the species, being mostly rehabilitation, with some areas of remnant woodland. Over time, foraging habitat would be at least partially restored through rehabilitation works. Regardless of rehabilitation works, potential foraging habitat would remain abundant within the locality and the currently proposed removal of foraging habitat is not expected to cause a long-term decrease to any population of the species.	Unlikely
reduce the area of occupancy of an important population;	
The Project would not impact the area of occupancy of the New Holland Mouse for the following reasons: • The areas to be cleared are not sufficient in extent to impact the area of occupancy of the species at a 2km grid square scale (which is the standard unit for measuring area of occupancy according to the IUCN); and • New Holland Mouse would still be expected to forage within the vicinity of the subject site, given potential habitat extends beyond the subject site boundary.	Unlikely
fragment an existing important population into two or more populations;	
The Project is unlikely to increase fragmentation for any population of the species. The New Holland Mouse is a mobile species and the Project would not impact on areas where the species is known to occur.	None
adversely affect habitat critical to the survival of a species;	
Habitat critical to the survival of the species is not likely to include the subject site, as no known previous records occur in the subject site. The potential foraging habitat to be removed is not considered critical to the species survival, given the majority of the area to be impacted consists of rehabilitated areas.	Unlikely
disrupt the breeding cycle of an important population	
The Project is unlikely to disrupt the breeding cycle of the species as the habitat to be impacted by the Project is marginal (mostly rehabilitation) and no known populations occur in the subject site.	None
modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;	
The extent of foraging habitat to be removed is not considered sufficient to result in the decline of the species given the local abundance of similar habitat. The Project would not isolate areas of foraging habitat.	Unlikely
result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;	

The Project is unlikely to increase the likelihood of weeds being established in areas adjacent to disturbance areas that constitute potential foraging habitat for the species. The Project will include measures to control weeds becoming established in such areas through the implementation of a Landscape and Rehabilitation Plan. Potential invasive predators such as the fox are likely to be already present within the subject site and the Project is not expected to increase the level of predation threat for the New Holland Mouse.	Unlikely
introduce disease that may cause the species to decline, or	
There are no known documented diseases that are currently contributing to the decline of the species. The Project in not expected to cause an increased risk of any diseases.	Unlikely
interfere substantially with the recovery of the species.	
Currently, there is no recovery plan for this species. The amount and type of foraging habitat removal required for the Project is not considered to constitute substantial interference with the recovery of the species.	Unlikely
Conclusion: Impacts from the Project relate to the removal of foraging habitat for the New Holland Mouse within the proposed disturbance areas. Whilst protection of foraging habitat is considered important for this species, impacts from the Project are not considered to be significant for the following reasons: • The habitat to be removed is not considered to be particularly important foraging habitat in terms of its constitution or size; • Similarly important foraging habitat occurs throughout the locality including within protected areas.	

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Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)

Appendix I

Air quality and greenhouse gas assessment

AIR QUALITY IMPACT AND GREENHOUSE GAS ASSESSMENT

STOCKTON QUARRY DRY SAND EXTRACTION PROJECT

Boral Resources (NSW) Pty Ltd

20 June 2023

Job Number 22111497

Prepared by
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Air Quality Impact and Greenhouse Gas Assessment Stockton Quarry Dry Sand Extraction Project

DOCUMENT CONTROL

Report Version	Prepared by	Reviewed by
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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Boral Construction Material Limited on behalf of Boral Resources (NSW) Pty Ltd (Boral). The report presents an assessment of potential air quality impacts and greenhouse gas emissions associated with the proposed dry sand extraction operation of the inland dunes at the Stockton Sand Quarry (hereafter referred to as the Project).

The Project involves the extraction of sand from the inland vegetated dunes over a series of five stages, commencing in Stage 1. The Project would involve the extraction of sand above the water table from approximately 26 m AHD (in Stage 1) down to approximately 3.7 m AHD, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the current dredge application (SSD 9490) presented in the *Air Quality Impact Assessment Stockton Sand Quarry*. (**Todoroski Air Sciences, 2019**). Vegetation within the Project area is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

To assess the potential air quality and greenhouse gas impacts associated with the proposed Project, this report incorporates the following aspects:

- A background and description of the existing operations and proposed Project;
- A review of the meteorological and air quality environment surrounding the Project site;
- A description of the dispersion modelling approach used to assess potential air quality impacts;
- Presentation of the predicted results and a discussion of the potential air quality impacts; and,
- Calculation of the potential greenhouse gas emissions associated with the Project.

This air quality impact and greenhouse gas assessment has been prepared in general accordance with the New South Wales (NSW) Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**). The assessment forms part of the Environmental Impact Statement (EIS) prepared to accompany the State Significant Development (SSD) application for the Project.

2 PROJECT BACKGROUND

2.1 Project overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in **Figure 2-1**, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Figure 2-1: Local context

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to

lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 2-2 shows the quarry, the project, and the existing windblown project.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the project on 18 January 2023. This Air Quality Impact and Greenhouse Gas Assessment has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project.

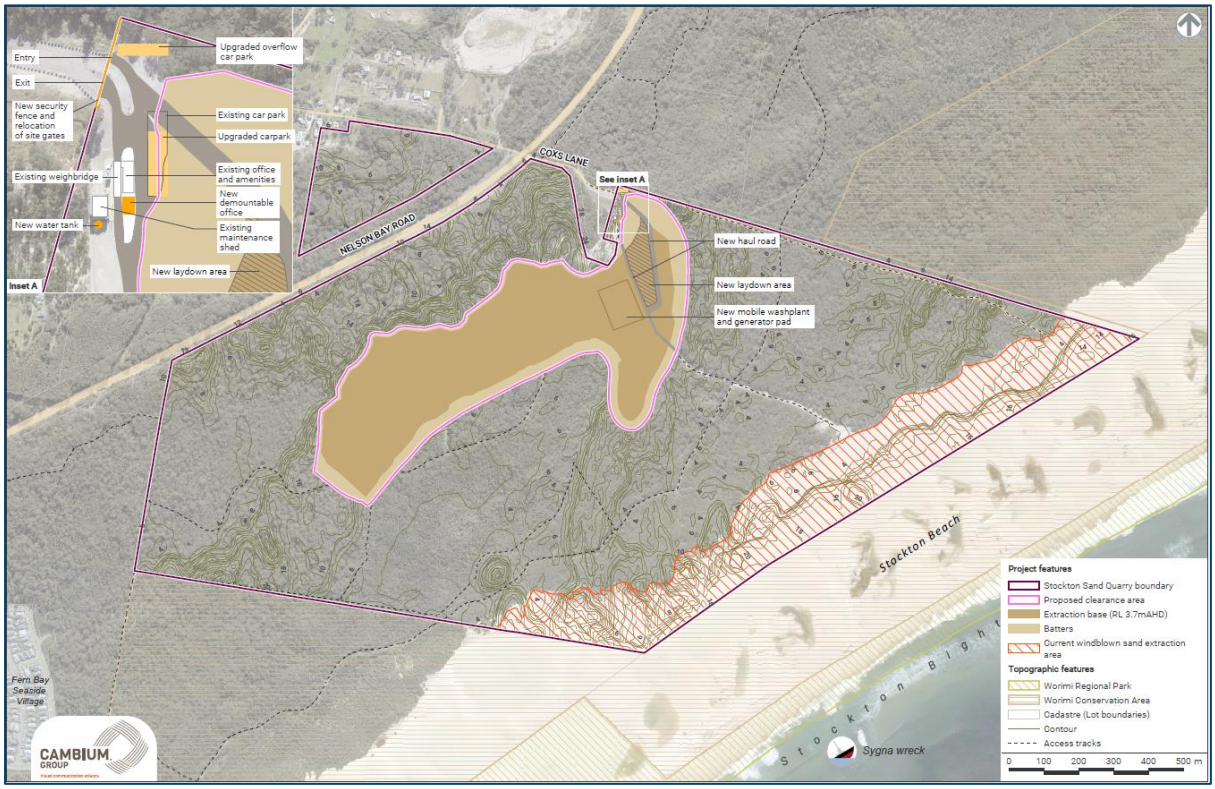

Figure 2-2: The Project

2.2 Project description

As shown in **Figure 2-2**, the project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to a minimum 0.7 m above the water table, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in **Figure 2-3**, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project (shown in **Figure 2-3**) mirror the first five stages of the dredge application. This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in **Figure 2-2**, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

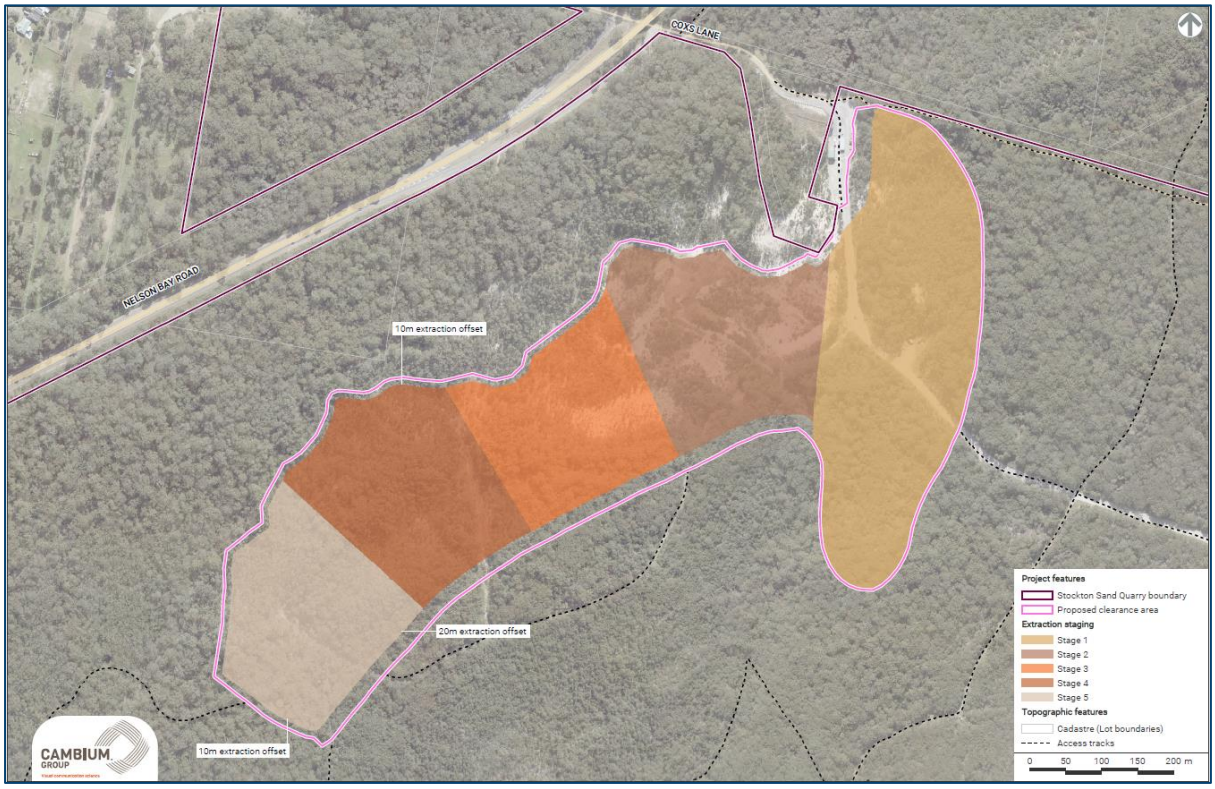

Figure 2-3: Extraction staging plan

2.3 Project setting

The Project site is located in Fullerton Cove, approximately 9.8km north-northeast of Newcastle Central Business District (CBD), within the Port Stephens LGA. The surrounding land use is a mixture of rural, residential, public recreation and environment conservation areas.

Figure 2-4 presents the location of the Project site and nearest residential receptor locations assessed as discrete receptors in this assessment. The nearest residential receptors to the Project site are located on Coxs Lane approximately 0.5km to the northwest of the site entrance. Two residential receptors located in the Fern Bay Seaside Village residential development have been included and are considered representative of this location.

Figure 2-5 presents a pseudo three-dimensional visualisation of the topography in the general vicinity of the Project site. The Project site can be characterised as gently undulating with flat terrain to west and northwest and sand dunes to the east on Stockton Beach.

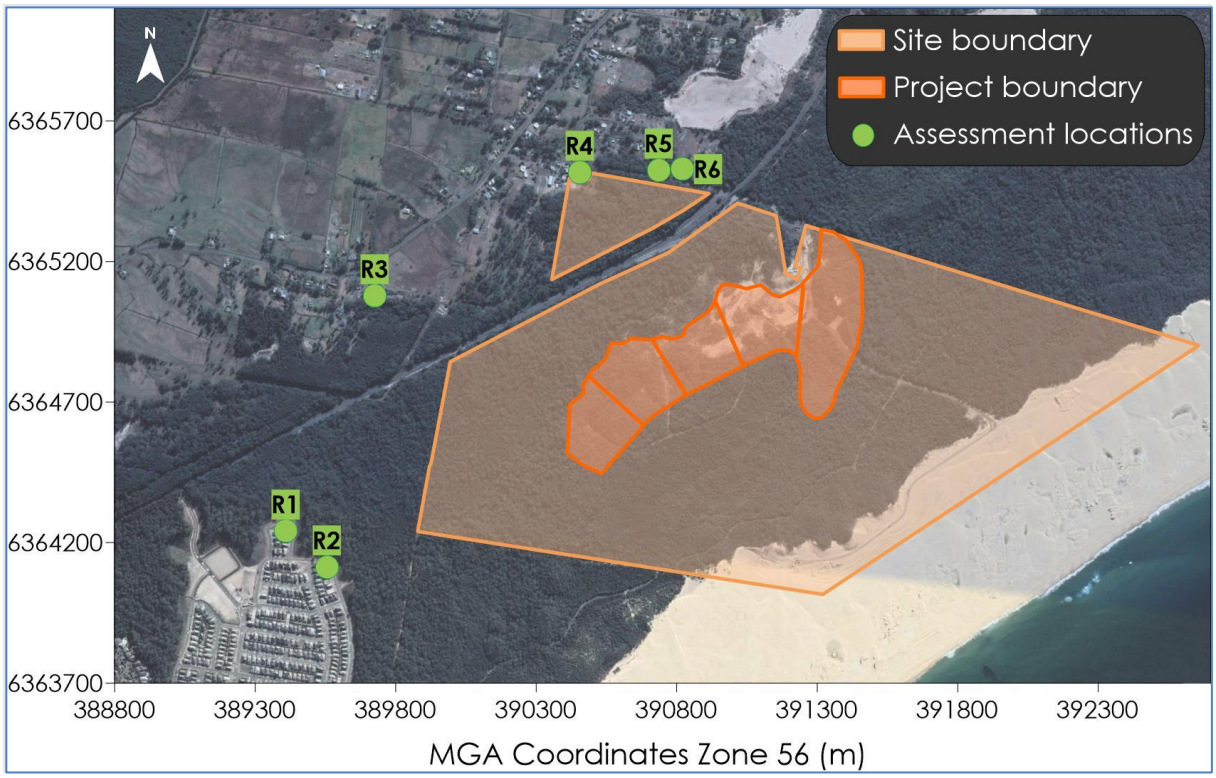

Figure 2-4: Project setting

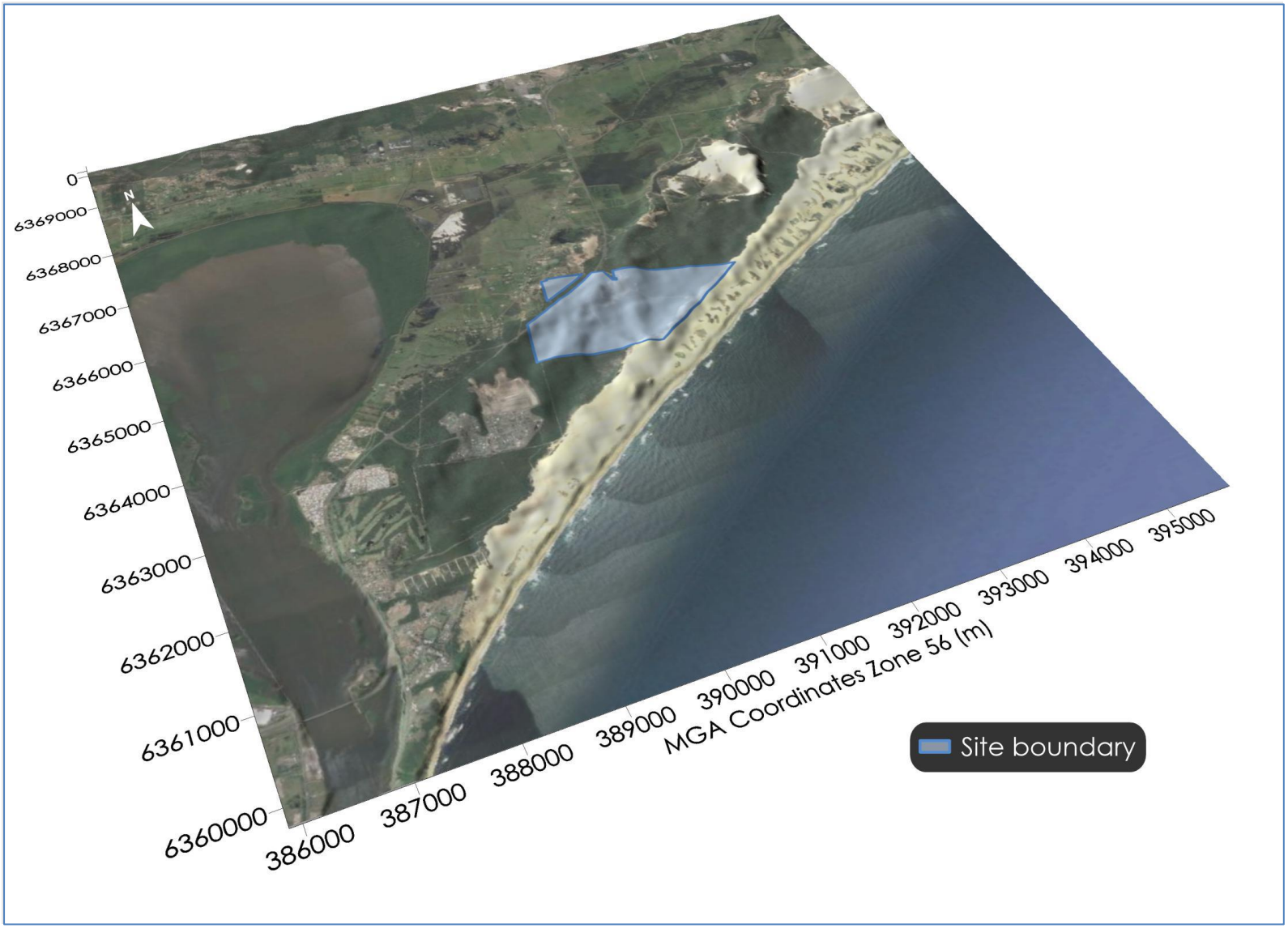

Figure 2-5: Representative visualisation of topography in the area surrounding the Project

3 STUDY REQUIREMENTS

The purpose of this report is to provide an assessment of the maximum likely effects on air quality that may arise due to the Project. The assessment presented in this report addresses planning and regulatory agency requirements, as set out below.

3.1 Secretary's Environmental Assessment Requirements

In preparing this Air Quality Assessment, the Secretary's Environmental Assessment Requirements (SEAR) issued for the Project in January 2023 have been addressed. The key matters raised for consideration in this Air Quality Assessment are outlined in **Table 3-1** along with a reference as to where the requirements are addressed in the report.

Table 3-1: Secretary's Environmental Assessment Requirements (SSD-52984213)

Specific Issue	General requirements	Section
Air quality and odour – including:	A detailed assessment of potential construction and operational air quality impacts, in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	6.5 & 7
	An assessment of potential dust and other emissions generated from processing, operational activities and transportation of quarry products;	6.5 & 7
	Reasonable and feasible mitigation measures to minimise dust and emissions; and	8
	Monitoring and management measures, in particular, real-time air quality monitoring;	8
	A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant EPA guidelines; and	6.5 & 7
	A greenhouse gas assessment of the operation of the development.	9

3.2 NSW EPA

The NSW EPA agency comments for air quality are outlined in **Table 3-2** along with a reference to where the requirements are addressed in the report.

Table 3-2: NSW EPA agency comments for air quality (SSD-52984213)

Air quality	Section
Impacts related to the following environmental issues need to be assessed, quantified and reported on: - Air Issues, including odour: air quality including dust and odour generation from the operation on the surrounding landscape and/or community	6.5 & 7
The EIS must demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations (POEO) Act (1997)* and the *POEO (Clean Air) Regulation (2002)*. Particular consideration should be given to section 129 of the POEO Act concerning control of "offensive odour".	4.6
The EIS must include an air quality impact assessment (AQIA). The AQIA must be Carried out in accordance with the document, *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (2016), available at: https://www.epa.nsw.gov.au//media/epa/corporate-site/resources/air/approvedmethods-for-modelling-and-assessmentof-air-pollutants-in-nsw-160666.pdf	This report
The EIS must detail emission control techniques/practices that will be employed at the site and identify how the proposed control techniques/practices will meet the requirements of the POEO Act, *POEO (Clean Air) Regulation* and associated air quality limits or guideline criteria.	8 & Appendix B

4 AIR QUALITY CRITERIA

4.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Air quality goals refer to measures of the total mass of all particles suspended in air defined as the Total Suspended Particulate matter (TSP). The upper size range for TSP is nominally taken to be 30 micrometres (µm) as in practice particles larger than 30 to 50µm will settle out of the atmosphere too quickly to be regarded as air pollutants.

Two sub-classes of TSP are also included in the air quality goals, namely PM_{10}, particulate matter with equivalent aerodynamic diameters of 10µm or less, and $PM_{2.5}$, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

Particulate matter, typically in the upper size range, that settles from the atmosphere and deposits on surfaces is characterised as deposited dust. The deposition of dust on surfaces may be considered a nuisance and can adversely affect the amenity of an area by soiling property in the vicinity.

4.2 Nitrogen dioxide

Nitrogen dioxide (NO_2) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO_2 belongs to a family of reactive gases called oxides of nitrogen (NO_X). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO_2 is generally a small fraction of the total NO_X generated.

4.3 NSW EPA impact assessment criteria

Table 4-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2022**).

The air quality goals for total impact relate to the total pollutant burden in the air and not just the contribution from the Project. Consideration of background pollutant levels needs to be made when using these goals to assess potential impacts.

Table 4-1: NSW EPA air quality impact assessment criteria

Pollutant	Averaging Period	Impact	Criterion
TSP	Annual	Total	90 µg/m³
PM_{10}	Annual	Total	25 µg/m³
	24 hour	Total	50 µg/m³
$PM_{2.5}$	Annual	Total	8 µg/m³
	24 hour	Total	25 µg/m³
Deposited dust	Annual	Incremental	2 g/m²/month
		Total	4 g/m²/month

Source: **NSW EPA, 2022**

µg/m³ = micrograms per cubic metre

g/m²/month = grams per square metre per month

4.4 NSW Voluntary Land Acquisition and Mitigation Policy (VLAMP)

Part of the NSW VLAMP dated September 2018 describes the NSW Government's policy for voluntary mitigation and land acquisition to address particulate matter impacts from state significant mining, petroleum, and extractive industry developments.

Voluntary mitigation rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-2** at any residence on privately owned land or workplace. [1]

Table 4-2: Particulate matter mitigation criteria

Pollutant	Averaging period	Mitigation criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24 hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development.

Voluntary acquisition rights may apply per the VLAMP where, even with best practice management, the development contributes to exceedances of the criteria in **Table 4-3** at any residence on privately owned land, workplace or on more than 25 per cent (%) of any privately owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls (vacant land).

Table 4-3: Particulate matter acquisition criteria

Pollutant	Averaging period	Acquisition criterion		Impact type
$PM_{2.5}$	Annual	8 µg/m³*		Human health
$PM_{2.5}$	24 hour	25 µg/m³**		Human health
PM_{10}	Annual	25 µg/m³*		Human health
PM_{10}	24-hour	50 µg/m³**		Human health
TSP	Annual	90 µg/m³*		Amenity
Deposited dust	Annual	2 g/m²/month**	4 g/m²/month*	Amenity

Source: **NSW Government (2018)**

*Cumulative impact (i.e. increase in concentration due to the development plus background concentrations due to all other sources).

**Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

4.5 Crystalline silica

Silica occurs in nature in a crystalline or amorphous form, and may be synthetically produced in amorphous forms. Silica is commonly found in soil and rocks, the most common form is quartz, followed by cristobalite and tridymite. The crystalline form of silica has potential to cause adverse health effects in humans. Occupational exposure to respirable crystalline silica has potential to result in silicosis (**NIOSH, 1974**).

[1] Where any exceedance would be unreasonably detrimental to workers health or carrying out of the business.

However, given that the Project would solely be washing then screening the material with no crushing proposed for operations, there is minimal risk for exposure and thus respirable crystalline silica has not been further assessed in this report.

4.6 Protection of the Environment Operations Act, 1997

The general obligations of the NSW *Protection of the Environment Operations Act, 1997* and the Regulations made under the Act (namely the NSW *Protection of the Environment Operations (Clean Air) Regulation, 2022*) would be followed for the Project. The Project would operate in accordance with the relevant regulatory framework for air quality to ensure compliance with this legislation.

5 EXISTING ENVIRONMENT

This section describes the existing environment including the climate and ambient air quality in the area surrounding the Project.

5.1 Local climatic conditions

Long-term climatic data from the closest Bureau of Meteorology (BoM) weather station at Williamtown Royal Australian Air Force (RAAF) (Site No. 061078) were analysed to characterise the local climate in the proximity of the Project. Williamtown RAAF weather station is located approximately 6.1km north- northwest of the Project.

Table 5-1 and **Figure 5-1** present a summary of data from the Williamtown RAAF weather station collected over a 59 to 73 year period for the various meteorological parameters.

The data indicate that January is the hottest month with a mean maximum temperature of 28.3 degrees Celsius (ºC) and July is the coldest month with a mean minimum temperature of 6.5ºC.

Rainfall decreases during the latter half of the year, with an annual average rainfall of 1132.4 millimetres (mm) over 86.3 days. The data indicate that March is the wettest month with an average rainfall of 128.3mm over 8.4 days and September is the driest month with an average rainfall of 60.6mm over 5.7 days.

Relative humidity levels exhibit little variability over the day and seasonal fluctuations. Mean 9am relative humidity ranges from 64% in October to 80% in June. Mean 3pm relative humidity levels range from 50% in August and September to 62% in February.

Wind speeds during the warmer months have a greater spread between the 9am and 3pm conditions compared to the colder months. Mean 9am wind speeds range from 10.2 kilometres per hour (km/h) in March to 16.8km/h in August. Mean 3pm wind speeds range from 15.8km/h in May to 23.5km/h in November and December.

Table 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann.
Temperature													
Mean max. temp. (ºC)	28.3	27.7	26.3	23.7	20.4	17.7	17.2	18.8	21.5	23.8	25.6	27.4	23.2
Mean min. temp. (ºC)	18.2	18.1	16.5	13.2	10.1	8.0	6.5	6.9	9.2	12.0	14.4	16.6	12.5
Rainfall													
Rainfall (mm)	99.4	118.9	128.3	109.5	108.5	123.0	75.6	72.0	60.6	76.1	82.9	77.1	1132.4
No. of rain days	7.2	7.5	8.4	7.5	7.7	8.3	6.5	6.0	5.7	7.3	7.2	7.0	86.3
9am conditions													
Mean temp. (ºC)	23.0	22.5	21.2	18.2	14.3	11.6	10.5	12.2	15.7	18.8	20.5	22.2	17.6
Mean R.H. (%)	72	76	77	76	79	80	77	71	66	64	66	68	73
Mean W.S. (km/h)	11.9	10.6	10.2	11.4	13.7	15.9	16.4	16.8	15.3	14.4	14.4	12.9	13.7
3pm conditions													
Mean temp. (ºC)	26.5	26.1	24.9	22.5	19.3	16.8	16.2	17.6	20.0	21.9	23.8	25.6	21.8
Mean R.H. (%)	59	62	61	59	60	60	55	50	50	54	55	56	57
Mean W.S. (km/h)	21.9	20.6	18.9	17.2	15.8	17.5	18.7	20.9	22.0	22.5	23.5	23.5	20.2

Source: **Bureau of Meteorology, 2023**

R.H. – Relative Humidity, W.S. – wind speed

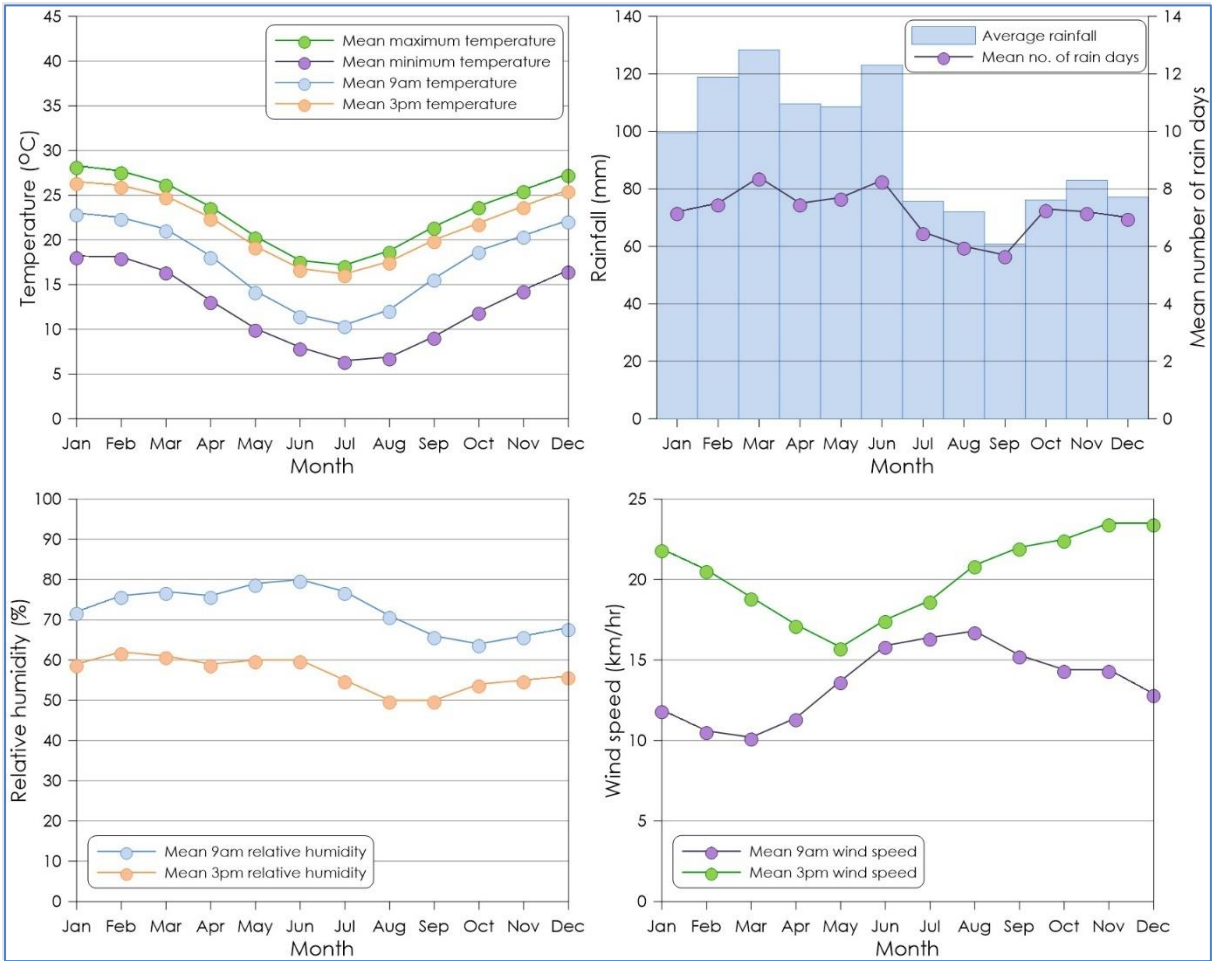

Figure 5-1: Monthly climate statistics summary – Williamtown RAAF weather station

5.2 Local meteorological conditions

Annual and seasonal windroses for the Williamtown RAAF weather station during the 2021 calendar period are presented in **Figure 5-2**.

The 2021 calendar year was selected as the meteorological year for the dispersion modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

On an annual basis, winds predominantly occur from the west-northwest and northwest. In summer, winds occur from the northeast to the east-northeast, and the southeast quadrant with varied winds from other directions. Autumn and winter have a similar distribution to the annual distribution with winds predominately from the west-northwest and northwest. In spring, winds are primarily from the west-northwest with varied winds from other directions.

Figure 5-2 : Annual and seasonal windroses – Williamtown RAAF weather station (2021)

5.3 Local air quality monitoring

The main sources of air pollutants in the area surrounding the Project would include emissions from active sand quarrying, agricultural activities, anthropogenic activities such as various industrial and commercial activities and motor vehicle exhaust and also natural sources such as the local sand dunes.

Ambient air quality monitoring data from the Project site are not available. Therefore, the available data from air quality monitors operated by the NSW Department of Planning and Environment (DPE) were used to quantify the existing background level for assessed pollutants at the Project site.

These include the Stockton, Beresfield and Wallsend monitors. The location of these monitors relative to the Project site is shown in **Figure 5-3**.

We note that there are other NSW DPE monitors within Newcastle which are subject to local industrial and urban sources which are not typically representative of the Project site. The Stockton, Beresfield and Wallsend monitors positioned in areas more similar to the Project site and thus taken to be generally representative of the background levels and have been used to quantify the existing ambient levels of air pollutants in this study.

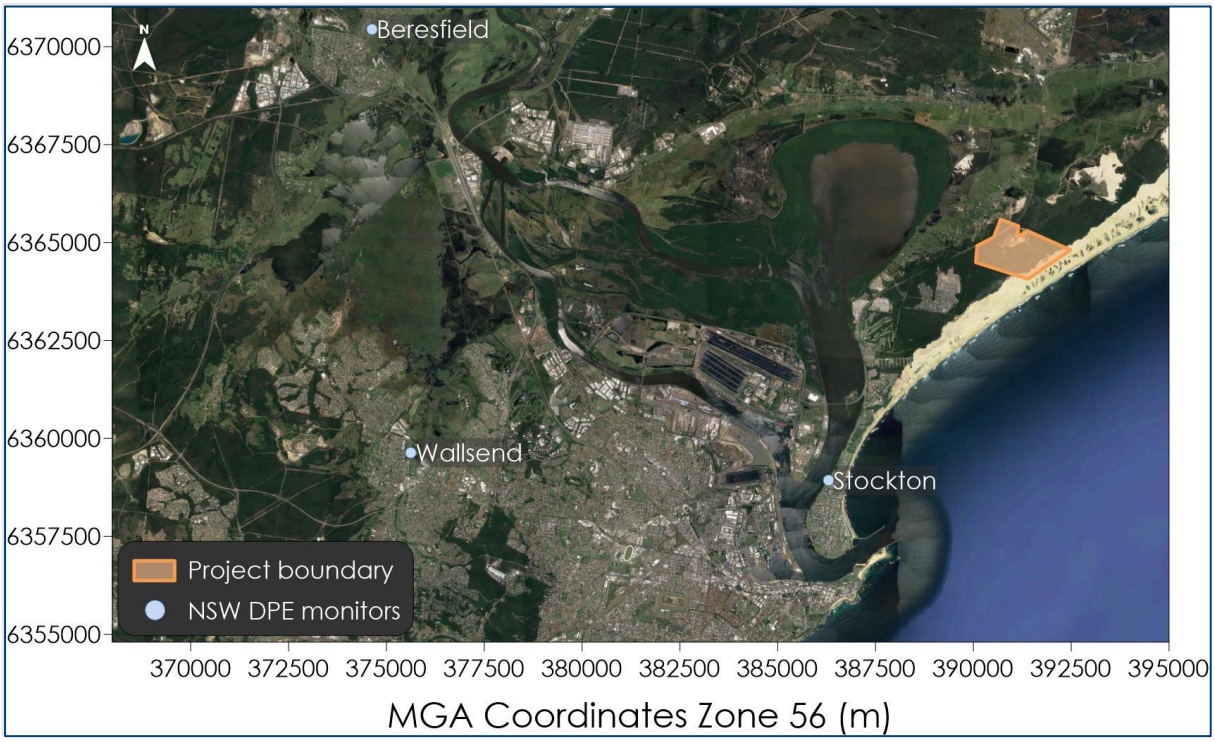

Figure 5-3: Location of NSW DPE air quality monitors

5.3.1 PM_{10} monitoring

A summary of the available PM_{10} monitoring data from the NSW DPE monitoring stations is presented in **Table 5-2**. Recorded 24-hour average PM_{10} concentrations are presented in **Figure 5-4**.

A review of **Table 5-2** indicate that the annual average PM_{10} concentrations for all monitoring stations reviewed were below the relevant criterion of 25µg/m^3 with the exception of the Stockton monitor, which exceeded the relevant criterion in each year of the review and the Beresfield monitoring station

in 2019. The maximum 24-hour average PM_{10} concentrations were found to exceed the relevant criterion of 50µg/m^3 on occasion during the review period.

Table 5-2: Summary of PM_{10} levels from NSW DPE monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2017	**36.4**	19.6	17.4	**25**
2018	**38.7**	21.6	19.4	**25**
2019	**43.6**	**25.9**	22.8	**25**
2020	**34.5**	18.5	17.7	**25**
2021	**30.1**	15.9	14.7	**25**
Year	**Maximum 24-hour average**			**Criterion**
2017	**96.7**	49.4	47.9	**50**
2018	**196.6**	**149.1**	**136.5**	**50**
2019	**169.5**	**136.7**	**127.9**	**50**
2020	**127.0**	**77.7**	**77.9**	**50**
2021	**64.2**	36.3	33.0	**50**

It can be seen from **Figure 5-4** that PM_{10} concentrations nominally peak in spring and summer with the warmer weather raising the potential for drier ground, elevating the occurrence of windblown dust. Elevated PM_{10} concentrations at the Stockton monitor are largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

Anomalously high PM_{10} concentrations recorded in November 2018 at the monitors have been attributed to state-wide dust storm events originating from the Victorian Mallee and Southern and Western NSW region (**NSW DPIE 2020a**). The high PM_{10} concentrations recorded at the monitors in November and December 2019 and January 2020 are attributed to wildfires and the drought period (**NSW DPIE 2019 & NSW DPIE 2020b**).

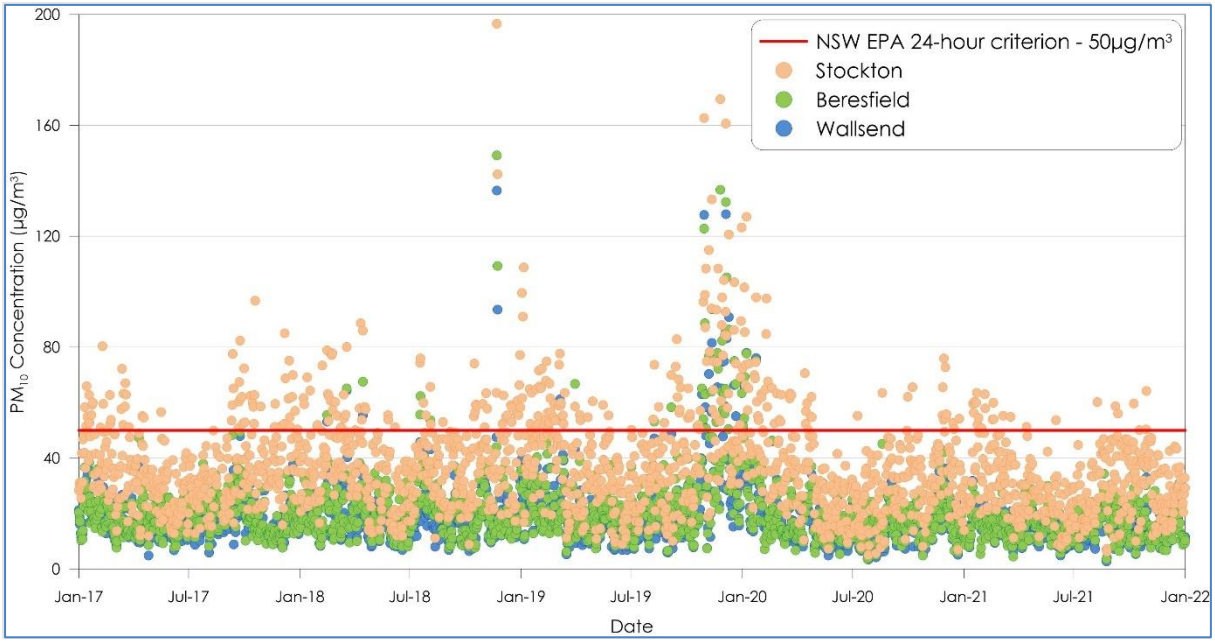

Figure 5-4: 24-hour average PM_{10} concentrations

5.3.2 $PM_{2.5}$ monitoring

A summary of the available data from the NSW DPE monitoring stations is presented in **Table 5-3**. Recorded 24-hour average $PM_{2.5}$ concentrations are presented in **Figure 5-5**.

Table 5-3 indicates that the annual average and 24-hour average $PM_{2.5}$ concentrations for the monitoring stations were above the annual average criterion of 8µg/m³ and 24-hour average criterion of 25µg/m³ on occasion during the review period.

Table 5-3: Summary of $PM_{2.5}$ levels from NSW DPE monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2017	**9.8**	7.6	7.3	**8**
2018	**10.0**	**8.7**	7.5	**8**
2019	**13.0**	**12.1**	**10.4**	**8**
2020	**9.3**	7.7	7.3	**8**
2021	**8.3**	5.9	6.1	**8**
Year	**Maximum 24-hour average**			**Criterion**
2017	**32.0**	18.7	20.4	**25**
2018	**26.9**	24.9	20.2	**25**
2019	**98.6**	**100.5**	**108.3**	**25**
2020	**72.9**	**49.7**	**56.8**	**25**
2021	20.8	18.9	21.4	**25**

It can be seen from **Figure 5-5** that 24-hour average $PM_{2.5}$ concentrations are relatively evenly distributed through the year with the Stockton monitor recording overall higher levels largely due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach.

Similar to the PM_{10} monitoring data, the mass bushfires affecting NSW in 2019 and 2020 are seen in the $PM_{2.5}$ monitoring data.

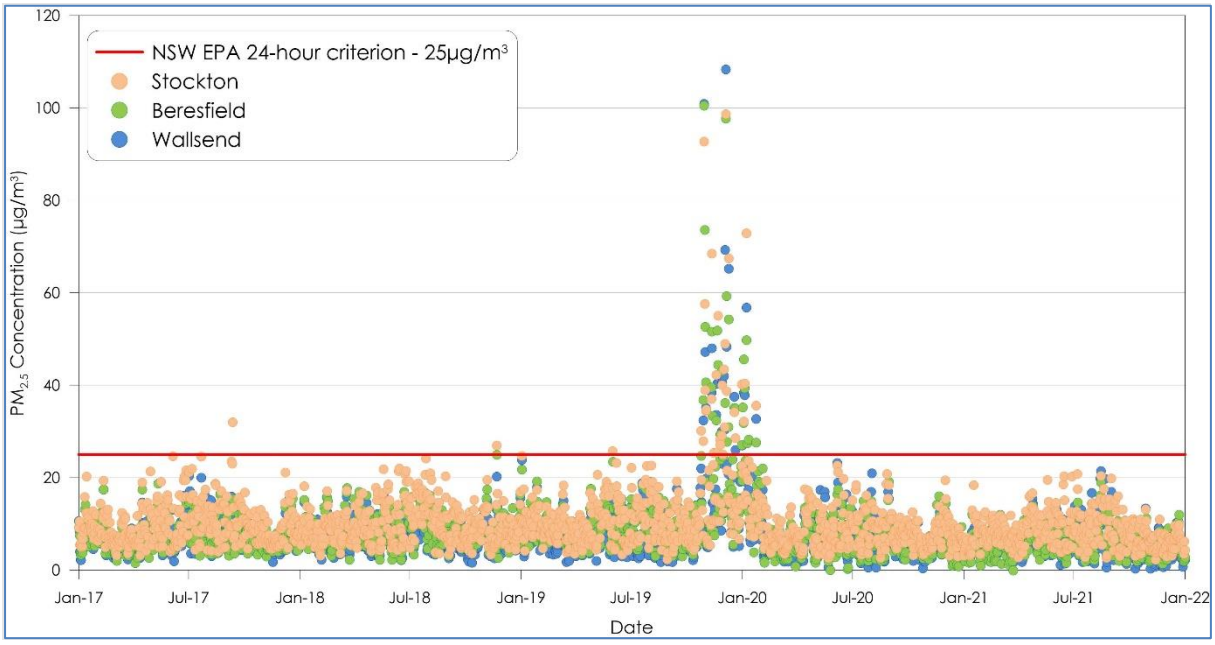

Figure 5-5: 24-hour average $PM_{2.5}$ concentrations

5.3.3 NO_2 monitoring

A summary of the available NO_2 data from the NSW DPE monitoring stations is presented in **Table 5-4**. The daily 1-hour maximum NO_2 concentrations are presented in **Figure 5-6**.

Table 5-4 indicates that the annual and maximum 1-hour average NO_2 concentrations for all monitors during the review period are well below the respective criterion.

It can be seen from **Figure 5-6** that concentrations are generally higher in cooler months when temperatures are low and there is less sunlight, making it more difficult for NO_2 to convert to ozone (**Department of the Environment, Climate Change and Water [DECCW], 2010**).

Table 5-4: Summary of NO_2 levels from NSW DPE monitoring (µg/m³)

Year	Stockton	Beresfield	Wallsend	Criterion
	Annual average			
2017	16.4	18.5	16.4	**31**
2018	16.4	18.5	14.4	**31**
2019	16.4	16.4	14.4	**31**
2020	16.4	14.4	12.3	**31**
2021	16.4	12.3	10.3	**31**
Year	**Maximum 1-hour average**			Criterion
2017	94.3	82.0	75.9	**164**
2018	90.2	82.0	71.8	**164**
2019	90.2	114.8	86.1	**164**
2020	94.3	71.8	59.5	**164**
2021	96.4	69.7	67.7	**164**

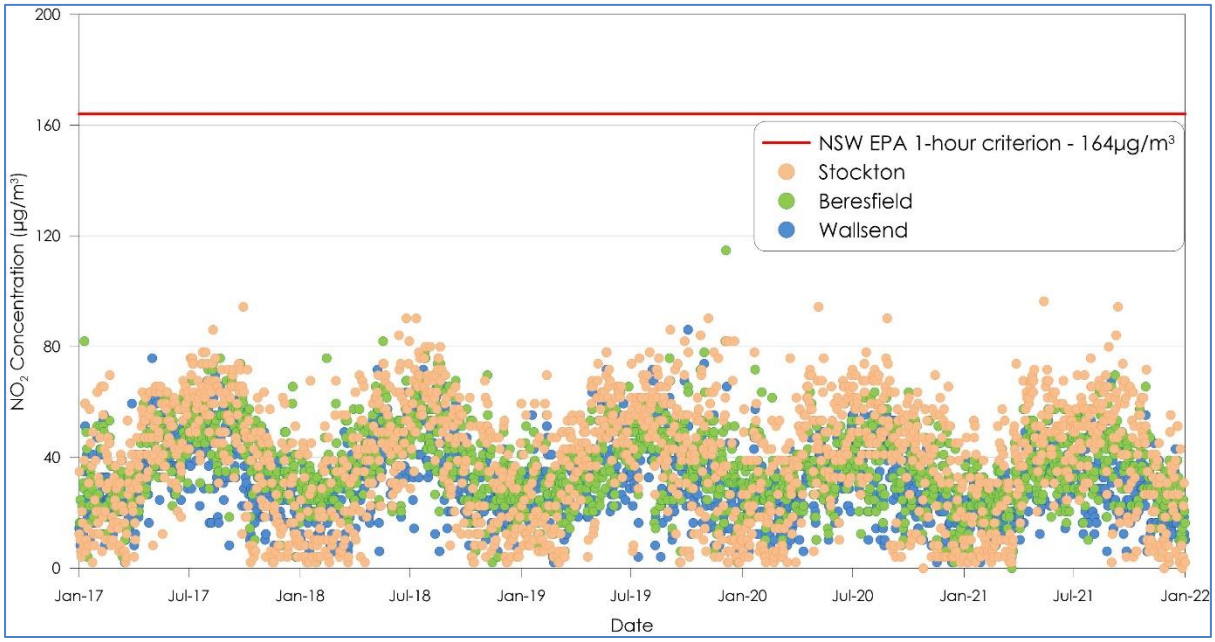

Figure 5-6: Daily 1-hour maximum NO_2 concentrations

5.3.4 Estimated background levels

As outlined above, there are no readily available site specific monitoring data, and therefore the background air quality levels from the Stockton monitor for the 2021 calendar year were used to represent the background levels for the Project.

The 2021 calendar period corresponds to the period of meteorological modelling based on an analysis of long-term data trends in meteorological data recorded for the area as outlined in **Appendix A**.

5.3.4.1 $PM_{2.5}$ and PM_{10}

As noted, the $PM_{2.5}$ and PM_{10} concentrations at the Stockton monitor are elevated due to heavily salt laden air or particulates blowing from the east along the surf break of Stockton Beach. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To account for this, background $PM_{2.5}$ and PM_{10} concentrations have been adjusted to discount the contribution associated with salt laden air and we estimate an approximate annual average $PM_{2.5}$ and PM_{10} concentration of 6.4µg/m³ and 14.5µg/m³, respectively. Further detailed calculations of background $PM_{2.5}$ and PM_{10} estimates are provided in **Appendix B**.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with levels measured at the Beresfield and Wallsend monitors.

5.3.4.2 TSP and Deposited dust

In the absence of available data, estimates of the annual average background TSP and deposited dust concentrations can be determined from a relationship between PM_{10}, TSP and deposited dust concentrations and the measured PM_{10} levels.

This relationship assumes that an annual average PM_{10} concentration of 25µg/m³ corresponds to a TSP concentration of 90µg/m³ and a dust deposition value of 4g/m²/month. This assumption is based on the NSW EPA air quality impact criteria.

Applying this relationship with the measured annual average PM_{10} concentration of 14.5µg/m³ indicates an approximate annual average TSP concentration and deposition value of 52.1µg/m³ and 2.3g/m²/month, respectively.

5.3.4.3 Summary of background levels

The background air quality levels applied in this assessment are summarised in **Table 5-5**.

Table 5-5: Summary of background levels

Pollutant	Background level	Units
Annual average TSP	52.1	µg/m³
24-hour average PM_{10}	Daily varying	µg/m³
Annual average PM_{10}	14.5	µg/m³
24-hour average $PM_{2.5}$	Daily varying	µg/m³
Annual average $PM_{2.5}$	6.4	µg/m³
Annual average deposited dust	2.3	g/m²/month
Annual average NO_2	16.4	µg/m³
1-hour average NO_2	96.4	µg/m³

6 DISPERSION MODELLING APPROACH

6.1 Introduction

For this assessment, the CALPUFF modelling suite is applied to dispersion modelling. The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation, 2011**).

6.2 Meteorological modelling

The meteorological modelling methodology applied a 'hybrid' approach which includes a combination of prognostic model data from The Air Pollution Model (TAPM) with surface observations in the CALMET model.

The centre of analysis for TAPM was 32deg51min south and 151deg50min east. The simulation involved an outer grid of 30 km, with three nested grids of 10 km, 3 km and 1 km with 35 vertical grid levels. The CALMET domain was run on a 10 x 10km area with 0.1 km grid resolution.

The 2021 calendar year was selected as the meteorological year for the dispersion modelling based on analysis of long-term data trends in meteorological data and ambient air quality data recorded for the area as outlined in **Appendix A**.

The outputs of the CALMET modelling are evaluated using visual analysis of the wind fields and extracted data.

Figure 6-1 presents a visualisation of the wind field generated by CALMET for a single hour of the modelling period. The wind fields are seen to follow the terrain well and indicate the simulation produces realistic fine scale flow fields (such as terrain forced flows) in surrounding areas.

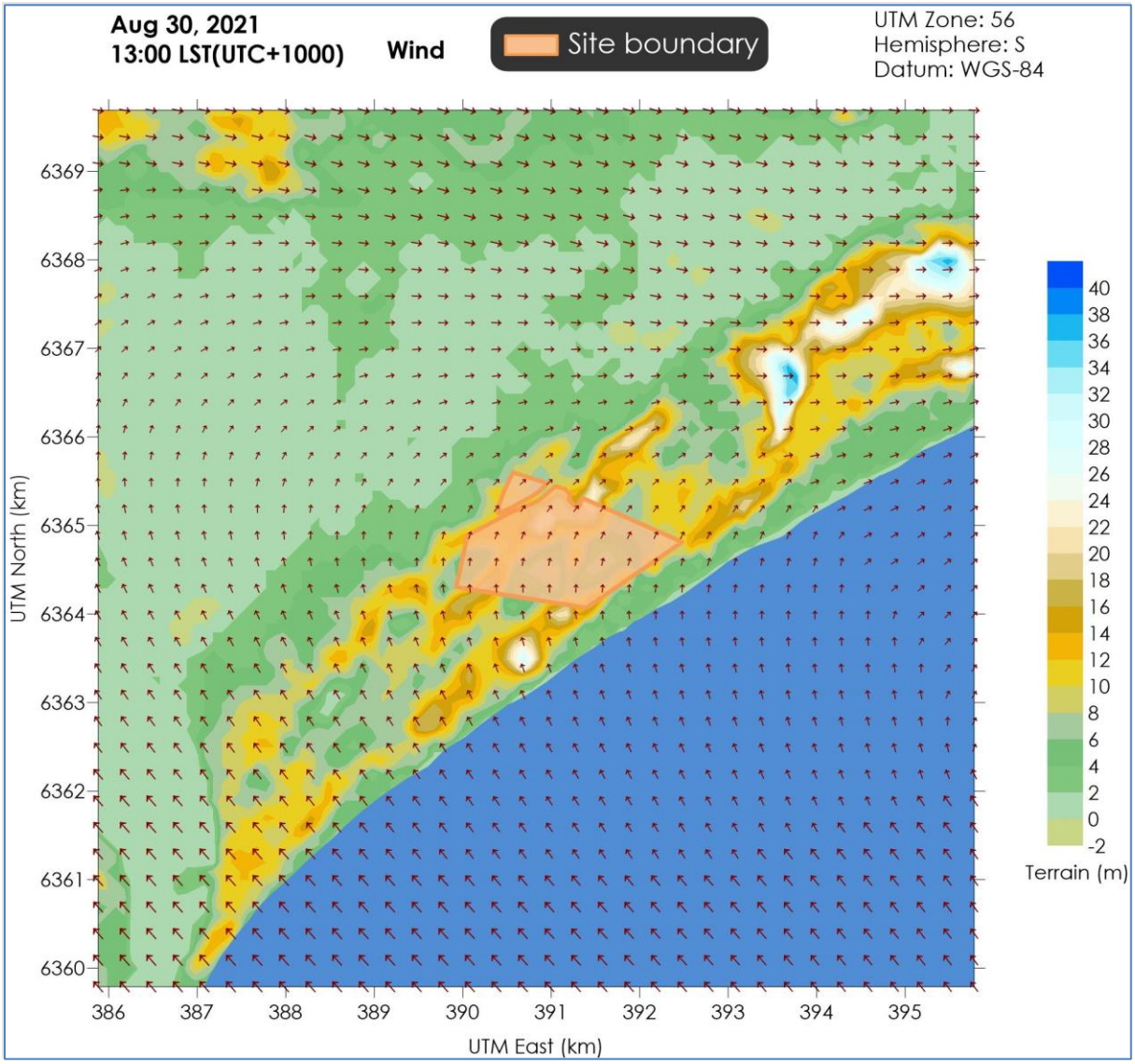

Figure 6-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 6-2** and **Figure 6-3**.

Figure 6-2 presents the annual and seasonal windroses from the CALMET data. Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds.

Figure 6-3 includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and shows sensible trends considered to be representative of the area.

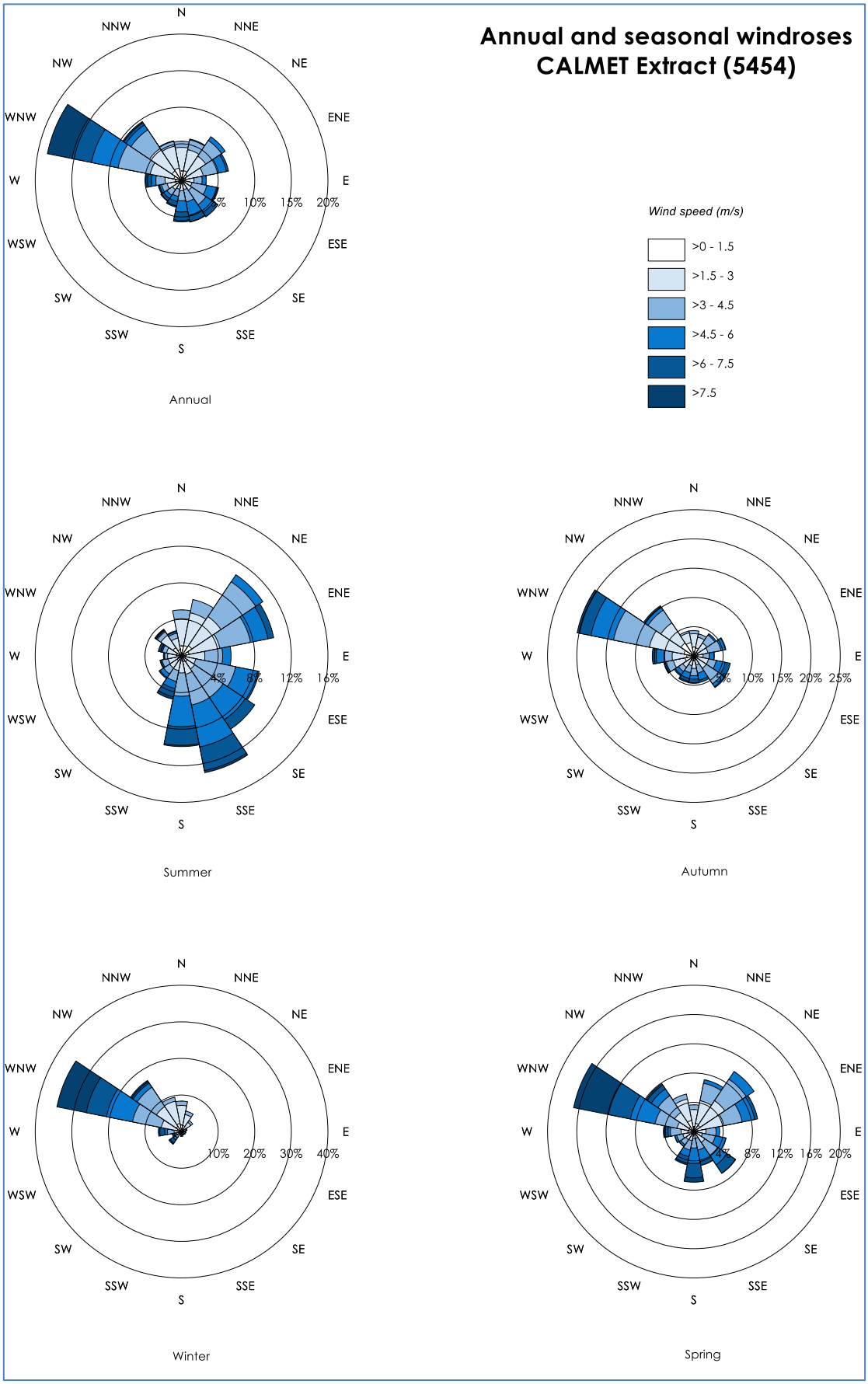

Figure 6-2: Annual and seasonal windroses from CALMET (Cell reference 5454)

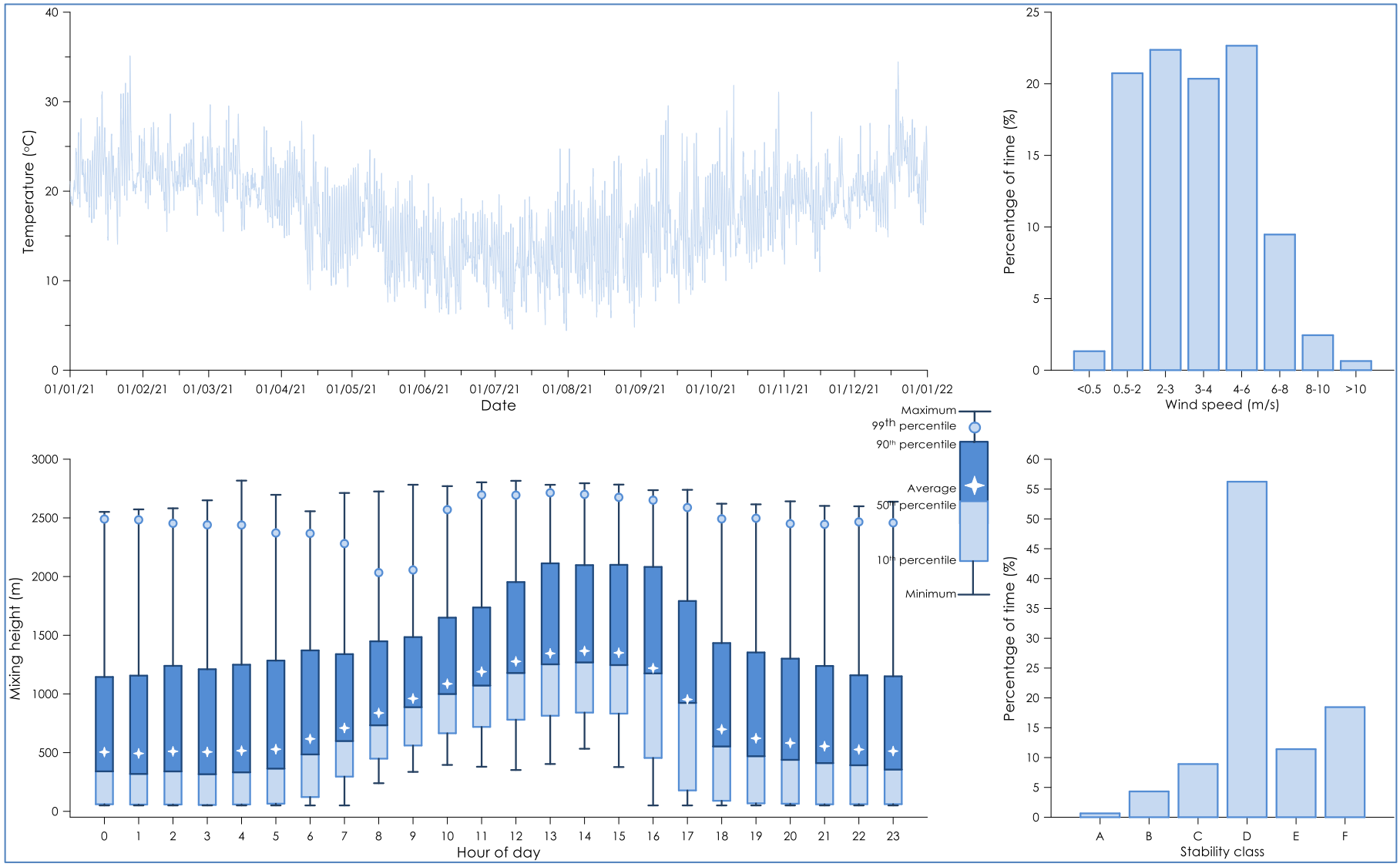

Figure 6-3: Meteorological analysis of CALMET (Cell Ref 5454)

6.3 Dispersion modelling

Dust emissions from each operational activity of the Project were represented by a series of volume sources and were included in the CALPUFF model via an hourly varying emission file. Meteorological conditions associated with dust generation (such as wind speed) and levels of dust generating activity were considered in calculating the hourly varying emission rate for each source.

It should be noted that as a conservative measure, the effect of the precipitation rate (rainfall) in reducing dust emissions has not been considered in this assessment.

6.4 Modelling scenario

To identify a potential worst-case operating scenario for the Project, each of the activities associated with the different stages were analysed in regard to the quantity of material extracted and handled in each year, the location of the activity and the potential to generate dust at the receptor locations.

Three potential operating scenarios representing the Project were investigated in detail to identify which would likely represent a worst-case operating scenario. These include:

- Scenario 1: Sand extraction occurring from the existing windblown sand extraction area concurrently with sand extraction using an excavator in Stage 1. A maximum production rate of 750,000tpa is assumed with a maximum capacity of 250,000tpa extracted from the existing windblown sand extraction area and 500,000tpa from Stage 1 of the Project. Sand processing is occurring at the new mobile wash plant pad positioned at the north near the site entrance and 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 2-3**) with a maximum potential for dust generation to occur from both existing and proposed operations.

- Scenario 2: Sand extraction occurring from Stage 1 only at a maximum production rate of 750,000tpa. Sand extraction is conducted with a loader and sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material is also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the nearest receptors to the Project (refer to **Figure 2-3**) with a maximum potential for dust generation to occur from proposed operations only.

- Scenario 3: Sand extraction occurring from only Stage 5 at a maximum production rate of 750,000tpa. Sand extraction is conducted with a loaderand sand processing is occurring at the new mobile wash plant pad with 70,000 tonnes of VENM material also imported and stockpiled within the Stage 1 area. In this scenario, activity is occurring closest to the receptors at Fern Bay to the Project (refer to **Figure 2-3**) with a maximum potential for dust generation to occur from proposed operations only.

6.5 Emission estimation

6.5.1 Construction emissions

The establishment of the Project would involve the construction of the associated infrastructure including the wash plant and haul roads. This construction activity has the potential to generate small amounts of dust emissions.

Potential construction dust emissions will be primarily generated due to material handling, vehicle movements, windblown dust generated from exposed areas and stockpiles. Exhaust emissions will be from the operation of construction vehicles and plant.

The potential dust impacts due to these activities are difficult to accurately quantify on any given day due to the short sporadic periods of dust generating activity which may occur over the construction time frame. The sources of dust are temporary in nature and will only occur during the construction period.

The total amount of dust generated from the construction process is unlikely to be significant given the nature of the activities. Additionally, the potential dust emissions generated by the construction activities would be less than the emissions produced during the operational stages of the Project. Also, as the activities would occur for a limited period, no significant or prolonged effect at any off-site receptor is predicted to arise.

6.5.2 Odour emissions

Odour emissions have some potential to arise from the diesel exhaust emissions of on-site plant equipment as well as vehicles travelling on and off site. These odorous emissions are generally considered to be too low to generate any significant off-site pollutant concentrations and have not been assessed further in this study. The Project would emit a wet sand odour given the nature of the material handled as well as the close proximity of the Project to the beach and the surrounding sand quarry operations.

6.5.3 Dust emissions

The significant dust generating activities associated with operation of the Project are identified as loading/unloading of material, vehicles travelling on-site, screening sand material and windblown dust from exposed areas and stockpiles. The on-site vehicle and plant equipment also have the potential to generate particulate emissions from the diesel exhaust.

Dust emission estimates for each of the scenarios have been calculated by analysing the various types of dust generating activities taking place and utilising suitable emissions sourced from both locally developed and United States Environmental Protection Agency (US EPA) developed documentation.

The estimated TSP emissions for activities associated with the operation of the Project for each of the scenarios are presented in **Table 6-1**. Detailed calculations of the dust emission estimates are provided in **Appendix C**.

Table 6-1: Comparison of estimated dust emissions for the Project (kg/yr)

Activity	TSP Emissions (kg/yr)		
	Scenario 1	Scenario 2	Scenario 3
Loading sand to haul truck at windblown sand area	370	-	-
Loading sand to haul truck at Stage 5	-	-	1,110
Hauling sand to processing area	-	-	21,931
Unloading sand to stockpile	-	-	1,110
Hauling RAW sand from windblown sand area to offsite	14,829	-	-
Excavator loading topsoil to haul truck	62	62	35
Hauling to topsoil stockpile	284	284	602
Emplacing at topsoil stockpile	62	62	35
Loading sand to screen	740	1,110	1,110

Activity	TSP Emissions (kg/yr)		
	Scenario 1	Scenario 2	Scenario 3
Screening RAW sand – uncontrolled (dry sand)	6,250	-	-
Screening RAW sand – controlled (wet sand)	-	825	825
Unloading processed sand to stockpile	740	1,110	1,110
Rehandle processed sand material at product stockpile	74	111	111
Loading product sand material to haul truck	740	1,110	1,110
Hauling product sand offsite	6,673	10,009	10,009
Hauling VENM material onsite	1,038	1,165	1,165
Unloading VENM material at stockpile	104	104	104
Loading VENM material to haul truck	-	-	104
Hauling VENM material to Stage 5	-	-	1,773
Unloading VENM material at Stage 5	-	-	104
Wind erosion - exposed area	3,690	3,690	5,795
Exhaust emissions from on-site equipment	449	449	622
Total emissions	**36,102**	**20,088**	**48,763**

Based on the estimated dust emissions set out in **Table 6-1**, Scenario 3 is estimated to generate the most dust overall for the scenarios considered and as such, the dispersion modelling for the Project is based on Scenario 3 which would represent a worst-case potential operating scenario. The higher estimated emissions in Scenario 3 are predominantly a result of the increased hauling distance between the Stage 5 area, the wash plant, and the site entrance compared to the other stages.

In comparison to the air quality assessment for the dredge application report (**Todoroski Air Sciences, 2019**), the estimated dust emissions for the Project scenarios generally produce more dust with the worst-case scenario, i.e., Scenario 3 for the Project, generating almost double the amount of dust as the worst-case scenario for the dredge application report. The key factors causing this is the removal of the dredging processes, which allows for the extraction of sand without the generation of dust, and with no changes to the overall extraction area or rate of extraction for the Project.

6.5.4 NO_x emissions

The NO_X emissions associated with operation of the Project are identified from exhaust emissions from on-site vehicle and plant equipment.

NO_X emission estimates for the Project have been calculated by analysing the various types of vehicle and plant equipment and utilising suitable emission factors sourced from DieselNet (**Ecopoint DieselNet, 2023**).

The estimated NO_X emissions associated with the Project are summarised in **Table 6-2**. In comparison to the air quality assessment for the dredge application report (**Todoroski Air Sciences, 2019**) the estimated NO_X emissions for the Project are slightly higher due to the additional hauling of sand required instead of dredging.

Table 6-2: Estimated annual NO_X emissions for the Project (kg)

Equipment type	Scenario 1
Cat D7 dozer	1,794
Front end loaders - Volvo 180H	2,241
Front end loaders - Volvo 180G	3,043
Water truck - 1987 Volvo F86	1,249
Truck and dog	1,178
Mobile screen - power screen M90	957

Equipment type	Scenario 1
Excavator - 40 tonne	1,958
Dump truck - 40 tonne	4,178
Diesel generator	316
Wash plant	981
Total NO_X emissions	**17,896**

6.5.5 Emissions from other quarry operations

The nearest quarry at Fullerton Cove Sand Quarry located approximately 0.7km to the north of the Project, ceased operations in June 2020 with no plan to re-commence operations. Therefore, emissions from this site have not been included for the cumulative assessment.

7 DISPERSION MODELLING RESULTS

This section presents the predicted air quality levels which may arise from air emissions generated by the Project.

7.1 Dust concentrations

The dispersion model predictions presented in this section include those for the operation of the Project in isolation (incremental impact) and the operation of the Project with consideration of other sources (total cumulative impact). The results show the predicted maximum 24-hour average $PM_{2.5}$ and PM_{10} concentrations, annual average $PM_{2.5}$, PM_{10} and TSP concentrations, and annual average dust (insoluble solids) deposition rates.

It is important to note that when assessing impacts per the maximum 24-hour average levels, these predictions are based on the highest predicted 24-hour average concentrations which were modelled at each point within the modelling domain for the worst day (i.e. a 24-hour period) during the one year long modelling period.

The cumulative (total) impact is defined as the modelling impact associated with the operation of the Project combined with the estimated ambient background levels in **Section 5.3.4**.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-1 presents the predicted incremental and cumulative particulate dispersion modelling results at each of the assessed residential receptor locations. The predicted incremental results show that minimal incremental effects would arise at the assessed receptors due to the Project. The predicted cumulative results indicate that the assessed receptors are predicted to experience levels below the relevant criteria for each of the assessed dust metrics.

It is noted that the incremental concentrations for the Project are higher than the predicted concentrations for the dredge application report. The predicted maximum 24-hour average PM_{10} level at the assessed receptor locations for the Project is 2.7µg/m^3 compared to a maximum level of 2.1µg/m^3. The increase in the predicted levels can be attributed to the additional dust generated as a result of the exclusion of the dredging processes. Once the dredging application is approved, there will be a reduction in dust impacts in the surrounding area relative to the Project.

Table 7-1: Dust dispersion modelling results

Receptor ID	Incremental						Cumulative			
	$PM_{2.5}$ (µg/m^3)		PM_{10} (µg/m^3)		TSP (µg/m^3)	DD* (g/m^2/mth)	$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	TSP (µg/m^3)	DD (g/m^2/mth)
	24-hr ave.	Ann. ave.	24-hr ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.	Ann. ave.
	Air quality impact criteria									
	-	-	-	-	-	2	8	25	90	4
R1	0.2	<0.1	1.1	<0.1	<0.1	<0.1	6.4	14.5	52.2	2.3
R2	0.2	<0.1	1.3	<0.1	0.1	<0.1	6.4	14.6	52.2	2.3
R3	0.2	<0.1	1.3	<0.1	0.1	<0.1	6.4	14.6	52.2	2.3
R4	0.3	<0.1	1.5	0.1	0.3	<0.1	6.4	14.6	52.4	2.3
R5	0.4	<0.1	2.2	0.2	0.4	<0.1	6.4	14.7	52.5	2.4
R6	0.4	<0.1	2.7	0.2	0.5	<0.1	6.4	14.7	52.6	2.4

*Deposited dust

7.2 Assessment of Total (Cumulative) 24-hour average $PM_{2.5}$ and PM_{10} Concentrations

The results for incremental 24-hour average $PM_{2.5}$ and PM_{10} concentrations indicate there are no predicted exceedances of the relevant criteria at the assessment locations for the assessed scenario.

When assessing the total (cumulative) 24-hour average impacts based on model predictions an assessment of cumulative 24-hour average $PM_{2.5}$ and PM_{10} impacts was undertaken in accordance with Section 11.2 of the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA**, **2022**). The Level 2 contemporaneous assessment was adopted which involves matching one year of ambient air quality monitoring data with meteorological data representing the same period.

Table 7-2 provides a summary of the findings from the Level 2 assessments for the assessed receptor locations for both $PM_{2.5}$ and PM_{10}. The results in **Table 7-2** indicate that the Project does not increase the number of days above the 24-hour average criterion at the assessed receptor for $PM_{2.5}$ and PM_{10}.

Detailed tables of the contemporaneous assessment results are provided in **Appendix E**.

Table 7-2: NSW EPA contemporaneous assessment - maximum number of additional days above 24-hour average criterion

Receptor ID	$PM_{2.5}$	PM_{10}
R1	0	0
R2	0	0
R3	0	0
R4	0	0
R5	0	0
R6	0	0

Time series plots of the predicted cumulative 24-hour average $PM_{2.5}$ and PM_{10} concentrations for selected receptors R2 and R6 are presented in **Figure 7-1** to **Figure 7-4**.

The orange bars in the figures represent the contribution from the Project and the blue bars represent the background levels. It is clear from the figures that the Project has a small influence at the assessed receptor locations and in most cases would be difficult to discern beyond the expected background level.

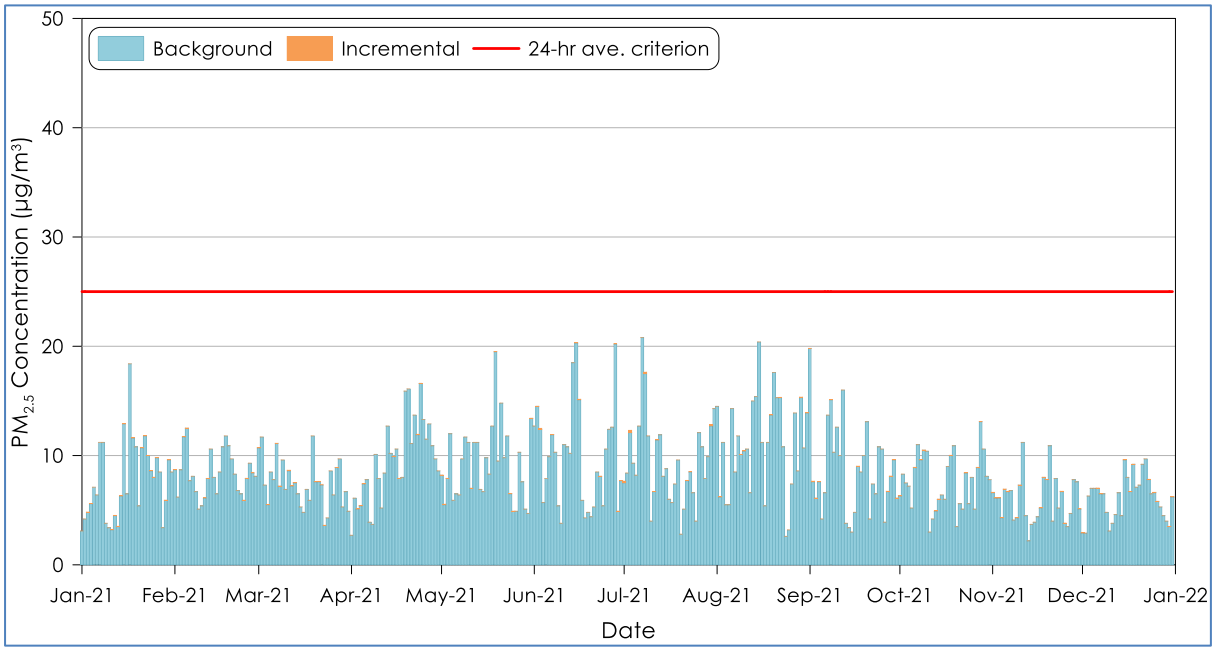

Figure 7-1: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R2

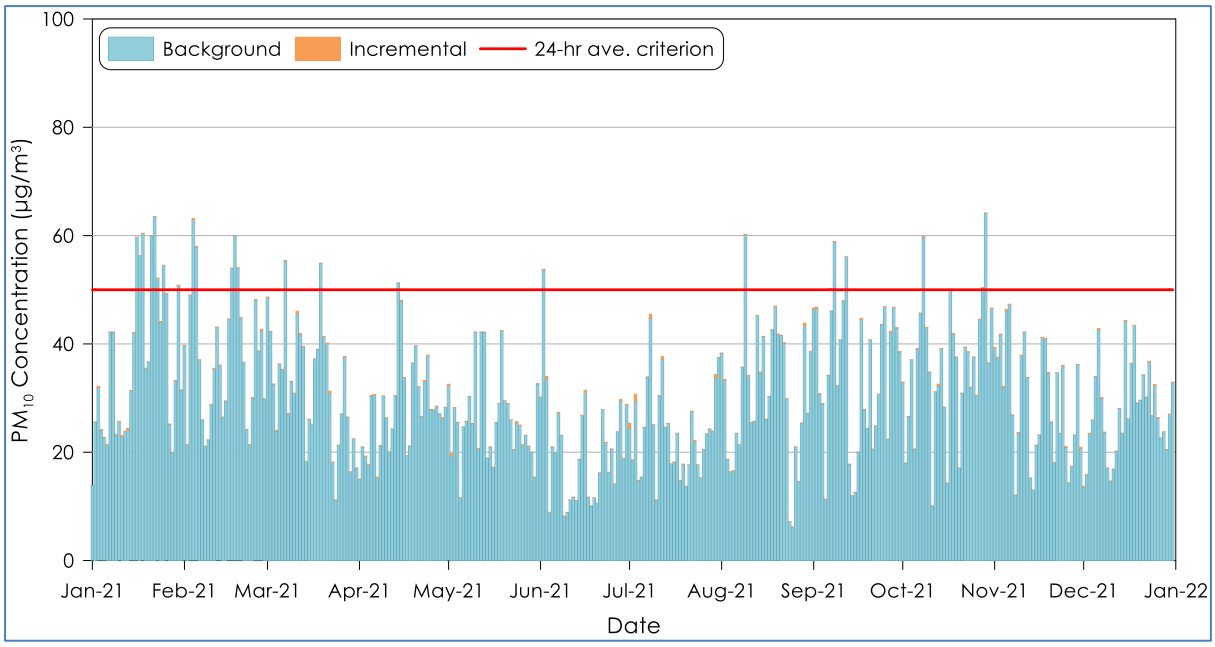

Figure 7-2: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R2

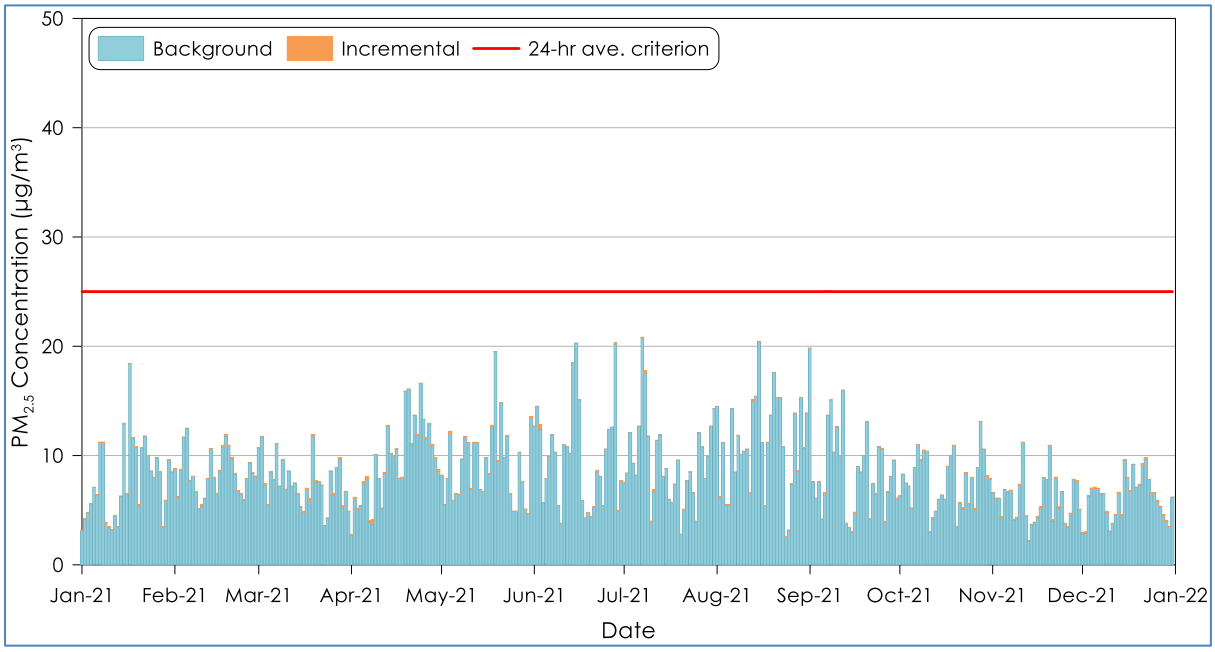

Figure 7-3: Time series plots of predicted cumulative 24-hour average $PM_{2.5}$ concentrations for R6

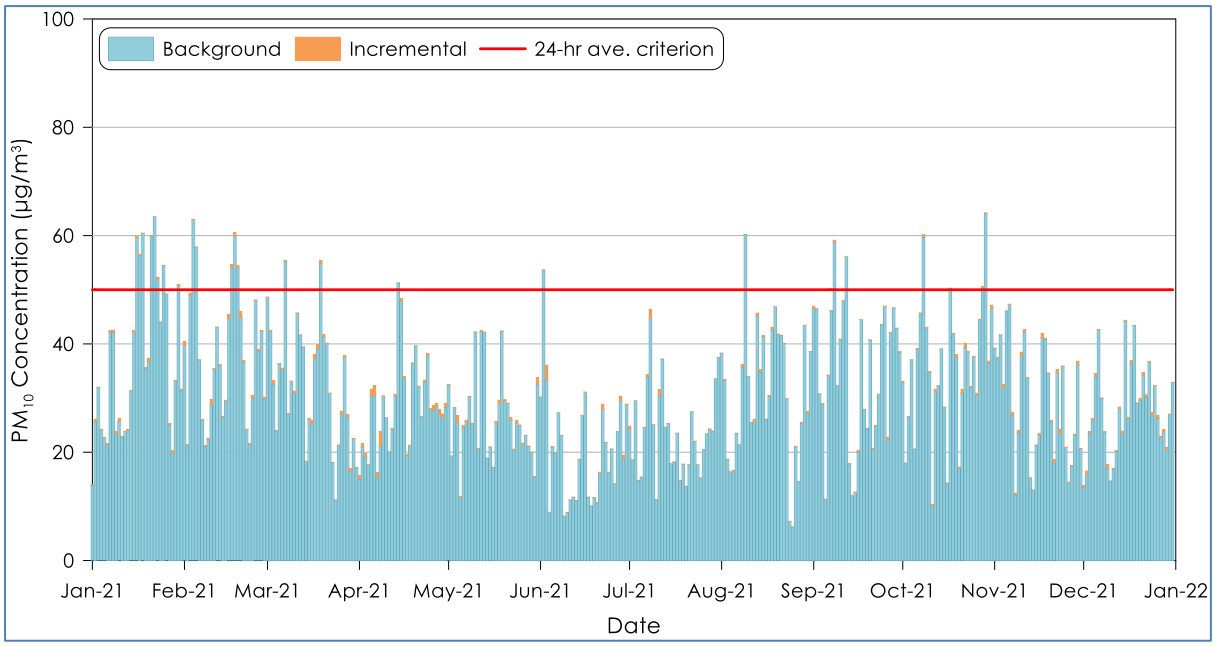

Figure 7-4: Time series plots of predicted cumulative 24-hour average PM_{10} concentrations for R6

7.3 NO_x concentrations

Dispersion modelling of the potential NO_X emissions associated with diesel powered equipment was conducted for the modelling scenario. Modelling sources were described as point sources and impacts due to the Project were added to the ambient background level to assess potential impacts.

For the transformation of NO_x to NO_2 it has been assumed that a conservative conversion level of 50% occurs, whereas a value between 10% and 20% would be more realistic.

Associated isopleth diagrams of the dispersion modelling results are presented in **Appendix D**.

Table 7-3 presents the predicted incremental and cumulative NO_2 dispersion modelling results at each of the assessed residential receptor locations. The results show that minimal incremental effects would arise at the residential receptor locations due to NO_2 emissions associated with the Project and predicted cumulative levels would be below the relevant criteria.

Table 7-3: NO_2 dispersion modelling results for residential receptors

Receptor ID	Incremental		Cumulative	
	1-hour average	Annual average	1-hour average	Annual average
	Air quality impact criteria			
	-	-	164	31
R1	12.6	<0.1	109.0	16.4
R2	10.2	<0.1	106.6	16.4
R3	10.8	<0.1	107.2	16.5
R4	19.6	0.1	116.0	16.5
R5	26.1	0.1	122.5	16.5
R6	26.8	0.1	123.2	16.5

7.4 Assessment of impacts per VLAMP criteria

The results in **Table 7-1** indicate the predicted level at the assessed receptors would be below the applicable VLAMP mitigation and acquisition criteria.

The potential impacts due to the Project, extending over more than 25% of any privately-owned land, have been evaluated using the predicted pollutant dispersion contours.

The results at the criteria level concentrations show the maximum 24-hour average PM_{10} predictions would have the most spatial extent, relative to any of the other assessed dust metrics and hence 24-hour average PM_{10} represents the most impacting parameter.

Based on the isopleth diagrams in **Appendix D**, the extent of the predicted maximum 24-hour average PM_{10} level of 50µg/m^3 would not extend over more than 25% of any privately-owned land parcels, and it can be concluded that the Project would not cause impact per this criterion.

8 DUST MITIGATION AND MANAGEMENT

The proposed operations at the Project have the potential to generate dust emissions.

To ensure that activities associated with the Project have a minimal effect on the surrounding environment and at residential receptor locations, it is recommended that appropriate operational and physical mitigation measures should be implemented where feasible and reasonable as outlined in **Table 8-1**.

Table 8-1: Potential operational dust mitigation options

Source	Mitigation Measure
General	Activities to be assessed during adverse weather conditions and modified as required (e.g. cease activity where reasonable levels of dust cannot be maintained using the available means).
	Weather forecast to be checked prior to undertaking material handling or processing.
	Engines of on-site vehicles and plant to be switched off when not in use.
	Vehicles and plant are to be fitted with pollution reduction devices where practicable.
	Vehicles are to be maintained and serviced according to manufacturer's specifications.
	Visual monitoring of activities is to be undertaken to identify dust generation.
Exposed areas/stockpiles	The extent of exposed surfaces and stockpiles is to be kept to a minimum.
	Exposed areas and stockpiles are either to be covered or are to be dampened with water as far as is practicable if dust emissions are visible, or there is potential for dust emissions outside operating hours.
	Minimise dust generation by undertaking rehabilitation earthworks when topsoil and subsoil stockpiles are moist and/or wind speed is below 10 m/s.
Material handling	Reduce drop heights from loading and handling equipment where practical.
	Dampen material when excessively dusty during handling.
Hauling activities	Haul roads should be watered using water carts such that the road surface has sufficient moisture to minimise on-road dust generation but not so much as to cause mud/dirt track out to occur.
	Regularly inspect haul roads and maintain surfaces to remove potholes or depressions
	Driveways and hardstand areas to be swept/cleaned regularly as required etc.
	Vehicle traffic is to be restricted to designated routes.
	Speed limits are to be enforced.
	Vehicle loads are to be covered when travelling off-site.

Prior to commencement of operations at the Project, a detailed Air Quality Management Plan will be developed for the site. The Air Quality Management Plan would outline the measures to manage dust emissions at the site and include aspects such as key performance indicators, response mechanisms, compliance reporting and complaints management.

9 GREENHOUSE GAS ASSESSMENT

The National Greenhouse Accounts (NGA) Factors document published by the Department of the Environment and Energy defines three scopes (Scope 1, 2 and 3) for different emission categories based on whether the emissions generated are from "direct" or "indirect" sources.

Scope 1 emissions encompass the direct sources from the Project defined as:

> "*...from sources within the boundary of an organisation as a result of that organisation's activities*" (**Department of Climate Change, Energy, the Environment and Water, 2022a**).

Scope 2 and 3 emissions occur due to the indirect sources from the Project as:

> "*...emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation*" (**Department of Climate Change, Energy, the Environment and Water, 2022a**).

For the purpose of this assessment, emissions generated in all three scopes defined above provide a suitable approximation of the total Greenhouse Gas (GHG) emissions generated from the Project.

Scope 3 emissions can be a significant component of the total emissions inventory; however, these emissions are often not directly controlled by the operation. These emissions are understood to be considered in the Scope 1 emissions from other various organisations related to the Project.

Scope 3 emissions also arise from a number of various other sources indirectly associated with the operation of the Project such as emissions generated by employees travelling to and from the site. The relatively minor individual contributions that are difficult to accurately quantify due to the diversity and nature of the sources, have not been considered further in this assessment.

9.1 Emission sources

Scope 1 and 2 GHG emission sources identified from the operation of the Project are the on-site combustion of diesel fuel, oil and grease consumption and on-site consumption of electricity.

Scope 3 emissions have been identified as resulting from the purchase of diesel, oil and grease, electricity for use on-site and the transport of product material.

Estimated quantities of materials that have the potential to emit GHG emissions associated with Scope 1 and 2 emissions for the Project have been summarised in **Table 9-1** below. These estimates are based on a conservative upper limit of the assumed maximum production of the Project. The assessment provides a reasonable worst-case approximation of the potential GHG emissions for the purpose of this assessment.

Table 9-1: Summary of annual quantities of materials estimated for the Project

Type	Project	Units
Diesel	473	kL
Electricity	10	MWh
Oils and greases	2	kL

Note: Mt = million tonnes, kL = kilolitres, t = tonne and MWh = megawatt hour

The quantity of diesel fuel required to transport the materials for the Project to and from site has been estimated based on an approximate return travel distance. **Table 9-2** summarises the estimated travel distance calculations.

Table 9-2: Estimated travel distance

Distance (km)	Amount of material transported (tpa)	Payload (t)	Estimated travel distance (km)
35	337,500	34	347,426
120	187,500	34	661,765
180	187,500	34	992,647
45	37,500	34	49,632

To estimate the consumption of diesel fuel required for these activities, the average fuel consumption of 53.1L/100km for articulated trucks is applied (**ABS, 2023**).

9.2 Emission factors

To quantify the amount of carbon dioxide equivalent (CO_2-e) material generated from the Project, emission factors obtained from the NGA Factors (**Department of Climate Change, Energy, the Environment and Water, 2021b**) are summarised in **Table 9-3**.

Table 9-3: Summary of emission factors

Type	Energy content factor	Emission factor			Units	Scope
		CO_2	CH_4	N_2O		
Diesel	38.6	69.9	0.1	0.2	kg CO_2-e/GJ	1
		17.3	-	-		3
Petroleum based greases	38.8	3.5	-	-	kg CO_2-e/GJ	1
		18	-	-		3
Electricity	-	0.73	-	-	kg CO_2-e/kWh	2
		0.06	-	-		3

Note: kWh = kilowatt hour, CO_2 = Carbon Dioxide, CH_4 = Methane and N_2O = Nitrous Oxide

9.3 Summary of greenhouse gas emissions

Table 9-4 summarises the estimated annual CO_2-e emissions due to the Project.

Table 9-4: Summary of CO_2-e emissions for the Project (t CO_2-e)

Type	Scope 1	Scope 2	Scope 3
Diesel	1,281	-	316
Electricity	-	7	0.6
Oils and greases	0.3	-	1
Transport of product	-	-	2,952
Total	**1,281**	**7**	**3,269**

9.4 Contribution of greenhouse gas emissions

Table 9-5 summarises the emissions associated with the Project based on Scopes 1, 2 and 3.

Table 9-5: Summary of CO_2-e emissions per scope (kt CO_2-e)

Period	Scope 1	Scope 2	Scope 3
Annual	**1,281**	**7**	**3,269**

The estimated annual greenhouse emissions for Australia during 2022 was 486.9 million tonnes of carbon dioxide equivalent (Mt CO_2-e) (**Department of Climate Change, Energy, the Environment and Water, 2022b**). In comparison, the estimated annual average greenhouse emission for the Project is 0.001Mt CO_2-e (Scope 1 and 2). Therefore, the annual contribution of greenhouse emissions from the Project in comparison to the Australian greenhouse emissions for the 2022 period is estimated to be approximately 0.0003 per cent (%).

At a state level, the estimated greenhouse emissions for NSW in the 2019 period was 136.6Mt CO_2-e (**Department of Climate Change, Energy, the Environment and Water, 2022b**). The annual contribution of greenhouse emissions from the Project in comparison to the NSW greenhouse emissions for the 2019 period is estimated to be approximately 0.001%.

The estimated GHG emissions generated in all three scopes are based on approximated quantities of materials and where applicable, generic emission factors. Therefore, the estimated emissions for the Project are considered conservative.

9.5 Greenhouse gas management

The Project would also utilise various mitigation measures to minimise the overall generation of GHG emissions. Some examples of GHG mitigation and management practices that would be applied during construction and operation of the Project include:

- Investigating ways to reduce energy consumption throughout the life of the Project and reviewing energy efficient alternatives;
- Regular maintenance of equipment and plant;
- Ensure plant and equipment are fitted with appropriate controls;
- Ensure plant and equipment are switched off when not in use;
- Monitoring the consumption of fuel and regularly maintaining diesel powered equipment to ensure operational efficiency;
- Monitoring the total site electricity and investigating avenues to minimise consumption; and,
- Source consumable materials from environmentally sustainable sources.

10 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the Project at the Stockton Sand Quarry.

Air dispersion modelling was used to predict the potential for off-site dust impacts in the surrounding area due to the operation of the Project. The estimated dust emissions applied in the modelling are likely to be conservative and would overestimate the actual impacts.

It is predicted that all the assessed air pollutants generated by the operation of the Project would comply with the relevant assessment criteria at the applicable receptor locations and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area.

A direct comparison with the predicted impacts for the dredging application indicate that the Project would result in higher air impacts in the receiving environment, however, would remain compliant with the assessment criteria. Once the dredging application is approved, there would be a reduction in dust generation and an improvement in air quality due to the Project in the surrounding area.

Nevertheless, the site would apply appropriate dust and odour management measures to minimise air emissions from the site. Overall, the assessment demonstrates that the Project can operate without causing any significant air quality impact at residential receptor locations in the surrounding environment.

A conservative greenhouse gas assessment of the Project has been completed. The estimated annual average greenhouse emission is 0.001Mt CO_2-e material (Scope 1 and 2), which is calculated to be approximately 0.0003% of the Australian greenhouse emissions and approximately 0.001% of the NSW greenhouse emissions for the 2022 and 2019 period, respectively.

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Appendix A

Selection of Meteorological Year

Selection of meteorological year

A statistical analysis of the latest five contiguous years of meteorological data from the nearest BoM weather station with suitable available data, Williamtown RAAF weather station, is presented in **Table A-1**.

The standard deviation of the latest five years of meteorological data spanning 2017 to 2022 was analysed against the long-term measured wind speed, temperature and relative humidity. The analysis indicates that 2017 is the closest to the long-term average for wind speed, is closest for temperature and 2020 is closest to the long-term average for relative humidity.

Based on a score weighing analysis, the 2021 period is most representative on the long-term average and was selected for modelling.

Table A-1: Statistical analysis results for Williamtown RAAF

Year	Wind speed	Temperature	Relative humidity	Score
2017	0.5	1.0	4.9	6.9
2018	0.6	0.8	5.1	7.1
2019	0.6	1.1	5.1	7.4
2020	0.6	0.6	2.6	4.3
2021	0.6	0.5	2.6	4.2

Figure A-1 shows the frequency distributions for wind speed, temperature and relative humidity for the 2021 year compared with the mean of the 2017 to 2021 data set. The 2021 year data appear to be well aligned with the mean data.

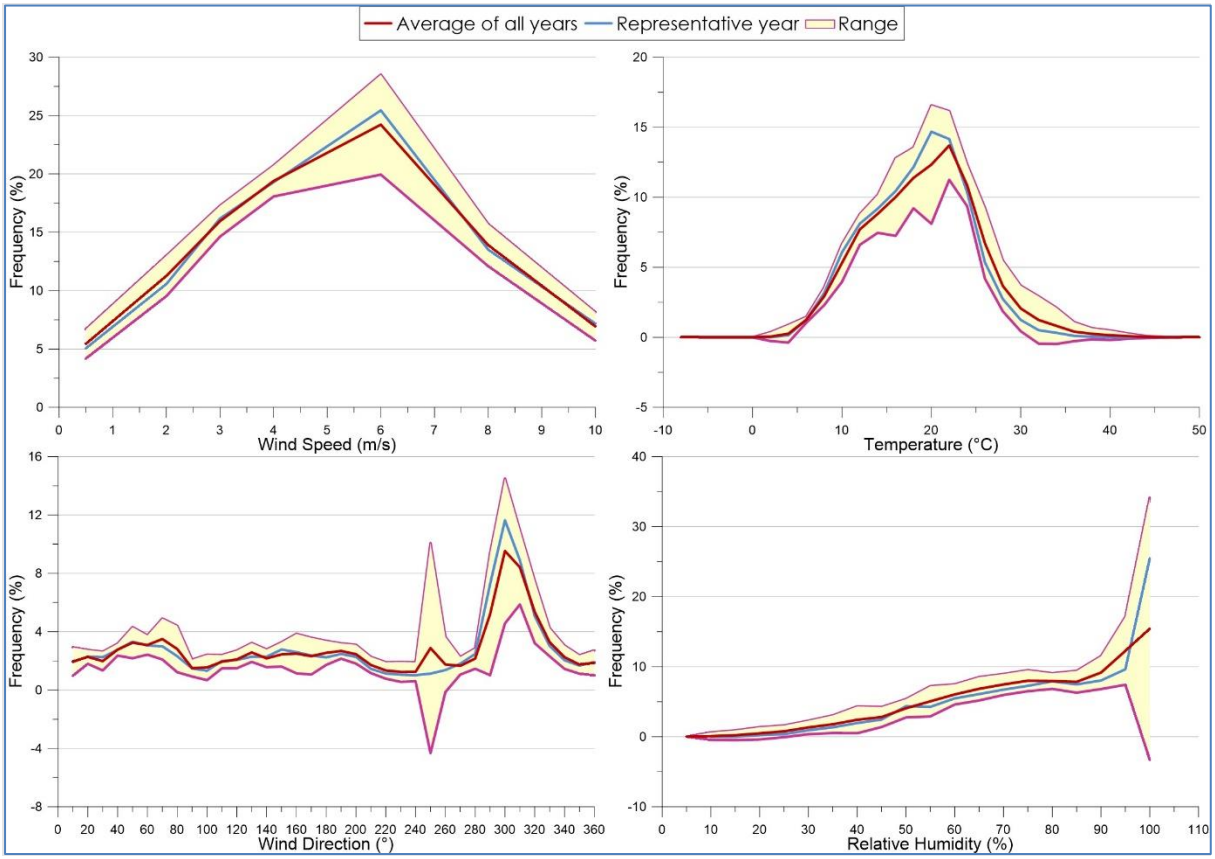

Figure A-1: Frequency distributions for wind speed, wind direction, temperature and relative humidity

Appendix B

Estimated background levels for Stockton Monitor

Estimated background levels for Stockton Monitor

Due to the location of the Stockton DPE monitoring site, it is subject to heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach.

Figure B-1 presents a pollution rose of the hourly $PM_{10,}$ wind speed and wind direction data recorded at Stockton during the 2021 calendar year. Recorded pollutant concentrations are presented as pseudo source locations based on the concurrent wind speed and direction data recorded at the Stockton DPE monitor. White spaces in the figures represent conditions in which no data has been recorded, and outliers are identifiable as points largely surrounded by white space.

It can be seen in **Figure B-1** that higher PM_{10} levels originate from the north-eastern directions under wind speeds below 6m/s. Higher PM_{10} levels were also recorded from the east-southeast and southeast direction under high and moderate wind speeds.

Elevated levels can be seen as patchy red areas in **Figure B-1** along a north-east axis from the monitor. This indicates that heavily salt laden air or particulates blowing from the northeast along the surf break of Stockton Beach were the likely primary contributors to the elevated PM_{10} levels. This is assumed for $PM_{2.5}$ levels as well.

A particle characterisation study that was conducted in the Lower Hunter has estimated that of the recorded annual averages at the Stockton DPE monitor 23% and 63% of $PM_{2.5}$ and $PM_{2.5\text{-}10}$ concentrations, respectively, are contributed from fresh sea salt particles at Stockton **(CSIRO, ANSTO & OEH 2016)**. Fresh sea salt aerosol arises from the wave-breaking in the ocean and is a natural source of particles.

To estimate the annual average concentrations at the Stockton DPE monitor without contribution from fresh sea salt particles, the difference in the measured $PM_{2.5}$ and PM_{10} annual averages excluding 63% are summed with the measured $PM_{2.5}$ annual average excluding 23% to estimate the annual average PM_{10} concentration with the contribution of fresh sea salt particles removed. The annual average $PM_{2.5}$ concentration is estimated by excluding 23% of the measured value.

Using these contributions approximate annual average $PM_{2.5}$ and PM_{10} concentrations of 6.4µg/m^3 and 14.5µg/m^3 were calculated respectively.

These estimates for the annual average $PM_{2.5}$ and PM_{10} concentrations are comparable with level measured at the Beresfield and Wallsend monitors.

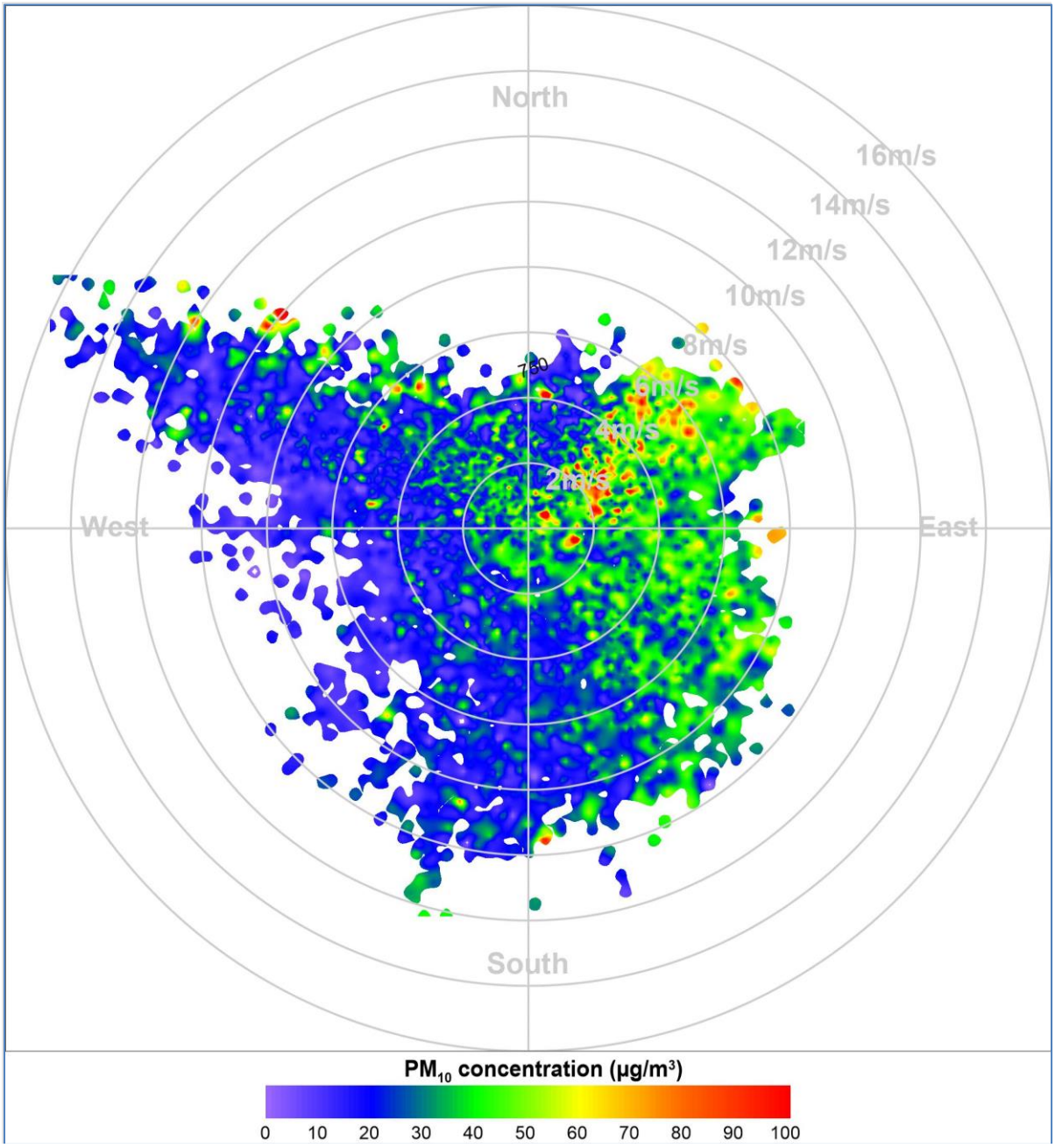

Figure B-1: PM_{10} pollution rose for Stockton Monitor for 2021

Appendix C

Emission Calculations

Emission Calculation

The dust emissions from the Project have been estimated from the operational description of the proposed activities provided by the Proponent and have been combined with emissions factor equations and utilising suitable emission and load factors that relate to the quantity of dust emitted from particular activities based on intensity, the prevailing meteorological conditions and composition of the material being handled.

Emission factors and associated controls have been sourced from:

- United States (US) EPA AP42 Emission Factors (**US EPA, 1985 and Updates**);
- Office of Environment and Heritage document, "NSW Coal Mining Benchmarking Study: Best Practise Measures for Reducing Non-Road Diesel Exhaust Emissions, Final Report" (**EPA NSW, 2015**).

The emission factor equations used for each dust generating activity are outlined in **Table C-1** below. A detailed dust emission inventory for the different scenarios are presented in **Table C-2** to **Table C-4.**

Control factors include the following:

- Hauling on unpaved surfaces – 80% control for watering of trafficked areas; and,
- Wind erosion from exposed areas – 50% control for watering of exposed areas.

Table C-1: Emission factor equations

Activity	Emission factor equation		
	TSP	PM_{10}	$PM_{2.5}$
Loading / emplacing material	$EF = 0.74 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.35 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$	$EF = 0.053 \times 0.0016 \times \left(\frac{U}{2.2}^{1.3} / \frac{M}{2}^{1.4}\right)\ kg/tonne$
Hauling on unsealed surfaces	$EF = \left(\frac{0.4536}{1.6093}\right) \times 4.9 \times (s/12)^{0.7} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 1.5 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$	$EF = \left(\frac{0.4536}{1.6093}\right) \times 0.15 \times (s/12)^{0.9} \times (1.1023 \times M/3)^{0.45}\ kg/VKT$
Screening - uncontrolled	$EF = 0.0125\ kg/tonne$	$EF = 0.0043\ kg/tonne$	$0.075 \times TSP$
Screening - controlled	$EF = 0.0011\ kg/tonne$	$EF = 0.00037\ kg/tonne$	$EF = 0.000025\ kg/tonne$
Wind erosion on exposed areas, stockpiles	$EF = 850\ kg/ha/year$	$0.5 \times TSP$	$0.075 \times TSP$

EF = emission factor, U = wind speed (m/s), M = moisture content (%), s = silt content (%), VKT = vehicle kilometres travelled (km).

Table C-2: Dust Emissions Inventory – Scenario 1

Scenario 1	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 1	Units	Var. 2	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Loading sand to haul truck at windblown sand area	370	175	26	250,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling RAW sand from windblown sand area to offsite	14,829	3,779	378	250,000	t/yr	0.297	0.076	0.008	kg/t	28.00	t/l	4.0	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Excavator loading topsoil to haul truck - Stage 1	62	29	4	63	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling to topsoil stockpile	284	73	7	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/l	0.5	km/return	2.6	0.7	0.1	kg/VKT	4.8	S.C %	48	Ave GMV (t)	80	C %
Emplacing at topsoil stockpile	62	29	4	63	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading sand to screen in Stage 1	740	350	53	500,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Screening RAW sand - uncontrolled	6,250	2,150	469	500,000	t/yr	0.001	0.000	0.0000	kg/t														
Unloading processed sand to stockpile	740	350	53	500,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Rehandle processed sand material at product stockpile	74	35	5	50,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading product sand material to haul truck	740	350	53	500,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling product sand offsite	6,673	1,701	170	500,000	t/yr	0.067	0.017	0.002	kg/t	28.00	t/l	0.9	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Hauling VENM material onsite	1,038	265	26	70,000	t/yr	0.074	0.019	0.002	kg/t	28.00	t/l	1.0	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Unloading VENM material at stockpile	104	49	7	70,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Wind erosion - exposed area	3,690	1,845	277	8.7	ha	850	425	64	kg/ha/yr													50	C %
Exhaust emissions from on-site equipment	449	449	435																				
Total TSP emissions (kg/yr)	**36,102**	**11,627**	**1,969**																				

Table C-3: Dust Emissions Inventory – Scenario 2

Scenario 2	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 1	Units	Var. 2	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Excavator loading topsoil to haul truck - Stage 1	62	29	4	63	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling to topsoil stockpile	284	73	7	63	t/yr	0.034	0.009	0.001	kg/t	40.00	t/l	0.5	km/return	2.6	0.7	0.1	kg/VKT	4.8	S.C %	48	Ave GMV (t)	80	C %
Emplacing at topsoil stockpile	62	29	4	63	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading sand to screen in Stage 1	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Screening RAW sand - controlled (wet sand)	825	278	19	750,000	t/yr	0.013	0.004	0.0009	kg/t														
Unloading processed sand to stockpile	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Rehandle processed sand material at product stockpile	111	52	8	75,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading product sand material to haul truck	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling product sand offsite	10,009	2,551	255	750,000	t/yr	0.067	0.017	0.002	kg/t	28.00	t/l	0.9	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/l	1.1	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Unloading VENM material at stockpile	104	49	7	70,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Wind erosion - exposed area	3,690	1,845	277	8.7	ha	850	425	64	kg/ha/yr													50	C %
Exhaust emissions from on-site equipment	449	449	435																				
Total TSP emissions (kg/yr)	**20,088**	**7,226**	**1,285**																				

Table C-4: Dust Emissions Inventory – Scenario 3

Scenario 3	TSP emission	PM10 emission	PM2.5 emission	Intensity	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 1	Units	Var. 2	Units	EF - TSP	EF - PM10	EF - PM25	Units	Var. 3	Units	Var. 4	Units	Var. 5	Units
Excavator loading topsoil to haul truck - Stage 5	35	17	3	36	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling to topsoil stockpile	602	154	15	36	t/yr	0.127	0.032	0.003	kg/t	40.00	t/l	1.9	km/return	2.6	0.7	0.1	kg/VKT	4.8	S.C %	48	Ave GMV (t)	80	C %
Emplacing at topsoil stockpile	35	17	3	36	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading sand to haul truck in Stage 5	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling RAW sand to stockpile at processing area	21,931	5,590	559	750,000	t/yr	0.146	0.037	0.004	kg/t	40.00	t/l	2.2	km/return	2.6	0.7	0.1	kg/VKT	4.8	S.C %	48	Ave GMV (t)	80	C %
Unloading sand to stockpile	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading sand to screen at processing area	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Screening RAW sand - controlled (wet sand)	825	278	19	750,000	t/yr	0.013	0.004	0.0009	kg/t														
Unloading processed sand to stockpile	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Rehandle processed sand material at product stockpile	111	52	8	75,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading product sand material to haul truck	1,110	525	79	750,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling product sand offsite	10,009	2,551	255	750,000	t/yr	0.067	0.017	0.002	kg/t	28.00	t/l	0.9	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Hauling VENM material onsite	1,165	297	30	70,000	t/yr	0.083	0.021	0.002	kg/t	28.00	t/l	1.1	km/return	2.1	0.5	0.1	kg/VKT	4.8	S.C %	28	Ave GMV (t)	80	C %
Unloading VENM material at stockpile	104	49	7	70,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Loading VENM material to haul truck	104	49	7	70,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Hauling VENM material to Stage 5	1,773	452	45	70,000	t/yr	0.127	0.032	0.003	kg/t	40.00	t/l	1.9	km/return	2.6	0.7	0.1	kg/VKT	4.8	S.C %	48	Ave GMV (t)	80	C %
Unloading VENM material at Stage 5	104	49	7	70,000	t/yr	0.001	0.001	0.0001	kg/t	2.00	ave. (WS/2.2)^1.3 m/s	2.8	M.C %										
Wind erosion - exposed area	5,795	2,898	435	13.6	ha	850	425	64	kg/ha/yr													50	C %
Exhaust emissions	622	622	604																				
Total TSP emissions (kg/yr)	**48,763**	**15,697**	**2,394**																				

Appendix D

Isopleth Diagrams

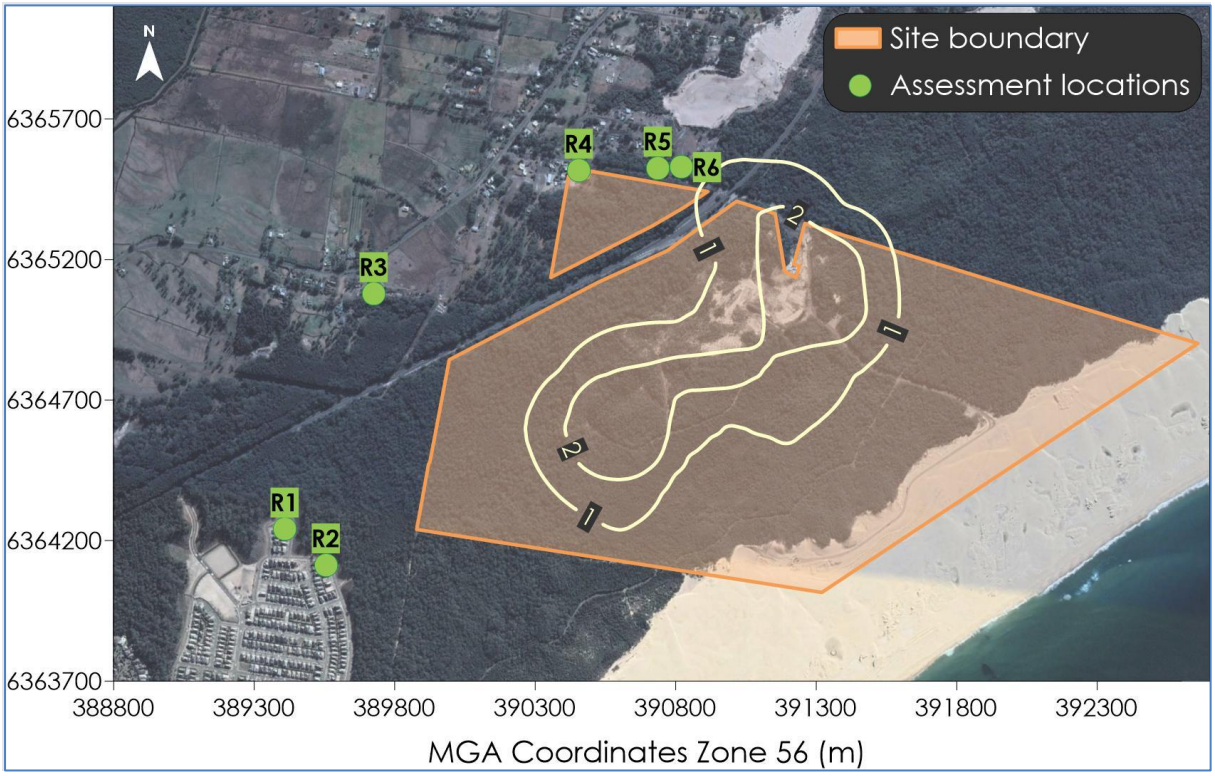

Figure D-1: Predicted incremental maximum 24-hour average $PM_{2.5}$ concentrations (µg/m³)

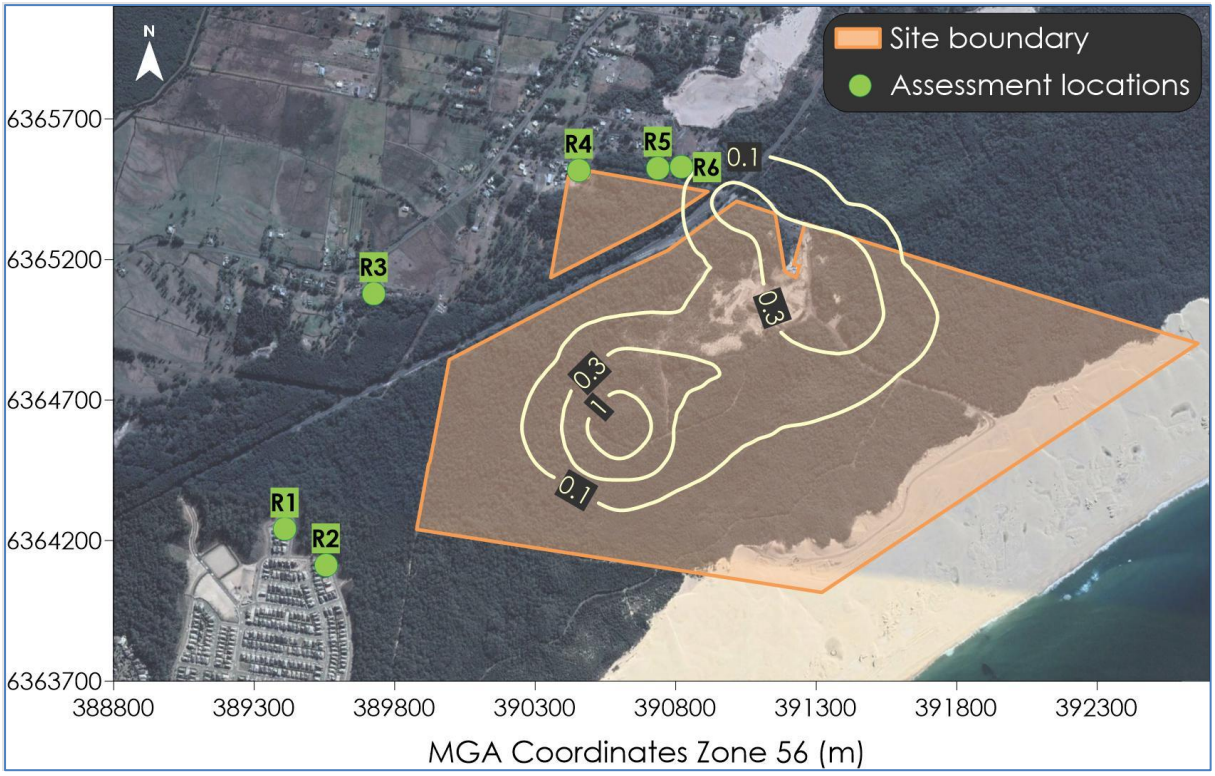

Figure D-2: Predicted incremental annual average $PM_{2.5}$ concentrations (µg/m³)

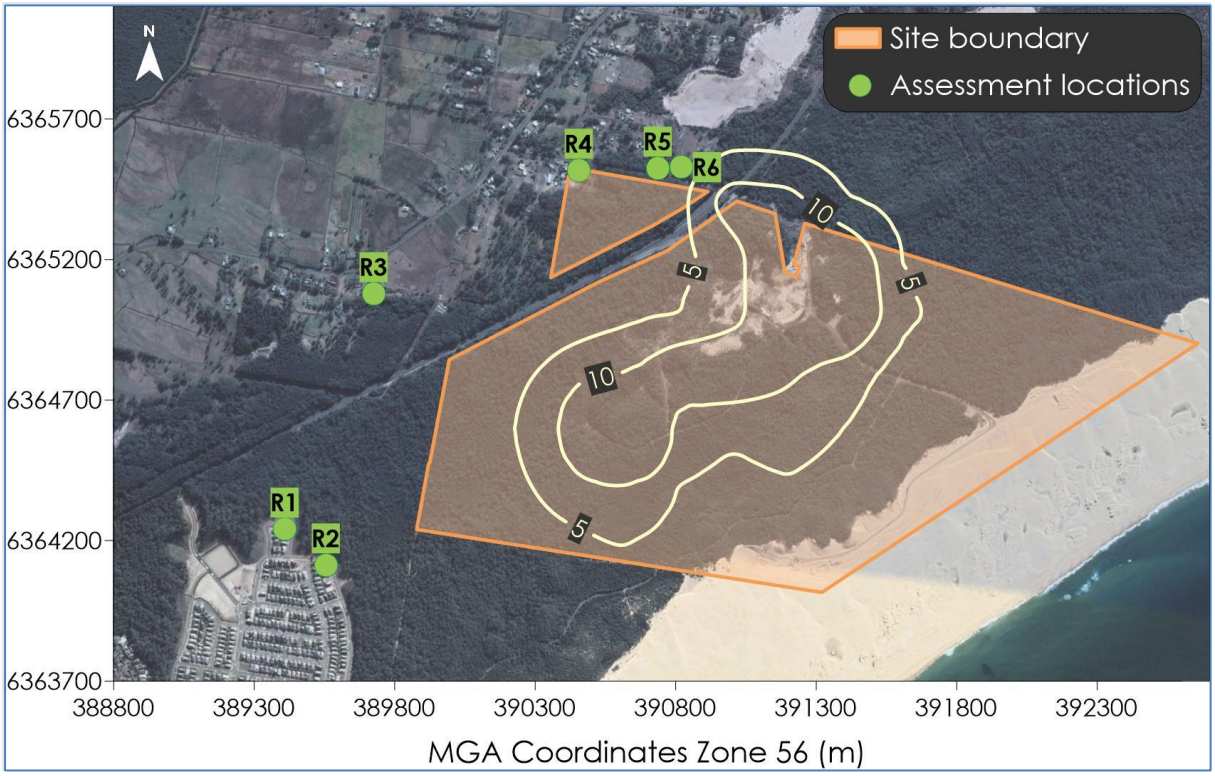

Figure D-3: Predicted incremental maximum 24-hour average PM_{10} concentrations (µg/m³)

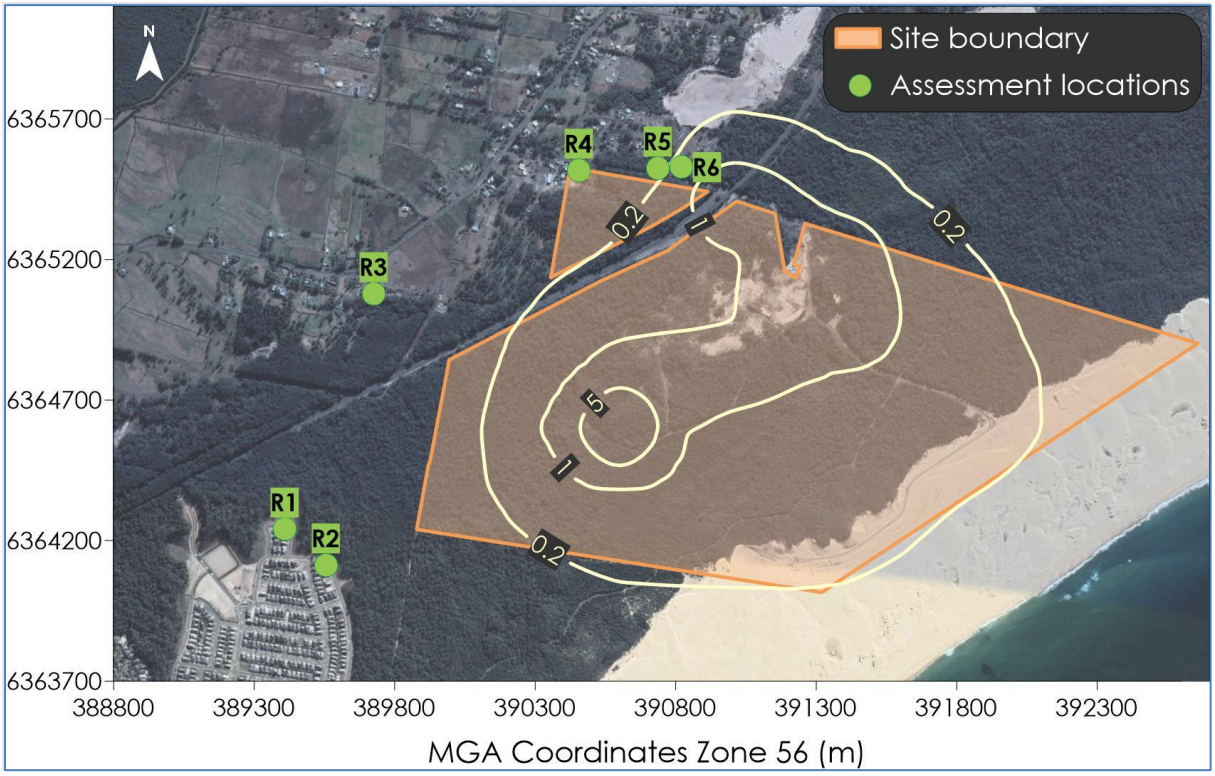

Figure D-4: Predicted incremental annual average PM_{10} concentrations (µg/m³)

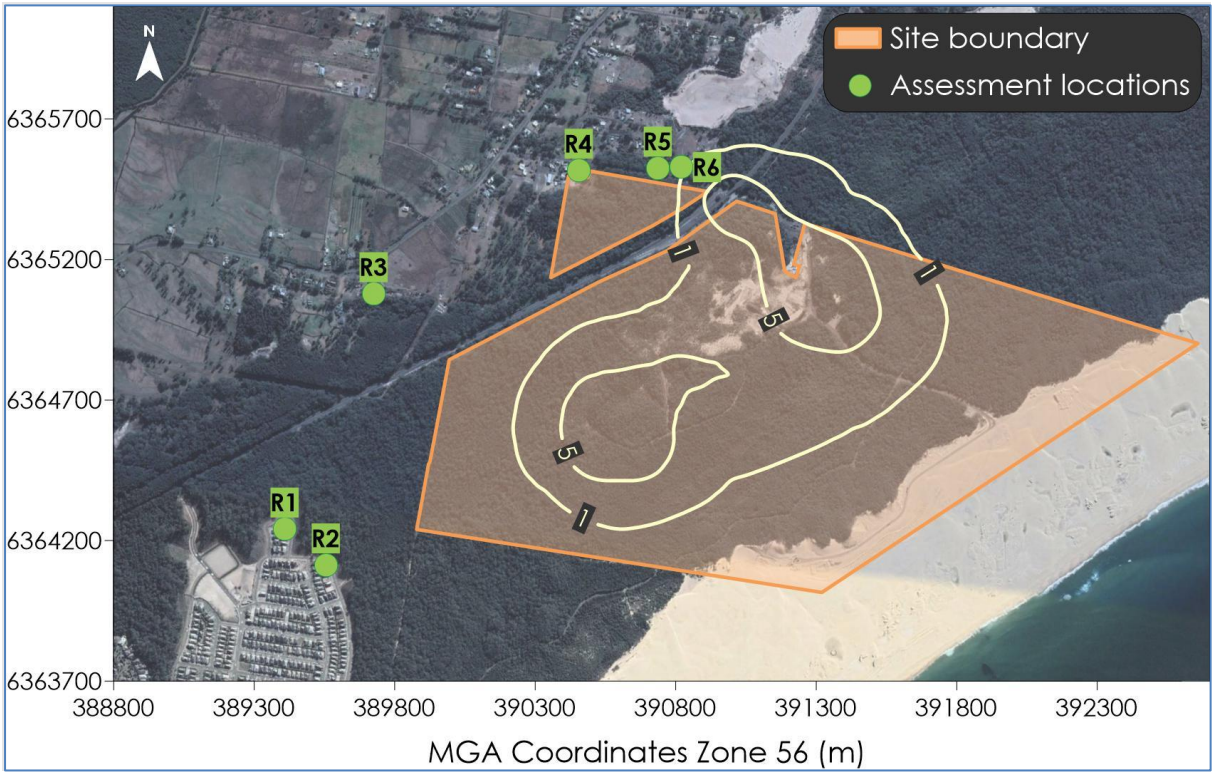

Figure D-5: Predicted incremental annual average TSP concentrations (µg/m³)

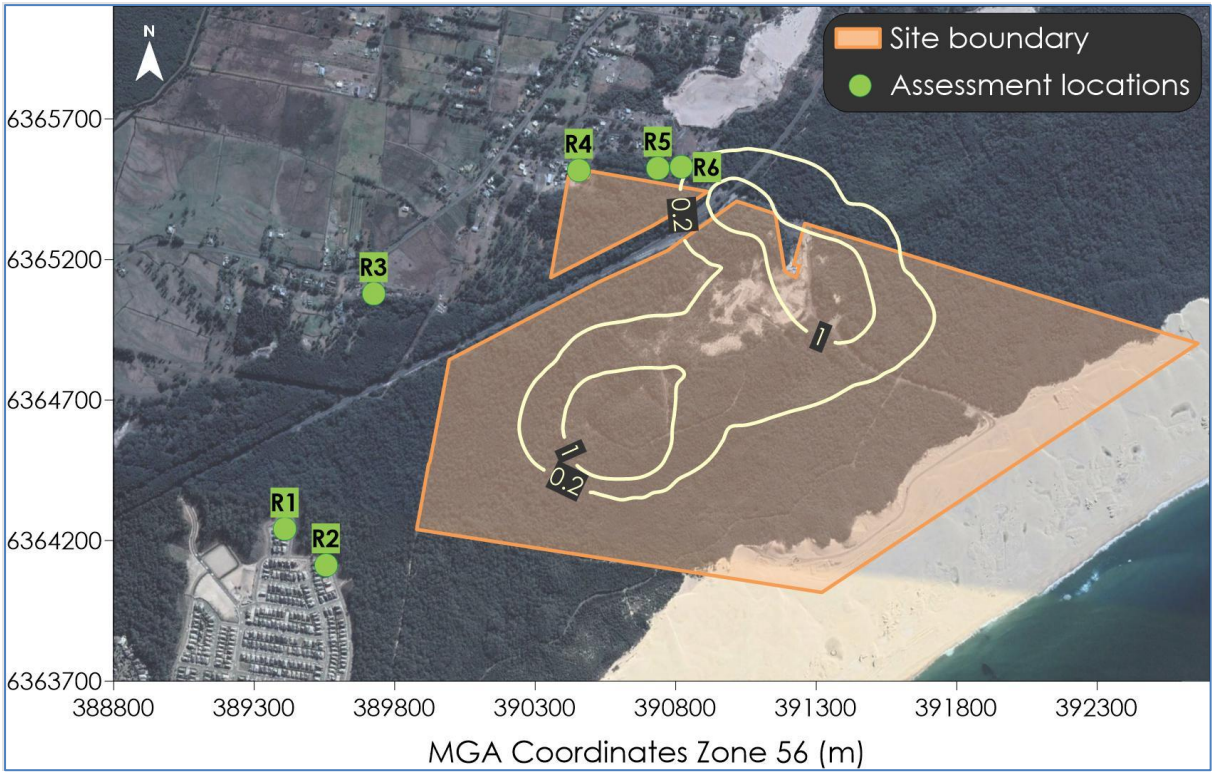

Figure D-6: Predicted incremental annual average dust deposition levels (g/m²/month)

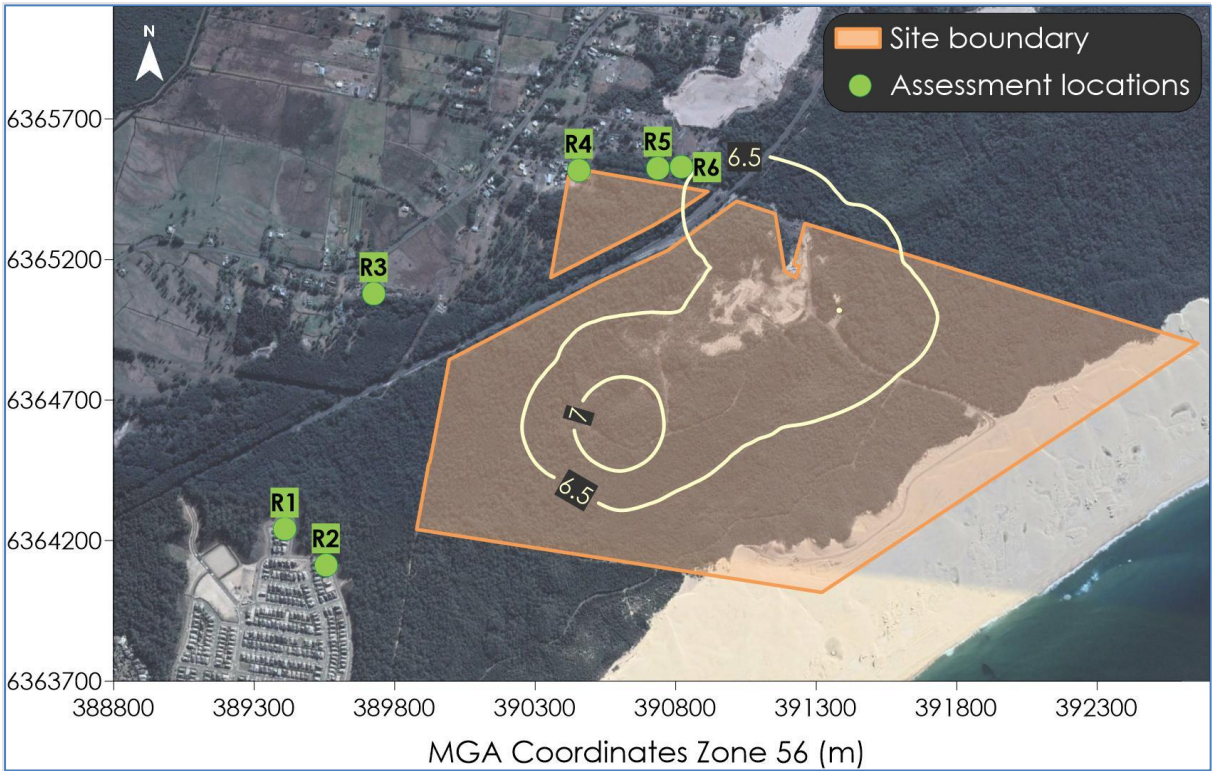

Figure D-7: Predicted cumulative annual average $PM_{2.5}$ concentrations (µg/m³)

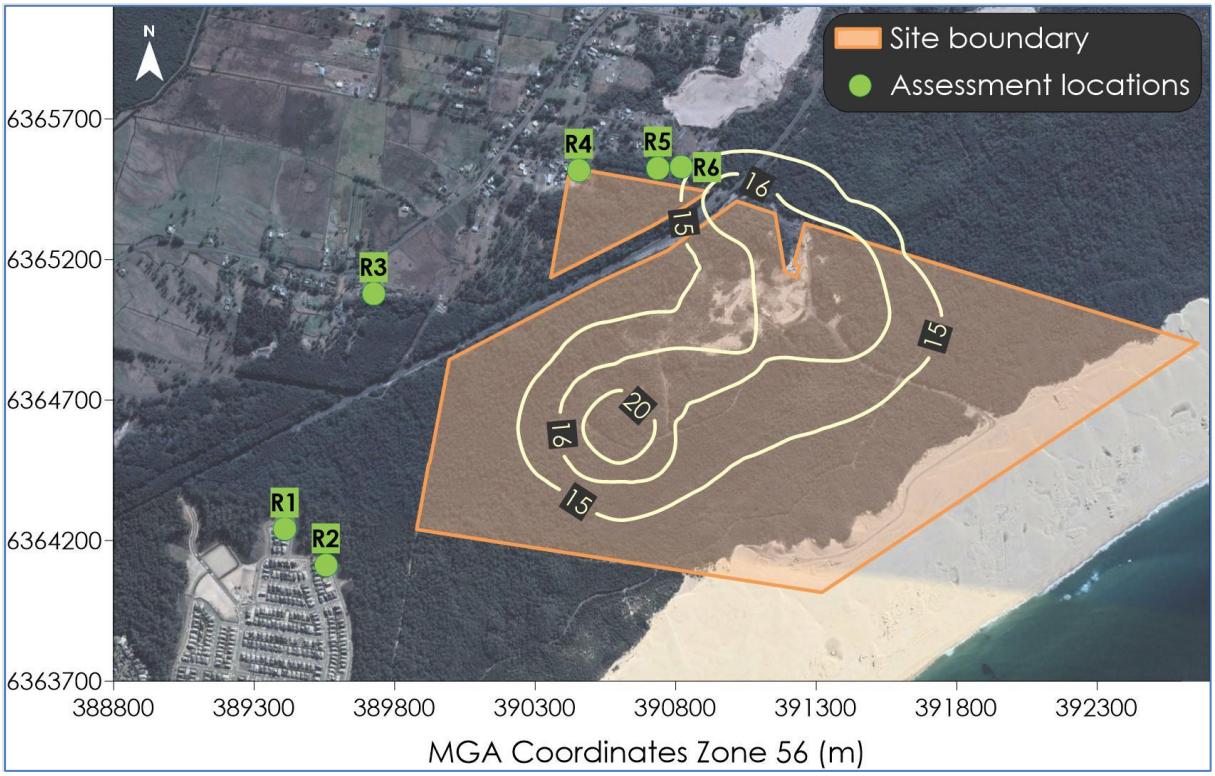

Figure D-8: Predicted cumulative annual average PM_{10} concentrations (µg/m³)

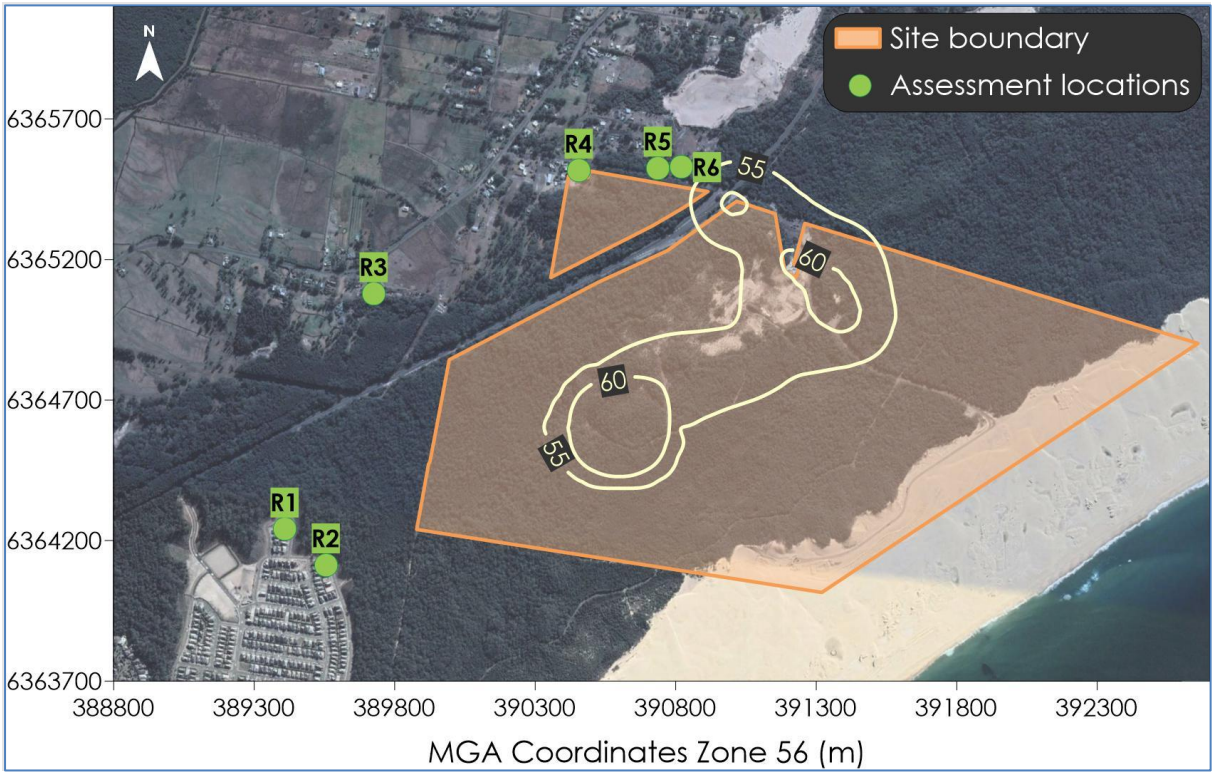

Figure D-9: Predicted cumulative annual average TSP concentrations (µg/m³)

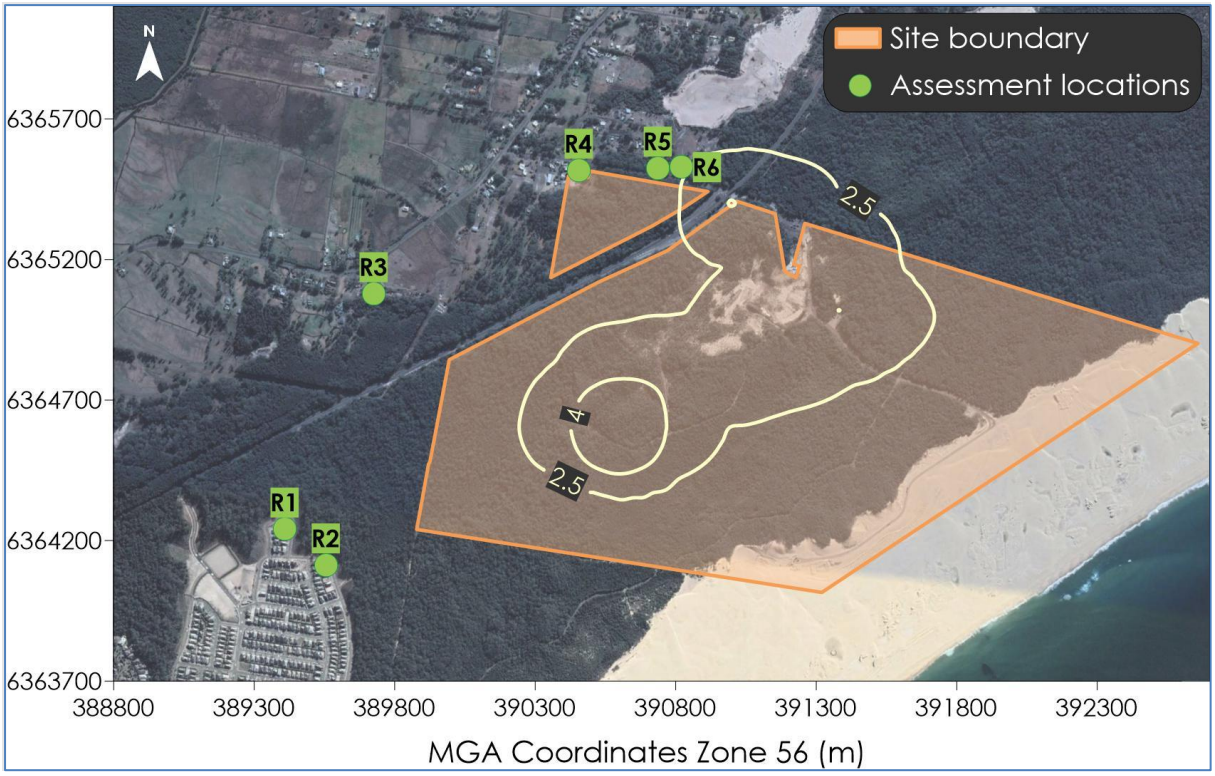

Figure D-10: Predicted cumulative annual average dust deposition levels (g/m²/month)

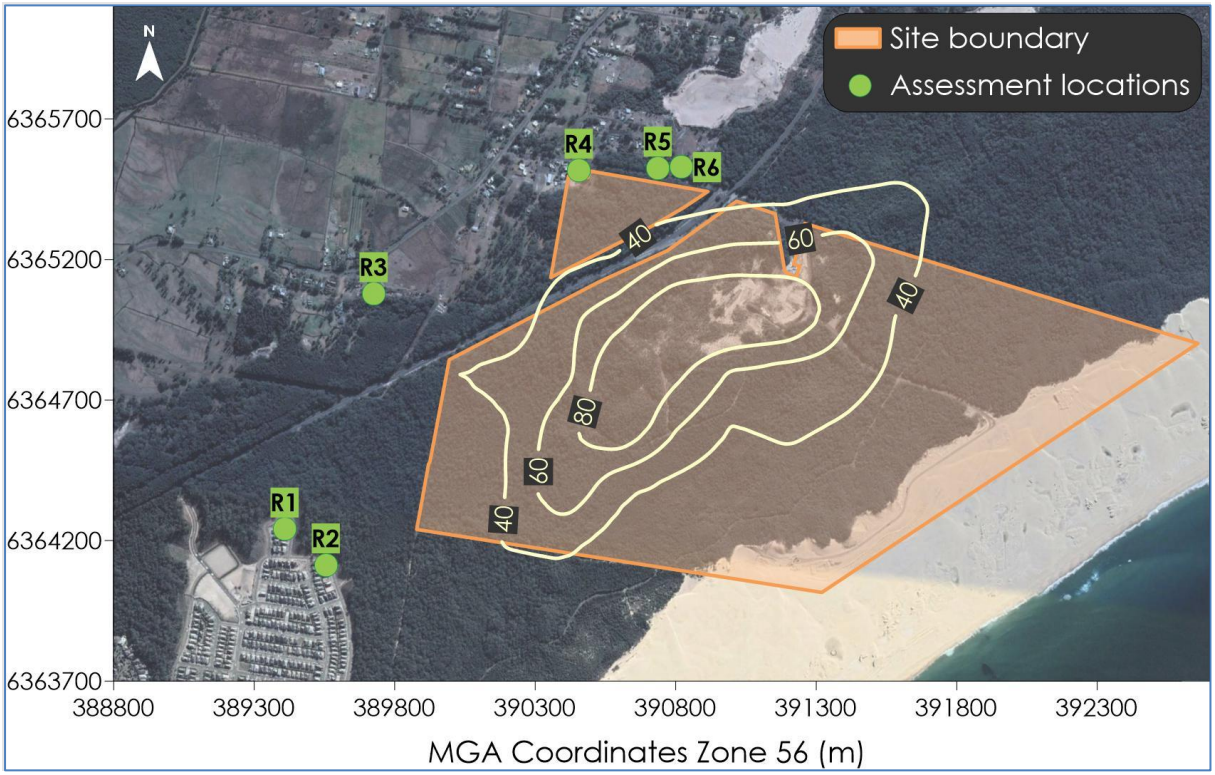

Figure D-11: Predicted incremental 1-hour average NO_2 concentrations (µg/m³)

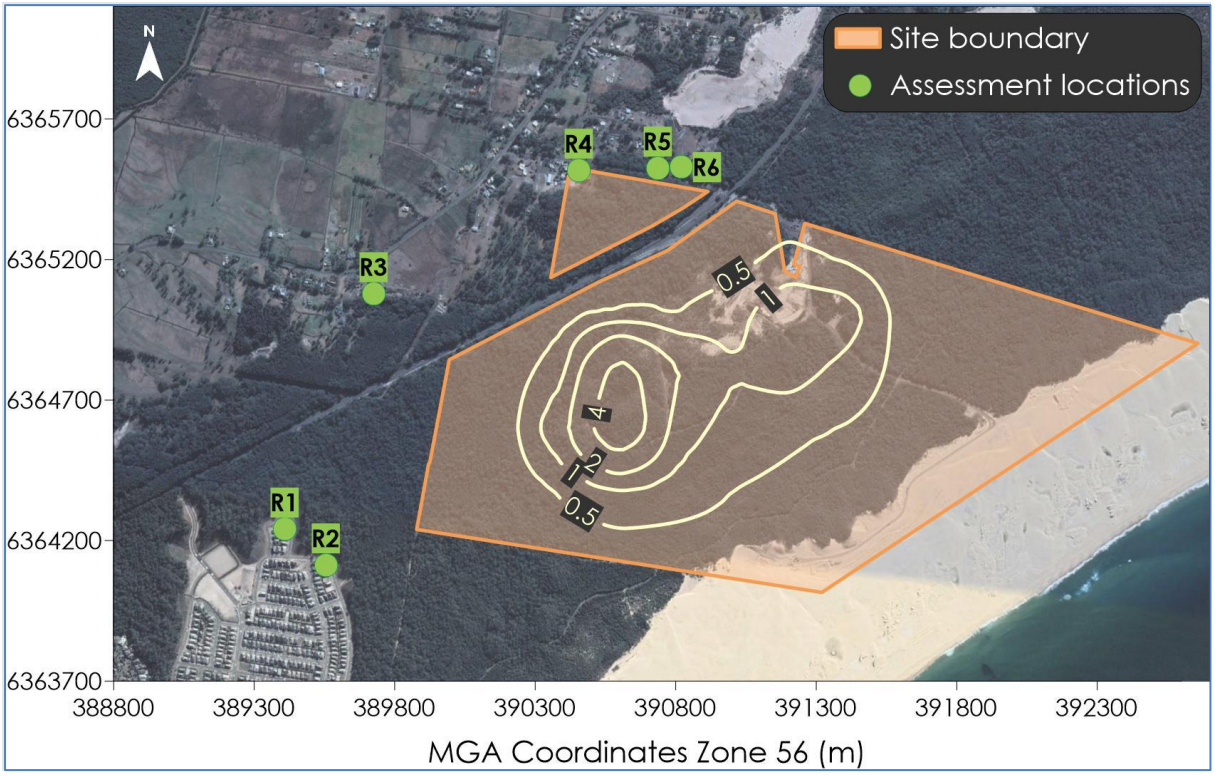

Figure D-12: Predicted incremental annual average NO_2 concentrations (µg/m³)

Appendix E

Further detail regarding 24-hour $PM_{2.5}$ and PM_{10} analysis

Further detail regarding 24-hour average $PM_{2.5}$ and PM_{10} analysis

The analysis below provides a cumulative 24-hour $PM_{2.5}$ and a cumulative 24-hour PM_{10} impact assessment in accordance with the NSW EPA Approved Methods; refer to the worked example on Page 49 to 51 of the Approved Methods.

The background level is the ambient level at Stockton monitoring station for $PM_{2.5}$ and PM_{10}.

The predicted increment is the predicted level to occur at the receptor due to the Project.

The total is the sum of the background level and the predicted level. The totals may have minor discrepancies due to rounding.

Table E-1 to **Table E-4** assesses receptors R2 and R6 and shows the predicted maximum cumulative levels at the selected receptor. The left half of the table examines the cumulative impact during the periods of highest background levels and the right half of the table examines the cumulative impact during the periods of highest contribution from the Project.

Tables E-5 show the periods of highest background PM_{10} levels where the measured background level is already over the criteria of 50µg/m³ at receptors R2 and R6 surrounding the Project which has been excluded from **Table E-1** to **Table E-4**.

The green shading represents days ranked per the highest background level but below the criteria.

The blue shading represents days ranked per the highest predicted increment level but below the criteria.

The orange shading represents days where the measured background level is already over the criteria.

Any value above the $PM_{2.5}$ criterion of 25µg/m³ or above the PM_{10} criterion of 50µg/m³ is in **bold red.**

Table E-1: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
7/07/2021	20.8	0.0	20.8	3/07/2021	12.1	0.2	12.3
15/08/2021	20.4	0.0	20.4	1/07/2021	7.5	0.2	7.7
15/06/2021	20.3	0.0	20.3	8/07/2021	17.5	0.1	17.6
28/06/2021	20.2	0.0	20.2	30/07/2021	12.7	0.1	12.8
1/09/2021	19.8	0.0	19.8	3/06/2021	12.4	0.1	12.5
19/05/2021	19.5	0.0	19.5	12/07/2021	11.4	0.1	11.5
14/06/2021	18.5	0.0	18.5	11/03/2021	8.6	0.1	8.7
17/01/2021	18.4	0.0	18.4	2/09/2021	7.6	0.1	7.7
20/08/2021	17.6	0.0	17.6	29/08/2021	15.3	0.1	15.4
8/07/2021	17.5	0.1	17.6	22/03/2021	7.3	0.1	7.4

Table E-2: Cumulative 24-hour average $PM_{2.5}$ concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
7/07/2021	20.8	0.1	20.9	8/04/2021	3.7	0.4	4.1
15/08/2021	20.4	0.0	20.4	3/06/2021	12.4	0.4	12.8
15/06/2021	20.3	0.0	20.3	6/04/2021	7.8	0.3	8.1
28/06/2021	20.2	0.1	20.3	8/07/2021	17.5	0.3	17.8
1/09/2021	19.8	0.1	19.9	4/05/2021	12.0	0.2	12.2
19/05/2021	19.5	0.0	19.5	5/04/2021	7.4	0.2	7.6
14/06/2021	18.5	0.0	18.5	11/07/2021	6.7	0.2	6.9
17/01/2021	18.4	0.1	18.5	31/05/2021	13.4	0.2	13.6
20/08/2021	17.6	0.0	17.6	18/03/2021	5.9	0.2	6.1
8/07/2021	17.5	0.3	17.8	20/02/2021	9.7	0.2	9.9

Table E-3: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R2

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
26/01/2021	49.2	0.0	49.2	3/07/2021	29.5	1.3	30.8
3/02/2021	49.0	0.0	49.0	1/07/2021	24.4	1.0	25.4
1/03/2021	48.6	0.1	48.7	8/07/2021	44.7	0.9	45.6
25/02/2021	48.1	0.1	48.2	30/07/2021	33.6	0.8	34.4
11/09/2021	48.0	0.0	48.0	3/06/2021	33.5	0.5	34.0
15/04/2021	47.9	0.2	48.1	12/07/2021	37.2	0.5	37.7
6/11/2021	47.3	0.1	47.4	29/08/2021	43.4	0.4	43.8
19/08/2021	46.9	0.2	47.0	22/03/2021	30.9	0.4	31.3
25/09/2021	46.9	0.0	46.9	2/05/2021	19.3	0.4	19.7
28/09/2021	46.7	0.2	46.8	16/06/2021	31.1	0.4	31.5

Table E-4: Cumulative 24-hour average PM_{10} concentration (µg/m³) – Receptor R6

Ranked by Highest to Lowest Background Concentrations				Ranked by Highest to Lowest Predicted Incremental Concentration			
Date	Measured background level	Predicted increment	Total cumulative 24-hr average level	Date	Measured background level	Predicted increment	Total cumulative 24-hr average level
26/01/2021	49.2	0.0	49.2	8/04/2021	21.2	2.7	23.9
3/02/2021	49.0	0.4	49.4	3/06/2021	33.5	2.6	36.1
1/03/2021	48.6	0.1	48.7	8/07/2021	44.7	1.7	46.4
25/02/2021	48.1	0.0	48.1	6/04/2021	30.6	1.7	32.3
11/09/2021	48.0	0.0	48.0	4/05/2021	25.5	1.3	26.8
15/04/2021	47.9	0.4	48.3	5/04/2021	30.4	1.3	31.7
6/11/2021	47.3	0.1	47.4	11/07/2021	30.4	1.1	31.5
19/08/2021	46.9	0.0	46.9	20/02/2021	44.9	1.1	46.0
25/09/2021	46.9	0.2	47.1	31/05/2021	32.6	1.1	33.7
28/09/2021	46.7	0.0	46.7	22/06/2021	27.9	1.0	28.9

Table E-5: Summary of 24-hour average PM_{10} concentration (µg/m³) above the criteria

Ranked by Highest to Lowest Background Concentrations			
Date	Measured background level	Predicted increment	
		R2	R6
29/10/2021	64.2	0.0	0.0
22/01/2021	63.5	0.1	0.0
4/02/2021	63.0	0.2	0.0
18/01/2021	60.4	0.1	0.2
9/08/2021	60.2	0.1	0.0
21/01/2021	59.9	0.1	0.1
18/02/2021	59.9	0.0	0.8
16/01/2021	59.7	0.0	0.3
8/10/2021	59.7	0.1	0.6
8/09/2021	58.8	0.1	0.4
5/02/2021	57.9	0.2	0.0
17/01/2021	56.3	0.0	0.3
12/09/2021	56.1	0.0	0.0
7/03/2021	55.3	0.2	0.0
19/03/2021	54.9	0.0	0.5
25/01/2021	54.5	0.1	0.0
19/02/2021	54.1	0.0	0.5
17/02/2021	54.0	0.0	0.8
2/06/2021	53.7	0.1	0.0
23/01/2021	52.1	0.1	0.3
14/04/2021	51.3	0.0	0.0
30/01/2021	50.8	0.1	0.3
28/10/2021	50.3	0.1	0.3
17/10/2021	50.1	0.0	0.3

Appendix J

Noise impact assessment

REPORT

STOCKTON SAND QUARRY

FULLERTON COVE

NOISE IMPACT ASSESSMENT
RWDI # 2104671.02
19 June 2023

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DOCUMENT CONTROL

Version	Status	Date	Prepared By	Reviewed By
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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (LAmax) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

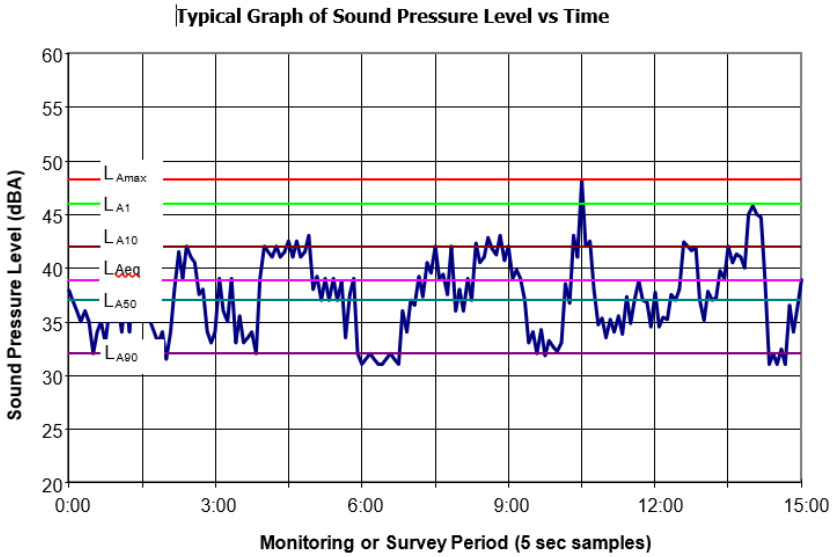
L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10th percentile (lowest 10th percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.



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Appendix A: Unattended Noise Monitoring Results

1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in **Figure 1-1**, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 1-2 shows the quarry, the project, and the existing windblown project.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the project on 18 January 2023. This Noise Impact Assessment has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project.

RWDI Australia Pty Ltd (RWDI) has been engaged by Arnold Planning on behalf of Boral to conduct a Noise Impact Assessment (NIA) for the proposed Stockton Quarry Dry Sand Extraction Project (the Project).

This report provides a detailed assessment of potential operational noise impacts. The assessment has been conducted in general accordance with the NSW Environmental Protection Authority (EPA) *Noise Policy for Industry (NPfI).*

Minor construction works are proposed. Noise emissions from these activities would be considered under the *Interim Construction Noise Guideline (ICNG).*

The Project will generate heavy vehicle movements along Nelson Bay Road, Cabbage Tree Road, and Medowie Road. A detailed assessment of road traffic noise has therefore also been conducted in accordance with the EPA's NSW *Road Noise Policy (RNP).*

It should be noted that no significant sources of vibration have been identified for the Project. Additionally, the distance between the quarry and the closest receivers is over 500 metres (m), therefore a detailed assessment of potential vibration impacts is not considered necessary.

1.1 Secretary's Environmental Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the Project on 18 January 2023. This NIA has been prepared to address the relevant SEARs and inform the preparation of an Environmental Impact Statement (EIS) for the Project. The following table identifies in which sections of the report they are addressed.

Table 1-1: Secretary's Environmental Assessment Requirements, DPE

Key Issue	Description	Report Section
Noise	A detailed assessment of the likely construction, operational and off-site transport noise impacts of the development in accordance with the Interim Construction Noise Guideline, NSW Noise Policy for Industry and the NSW Road Noise Policy respectively, and having regard to the Voluntary Land Acquisition and Mitigation Policy;	Sections 4,5 and 6 addresses construction, operational, and off-site transport noise impacts.
	If a claim is made for specific construction noise criteria for certain activities, then this claim must be justified and accompanied by an assessment of the likely noise impacts of those activities under the Interim Noise Construction Guideline	Standard NMLs as per the ICNG applied for this assessment, Sections 3.4 and 5
	Include reasonable and feasible mitigation measures to minimise noise emissions	Recommendations are provided in Sections 4.8 and 5.5

Key Issue	Description	Report Section
	Include consideration of monitoring and management measures, in particular, real-time, and attended noise monitoring	Predicted noise levels from construction and operational sources were minimal. Real time unattended noise monitoring is not considered necessary. Recommendations for attended noise monitoring in response to complaints has been made in Section 4.8.

Furthermore, the EPA provided additional requirements for the EIS. **Table 1-2**Table 1-2 presents these requires and identifies how they have been addressed in this assessment.

Table 1-2: EPA EIS Requirements

Requirement	Report Section
Construction noise associated with the proposed development should be assessed using the Interim Construction Noise Guideline (DECC, 2009). These are available at: **https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/interimconstructionnoise-guideline**	Sections 3.4 and 5 addresses construction noise impacts.
Vibration from all activities (including construction and operation) to be undertaken on the premises should be assessed using the guidelines contained in the Assessing Vibration: a technical guideline (DEC, 2006). These are available at: **https://www.epa.nsw.gov.au/yourenvironment/noise/industrial-noise/assessing-vibration**	No significant sources of vibration have been identified for the Project. Additionally, the distance between the quarry and the closest receivers is over 500 metres (m), therefore a detailed assessment of potential vibration impacts is not considered necessary.
If blasting is required for any reasons during the construction or operational stage of the proposed development, blast impacts should be demonstrated to be capable of complying with the guidelines contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990).These are available at: **https://www.epa.nsw.gov.au/yourenvironment/noise/industrial-noise/interim-constructionnoise-guideline**	No blasting is required and has not been assessed.

Requirement	Report Section
Operational noise from all industrial activities (including private haul roads and private railway lines) to be undertaken on the premises should be assessed using the guidelines contained in the NSW Noise Policy for Industry (EPA, 2017). https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/noise-policyforindustry-(2017)	Sections 3.2 and 4 addresses operational noise
Noise on public roads from increased road traffic generated by land use developments should be assessed using the guidelines contained in the NSW Road Noise Policy and associated application notes (EPA, 2011). **https://www.epa.nsw.gov.au/yourenvironment/noise/transport-noise**	Sections 3.5 and 6 addresses additional road traffic noise

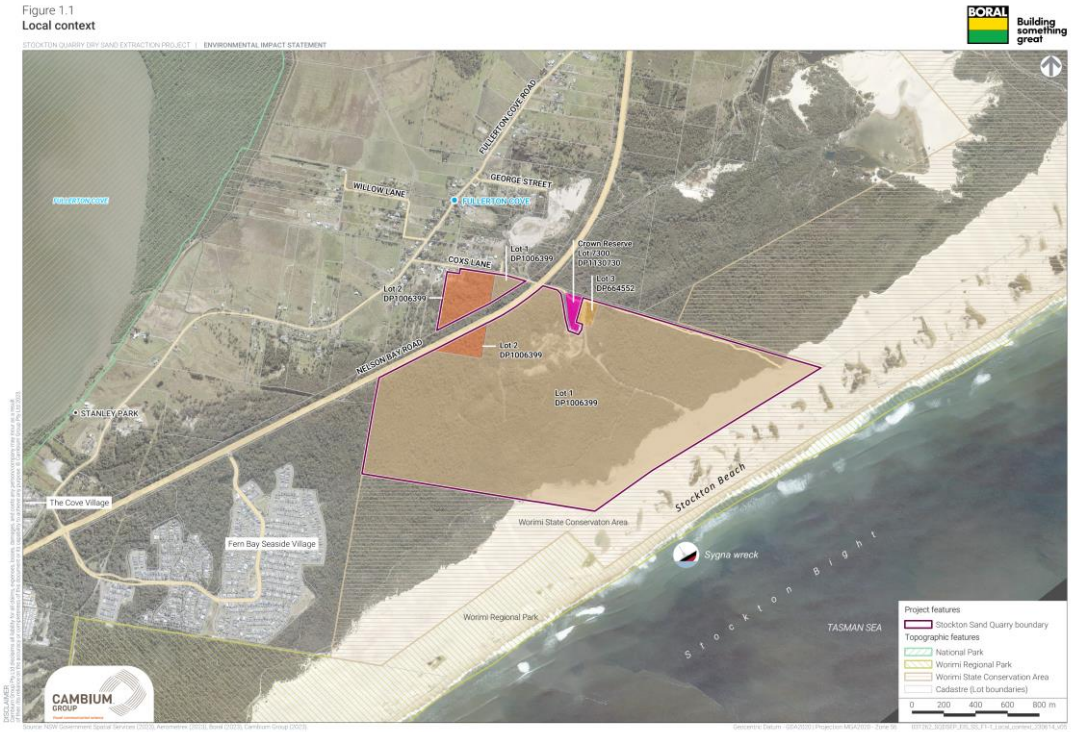

Figure 1-1: Local Context

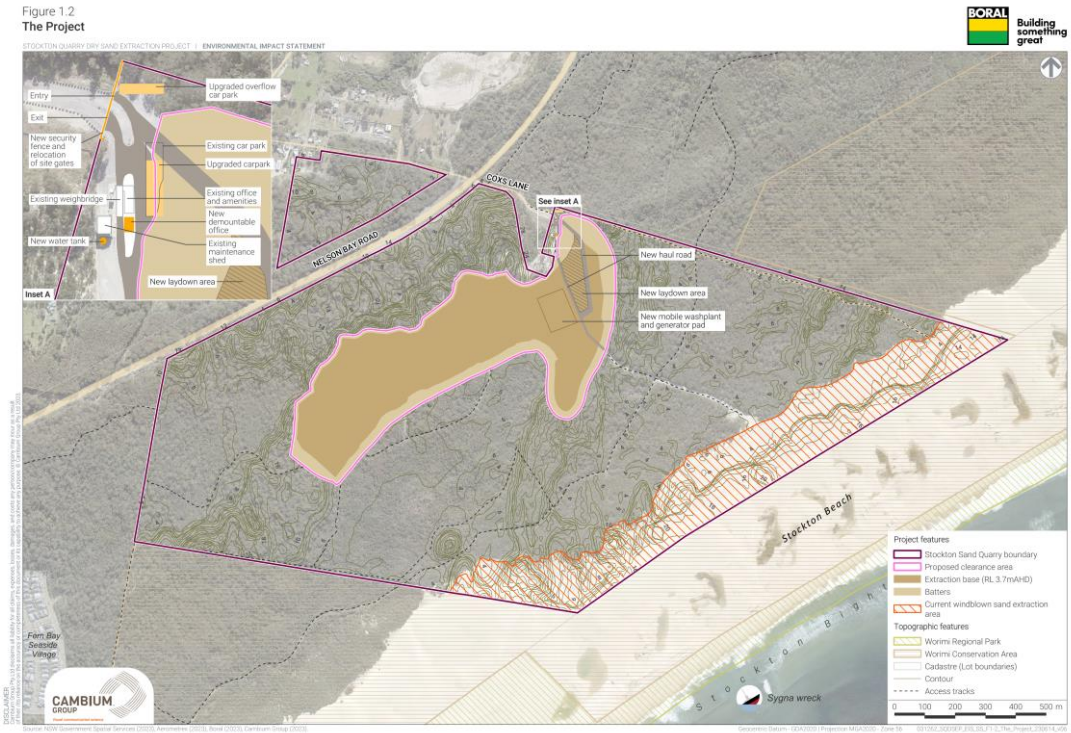

Figure 1-2: The Project

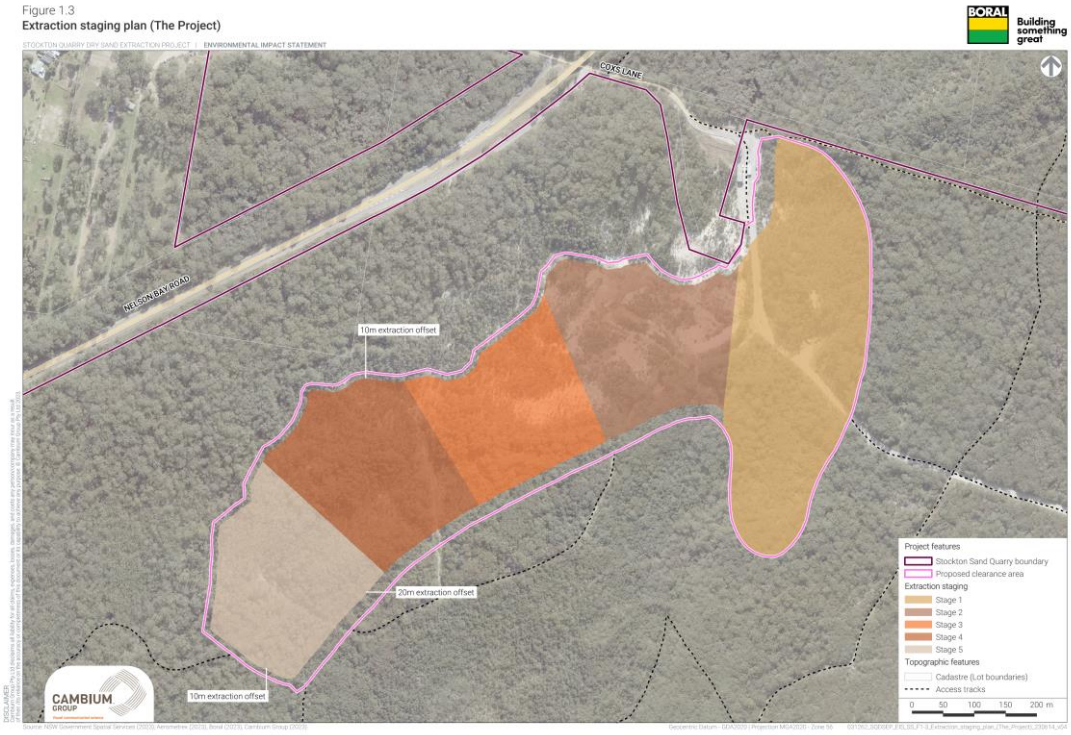

Figure 1-3: Extraction Stage Plan (The Project)

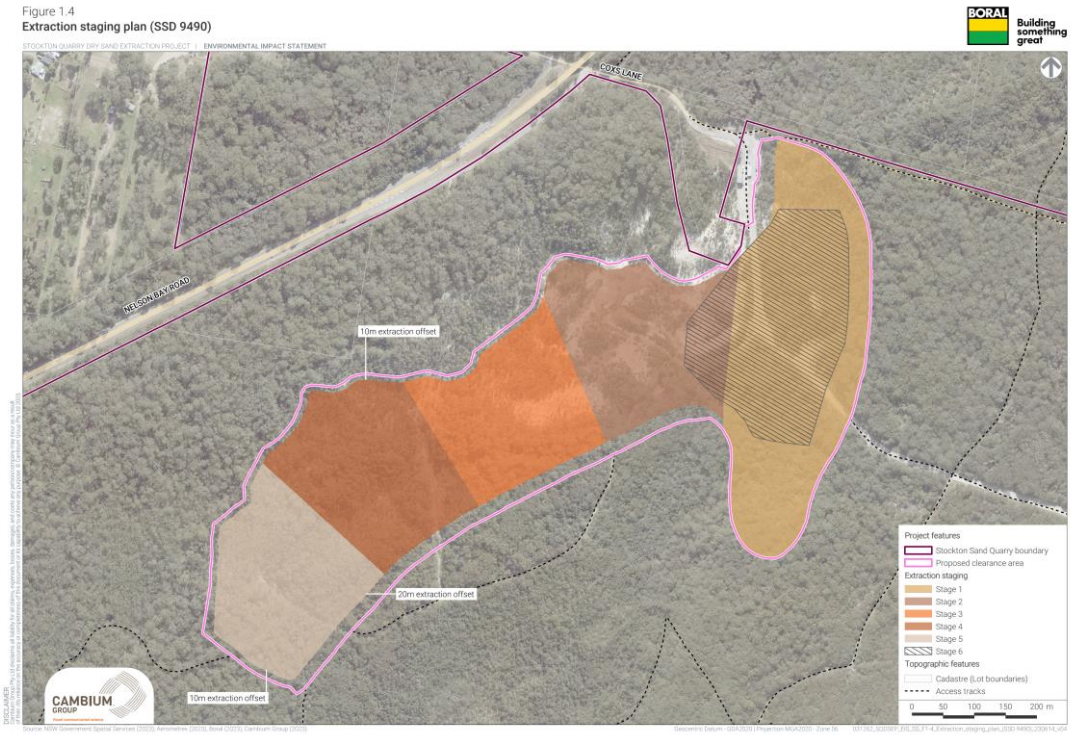

Figure 1-4: Extraction Staging Plan (SSD 9490)

2 PROJECT DESCRIPTION

2.1 Location and Surrounding Receivers

The Project site is located at the end of Coxs Road to the east of Fullerton Cove from Nelsons Bay Road to Stockton Beach, covering an area of approximately 37 ha. The site is accessed by road from Coxs Lane and Nelson Bay Road. The nearest and most potentially affected receivers comprise:

- Residences along Coxs Lane, George Street and Fullerton Cove Road in Fullerton Cove to the north-west of the site; and
- Residences along Tuckeroo Circuit and Norfolk Street within the Fern Bay Seaside Village, Fern Bay to the south west of the site.

These receivers are all residential. There are no other sensitive receiver types identified in the surrounding area. The nearby sensitive receivers are described in **Table 2-1** and shown in **Figure 2-1**.

Table 2-1: Sensitive Receivers

Receiver ID	Address	Lot/DP Number
R1	11 George Street, Fullerton Cove	Lot 7 DP 255734
R2	9 George Street, Fullerton Cove	Lot 6 DP 255734
R3	14 George Street, Fullerton Cove	Lot 8 DP 255734
R4	12 George Street, Fullerton Cove	Lot 9 DP 255734
R5	Unknown Address, Fullerton Cove	Lot 5 DP 1105459
R6	6 Coxs Lane, Fullerton Cove	Lot 6 DP 998656
R7	1 Zircon Lane, Fullerton Cove	Lot 72 DP 876716
R8	17a Coxs Lane, Fullerton Cove	Lot 8 DP 742586
R9	12 Coxs Lane, Fullerton Cove	Lot 1 DP 120634
R10	10 Coxs Lane, Fullerton Cove	Lot 11 DP 881613
R11	4 Coxs Lane, Fullerton Cove	Lot 1 DP 724265
R12	306 Fullerton Cove Road, Fullerton Cove	Lot 100 DP 819758
R13	304 Fullerton Cove Road, Fullerton Cove	Lot 101 DP 819758
R14	14 Tuckeroo Circuit, Fern Bay	Lot 28 DP 280063
R15	16 Tuckeroo Circuit, Fern Bay	Lot 29 DP 280063
R16	18 Tuckeroo Circuit, Fern Bay	Lot 30 DP 280063
R17	20 Tuckeroo Circuit, Fern Bay	Lot 31 DP 280063
R18	22 Tuckeroo Circuit, Fern Bay	SP98989
R19	101 Norfolk Street, Fern Bay	Lot 49 DP 280063

Receiver ID	Address	Lot/DP Number
R20	99 Norfolk Street, Fern Bay	Lot 48 DP 280063
R21	97 Norfolk Street, Fern Bay	Lot 47 DP 280063
R22	93 Norfolk Street, Fern Bay	Lot 45 DP 280063
R23	91 Norfolk Street, Fern Bay	Lot 44 DP 280063
R24	2 Uralla Street, Fern Bay	Lot 43 DP 280063
R25	87 Norfolk Street, Fern Bay	Lot 37 DP 280057
R26	85 Norfolk Street, Fern Bay	Lot 38 DP 280057
R27	81 Norfolk Street, Fern Bay	Lot 40 DP 280057
R28	79 Norfolk Street, Fern Bay	Lot 41 DP 280057
R29	77 Norfolk Street, Fern Bay	Lot 42 DP 280057
R30	75 Norfolk Street, Fern Bay	Lot 43 DP 280057
R31	73 Norfolk Street, Fern Bay	Lot 44 DP 280057
R32	71 Norfolk Street, Fern Bay	Lot 45 DP 280057
R33	69 Norfolk Street, Fern Bay	Lot 46 DP 280057
R34	248 Fullerton Cove Road, Fullerton Cove	Lot 3421 DP 1232950
R35	260 Fullerton Cove Road, Fullerton Cove	Lot 1 DP 745337

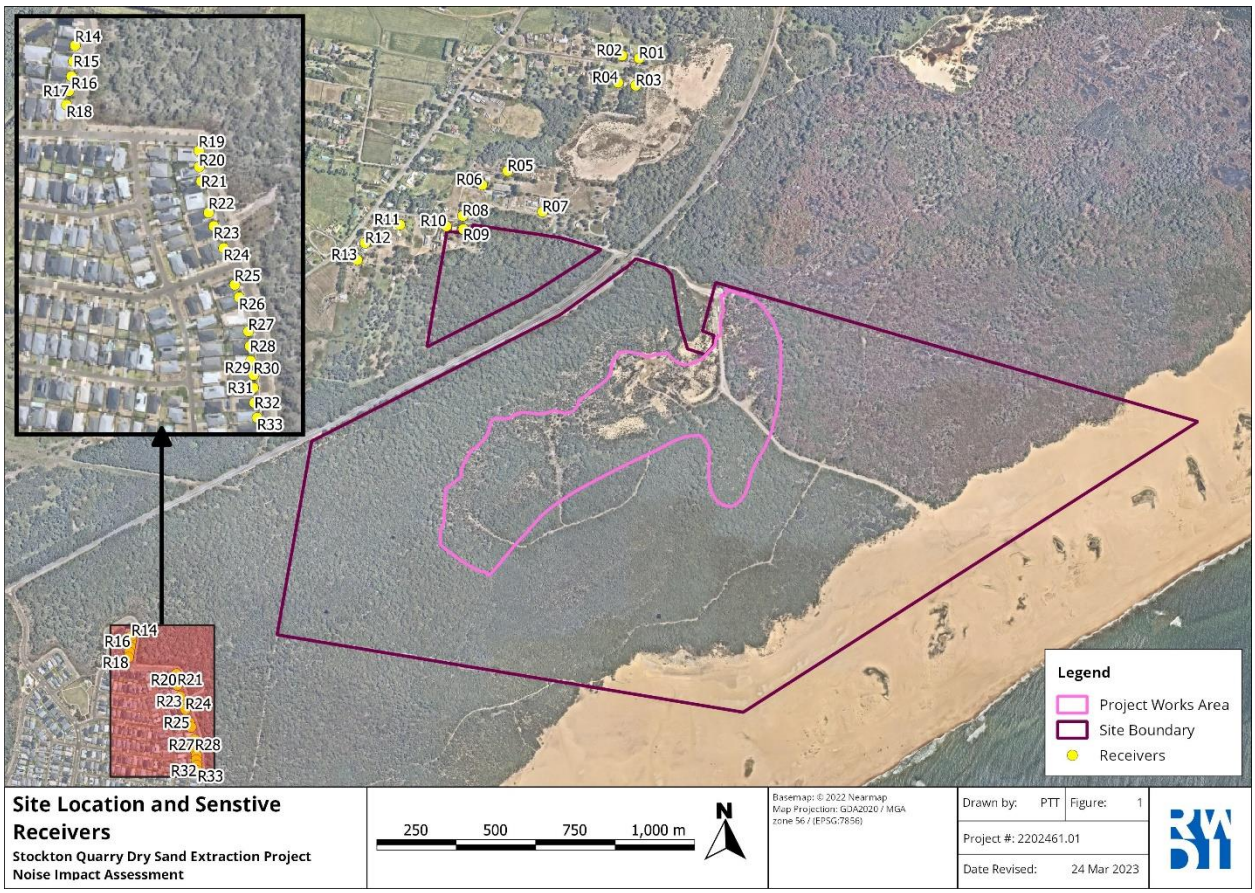

Figure 2-1: Site Location and Sensitive Receivers

2.2 Project Description

As shown in **Figure 1-2**, the project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to a minimum 0.7 m above the water table, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in **Figure 1-3**, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project (shown in **Figure 1-3**) mirror the first five stages of the dredge application (shown in **Figure 1-4**). This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;

- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in **Figure 1-2**, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

2.3 Hours of Operation

The Project will continue to operate in accordance with the following approved hours of operation in the 2006 development consent:

- Monday to Friday – 6:15 am to 5:00 pm;
- Saturday – 6:15 am to 12 noon; and
- no operation on Sundays or Public Holidays.

The site is also approved to operate extended hours during major supply contracts as follows:

- Monday to Friday – 6:15 am to 6:00 pm;
- Saturday – 6:15 am to 3:00 pm; and
- no operation on Sundays or Public Holidays.

Construction activities associated with the Project would be restricted to the standard construction hours recommended in the *ICNG*:

- Monday to Friday – 7:00 am to 6:00 pm
- Saturday – 8:00 am to 1:00 pm; and
- no construction on Sundays or Public Holidays.

2.4 Relationship with SSD-9490

This Project and assessment have been prepared as an interim solution whilst outstanding water matters associated with the Dredge Application are resolved. This application incorporates the approved aspects of the Dredge Application (i.e., same extraction footprint and rate of extraction) and allows for extraction to transition to dredging when/if the Dredge Application is approved.

3 NOISE CRITERIA

3.1 Existing Noise Levels

Unattended noise monitoring was conducted between 27 March and 6 April 2023 to determine the existing ambient and traffic noise levels. The monitoring was undertaken at three locations, as shown and described in **Table 3-1**. **Figure 3-1** presents the location of noise monitoring relative to the Project.

Table 3-1: Noise Monitoring Locations

Location	Purpose	Address
M1	Existing ambient noise levels	4 Coxs Lane, Fullerton Cove (R11)
M2	Existing traffic noise levels	157 Cabbage Tree Road, Williamtown
M3	Existing traffic noise levels	1051 Nelson Bay Road, Fern Bay

Figure 3-1: Noise Monitoring Locations

Measured ambient noise levels at location M1 are considered representative of the ambient environment for all receivers in the Fullerton Cove region surrounding the site. These measured levels are also used to assess the noise impact on receivers in the Fern Bay Seaside Village. Due to the proximity of these receivers to the coastline, the levels measured at M1 are considered conservative for the Fern Bay Seaside Village.

The noise monitoring equipment used for these measurements consisted of an ARL NGARA environmental noise logger set to A-weighted, fast response. This equipment is capable of remotely monitoring and storing noise level descriptors for later detailed analysis. The equipment calibration was checked before and after the survey and no significant drift was noted.

From the background noise levels (L_{A90}) the Rating Background Levels (RBLs) (see glossary of acoustic terms) were determined using the methodology recommended in the *NPfI*. The existing windblown sand operation was not audible during deployment or collection of unattended noise monitoring equipment and is unlikely to contribute significantly to background levels in the vicinity of the Project.

The existing ambient noise levels are presented in **Table 3-2** and **Table 3-3** presents the measured road traffic noise levels on Nelson Bay Road and Cabbage Tree Road. Due to the operating hours of the site, the results from the morning (AM) shoulder period are also presented. Daily plots of the noise logger data are presented in Appendix A.

Table 3-2: Existing Ambient Noise Levels

Monitoring Location	Time of Day[1]	Noise Levels (dBA)	
		RBL	$L_{Aeq,Period}$
M1	AM shoulder	37	49
	Day	37	53
	Evening	37	62
	Night	35	47
M2	AM shoulder	43[2]	62
	Day	43	64
	Evening	43[2]	63
	Night	40	58
M3	AM shoulder	44	68
	Day	58	71
	Evening	51	69
	Night	39	64

Note 1: Day = 7:00 am – 6:00 pm; Evening = 6:00 pm – 10:00 pm; Night = 10:00 pm – 7:00 am; AM Shoulder = 5:00 am – 7:00 am.

Note 2: As per the *NPfI*, daytime RBLs have been adopted for these periods as their measured RBLs were higher (44 dBA during AM shoulder and evening).

Table 3-3: Measured Traffic Noise Levels

Location	Day $L_{Aeq,15hour}$	Night $L_{Aeq,9hour}$
M2	59	47
M3	71	64

Note: Day = 7:00 am – 10:00 pm; Night = 10:00 pm – 7:00 am.

3.2 EPL License Conditions

Section L3 of the EPL states the noise limit conditions. These conditions are described in **Table 3-4** below. Compliance with Limit L3.1 is to be assessed in conjunction with operational noise criteria outlined in the *NPfI*.

Table 3-4: EPL noise limits

Limit	Description
L3.1	Noise emissions from the premises must not exceed an $L_{eq(15\ minute)}$ noise emission criterion of 35 dB(A) at the nearest residential receiver.
L3.2	Noise from the premises is to be measured at the worst affected point or within the residential boundary, or the most affected point within 30 metres of a dwelling (rural situations) where the dwelling is more than 30 metres from the boundary, to determine compliance with the noise limit in this licence.
L3.2	The noise emission limit identified in this licence applies in the following weather conditions: - wind speed up to 3 m/s at 10 m above ground level; or - temperature inversion conditions of up to 3 C/100m and wind speed up to 2 m/s at 10 m above ground level.

3.3 Operational Noise Trigger Levels

The *NPfI* provides a framework for assessing environmental noise impacts from industrial premises and industrial development proposals in New South Wales.

The *NPfI* recommends the development of project noise trigger levels, which provide a benchmark for assessing a proposal or site. The project noise trigger levels should not be interpreted as mandatory noise criteria but, rather, as noise levels that, if exceeded, would indicate a potential noise impact on the community.

The project noise trigger level is the lower value of the project intrusiveness noise level and the project amenity noise level. The project intrusiveness noise level assesses the likelihood of noise being intrusive above the ambient noise level and is applied to residential receivers only. The project amenity noise level ensures the total industrial noise from all sources in the area does not rise above a maximum acceptable level.

3.3.1 *NPfI* Project Intrusiveness Noise Levels

The intrusiveness noise level is the noise level 5 dB above the background noise level (RBL) for each time period (daytime, evening or night time) of interest at a residential receiver. The RBL is derived from the measured L_{A90} noise levels.

The *NPfI* stipulates that project intrusiveness noise levels should not be set below 40 dBA during the daytime and 35 dBA in the evening and night time. Additionally, the *NPfI* recommends that the project intrusiveness noise level for evening is set at no greater than that for the daytime, and that the project intrusiveness level for night time is set at no greater than that for the evening and daytime.

As the site currently has approval for operation from 6:15am, intrusiveness noise levels have been derived for the morning (AM) shoulder period (5:00 am – 7:00 am).

Intrusiveness noise levels for the project are calculated from the RBLs at location M1, given it is the closest monitoring location to the site, and are presented in **Table 3-5**.

Table 3-5: Project Intrusiveness Noise Levels

Receiver	Time of Day	RBL	Project Intrusiveness Noise Level ($L_{Aeq,15min}$)
All	Morning shoulder	37	42
	Day	37	42
	Evening	37	42
	Night	35	40

Note: Day = 7:00 am – 6:00 pm; Evening = 6:00 pm – 10:00 pm; Night = 10:00 pm – 7:00 am; AM Shoulder = 5:00 am – 7:00 am.

3.3.2 *NPfI* Project Amenity Noise Levels

Project amenity noise levels aim to set a limit on continuing increases in noise levels from all industrial noise sources affecting a variety of receiver types; that is, the ambient noise level in an area from all industrial noise sources remains below recommended amenity noise levels.

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include transportation noise (when on public transport corridors), noise from motor sport, construction noise, community noise, blasting, shooting ranges, occupational workplace noise, wind farms, amplified music/patron noise.

The amenity noise level aims to limit continuing increases in noise levels which may occur if the intrusiveness level alone is applied to successive development within an area.

The recommended amenity noise level represents the objective for total industrial noise at a receiver location. The project amenity noise level represents the objective for noise from a single industrial development at a receiver location.

To prevent increases in industrial noise due to the cumulative effect of several developments, the project amenity noise level for each new source of industrial noise is set at 5 dB below the recommended amenity noise level.

The following exceptions apply to determining the project amenity noise level:

- For high-traffic areas the amenity criterion for industrial noise becomes the $L_{Aeq,period(traffic)}$ minus 15 dB.
- In proposed developments in major industrial clusters.
- If the resulting project amenity noise level is 10 dB or more lower than the existing industrial noise level, the project amenity noise level can be set at 10 dB below existing industrial noise levels if it can be demonstrated that existing industrial noise levels are unlikely to reduce over time.
- Where cumulative industrial noise is not a consideration because no other industries are present in, or likely to be introduced into the area, the relevant amenity noise level is assigned as the project amenity noise level for the development.

Amenity noise levels are not used directly as regulatory limits. They are used in combination with the project intrusiveness noise level to assess the potential impact of noise, assess mitigation options and determine achievable noise requirements.

The project amenity noise levels are calculated from the recommended amenity noise levels presented in **Table 3-6**.

Table 3-6: Recommended Amenity Noise Levels

Receiver	Noise Amenity Area	Time of Day	Recommended Amenity Noise Level (dBA $L_{Aeq,period}$)
Residential	Rural	Day	50
		Evening	45
		Night	40
	Suburban	Day	55
		Evening	45
		Night	40
	Urban	Day	60
		Evening	50
		Night	45
Area specifically reserved for passive recreation (e.g. national park)	All	When in use	50
Active recreation area (e.g. school playground, golf course)	All	When in use	55
Commercial premises	All	When in use	65
Industrial premises	All	When in use	65
Industrial interface (applicable only to residential noise amenity areas)	All	All	Add 5 dBA to recommended noise amenity area

Note: Day = 7:00 am – 6:00 pm; Evening = 6:00 pm – 10:00 pm; Night = 10:00 pm – 7:00 am.

Recommended amenity noise levels presented in **Table 3-6** above represent the objective for total industrial noise at a receiver location. In the case of a single new noise source being proposed, the project amenity noise level represents the objective for noise from a single industrial development at the receiver location. This is calculated as the recommended amenity noise level minus 5 dB.

Due to different averaging periods for the $L_{Aeq,15min}$ and $L_{Aeq,period}$ noise descriptors, the values of project intrusiveness and amenity noise levels cannot be compared directly when identifying noise trigger levels i.e.,

the most stringent values of each category. In order to make a comparison between descriptors, the *NPfI* assumes that the $L_{Aeq,15min}$ equivalent of an $L_{Aeq,period}$ noise level is equal to the $L_{Aeq,15min}$ level plus 3 dB.

Based on the methodology for determining residential receiver category in the *NPfI*, the area surrounding the site can be classified as 'Suburban Residential'. These amenity noise levels have been adopted and are presented in **Table 3-7**.

Table 3-7: Project Amenity Noise Levels

Noise Amenity Area	Time of Day	Recommended Amenity Noise Level ($L_{Aeq,period}$ dBA)	Project Amenity Noise Level ($L_{Aeq,15min}$ dBA)
Suburban	Day	55	53
	Evening	45	43
	Night	40	38

Note: Day = 7:00 am – 6:00 pm; Evening = 6:00 pm – 10:00 pm; Night = 10:00 pm – 7:00 am.

3.3.3 *NPfI* Project Noise Trigger Levels

Table 3-8 below shows the project noise levels for sensitive receivers, with the project noise trigger levels (PNTLs) shown in **bold**.

Table 3-8: Project Noise Trigger Levels

Receiver	Time of Day	Project Intrusiveness Noise Levels ($L_{Aeq,15min}$ dBA)	Project Amenity Noise Levels ($L_{Aeq,15min}$ dBA)
All	Morning shoulder	**42**	**n/a[2]**
	Day	**42**	53
	Evening	**42**	43
	Night	40	**38**

Note1: Day = 7:00am – 6:00pm; Evening = 6:00pm – 10:00pm; Night = 10:00pm – 7:00am; AM Shoulder = 5:00am – 7:00am.
Note 2: The *NPfI* does not specify amenity noise levels for shoulder periods.

3.3.4 *NPfI* Maximum Noise Trigger Levels

Noise sources at night occurring over a short duration have the potential to cause sleep disturbance despite complying with project noise trigger levels. The site intends to operate from 6:15 am, during the morning shoulder period. Therefore, maximum noise level events need to be considered for potential sleep disturbance.

The *NPfI* recommends that, where the night time L_{Amax} receiver noise levels from a development exceeds 52 dBA or the RBL plus 15 dBA, whichever is the greater, then a more detailed assessment of potential sleep disturbance impacts is warranted. **Table 3-9** presents the maximum noise trigger levels for the receivers identified in this assessment. These noise levels are typically addressed at the facade of potentially affected dwellings and should consider multiple storey dwellings.

Table 3-9: Maximum Noise Trigger Levels

Receiver	Night RBL (dBA)	RBL + 15 dBA	Maximum Noise Trigger Level (dBA)
All	35	50	52

Additionally, in instances where night time $L_{Aeq,15min}$ noise levels exceed 40 dBA or the prevailing RBL plus 5 dBA, whichever is the greater, then a detailed assessment of potential sleep disturbance impacts is warranted.

3.4 Construction Noise Criteria

The NSW EPA *Interim Construction Noise Guideline (ICNG)* requires project-specific Noise Management Levels (NMLs) to be established for noise affected receivers. In the event construction noise levels are predicted to be above the NMLs, all feasible and reasonable work practices are investigated to minimise noise emissions.

Having investigated all feasible and reasonable work practices, if construction noise levels are still predicted to exceed the NMLs then the potential noise impacts would be managed via site-specific construction noise management plans, to be prepared in the detailed design phase.

Table 3-10 details the *ICNG* noise management levels.

Table 3-10: **Interim Construction Noise Guideline Criteria**

Time	NML	How to Apply
Recommended Standard Hours: Mon to Fri: 7am – 6pm Sat: 8am – 1pm Sun/Public Holidays: No Work	Noise Affected RBL+10dB	The noise affected level represents the point above which there may be some community reaction to noise. • Where the predicted or measure L_{AEQ} is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. • The proponent should also inform all potentially affected residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly Noise Affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours the very noisy activities can occur, taking into account: 1. Times identified by community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning, mid-afternoon for works near residences.

Time	NML	How to Apply
		2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

In consideration of the proposed construction hours, **Table 3-11** presents the applicable noise management levels for construction activities at surrounding receivers that have been adopted for all applications.

Table 3-11: Site-Specific Construction Noise Management Levels – Standard Hours[1]

Receiver	NML
All residential receivers	52

Note 1: Standard Hours (7am – 6pm Monday to Friday, 8am – 1pm Saturday with no work on Sundays or Public Holidays)

3.5 Road Traffic Noise Criteria

The *RNP* provides criteria for managing noise levels associated with a development that will increase traffic on a particular road.

Although trucks accessing the site will continue to operate in the same manner as for the current operations, the increase in total sand dispatched to 750,000 tpa will result in additional trucks on the surrounding road network until 2028.

It is also proposed to import 70,000 tpa of VENM/sand post 2028 which will be utilised for stabilisation works as required within the site.

The *RNP* assessment criteria for residential land uses are presented in **Table 3-12**.

Table 3-12: Road Traffic Noise Assessment Criteria for Residential Receivers

Road Category	Type of Proposal / Land Use	Noise Criteria (dBA)	
		Day (7am-10pm) (dBA)	Night (10pm-7am) (dBA)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use development	$L_{Aeq,15hr}$ 60 (external)	$L_{Aeq,9hr}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use development	$L_{Aeq,1hr}$ 55 (external)	$L_{Aeq,1hr}$ 50 (external)

The *RNP* also offers the relative increase criteria to manage the permissible increase in road traffic noise from a land use development. This criteria states that:

"*For existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding 'no build option'.*"

As the measured $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ from **Table 3-3** are above the *RNP* assessment criteria at both assessment locations, the relative increase criterion is to be adopted.

4 OPERATIONAL NOISE ASSESSMENT

4.1 Operational Noise Modelling Methodology

4.1.1 Computer Noise Model

Operational noise emissions associated with the Project were modelled using the CadnaA acoustic noise prediction software and the CONCAWE noise prediction algorithm. The CONCAWE noise propagation model is used around the world and is widely accepted as an appropriate model for predicting noise over significant distances. Factors addressed in the noise modelling are:

- Equipment noise level emissions and locations;
- Shielding from ground topography and structures;
- Noise attenuation due to geometric spreading;
- Ground absorption; and,
- Atmospheric absorption.

4.1.2 Ground Topography

Topographical data for the site and nearby surrounding area has been sourced from NSW Spatial Services as 1 m contours and has been incorporated in the model.

4.1.3 Ground Absorption

A ground absorption factor of 0.75 has been applied to the entire model. This global ground absorption value conservatively represents the mix of hard ground (absorption = 0) and soft ground (absorption = 1) on and around the site.

4.1.4 Meteorological Effects

At relatively large distances from a source, the resultant noise levels at receivers can be influenced by meteorological conditions, particularly temperature inversions and gradient winds. Where these factors are a feature of an area their effect on resultant noise levels should be taken into account.

'Fact sheet D' of the *NPfI* states that an assessment can incorporate noise-enhancing meteorological conditions into the modelling for all assessment periods without undertaking detailed meteorologic analysis. Stability class D with light winds (3 m/s at 10 m AGL) for day and evening periods and stability class F with winds up to 2 m/s at 10 m AGL for the night period should be adopted as a conservative approach. These conditions have been included in this assessment, noting the night time meteorological conditions were adopted for the morning shoulder period.

4.2 Sources of Operational Noise

The major noise sources associated with the operation of the Project are:

- Mobile plant, such as excavator, dozer, front end loader (FEL) and dump trucks;
- The mobile screen (Stage 1);
- The wash plant (Stage 2 onwards);
- The booster pump; and,
- Road trucks exporting sand and importing virgin excavated natural material (VENM) during rehabilitation.

Source sound power levels for mobile plant items, including road trucks, have been taken from previous measurements of similar equipment conducted by RWDI on similar sites. RWDI (formerly Wilkinson Murray) undertook a site visit to Stockton Sand Quarry to measure sound power levels for existing plant. Results of these measurements validated the assumed sound power levels.

The wash plant operating on the site would be similar to those operating on existing Boral sand extraction sites. Accordingly, the sound power level for this item has been taken from the noise impact assessment conducted by Wilkinson Murray for the Boral operated Dunmore Lakes Sand Project (*Dunmore Lakes Sand Project – Modification 2 Noise Impact Assessment*, Wilkinson Murray, 2019).

Table 4-1 summarises the operational noise sources associated with the Project and their respective SWL. Equipment used in each of the assessment scenarios is detailed in Section 4.3.

Table 4-1: Operational Noise Sources and Sound Power Levels

Item	Description (typical)	SWL (dBA) per item
Dozer	Caterpillar D7	113
FEL	Volvo 180H	108
Excavator	40 tonne	113
Dump truck	Caterpillar 740	110
Road truck	Truck and dog	104
Water cart	1987 Volvo F86	103
Mobile screen	Powerscreen M90	101
Wash plant - Course	Screentec HS-180-602	104
Wash plant - Fine	Sandtec HS-300-950	104
Diesel generator	-	80
Water Recycling Filter Press	-	101

4.3 Modelled Activities and Assessment Scenarios

Two separate scenarios have been chosen for modelling that represent the worst-case scenarios for the nearby receivers.

Receivers to the north-west of the site will be worst impacted during Stage 1 where a significant portion of the plant and activity is located at the northern most area of the site near the site entrance. During Stage 1, extraction will still be taking place in the windblown sand extraction area as well, and therefore plant has also been modelled in this area. Trucks and a water cart moving between pit 7 and the northern end of the site have been included in this scenario. It is noted that windblown extraction is part of the existing approved operations. RWDI has conservatively included these operations in the modelling as the community would not be able distinguish the separation.

Site activities between Stages 2-5 will be reasonably similar, therefore the Stage 5 was selected as this is when plant and activities will be closest to the Fern Bay receivers to the south-west of the site. A water cart has been included moving between the Stage 5 area and the entrance to the site in Stage 1. **Table 4-2** presents the list of plant modelled in each scenario.

Table 4-2: Scenario Plant List

Scenario (Extraction Stage)	Plant	Quantity	Area
Scenario 1 (Stage 1)	Dozer	1	Stage 1
	Mobile screen	1	Stage 1
	Excavator	1	Stage 1
	FEL	1	Stage 1
	FEL	1	Windblown Extraction Area
	Truck	5	Stage 1
	Truck	2	Windblown Extraction Area
	Truck	1	Haul road – Windblown Extraction Area to weighbridge
	Water cart	1	Haul road – Windblown Extraction Area to weighbridge
Scenario 2 (Stage 5)	Dozer	1	Stage 5
	Excavator	1	Stage 5
	FEL	1	Stage 1
	Generator	1	Boundary Stage 3/4
	Wash plant - Course	2	Stage 1

Scenario (Extraction Stage)	Plant	Quantity	Area
	Wash plant - Fine	1	Stage 1
	Water Recycling Filter Press	1	Stage 1
	Dump truck	2	Stage 5
	Truck	4	Stage 1
	VENM truck (tipping)	1	Stage 5
	Water cart	1	Haul road – Stage 5 to weighbridge

4.4 Predicted Operational Noise Levels

4.4.1 Predicted Daytime $L_{Aeq,15min}$ Operational Noise Levels

The predicted $L_{Aeq,15min}$ noise levels associated with the operation of the Project during the day period are presented in **Table 4-3**. Based on the results of **Table 4-3** there are no exceedances of the project noise trigger level for either scenario during the day period.

Table 4-3: Predicted Daytime $L_{Aeq,15min}$ Operational Noise Levels

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R01	42	29	29	Yes
R02	42	30	29	Yes
R03	42	30	29	Yes
R04	42	31	30	Yes
R05	42	28	32	Yes
R06	42	27	31	Yes
R07	42	28	33	Yes
R08	42	27	32	Yes
R09	42	27	33	Yes
R10	42	27	31	Yes
R11	42	25	31	Yes
R12	42	24	31	Yes
R13	42	24	31	Yes

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R14	42	21	24	Yes
R15	42	20	24	Yes
R16	42	20	24	Yes
R17	42	21	24	Yes
R18	42	20	23	Yes
R19	42	25	27	Yes
R20	42	24	26	Yes
R21	42	23	26	Yes
R22	42	25	26	Yes
R23	42	25	26	Yes
R24	42	23	25	Yes
R25	42	22	25	Yes
R26	42	22	24	Yes
R27	42	21	23	Yes
R28	42	20	23	Yes
R29	42	20	23	Yes
R30	42	19	23	Yes
R31	42	18	22	Yes
R32	42	18	22	Yes
R33	42	18	22	Yes
R34	42	23	30	Yes
R35	42	23	30	Yes

4.4.2 Predicted AM Shoulder $L_{Aeq,15min}$ Operational Noise Levels

The predicted $L_{Aeq,15min}$ noise levels associated with the operation of the Project during the AM shoulder period are presented in **Table 4-4**. Based on the results of **Table 4-4** there are no exceedances of the project noise trigger level for either scenario during the AM shoulder period.

Table 4-4: Predicted AM Shoulder $L_{Aeq,15min}$ Operational Noise Levels

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R1	42	29	29	Yes
R2	42	30	29	Yes
R3	42	30	29	Yes
R4	42	31	30	Yes
R5	42	28	32	Yes
R6	42	27	31	Yes
R7	42	28	33	Yes
R8	42	27	32	Yes
R9	42	27	33	Yes
R10	42	27	31	Yes
R11	42	25	31	Yes
R12	42	24	31	Yes
R13	42	24	31	Yes
R14	42	21	24	Yes
R15	42	20	24	Yes
R16	42	20	24	Yes
R17	42	21	24	Yes
R18	42	20	23	Yes
R19	42	25	27	Yes
R20	42	24	26	Yes
R21	42	23	26	Yes
R22	42	25	26	Yes
R23	42	25	26	Yes
R24	42	23	25	Yes
R25	42	22	25	Yes
R26	42	22	24	Yes
R27	42	21	23	Yes
R28	42	20	23	Yes

Receiver	Project Noise Trigger Level ($L_{Aeq,15min}$ dBA)	Predicted Noise Levels – Scenario 1 (dBA)	Predicted Noise Levels – Scenario 2 (dBA)	Compliance
R29	42	20	23	Yes
R30	42	19	23	Yes
R31	42	18	22	Yes
R32	42	18	22	Yes
R33	42	18	22	Yes
R34	42	23	30	Yes
R35	42	23	30	Yes

4.5 Environmental Protection License Noise Limits

EPL Limit L3.1 states that noise emissions from the premises must not exceed an $L_{Aeq15min}$ noise emission criterion of 35 dBA at the nearest residential receiver. This assessment has predicted a maximum $L_{Aeq,15min}$ noise level at any receiver of 33 dBA. Compliance with this limit condition is therefore predicted to be achieved at all times.

4.6 Cumulative Noise Impacts

The noise assessment methodology recommended by the *NPfI* implicitly considers potential cumulative impacts from multiple industrial activities through the amenity noise levels. Predicted $L_{Aeq,15min}$ noise levels are at least 10 dB below the Recommended Amenity Noise Level for suburban residential receivers of $L_{Aeq,15min}$ 43 dBA during the night period and $L_{Aeq,15min}$ 58 dBA during the day period. Therefore, noise emissions from the Project would not increase the ambient noise level at surrounding receivers to above the Recommended Amenity Noise Level and would not result in an exceedance of cumulative noise goals.

4.7 L_{Amax} Operational Noise Levels

A typical L_{Amax} sound power level can range from 3-7 dB above the operational L_{Aeq} sound power level. As detailed above, the predicted $L_{Aeq,15min}$ noise levels during the morning shoulder period are well below the project specific criterion at each receiver. Given this, the Project would also meet the maximum noise trigger levels detailed in **Table 3-9**. No further assessment of maximum noise levels is therefore warranted.

4.8 Reasonable and Feasible Noise Mitigation and Management

Although noise predictions have indicated compliance with the noise trigger levels, appropriate noise mitigation and management measures should be implemented to ensure noise impacts from the Project is minimal. These could include:

- Turning off all engines when not required.

- Training of staff and employers should include noise awareness component, community consultation and response to complaints.
- Minimise use of reversing alarms or alternatively installing “squawkers”.
- Consider the selection of plant and processes with reduced noise emissions.
- A complaints handling process and noise monitoring procedures in response to complaints.

5 CONSTRUCTION NOISE ASSESSMENT

5.1 Proposed Construction Activity

It is estimated that the construction activities would consist of:

1. The construction of the road will be undertaken by onsite equipment and supplemented with grader and potentially offroad trucks. This activity would be completed once the area has been cleared of vegetation and safe access is achieved.
2. Vegetation clearing will be with excavator fitted with blades and grabs and vegetation will be processed with a chipper/mulcher. It is expected that this process could take 2-4 weeks and completed at the same time as the other construction activities.
3. Earthworks for the plant, construction of concrete slab, erection of plant, commissioning and testing of plant could be completed within 6 weeks. This equipment will include delivery trucks, cranes, and concrete agitators. Earthworks to be completed with excavators and bobcats.
4. Installation of water tank will take approximately one week, and tank will be delivered by truck and constructed by crane/franna.
5. Installation of new building will be via delivery truck and crane to position. The time frame of this activity will be short, anticipated less than 1 week.

It is anticipated that steps 1 & 2 will be completed first, potentially at the same time, and Step 3 completed once area for plant construction has been extracted/prepared.

Works would be completed during the standard daytime construction hours of Monday to Friday 7.00am to 6.00pm and Saturday 8.00am to 1.00pm.

5.2 Construction Noise Modelling

Construction noise modelling employed the same methodology as outlined in Section 4.1.

Three construction stages have been developed for noise modelling. It has been assumed that Steps 1 and 2 would occur concurrently and Steps 4 and 5 would occur concurrently to represent worst case scenarios. These stages are outlined in **Table 5-1**.

Table 5-1: Construction Equipment and Staging

Stage	Equipment	Quantity	SWL/item	SWL/Stage
Stage 1 Vegetation Clearing and Road Construction	Grader	1	104	118
	Excavator	1	113	
	Chipper	1	107	
	Dozer	1	113	
	Dump Truck	1	110	
Stage 2 Earthworks and Concrete Slab	Road Truck	1	104	114
	Crane	1	99	

Stage	Equipment	Quantity	SWL/item	SWL/Stage
	Concrete Agitators	1	104	
	Excavator	1	113	
	Bobcat	1	90	
Stage 3 Tank and Building Construction	Crane	1	99	109
	Road Truck	1	104	
	Hand tools	1	107	

Consistent with the requirements of the *ICNG*, and to inform the scheduling of construction activity and management of noise during the detailed design phase, the construction noise impacts are based on a worst-case assessment. The *ICNG* recommends that the realistic worst-case or conservative noise levels from the source should be predicted for assessment locations representing the most noise exposed residences or other sensitive land uses. For each receiver area the noise levels are predicted at the most noise-exposed location, which would usually be the closest receiver.

For most construction activities, it is expected that the construction noise levels would frequently be lower than predicted at the most-exposed receiver as the noise levels presented in this report are based on a realistic worst-case assessment.

5.3 Predicted Construction Noise Levels

Table 5-2 presents the predicted noise levels from proposed construction activity.

Table 5-2: Predicted Construction Noise Levels

Receiver	NML	Predicted Noise Level $L_{Aeq,15min}$ dBA		
		Stage 1	Stage 2	Stage 3
R01	52	26	21	18
R02	52	26	21	18
R03	52	27	22	19
R04	52	27	22	19
R05	52	33	25	22
R06	52	32	21	18
R07	52	32	24	21
R08	52	33	21	16
R09	52	33	22	17
R10	52	32	22	16
R11	52	30	20	15

Receiver	NML	Predicted Noise Level $L_{Aeq,15min}$ dBA		
		Stage 1	Stage 2	Stage 3
R12	52	30	19	14
R13	52	31	19	15
R14	52	23	13	8
R15	52	23	13	8
R16	52	24	14	9
R17	52	23	14	9
R18	52	21	12	8
R19	52	26	17	13
R20	52	26	17	12
R21	52	25	16	11
R22	52	26	18	13
R23	52	26	18	13
R24	52	25	15	11
R25	52	22	13	9
R26	52	22	13	9
R27	52	21	11	7
R28	52	21	10	6
R29	52	21	10	6
R30	52	21	10	6
R31	52	20	10	5
R32	52	20	10	5
R33	52	20	10	5
R34	52	26	17	12
R35	52	28	19	13

5.4 Cumulative Impacts with Operational Noise

Noise associated with construction activities would largely be indistinguishable from operational activities given similar plant would be deployed and construction activities would occur in areas adjacent to operational activities.

The highest noise level of 34 dBA is predicted at some of the receivers to the north when completing a logarithmic sum of predicted daytime operational noise levels (**Table 4-3**) and Stage 1 construction noise levels (**Table 5-2**). This level remains below the construction NMLs and the operational noise PNTL, and the EPL limits. It is noted that this is conservative as some of the equipment supporting construction activity would already be on site and part of general operations.

5.5 Construction Noise Mitigation and Management

5.5.1 Noise Management Control

Although predicted noise levels are below the NMLs, noise management control measures should be implemented in order to minimise and prevent impacts on the surrounding receivers.

Prior to commencement of works, it is recommended that a Construction Noise and Vibration Management Plan (CNVMP) should be prepared and implemented in accordance with the requirements of the *ICNG*, and the recommendations documented herein. The CNVMP should take into consideration measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable. Reasonable and feasible noise mitigation measures should be outlined to reduce the noise impact from construction activities. The following preliminary controls are recommended:

- *Site Induction Training* – Training should include noise awareness component, community consultation and response to complaints as provided in the CNVMP.
- *Operator Instruction* – Operators should be trained in order to raise their awareness of potential noise problems and to increase their use of techniques to minimise noise emission.
- *Site Noise Planning* – Where practical, the layout and positioning of fixed noise-producing plant and activities away from the nearby receivers.
- *Scheduling* – Where practical, minimise the number of tools and machines operating simultaneously.
- *Plant Equipment* – Where possible, plant and equipment with a low sound power level should be selected while still maintaining efficiency of function.

5.5.2 Community consultation

Consultation with and the provision of information to the surrounding community is regarded as a major factor in controlling the negative reaction to the inevitable impacts associated with construction works. Contact details should be prominently displayed on the site boundary fence.

5.5.3 Response to complaints

Should ongoing complaints of excessive noise and vibration impacts occur, measures shall be undertaken to investigate the complaint, the cause of the complaint identified and changes to work practices implemented by the contractor.

Documentation and training of site staff shall occur to ensure the practices that produced the complaints are not repeated. If a noise and vibration complaint is received the complaint should be recorded. The complaint form should list:

- The name and location of the complainant (if provided) as well as the time, date and nature of the complaint received.
- The name of the employee who received the complaint, actions taken to investigate the complaint, and a summary of the results of the investigation.
- Required remedial action, if required.
- Validation of the remedial action by a site manager.
- Summary of feedback to the complainant.

A permanent Register of Complaints should be held. All complaints received should be fully investigated and reported to management. The complainant should also be notified of the results and actions arising from the investigation.

The investigation of a complaint shall involve where applicable:

- an investigation of the activities occurring at the time of the incident;
- inspection of the activity;
- whether work practices were being carried out either within established guidelines or outside these guidelines; and
- measurements at the affected receiver.

6 ROAD TRAFFIC NOISE ASSESSMENT

Based on information sourced from the Traffic Impact Assessment for this Project (Traffix, 2023), the site will be accessed via the following routes:

a) North onto Nelson Bay Road between Cabbage Tree Road and Cox Lane for access to the Central Coast, Sydney and Hunter Valley. This route accounts for 50% of vehicle movements.
b) South onto Nelson Bay Road between Cox Lane and Teal Street and Cormorant Road for access to the Newcastle area. This route accounts for 45% of vehicle movements.
c) North onto Nelson Bay Road, north of Cabbage Tree Road and Medowie Road for access to Port Stephens and North Coast. This route accounts for 5% of vehicle movements.

These roads are classified as arterial or sub-arterial based on the classification guidelines in the *RNP*.

Traffic generation for the Project is predicted to result in an increase 132 heavy vehicle movements on a busy weekday. Traffic movements on Saturdays are predicted to be minimal based on current operations and therefore assessment of Saturday movements has not been conducted.

These movements have been divided evenly across the operating hours of the site and divided between the routes as described above. The breakdown of movements is presented in **Table 6-1**.

Two-way 5-day average traffic volumes for the surrounding road network have also been sourced from the Traffic Impact Assessment (Traffix, 2023). The increase in traffic noise due to the additional heavy traffic from the Project has been assessed using the *CORTN* calculation method.

Table 6-1: Busy Weekday Movements

Route	% of Project Movements	Increase in Busy Day Heavy Vehicles from Project	Existing Daily (Weekday) Average Traffic Volume		Relative Noise Increase (dBA)
			Total	% of Heavy Vehicles	
a)	50	66	20,357	9.06	<0.1
b)	45	59	19,918	5.82	<0.1
c)	5	7	15,352	11.74	<0.1

Compliance is expected to be achieved on a busy day at all assessment locations, with predicted relative increases of less than 0.2 dB along all routes. Based on compliance during the busy weekday, it is expected that compliance will be comfortably achieved during an average weekday.

7 CONCLUSION

RWDI Australia Pty Limited has been engaged by Arnold Planning on behalf of Boral to conduct a Noise Impact Assessment for the proposed Stockton Quarry Dry Sand Extraction Project.

This NIA provides a detailed assessment of potential operational noise impacts associated with the Project and will accompany an Environmental Impact Statement for submission to the Department of Planning and Environment. The assessment has been conducted in general accordance with the *Noise Policy for Industry* (NPfI).

Unattended noise monitoring was conducted to determine the existing ambient noise levels at the most potentially affected residential receivers in the area surrounding the Project.

Based on information from Boral, operating parameters, equipment, and source sound power levels have been developed to describe several noise assessment scenarios for the Project.

$L_{Aeq,15min}$ operational noise levels have been predicted at sensitive receivers for each assessment scenario. The predicted noise levels comply with the established project noise trigger levels. In accordance with the *Noise Policy for Industry* and *Voluntary Land Acquisition and Mitigation Policy*, no further noise mitigation measures or controls are warranted.

Noise impacts associated with proposed construction is expected to comply with construction noise management levels developed in accordance with the *Interim Construction Noise Guideline*. Operational and construction noise levels are sufficiently low such that cumulative levels remain below the construction NMLs and the operational noise PNTLs.

Noise impacts due to heavy vehicle movements on the surrounding road network have been assessed. The predicted relative increase in noise levels is within the allowable limits outlined in the *Road Noise Policy* on all designated access routes.

The assessment has concluded that all noise impacts are compliant with relevant noise goals and noise outcomes are consistent with the Dredge Application (SSD-9490).

8 STATEMENT OF LIMITATIONS

This report titled *Stockton Sand Quarry Noise and Vibration Impact Assessment*, dated 19 June 2023, was prepared by RWDI Australia Pty Ltd ("RWDI") for Arnold Planning c/o Boral Australia ("Client"). The findings and conclusions presented in this report have been prepared for the Client and are specific to the project described herein ("Project"). The conclusions and recommendations contained in this report are based on the information available to RWDI when this report was prepared. Because the contents of this report may not reflect the final design of the Project or subsequent changes made after the date of this report, RWDI recommends that it be retained by Client during the final stages of the project to verify that the results and recommendations provided in this report have been correctly interpreted in the final design of the Project.

The conclusions and recommendations contained in this report have also been made for the specific purpose(s) set out herein. Should the Client or any other third party utilize the report and/or implement the conclusions and recommendations contained therein for any other purpose or project without the involvement of RWDI, the Client or such third party assumes any and all risk of any and all consequences arising from such use and RWDI accepts no responsibility for any liability, loss, or damage of any kind suffered by Client or any other third party arising therefrom.

Finally, it is imperative that the Client and/or any party relying on the conclusions and recommendations in this report carefully review the stated assumptions contained herein and to understand the different factors which may impact the conclusions and recommendations provided.

APPENDIX A

UNATTENDED NOISE MONITORING RESULTS

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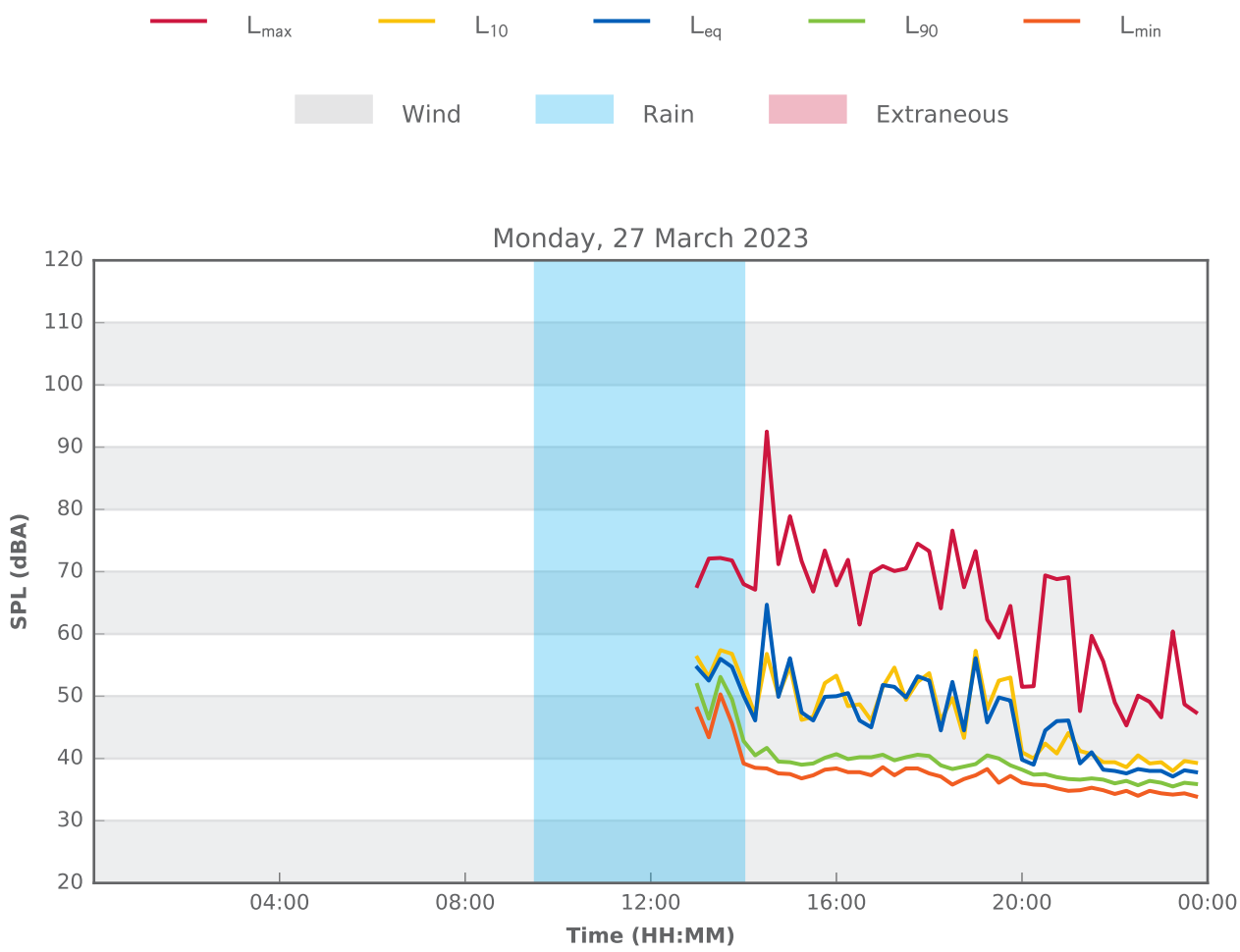

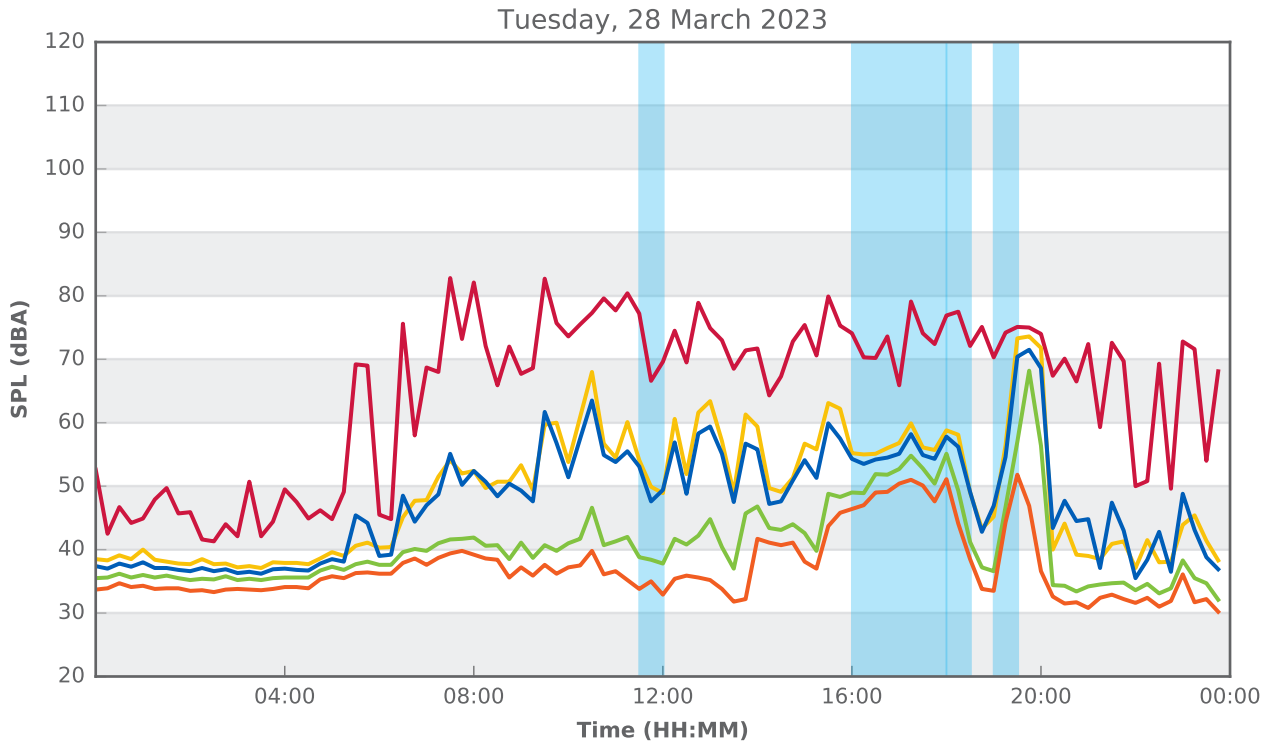

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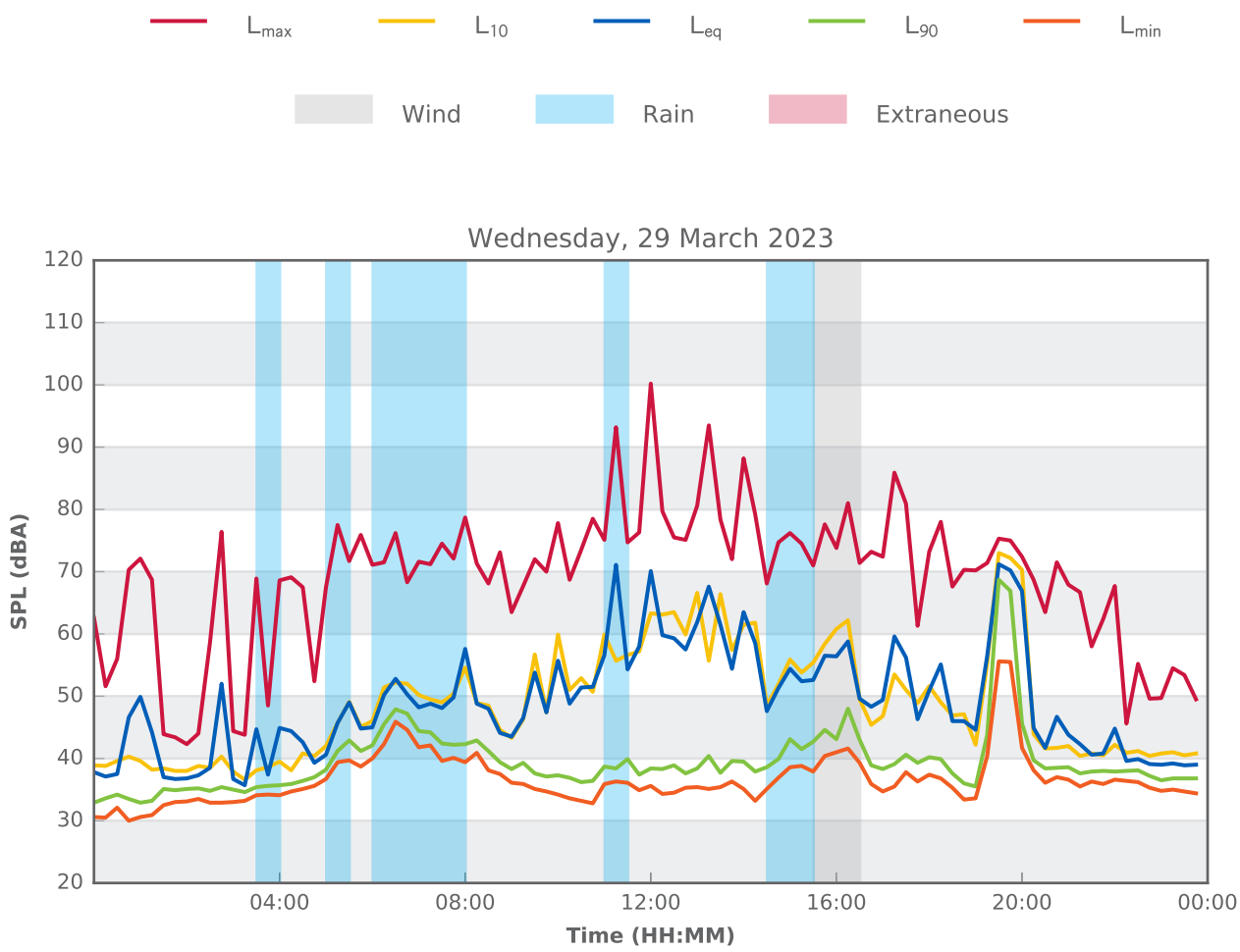

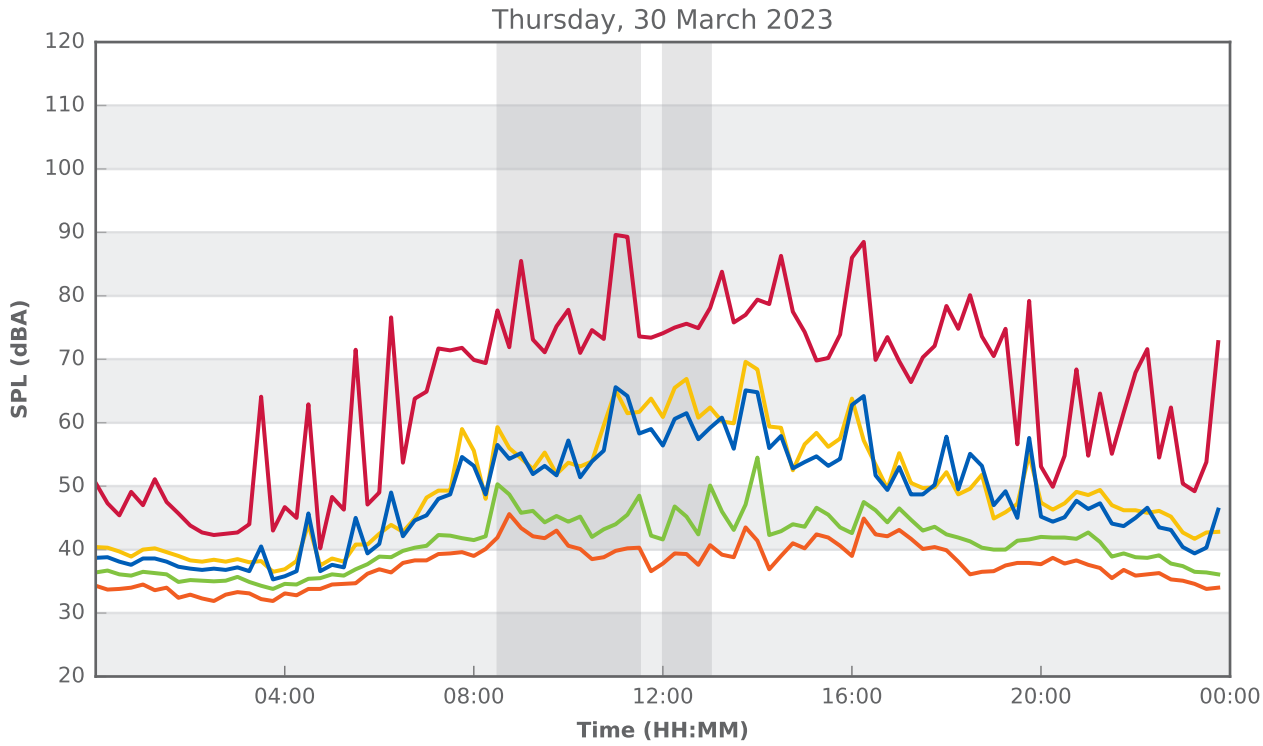

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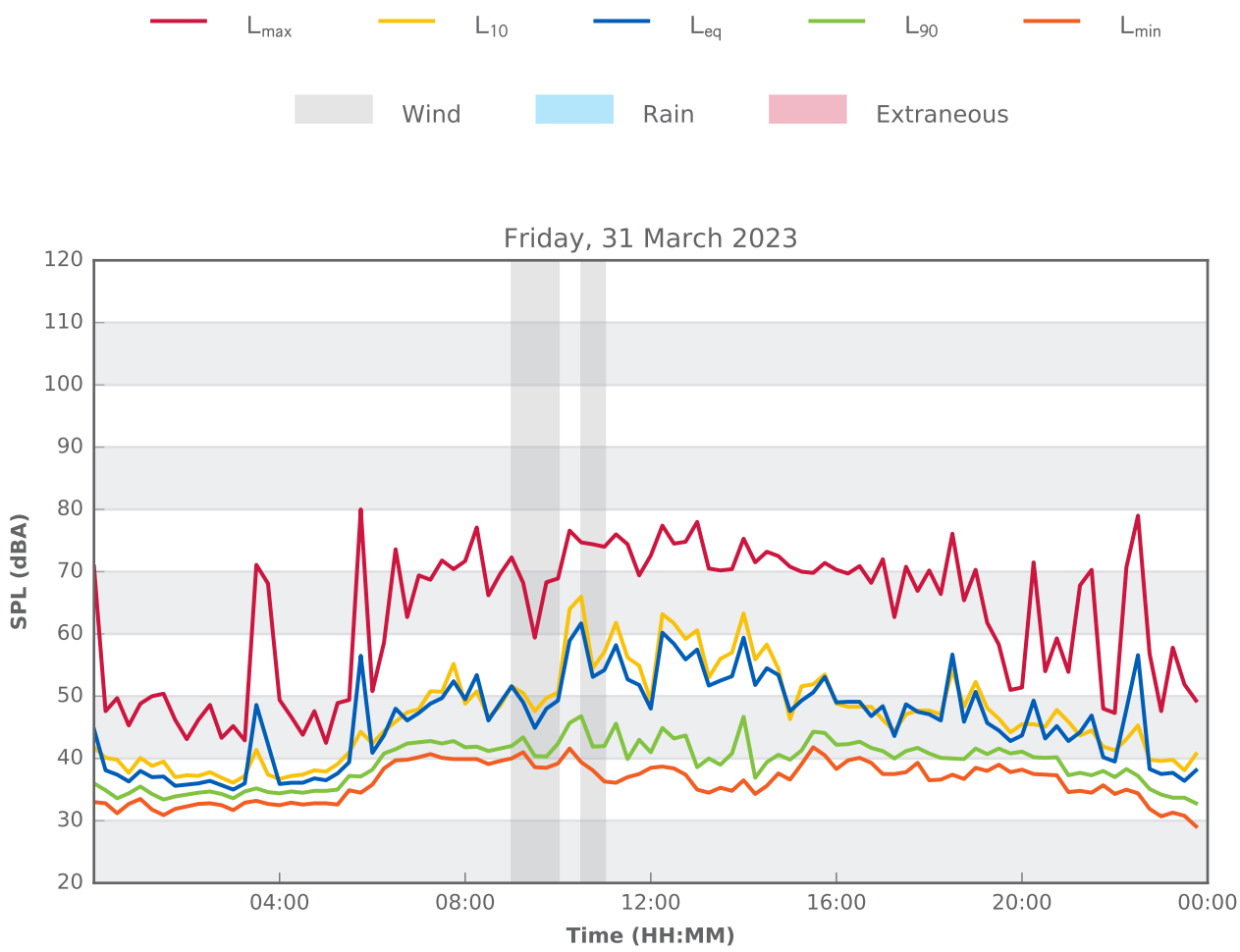

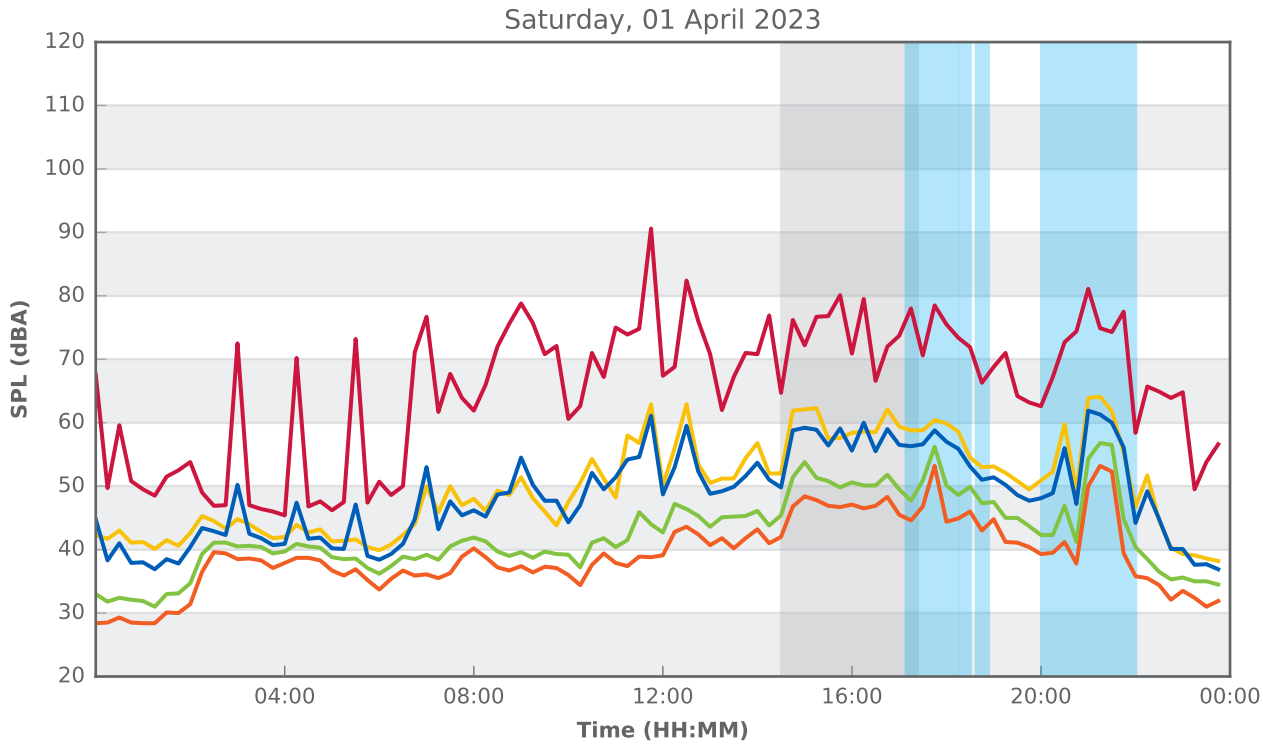

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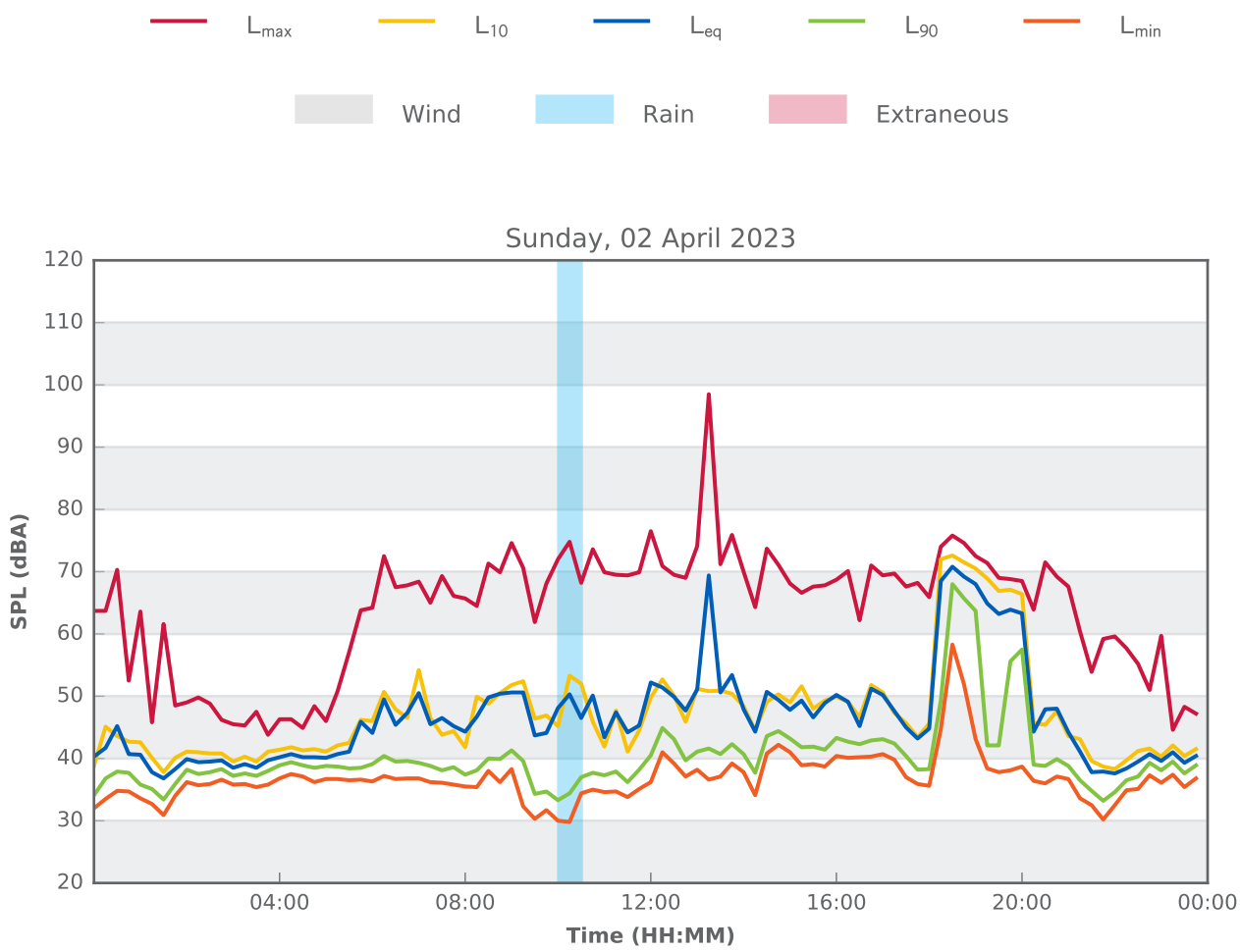

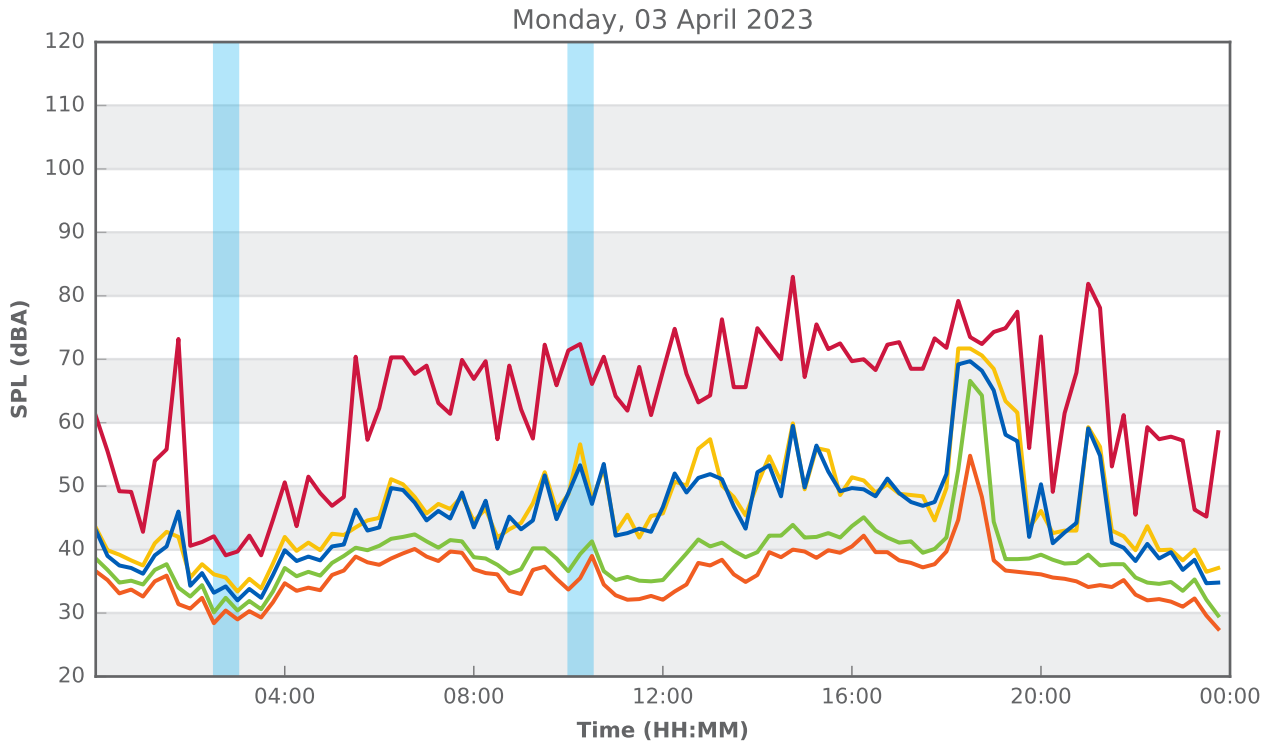

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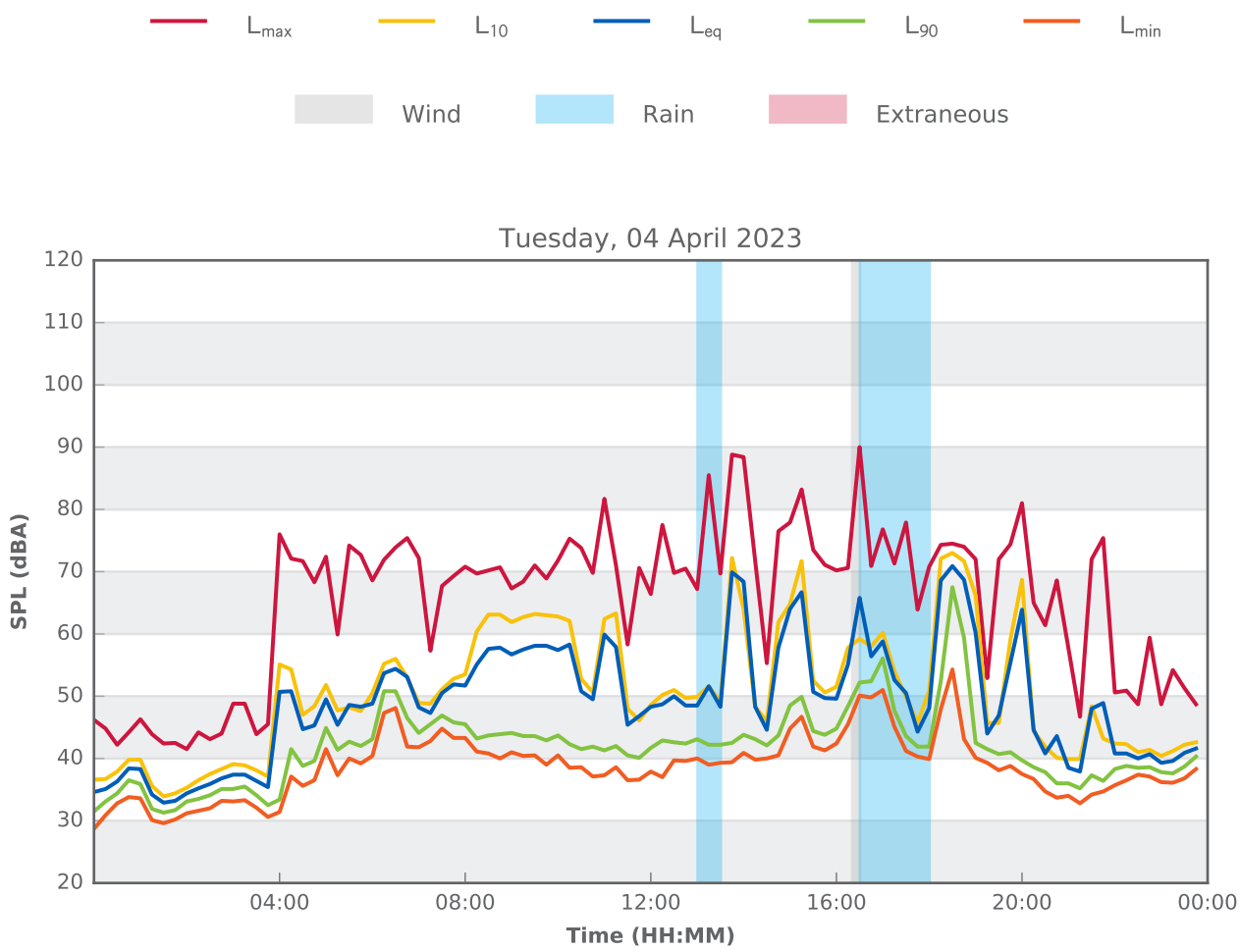

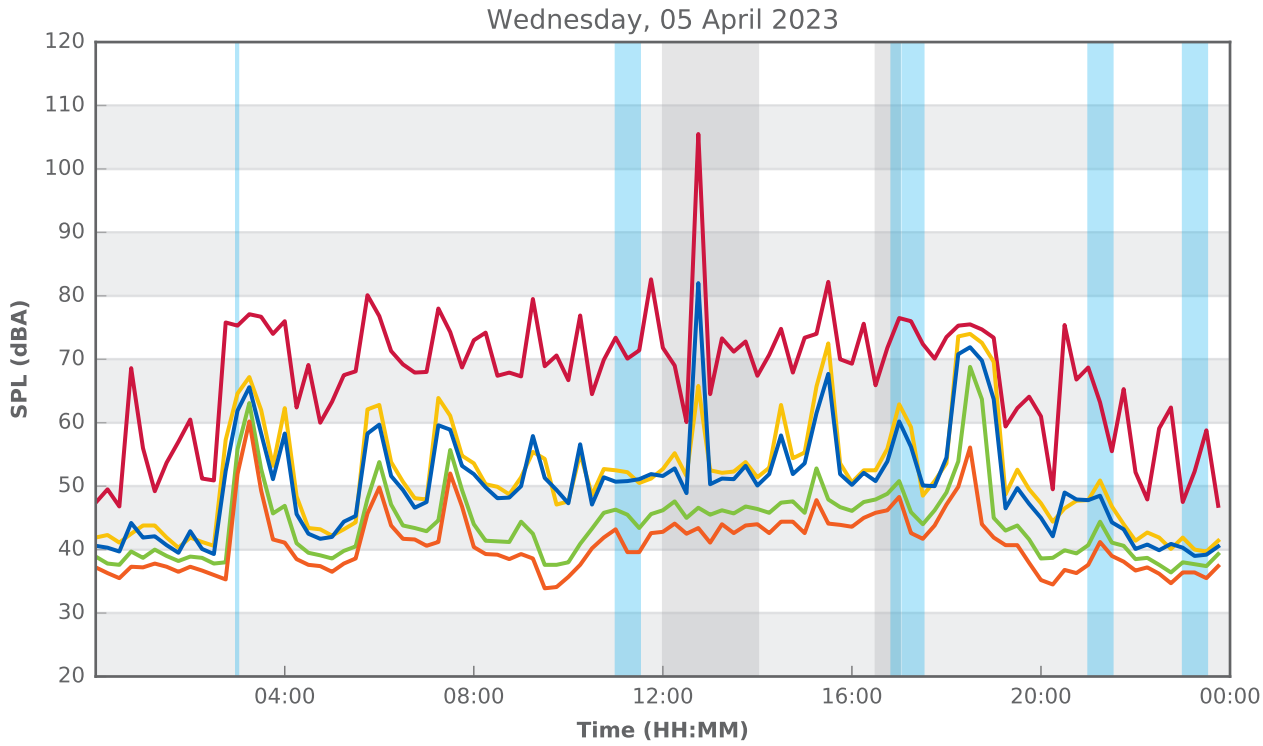

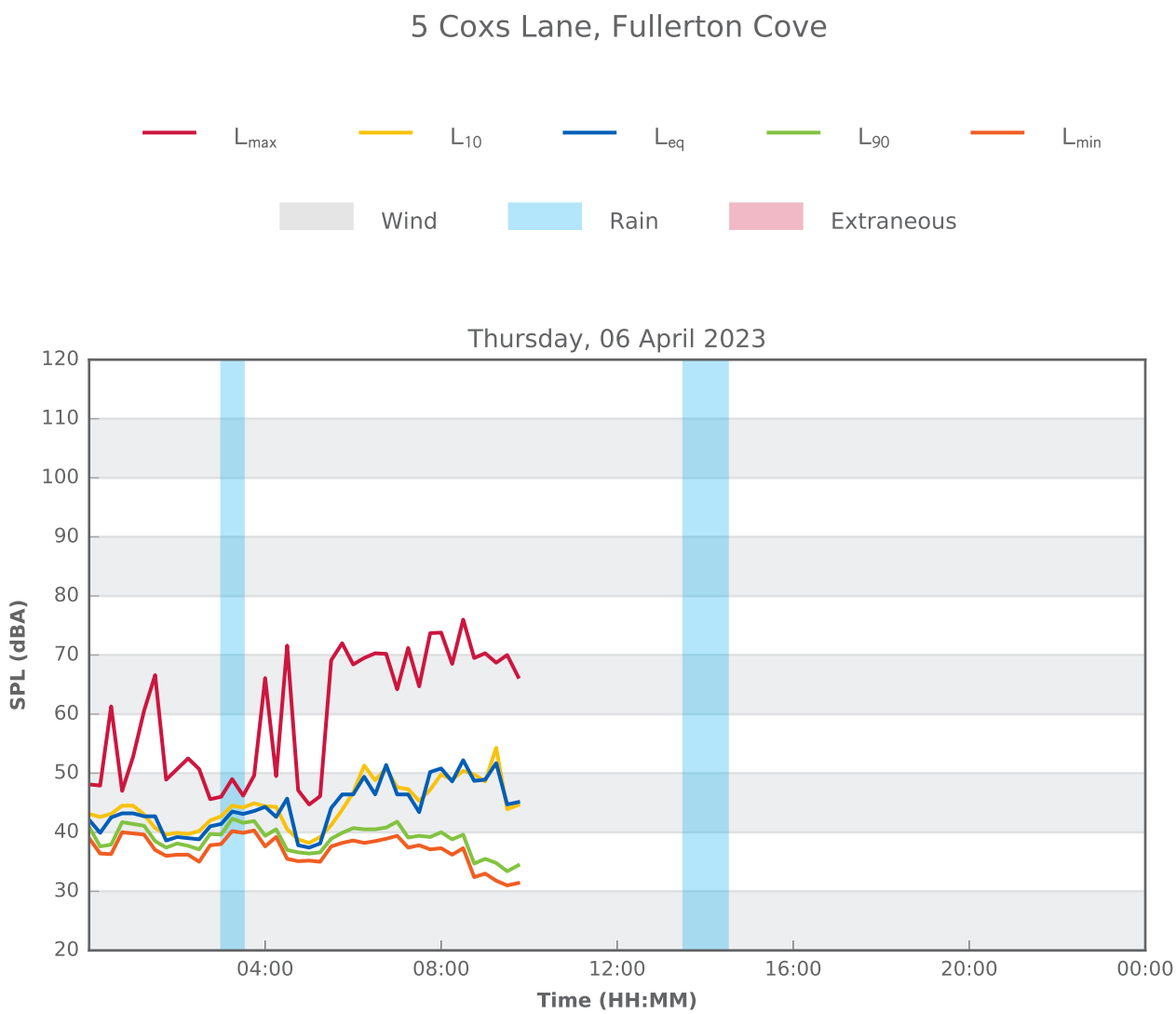
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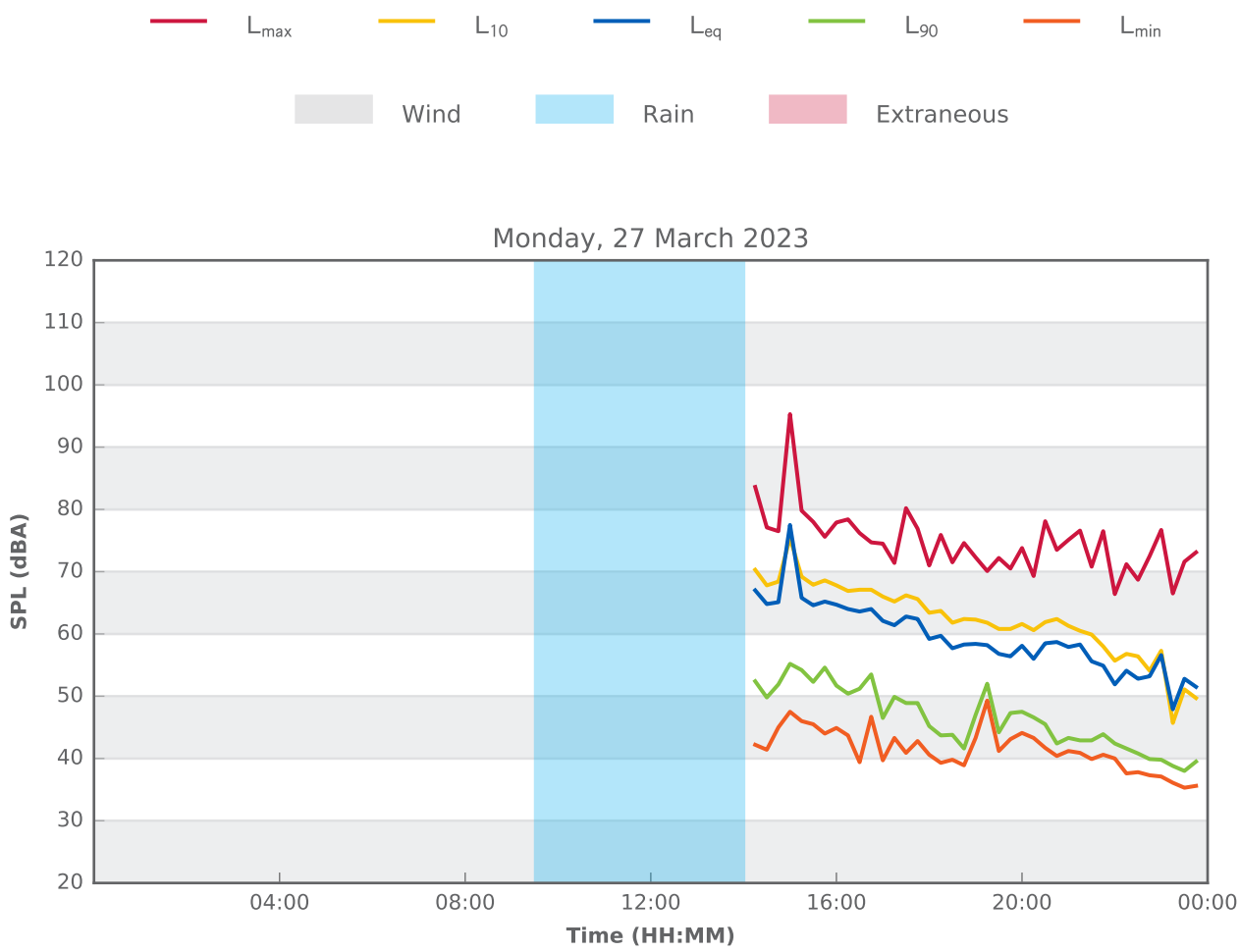

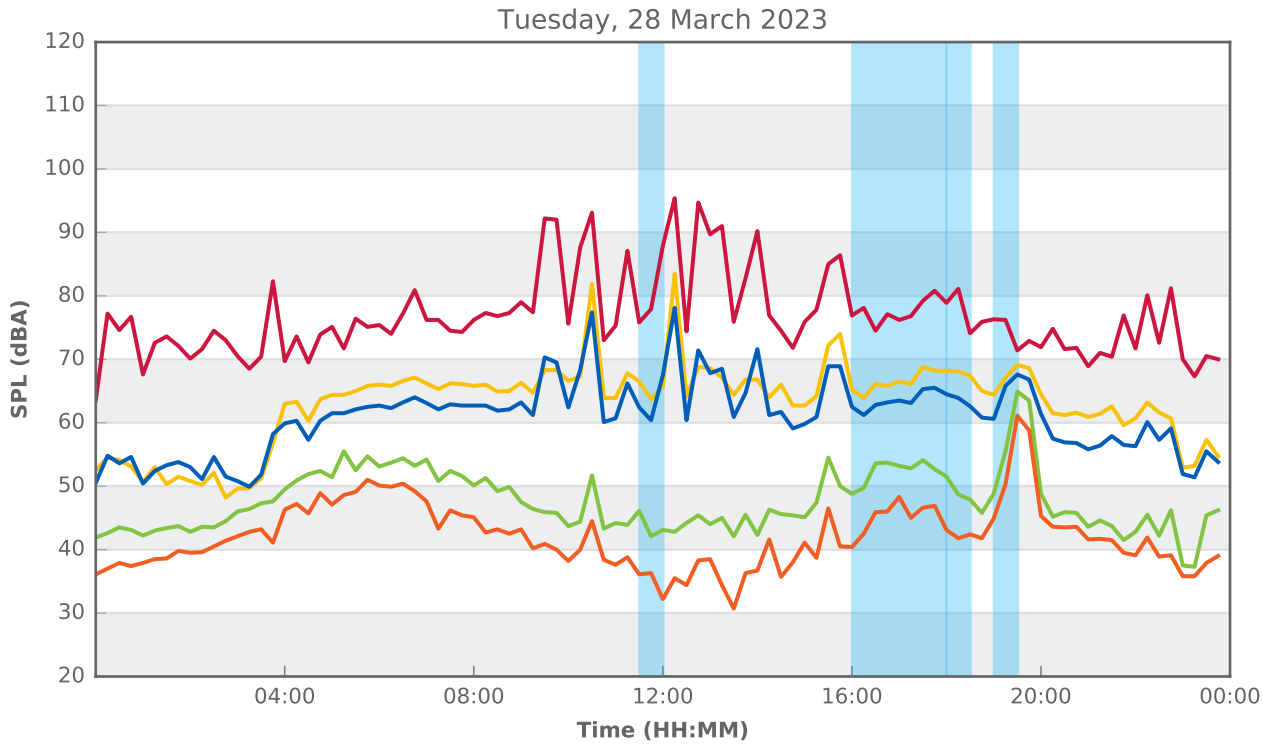

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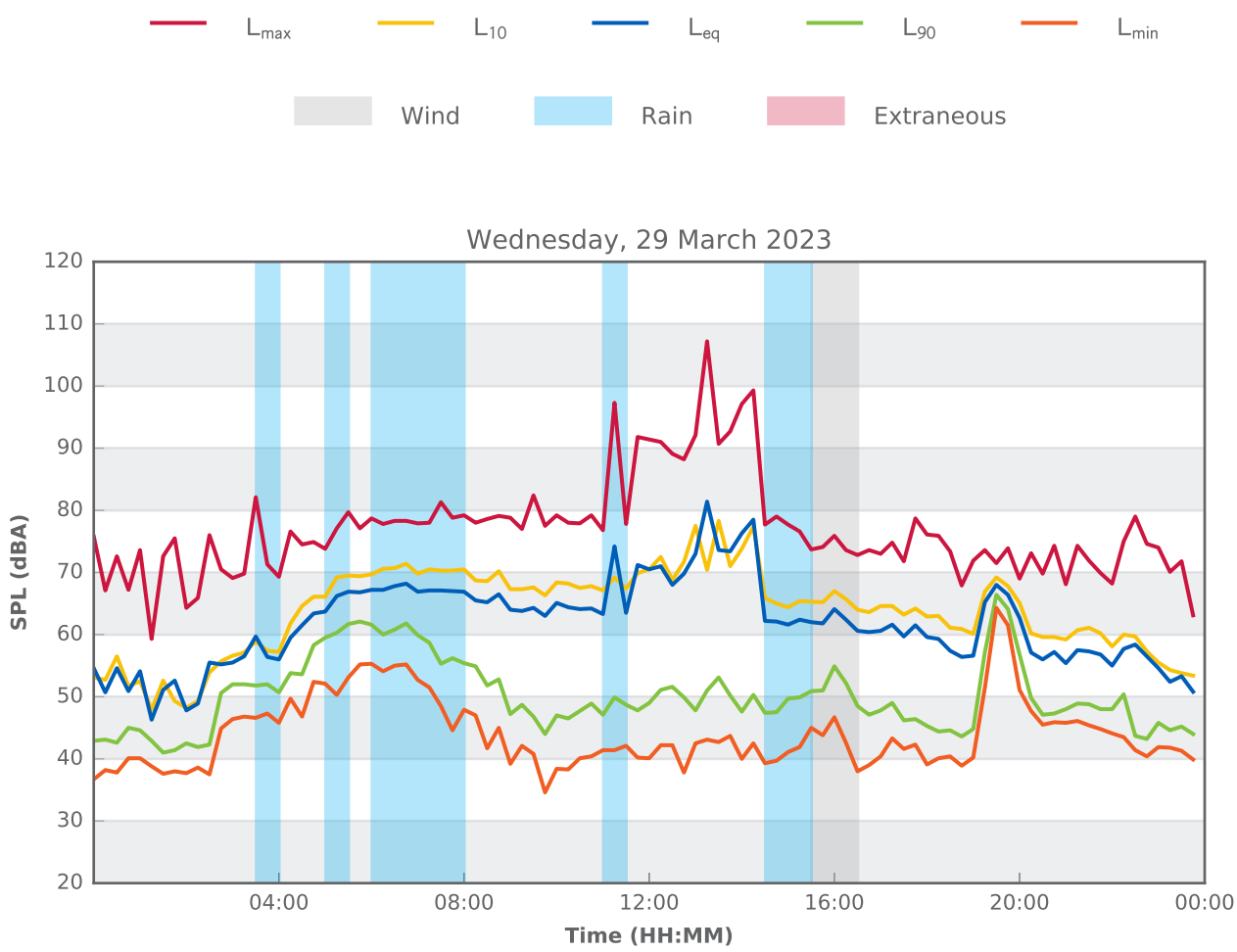

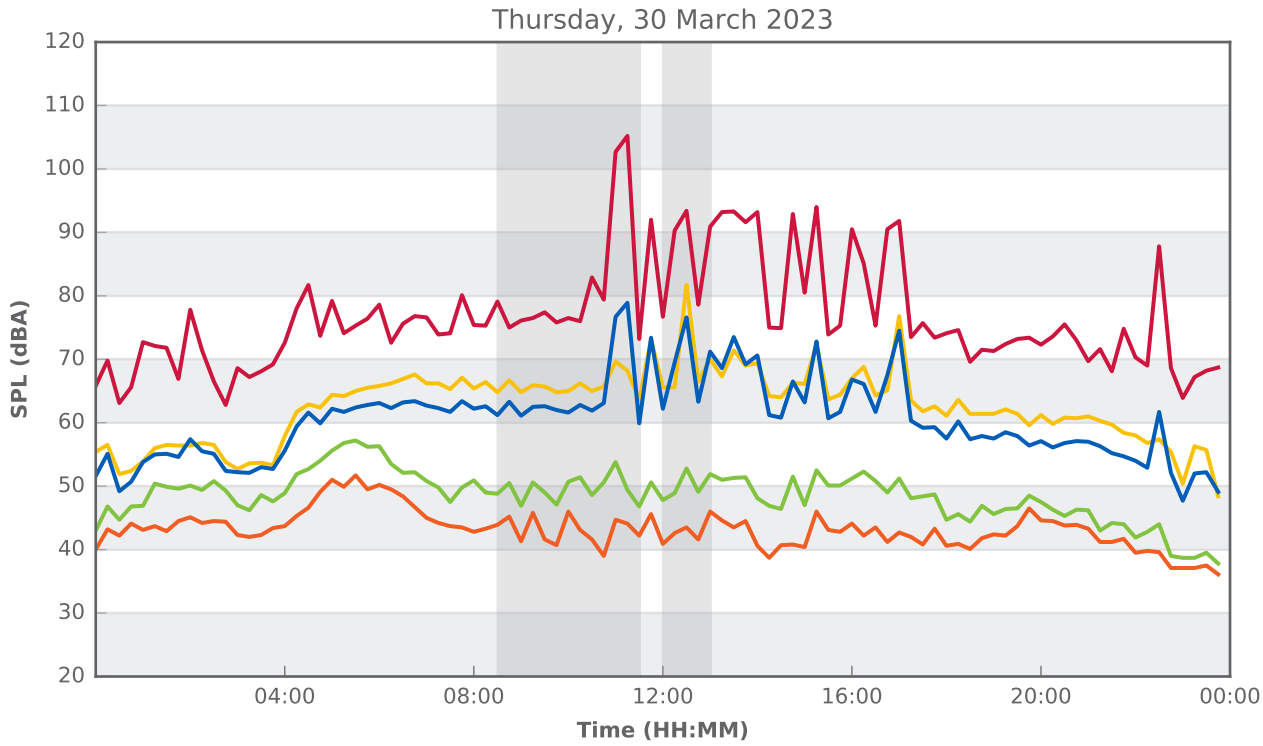

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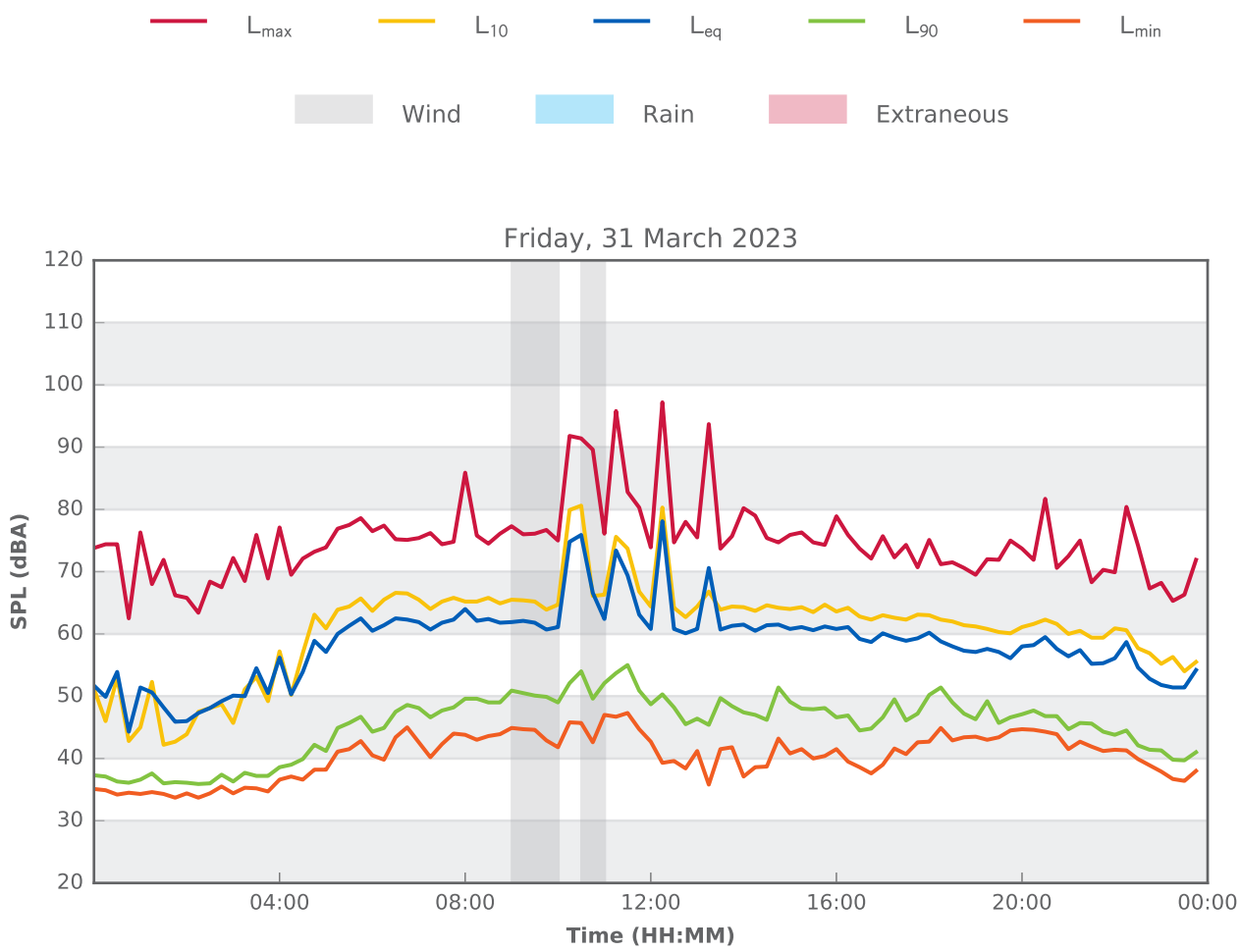

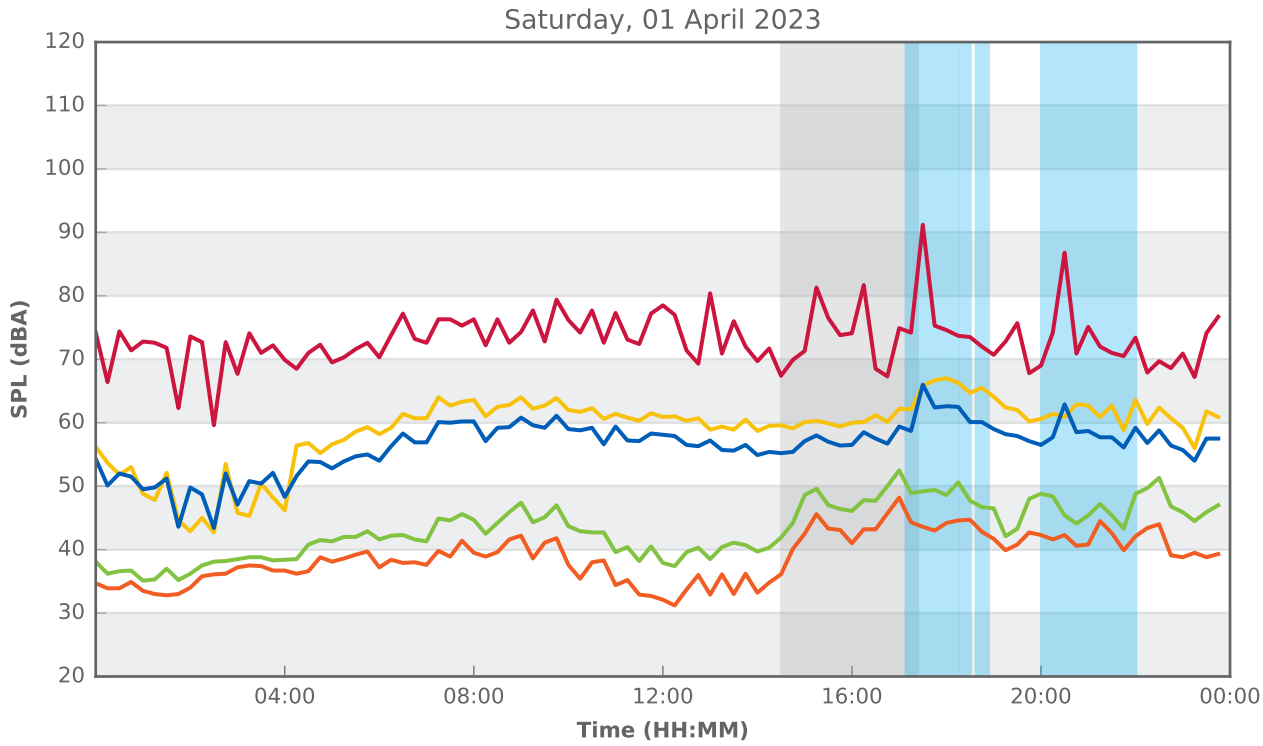

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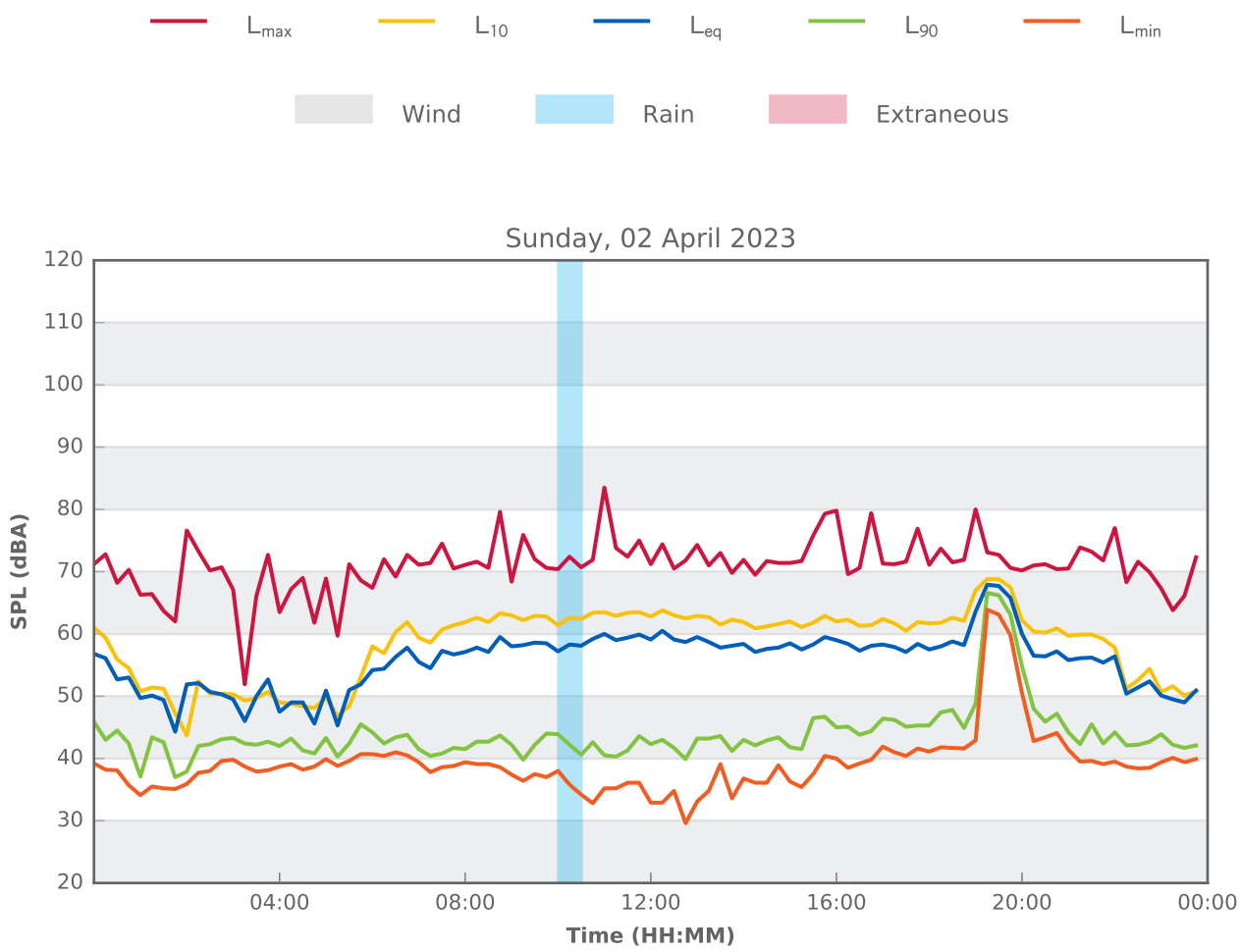

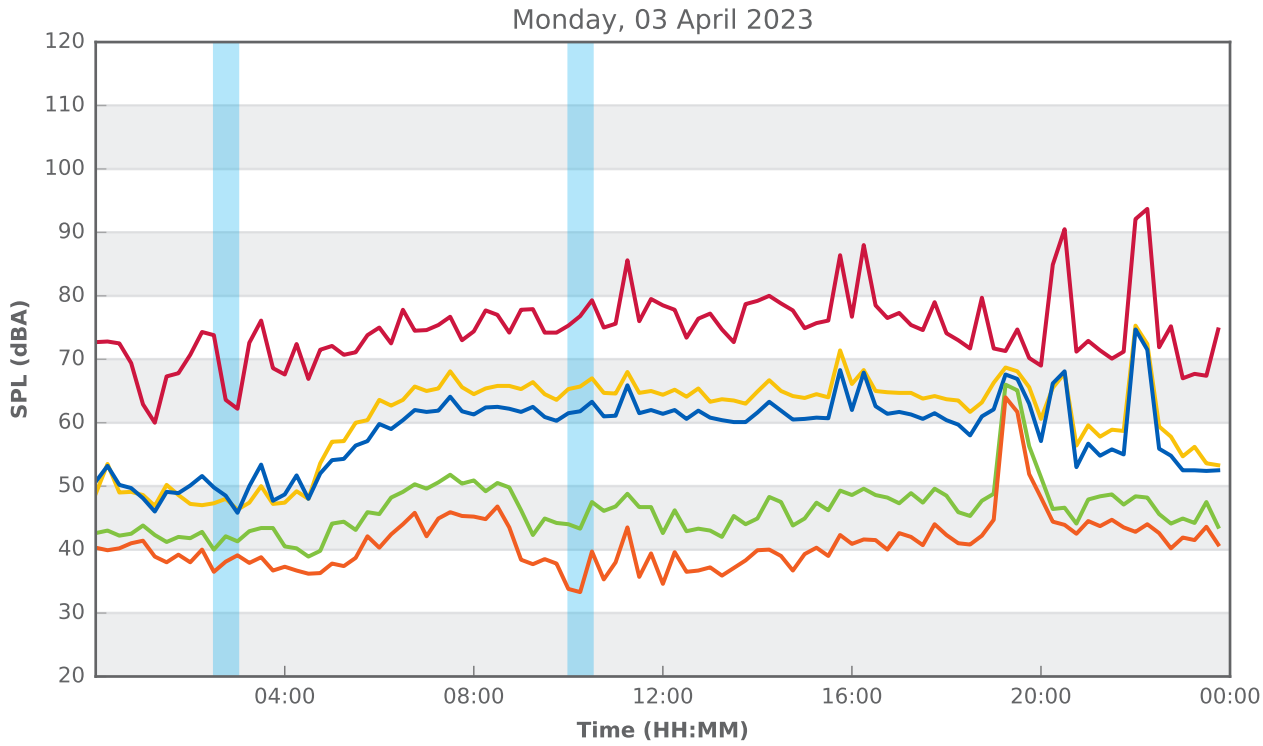

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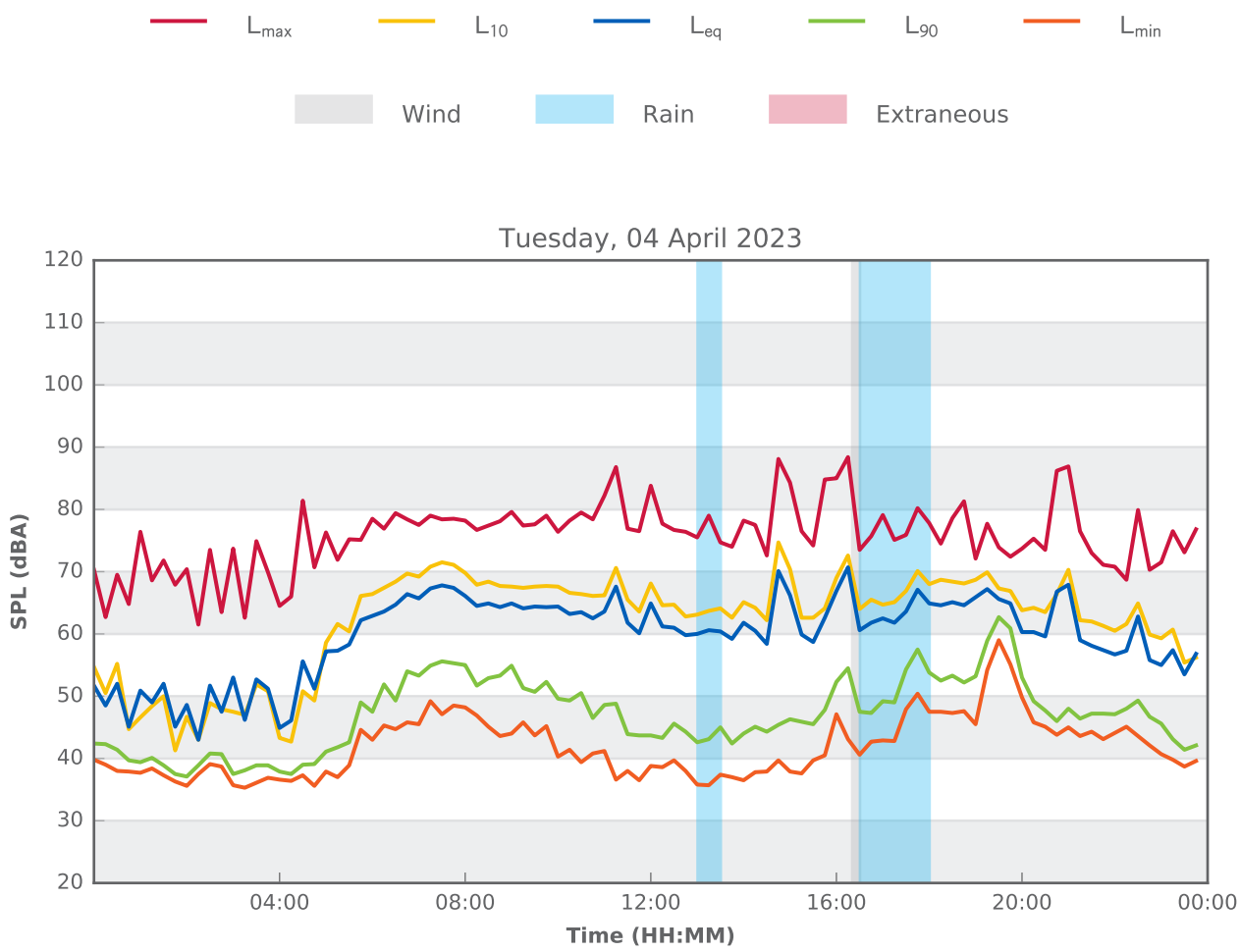

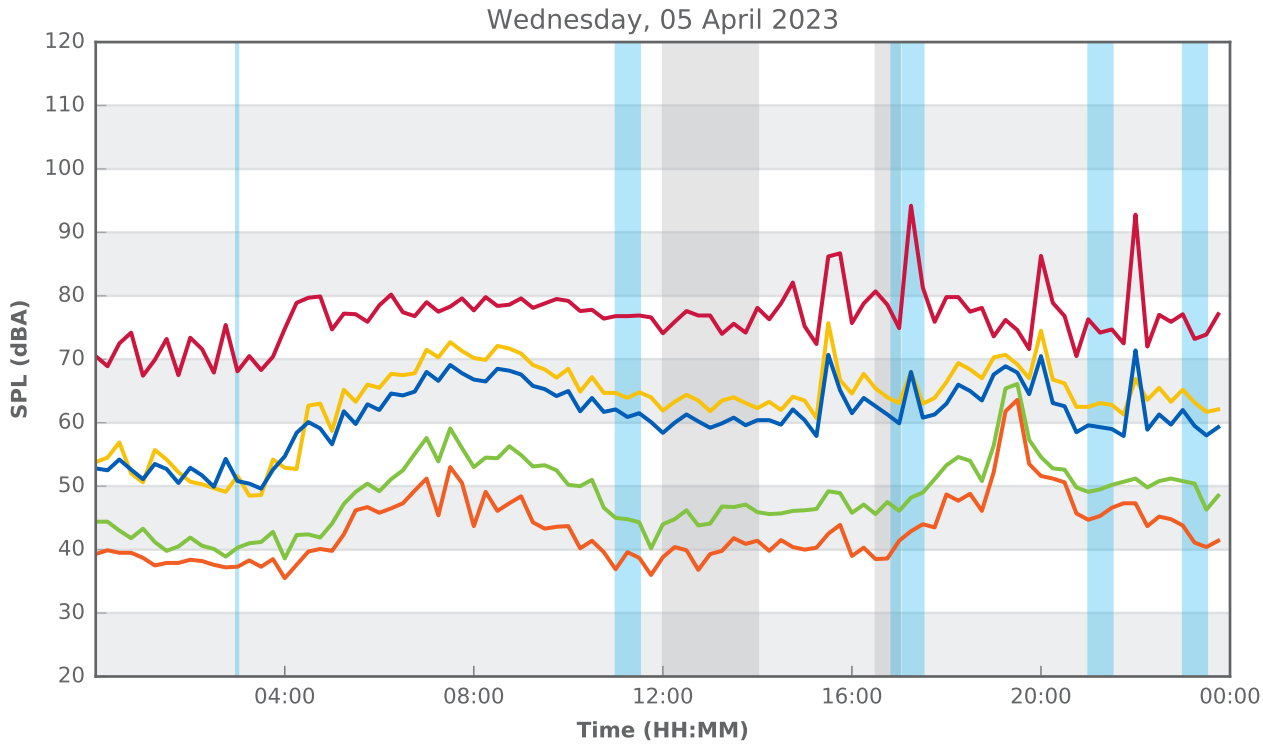

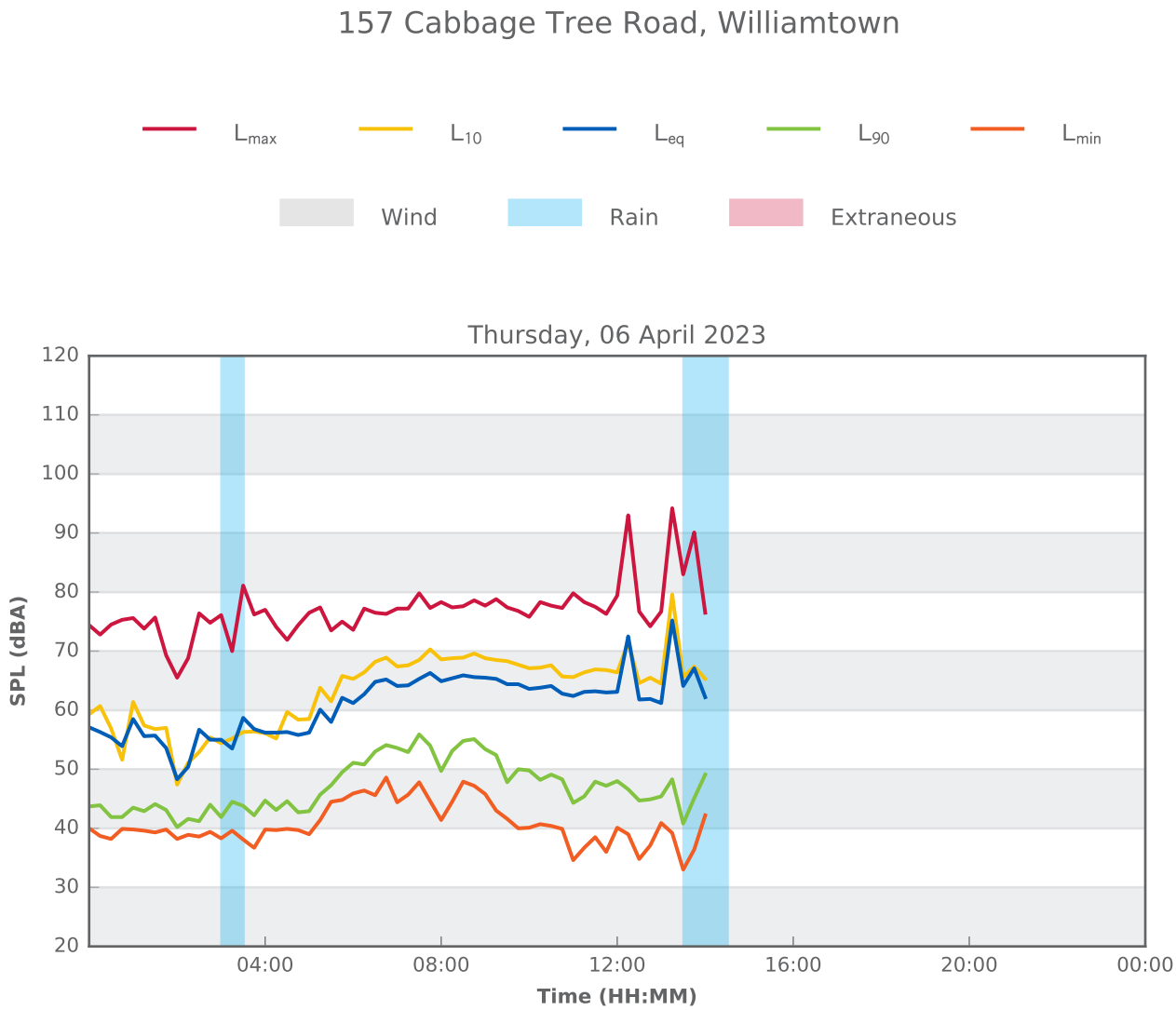
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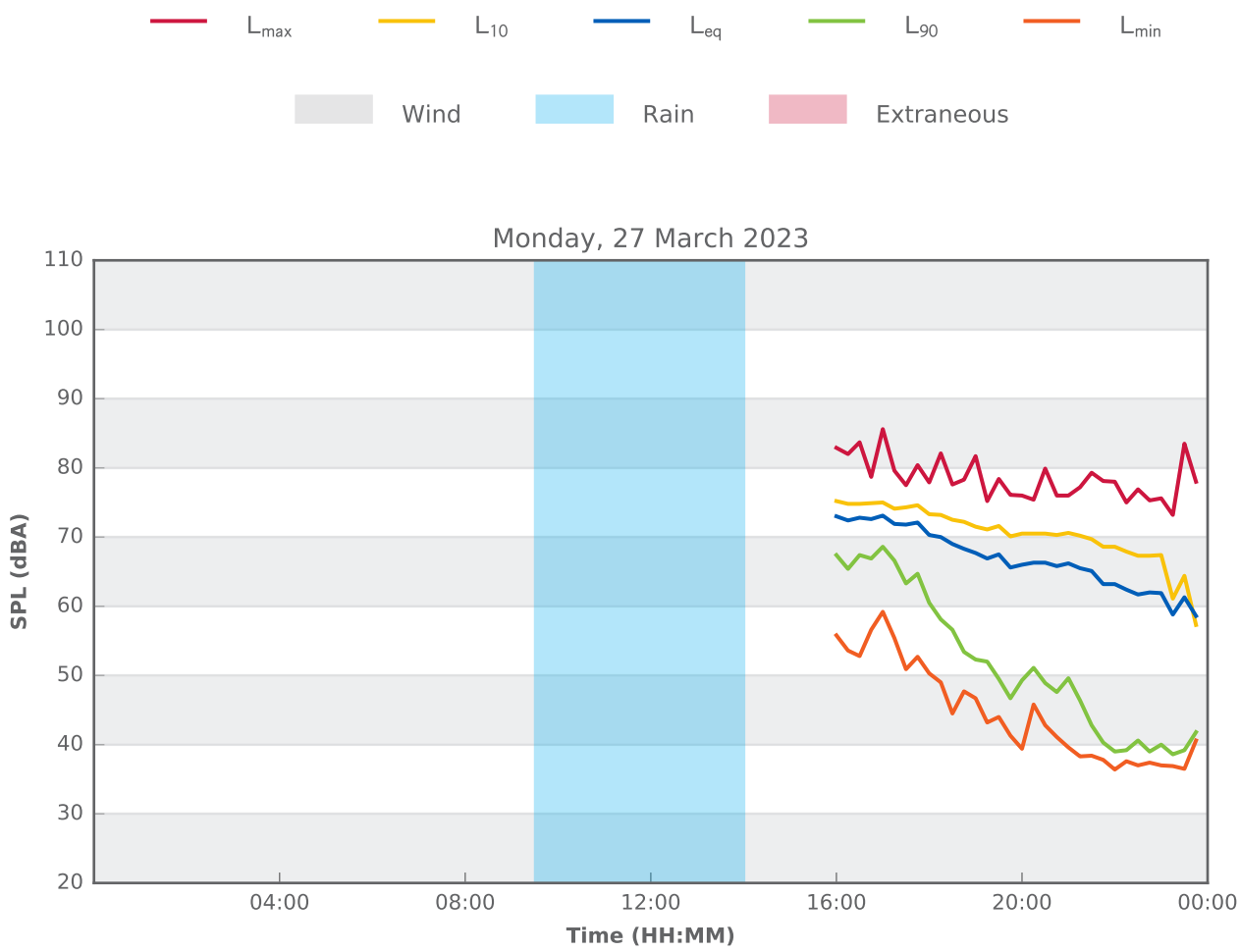

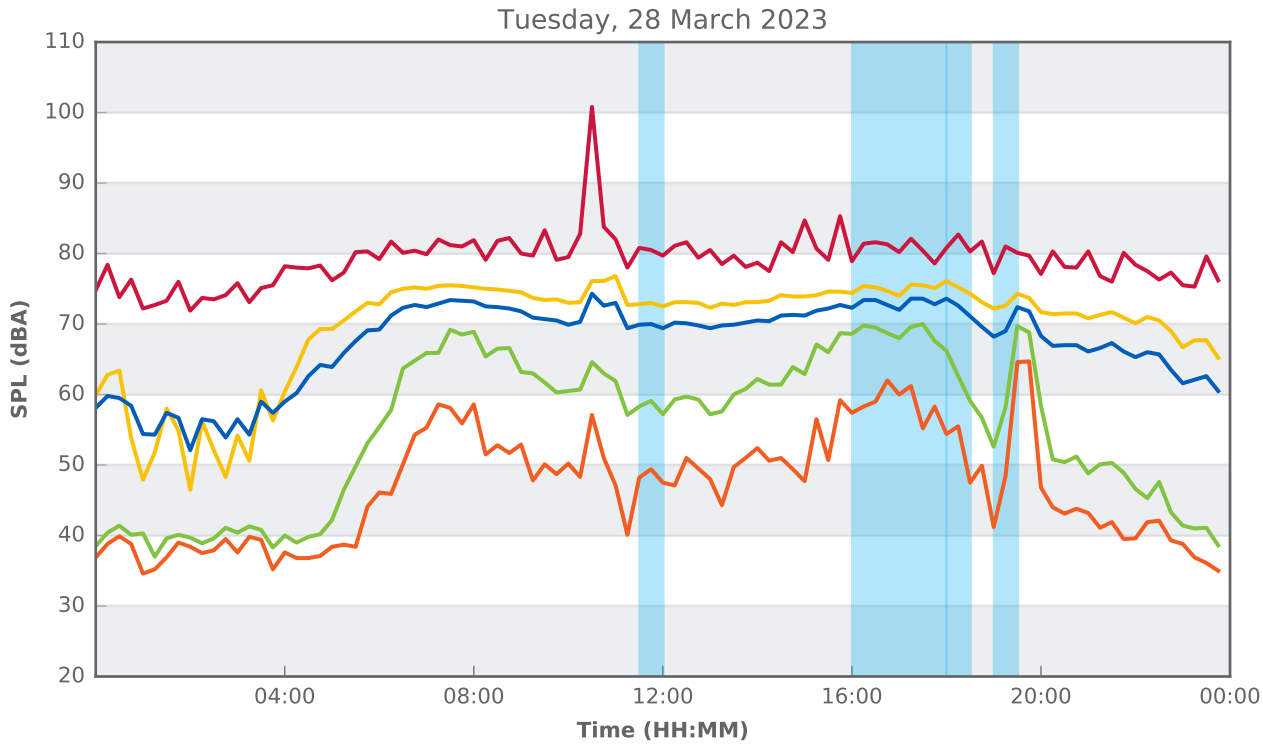

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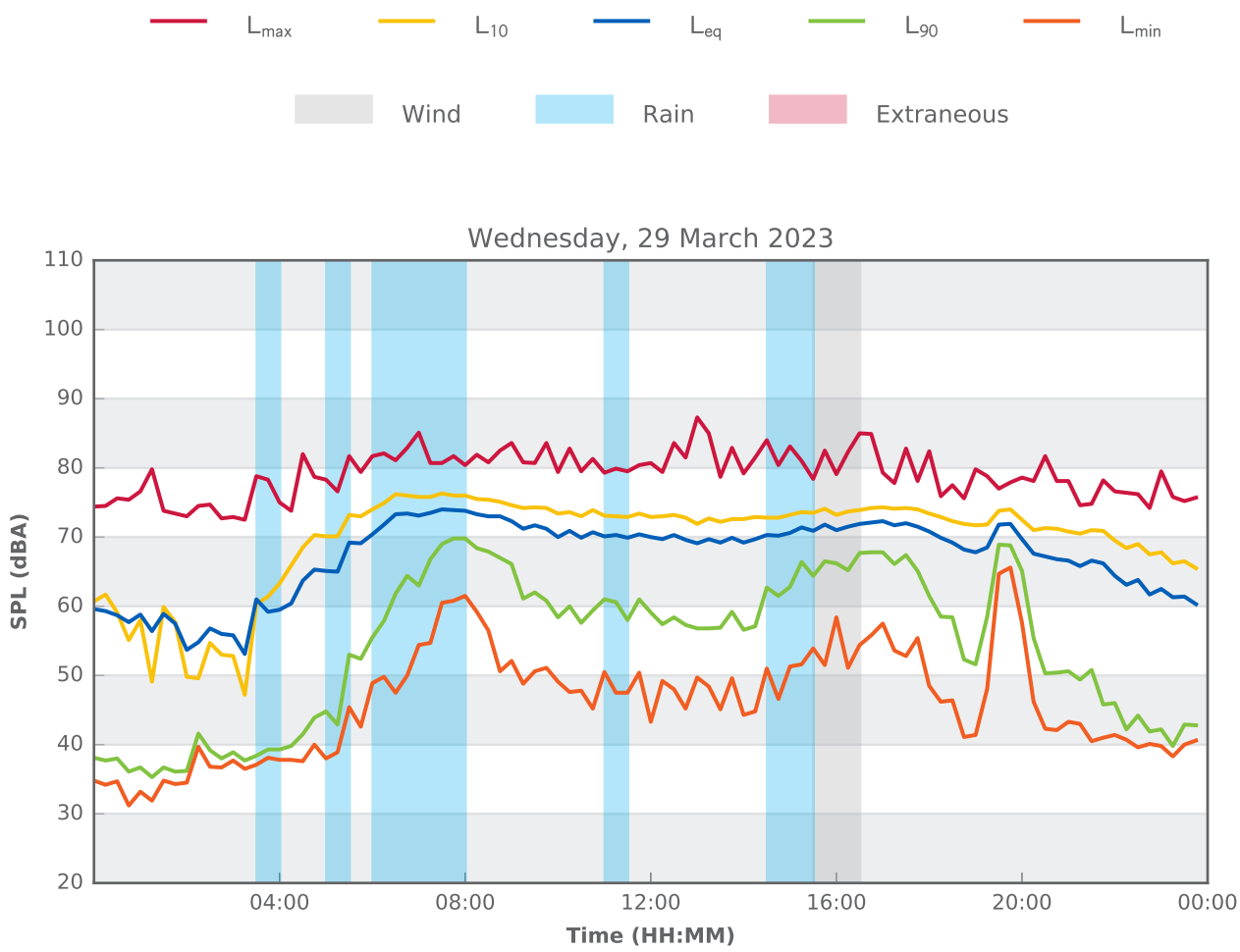

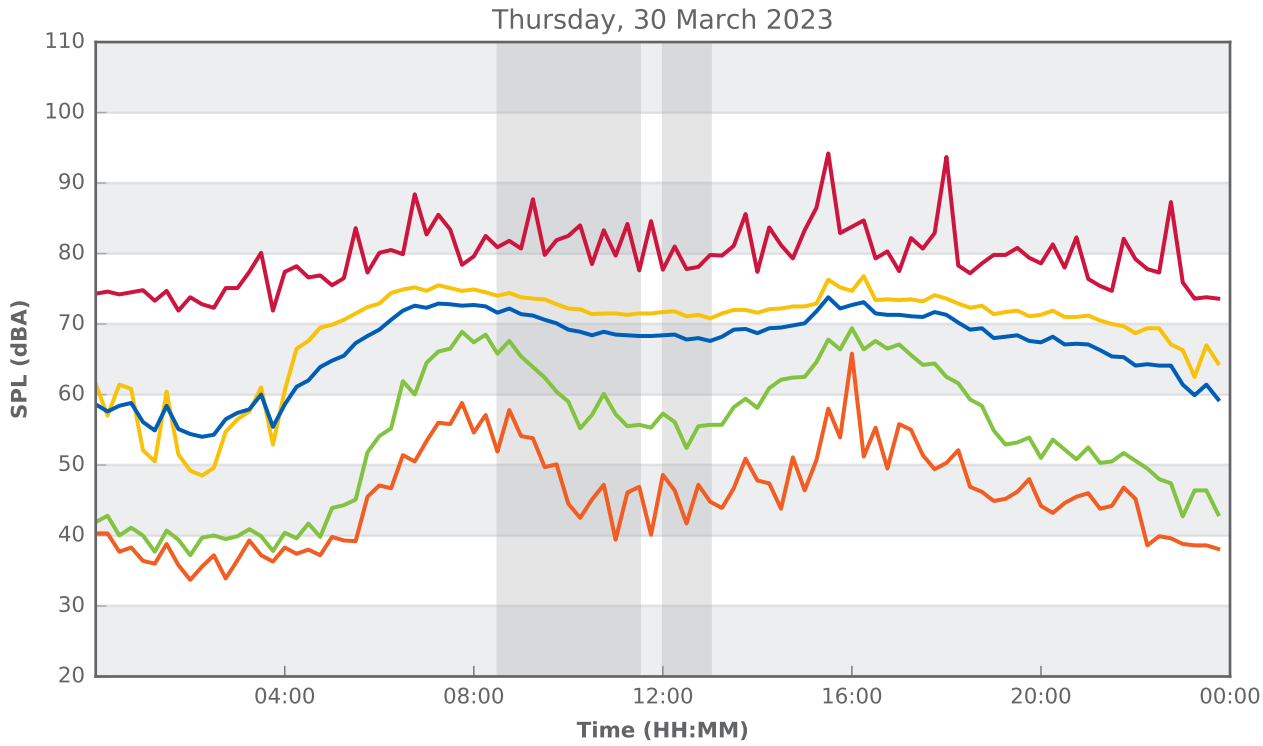

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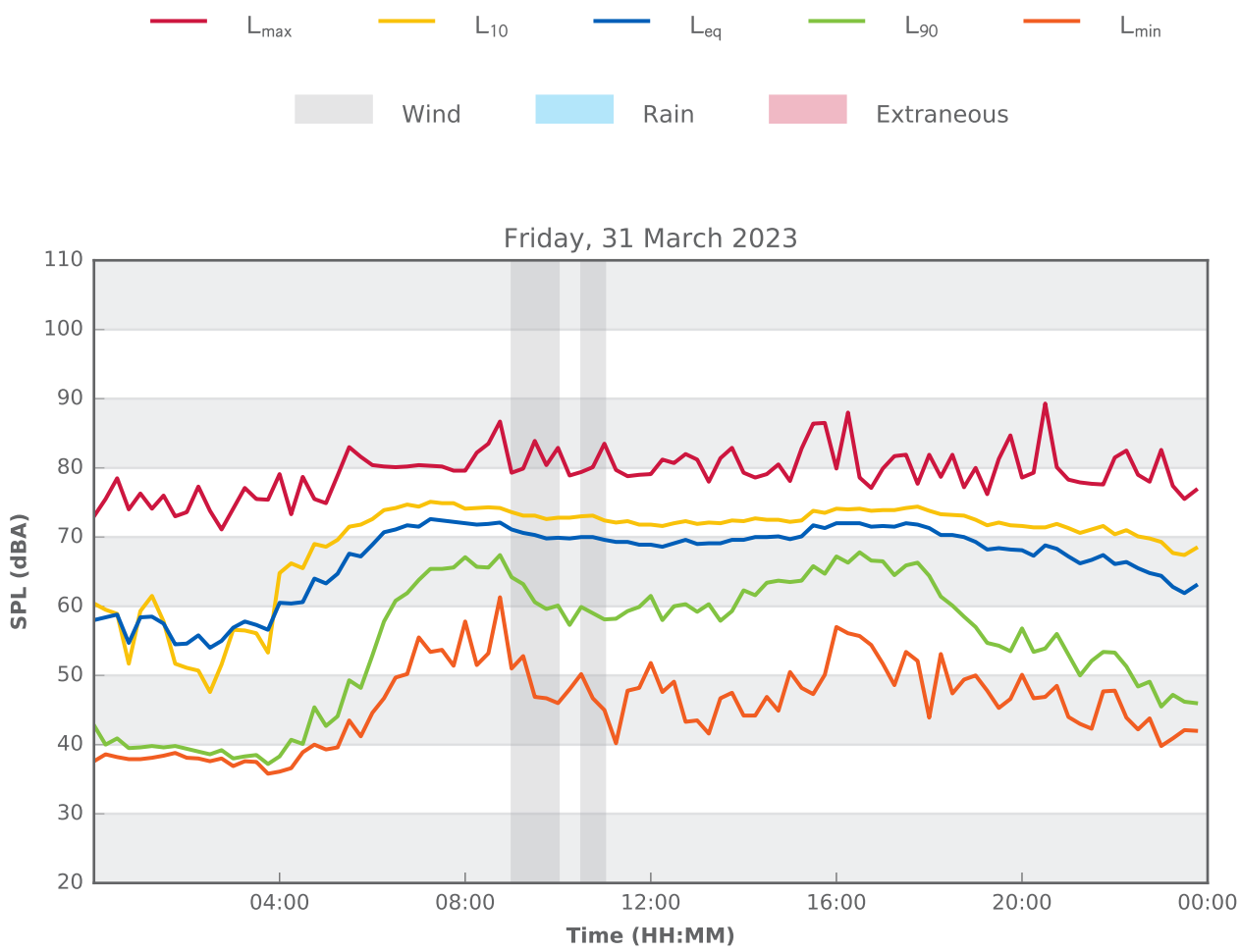

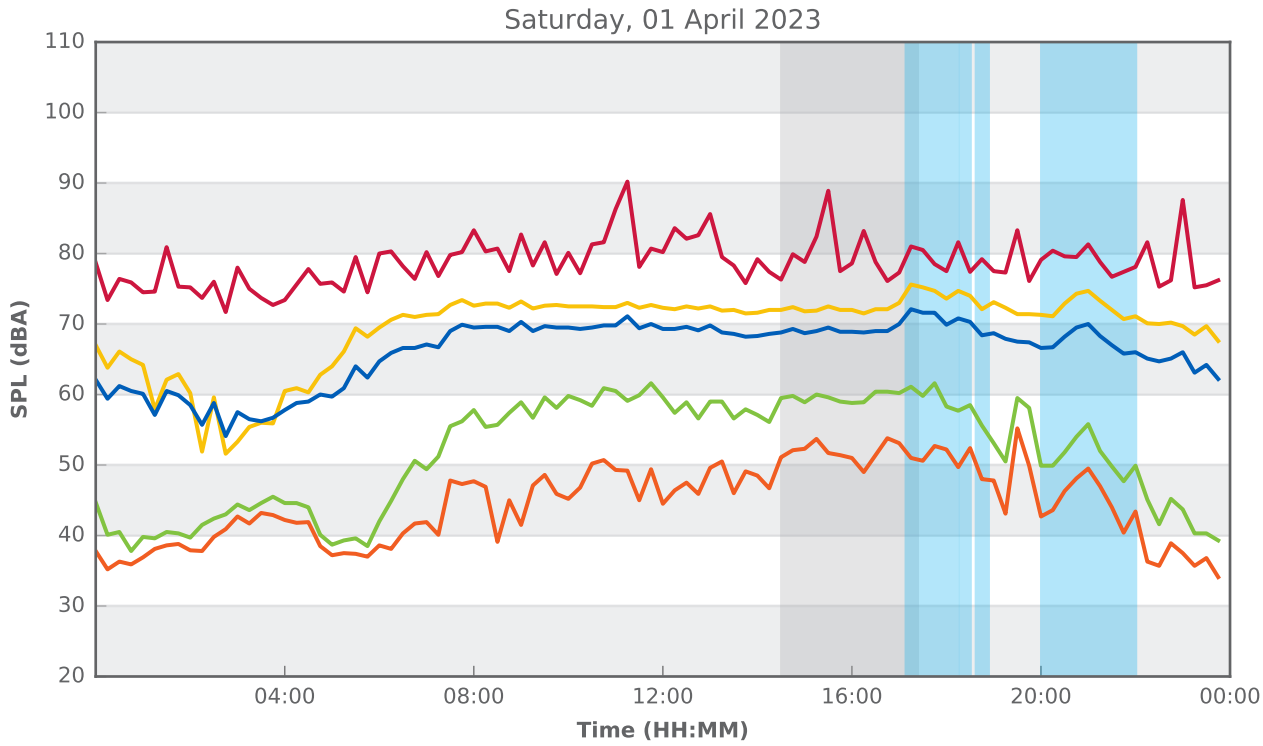

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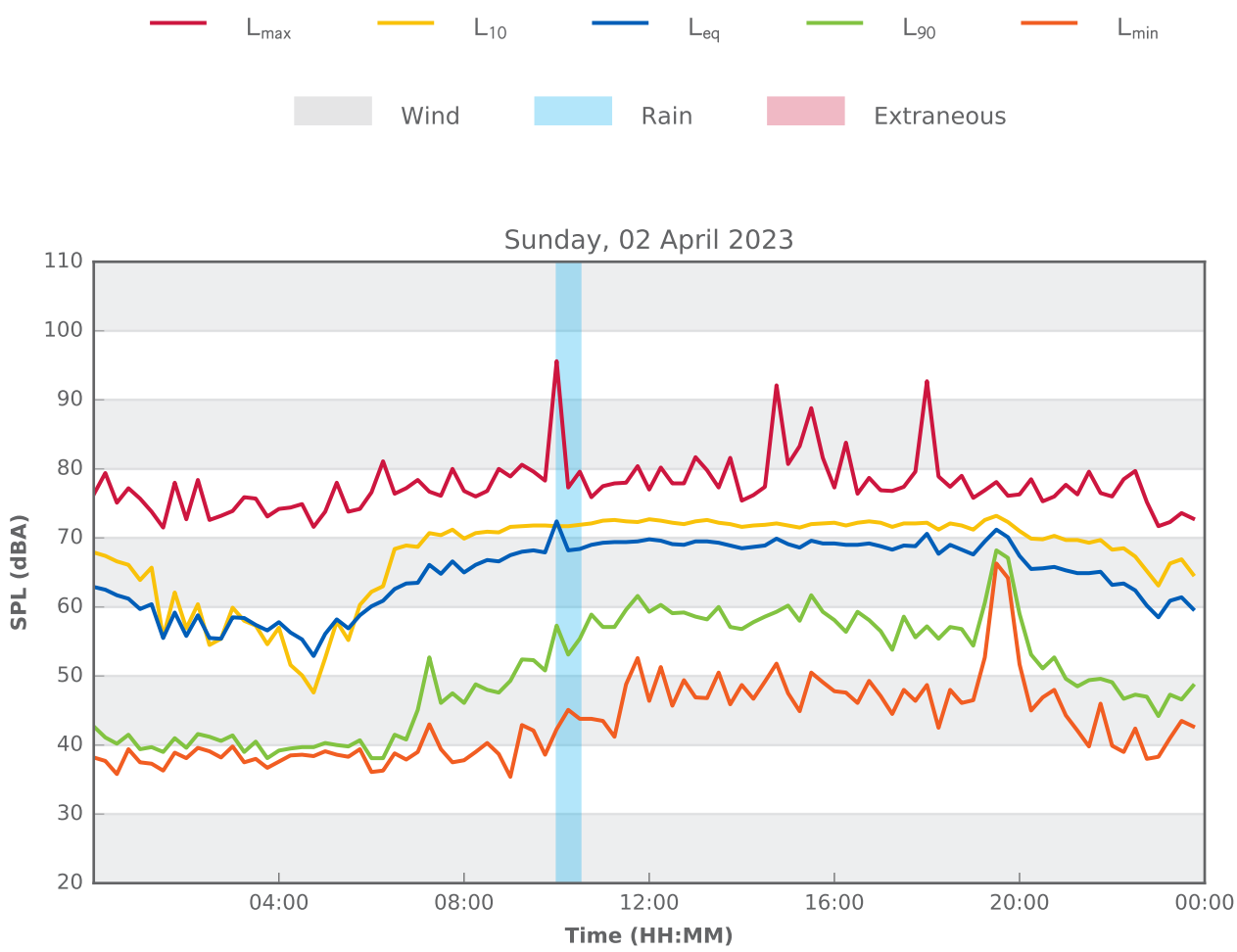

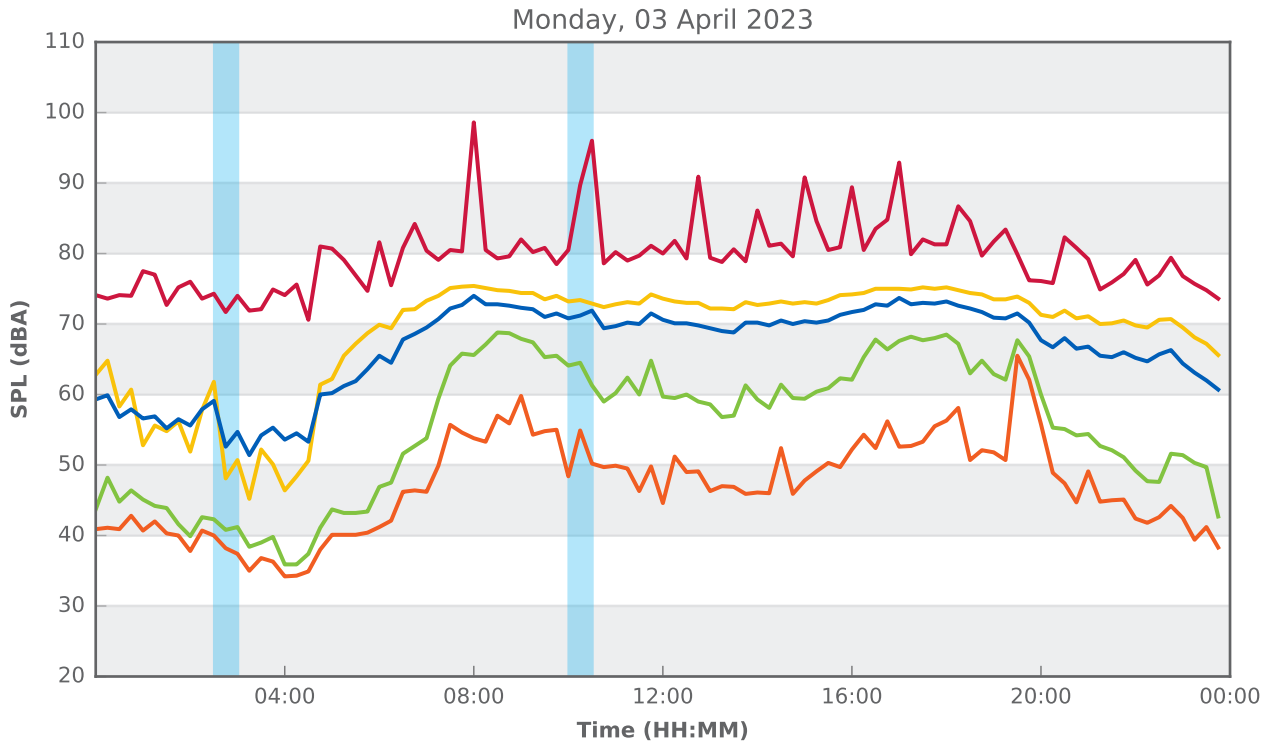

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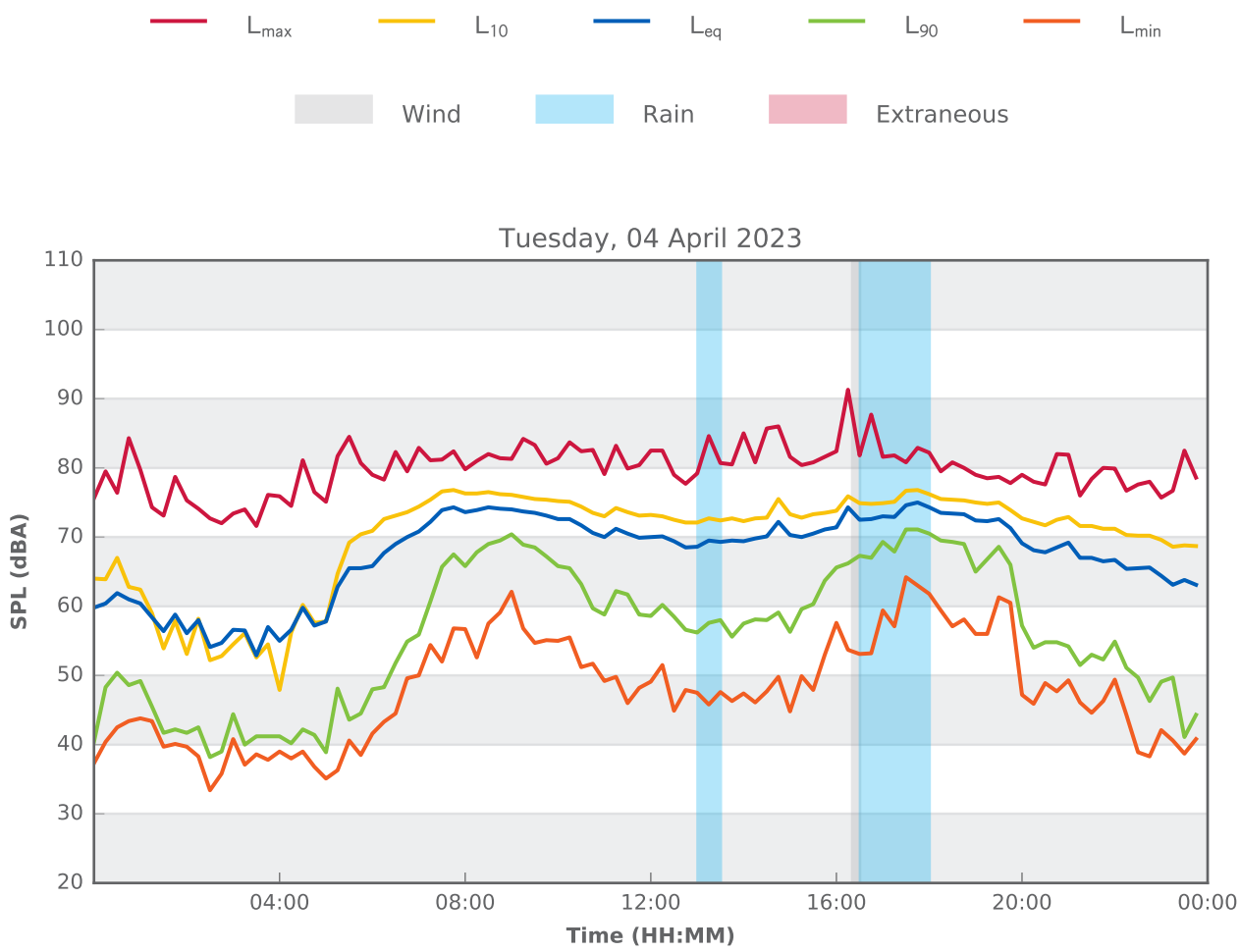

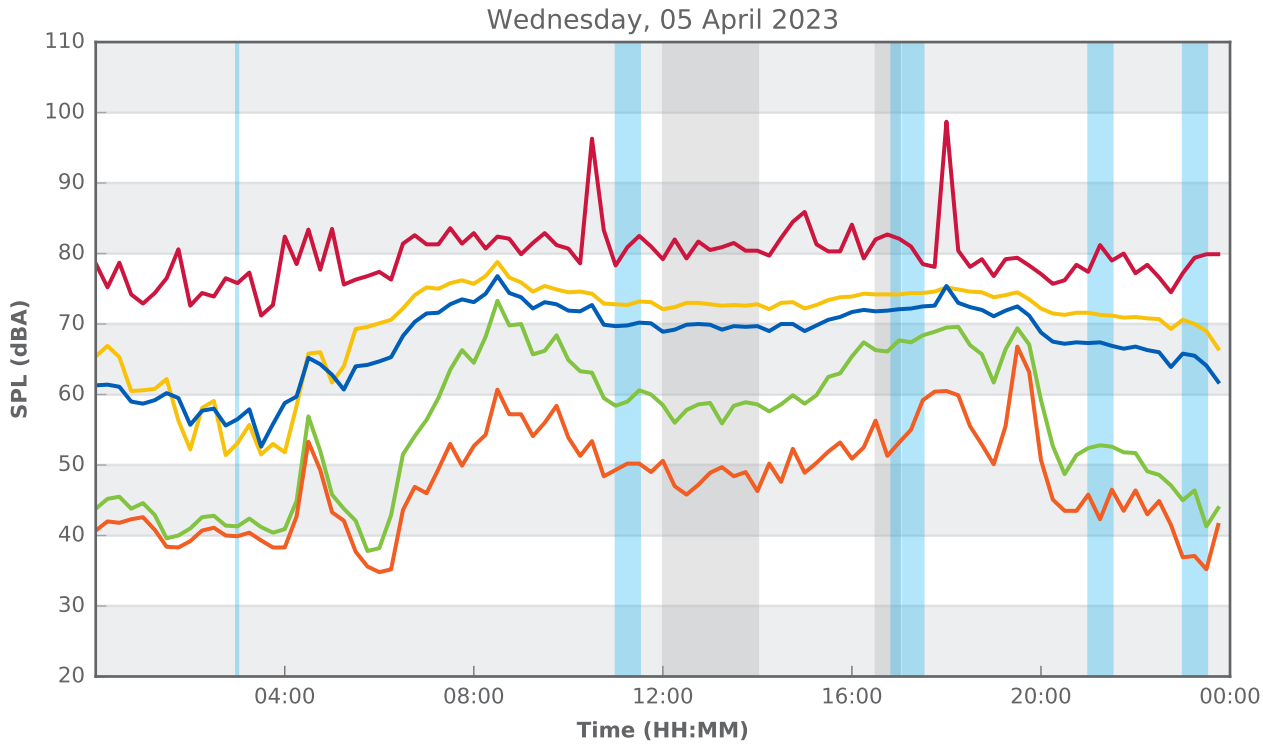

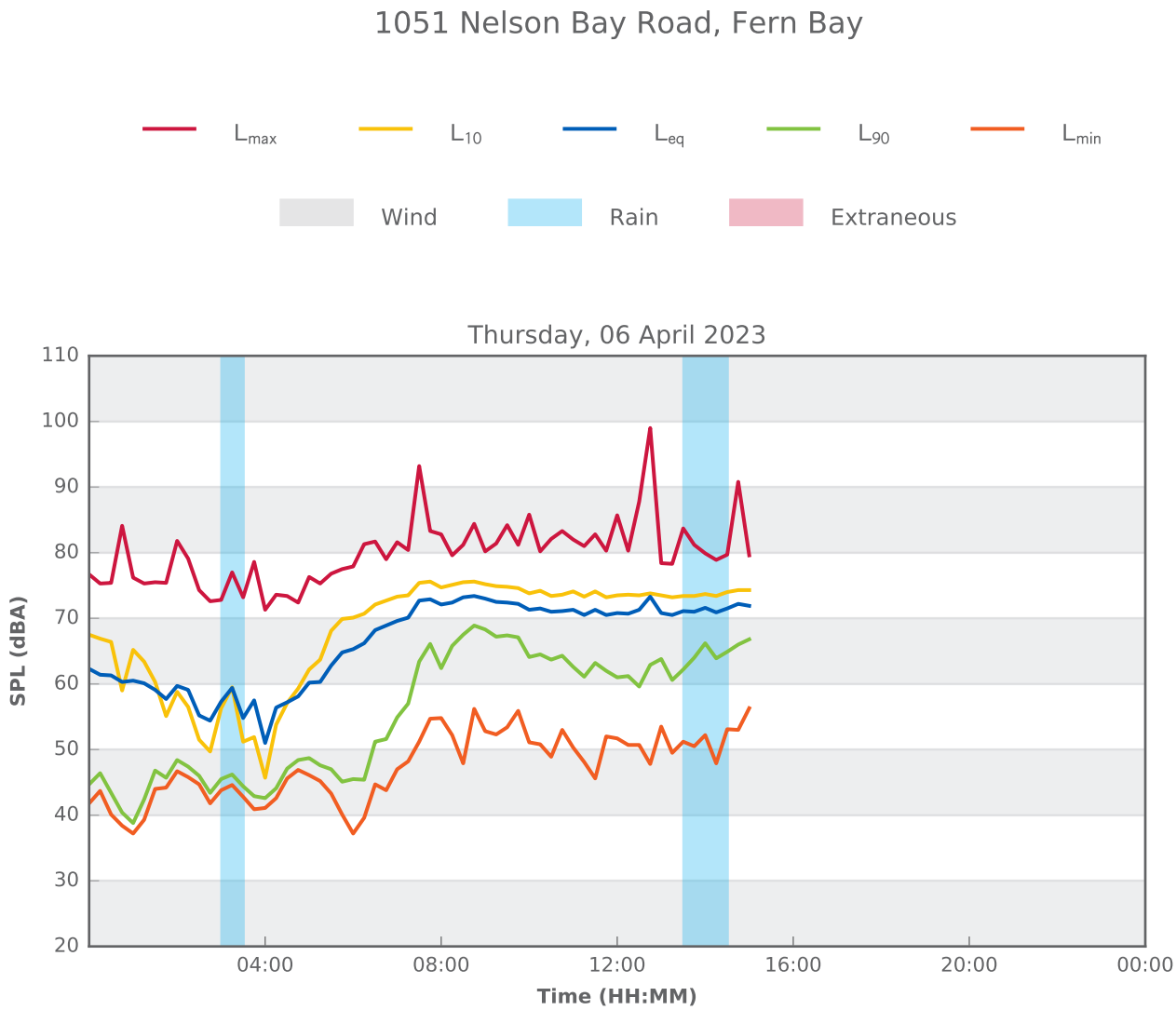
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Appendix K

Traffic and transport assessment

TRAFFIX
TRAFFIC AND TRANSPORT PLANNERS

TRAFFIC & TRANSPORT IMPACT ASSESSMENT (TTIA)

Stockton Dry Sand Extraction Project (SSD-52984213)
32 Coxs Lane, Fullerton Cove NSW

Reference: 22.590r01v02
Date: Jul y 2023

Suite 2.08, 50 Holt St
Surry Hills, NSW 2010

t: (02) 8324 8700
w: www.traffix.com.au

DOCUMENT VERIFICATION

Job Number	22.590			
Project	Stockton Dry Sand Extraction Project			
SSDA No.	SSD-52984213			
Client	Boral Construction Materials Ltd			
Revision	**Date**	**Prepared By**	**Checked By**	**Signed**
v02	03/07/2023	Shenara Wanigasekera	Ben Liddell	

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Appendix A: Reduced Plans
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1. INTRODUCTION

TRAFFIX has been commissioned by Boral Construction Materials Ltd to undertake a traffic and transport impact assessment in support of a State Significant Development Application (SSD-52985213) relating to the proposed dry sand extraction project at the Boral Stockton Quarry, located at 32 Cox Lane, Fullerton Cove. The development is located within the Port Stephens Council Local Government Area (LGA) and has been assessed under that Council's controls.

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping, and construction markets.

As shown in **Figure 1**, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area) granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and

dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source combined with water availability, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- The dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- The dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the project on 18 January 2023. This traffic impact assessment has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project. The report is structured as follows:

- Section 2: Addresses the State Significant Development Responses relevant to Transport Matters.
- Section 3: Describes the site and its location.
- Section 4: Discusses strategic context.
- Section 5: Documents existing traffic conditions.
- Section 6: Describes the existing development.
- Section 7: Describes the proposed development.
- Section 8: Assesses the parking requirements.
- Section 9: Assesses traffic and transport impacts.
- Section 10: Analyses road safety.
- Section11: Outlines the Austroads Assessment.
- Section 12: Discusses access and internal design aspects.
- Section 13: Presents the overall study conclusions.

2. STATE SIGNIFICANT DEVELOPMENT RESPONSES RELEVANT TO TRANSPORT MATTERS

2.1 SEARs Responses

A response to each relevant requirement of the SEAR is provided below, including references to sections of this report where applicable. Reference should also be made to the SEARs and the below matters relate specifically to Item 2.

2. Key Issues

SEARs Requirements	Reference
Traffic & Transport	
• accurate predictions of the road traffic generated by the construction and operation of the development, including a description of the types of vehicles likely to be used for transportation of quarry products.	**Refer to Section 7.2 and 9**
• a road safety audit	**Refer to Section 10.3**
• a detailed assessment of potential traffic impacts on the capacity condition, safety and efficiency of the local and State road network, having regard to the cumulative impacts of the development in relation to the proposed, approved and existing developments in the vicinity of the site in accordance with the Roads and Maritime Services NSW's Guide to Traffic Generating Developments (2002). This assessment must include a strategy to manage and/or minimise traffic impacts over the life of the development; and	**Refer to Section 9,10 and 11**
• a description of the measures that would be implemented to mitigate and/or manage any impacts.	**Refer to Section 9 and 10**

2.2 Transport for NSW Responses

In addition, Transport for NSW (TfNSW) requested considerations for SEARs within their letter dated 28 December 2022 (Ref: NTH22/00853/01). A response to each of TfNSW's requirements is provided below, including references to sections of this report where applicable.

TfNSW Requirements	Reference
Traffic Impact Assessment – Requested Considerations for SEAR	
Traffic Impact Assessment (TIA) be prepared by suitably qualified person/s in accordance with the Austroads Guide to Traffic Management Part 12, the complementary TfNSW Supplement and RTA Guide to Traffic Generating Developments.	**Noted**
The TIA is to identify the impacts of the development and the proposed on-site and off-site measures proposed to mitigate the impacts of the development on any road or rail related infrastructure. The TIA must explain and justify all inputs informing the proposed mitigation measures and TIA conclusions.	**Refer to Section 9 and 10**
The TIA should be tailored to the scope of the proposed development and include, but not necessarily be limited to, consideration of the following; • A map of the proposed transport route/s identifying all public roads proposed to obtain access from the classified (State) road/s to the development site.	**Refer to Section 7.3**
• The total impact of existing and proposed development on the road network with consideration for a 10 year horizon. This should include. o Identify Annual Average Daily Traffic (AADT) volumes with percentage heavy vehicles along the transport route/s and diagrammatically demonstrate AM and PM peak hour movements at key intersections. o Background traffic data from published sources and/or recent survey data. The source of data and any assumptions are to be clearly explained and justified, including the growth rate applied to the future horizon. o The volume and distribution of existing and proposed trips to be generated by the construction, operational and decommission phases of the development. This should identify the maximum daily and hourly demands generated by the development, particularly where they coincide with the network peak hour.	**Refer to Section 5 and 9**

TfNSW Requirements	Reference
○ The type and frequency of design vehicles accessing the development site.	
• Details of the road geometry and alignment along the identified transport route/s, including existing formations, crossings, intersection treatments and any identified hazards. This should include: ○ An assessment of turn treatment warrants in accordance with the Austroads Guide to Traffic Management Part 6 and Austroads Guide to Road Design Part 4A for intersections along the identified transport route/s, identifying the existence of the minimum basic turn treatments and addressing the need for any warranted higher order treatments. ○ Swept path analysis demonstrating the largest design vehicle entering and leaving the development, and moving in each direction through intersections along the proposed transport route/s.	**Refer to Section 5, 7.3 and 11**
• Capacity analysis using SIDRA or other relevant application, to identify an acceptable Level of Service (LOS) at intersections with the classified (State) road/s, and where relevant, analysis of any other intersections along the proposed transport route/s.	**Refer to Section 9**
• A review of crash data along the identified transport route/s for the most recent 5-year reporting period and an assessment of road safety along the proposed transport route/s considering the safe systems principles adopted under Future Transport 2056.	**Refer to Section 10**
• Strategic (2D) design drawings of all proposed road works and the site access demonstrating scope, estimated cost and constructability of works required to mitigate the impacts of the development on road safety, traffic efficiency and the integrity of transport infrastructure. Works must be appropriately designed for the existing posted speed limit.	**Refer to Section 9.10.2, noting no external works are considered necessary.**
• Site plan demonstrating site access, internal manoeuvring, servicing and parking areas consistent with the relevant parts of AS2890 and Council requirements.	**Refer to Appendix A**
• Details of measures to address impacts and/or provide connections for public transport services and active transport modes, such as, public and school bus services, walking and cycling	**Refer to Section 9.13**
• Details of measures to ameliorate the impacts of road traffic noise, dust, and/or glare generated along the proposed transport route/s	**Refer to Section 9.14**

TfNSW Requirements	Reference
• Details of any Traffic Management Plan (TMP) proposed to address the construction and operation phases of the proposed development. The TMP should be prepared and implemented in accordance with Australian Standard 1742.3 and the Work Health and Safety Regulation 2017. It is recommended that any TMP include, but not necessarily limited to, the following: o A map of the primary transport route/s highlighting critical locations. o An induction process for vehicle operators and regular toolbox meetings. o Procedures for travel through residential areas, school zones and/or bus route/s. o Any proposed temporary measures such a Traffic Guidance Scheme (TGS). o A Driver Code of Conduct for heavy vehicle operators. o A complaint resolution and disciplinary procedure.	**Section 9.16**
Community consultation measures proposed for peak periods.	**Refer to Section 9.15**
Where road safety concerns are identified at a specific location along the proposed haulage routes, TfNSW suggests that the TIA be supported by a targeted Road Safety Audit undertaken by suitably qualified persons in accordance with the Austroads Guidelines.	**Refer to Section 10.3**
Any roadwork on classified State road/s is to be designed and constructed in accordance with the current Austroads Guidelines, Australian Standards and TfNSW Supplements.	**Noted**

3. LOCATION AND SITE

The subject site is known as Boral Stockton Quarry, located at 32 Coxs Lane, Fullerton Cove. It is located approximately 10.6 kilometres northeast of Newcastle Central Business District (CBD) and approximately 4.6 kilometres south of Newcastle Airport.

The site has a total area of approximately 246 hectares and accommodates the existing Stockton Sand Quarry operated by Boral. The quarry consists of three lots (Lot 1 DP 1006399, Lot 2 DP 1006399 and Lot 3 DP 664552) and is surrounded by the Worimi State Conservation Area.

The site access is located on a Crown land title (Lot 7300 DP 1130730) which is accessed via Cox Lane under a licence agreement with the NSW Department of Planning and Environment (DPE).

A Location Plan is presented in **Figure 1**, with a Site Plan presented in **Figure 2**.

Figure 1: Location Plan

Figure 2: Site Plan

4. STRATEGIC CONTEXT

4.1 State Environmental Planning Policy (Transport and Infrastructure) 2021

This policy aims to provide a consistent planning regime for infrastructure and the provision of services. This planning policy outlines where consultation with the relevant public authorities is required during the assessment process and prior to development commencing.

4.2 Greater Newcastle Future Transport Plan

The Greater Newcastle Future Transport Plan is a key supporting plan within the Future Transport 2056 suite and was developed in collaboration with the Department of Planning and Environment's Greater Newcastle Metropolitan Plan 2036. The key role of this plan is to identify key transport policies, services, and infrastructure initiatives for investigation within the greater Newcastle area. In particular, the plan aims to increase liveability in the Greater Newcastle Area through more sustainable travel behaviour.

4.3 Local Environmental Plans (LEPs)

The Port Stephens Local Environmental Plan 2013 is relevant to the site.

4.4 Development Control Plans (DCPs)

The Port Stephens Development Control Plan 2014 is relevant to the site.

5. EXISTING TRAFFIC CONDITIONS

5.1 Road Network

The road hierarchy in the vicinity of the site is shown in **Figure 3** with the following roads of particular interest:

- Nelson Bay Road: a TfNSW Main Road (MR 108) that generally runs in a north to south direction between Galoola Drive in the north and Teal Street in the south. In the vicinity of the site, Nelson Bay Road is subject to a speed zoning of 100km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along this road.
- Cabbage Tree Road: a TfNSW Main Road (MR 302) that generally traverses east to west between Nelson Bay Road in the east and Masonite Road in the west. In the vicinity of the site, Cabbage Tree Road is subject to a speed zoning of 60km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along this road.
- Seaside Boulevard: a local road that forms a loop between Nelson Bay Road in the northeast and the southwest. It is subject to a speed zoning of 60km/h and carries a single lane of traffic in either direction. Kerbside parking is generally not permitted along either side of the road in the vicinity of the site.
- Fullerton Cove Road: a local road that forms a loop between Nelson Bay Road in the northeast and the southwest. It is subject to a speed zoning of 70km/h and carries a single lane of traffic in either direction. Kerbside parking is not permitted along either side of the road.
- Cox Lane: a local road that generally traverses east to west between the subject site in the east (32 Coxs Lane, Fullerton Cove) and Fullerton Cover Road in the west. It is subject to a speed zoning of 70km/h and accommodates two-way flow of traffic. Kerbside parking is not permitted along either side of the road.

- Lavis Lane: a local road that generally traverses east to west between Macs Trak in the east and Nelson Bay Road in the west. There is no posted speed limit along this road, and as such, a default local speed limit of 50km/h is applicable. Kerbside parking is not permitted along either side of the road.

Figure 3: Road Hierarchy

5.2 Key Intersections

The key intersections in the vicinity of the site are shown below and provide an understanding of the existing road geometry and alignment.

5.2.1 Nelson Bay Road, Cabbage Tree Road and Lavis Lane

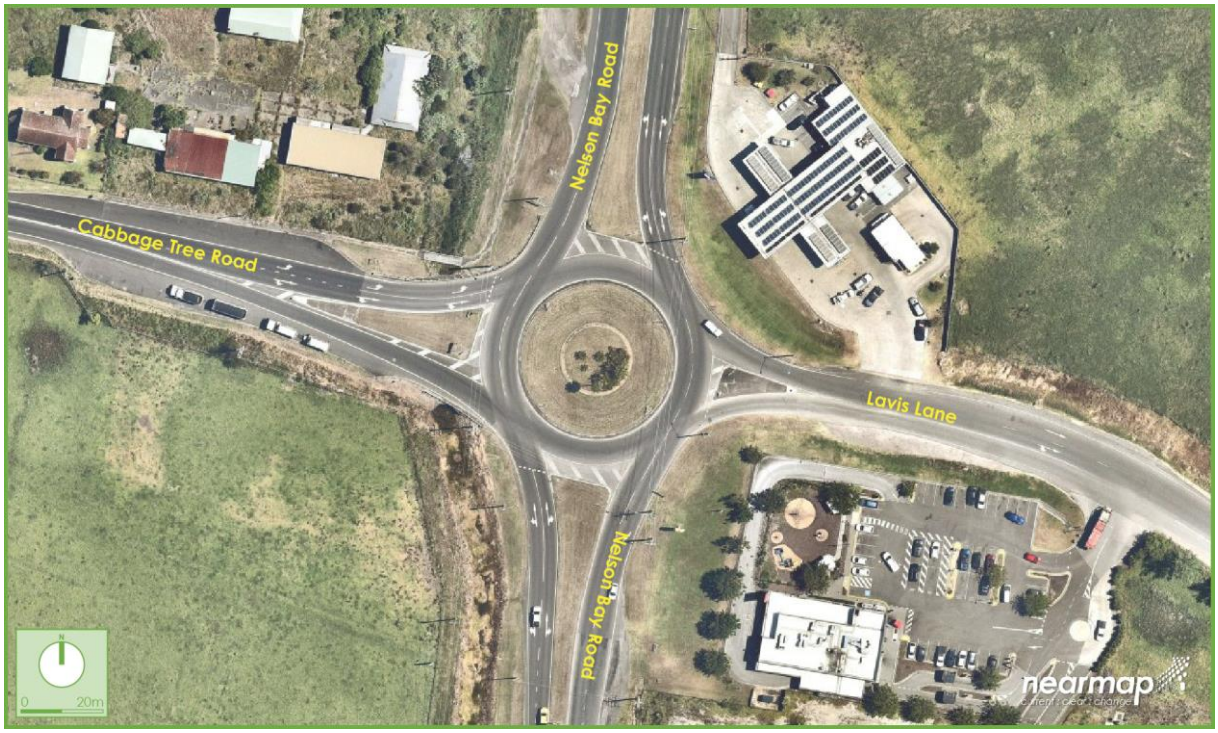


Figure 4: Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane

It can be seen from **Figure 4** that the intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane is a four-legged roundabout. The main attributes of each approach outlined as follows:

- Nelson Bay Road (north and south legs)
  - The northbound approach provides two (2) lanes, with the western lane allowing for left turns and through movements and the eastern lane allowing for right turns and through movements.
  - The southbound approach provides two (2) lanes, with the eastern lane allowing for left turns and through movements and the western lane allowing for right turns and through movements.

- Cabbage Tree Road (east leg)
  - The eastbound approach provides two (2) lanes, with the northern lane permitting left turns only and the southern lane permitting right turns and through movements.
- Lavis Lane (west leg)
  - The westbound approach provides a single through lane, permitting all movements.

5.2.2 Nelson Bay Road and Cox Lane (On-Ramp)

Figure 5: Intersection of Nelson Bay Road and Cox Lane (On-Ramp)

It can be seen from **Figure 5** that the intersection of Nelson Bay Road and Cox Lane (On-Ramp) is a three-legged priority intersection. The main attributes of each approach outlined as follows:

- Cox Lane (east and west leg)
  - The eastbound approach provides a single through lane. Right turns into the Nelson Bay Road on-ramp are permitted.
  - The westbound approach provides a single through lane. Left turns into the Nelson Bay Road on-ramp are permitted.
- Nelson Bay Road On-Ramp (south leg)

- This leg is an exit lane only and has no approach lanes.

5.2.3 Nelson Bay Road and Cox Lane (Off-Ramp)

Figure 6: Intersection of Nelson Bay Road and Cox Lane (Off-Ramp)

It can be seen from **Figure 6** that the intersection of Nelson Bay Road and Cox Lane (Off-Ramp) is a three-legged priority intersection. The main attributes of each approach outlined as follows:

- Cox Lane (east and west leg)
  - The eastbound approach provides a single through lane. Right turns into the Nelson Bay Road off-ramp are not permitted.
  - The westbound approach provides a single through lane. Left turns into the Nelson Bay Road off-ramp are not permitted.
- Nelson Bay Road Off-Ramp (south leg)
  - The northbound approach provides a single through lane from which left and right turns are permitted.

5.2.4 Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road

Figure 7: Intersection of Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road

It can be seen from **Figure 7** that the intersection of Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road is a four-legged roundabout intersection. The main attributes of each approach outlined as follows:

- Seaside Boulevard (southeast leg)
  - The northwest approach provides two (2) lanes, with the western lane permitting left turns only and the eastern lane permitting right and through movements.
- Fullerton Cove Road (north-west leg)
  - The southeast approach provides a single lane from which all movements are permitted.
- Nelson Bay Road (northeast and southwest legs)
  - The northeast approach provides two (2) lanes, with the western lane allowing for left turns and through movements and the eastern lane allowing for right turns and through movements.

- The southwest approach provides two (2) lanes, with the eastern lane allowing for left turns and through movements and the western lane allowing for right turns and through movements.

5.3 Approved 25/26m B-Double Routes

The roads surrounding the subject site are approved TfNSW 25/26m B-double routes. The approved B-Double routes are illustrated in **Figure 8** below.

Figure 8: Approved B-Double Truck Routes

5.4 Traffic Survey Locations

In order to determine the existing traffic conditions, a number of traffic surveys were conducted at key locations surrounding the site. The location and type of survey is indicated in **Figure 9** below:

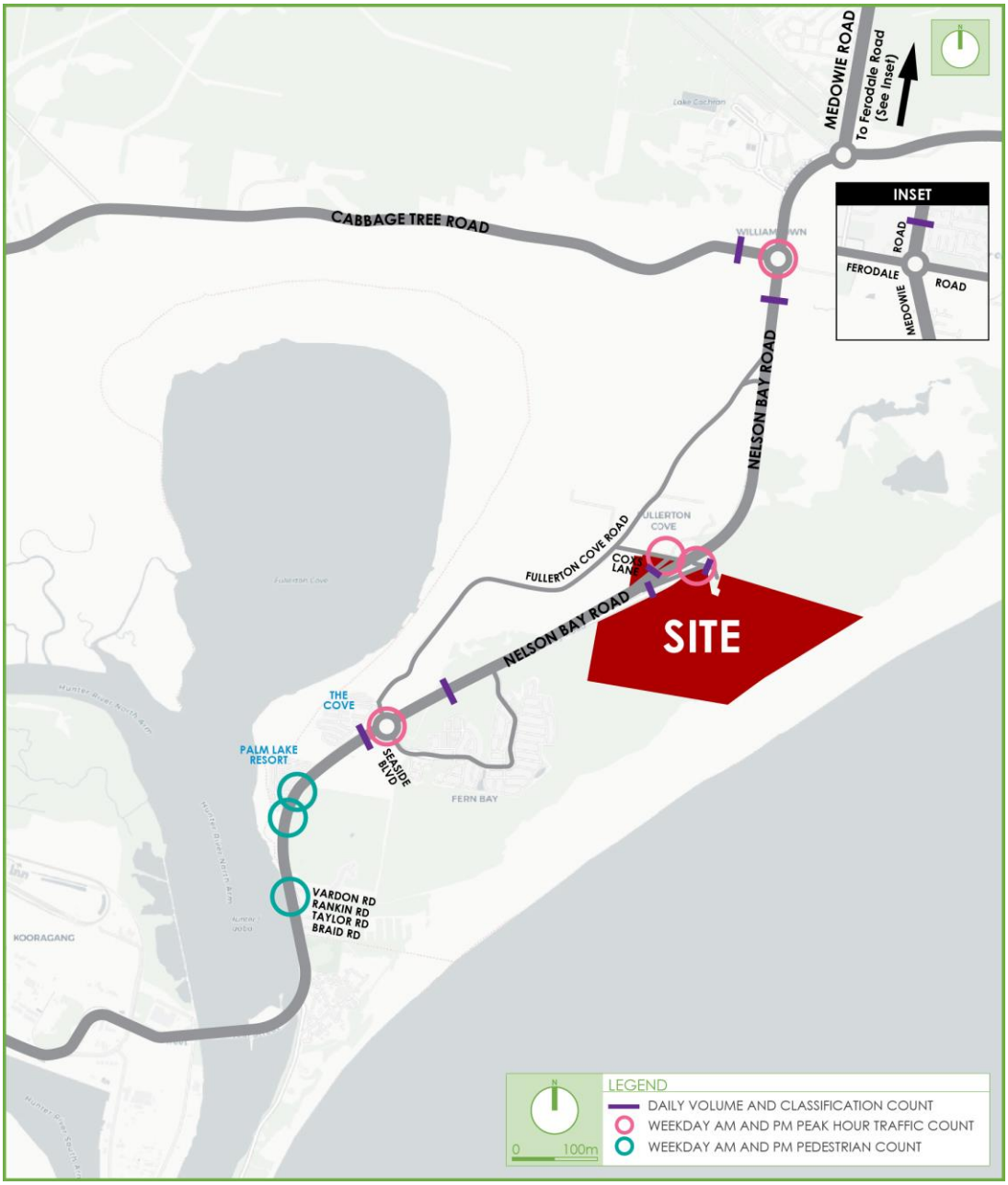


Figure 9: Survey Locations

5.5 Existing Traffic Volumes

5.5.1 Intersection Counts

The existing traffic volumes during the critical morning and evening peak periods are summarised in **Figure 10** and **Figure11** below.

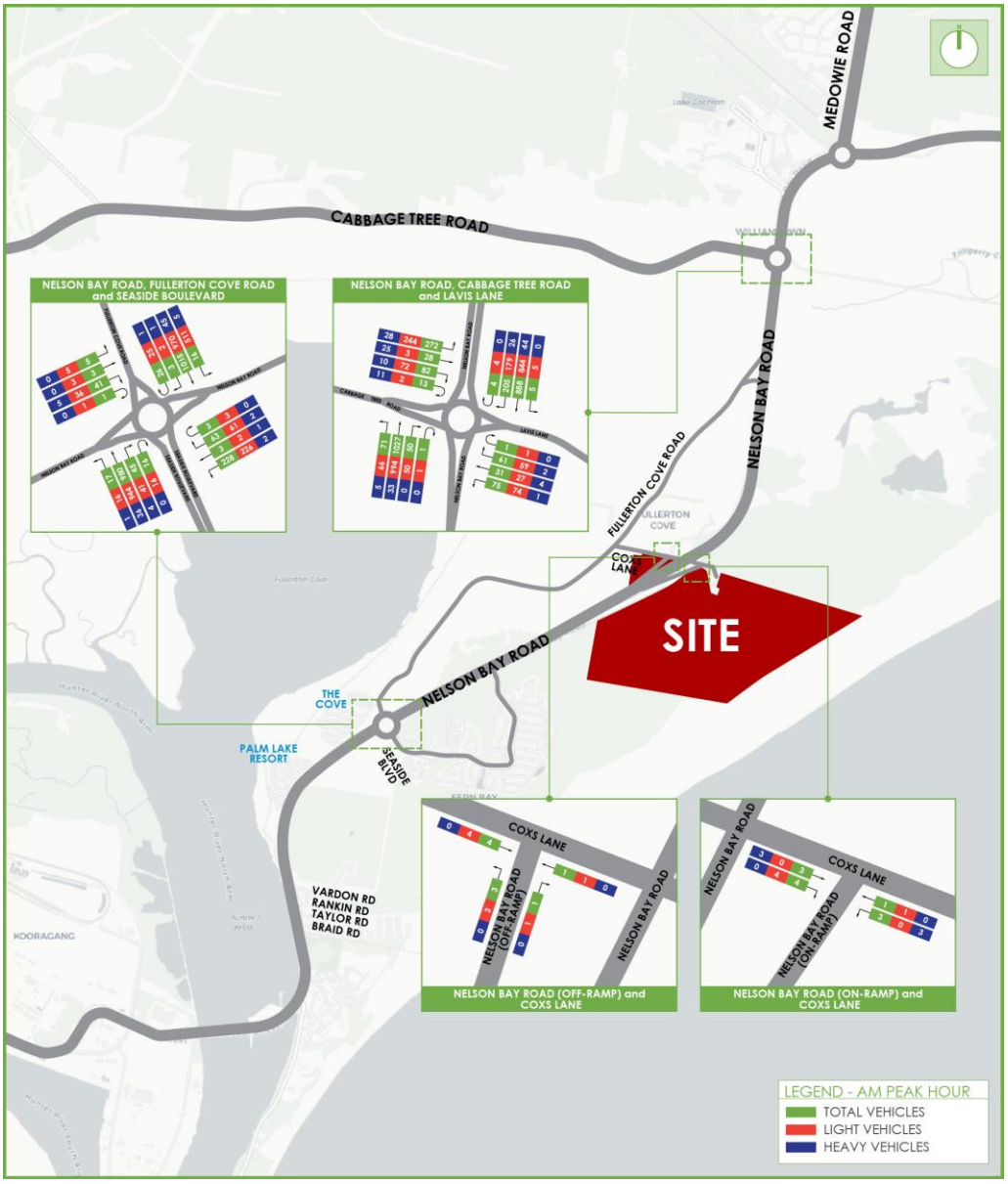


Figure 10: Existing Intersection Volumes – Morning Peak Period

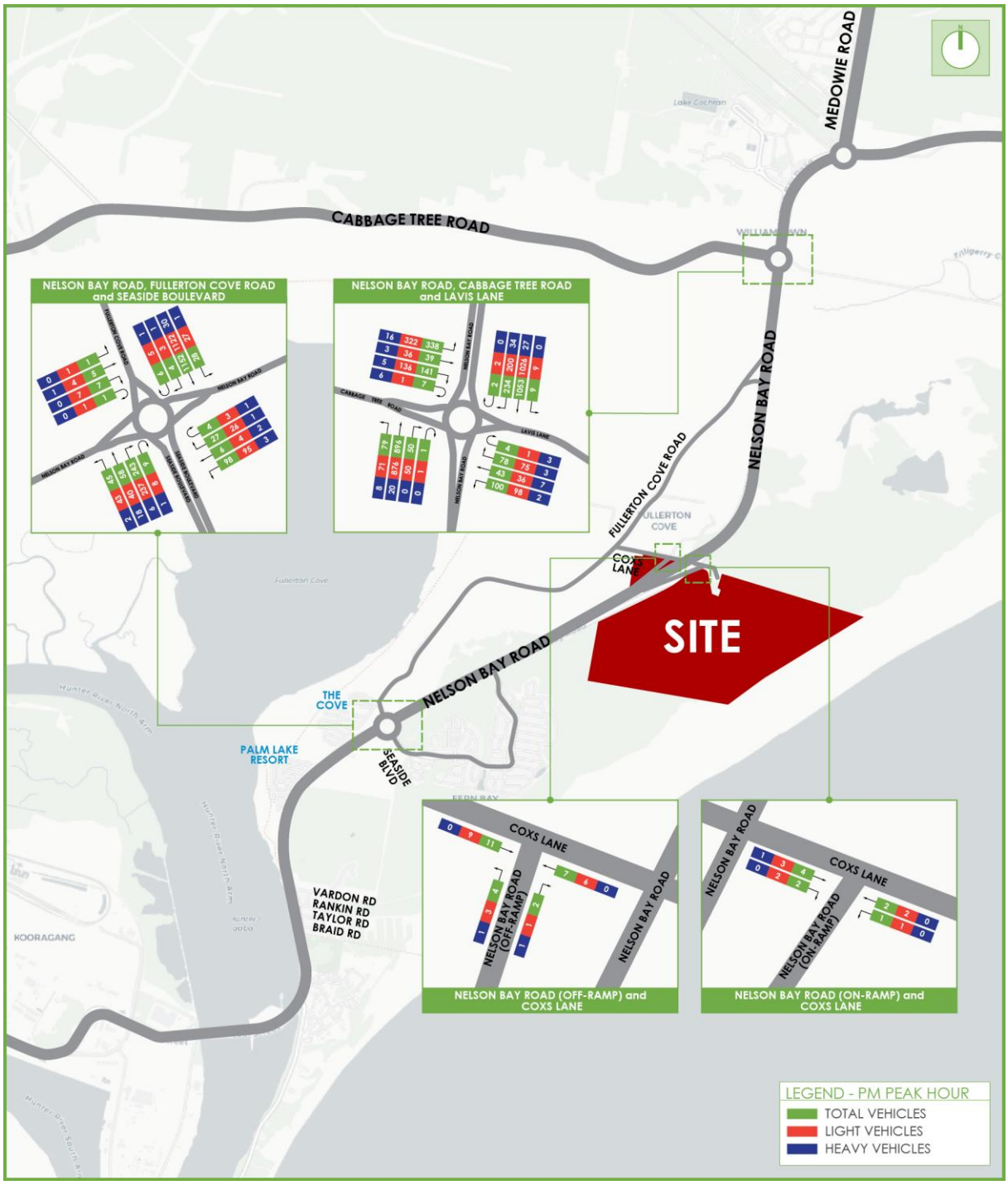


Figure 11: Existing Intersection Volumes – Evening Peak Hour

5.5.2 Daily Volume and Classification Count Data

Figure 12 below summarises key volume and classification data obtained by automatic traffic counts (ATC) in the vicinity of the site. It should be noted that the tube counter at the Nelson Bay Road off-ramp onto Coxs Lane was damaged and no data was able to be retrieved. Therefore, data for this location has been established by factoring historic 2019 data. The factors were adopted from the on-ramp onto Nelson Bay Road from Cox Road.

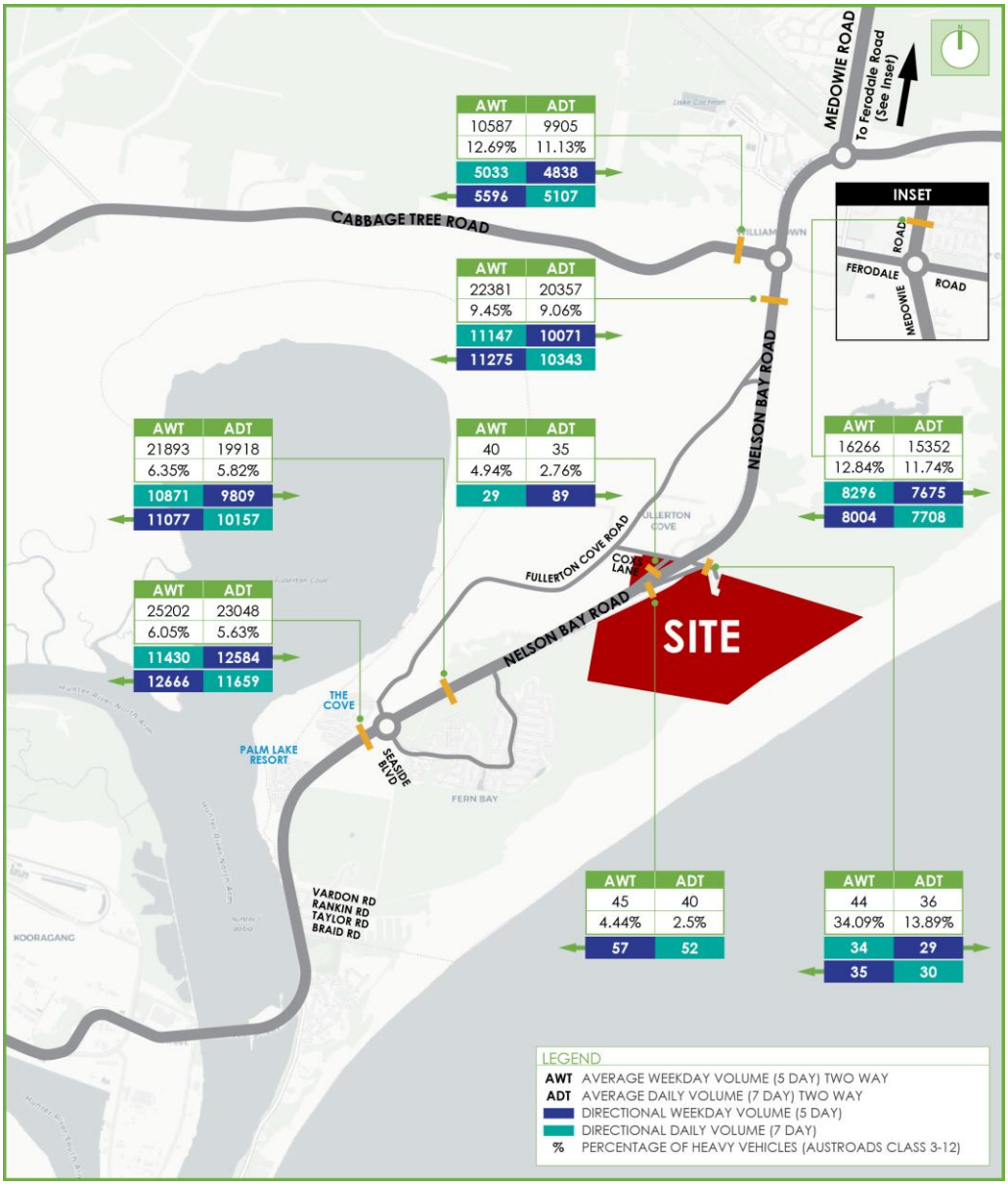


Figure 12: Daily Volume and Classification (ATC) Data

5.5.3 TfNSW Permanent Count Data

The closest TfNSW permanent count station (ID: 05962) is located on Nelson Bay Road, approximately 310 metres east of Greenleaf Road in Kooragang. The data available at this counter is only available up to 2018. The relevant data available at this counter between 2014 to 2018 is provided in **Table 1** below.

Table 1: TfNSW Permanent Count Station Data

Year	Average Annual Daily Traffic		
	Northbound	Southbound	Bi-Directional
2014	11,683	11,750	23,433
2015	11,841	12,033	23,874
2016	12,460	12,459	24,919
2017	12,676	13,137	25,813
2018	12,727	13,008	25,735

As seen from the above historical data, the traffic along Nelson Bay Road has grown at approximately 2.5% per year over the 5-year period.

6. DESCRIPTION OF EXISTING DEVELOPMENT

6.1 Approved Existing Operations

The existing development is approved under DA 140-05-2006 and comprises the following components:

- Approval for extraction of up to 500,000 tonnes per annum (tpa) of sand from the windblown sand extraction area.
- Operations commencing 2008 and ceasing in 2028.
- Four (4) full time staff and one (1) casual staff are currently employed (this does not include truck drivers or service personnel).

6.2 Existing Hours of Operation

The approved hours of operation are as follows:

- Monday to Friday: 6:15am-5:00pm
- Saturday: 6:15am-12:00pm; and
- Sunday and Public Holidays: No operations

In addition, the site is approved to extend operational hours for major supply contracts as presented below:

- Monday to Friday: 6:15am-6:00pm
- Saturday: 6:15am-3:00pm; and
- Sunday and Public Holidays: No operations

7. DESCRIPTION OF PROPOSED DEVELOPMENT

A detailed description of the proposed development is provided in the Environmental Impact Statement prepared separately. In summary, the subject State Significant Development Application seeks approval for the following:

7.1 Proposed Operations

- The Stockton Dry Sand Extraction Project involves the extraction of dry sand from inland dunes, (above the groundwater table).
- Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, consisting of sand and high organic content filter 'cakes' until either:
  - the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
  - the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

  Within the overall quantum of proposed dispatched material, a maximum of 150 tons of filter 'cakes' would be dispatched per week.
- Up to 70,000tpa of virgin excavated natural materials (VENM) is proposed to be imported by road for use in rehabilitation and stabilisation works. This is proposed to continue indefinitely past 2028.
- It is noted that Boral are seeking a development consent period of 10 years for the SSD approval.
- Construction of a new haul roads to support the proposed increase in extraction.
- Construction of new prefabricated office building.
- Two (2) additional full-time staff and two (2) casual staff are proposed (six full-time and three casual employees in total).
- Relocation of at-grade car park.

- Relocation of entry gates within the property boundary; and
- Relocation of on-site storage facilities.

It is noteworthy that the subject application does not seek to alter the approved hours of operation.

7.2 Truck Types

The anticipated truck sizes that will be utilised by Boral are as follows:

7.2.1 Product Transport Vehicles – Sand Product

Boral currently utilises 19m truck and dogs to transport sand product out of the site. No changes are proposed to these arrangements.

7.2.2 Product Transport Vehicles – Virgin Excavated Natural Material (VENM)

Trucks used to import VENM to the site are proposed to be a combination of both 19m truck and dog vehicles and 12.5m Heavy Rigid Vehicles (HRVs). Approximately 75% of the total vehicles are anticipated to be 19m truck and dogs with the remainder being HRVs.

7.3 Proposed Transport Routes

It should be noted that all vehicles entering the site from the north are required to travel south to the intersection of Nelson Bay Road, Fullerton Cove Road, and Seaside Boulevard. Trucks would use this roundabout intersection to conduct a U-turn to approach the Nelson Bay Road off-ramp onto Coxs Lane from the south. As such all trucks accessing the site will be required to travel through this roundabout intersection to access the off-ramp.

Based on the above, **Figure 13** shows the truck routes that will be utilised for development traffic.

Figure 13: Transport Routes

As seen from the above, the transport routes shown in Figure 8 are approved 25/26m B-double routes, thus no further assessment (swept path analysis) is considered necessary in this application.

The parking and traffic impacts arising from the development are discussed in **Section 8** and **Section 9**. Reference should be made to the plans submitted separately to DPE which are presented at reduced scale in **Appendix A**.

8. PARKING REQUIREMENTS

8.1 Car Parking

The Port Stephens Council Development Control Plan 2021 (DCP) does not provide a car parking rate in relation to quarry developments. As such, a first principles assessment has been undertaken to determine the car parking requirements for the proposal.

The existing quarry currently provides an informal car parking area which accommodates all staff. The proposed changes to the development will result in a total of six (6) full-time employees and three (3) casual employees being on-site at any given time. This excludes truck drivers and associated service personnel.

Assuming a 100% car driver modal split, there would be a requirement for nine (9) staff car parking spaces on site.

The development provides an informal gravel parking area at the entrance to the quarry that is able to accommodate approximately 15 cars, if required. Therefore, the development is able to accommodate all parking demands of the proposed development, including the occasional service personnel vehicle.

8.2 Bicycle Parking

The DCP does not provided a minimum requirement in terms of bicycle parking for quarry developments. Accordingly, no bicycle parking is proposed on site. This is considered appropriate for the nature of the site which is generally isolated from cycling infrastructure and the development itself resulting in a large number of heavy vehicle movements to and from the site.

8.3 Waste Collection

The development currently accommodates 19m truck and dogs circulating around the site. Therefore, all waste collection vehicles (whether private or Council) can be accommodated within the site.

9. TRAFFIC AND TRANSPORT IMPACTS

9.1 Background

Information was provided by Boral with regards to the existing and proposed vehicle movements on-site and subsequently the surrounding road network. It should be noted that deliveries and maintenance vehicles will generally occur outside of peak hours, and therefore, these occasional vehicle trips have been excluded from the following analysis.

This assessment has been conducted for weekdays only, as the quarry only operates for half a day on Saturdays and in some instances, no sand product is transported on weekends.

9.2 Dredge Application Submitted for Assessment (SSD 9490)

A State Significant Development (SSD) application (Ref: SSD 9490) has been submitted for assessment independent of this proposal. This application proposes to extract and dredge up to 9 million tonnes of sand from the inland dunes area. It is noted that whilst these applications are independent of each other. The proposed site throughputs are consistent and as such the traffic volumes are also consistent with those detailed in the following sections of the report.

9.3 Approved DA Trip Generation (DA140-6-2005)

As mentioned above, the development is currently operating under a previous consent (DA140-6-2005), which permits a level of traffic generation associated with the approved operations. In summary, the approved operations generate the following traffic.

9.3.1 Light Vehicles (Staff)

The light vehicle trips associated with employee and visitor movements are estimated to be:

Light vehicle movements per peak day

- 24 vehicle trips per day (12 in, 12 out).

Light vehicle movements within peak hour of peak day

It is assumed that all staff arrive and depart the site by car. A total of five (5) workers (four (4) full time staff and one (1) casual staff) are currently employed on-site, therefore generating the following vehicle movements:

- 5 vehicle trips per morning peak hour (5 in, 0 out); and
- 5 vehicle trips per evening peak hour (0 in, 5 out).

9.3.2 Product Transport Vehicles – Sand Product

The existing truck movements associated with transportation of sand product are summarised below:

Truck movements per peak day

- 152 vehicle trips per day (76 in, 76 out).

Truck movements within peak hour of peak day

The peak hour volumes were assumed to be approximately 10% of the peak day volumes and equate to the following:

- 16 vehicle trips per morning peak hour (8 in, 8 out); and
- 16 vehicle trips per evening peak hour (8 in, 8 out).

9.3.3 Combined Approved Trip Generation

The combined trip generation of the approved development is summarised in **Table 2** below. It is noted that the peak hour traffic volumes are the critical value when assessing the impacts on the surrounding road network:

Table 2: Combined Approved Trip Generation

Type of Vehicle	Daily Volumes (veh/day)		
	In	Out	Total
Light Vehicles	12	12	24
Heavy Vehicles	76	76	152
Total	**88**	**88**	**176**

Type of Vehicle	Peak Hour Volumes (veh/hr)					
	AM			PM		
	In	Out	Total	In	Out	Total
Light Vehicles	5	0	5	0	5	5
Heavy Vehicles	8	8	16	8	8	16
Total	**13**	**8**	**21**	**8**	**13**	**21**

9.4 Subject Development Trip Generation

9.4.1 Background

Boral has provided the proposed operational details with regards to heavy vehicle movements. The trip generation for the proposed development is summarised below for each vehicle category:

9.4.2 Light Vehicles (Staff)

The light vehicle trips associated with employee and visitor movements are estimated to be:

Light vehicle movements per peak day

- 34 vehicle trips per day (17 in, 17 out).

Light vehicle movements within peak hour of peak day

To accommodate the proposed changes, two (2) additional full-time staff and two (2) casual staff are proposed on-site at any given time (total of 6 full time and 3 casual staff). It is assumed that all staff drive to the site resulting in the following traffic generation:

- 9 vehicle trips per morning peak hour (9 in, 0 out); and
- 9 vehicle trips per evening peak hour (0 in, 9 out).

9.4.3 Product Transport Vehicles – Sand Product

The proposed changes to the development involve transporting up to 750,000tpa of sand product from the Quarry up to 2028. The existing development is approved to transport 500,000tpa of sand product. This would be a proposed net increase of 250,000tpa up until 2028.

Sand products are proposed to be transported by 19m truck and dogs with an average capacity of 34 tonnes.

Based on information provided by Boral the truck movements for sand product transport can be summarised as follows:

Truck movements per peak day

- 228 vehicle trips per day (114 in, 114 out).

Truck movements within peak hour of peak day

- 52 vehicle trips per morning peak hour (26 in, 26 out); and
- 52 vehicle trips per evening peak hour (26 in, 26 out).

9.4.4 Product Transport Vehicles – VENM

The development will be importing up to 70,000tpa of VENM which will be utilised for stabilisation works as required within the site. This is proposed to continue past 2028.

A combination of 19m long truck and dogs with an average capacity of 34 tonnes and heavy rigid vehicles (HRVs) with an average load of 12 tonnes will be used for this purpose.

Based on information provided by Boral the truck movements for VENM Transport can be summarised as follows:

Truck movements per peak day

- 56 vehicle trips per day (28 in, 28 out).

Truck movements within peak hour of peak day

- 8 vehicle trips per morning peak hour (4 in, 4 out); and
- 8 vehicle trips per evening peak hour (4 in, 4 out).

9.4.5 Combined Development Trip Generation

Therefore, the combined traffic generation of the proposed development is summarised in **Table 3** below:

Table 3: Combined Development Trip Generation

Type of Vehicle	Daily Volumes (veh/day)		
	In	Out	Total
Light Vehicles	17	17	34
Heavy Vehicles	142	142	284
Total	**159**	**159**	**318**

Type of Vehicle	Peak Hour Volumes (veh/hr)					
	AM			PM		
	In	Out	Total	In	Out	Total
Light Vehicles	9	0	9	0	9	9
Heavy Vehicles	30	30	60	30	30	60
Total	**39**	**30**	**69**	**30**	**39**	**69**

9.5 Proposed Traffic Volume Increase

The above traffic is not a net increase above the existing 2008 approval. When accounting for the existing approval the net traffic associated with the subject SSD is summarised in **Table 4** below.

Table 4: Proposed Increase over the Approved Development

Type of Vehicle	Daily Volumes (veh/day)		
	In	Out	Total
Light Vehicles	+5	+5	+10
Heavy Vehicles	+66	+66	+132
Total	**+71**	**+71**	**+142**

Type of Vehicle	Peak Hour Volumes (veh/hr)					
	AM			PM		
	In	Out	Total	In	Out	Total
Light Vehicles	+4	0	+4	0	+4	+4
Heavy Vehicles	+22	+22	+44	+22	+22	+44
Total	**+26**	**+22**	**+48**	**+22**	**+26**	**+48**

9.6 Traffic Volumes (Until 2028)

In order to provide a conservative modelling scenario, the total traffic volumes detailed in Table 3 above have been distributed onto the surrounding road network. It should be noted that this method does not discount the existing traffic volumes captured in the 2022 intersection surveys.

9.7 Traffic Volumes after 2028

After 2028, the development proposes to reduce sand production back to the existing approved level which will result in no additional sand product trucks over the approved development. The only increase in truck movements will be in relation to VENM trucks which

will result in 56 truck movements in the peak hour (28 in and 28 out). However, it is noted that post 2028, the VENM trucks will transport both sand and VENM products.

In relation to SIDRA 9 modelling of the surrounding intersections, only the critical scenarios have been modelled being the proposed increase in production up until 2028, noting that the truck movements after 2028 are less than this critical scenario.

9.8 Vehicle Trip Distribution

Assumptions have been made regarding the distribution of development traffic around the surrounding road network. These assumptions have been made based on the supply areas that Boral distributes to and their records of the demand from each area. In summary, 45% of Boral's sand product is transported to Newcastle supply areas, 50% to the Central Coast, Sydney, and Hunter Valley and 5% to Port Stephens and the North Coast. These routes are summarised in **Table 5** below.

Table 5: Traffic Distributions

Direction	Inbound Movements	Outbound Movements	Locations (To/From)
Arrives/departs south via Nelson Bay Road, Teal Street and Cormorant Road	45%	45%	Newcastle
Arrives/departs north via Nelson Bay Road and Cabbage Tree Road	50%	50%	Central Coast, Sydney and Hunter Valley
Arrives/departs north via Nelson Bay Road (north of Cabbage Tree Road)	5%	5%	Port Stephens and North Coast

It should be noted that all vehicles entering the site from the north are required to travel south to the intersection of Nelson Bay Road, Fullerton Cove Road, and Seaside Boulevard. Trucks would use this roundabout intersection to conduct a U-turn to approach the Nelson Bay Road off-ramp onto Coxs Lane from the south. As such all trucks accessing the site will be required to travel through this roundabout intersection to access the off-ramp.

Trucks importing VENM to the site are expected to follow the same transport routes with a similar split expected.

Figure 14 and **Figure 15** below shows the distributions of heavy vehicle traffic generated by the proposed development at the key intersections in the vicinity of the site in the morning and evening peak period. This distribution is based on the truck routes that are illustrated within Figure 13.

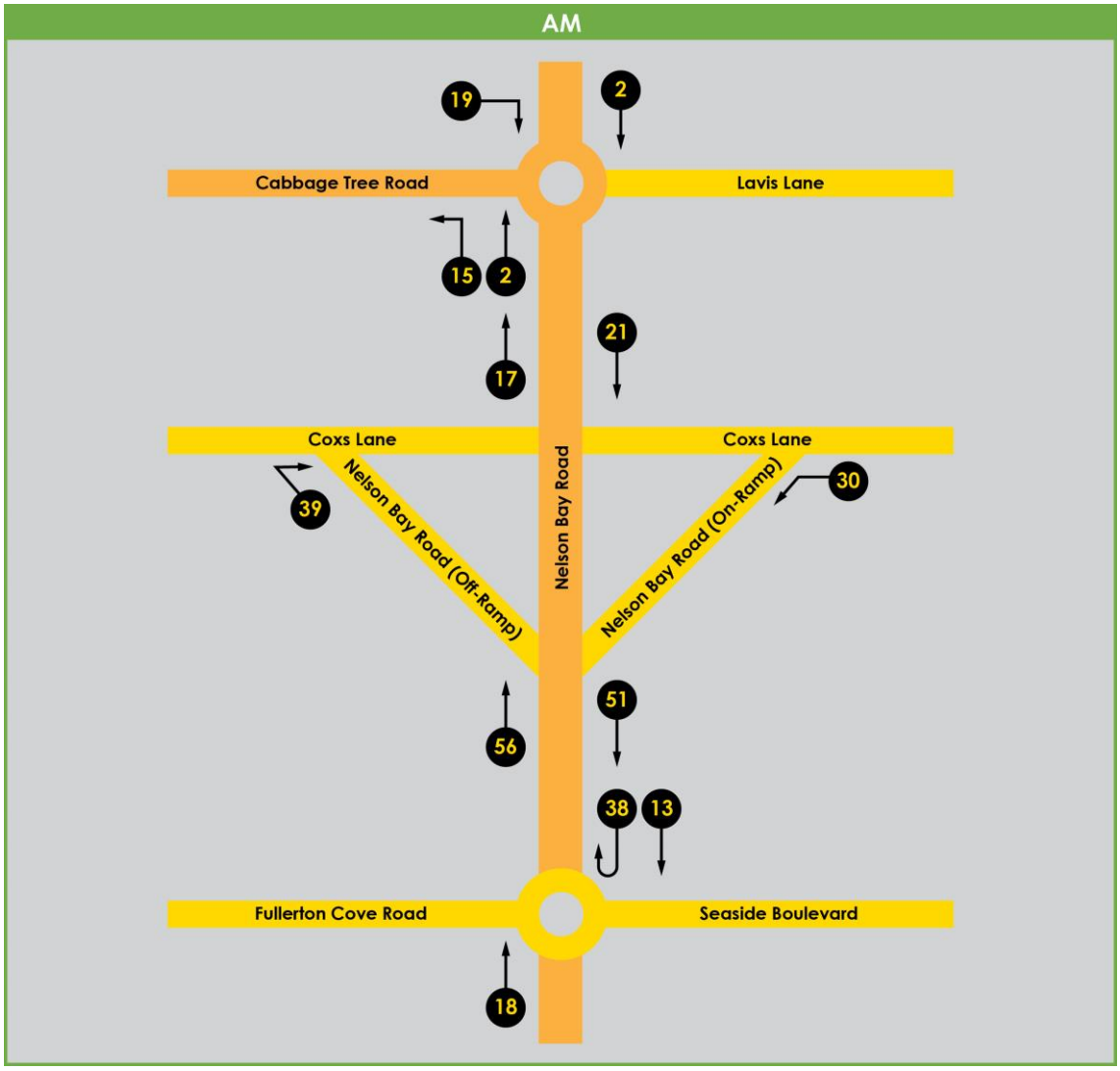


Figure 14: Development Traffic Distribution at Key Intersections – AM Peak Hour

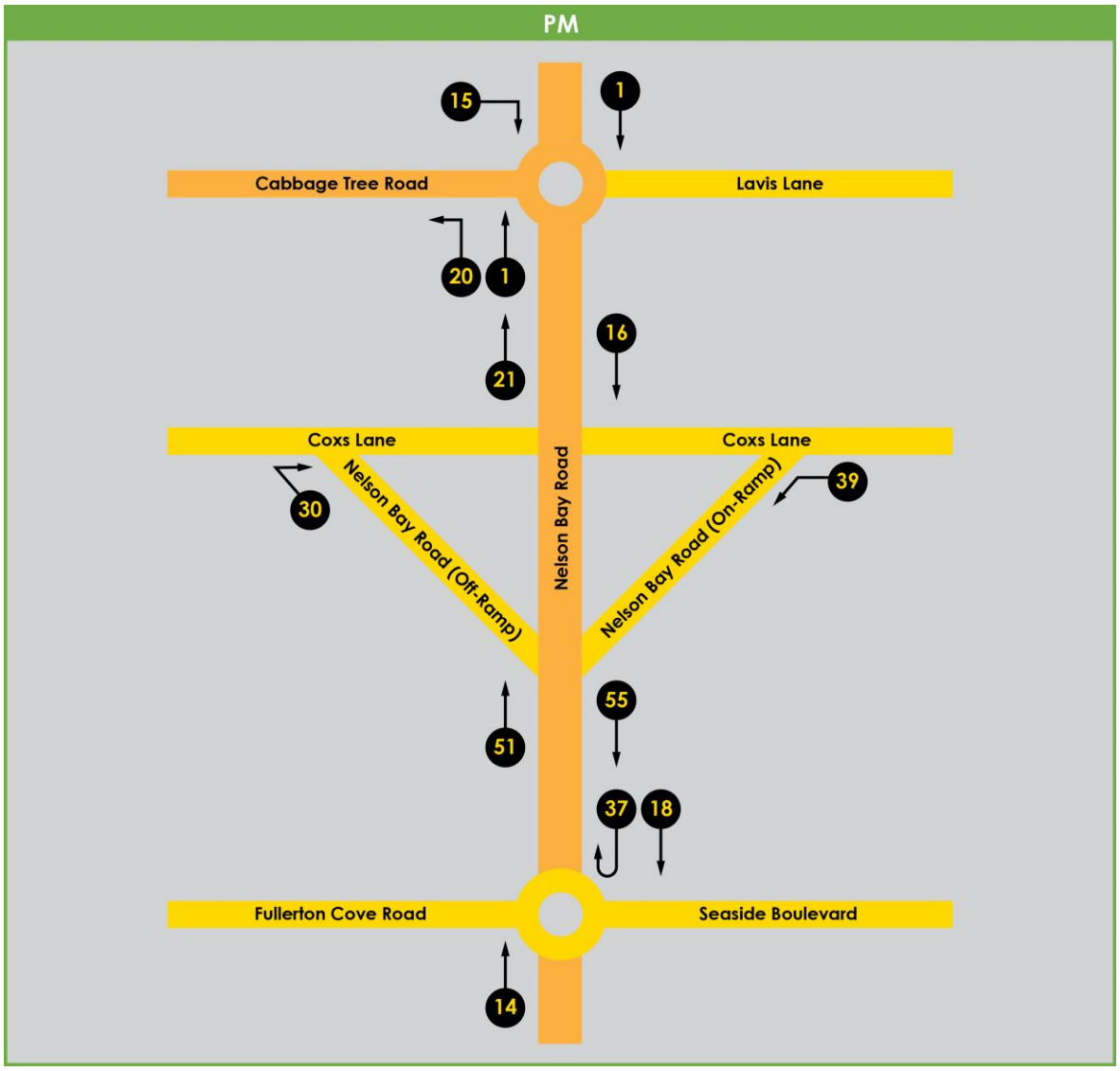


Figure 15: Development Traffic Distribution at Key Intersections – PM Peak Hour

9.9 Modelling Scenarios

In order to assess the potential traffic impacts of a proposed development, the following scenarios were identified:

- 2023 Base Case; and
- 2023 Base Case + Existing Approval + Net Increase.

9.10 Peak Period Intersection Performance

9.10.1 Background

Traffic surveys were undertaken of the key intersections described in Section 5, which are considered to be most critical in relation to the site. These counts were undertaken on 22 November 2022 during the network peak periods, being between 6:00am and 9:00am (morning peak period) and 3:00pm and 6:00pm (evening peak period).

This data forms the base case volumes for software modelling undertaken to assess intersection performance characteristics under existing traffic conditions. The SIDRA Intersection 9 model produces a range of outputs, the most useful of which are the Degree of Saturation (DoS) and Average Vehicle Delay per vehicle (AVD). The AVD is in turn related to a level of service (LoS) criteria. These performance measures can be interpreted using the following explanations:

DoS the DoS is a measure of the operational performance of individual intersections. As both queue length and delay increase rapidly as DoS approaches 1, it is usual to attempt to keep DoS to less than 0.9. When DoS exceeds 0.9 residual queues can be anticipated, as occurs at many major intersections throughout the metropolitan area during peak periods. In this regard, a practical limit at 1.1 can be assumed. For intersections controlled by roundabout or give way / stop control, satisfactory intersection operation is generally indicated by a DoS of 0.8 or less.

AVD the AVD for individual intersections provides a measure of the operational performance of an intersection. In general, levels of acceptability of AVD for individual intersections depend on the time of day (motorists generally accept higher delays during peak commuter periods) and the road system being modelled (motorists are more likely to accept longer delays on side streets than on the main road system).

LoS this is a comparative measure which provides an indication of the operating performance of an intersection as shown within **Table 6**.

Table 6: Intersection Performance Indicators (TfNSW)

Level of Service (LoS)	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way and Stop Signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays. Roundabouts require other control mode	At capacity and requires other control mode
F	More than 70	Unsatisfactory and requires additional capacity.	Unsatisfactory and requires other control mode or major treatment.

A summary of the modelled results is provided in **Table 7**, reference should also be made to the SIDRA outputs provided in **Appendix B** which provide detailed results for individual lanes and approaches.

Table 7: Intersection Performance for Existing and Development Scenarios

Intersection	Control Type	Scenario	Period	Degree of Saturation	Average Delay	Level of Service*
Nelson Bay Road, Cabbage Tree Road and Lavis Lane	Roundabout	Existing	AM	0.490	20.8	B
			PM	0.598	20.5	B
		Existing + Development	AM	0.503	21.2	B
			PM	0.613	21.0	B
Nelson Bay Road and Cox Lane (On-Ramp)	Priority	Existing	AM	0.004	6.7	A
			PM	0.004	5.5	A
		Existing + Development	AM	0.036	6.7	A
			PM	0.036	6.4	A
Nelson Bay Road and Cox Lane (Off-Ramp)	Priority	Existing	AM	0.003	5.7	A
			PM	0.007	6.4	A
		Existing + Development	AM	0.047	6.7	A
			PM	0.043	7.1	A
Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road	Roundabout	Existing	AM	0.471	17.7	B
			PM	0.595	19.4	B
		Existing + Development	AM	0.504	17.8	B
			PM	0.641	18.5	B

*LoS for a priority and roundabout intersections is based on the worst performing movement.

9.10.2 Existing + Development Performance

It can be seen from Table 7 that all intersections operate satisfactorily (with LoS A or B) under both the 'Existing' and 'Existing plus Development' scenarios. The latter being the scenario that reflects the criteria for assessing impacts under current TfNSW Guidelines. That is, the EP&A Act as well as the TfNSW Guidelines require that a development need only be assessed for improvements that are required to support the development itself. This is a consequence of the need to identify a nexus between development and any measures required to manage its associated impacts. As can be seen in Table 7, these scenarios are both satisfactory in terms

of the network performance and projected impacts, such that the concept development is supportable on traffic grounds.

Specifically, the intersection of Nelson Bay Road, Cabbage Tree Road, and Lavis Lane experiences minimal change to the intersection delay between the 'Existing' and the 'Existing plus Development' scenario for both the morning and evening network peaks, maintaining a LoS 'B' and operating with spare capacity in all scenarios.

The on-ramp onto Nelson Bay Road from Coxs Lane maintains a LoS 'A' in all scenarios and experiences an incremental increase in average delay of 0.9 seconds between the 'Existing' and the 'Existing plus Development' scenario in the evening peak hour scenarios. Similarly, the off-ramp from Nelson Bay Road onto Coxs Lane operates at a LoS 'A' in all scenarios. Both intersections operate with spare capacity in all scenarios.

For the Nelson Bay off-ramp, the largest change in average delay occurs in the morning peak hour with a minor increase of 1.0 second. Lastly, the intersection of Nelson Bay Road, Seaside Boulevard, and Fullerton Cove Road maintains a LoS 'B' in all scenarios. The largest change in average delay occurs in the morning peak hour period with a minor increase of 0.1 second. In the evening the average delay is reduced, however, this is due to an increase in overall vehicle movements which results in a lower average value. It is noted that this intersection also continues to operate with spare capacity in all scenarios.

In summary, the 'Existing plus Development' scenario will operate satisfactorily with no road network improvements required. Therefore, no strategic designs have been prepared for intersection upgrades as requested by TfNSW.

This outcome deals with the development impacts as per standard practice based on TfNSW Guidelines. However, to address the SEAR information requests from TfNSW and in the spirit of providing an input to Council and TfNSW in relation to their ongoing strategic planning responsibilities, further modelling has been undertaken as discussed in the following sections.

9.11 Sensitivity Testing – 10 Year Growth

The 10-year growth scenario reflects traffic conditions arising from 10 years of 'background' traffic growth at a rate of 2.5% per annum. This growth rate was determined by examining

historic traffic data from the permanent counter located along Nelson Bay Road as outlined in Section 5. The results of this sensitivity testing for both existing and development scenarios are provided within **Table 8** below.

Table 8: Sensitivity Tests for Existing and Development Scenarios

Intersection	Control Type	Scenario	Period	Degree of Saturation	Average Delay	Level of Service*
Nelson Bay Road, Cabbage Tree Road and Lavis Lane	Roundabout	10 Year Existing	AM	0.640	24.2	B
			PM	0.887	75.7	F
		10 Year Existing + Development	AM	0.656	25.4	B
			PM	0.945	121.7	F
Nelson Bay Road and Cox Lane (On-Ramp)	Priority	10 Year Existing	AM	0.006	6.7	A
			PM	0.005	5.5	A
		10 Year Existing + Development	AM	0.037	6.7	A
			PM	0.036	6.4	A
Nelson Bay Road and Cox Lane (Off-Ramp)	Priority	10 Year Existing	AM	0.003	5.7	A
			PM	0.008	6.4	A
		10 Year Existing + Development	AM	0.048	6.7	A
			PM	0.044	7.1	A
Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road	Roundabout	10 Year Existing	AM	0.603	58.4	E
			PM	0.786	43.1	D
		10 Year Existing + Development	AM	0.637	85.0	F
			PM	0.839	75.1	F

*LoS for a priority and roundabout intersections is based on the worst performing movement.

9.11.1 Performance of 10 Year Growth on Existing Scenario

The '10 Year Existing' scenario reflects traffic conditions in 2032 which will arise based on expected growth on the network generally. This scenario will include all developments in the locality that occur over the next 10 years, assuming a continued annual growth rate of 2.5% per annum. It also included growth in 'external' traffic on the main road network, relating to

the wider region. That is, the 2032 scenario includes development wherever it occurs, including the subject site. There is no doubt other development proposals will emerge over the next 10 years and it is reasonable to assume that TfNSW's strategic planning has adopted a land use scenario that takes some account of these factors.

Hence, it may be argued that the '10 Year Existing' is not a base case as such, but a strategic scenario for more general consideration and adoption by TfNSW. There is also a case to be made that it would include the impacts of the subject site, though this would no doubt depend upon the strategic land use inputs adopted in any future strategic plan.

The intersection of Nelson Bay Road, Cabbage Tree Road, and Lavis Lane maintains a LoS 'B' in the morning scenario with minimal changes to average delay and operating with spare capacity. However, in the evening peak hour it is evident that the intersection operates at a LoS 'F' and will operate at this LoS regardless on whether the subject development is approved or not.

The intersection of the on-ramp onto Nelson Bay Road from Coxs Lane and the intersection of the off-ramp onto Nelson Bay Road from Coxs Lane both operate at a LoS 'A' with spare capacity for both the morning and evening peak periods.

In relation to the intersection of Nelson Bay Road, Seaside Boulevard, and Fullerton Cove Road, the intersection operates at a LoS 'E' in the morning peak hour period and a LoS 'D' in the evening peak hour period. This indicates that the intersection will be at capacity in 2032 and TfNSW may need to explore a higher order of intersection control.

It is emphasised that the above is in relation to the growth rate applied to background (existing) traffic only. This outcome reflects conditions arising from 10 years of 'background' traffic growth at a rate of 2.5% per annum, which is a cumulative increase of 25% on all movements at all intersections. These are increases that are likely to occur irrespective of the proposed development and the need for improvements is the responsibility of TfNSW in addressing their respective strategic planning responsibilities.

9.11.2 Sensitivity Testing – Performance of 10 Year Growth Existing Plus Development Scenario

As discussed above, the development impacts are expected to be included in the '10 Year Existing' outlined above, which accommodates a substantial (25% increase in network traffic volumes that are orders of magnitude above the subject development site generation. That is, this scenario as requested by TfNSW incorporates an element of 'double dipping' of the development impacts.

Nevertheless, this scenario has been constructed to facilitate TfNSW' s request. The results are also shown in **Table 8**. Intersections which are already operating with higher average delays under the '10 Year Existing' scenario will continue to deteriorate under the '10 Year Existing plus Development' scenario. However, it should be noted that the percentage of development traffic proposed through each critical intersection compared to the total throughput of background traffic is minimal as demonstrated below.

Intersection of Nelson Bay Road, Cabbage Tree Road, and Lavis Lane

- 0.9% of the 4,026 veh/hr travelling through the intersection is attributed to traffic from the proposed development in the evening peak hour.

Intersection of Nelson Bay Road, Seaside Boulevard, and Fullerton Cove Road

- 2.1% of the 3,243 veh/hr travelling through the intersection is attributed to traffic from the proposed development in the morning peak hour.
- 2.0% of the 3,439 veh/hr travelling through the intersection is attributed to traffic from the proposed development in the evening peak hour.

As seen from the above, for the critical scenarios, the development traffic makes up a minor proportion of the overall throughput at each intersection in the '10 Year plus Development' scenario. That is, infrastructure requirements under this scenario are fundamentally determined by strategic network volume increases over 10 years, not by the subject development.

9.11.3 Summary on Network Performance

In summary, the surrounding road network will experience small increases to the average delay during morning and evening peak periods, however, will still provide spare capacity. Therefore,

no external intersections improvements are considered necessary to accommodate the proposed development scheme.

9.12 Cumulative Traffic Impacts

Consideration has been given to other significant developments including quarries located in the area and the traffic currently generated from these developments.

9.12.1 Macka's Sand Quarry

This existing quarry is located at Lot 218 Nelson Bay Road, Salt Ash. It is located north of the intersection of Cabbage Tree Road and Nelson Bay Road, one of the key intersections in the proximity of the subject site.

The most recent approved modification to the DA consent, was determined on 15 March 2016, and was with regards to increasing truck movements. The approval for quarrying operations was granted on site until 31 December 2029. Therefore, it is evident that the traffic volumes from this nearby quarry would be captured within the traffic surveys conducted at the end of 2022.

9.12.2 Cabbage Tree Road Sand Quarry

This is a recently constructed quarry located at 398 Cabbage Tree Road, Williamstown. The most recent modification to the DA consent was determined on 12 March 2021. This quarry is located west of the intersection of Cabbage Tree Road and Nelson Bay Road which was a key intersection that was surveyed for this development application.

The original consent for the site allows for extraction of sand products over a period of up to 15 years. Construction of the site commenced on 14 August 2019 and sand extraction commenced in May 2020. Therefore, the truck volumes generated from this nearby quarry development would be captured in the traffic surveys conducted at the end of 2022.

9.12.3 Salt Ash Quarry

The Salt Ash Quarry is located at 8 Oakvale Drive, Salt Ash and is located north of the intersection of Cabbage Tree Road and Nelson Bay Road.

The development has been operational for a number of years with the most recent modification to the DA consent involving changes to approved trucking hours. This modification was approved on 7 September 2022. The traffic surveys of the key intersections in the vicinity of the subject site were conducted on 22 November 2022. As such, the changes to trucking operations would have been captured within the traffic surveys.

In addition, it should be noted that a newer application (SSD – 9099356) has been made which proposes to extract and process up to 550,000 tonnes per annum (tpa) of sand at the Salt Ash site. This would include both dry extraction and dredging techniques and would include importing up to 200,000 tpa of sand from their Tanilba Bay, Anna Bay and other local operations. This application has not yet been approved; however it is noted that the traffic impact assessment for the proposal shows that truck movements would also travel through the intersection of Cabbage Tree Road and Nelson Bay Road. The traffic volumes for the peak hour are moderate and are expected to be readily accommodated by the intersection which currently operates with spare capacity, should this development be approved.

9.12.4 Fern Bay Seaside Village

Fern Bay Seaside Village is a residential subdivision located off Seaside Boulevard to the south of the subject site. As part of the consent for this development, a northern access intersection was required to be constructed off Nelson Bay Road. This intersection is fully constructed and is restricted to a left-in and left-out treatment.

The development is fully constructed and as such the traffic surveys conducted of the intersection of Nelson Bay Road, Seaside Boulevard and Fullerton Cove Road in particular, will capture the traffic volumes generated by this site in the peak periods.

9.13 Pedestrian, Cyclist and Public Transport Impacts

It is emphasised that no changes are proposed to the existing approved truck routes for the quarry. The increase in the volume of trucks is not expected to adversely impact other road users such as buses as discussed within Section 9.10.

Currently, Nelson Bay Road provides sealed road shoulders suitable for cyclists except the narrow bridge above Cox Lane. It is expected that as the area develops, any future upgrades to Nelson Bay Road would include suitable measures to accommodate cyclists.

There is no pedestrian path along Nelson Bay Road in the vicinity of the site or the on-ramps onto Nelson Bay Road. This reflects the low pedestrian numbers of the area and as such, pedestrians are not expected to be impacted by the continued use of the approved truck route to the quarry.

It is noted that between the Nelson Bay off-ramp and the subject site, no separated cycle path or pedestrian path is provided. However, this section of roadway only leads to the quarry development and is already subject to heavy vehicle movements from the development.

As such, the proposal is not expected to have any negative impacts on pedestrians, cyclists and bus routes travelling within the vicinity of the site.

9.14 Noise, Dust and Glare

Reference should be made to the acoustic report which details the noise impacts arising from the subject proposal, including truck noise along the transport route. Drivers will be required to comply with Boral's internal guidelines with regards to vehicle noise/driver behaviour etc.

With regards to dust, Boral will ensure all dust mitigations measures are implemented in accordance with Boral's internal guidelines and the appropriate NSW Environment Protection Authority regulations. Vehicle headlight glare impacts on residents will be minimal, noting the short distance between the site and the major road connection and the daylight operating hours.

9.15 Community Consultation

Reference should be made to any additional information provided by the applicant with regards to community consultation measures currently undertaken and proposed.

9.16 Operational Traffic Management Plan

A Vehicle and Pedestrian Management Plan for the quarry has been prepared by Boral (Ref: Vehicle and Pedestrian Management Plan – Stockton Quarry, version 1.01, dated August 2021). This document will be submitted separately and contains details of the following:

- The traffic and pedestrian management procedures within the site.
- Specifications for internal road construction within the quarry.
- Hazards within the site.
- Barriers and signs within the site.
- Parking area information and specifications
- Maintenance procedures.
- Roles and responsibilities.
- The monitoring and review strategy.

10. ROAD SAFETY ANALYSIS

10.1 TfNSW Crash Data

Crash data was obtained for the length of Nelson Bay Road between Cabbage Tree Road and Fullerton Street, including at the intersections within this section of roadway. This data was obtained from TfNSW for the most recent 5-year reporting period being between 2017 to 2021. The locations of these crashes are illustrated in **Figure 16** and detailed within **Table 9** below.

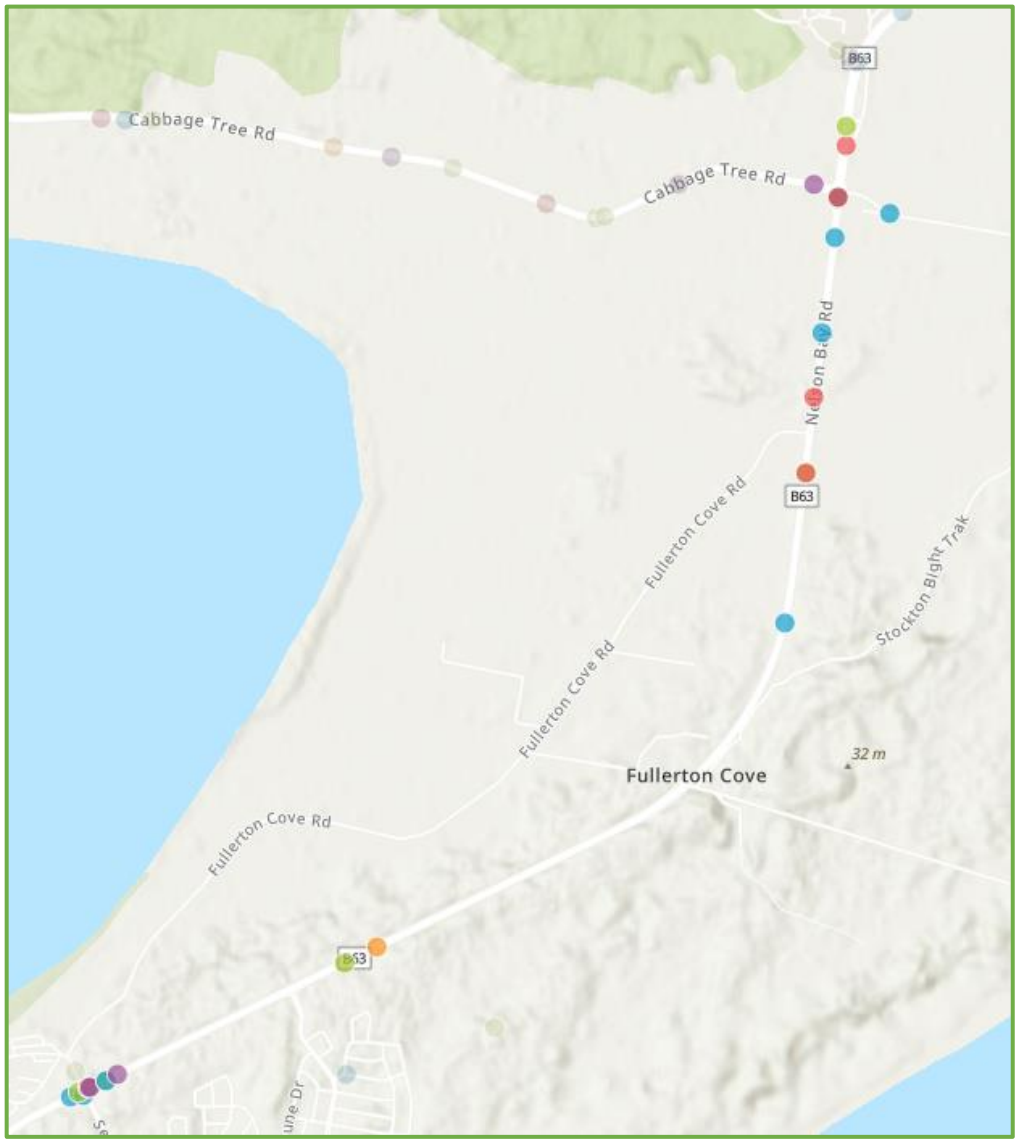


Figure 16: Crash Data along Nelson Bay Road

Table 9: TfNSW Crash Data Details for Nelson Bay Road

Reporting Year	Crash Id	Degree of Crash	RUM Code	RUM - Description	Type of Location	Natural Lighting	No. Killed	No. Injured
2017	1128128	Non-casualty (towaway)	70	Off road to left	Roundabout	Daylight		
2017	1135937	Non-casualty (towaway)	71	Off rd left => obj	2-way undivided	Darkness		
2017	1145002	Serious Injury	12	Left far	Roundabout	Darkness		1
2017	1145727	Minor/Other Injury	30	Rear end	2-way undivided	Daylight		1
2018	1159636	Fatal	5	Ped walk against	2-way undivided	Darkness	1	1
2018	1160601	Non-casualty (towaway)	39	Other same direction	Roundabout	Daylight		
2018	1161768	Non-casualty (towaway)	30	Rear end	Roundabout	Daylight		
2018	1162333	Moderate Injury	21	Right through	Roundabout	Darkness		2
2018	1173973	Non-casualty (towaway)	30	Rear end	Roundabout	Darkness		
2018	1179772	Moderate Injury	67	Struck animal	2-way undivided	Darkness		2
2018	1180940	Moderate Injury	30	Rear end	2-way undivided	Daylight		1
2018	1181150	Moderate Injury	83	Off rt/rt bend=>obj	2-way undivided	Daylight		1
2018	1191812	Moderate Injury	73	Off road right => obj	Roundabout	Daylight		1
2018	1192438	Serious Injury	40	U turn	2-way undivided	Daylight		3
2019	1206809	Moderate Injury	42	Leaving parking	2-way undivided	Darkness		1
2019	1212371	Serious Injury	73	Off road right => obj	2-way undivided	Daylight		1
2020	1226237	Serious Injury	30	Rear end	Divided road	Daylight		2
2020	1232150	Moderate Injury	81	Off left/rt bend =>obj	2-way undivided	Daylight		1
2020	1236933	Moderate Injury	72	Off road to right	Roundabout	Daylight		1
2020	1239001	Serious Injury	73	Off road right = > obj	2-way undivided	Daylight		1
2020	1240327	Moderate Injury	20	Head on	2-way undivided	Darkness		1
2020	1242283	Serious Injury	42	Leaving parking	2-way undivided	Daylight		1
2020	1249071	Non-casualty (towaway)	73	Off road right => obj	Roundabout	Daylight		
2020	1253237	Minor/Other Injury	35	Lane change left	Roundabout	Daylight		2
2021	1264969	Non-casualty (towaway)	30	Rear end	Divided road	Daylight		
2021	1267587	Minor/Other Injury	3	Ped on carriageway	2-way undivided	Dusk		1
2021	1273909	Non-casualty (towaway)	67	Struck animal	2-way undivided	Darkness		

10.2 Crash Statistics Analysis

From the crash statistics presented in the table above, it can be seen that there were a total of 27 crashes in this section of roadway between 2017 and 2021. Out of these 27 crashes, eight (8) crashes were non casualty crashes, 18 of the crashed resulted in injuries and a single crash was fatal.

Nine (9) crashes resulting in injuries occurred at or in proximity to the intersection of Nelson Bay Road and Fullerton Cove Road. These crashes included a rear end crash, a head on crash, coming off the carriageway to the right, coming off the carriageway into a parked car and a left far crash amongst others.

In addition, five (5) crashes resulting in injuries occurred at the intersection of Nelson Bay Road and Cabbage Tree Road. These also varied in nature, such as leaving parking, off carriageway left on a right bend and into an object, right through etc.

The accident with a fatality occurred at night along Nelson Bay Road and involved a pedestrian walking against the traffic on the road. In general, only one other accident involved a pedestrian, and this involved a person walking along the carriageway.

As seen from the above there are a multitude of crash types and locations. No discernible pattern is recognised amongst these crashes, and therefore, no intersection treatment or remedial measures are put forward in this instance.

10.3 Road Safety Audit

An independent Stage 5 Road Safety Audit (RSA) has been conducted along Nelson Bay Road between Cabbage Tree Road and Fullerton Street. This audit concerns the existing road and traffic management for this section of road. The purpose of this audit is to identify any potential safety concerns or hazards with regards to road users.

Reference should be made to the independent Road Safety Audit which can be provided separately should DPE request.

11. AUSTROADS ASSESSMENT

11.1 TfNSW Request

As requested by TfNSW in their agency advice, an assessment of turn warrant treatments in accordance with Austroads is required for intersections along the identified transport route/s. The Austroads turn warrant assessment relates to priority-controlled intersections, specifically, the major road turn treatments for the basic, auxiliary lane and channelised layouts.

Noting the transport routes presented in **Figure 13**, the existing intersection arrangements, and the existing movement restrictions at key priority-controlled intersections, the intersection of Cox Lane and the Nelson Bay Road on-ramp is the only public intersection where the turn warrant assessment is relevant.

The Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings Management, Section 3.3.6 provides the warrants for basic (BA), auxiliary lane (AU) and channelised (CH) turn treatments. More specifically, Figure 3.25 provides the warrants for turn treatments on major roads at unsignalised intersections with a design speed less than or equal to 70km/h, as presented in **Figure 17** below. Figure 3.26 of the Guide also provides the major road volume calculations, and this is presented in **Figure 18**.

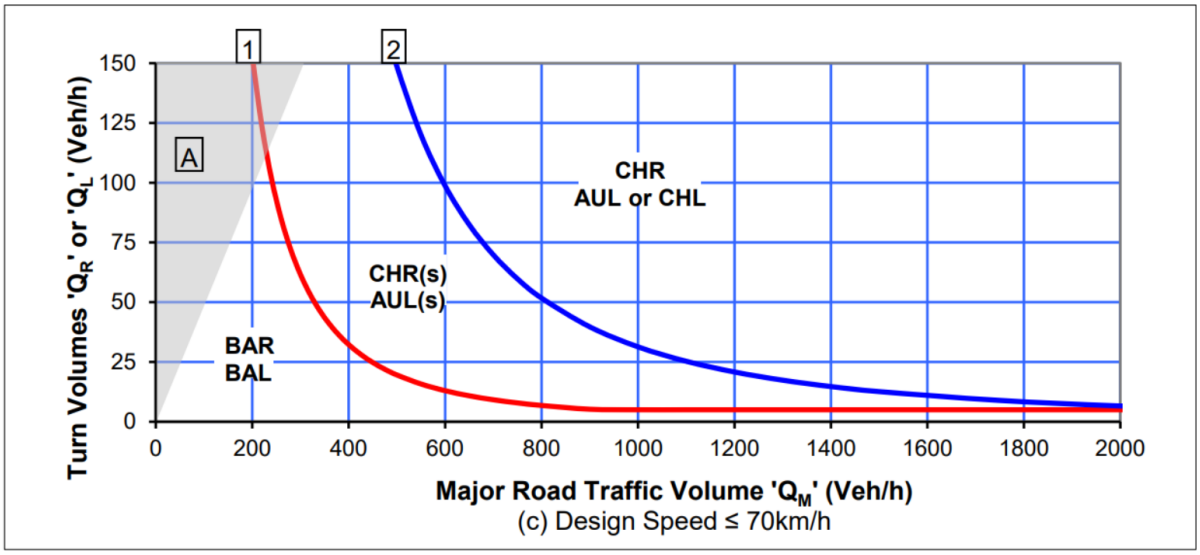
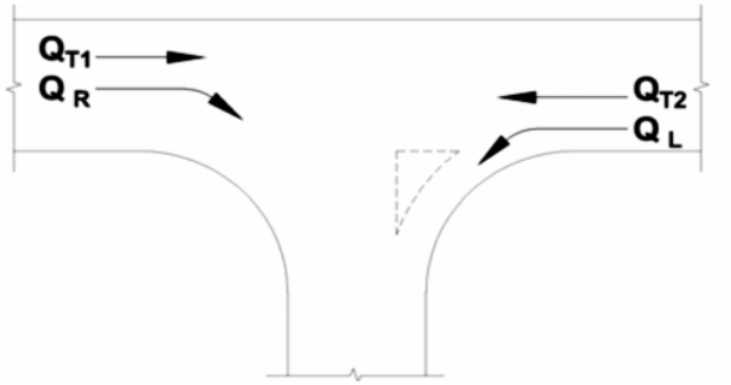


Figure 17: Warrants for Turn Treatments on the Major Road

Source: AGTM06 Figure 3.25



Road type	Turn type	Splitter island	Q_M (veh/h)
Two-lane two-way	Right	No	= Q_{T1} + Q_{T2} + Q_L
		Yes	= Q_{T1} + Q_{T2}
	Left	Yes or no	= Q_{T2}
Four-lane two-way	Right	No	= 50% x Q_{T1} + Q_{T2} + Q_L
		Yes	= 50% x Q_{T1} + Q_{T2}
	Left	Yes or no	= 50% x Q_{T2}
Six-lane two-way	Right	No	= 33% x Q_{T1} + Q_{T2} + Q_L
		Yes	= 33% x Q_{T1} + Q_{T2}
	Left	Yes or no	= 33% x Q_{T2}

Figure 18: Calculation of the Major Road Volumes

Source: AGTM06 Figure 3.26

11.2 Cox Lane/On-Ramp Assessment

11.2.1 Left-turn Treatment Assessment

It can be seen from **Figure 18** that the type of turn treatment required is based on the major road traffic volume (Q_M) and turn volume (Q_L). Accordingly, the predicted traffic generation of the development estimates that a total of 39 vehicles per hour turning left in the PM peak (marginally higher than AM).

- 39 southbound vehicles (Q_L).

The existing PM traffic volume parameters (Q_{T2} and Q_L) based on survey information was as follows:

- 2 westbound vehicles (Q_{T2}); and

- 1 southbound vehicle (Q_L).

Application of the above traffic volumes to AGTM06 Figure 3.25, results in the following left turn treatment:

- Basic Left-turn Treatment (Q_L = 40 veh/h and Q_M = 2 veh/h).

11.2.2 Left-turn Treatment Discussion

It is clear from the left-turn assessment above that the existing and proposed traffic volumes are minimal. Whilst the assessment shows the minimal intersection treatment (BAL) is required, this requirement is triggered if Q_M or Q_L is greater than 1. The left turn movement from Cox Lane into the on-ramp has no opposing movements, the majority of vehicles undertaking the turn will be drivers familiar with the intersection and transport routes and there have been no recorded crashes at the intersection within the last 5 years. Austroads Guides permits professional judgment to be applied, and no further road/intersection improvements are considered necessary for the left-turn treatment at this intersection.

11.2.3 Right-turn Treatment Assessment

It can be seen from **Figure 18** that the type of turn treatment required is based on the major road traffic volume (Q_M) and turn volumes (Q_R, Q_{T1} and Q_L). Accordingly, the predicted traffic generation of the development estimates the following in the PM peak (marginally higher than AM).

- 30 eastbound vehicles (Q_{T1});
- 0 southbound vehicles (Q_{T2}); and
- 39 southbound vehicles (Q_L).

The existing PM traffic volume parameters (Q_R, Q_{T1} and Q_L) based on survey information was as follows:

- 4 eastbound vehicles (Q_{T1});
- 2 southbound vehicles (Q_{T2}); and
- 1 southbound vehicle (Q_L).

Application of the above traffic volumes to AGTM06 Figure 3.25, results in the following left turn treatment:

- Basic Right-turn Treatment (Q_R = 2 veh/h and Q_M = 76 veh/h).

11.2.4 Right-turn Treatment Discussion

It is clear from the right-turn assessment above that the existing and proposed traffic volumes are minimal. Again, the assessment shows the minimal intersection treatment (BAR) is required, and this requirement is triggered if Q_M or Q_R is greater than 1. The right turn movement from Cox Lane into the on-ramp has minimal traffic volumes (1 vehicle every 30 minutes) and the SIDRA Intersection Modelling demonstrates negligible queuing for right turn movements. As such, no further road/intersection improvements are considered necessary for the right-turn treatment at this intersection.

12. ACCESS AND INTERNAL DESIGN ASPECTS

12.1 Site Vehicular Access

No changes are proposed to the existing approved access which is located off Coxs Lane. This is approved for use by up to 19m truck and dogs and this is considered appropriate for the proposed changes under the subject proposal.

12.2 Internal Design

The existing development provides car parking in the form of an informal gravel area at the entrance to the quarry. This area is able to accommodate approximately 15 car parking spaces, if required. This parking area is located adjacent to the access and no changes are proposed to this arrangement. Therefore, this is considered appropriate to be maintained for the proposed development.

In relation to internal roadways, the alignment of the paths used by trucks internally will be determined by the quarry operations and would be fluid in nature. As such, these are not applicable to be assessed under the AS 2890 series. This is consistent with the current arrangements on site and is therefore considered appropriate.

13. CONCLUSIONS

The following is noteworthy:

- The proposal seeks approval in relation to the proposed dry sand excavation project at Boral Stockton Quarry. The proposal seeks an increase in extraction to 750,000tpa up until 2028. After 2028, it is proposed that the site wide limit for extraction reduce to no more than 500,000tpa. No changes are proposed to the site's existing operational hours. It should be noted that the parallel application (Ref: SSD 9490) which involves dredging proposes the same overall throughput. As such overall traffic volumes are consistent between the two applications.
- The proposed development provides an informal gravel carpark at the entrance to the quarry that is able to accommodate approximately 15 car parking spaces. No changes are proposed to this area, and it is considered suitable to accommodate all site demands as detailed above.
- Traffic generation arising from the proposal has been assessed using various scenarios as discussed in Section 9. In terms of the overall network performance arising from the proposed development, all intersections operate satisfactorily (with LoS A or B) under both the 'Existing' and 'Existing Plus Development' scenarios. This assessment of existing and existing plus development scenarios reflects the criteria for assessing impacts under current TfNSW Guidelines. That is, the EP&A Act as well as the TfNSW Guidelines require that a development need only be assessed for improvements that are required to support the development itself.
- In addition, sensitivity testing was conducted to provide an indication of the traffic flows near the site in 10 years' time. This sensitivity testing showed that the intersection of Nelson Bay Road, Cabbage Tree Road, and Lavis Lane and the intersection of Nelson Bay Road, Seaside Boulevard, and Fullerton Cove Road experienced high average delays in the 10 Year Existing scenario. When modelling the 'Existing plus Development' Scenario for 10 Year growth, the critical intersections already at capacity continued to deteriorate. When examining the throughputs at each critical intersection, the development traffic constitutes less than 2% of the total throughput. Thus, the infrastructure requirements under this

scenario are fundamentally determined by strategic network volume increases over 10 years, not by the subject development.

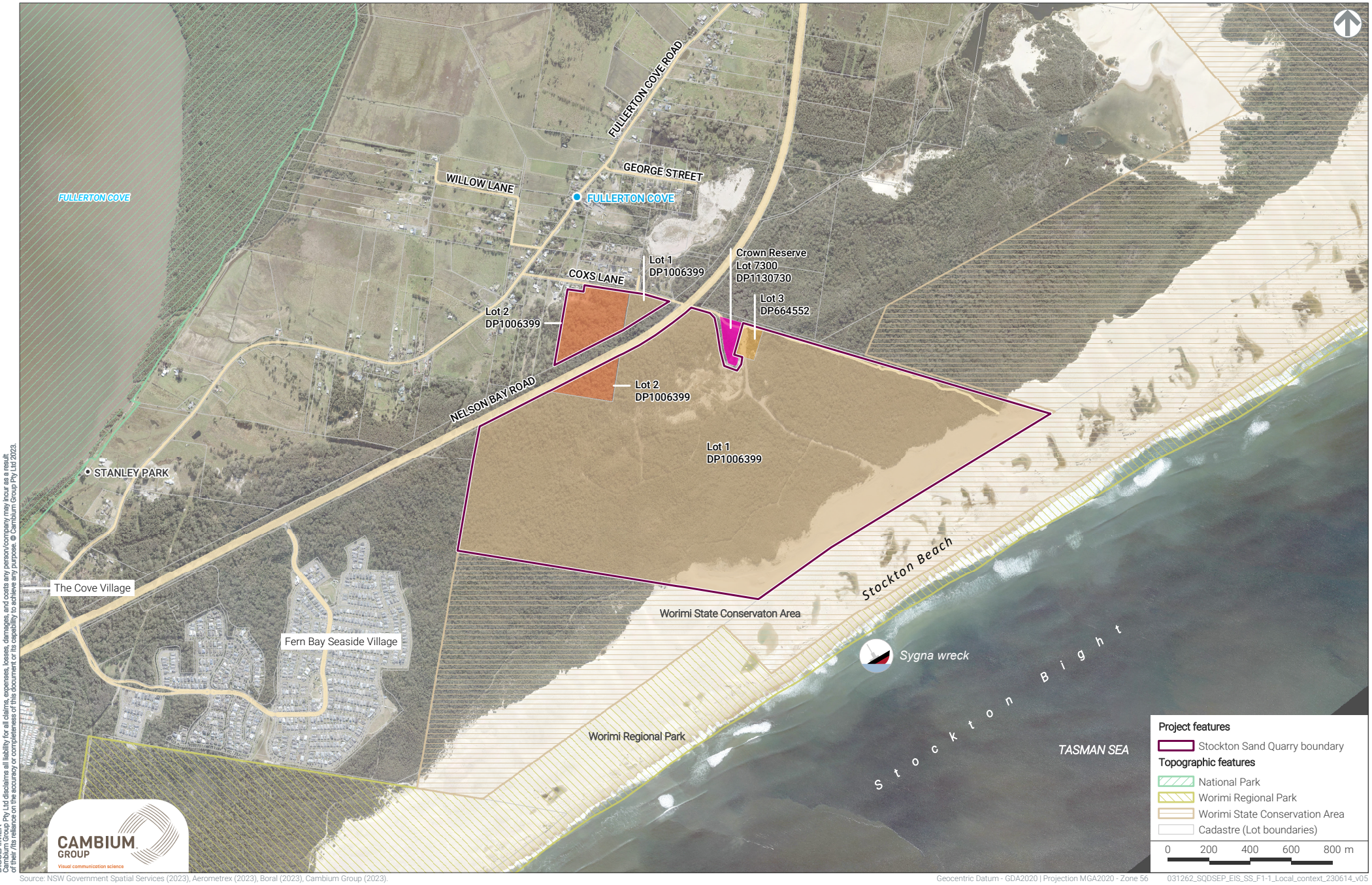
- A review of TfNSW crash data was undertaken, however, no discernible crash patterns were recognised.
- An independent Road Safety Audit has been undertaken along Nelson Bay Road.
- A turn warrant assessment has been undertaken at the intersection of Cox Lane and the Nelson Bay Road on-ramp in accordance with Austroads Guidelines. No intersection improvements are proposed at this intersection due to the reasons outlined in Section 11.
- The proposed development does not propose any changes to the existing vehicle access or internal car parking areas.

This traffic and transport impact assessment therefore demonstrates that the subject application is supportable on traffic planning grounds. TRAFFIX anticipates an ongoing involvement during the development approval process.

APPENDIX A

Reduced Plans

Figure 1.1
Local context



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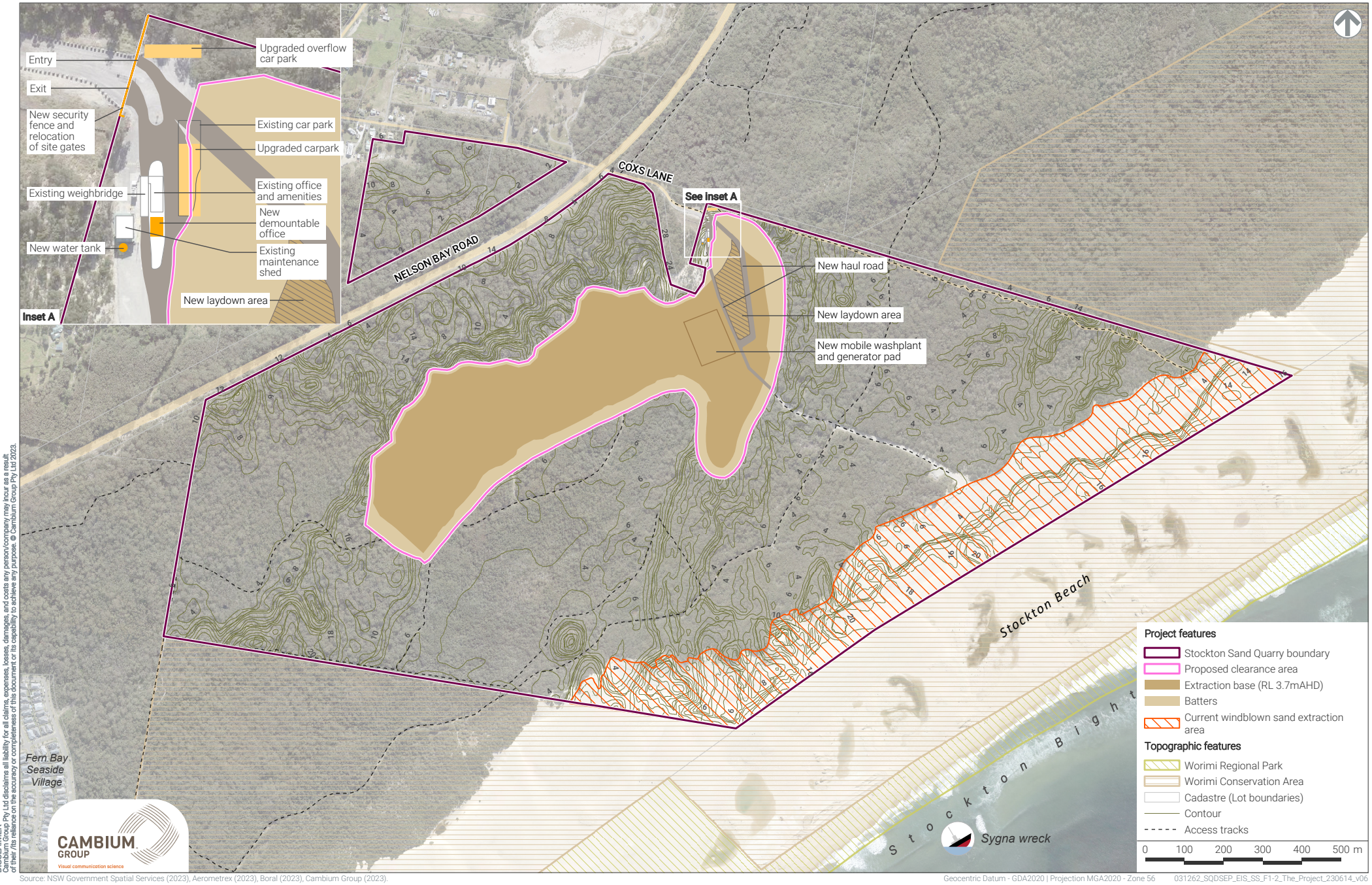
Geocentric Datum - GDA2020 | Projection MGA2020 - Zone 56 031262_SQDSEP_EIS_SS_F1-1_Local_context_230614_v05

Figure 1.2
The Project



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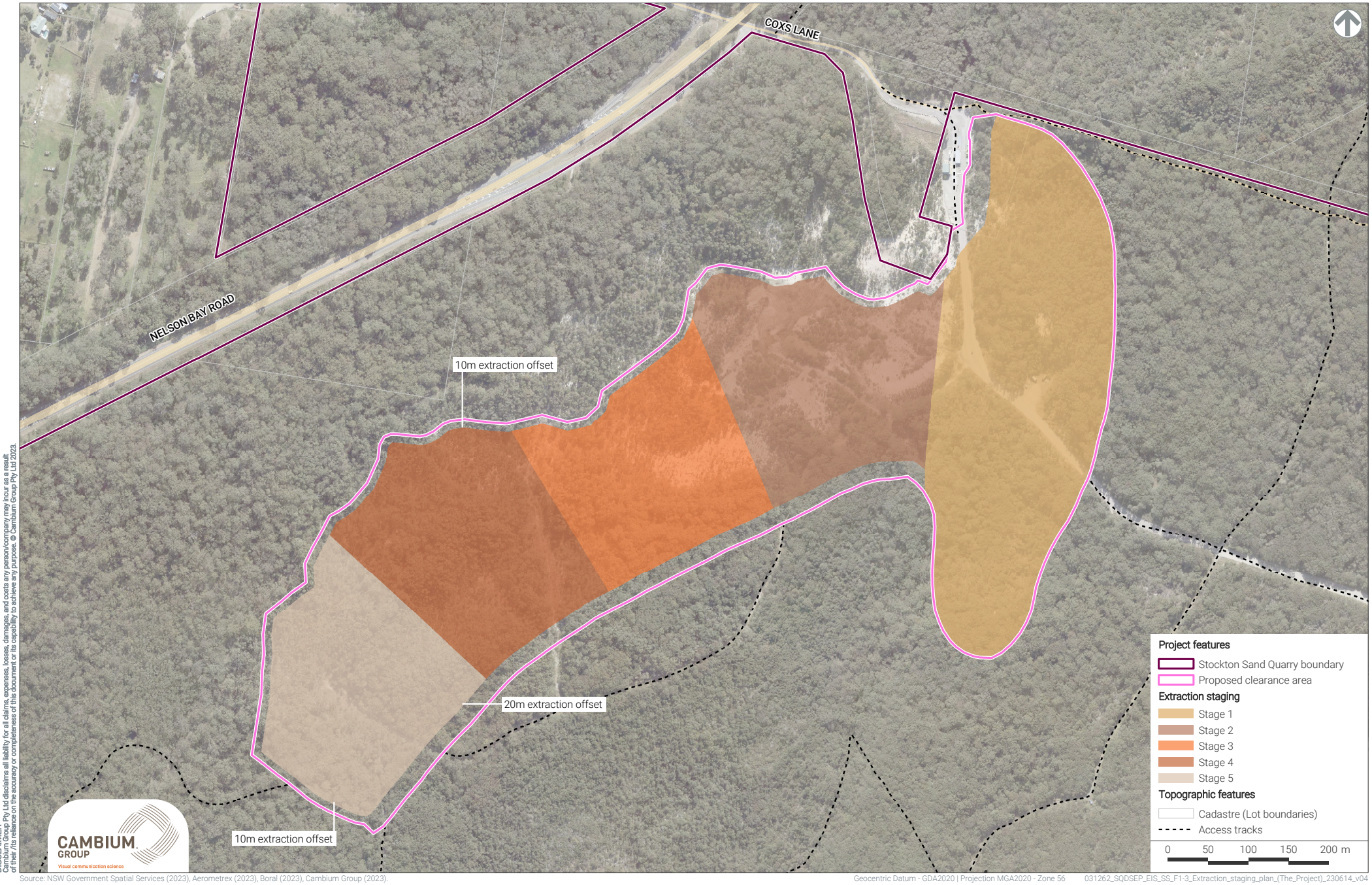
Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Figure 1.3
Extraction staging plan (The Project)



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Geocentric Datum - GDA2020 | Projection MGA2020 - Zone 56 031262_SQDSEP_EIS_SS_F1-3_Extraction_staging_plan_(The_Project)_230614_v04

APPENDIX B

SIDRA Outputs

USER REPORT FOR SITE

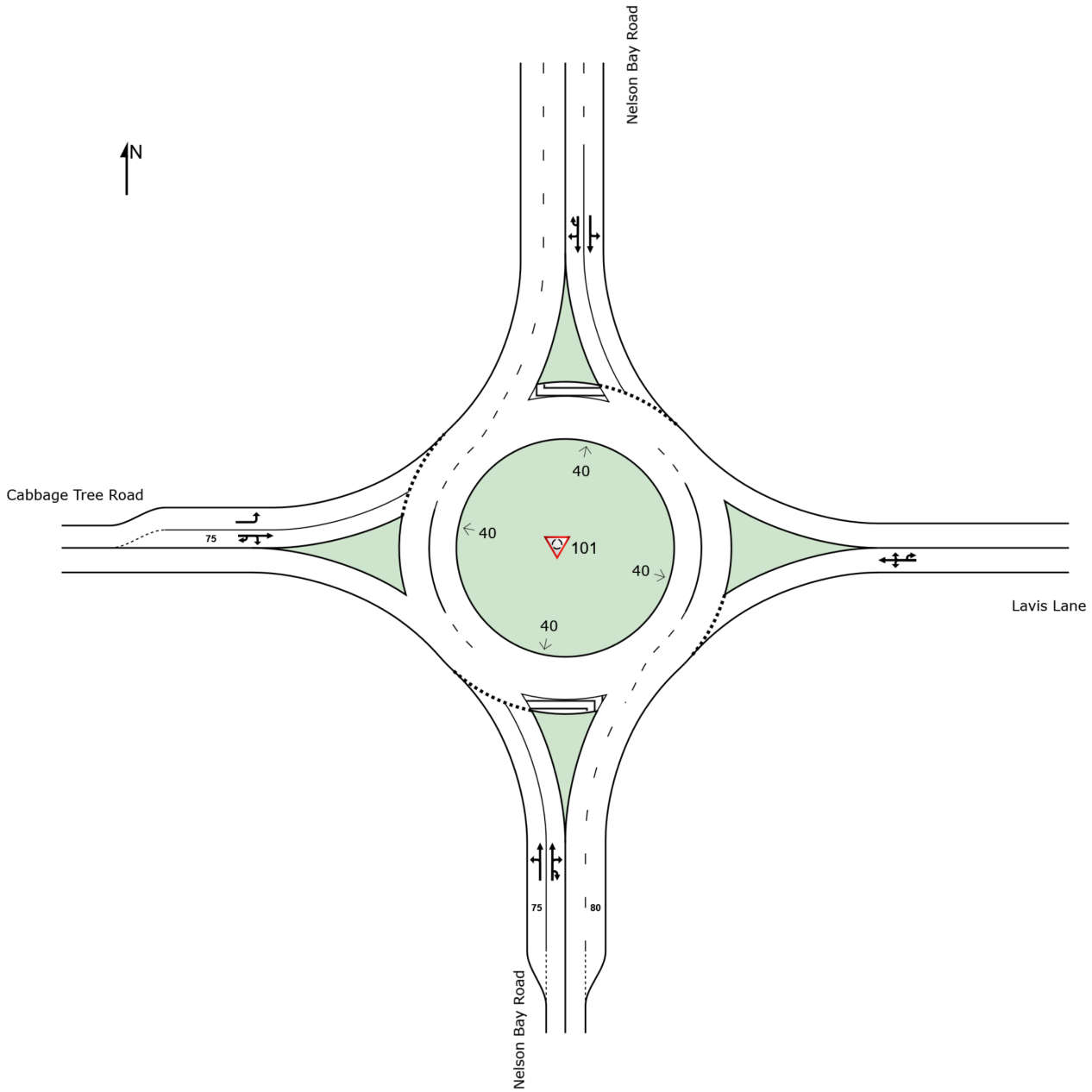
Project: 22.590m01v01 Stockton Quarry **Template: Layouts**

Site: 101 [101_EXAM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout

Site Layout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



USER REPORT FOR SITE

Project: 22.590m01v01 Stockton Quarry

Output produced by SIDRA INTERSECTION Version: 9.1.2.202

Template: Movement Summaries

Site: 101 [101_EXAM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	75	7.0	75	7.0	0.470	8.8	LOS A	3.9	28.4	0.64	0.59	0.64	60.2
2	T1	All MCs	1081	3.2	1081	3.2	0.470	9.7	LOS A	3.9	28.4	0.66	0.61	0.66	69.0
3	R2	All MCs	53	0.0	53	0.0	0.470	16.6	LOS B	3.7	26.4	0.68	0.63	0.68	54.5
3u	U	All MCs	1	0.0	1	0.0	0.470	20.1	LOS B	3.7	26.4	0.68	0.63	0.68	67.9
Approach			1209	3.3	1209	3.3	0.470	9.9	LOS A	3.9	28.4	0.66	0.61	0.66	67.6
East: Lavis Lane															
4	L2	All MCs	79	1.3	79	1.3	0.263	8.3	LOS A	1.3	9.2	0.73	0.76	0.73	53.4
5	T1	All MCs	33	12.9	33	12.9	0.263	5.5	LOS A	1.3	9.2	0.73	0.76	0.73	48.3
6	R2	All MCs	64	3.3	64	3.3	0.263	11.4	LOS A	1.3	9.2	0.73	0.76	0.73	52.9
6u	U	All MCs	1	0.0	1	0.0	0.263	13.4	LOS A	1.3	9.2	0.73	0.76	0.73	44.7
Approach			177	4.2	177	4.2	0.263	9.0	LOS A	1.3	9.2	0.73	0.76	0.73	52.1
North: Nelson Bay Road															
7	L2	All MCs	5	0.0	5	0.0	0.323	7.9	LOS A	2.4	17.2	0.49	0.53	0.49	56.4
8	T1	All MCs	935	5.0	935	5.0	0.490	9.8	LOS A	4.4	32.9	0.52	0.56	0.52	69.3
9	R2	All MCs	216	12.7	216	12.7	0.490	15.6	LOS B	4.4	32.9	0.54	0.57	0.54	58.9
9u	U	All MCs	4	0.0	4	0.0	0.490	18.6	LOS B	4.4	32.9	0.54	0.57	0.54	68.4
Approach			1160	6.4	1160	6.4	0.490	10.9	LOS A	4.4	32.9	0.52	0.56	0.52	67.0
West: Cabbage Tree Road															
10	L2	All MCs	286	10.3	286	10.3	0.366	6.6	LOS A	2.0	15.4	0.77	0.79	0.81	58.3
11	T1	All MCs	29	10.7	29	10.7	0.257	7.3	LOS A	1.1	9.4	0.75	0.86	0.75	46.5
12	R2	All MCs	86	12.2	86	12.2	0.257	14.0	LOS A	1.1	9.4	0.75	0.86	0.75	53.0
12u	U	All MCs	14	84.6	14	84.6	0.257	20.8	LOS B	1.1	9.4	0.75	0.86	0.75	47.0
Approach			416	13.2	416	13.2	0.366	8.7	LOS A	2.0	15.4	0.77	0.81	0.79	55.6
All Vehicles			2962	5.9	2962	5.9	0.490	10.1	LOS A	4.4	32.9	0.63	0.63	0.63	64.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity

Site: 105 [105_EXPM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln (Site Folder: Existing Scenarios)]

Scenario: Existing PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	83	10.1	83	10.1	0.436	9.1	LOS A	3.6	26.0	0.68	0.61	0.68	59.9
2	T1	All MCs	943	2.2	943	2.2	0.436	9.9	LOS A	3.6	26.0	0.70	0.63	0.70	68.9
3	R2	All MCs	38	5.6	38	5.6	0.436	17.2	LOS B	3.3	23.8	0.71	0.65	0.71	54.3
3u	U	All MCs	1	0.0	1	0.0	0.436	20.4	LOS B	3.3	23.8	0.71	0.65	0.71	67.8
Approach			1065	3.0	1065	3.0	0.436	10.1	LOS A	3.6	26.0	0.69	0.63	0.69	67.5
East: Lavis Lane															
4	L2	All MCs	105	2.0	105	2.0	0.447	13.6	LOS A	2.7	19.7	0.85	0.92	1.02	51.1
5	T1	All MCs	45	16.3	45	16.3	0.447	9.1	LOS A	2.7	19.7	0.85	0.92	1.02	46.4
6	R2	All MCs	82	3.8	82	3.8	0.447	14.8	LOS B	2.7	19.7	0.85	0.92	1.02	50.5
6u	U	All MCs	4	75.0	4	75.0	0.447	20.3	LOS B	2.7	19.7	0.85	0.92	1.02	42.5
Approach			237	6.7	237	6.7	0.447	13.3	LOS A	2.7	19.7	0.85	0.92	1.02	49.7
North: Nelson Bay Road															
7	L2	All MCs	9	0.0	9	0.0	0.394	8.4	LOS A	3.1	22.0	0.59	0.56	0.59	55.8
8	T1	All MCs	1108	2.6	1108	2.6	0.598	11.0	LOS A	6.1	44.6	0.63	0.59	0.63	68.9
9	R2	All MCs	246	14.5	246	14.5	0.598	16.2	LOS B	6.1	44.6	0.67	0.60	0.67	58.2
9u	U	All MCs	2	0.0	2	0.0	0.598	19.1	LOS B	6.1	44.6	0.67	0.60	0.67	67.6
Approach			1366	4.7	1366	4.7	0.598	11.9	LOS A	6.1	44.6	0.64	0.59	0.64	66.5
West: Cabbage Tree Road															
10	L2	All MCs	356	4.7	356	4.7	0.414	6.4	LOS A	2.4	17.7	0.77	0.78	0.83	59.3
11	T1	All MCs	41	7.7	41	7.7	0.323	7.0	LOS A	1.6	11.7	0.74	0.83	0.76	46.7
12	R2	All MCs	148	3.5	148	3.5	0.323	13.4	LOS A	1.6	11.7	0.74	0.83	0.76	54.7
12u	U	All MCs	7	85.7	7	85.7	0.323	20.5	LOS B	1.6	11.7	0.74	0.83	0.76	47.2
Approach			553	5.7	553	5.7	0.414	8.5	LOS A	2.4	17.7	0.76	0.80	0.81	56.6
All Vehicles			3221	4.4	3221	4.4	0.598	10.8	LOS A	6.1	44.6	0.69	0.66	0.71	63.4

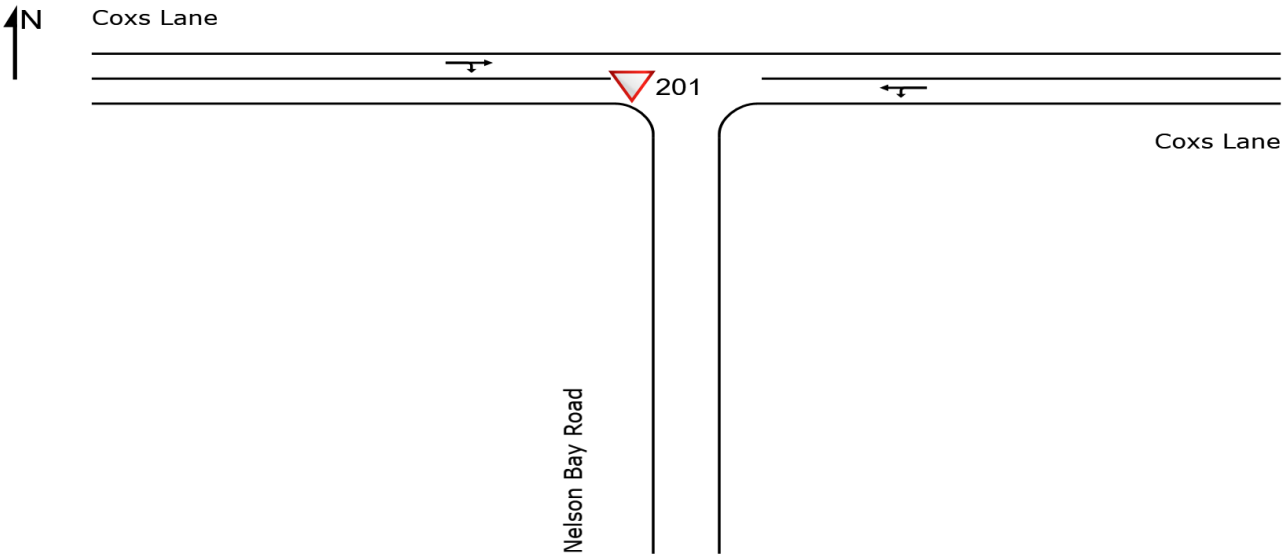
Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 201 [201_EXAM Nelson Bay Rd On-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 6:00am - 7:00am
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Site Layout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



Site: 201 [201_EXAM Nelson Bay Rd On-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 6:00am - 7:00am
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	3	100.0	3	100.0	0.003	6.7	LOS A	0.0	0.0	0.00	0.42	0.00	46.9
5	T1	All MCs	1	0.0	1	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.42	0.00	54.2
Approach			4	75.0	4	75.0	0.003	5.0	NA	0.0	0.0	0.00	0.42	0.00	48.5
West: Coxs Lane															
11	T1	All MCs	3	100.0	3	100.0	0.004	0.0	LOS A	0.0	0.2	0.03	0.34	0.03	56.1
12	R2	All MCs	4	0.0	4	0.0	0.004	5.5	LOS A	0.0	0.2	0.03	0.34	0.03	54.4
Approach			7	42.9	7	42.9	0.004	3.1	NA	0.0	0.2	0.03	0.34	0.03	55.0
All Vehicles			12	54.5	12	54.5	0.004	3.8	NA	0.0	0.2	0.02	0.37	0.02	52.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 205 [205_EXPM Nelson Bay Rd On-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing PM Peak
Peak Hour: 3:15pm - 4:15pm
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	1	0.0	1	0.0	0.002	5.5	LOS A	0.0	0.0	0.00	0.20	0.00	54.8
5	T1	All MCs	2	0.0	2	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.20	0.00	57.7
Approach			3	0.0	3	0.0	0.002	1.8	NA	0.0	0.0	0.00	0.20	0.00	56.7
West: Coxs Lane															
11	T1	All MCs	4	25.0	4	25.0	0.004	0.0	LOS A	0.0	0.1	0.02	0.20	0.02	57.3
12	R2	All MCs	2	0.0	2	0.0	0.004	5.5	LOS A	0.0	0.1	0.02	0.20	0.02	55.2
Approach			6	16.7	6	16.7	0.004	1.8	NA	0.0	0.1	0.02	0.20	0.02	56.4
All Vehicles			9	11.1	9	11.1	0.004	1.8	NA	0.0	0.1	0.01	0.20	0.01	56.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

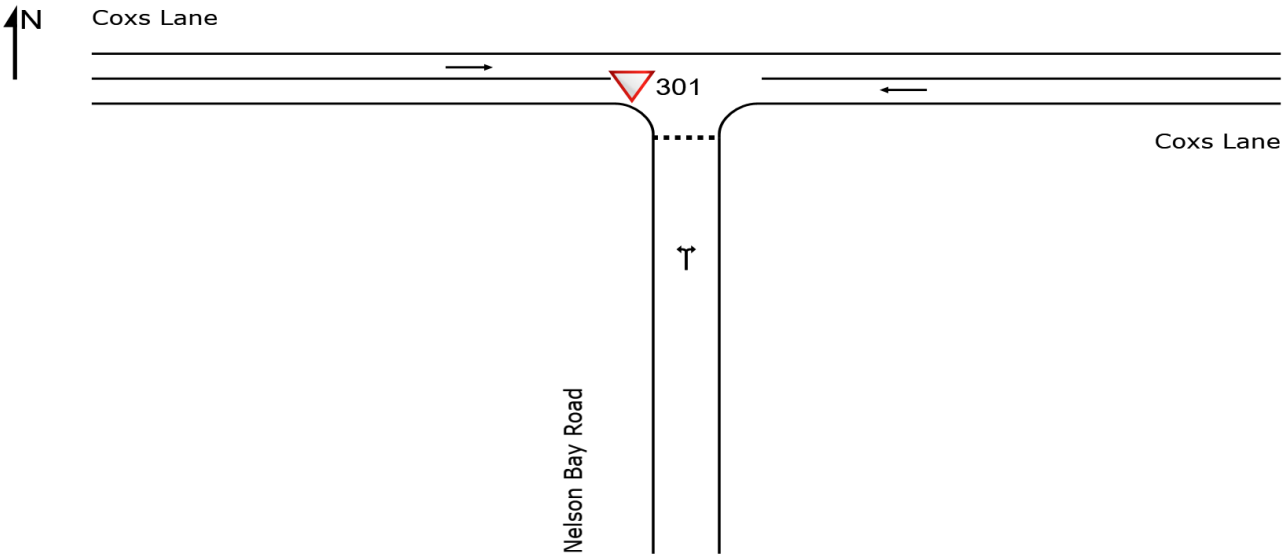
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 301 [301_EXAM Nelson Bay Rd Off-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:30am - 8:30am
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Site Layout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



Site: 301 [301_EXAM Nelson Bay Rd Off-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:30am - 8:30am
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	3	0.0	3	0.0	0.003	5.5	LOS A	0.0	0.1	0.01	0.58	0.01	52.8
3	R2	All MCs	1	0.0	1	0.0	0.003	5.7	LOS A	0.0	0.1	0.01	0.58	0.01	51.1
Approach			4	0.0	4	0.0	0.003	5.6	LOS A	0.0	0.1	0.01	0.58	0.01	52.4
East: Coxs Lane															
5	T1	All MCs	1	0.0	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			1	0.0	1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	4	0.0	4	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			4	0.0	4	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			9	0.0	9	0.0	0.003	2.5	NA	0.0	0.1	0.01	0.26	0.01	56.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 305 [305_EXPM Nelson Bay Rd Off-Ramp and Coxs Ln (Site Folder: Existing Scenarios)]

Scenario: Existing PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	4	25.0	4	25.0	0.005	5.8	LOS A	0.0	0.2	0.05	0.57	0.05	51.7
3	R2	All MCs	2	50.0	2	50.0	0.005	6.4	LOS A	0.0	0.2	0.05	0.57	0.05	48.5
Approach			6	33.3	6	33.3	0.005	6.0	LOS A	0.0	0.2	0.05	0.57	0.05	50.7
East: Coxs Lane															
5	T1	All MCs	7	14.3	7	14.3	0.004	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			7	14.3	7	14.3	0.004	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	12	18.2	12	18.2	0.007	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			12	18.2	12	18.2	0.007	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			25	20.8	25	20.8	0.007	1.5	NA	0.0	0.2	0.01	0.14	0.01	57.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

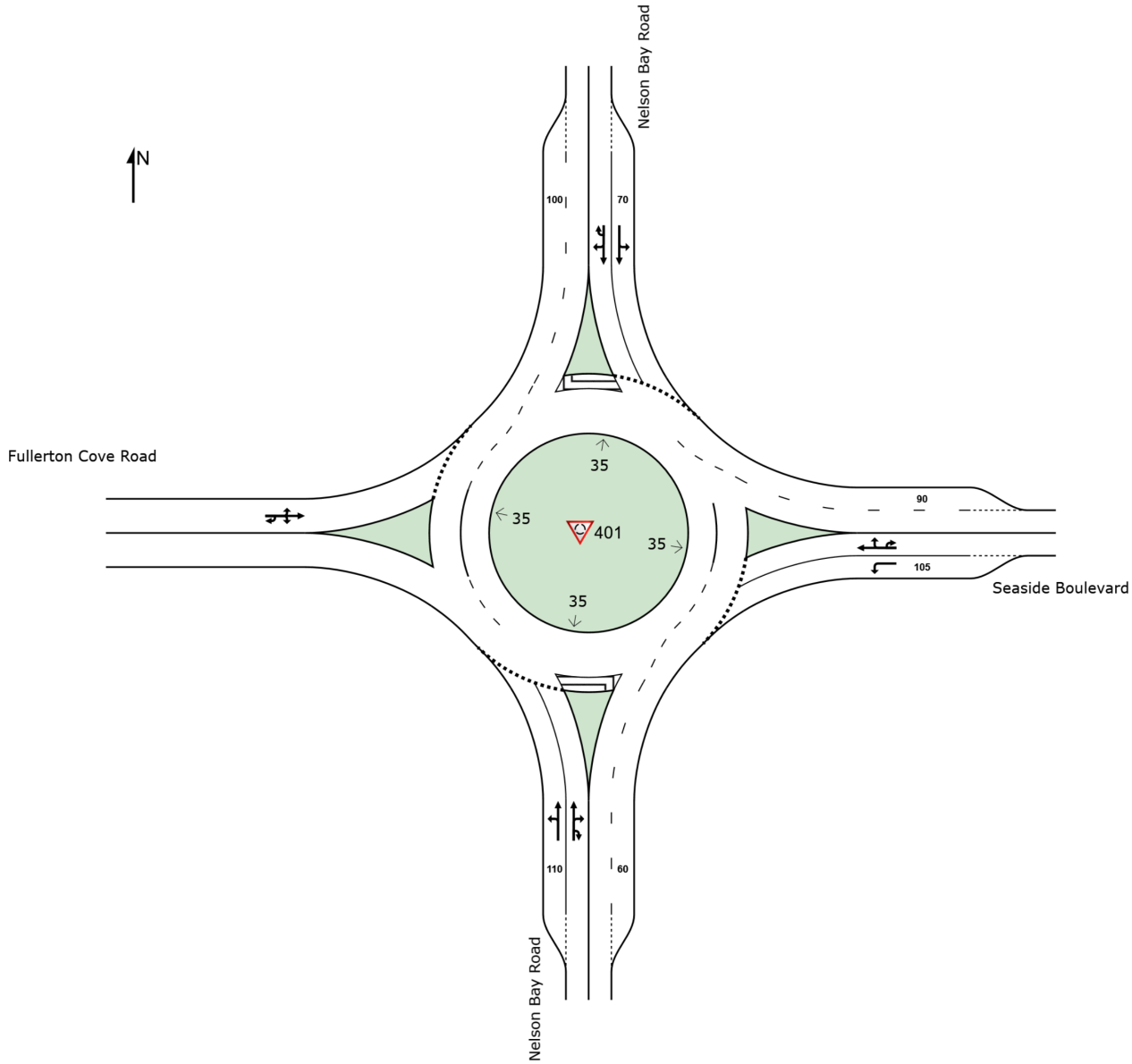
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 401 [401_EXAM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout

Site Layout

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



Site: 401 [401_EXAM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd (Site Folder: Existing Scenarios)]

Scenario: Existing AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	18	5.9	18	5.9	0.305	7.5	LOS A	2.0	14.8	0.33	0.50	0.33	63.6
11	T1	All MCs	1032	3.7	1032	3.7	0.414	9.4	LOS A	3.2	23.4	0.34	0.51	0.34	71.2
12	R2	All MCs	47	8.9	47	8.9	0.414	14.4	LOS A	3.2	23.4	0.34	0.52	0.34	60.5
12u	U	All MCs	17	0.0	17	0.0	0.414	17.5	LOS B	3.2	23.4	0.34	0.52	0.34	60.9
Approach			1114	3.9	1114	3.9	0.414	9.7	LOS A	3.2	23.4	0.34	0.51	0.34	70.4
East: Seaside Boulevard															
1	L2	All MCs	240	0.9	240	0.9	0.271	11.8	LOS A	1.5	10.3	0.72	0.73	0.72	59.7
2	T1	All MCs	3	33.3	3	33.3	0.124	9.6	LOS A	0.5	4.0	0.69	0.83	0.69	39.7
3	R2	All MCs	66	3.2	66	3.2	0.124	14.2	LOS A	0.5	4.0	0.69	0.83	0.69	53.4
3u	U	All MCs	3	0.0	3	0.0	0.124	16.5	LOS B	0.5	4.0	0.69	0.83	0.69	48.2
Approach			313	1.7	313	1.7	0.271	12.3	LOS A	1.5	10.3	0.72	0.75	0.72	57.9
North: Nelson Bay Road															
4	L2	All MCs	17	31.3	17	31.3	0.252	8.3	LOS A	1.5	11.0	0.32	0.51	0.32	61.3
5	T1	All MCs	1068	4.4	1068	4.4	0.471	9.7	LOS A	3.7	26.7	0.35	0.51	0.35	71.0
6	R2	All MCs	3	33.3	3	33.3	0.471	15.2	LOS B	3.7	26.7	0.36	0.51	0.36	45.1
6u	U	All MCs	27	3.8	27	3.8	0.471	17.7	LOS B	3.7	26.7	0.36	0.51	0.36	60.8
Approach			1116	4.9	1116	4.9	0.471	9.9	LOS A	3.7	26.7	0.35	0.51	0.35	70.5
West: Fullerton Cove Road															
7	L2	All MCs	5	0.0	5	0.0	0.071	10.0	LOS A	0.3	2.0	0.59	0.80	0.59	54.9
8	T1	All MCs	3	0.0	3	0.0	0.071	7.4	LOS A	0.3	2.0	0.59	0.80	0.59	47.2
9	R2	All MCs	43	12.2	43	12.2	0.071	13.9	LOS A	0.3	2.0	0.59	0.80	0.59	51.8
9u	U	All MCs	1	0.0	1	0.0	0.071	16.3	LOS B	0.3	2.0	0.59	0.80	0.59	31.1
Approach			53	10.0	53	10.0	0.071	13.2	LOS A	0.3	2.0	0.59	0.80	0.59	51.5
All Vehicles			2595	4.2	2595	4.2	0.471	10.2	LOS A	3.7	26.7	0.39	0.55	0.39	68.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 405 [405_EXPM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd (Site Folder: Existing Scenarios)]

Scenario: Existing PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	47	4.4	47	4.4	0.341	7.2	LOS A	2.5	17.9	0.25	0.49	0.25	64.8
11	T1	All MCs	1008	1.9	1008	1.9	0.462	8.9	LOS A	4.1	29.0	0.25	0.52	0.25	71.6
12	R2	All MCs	256	2.5	256	2.5	0.462	14.1	LOS A	4.1	29.0	0.26	0.55	0.26	60.4
12u	U	All MCs	9	11.1	9	11.1	0.462	17.6	LOS B	4.1	29.0	0.26	0.55	0.26	60.0
Approach			1321	2.2	1321	2.2	0.462	9.9	LOS A	4.1	29.0	0.25	0.53	0.25	68.8
East: Seaside Boulevard															
1	L2	All MCs	103	3.1	103	3.1	0.138	12.1	LOS A	0.8	5.5	0.77	0.75	0.77	59.2
2	T1	All MCs	6	33.3	6	33.3	0.079	9.7	LOS A	0.4	2.8	0.74	0.84	0.74	39.6
3	R2	All MCs	28	3.7	28	3.7	0.079	14.3	LOS A	0.4	2.8	0.74	0.84	0.74	53.3
3u	U	All MCs	4	25.0	4	25.0	0.079	18.0	LOS B	0.4	2.8	0.74	0.84	0.74	47.5
Approach			142	5.2	142	5.2	0.138	12.6	LOS A	0.8	5.5	0.76	0.77	0.76	56.6
North: Nelson Bay Road															
4	L2	All MCs	29	3.6	29	3.6	0.318	9.1	LOS A	2.0	14.1	0.53	0.59	0.53	60.7
5	T1	All MCs	1213	2.6	1213	2.6	0.595	10.8	LOS A	5.1	36.8	0.60	0.60	0.60	69.3
6	R2	All MCs	4	25.0	4	25.0	0.595	16.4	LOS B	5.1	36.8	0.63	0.61	0.63	44.0
6u	U	All MCs	6	16.7	6	16.7	0.595	19.4	LOS B	5.1	36.8	0.63	0.61	0.63	58.7
Approach			1253	2.8	1253	2.8	0.595	10.8	LOS A	5.1	36.8	0.60	0.60	0.60	69.0
West: Fullerton Cove Road															
7	L2	All MCs	1	0.0	1	0.0	0.047	9.5	LOS A	0.2	1.3	0.60	0.80	0.60	54.5
8	T1	All MCs	5	20.0	5	20.0	0.047	8.6	LOS A	0.2	1.3	0.60	0.80	0.60	46.7
9	R2	All MCs	28	0.0	28	0.0	0.047	13.9	LOS A	0.2	1.3	0.60	0.80	0.60	54.3
9u	U	All MCs	1	0.0	1	0.0	0.047	16.7	LOS B	0.2	1.3	0.60	0.80	0.60	30.9
Approach			36	2.9	36	2.9	0.047	13.1	LOS A	0.2	1.3	0.60	0.80	0.60	52.4
All Vehicles			2752	2.6	2752	2.6	0.595	10.5	LOS A	5.1	36.8	0.44	0.58	0.44	67.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 102 [102_PRAM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln (Site Folder: Development Scenarios)]

Scenario: Proposed AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	91	23.3	91	23.3	0.483	8.8	LOS A	4.1	30.1	0.66	0.60	0.66	59.6
2	T1	All MCs	1083	3.4	1083	3.4	0.483	9.7	LOS A	4.1	30.1	0.67	0.61	0.67	68.8
3	R2	All MCs	53	0.0	53	0.0	0.483	16.6	LOS B	3.8	27.6	0.69	0.63	0.69	54.5
3u	U	All MCs	1	0.0	1	0.0	0.483	20.1	LOS B	3.8	27.6	0.69	0.63	0.69	67.9
Approach			1227	4.7	1227	4.7	0.483	10.0	LOS A	4.1	30.1	0.67	0.61	0.67	67.2
East: Lavis Lane															
4	L2	All MCs	79	1.3	79	1.3	0.272	8.8	LOS A	1.3	9.7	0.75	0.77	0.75	53.3
5	T1	All MCs	33	12.9	33	12.9	0.272	5.7	LOS A	1.3	9.7	0.75	0.77	0.75	48.2
6	R2	All MCs	64	3.3	64	3.3	0.272	11.6	LOS A	1.3	9.7	0.75	0.77	0.75	52.7
6u	U	All MCs	1	0.0	1	0.0	0.272	13.6	LOS A	1.3	9.7	0.75	0.77	0.75	44.6
Approach			177	4.2	177	4.2	0.272	9.3	LOS A	1.3	9.7	0.75	0.77	0.75	52.0
North: Nelson Bay Road															
7	L2	All MCs	5	0.0	5	0.0	0.332	8.1	LOS A	2.4	17.8	0.53	0.55	0.53	56.2
8	T1	All MCs	937	5.2	937	5.2	0.503	10.1	LOS A	4.6	34.2	0.56	0.57	0.56	68.9
9	R2	All MCs	216	12.7	216	12.7	0.503	15.8	LOS B	4.6	34.2	0.58	0.58	0.58	58.7
9u	U	All MCs	4	0.0	4	0.0	0.503	18.8	LOS B	4.6	34.2	0.58	0.58	0.58	68.1
Approach			1162	6.5	1162	6.5	0.503	11.2	LOS A	4.6	34.2	0.56	0.57	0.56	66.7
West: Cabbage Tree Road															
10	L2	All MCs	286	10.3	286	10.3	0.368	6.6	LOS A	2.0	15.5	0.78	0.79	0.82	58.3
11	T1	All MCs	29	10.7	29	10.7	0.313	7.6	LOS A	1.4	12.3	0.76	0.89	0.80	46.2
12	R2	All MCs	106	23.8	106	23.8	0.313	15.0	LOS B	1.4	12.3	0.76	0.89	0.80	51.0
12u	U	All MCs	14	84.6	14	84.6	0.313	21.2	LOS B	1.4	12.3	0.76	0.89	0.80	46.7
Approach			436	15.9	436	15.9	0.368	9.2	LOS A	2.0	15.5	0.77	0.83	0.81	54.8
All Vehicles			3002	7.0	3002	7.0	0.503	10.3	LOS A	4.6	34.2	0.65	0.64	0.65	63.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 106 [106_PRPM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln (Site Folder: Development Scenarios)]

Scenario: Proposed PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	99	24.5	99	24.5	0.450	9.2	LOS A	3.8	27.7	0.69	0.61	0.69	59.4
2	T1	All MCs	945	2.4	945	2.4	0.450	10.0	LOS A	3.8	27.7	0.71	0.63	0.71	68.7
3	R2	All MCs	38	5.6	38	5.6	0.450	17.2	LOS B	3.5	25.0	0.72	0.65	0.72	54.3
3u	U	All MCs	1	0.0	1	0.0	0.450	20.4	LOS B	3.5	25.0	0.72	0.65	0.72	67.7
Approach			1083	4.6	1083	4.6	0.450	10.2	LOS A	3.8	27.7	0.71	0.63	0.71	67.1
East: Lavis Lane															
4	L2	All MCs	105	2.0	105	2.0	0.467	14.7	LOS B	2.9	21.2	0.87	0.94	1.06	50.6
5	T1	All MCs	45	16.3	45	16.3	0.467	9.8	LOS A	2.9	21.2	0.87	0.94	1.06	46.0
6	R2	All MCs	82	3.8	82	3.8	0.467	15.5	LOS B	2.9	21.2	0.87	0.94	1.06	50.1
6u	U	All MCs	4	75.0	4	75.0	0.467	21.1	LOS B	2.9	21.2	0.87	0.94	1.06	42.2
Approach			237	6.7	237	6.7	0.467	14.1	LOS A	2.9	21.2	0.87	0.94	1.06	49.3
North: Nelson Bay Road															
7	L2	All MCs	9	0.0	9	0.0	0.405	8.6	LOS A	3.2	22.7	0.62	0.58	0.62	55.6
8	T1	All MCs	1111	2.7	1111	2.7	0.613	11.3	LOS A	6.3	46.3	0.67	0.60	0.67	68.5
9	R2	All MCs	246	14.5	246	14.5	0.613	16.4	LOS B	6.3	46.3	0.71	0.62	0.71	58.0
9u	U	All MCs	2	0.0	2	0.0	0.613	19.3	LOS B	6.3	46.3	0.71	0.62	0.71	67.3
Approach			1368	4.8	1368	4.8	0.613	12.2	LOS A	6.3	46.3	0.68	0.60	0.68	66.2
West: Cabbage Tree Road															
10	L2	All MCs	356	4.7	356	4.7	0.417	6.4	LOS A	2.5	18.1	0.77	0.79	0.84	59.2
11	T1	All MCs	41	7.7	41	7.7	0.376	7.4	LOS A	1.9	14.9	0.76	0.87	0.83	46.4
12	R2	All MCs	168	11.9	168	11.9	0.376	14.3	LOS A	1.9	14.9	0.76	0.87	0.83	52.9
12u	U	All MCs	7	85.7	7	85.7	0.376	21.0	LOS B	1.9	14.9	0.76	0.87	0.83	46.8
Approach			573	8.1	573	8.1	0.417	9.0	LOS A	2.5	18.1	0.77	0.82	0.84	55.8
All Vehicles			3261	5.5	3261	5.5	0.613	11.1	LOS A	6.3	46.3	0.72	0.68	0.74	62.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 202 [202_PRAM Nelson Bay Rd On-Ramp and Coxs Ln (Site Folder: Development Scenarios)]

Scenario: Proposed AM Peak
Peak Hour: 6:00am - 7:00am
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	35	100.0	35	100.0	0.033	6.7	LOS A	0.0	0.0	0.00	0.55	0.00	45.8
5	T1	All MCs	1	0.0	1	0.0	0.033	0.0	LOS A	0.0	0.0	0.00	0.55	0.00	52.7
Approach			36	97.1	36	97.1	0.033	6.5	NA	0.0	0.0	0.00	0.55	0.00	46.0
West: Coxs Lane															
11	T1	All MCs	44	78.6	44	78.6	0.036	0.0	LOS A	0.0	0.3	0.02	0.06	0.02	57.8
12	R2	All MCs	4	0.0	4	0.0	0.036	5.6	LOS A	0.0	0.3	0.02	0.06	0.02	55.6
Approach			48	71.7	48	71.7	0.036	0.5	NA	0.0	0.3	0.02	0.06	0.02	57.6
All Vehicles			84	82.5	84	82.5	0.036	3.0	NA	0.0	0.3	0.01	0.26	0.01	52.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 206 [206_PRPM Nelson Bay Rd On-Ramp and Coxs Ln (Site Folder: Development Scenarios)]

Scenario: Proposed PM Peak
Peak Hour: 3:15pm - 4:15pm
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	42	75.0	42	75.0	0.036	6.4	LOS A	0.0	0.0	0.00	0.54	0.00	48.3
5	T1	All MCs	2	0.0	2	0.0	0.036	0.0	LOS A	0.0	0.0	0.00	0.54	0.00	54.6
Approach			44	71.4	44	71.4	0.036	6.1	NA	0.0	0.0	0.00	0.54	0.00	48.6
West: Coxs Lane															
11	T1	All MCs	36	91.2	36	91.2	0.030	0.0	LOS A	0.0	0.1	0.01	0.04	0.01	57.3
12	R2	All MCs	2	0.0	2	0.0	0.030	5.5	LOS A	0.0	0.1	0.01	0.04	0.01	55.2
Approach			38	86.1	38	86.1	0.030	0.3	NA	0.0	0.1	0.01	0.04	0.01	57.1
All Vehicles			82	78.2	82	78.2	0.036	3.4	NA	0.0	0.1	0.01	0.31	0.01	52.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 302 [302_PRAM Nelson Bay Rd Off-Ramp and Coxs Ln (Site Folder: Development Scenarios)]

Scenario: Proposed AM Peak
Peak Hour: 7:30am - 8:30am
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	3	0.0	3	0.0	0.047	5.5	LOS A	0.2	1.7	0.03	0.61	0.03	52.7
3	R2	All MCs	42	75.0	42	75.0	0.047	6.7	LOS A	0.2	1.7	0.03	0.61	0.03	47.2
Approach			45	69.8	45	69.8	0.047	6.6	LOS A	0.2	1.7	0.03	0.61	0.03	47.7
East: Coxs Lane															
5	T1	All MCs	1	0.0	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			1	0.0	1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	4	0.0	4	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			4	0.0	4	0.0	0.002	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			51	62.5	51	62.5	0.047	5.9	NA	0.2	1.7	0.03	0.54	0.03	48.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 306 [306_PRPM Nelson Bay Rd Off-Ramp and Coxs Ln (Site Folder: Development Scenarios)]

Scenario: Proposed PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	4	25.0	4	25.0	0.043	5.9	LOS A	0.1	1.7	0.08	0.59	0.08	51.6
3	R2	All MCs	34	96.9	34	96.9	0.043	7.1	LOS A	0.1	1.7	0.08	0.59	0.08	46.2
Approach			38	88.9	38	88.9	0.043	7.0	LOS A	0.1	1.7	0.08	0.59	0.08	46.9
East: Coxs Lane															
5	T1	All MCs	7	14.3	7	14.3	0.004	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			7	14.3	7	14.3	0.004	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	12	18.2	12	18.2	0.007	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			12	18.2	12	18.2	0.007	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			57	64.8	57	64.8	0.043	4.6	NA	0.1	1.7	0.05	0.39	0.05	50.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 402 [402_PRAM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd (Site Folder: Development Scenarios)]

Scenario: Proposed AM Peak
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	18	5.9	18	5.9	0.326	7.9	LOS A	2.1	15.4	0.40	0.53	0.40	62.7
11	T1	All MCs	1051	5.0	1051	5.0	0.442	9.9	LOS A	3.4	24.5	0.41	0.53	0.41	70.2
12	R2	All MCs	47	8.9	47	8.9	0.442	14.7	LOS B	3.4	24.5	0.42	0.54	0.42	60.0
12u	U	All MCs	17	0.0	17	0.0	0.442	17.8	LOS B	3.4	24.5	0.42	0.54	0.42	60.4
Approach			1133	5.1	1133	5.1	0.442	10.2	LOS A	3.4	24.5	0.41	0.53	0.41	69.4
East: Seaside Boulevard															
1	L2	All MCs	240	0.9	240	0.9	0.285	12.4	LOS A	1.6	11.1	0.75	0.75	0.75	59.4
2	T1	All MCs	3	33.3	3	33.3	0.130	10.1	LOS A	0.6	4.2	0.71	0.84	0.71	39.4
3	R2	All MCs	66	3.2	66	3.2	0.130	14.5	LOS B	0.6	4.2	0.71	0.84	0.71	53.2
3u	U	All MCs	3	0.0	3	0.0	0.130	16.8	LOS B	0.6	4.2	0.71	0.84	0.71	47.9
Approach			313	1.7	313	1.7	0.285	12.9	LOS A	1.6	11.1	0.74	0.77	0.74	57.5
North: Nelson Bay Road															
4	L2	All MCs	17	31.3	17	31.3	0.269	8.4	LOS A	1.6	12.1	0.33	0.51	0.33	61.2
5	T1	All MCs	1082	5.6	1082	5.6	0.504	9.9	LOS A	4.1	31.1	0.36	0.52	0.36	70.3
6	R2	All MCs	3	33.3	3	33.3	0.504	15.3	LOS B	4.1	31.1	0.38	0.52	0.38	44.8
6u	U	All MCs	67	53.1	67	53.1	0.504	16.2	LOS B	4.1	31.1	0.38	0.52	0.38	58.4
Approach			1169	8.8	1169	8.8	0.504	10.2	LOS A	4.1	31.1	0.37	0.52	0.37	69.3
West: Fullerton Cove Road															
7	L2	All MCs	5	0.0	5	0.0	0.077	11.2	LOS A	0.3	2.3	0.63	0.82	0.63	54.4
8	T1	All MCs	3	0.0	3	0.0	0.077	7.8	LOS A	0.3	2.3	0.63	0.82	0.63	46.9
9	R2	All MCs	43	12.2	43	12.2	0.077	14.4	LOS A	0.3	2.3	0.63	0.82	0.63	51.4
9u	U	All MCs	1	0.0	1	0.0	0.077	16.8	LOS B	0.3	2.3	0.63	0.82	0.63	30.7
Approach			53	10.0	53	10.0	0.077	13.7	LOS A	0.3	2.3	0.63	0.82	0.63	51.0
All Vehicles			2667	6.4	2667	6.4	0.504	10.6	LOS A	4.1	31.1	0.43	0.56	0.43	67.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 406 [406_PRPM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd (Site Folder: Development Scenarios)]

Scenario: Proposed PM Peak
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	47	4.4	47	4.4	0.365	7.6	LOS A	2.6	18.6	0.35	0.51	0.35	63.5
11	T1	All MCs	1023	3.3	1023	3.3	0.494	9.4	LOS A	4.2	30.2	0.36	0.54	0.36	70.3
12	R2	All MCs	256	2.5	256	2.5	0.494	14.3	LOS A	4.2	30.2	0.37	0.56	0.37	59.8
12u	U	All MCs	9	11.1	9	11.1	0.494	17.9	LOS B	4.2	30.2	0.37	0.56	0.37	59.4
Approach			1336	3.2	1336	3.2	0.494	10.4	LOS A	4.2	30.2	0.36	0.54	0.36	67.7
East: Seaside Boulevard															
1	L2	All MCs	103	3.1	103	3.1	0.150	12.9	LOS A	0.9	6.2	0.80	0.77	0.80	58.8
2	T1	All MCs	6	33.3	6	33.3	0.086	10.3	LOS A	0.4	3.1	0.77	0.86	0.77	39.4
3	R2	All MCs	28	3.7	28	3.7	0.086	14.8	LOS B	0.4	3.1	0.77	0.86	0.77	53.0
3u	U	All MCs	4	25.0	4	25.0	0.086	18.5	LOS B	0.4	3.1	0.77	0.86	0.77	47.2
Approach			142	5.2	142	5.2	0.150	13.3	LOS A	0.9	6.2	0.79	0.79	0.79	56.2
North: Nelson Bay Road															
4	L2	All MCs	29	3.6	29	3.6	0.343	9.2	LOS A	2.2	16.0	0.55	0.59	0.55	60.5
5	T1	All MCs	1232	3.8	1232	3.8	0.641	11.2	LOS A	6.2	45.9	0.64	0.62	0.65	68.6
6	R2	All MCs	4	25.0	4	25.0	0.641	16.7	LOS B	6.2	45.9	0.68	0.63	0.70	43.6
6u	U	All MCs	45	76.7	45	76.7	0.641	17.1	LOS B	6.2	45.9	0.68	0.63	0.70	56.0
Approach			1311	6.3	1311	6.3	0.641	11.4	LOS A	6.2	45.9	0.64	0.62	0.65	67.7
West: Fullerton Cove Road															
7	L2	All MCs	1	0.0	1	0.0	0.052	10.5	LOS A	0.2	1.5	0.65	0.82	0.65	53.9
8	T1	All MCs	5	20.0	5	20.0	0.052	9.1	LOS A	0.2	1.5	0.65	0.82	0.65	46.3
9	R2	All MCs	28	0.0	28	0.0	0.052	14.3	LOS A	0.2	1.5	0.65	0.82	0.65	53.8
9u	U	All MCs	1	0.0	1	0.0	0.052	17.1	LOS B	0.2	1.5	0.65	0.82	0.65	30.6
Approach			36	2.9	36	2.9	0.052	13.5	LOS A	0.2	1.5	0.65	0.82	0.65	52.0
All Vehicles			2824	4.8	2824	4.8	0.641	11.0	LOS A	6.2	45.9	0.52	0.59	0.52	66.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 103 [103_EXAM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing AM Peak - 10 Year Growth
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	93	7.0	93	7.0	0.637	10.5	LOS A	7.2	51.9	0.82	0.70	0.90	59.1
2	T1	All MCs	1351	3.2	1351	3.2	0.637	11.9	LOS A	7.2	51.9	0.84	0.72	0.95	67.4
3	R2	All MCs	66	0.0	66	0.0	0.637	19.4	LOS B	7.0	50.5	0.86	0.75	1.00	53.4
3u	U	All MCs	1	0.0	1	0.0	0.637	22.9	LOS B	7.0	50.5	0.86	0.75	1.00	66.3
Approach			1512	3.3	1512	3.3	0.637	12.2	LOS A	7.2	51.9	0.84	0.72	0.95	66.1
East: Lavis Lane															
4	L2	All MCs	99	1.3	99	1.3	0.439	14.5	LOS B	2.6	19.1	0.87	0.93	1.03	50.8
5	T1	All MCs	41	12.9	41	12.9	0.439	9.5	LOS A	2.6	19.1	0.87	0.93	1.03	46.1
6	R2	All MCs	80	3.3	80	3.3	0.439	15.3	LOS B	2.6	19.1	0.87	0.93	1.03	50.3
6u	U	All MCs	1	0.0	1	0.0	0.439	17.2	LOS B	2.6	19.1	0.87	0.93	1.03	42.8
Approach			221	4.2	221	4.2	0.439	13.9	LOS A	2.6	19.1	0.87	0.93	1.03	49.7
North: Nelson Bay Road															
7	L2	All MCs	7	0.0	7	0.0	0.422	8.4	LOS A	3.4	24.5	0.60	0.57	0.60	55.8
8	T1	All MCs	1168	5.0	1168	5.0	0.640	11.4	LOS A	6.8	50.6	0.66	0.59	0.66	68.2
9	R2	All MCs	270	12.7	270	12.7	0.640	16.2	LOS B	6.8	50.6	0.70	0.61	0.70	58.1
9u	U	All MCs	5	0.0	5	0.0	0.640	19.2	LOS B	6.8	50.6	0.70	0.61	0.70	67.3
Approach			1450	6.4	1450	6.4	0.640	12.3	LOS A	6.8	50.6	0.67	0.60	0.67	66.0
West: Cabbage Tree Road															
10	L2	All MCs	358	10.3	358	10.3	0.584	9.8	LOS A	4.1	31.0	0.91	0.96	1.15	55.9
11	T1	All MCs	37	10.7	37	10.7	0.419	10.0	LOS A	2.2	17.7	0.85	0.97	0.98	45.1
12	R2	All MCs	108	12.2	108	12.2	0.419	16.7	LOS B	2.2	17.7	0.85	0.97	0.98	51.2
12u	U	All MCs	17	84.6	17	84.6	0.419	24.2	LOS B	2.2	17.7	0.85	0.97	0.98	45.6
Approach			520	13.2	520	13.2	0.584	11.7	LOS A	4.1	31.0	0.89	0.96	1.10	53.5
All Vehicles			3703	5.9	3703	5.9	0.640	12.2	LOS A	7.2	51.9	0.78	0.72	0.86	62.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 107 [107_EXPM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	104	10.1	104	10.1	0.606	11.1	LOS A	6.7	48.5	0.87	0.72	0.96	58.8
2	T1	All MCs	1179	2.2	1179	2.2	0.606	12.3	LOS A	6.7	48.5	0.87	0.74	1.00	67.3
3	R2	All MCs	47	5.6	47	5.6	0.606	20.3	LOS B	6.4	45.8	0.89	0.77	1.04	53.3
3u	U	All MCs	1	0.0	1	0.0	0.606	23.4	LOS B	6.4	45.8	0.89	0.77	1.04	66.1
Approach			1332	3.0	1332	3.0	0.606	12.5	LOS A	6.7	48.5	0.87	0.74	0.99	65.9
East: Lavis Lane															
4	L2	All MCs	132	2.0	132	2.0	0.887	75.7	LOS F[11]	10.0	73.9	1.00	1.50	2.37	34.2
5	T1	All MCs	57	16.3	57	16.3	0.887	46.0	LOS D[11]	10.0	73.9	1.00	1.50	2.37	32.0
6	R2	All MCs	103	3.8	103	3.8	0.887	51.4	LOS D[11]	10.0	73.9	1.00	1.50	2.37	34.0
6u	U	All MCs	5	75.0	5	75.0	0.887	58.5	LOS E[11]	10.0	73.9	1.00	1.50	2.37	30.1
Approach			296	6.7	296	6.7	0.887	61.3	LOS E[11]	10.0	73.9	1.00	1.50	2.37	33.6
North: Nelson Bay Road															
7	L2	All MCs	12	0.0	12	0.0	0.521	9.0	LOS A	4.6	32.5	0.72	0.61	0.72	55.1
8	T1	All MCs	1386	2.6	1386	2.6	0.790	23.4	LOS B	12.9	94.6	0.83	0.69	0.91	67.0
9	R2	All MCs	308	14.5	308	14.5	0.790	19.2	LOS B	12.9	94.6	0.90	0.74	1.04	56.6
9u	U	All MCs	3	0.0	3	0.0	0.790	21.9	LOS B	12.9	94.6	0.90	0.74	1.04	65.4
Approach			1708	4.7	1708	4.7	0.790	22.5	LOS B	12.9	94.6	0.84	0.70	0.93	64.8
West: Cabbage Tree Road															
10	L2	All MCs	445	4.7	445	4.7	0.639	9.4	LOS A	4.8	35.2	0.91	0.97	1.18	57.1
11	T1	All MCs	51	7.7	51	7.7	0.516	9.9	LOS A	3.0	22.4	0.86	0.97	1.05	45.3
12	R2	All MCs	186	3.5	186	3.5	0.516	16.2	LOS B	3.0	22.4	0.86	0.97	1.05	52.7
12u	U	All MCs	9	85.7	9	85.7	0.516	24.3	LOS B	3.0	22.4	0.86	0.97	1.05	45.7
Approach			691	5.7	691	5.7	0.639	11.5	LOS A	4.8	35.2	0.89	0.97	1.13	54.5
All Vehicles			4026	4.4	4026	4.4	0.887	20.2	LOS B	12.9	94.6	0.87	0.82	1.09	59.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Site: 203 [203_EXAM Nelson Bay Rd On-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing AM Peak - 10 Year Growth
Peak Hour: 6:00am - 7:00am
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	4	100.0	4	100.0	0.004	6.7	LOS A	0.0	0.0	0.00	0.42	0.00	46.9
5	T1	All MCs	1	0.0	1	0.0	0.004	0.0	LOS A	0.0	0.0	0.00	0.42	0.00	54.2
Approach			5	75.0	5	75.0	0.004	5.0	NA	0.0	0.0	0.00	0.42	0.00	48.5
West: Coxs Lane															
11	T1	All MCs	4	100.0	4	100.0	0.006	0.0	LOS A	0.0	0.2	0.04	0.34	0.04	56.1
12	R2	All MCs	5	0.0	5	0.0	0.006	5.5	LOS A	0.0	0.2	0.04	0.34	0.04	54.4
Approach			9	42.9	9	42.9	0.006	3.1	NA	0.0	0.2	0.04	0.34	0.04	55.0
All Vehicles			14	54.5	14	54.5	0.006	3.8	NA	0.0	0.2	0.02	0.37	0.02	52.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 207 [207_EXPM Nelson Bay Rd On-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing PM Peak - 10 Year Growth
Peak Hour: 3:15pm - 4:15pm
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	1	0.0	1	0.0	0.002	5.5	LOS A	0.0	0.0	0.00	0.20	0.00	54.8
5	T1	All MCs	3	0.0	3	0.0	0.002	0.0	LOS A	0.0	0.0	0.00	0.20	0.00	57.7
Approach			4	0.0	4	0.0	0.002	1.8	NA	0.0	0.0	0.00	0.20	0.00	56.7
West: Coxs Lane															
11	T1	All MCs	5	25.0	5	25.0	0.005	0.0	LOS A	0.0	0.1	0.02	0.20	0.02	57.2
12	R2	All MCs	3	0.0	3	0.0	0.005	5.5	LOS A	0.0	0.1	0.02	0.20	0.02	55.2
Approach			8	16.7	8	16.7	0.005	1.8	NA	0.0	0.1	0.02	0.20	0.02	56.4
All Vehicles			12	11.1	12	11.1	0.005	1.8	NA	0.0	0.1	0.01	0.20	0.01	56.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 303 [303_EXAM Nelson Bay Rd Off-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing AM Peak - 10 Year Growth
Peak Hour: 7:30am - 8:30am
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	4	0.0	4	0.0	0.003	5.5	LOS A	0.0	0.1	0.02	0.58	0.02	52.8
3	R2	All MCs	1	0.0	1	0.0	0.003	5.7	LOS A	0.0	0.1	0.02	0.58	0.02	51.1
Approach			5	0.0	5	0.0	0.003	5.6	LOS A	0.0	0.1	0.02	0.58	0.02	52.4
East: Coxs Lane															
5	T1	All MCs	1	0.0	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			1	0.0	1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	5	0.0	5	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			5	0.0	5	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			12	0.0	12	0.0	0.003	2.5	NA	0.0	0.1	0.01	0.26	0.01	56.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 307 [307_EXPM Nelson Bay Rd Off-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	5	25.0	5	25.0	0.006	5.8	LOS A	0.0	0.2	0.06	0.57	0.06	51.7
3	R2	All MCs	3	50.0	3	50.0	0.006	6.4	LOS A	0.0	0.2	0.06	0.57	0.06	48.4
Approach			8	33.3	8	33.3	0.006	6.0	LOS A	0.0	0.2	0.06	0.57	0.06	50.7
East: Coxs Lane															
5	T1	All MCs	9	14.3	9	14.3	0.005	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			9	14.3	9	14.3	0.005	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	14	18.2	14	18.2	0.008	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			14	18.2	14	18.2	0.008	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			32	20.8	32	20.8	0.008	1.5	NA	0.0	0.2	0.01	0.14	0.01	57.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 403 [403_EXAM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing AM Peak - 10 Year Growth
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	22	5.9	22	5.9	0.391	7.8	LOS A	2.9	21.0	0.41	0.51	0.41	62.7
11	T1	All MCs	1289	3.7	1289	3.7	0.530	10.7	LOS A	4.8	34.9	0.43	0.52	0.43	70.3
12	R2	All MCs	59	8.9	59	8.9	0.530	14.7	LOS B	4.8	34.9	0.44	0.53	0.44	59.9
12u	U	All MCs	21	0.0	21	0.0	0.530	17.7	LOS B	4.8	34.9	0.44	0.53	0.44	60.3
Approach			1392	3.9	1392	3.9	0.530	10.9	LOS A	4.8	34.9	0.43	0.52	0.43	69.6
East: Seaside Boulevard															
1	L2	All MCs	300	0.9	300	0.9	0.420	58.4	LOS E[11]	2.8	19.9	0.87	0.86	0.99	57.1
2	T1	All MCs	4	33.3	4	33.3	0.188	11.9	LOS A	0.9	6.7	0.79	0.87	0.79	38.5
3	R2	All MCs	83	3.2	83	3.2	0.188	16.1	LOS B	0.9	6.7	0.79	0.87	0.79	52.0
3u	U	All MCs	4	0.0	4	0.0	0.188	18.4	LOS B	0.9	6.7	0.79	0.87	0.79	47.0
Approach			391	1.7	391	1.7	0.420	48.5	LOS D[11]	2.8	19.9	0.85	0.86	0.94	55.5
North: Nelson Bay Road															
4	L2	All MCs	21	31.3	21	31.3	0.322	8.7	LOS A	2.1	15.2	0.39	0.52	0.39	60.8
5	T1	All MCs	1336	4.4	1336	4.4	0.603	22.5	LOS B	5.6	40.8	0.45	0.53	0.45	70.1
6	R2	All MCs	4	33.3	4	33.3	0.603	15.7	LOS B	5.6	40.8	0.48	0.54	0.48	44.5
6u	U	All MCs	34	3.8	34	3.8	0.603	18.0	LOS B	5.6	40.8	0.48	0.54	0.48	60.0
Approach			1395	4.9	1395	4.9	0.603	22.2	LOS B	5.6	40.8	0.45	0.53	0.45	69.6
West: Fullerton Cove Road															
7	L2	All MCs	7	0.0	7	0.0	0.110	14.3	LOS A	0.5	3.6	0.70	0.85	0.70	53.2
8	T1	All MCs	4	0.0	4	0.0	0.110	8.9	LOS A	0.5	3.6	0.70	0.85	0.70	46.0
9	R2	All MCs	54	12.2	54	12.2	0.110	15.5	LOS B	0.5	3.6	0.70	0.85	0.70	50.3
9u	U	All MCs	1	0.0	1	0.0	0.110	17.8	LOS B	0.5	3.6	0.70	0.85	0.70	30.0
Approach			66	10.0	66	10.0	0.110	15.0	LOS B	0.5	3.6	0.70	0.85	0.70	50.0
All Vehicles			3243	4.2	3243	4.2	0.603	20.4	LOS B	5.6	40.8	0.50	0.58	0.51	67.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Site: 407 [407_EXPM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd - 10 Year Growth (Site Folder: Existing 10 Year Growth)]

Scenario: Existing PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	59	4.4	59	4.4	0.432	7.3	LOS A	3.6	25.8	0.32	0.49	0.32	64.0
11	T1	All MCs	1261	1.9	1261	1.9	0.586	9.8	LOS A	6.3	44.7	0.34	0.52	0.34	70.9
12	R2	All MCs	320	2.5	320	2.5	0.586	14.2	LOS A	6.3	44.7	0.35	0.55	0.35	59.9
12u	U	All MCs	12	11.1	12	11.1	0.586	17.7	LOS B	6.3	44.7	0.35	0.55	0.35	59.6
Approach			1651	2.2	1651	2.2	0.586	10.6	LOS A	6.3	44.7	0.34	0.52	0.34	68.2
East: Seaside Boulevard															
1	L2	All MCs	129	3.1	129	3.1	0.245	43.1	LOS D[11]	1.6	11.3	0.91	0.83	0.91	57.1
2	T1	All MCs	8	33.3	8	33.3	0.141	12.7	LOS A	0.7	5.5	0.85	0.89	0.85	38.1
3	R2	All MCs	36	3.7	36	3.7	0.141	16.9	LOS B	0.7	5.5	0.85	0.89	0.85	51.5
3u	U	All MCs	5	25.0	5	25.0	0.141	20.8	LOS B	0.7	5.5	0.85	0.89	0.85	46.0
Approach			178	5.2	178	5.2	0.245	35.9	LOS C	1.6	11.3	0.90	0.85	0.90	54.6
North: Nelson Bay Road															
4	L2	All MCs	37	3.6	37	3.6	0.420	10.0	LOS A	2.9	20.6	0.64	0.63	0.64	60.0
5	T1	All MCs	1516	2.6	1516	2.6	0.786	21.3	LOS B	11.9	85.3	0.79	0.74	0.94	67.7
6	R2	All MCs	5	25.0	5	25.0	0.786	20.0	LOS B	11.9	85.3	0.85	0.78	1.05	42.9
6u	U	All MCs	8	16.7	8	16.7	0.786	22.9	LOS B	11.9	85.3	0.85	0.78	1.05	57.3
Approach			1566	2.8	1566	2.8	0.786	21.0	LOS B	11.9	85.3	0.79	0.74	0.93	67.4
West: Fullerton Cove Road															
7	L2	All MCs	1	0.0	1	0.0	0.074	13.0	LOS A	0.3	2.4	0.71	0.85	0.71	52.6
8	T1	All MCs	7	20.0	7	20.0	0.074	10.8	LOS A	0.3	2.4	0.71	0.85	0.71	45.3
9	R2	All MCs	36	0.0	36	0.0	0.074	15.7	LOS B	0.3	2.4	0.71	0.85	0.71	52.4
9u	U	All MCs	1	0.0	1	0.0	0.074	18.5	LOS B	0.3	2.4	0.71	0.85	0.71	29.7
Approach			45	2.9	45	2.9	0.074	15.0	LOS B	0.3	2.4	0.71	0.85	0.71	50.7
All Vehicles			3439	2.6	3439	2.6	0.786	16.7	LOS B	11.9	85.3	0.58	0.64	0.64	66.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Site: 104 [104_PRAM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed AM Peak - 10 Year Growth
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	109	20.5	109	20.5	0.651	10.9	LOS A	7.7	56.1	0.84	0.71	0.94	58.6
2	T1	All MCs	1353	3.4	1353	3.4	0.651	12.2	LOS A	7.7	56.1	0.85	0.73	0.98	67.2
3	R2	All MCs	66	0.0	66	0.0	0.651	19.7	LOS B	7.5	53.5	0.87	0.76	1.04	53.3
3u	U	All MCs	1	0.0	1	0.0	0.651	23.1	LOS B	7.5	53.5	0.87	0.76	1.04	66.1
Approach			1530	4.4	1530	4.4	0.651	12.4	LOS A	7.7	56.1	0.85	0.73	0.98	65.7
East: Lavis Lane															
4	L2	All MCs	99	1.3	99	1.3	0.461	15.8	LOS B	2.9	20.7	0.88	0.95	1.07	50.3
5	T1	All MCs	41	12.9	41	12.9	0.461	10.3	LOS A	2.9	20.7	0.88	0.95	1.07	45.7
6	R2	All MCs	80	3.3	80	3.3	0.461	16.0	LOS B	2.9	20.7	0.88	0.95	1.07	49.8
6u	U	All MCs	1	0.0	1	0.0	0.461	18.0	LOS B	2.9	20.7	0.88	0.95	1.07	42.5
Approach			221	4.2	221	4.2	0.461	14.9	LOS B	2.9	20.7	0.88	0.95	1.07	49.1
North: Nelson Bay Road															
7	L2	All MCs	7	0.0	7	0.0	0.433	8.6	LOS A	3.5	25.4	0.63	0.58	0.63	55.6
8	T1	All MCs	1171	5.1	1171	5.1	0.656	11.7	LOS A	7.1	52.6	0.70	0.61	0.70	67.9
9	R2	All MCs	270	12.7	270	12.7	0.656	16.4	LOS B	7.1	52.6	0.74	0.63	0.74	57.8
9u	U	All MCs	5	0.0	5	0.0	0.656	19.4	LOS B	7.1	52.6	0.74	0.63	0.74	67.0
Approach			1452	6.5	1452	6.5	0.656	12.6	LOS A	7.1	52.6	0.71	0.61	0.71	65.7
West: Cabbage Tree Road															
10	L2	All MCs	358	10.3	358	10.3	0.588	9.9	LOS A	4.1	31.2	0.91	0.96	1.15	55.9
11	T1	All MCs	37	10.7	37	10.7	0.500	11.0	LOS A	2.7	22.6	0.86	1.00	1.06	44.3
12	R2	All MCs	128	21.8	128	21.8	0.500	18.4	LOS B	2.7	22.6	0.86	1.00	1.06	49.0
12u	U	All MCs	17	84.6	17	84.6	0.500	25.4	LOS B	2.7	22.6	0.86	1.00	1.06	44.8
Approach			540	15.4	540	15.4	0.588	12.5	LOS A	4.1	31.2	0.90	0.98	1.12	52.6
All Vehicles			3743	6.8	3743	6.8	0.656	12.7	LOS A	7.7	56.1	0.80	0.73	0.90	62.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 108 [108_PRPM Nelson Bay Rd, Cabbage Tree Rd and Lavis Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Cabbage Tree Road and Lavis Lane
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	120	22.0	120	22.0	0.622	11.5	LOS A	7.2	52.7	0.88	0.73	0.99	58.3
2	T1	All MCs	1181	2.4	1181	2.4	0.622	12.6	LOS A	7.2	52.7	0.89	0.75	1.03	67.1
3	R2	All MCs	47	5.6	47	5.6	0.622	20.6	LOS B	6.8	48.8	0.90	0.78	1.08	53.2
3u	U	All MCs	1	0.0	1	0.0	0.622	23.7	LOS B	6.8	48.8	0.90	0.78	1.08	66.0
Approach			1349	4.3	1349	4.3	0.622	12.8	LOS A	7.2	52.7	0.89	0.75	1.03	65.6
East: Lavis Lane															
4	L2	All MCs	132	2.0	132	2.0	0.945	121.7	LOS F[11]	13.1	96.8	1.00	1.72	2.91	29.2
5	T1	All MCs	57	16.3	57	16.3	0.945	65.0	LOS E[11]	13.1	96.8	1.00	1.72	2.91	27.6
6	R2	All MCs	103	3.8	103	3.8	0.945	70.3	LOS E[11]	13.1	96.8	1.00	1.72	2.91	29.0
6u	U	All MCs	5	75.0	5	75.0	0.945	77.7	LOS F[11]	13.1	96.8	1.00	1.72	2.91	26.2
Approach			296	6.7	296	6.7	0.945	92.3	LOS F[11]	13.1	96.8	1.00	1.72	2.91	28.8
North: Nelson Bay Road															
7	L2	All MCs	12	0.0	12	0.0	0.535	9.3	LOS A	4.7	33.7	0.76	0.63	0.76	54.9
8	T1	All MCs	1388	2.7	1388	2.7	0.811	35.1	LOS C	14.4	105.6	0.87	0.72	0.99	66.5
9	R2	All MCs	308	14.5	308	14.5	0.811	20.2	LOS B	14.4	105.6	0.94	0.79	1.14	56.2
9u	U	All MCs	3	0.0	3	0.0	0.811	23.0	LOS B	14.4	105.6	0.94	0.79	1.14	64.9
Approach			1710	4.8	1710	4.8	0.811	32.2	LOS C	14.4	105.6	0.88	0.73	1.01	64.3
West: Cabbage Tree Road															
10	L2	All MCs	445	4.7	445	4.7	0.647	9.7	LOS A	5.0	36.2	0.92	0.97	1.20	56.8
11	T1	All MCs	51	7.7	51	7.7	0.591	11.1	LOS A	3.6	28.0	0.88	1.01	1.14	44.5
12	R2	All MCs	206	10.4	206	10.4	0.591	17.9	LOS B	3.6	28.0	0.88	1.01	1.14	50.7
12u	U	All MCs	9	85.7	9	85.7	0.591	25.6	LOS B	3.6	28.0	0.88	1.01	1.14	44.9
Approach			711	7.6	711	7.6	0.647	12.4	LOS A	5.0	36.2	0.91	0.99	1.18	53.6
All Vehicles			4066	5.3	4066	5.3	0.945	26.7	LOS B	14.4	105.6	0.90	0.86	1.19	57.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Site: 204 [204_PRAM Nelson Bay Rd On-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed AM Peak - 10 Year Growth
Peak Hour: 6:00am - 7:00am
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	36	100.0	36	100.0	0.033	6.7	LOS A	0.0	0.0	0.00	0.54	0.00	45.8
5	T1	All MCs	1	0.0	1	0.0	0.033	0.0	LOS A	0.0	0.0	0.00	0.54	0.00	52.8
Approach			37	96.4	37	96.4	0.033	6.5	NA	0.0	0.0	0.00	0.54	0.00	46.0
West: Coxs Lane															
11	T1	All MCs	45	78.9	45	78.9	0.037	0.0	LOS A	0.0	0.3	0.03	0.07	0.03	57.5
12	R2	All MCs	5	0.0	5	0.0	0.037	5.6	LOS A	0.0	0.3	0.03	0.07	0.03	55.4
Approach			50	70.7	50	70.7	0.037	0.6	NA	0.0	0.3	0.03	0.07	0.03	57.2
All Vehicles			87	81.6	87	81.6	0.037	3.1	NA	0.0	0.3	0.02	0.27	0.02	51.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 208 [208_PRPM Nelson Bay Rd On-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed PM Peak - 10 Year Growth
Peak Hour: 3:15pm - 4:15pm
Intersection of Nelson Bay Road On-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
East: Coxs Lane															
4	L2	All MCs	42	74.5	42	74.5	0.036	6.4	LOS A	0.0	0.0	0.00	0.53	0.00	48.5
5	T1	All MCs	3	0.0	3	0.0	0.036	0.0	LOS A	0.0	0.0	0.00	0.53	0.00	54.8
Approach			45	70.2	45	70.2	0.036	6.0	NA	0.0	0.0	0.00	0.53	0.00	48.8
West: Coxs Lane															
11	T1	All MCs	37	89.3	37	89.3	0.031	0.0	LOS A	0.0	0.2	0.02	0.04	0.02	57.2
12	R2	All MCs	3	0.0	3	0.0	0.031	5.6	LOS A	0.0	0.2	0.02	0.04	0.02	55.2
Approach			39	83.3	39	83.3	0.031	0.4	NA	0.0	0.2	0.02	0.04	0.02	57.1
All Vehicles			84	76.3	84	76.3	0.036	3.4	NA	0.0	0.2	0.01	0.30	0.01	52.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 304 [304_PRAM Nelson Bay Rd Off-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed AM Peak - 10 Year Growth
Peak Hour: 7:30am - 8:30am
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	4	0.0	4	0.0	0.048	5.5	LOS A	0.2	1.7	0.03	0.60	0.03	52.7
3	R2	All MCs	42	74.5	42	74.5	0.048	6.7	LOS A	0.2	1.7	0.03	0.60	0.03	47.3
Approach			46	68.2	46	68.2	0.048	6.6	LOS A	0.2	1.7	0.03	0.60	0.03	47.8
East: Coxs Lane															
5	T1	All MCs	1	0.0	1	0.0	0.001	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			1	0.0	1	0.0	0.001	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	5	0.0	5	0.0	0.003	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			5	0.0	5	0.0	0.003	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			53	59.7	53	59.7	0.048	5.8	NA	0.2	1.7	0.03	0.53	0.03	49.0

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 308 [308_PRPM Nelson Bay Rd Off-Ramp and Coxs Ln - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road Off-Ramp and Coxs Lane
Site Category: (None)
Give-Way (Two-Way)
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
1	L2	All MCs	5	25.0	5	25.0	0.044	5.9	LOS A	0.1	1.8	0.09	0.59	0.09	51.6
3	R2	All MCs	34	96.2	34	96.2	0.044	7.1	LOS A	0.1	1.8	0.09	0.59	0.09	46.2
Approach			39	86.7	39	86.7	0.044	7.0	LOS A	0.1	1.8	0.09	0.59	0.09	47.0
East: Coxs Lane															
5	T1	All MCs	9	14.3	9	14.3	0.005	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			9	14.3	9	14.3	0.005	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
West: Coxs Lane															
11	T1	All MCs	14	18.2	14	18.2	0.008	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			14	18.2	14	18.2	0.008	0.0	NA	0.0	0.0	0.00	0.00	0.00	60.0
All Vehicles			63	60.4	63	60.4	0.044	4.3	NA	0.1	1.8	0.05	0.37	0.05	51.1

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Site: 404 [404_PRAM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed AM Peak - 10 Year Growth
Peak Hour: 7:15am - 8:15am
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	22	5.9	22	5.9	0.415	8.1	LOS A	3.0	21.7	0.48	0.54	0.48	61.9
11	T1	All MCs	1308	4.7	1308	4.7	0.563	11.8	LOS A	5.0	36.5	0.51	0.55	0.51	69.4
12	R2	All MCs	59	8.9	59	8.9	0.563	15.0	LOS B	5.0	36.5	0.52	0.56	0.52	59.4
12u	U	All MCs	21	0.0	21	0.0	0.563	18.0	LOS B	5.0	36.5	0.52	0.56	0.52	59.8
Approach			1411	4.9	1411	4.9	0.563	12.0	LOS A	5.0	36.5	0.51	0.55	0.51	68.7
East: Seaside Boulevard															
1	L2	All MCs	300	0.9	300	0.9	0.447	85.0	LOS F[11]	3.2	22.3	0.89	0.90	1.06	56.1
2	T1	All MCs	4	33.3	4	33.3	0.199	12.6	LOS A	1.0	7.3	0.81	0.88	0.81	38.2
3	R2	All MCs	83	3.2	83	3.2	0.199	16.7	LOS B	1.0	7.3	0.81	0.88	0.81	51.6
3u	U	All MCs	4	0.0	4	0.0	0.199	19.0	LOS B	1.0	7.3	0.81	0.88	0.81	46.7
Approach			391	1.7	391	1.7	0.447	69.1	LOS E[11]	3.2	22.3	0.87	0.89	1.01	54.7
North: Nelson Bay Road															
4	L2	All MCs	21	31.3	21	31.3	0.341	8.7	LOS A	2.2	16.5	0.40	0.52	0.40	60.7
5	T1	All MCs	1349	5.4	1349	5.4	0.637	30.8	LOS C	6.3	47.1	0.48	0.54	0.48	69.5
6	R2	All MCs	4	33.3	4	33.3	0.637	15.7	LOS B	6.3	47.1	0.51	0.55	0.51	44.1
6u	U	All MCs	74	48.6	74	48.6	0.637	17.0	LOS B	6.3	47.1	0.51	0.55	0.51	57.9
Approach			1448	8.1	1448	8.1	0.637	29.7	LOS C	6.3	47.1	0.48	0.54	0.48	68.6
West: Fullerton Cove Road															
7	L2	All MCs	7	0.0	7	0.0	0.121	17.0	LOS B	0.6	4.2	0.74	0.86	0.74	52.4
8	T1	All MCs	4	0.0	4	0.0	0.121	9.5	LOS A	0.6	4.2	0.74	0.86	0.74	45.4
9	R2	All MCs	54	12.2	54	12.2	0.121	16.2	LOS B	0.6	4.2	0.74	0.86	0.74	49.6
9u	U	All MCs	1	0.0	1	0.0	0.121	18.5	LOS B	0.6	4.2	0.74	0.86	0.74	29.5
Approach			66	10.0	66	10.0	0.121	15.9	LOS B	0.6	4.2	0.74	0.86	0.74	49.3
All Vehicles			3316	6.0	3316	6.0	0.637	26.5	LOS B	6.3	47.1	0.54	0.59	0.56	66.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Site: 408 [408_PRPM Nelson Bay Rd, Fullerton Cove Rd and Seaside Blvd - 10 Year Growth (Site Folder: Development 10 Year Growth)]

Scenario: Proposed PM Peak - 10 Year Growth
Peak Hour: 4:00pm - 5:00pm
Intersection of Nelson Bay Road, Fullerton Cove Road and Seaside Boulevard
Site Category: (None)
Roundabout
Design Life Analysis (Final Year): Results for 10 years

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Nelson Bay Road															
10	L2	All MCs	59	4.4	59	4.4	0.461	7.7	LOS A	3.7	26.8	0.43	0.51	0.43	62.7
11	T1	All MCs	1275	3.0	1275	3.0	0.625	10.6	LOS A	6.5	46.8	0.46	0.54	0.46	69.7
12	R2	All MCs	320	2.5	320	2.5	0.625	14.6	LOS B	6.5	46.8	0.48	0.56	0.48	59.2
12u	U	All MCs	12	11.1	12	11.1	0.625	18.1	LOS B	6.5	46.8	0.48	0.56	0.48	58.9
Approach			1666	3.0	1666	3.0	0.625	11.3	LOS A	6.5	46.8	0.46	0.55	0.46	67.1
East: Seaside Boulevard															
1	L2	All MCs	129	3.1	129	3.1	0.276	75.1	LOS F[11]	1.8	13.1	0.95	0.85	0.95	56.5
2	T1	All MCs	8	33.3	8	33.3	0.158	13.6	LOS A	0.8	6.4	0.88	0.91	0.88	37.6
3	R2	All MCs	36	3.7	36	3.7	0.158	17.7	LOS B	0.8	6.4	0.88	0.91	0.88	50.9
3u	U	All MCs	5	25.0	5	25.0	0.158	21.8	LOS B	0.8	6.4	0.88	0.91	0.88	45.6
Approach			178	5.2	178	5.2	0.276	59.3	LOS E[11]	1.8	13.1	0.93	0.87	0.93	54.0
North: Nelson Bay Road															
4	L2	All MCs	37	3.6	37	3.6	0.448	10.0	LOS A	3.2	23.2	0.67	0.64	0.67	59.8
5	T1	All MCs	1535	3.5	1535	3.5	0.839	31.6	LOS C	15.5	114.6	0.86	0.79	1.08	66.4
6	R2	All MCs	5	25.0	5	25.0	0.839	21.8	LOS B	15.5	114.6	0.93	0.86	1.24	42.0
6u	U	All MCs	47	74.7	47	74.7	0.839	22.8	LOS B	15.5	114.6	0.93	0.86	1.24	54.3
Approach			1624	5.7	1624	5.7	0.839	30.8	LOS C	15.5	114.6	0.85	0.79	1.07	65.7
West: Fullerton Cove Road															
7	L2	All MCs	1	0.0	1	0.0	0.084	14.7	LOS B	0.4	2.9	0.76	0.87	0.76	51.7
8	T1	All MCs	7	20.0	7	20.0	0.084	11.6	LOS A	0.4	2.9	0.76	0.87	0.76	44.7
9	R2	All MCs	36	0.0	36	0.0	0.084	16.5	LOS B	0.4	2.9	0.76	0.87	0.76	51.6
9u	U	All MCs	1	0.0	1	0.0	0.084	19.2	LOS B	0.4	2.9	0.76	0.87	0.76	29.2
Approach			45	2.9	45	2.9	0.084	15.8	LOS B	0.4	2.9	0.76	0.87	0.76	49.9
All Vehicles			3512	4.3	3512	4.3	0.839	22.8	LOS B	15.5	114.6	0.67	0.68	0.77	65.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Roundabout Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

11 Level of Service is worse than the Level of Service Target specified in the Parameter Settings dialog.

Appendix L

Social impact assessment

Social Impact Assessment

Stockton Quarry Dry Sand Extraction Project, Fullerton Cove, NSW

Boral Resources (NSW) Pty Ltd

June 2023

AIGISGROUP

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18 July 2023

Abbreviations

ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
ANZSCO	Australian and New Zealand Standard Classification of Occupations.
BOCSAR	Bureau of Crime Statistics and Research (NSW)
DPE	Department of Planning and Environment (NSW)
EIS	Environmental Impact Statement
Ha	Hectares
Km	Kilometres
LGA	Local Government Area
Mt	Million tonnes
PSC	Port Stephens Council
SA1	Statistical Area Level 1 (ABS)
SA2	Statistical Area Level 2
SA4	Statistical Area Level 4
SAL	Suburbs and Localities (ABS)
SEIFA	Socioeconomic Indexes for Areas (ABS)[1]
SIA	Social Impact Assessment
SIMP	Social Impact Management Plan
SIMT	Social Impact Management Toolbox (DPE)
SSD	State Significant Development
SUA	Significant Urban Area (ABS)
Tpa	Tonnes per annum

[1] Comprising: IRSAD (Index of Relative Socioeconomic Advantage and Disadvantage); IRSD (Index of Relative Social Disadvantage; IEO; Index of Education and Occupation; IER (Index of Economic Resources).

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1 Introductory material

1.1 Purpose of report

This report presents a Social Impact Assessment (SIA) prepared on behalf of Boral Resources (NSW) Pty Ltd (Boral Resources). The SIA addresses a proposal for dry sand extraction at Boral Resources' existing Stockton Sand Quarry. The project is designated State Significant Development (SSD) and identified as SSD 52984213. The SIA forms part of the Environmental Impact Statement (EIS) for the project.

The SIA has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning and Environment (DPE) for the project. The SEARs include[2], *inter alia:*

- Provide a Social Impact Assessment prepared in accordance with the Social Impact Assessment Guideline for State Significant Projects, paying particular consideration to:
  - how the development might affect people's way of life, community,
  - access to and use of infrastructure, services and facilities, culture,
  - health and wellbeing, surroundings, personal and property rights,
  - decision-making systems, and fears and aspirations;
    - the principles in Section 1.2 of the guideline;
    - the review questions in Appendix C of the guideline.

Table 1 identifies the sections of the SIA in which these SEARs requirements are addressed.

Table 1: SIA SEARs compliance directory

SEARs requirement	Relevant SIA content
Provide a Social Impact Assessment prepared in accordance with the Social Impact Assessment Guideline for State Significant Projects, paying particular consideration to: • how the development might affect people's way of life, community, access to and use of infrastructure, services and facilities, culture, health and wellbeing, surroundings, personal and property rights, decision-making systems, and fears and aspirations.	Section 1.4; Section 3; Section 4; Section 5; Section 6.
The principles in Section 1.2 of the guideline.	Refer to Annexure 2 (SIA principles matrix)
The review questions in Appendix C of the guideline.	Refer to Annexure 2 (DPE Guidelines compliance matrix)
The EIS must detail the engagement undertaken and demonstrate how it was consistent with the Undertaking Engagement Guidelines for State Significant Projects. The EIS must detail how issues raised and feedback provided have been considered and responded to in the project.	Section 3; Section 5; Section 6

[2] DPE SEARs, SSD-52984213 (18 January 2023), page 7.

1.2 Relationship of this report to the SIA for the SSD 9490 application

This SIA draws on the SIA prepared for SSD 9490 by Element Environment Pty Ltd (Element), which was initially prepared in 2019, and was subsequently amended in response to submissions made to DPE during the exhibition stage. The Element SIA is discussed further in Section 2. As SSD 9490 proposes a project of larger scale, and potentially social impact, certain material such as initial scoping, is adopted from that SIA, as they are considered as remaining relevant in terms of the reduced project scale within the same local and regional context.

1.3 Site location and project description

1.3.1 Site location

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets. As shown in Figure 1, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Lane over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Figure 1

FULLERTON COVE ROAD
GEORGE STREET
WILLOW LANE
FULLERTON COVE
COXS LANE
Lot 1
DP1006399
Crown Reserve
Lot 7300
DP1130730
Lot 3
DP664552
Lot 2
DP1006399
NELSON BAY ROAD
Lot 2
DP1006399
Lot 1
DP1006399
STANLEY PARK
The Cove Village
Fern Bay Seaside Village
Worimi State Conservation Area
Stockton Beach
Sygna wreck
Worimi Regional Park
TASMAN SEA
Stockton Bight
Project features
Stockton Sand Quarry boundary
Topographic features
National Park
Worimi Regional Park
Worimi State Conservation Area
Cadastre (Lot boundaries)
0 200 400 600 800 m
CAMBIUM GROUP

1.3.2 Project overview

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area) granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach granted by the DPE in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, in local, regional and Sydney markets, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State Significant Development (SSD) application (SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

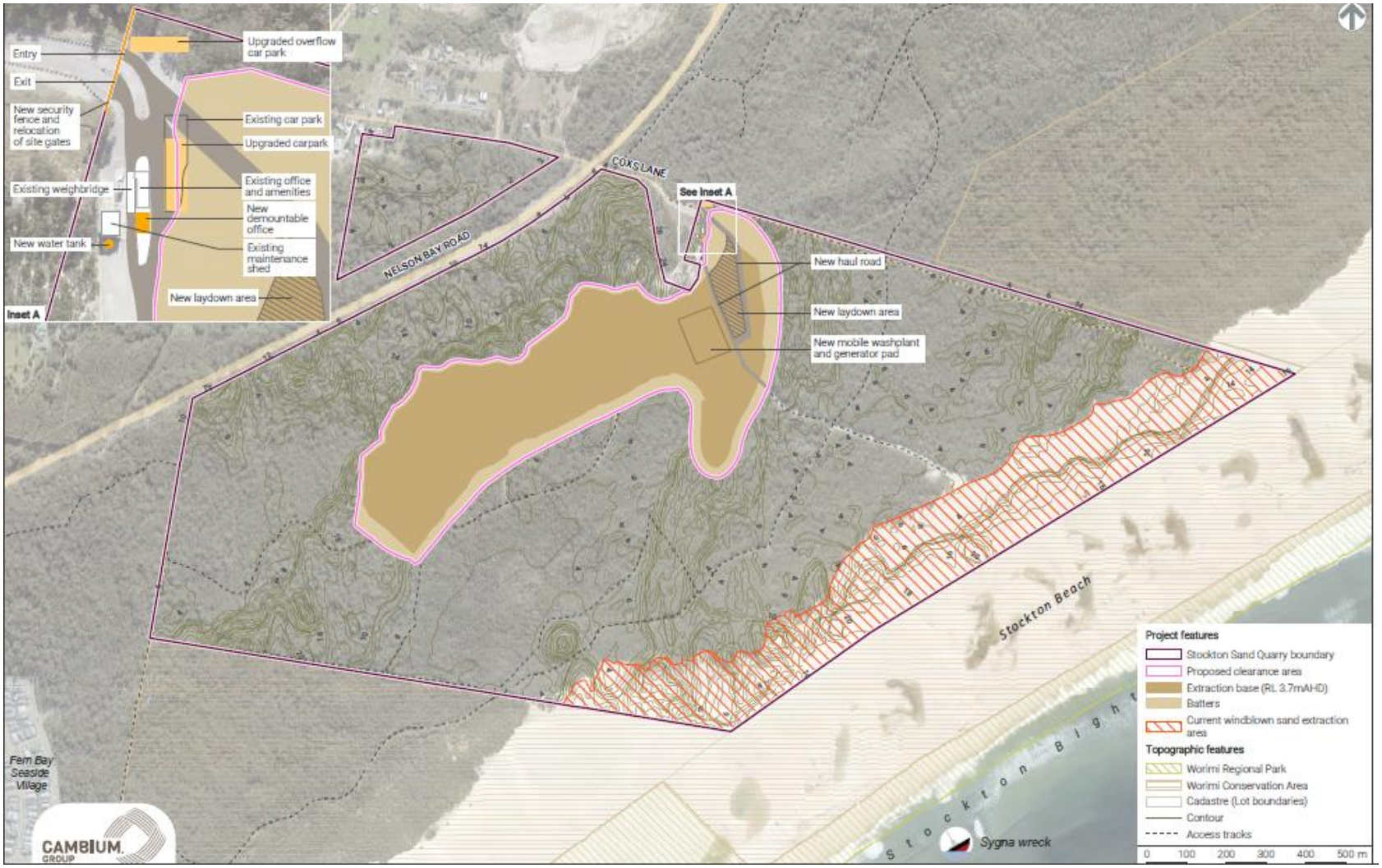
Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source combined with water availability, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 2 shows the quarry, the project, and the existing windblown project.

Figure 2


Entry
Exit
New security fence and relocation of site gates
Existing weighbridge
New water tank
Upgraded overflow car park
Existing car park
Upgraded carpark
Existing office and amenities
New demountable office
Existing maintenance shed
New laydown area
Inset A
COXS LANE
NELSON BAY ROAD
See inset A
New haul road
New laydown area
New mobile washplant and generator pad
Stockton Beach
Stockton Bight
Sygna wreck
Fern Bay Seaside Village
CAMBIUM GROUP
Project features
Stockton Sand Quarry boundary
Proposed clearance area
Extraction base (RL 3.7mAHD)
Batters
Current windblown sand extraction area
Topographic features
Worimi Regional Park
Worimi Conservation Area
Cadastre (Lot boundaries)
Contour
Access tracks
0 100 200 300 400 500 m

1.3.3 Project description – current application

As shown in Figure 2, the project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to a minimum 0.7 m above the water table, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

Sand would be extracted in five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project mirror the first five stages of the dredge application (SSD 9490). This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in Figure 2, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

1.4 Planning context

This section of the report examines the relationship between the proposed development and regional planning strategies published by relevant government agencies. The key focus of the analysis is the potential for the proposed project to contribute to achievement of local and regional objectives, in the context of the suitability of the site for this purpose. Suitability is interpreted as being established, due to continuous extraction operations under successive consents since the 1970s.

1.4.1 Planning context discussed in SSD 9490 SIA

The SSD 9490 SIA (Element, 2019)[3] identified a number of local and regional strategic planning documents to which SSD 9490 was relevant. The same suite of documents remain generally relevant to the current SSD 52984213. Relevant content is discussed in the following sections.

[3] A revised version of the report was prepared in 2020 in response to submissions to DPE. The 2020 version of the report addressed the matters raised in submissions and how these were to be addressed. The content referred to in this section was not changed as a result.

It is noted that the *Hunter Regional Plan 2036* was superseded by the *Hunter Regional Plan 2041* in December 2022 (i.e. subsequent to the preceding SIA). The current regional plan is discussed in Section 1.4.2, in the context of the current SSD application. Other strategic planning documents referenced in the preceding SIA remain current.

1.4.2 Hunter Regional Plan 2041

The DPE Hunter Regional Plan 2041 is the overarching strategic planning framework for the Hunter Region. The Plan emphasises the need for management of a variety of resources that will support future regional growth. This includes the need to secure supply of construction materials to support the continuing demand for additional housing, and public and employment-supporting infrastructure. The proposed project is clearly consistent with this objective.

Table 2: Relationship of proposal to Hunter Region Plan 2041

Plan ref.	Hunter Region Plan element	Relevance to the project
P.11	***The 2041 Vision for the Hunter*** Productive agricultural land and natural resources are the foundations of the region's economy with greater economic diversification in growing health, defence and aerospace, energy, tourism and transport sectors.	The proposed project will support continuing use of a natural resource, on an existing site and using extraction methods consistent with past and present activity. The sand produced is a critical input in supporting the development of public and private infrastructure that will underpin social and economic progress in the Hunter.
P.87	NSW needs a reliable supply of construction materials to support continued growth. These include sand and gravel, crushed rock, recycled materials and secondary aggregates created from construction, demolition and excavation.	The proposed project will directly address this requirement through supplying the market for the next 10 years.
P.143	**PLANNING PRIORITY 5:** ***Promote sustainable use of mineral and energy resources*** Mineral and energy resources need to be managed and protected from incompatible development or encroachment that could lead to mineral resource sterilisation. This could lead to higher management costs or a reduced potential to sustain or grow rural and resource industries. The district contains regionally significant construction, mineral and energy resources such as sand, gravel, hard rock, sandstone (dimension stone), clay and coal deposits. Extraction of these resources supports major infrastructure projects, industries and agricultural businesses. Development proposals for aggregate extraction will be promoted if they are in accordance with the district planning principles and local strategic planning. They should balance economic benefits	The proposed project is consistent with this Planning Priority. It represents ongoing extraction of a regionally significant sand resource, on an established quarry site. Sand extraction will support construction and infrastructure development. The proposed activity is similar to existing activity on the site, which complies with regulatory obligations and regional strategic objectives.

Cont.	with the protection of the environment and local communities. . . Planning for these areas and the surrounding areas must ensure: • mining and quarrying remain a permissible use, with development consent, in the resource areas • appropriate land use buffers are provided between these areas and future development • these areas contribute to the longer term formation of a green corridor, both during extraction (e.g. by maintaining existing vegetation links and/or restoration on areas not being quarried or mined) and on completion of resource extraction	

1.4.3 Port Stephens Council (PSC) strategies and plans

1.4.3.1 PSC documents reviewed

The following Port Stephens Council (PSC) planning documents were reviewed:

- Economic Development Strategy.
- Local Strategic Planning Statement.

Although the existing quarry and its continued use as proposed contribute to employment and economic activity in the PSC Local Government Area (LGA), the quarry is not specifically identified in the various planning documents examined. More broadly, there is also no substantive content in relation to extractive industries activity in the LGA. However, it is noted that the Port Stephens *Local Environmental Plan 2013* identifies that extractive industries are a permissible use (with consent) on RU1 Primary Production land, as the site is currently zoned.

1.4.3.2 PSC Economic Profile[4].

It is noted that the economic profile includes the following description of mining activity: '*The Mining Division includes units that mainly extract naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas.* ***The term mining is used in the broad sense to include underground or open cut mining; dredging; quarrying***[5]*; well operations or evaporation pans; recovery from ore dumps or tailings as well as beneficiation activities (i.e. preparing, including crushing, screening, washing and flotation) and other preparation work customarily performed at the mine site, or as a part of mining activity*'.

[4] https://www.portstephens.nsw.gov.au/community/our-profile
https://app.remplan.com.au/portstephens/economy/summary?state=Djd3Czd6Ri42BdghnPn0NNSnhXhPVB

[5] Emphasis added.

The profile also includes specific ANZSCO[6] sub sectors, including *Non Metallic Mineral Mining; 0911 Gravel and Sand Quarrying*.

Table 3: Headline economic indicators PSC LGA

Economic metric	LMCC value
Gross Regional Product (GRP, 2021)	$5.771 billion
Regional output	$14.107 billion
Mining output	$599.908
Mining % of regional output	4.25%
Total employment	31,070
Mining employment	491
Mining % of employment	1.6%
Regional exports	$6.985.0 billion
Mining exports	$489.689
Mining % regional exports	7.0%
Construction output	$1.718 billion
Construction % of regional output	12.2%

Sand produced by the quarry is a critical construction input. Construction makes the third-largest contribution to regional output, behind only manufacturing and public administration and safety (32.8% and 16.1%, respectively).

[6] Australian and New Zealand Standard Classification of Occupations.

2 Methodology

The proposed dry extraction method is consistent with the extraction methods currently used at the quarry. The project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application. Based on the consistency of extraction methods, the underlying assumption of the SIA is that any effects within the disturbance area will be consistent with those from current and previous extraction activity.

2.1 Methodological approach

The SIA has been prepared and informed by:

1. the Secretary's Environmental Assessment Requirements (SEARs) issued in respect of the dry extraction project (18 January 2023).
2. the requirements of NSW Department of Planning and Environment (DPE) *Social Impact Assessment Guideline for State Significant Projects* and its associated *Technical Supplement* (February 2023).
3. drawing on relevant material from the previously submitted SIA for *Stockton Sand Quarry Dredging*, prepared by Element Environment Pty Ltd [Element] (November 2019).

As part of the SIA, and in compliance with the DPE guidelines, engagement with local stakeholders has also been undertaken. It is noted that Element (2019) conducted local stakeholder engagement in relation to the more extensive SSD 9490 application, and that the outputs of that engagement are presumed to remain relevant, given the more limited scale of the proposed dry extraction as currently proposed, the relatively short period of time elapsed since that engagement, and comment made during stakeholder engagement demonstrating that some element of the local community is aware that the SSD 9490 consent process remains unresolved. The additional stakeholder engagement conducted for this current application has been undertaken with reference to DPE's *Undertaking Engagement Guidelines for State Significant Projects* (October 2022).

In the interests of maintaining the privacy of stakeholders, individual respondents are not personally identified in this report. Any stakeholder notified and subsequently engaged with is advised that this is the firm's approach. Compliance with the guidelines and by association, SEARs, based on the guidelines' review questions (guideline Appendix C) is presented in Annexure 2.

2.2 DPE SIA scoping process

As noted, the preceding SSD 9490 SIA addresses the larger scale sand dredging extraction application. The application of the DPE scoping tool by Element for SSD 9490 was reviewed, with the conclusion that it is appropriate to adopt those scoping outputs for the current SIA.

A copy of the summary scoping outcomes prepared by Element (2019) is presented in Annexure 3 for reference[7].

The project will be of lesser scale in terms of the risk of impacts it may produce. This lower risk of impacts corresponds with the proposed operations being similar to current and historical operations, and the lower level of impact of these when compared with the proposed dredging operations.

[7] The summary table is presented as Table 10 (page 48) in the SSD 9490 SIA.

3 Stakeholder engagement

3.1 Previous stakeholder engagement – SSD 9490 dredging project SIA 2019

Element undertook the previous stakeholder engagement activity in relation to the dredge SIA (2019). Element determined the 'area of social influence' as presented in Box 1. The area determined is identified in Figure 3. This area was also adopted for the engagement for the current proposal, as an appropriate representation of the immediate community/ population.

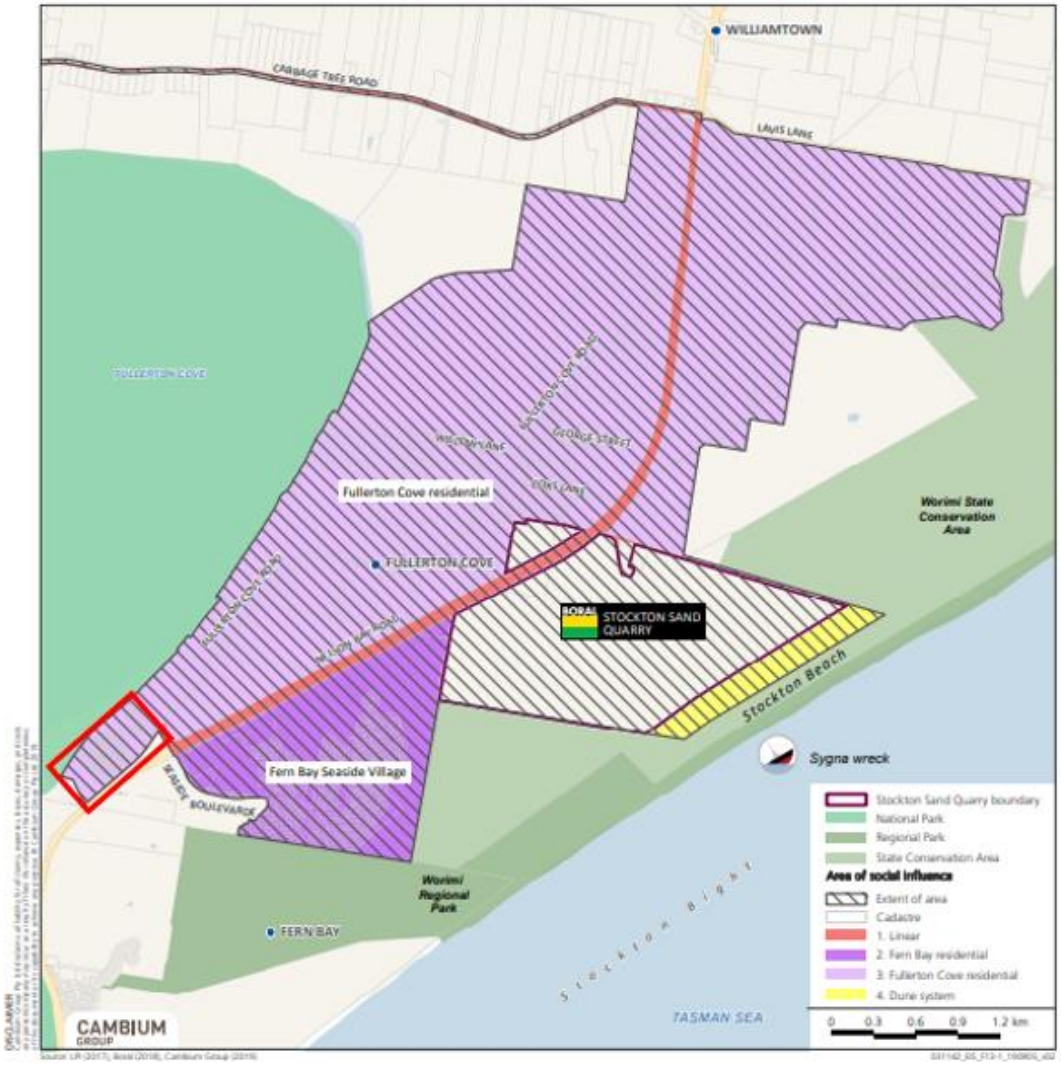
Box 1

The task of developing the ASI was assisted by the fact that the project has a long-term history. Operations began on the site during the 1970s. Boral acquired the site in 1992 and has developed strong connections with local residents and their Stockton based employees. The influence of the project on social conditions locally is therefore well understood by Boral. This was evident during the semi-structured interviews conducted with Boral staff, which formed a basis for the ASI development.

Historical correspondence records maintained by Boral provides evidence of complaints or issues raised by nearby residents and/or business owners. The Annual Environmental Management Reports (AEMR) submitted by Boral to [DPE] in accordance with the existing development consent are one source of correspondence records. A review of the AEMRs from recent years indicate that no complaints were received about Boral's operations.

Traffic routes proposed to be used by project vehicles were considered during the ASI development. It was anticipated that most social impacts related to traffic would be experienced at the roundabout (Seaside Boulevard and Nelson Bay Road intersection). Furthermore, Coxs Lane and Nelson Bay Road from its intersection with Seaside Boulevard to its intersection with Cabbage Tree Road were considered the logical parts of the road network where social impacts derived from traffic would occur. On other roads, the volume of non-project related vehicles was expected to reduce the likelihood of a project-related social impact being created.

Figure 3



3.1.1 Engagement methods

Element conducted its community engagement activity via several channels. These are described in the table presented in Annexure 4 of this SIA.

3.1.2 Engagement outcomes

Element reported limited response to the various engagement opportunities offered to local stakeholders. There were no responses to community notifications. One (1) respondent attended the community drop-in session, the notification having been delivered to 130 properties in Fullerton Cove and Fern Bay. No conclusion can be drawn in relation to this lack of responses, of itself. However, it is noted that feedback received during unstructured interviews conducted by Element indicated that the quarry's operations were not a matter of concern for the interviewed local parties, as noted in Annexure 4.

3.2 Submissions received on exhibition – dredging project 2020

Boral reports that '*A total of 24 submissions were received during the exhibition period. 13 from government agencies and 11 from the public and local/community organisations and interest groups*'[8]. Boral's report on these submissions indicates that these generally related to potential groundwater and aquifer impacts of proposed dredge operations. On this basis, these stakeholder submissions are generally not relevant to the current dry sand extraction project proposal.

One potentially tangential matter was identified in submissions. This related to vandalism (i.e. property damage to water management infrastructure on or around the quarry site). Material on reported crime occurrences that may be relevant to the current SSD 52984213 is presented in Section 4.3 (Social locality) and Annexure 6.

3.3 Project specific engagement – dry sand extraction (SSD-52984213)

The population in the immediate vicinity of the site is most likely to experience effects of operations of the proposed project. The site is located to the east of Nelson Bay Road (B63). The nearest rural residential allotment is situated approximately 0.5 kilometres from the site, west of B63. This is identified in Figure 4. As noted in Section 3.1, the 'area of social influence' determined by Element (2019) was adopted as the area for direct engagement for the current dry extraction project. Element presented this area in two parts, being 'Fullerton Cove residential' which is effectively to the west and north of the quarry site; and 'Fern Bay residential', to the south.

The area indicated in the red rectangle (bottom left) in Figure 2 is 'The Cove Village'. The area identified as Fern Bay residential is also labelled as Fern Bay Seaside Village. Both 'villages' are community title scheme areas. These are discussed separately in the following sections.

[8] The relevant material is contained in Section 6, Volume 2 of Boral Resources' Response to Submissions document. Element provided amendments to the SIA in response to submissions (2020).

Figure 4

3.3.1 Fullerton Cove residential

The Fullerton Cove residential area is briefly described as:

- All properties on Fullerton Cove Road.
- All properties on roads intersecting with Fullerton Cove Road, named roads being: Coxs Lane, George Street, Willow Lane.
- Properties on B63 between Fullerton Cove Road and Cabbage Tree Road/Lavis Lane;
- The property on the southwestern corner of the intersection between B63 and Cabbage Tree Road (i.e. with frontage to B63).
- Properties on the southern alignment of Lavis Lane (east of B63).

125 properties were canvassed in this area, by direct mail (delivery to property). A copy of the notification delivered is included in the SIA at Annexure 5. The notification was delivered on 8 February 2023. Recipients were requested to respond within 28 days.

As is identified in the notification, email was indicated as the preferred means of contact, on the basis of providing a documentary record of engagement, and timely response to stakeholder communications. However, also provided for in the notification, stakeholders were invited to contact Aigis Group by telephone or surface mail if preferred, or if additional information was required. The URL for the SSD on the DPE Planning Portal was also provided, to facilitate access to the lodged SSD application for interested parties, at the appropriate stage of the assessment process.

3.3.1.1 Responses to individual property notifications – Fullerton Cove

No documentary responses to the notification were received. One response was received by telephone. The project was discussed with the occupants of one property on Fullerton Cove Road during delivery of the notification. A summary of these two engagements is as follows:

- Respondent 1 (telephone response): The respondent resides approximately 2.4 kilometres (km) [linear] north of the quarry, on the western alignment of B63. The respondent sought clarification on the relationship between the current proposal and the continuing inland dredge SSD application. The respondent stated that no impacts had been experienced due to the quarry's operations.
- Respondent(s) 2 (personal conversation): The two (2) proprietors were present at a business premises on Fullerton Cove Road. The business is approximately 1.3km [linear] northwest of the quarry, on the western alignment of Fullerton Cove Road. The respondents were familiar with the quarry and had some interest in the continuing inland dredge SSD, with respect to possible groundwater effects. Regarding the current proposal, as it involves continuation of the existing extraction method, the respondents considered that this would have similar level effects to current operations, on the information provided and discussed. The respondents acknowledged the importance of continuing supply of sand to the construction and related industries.

3.3.2 The Cove Village, Fullerton Cove

The village is approximately 3.7km [linear] from the quarry site. It is a community title scheme (association), and therefore has a management committee as provided for under the *Community Land Management Act 2021*. This firm established contact with the Association Committee Secretary for The Cove Village (by email correspondence). The notification provided to other land occupants was then specifically addressed and provided to the Secretary by email, for the information of the committee and/or community. Subsequent to providing this material, no further contact took place with the Secretary, or other association members and therefore no matters were identified in terms of assessing social impacts of the project.

3.3.3 Fern Bay Seaside Village

As indicated in Figure 2, the village is directly south of the quarry site, east of B63. The village is a community title scheme (association), and therefore has a management committee as provided for under the *Community Land Management Act 2021*. This firm attempted to establish contact with the association or committee via two means;

- Initially via Rawson Communities[9], which was identified as a developer/manager of the estate.
- With the community association.

[9] https://www.rawsoncommunities.com.au/

No response was received from Rawson Communities, following two (2) email enquiries[10]. The firm established contact with the site administrator of a social media page for the Association[11], and subsequently attempted further contact via email correspondence. Notwithstanding that this community is nearer to the quarry site, no responses were received as a result of these attempts to engage with the community association's representative body.

Historical and recent direct stakeholder engagement on existing operations has not resulted in any substantial volume of negative interactions with the residents of the community. Feedback received from residents in Fern Bay during the preceding consultation for SSD 9490 did not result in the community identifying any material issues. Stakeholder engagement reporting (Element 2019:44-45) is included at Annexure 7, for reference. This demonstrates that Fern Bay residents who were consulted did not identify problems with current operations, to which the proposed dry extraction project will be similar. Furthermore, these engagements were undertaken for the dredge project, yet did not produce any material negative responses, despite the larger scale of that project.

3.4 Summary of responses to local stakeholder engagement

There was little response to local stakeholder engagement attempts for this project. The two responses that were recorded, one of which was an incidental direct engagement, indicated that the quarry is not a matter of concern to these respondents. It was also noted that sand produced by the quarry is essential to supporting industry and employment, which indicates a positive understanding of the need for sand extraction.

As noted in Section 3.3.3, attempts to engage with the representative body for Fern Bay Seaside Village had been unsuccessful up to the point of completing the SIA. However, material from engagement for the more extensive SSD 9490 project reports that no materially negative impacts were indicated by this community.

Generally, the engagement outcomes are consistent with expectations resulting from the limited community response received in relation to the larger scale SSD 9490. The local stakeholder position is discussed further in Section 5 (Impact assessment and prediction).

3.5 Institutional and other stakeholder engagement

Boral directly undertook engagement with statutory authorities and other agencies. Generally, these engagements are mandatory and relate to specific potential technical matters and effects of operations (such as traffic generation, for example). Accordingly, reporting of technical matters is addressed in the relevant reports for each matter stipulated in the SEARs, and detailed in the EIS.

[10] 7 February 2023 and 23 February 2023.
[11] 'Seaside Fern Bay Community & Precinct Association Information' Facebook group: https://www.facebook.com/groups/695964195133116 . The group is a private group.

At the time of lodgement of the SIA for inclusion in the EIS, this firm has not been advised of any matters resulting from these engagements that would be considered as presenting the risk of producing related, material social impacts. Similarly, there have also been no responses advised in terms of the proposal causing cumulative impacts. These outcomes are considered as consistent with the longstanding operation of the quarry at its present location.

4 Social locality and social baseline

4.1 Social locality

There are several elements to the social locality for this project. All areas nominated are based on Australian Bureau of Statistics (ABS) areas, as identified. These are:

- The area of social influence identified by Element (2019) in relation to SSD 9490, which was determined as also being relevant as the local element of the social locality for this SIA.
- The immediate population/community is discussed in detail in Sections 3.1 and 3.3. This area is represented by the Fullerton Cove SAL.[12]
- PSC LGA, as the host LGA.
- The Newcastle – Maitland Significant Urban Area (SUA) – as the adjacent regional population, to which some proportion of the quarry's product is likely to be distributed, and which is likely to accommodate a proportion of the workforce employed for quarry operations.
- New South Wales (NSW). The state population is reported as a reference population. As is identified in the Hunter Regional Plan 2041, state-level demand for construction materials such as sand is also a consideration (refer to Table 2). This also indicates NSW as a relevant population in terms of social locality.

The SAL, LGA and SUA are shown in Figures 4 to 6.

Figure 4: Fullerton Cove SAL

[12] ABS, Suburbs and Localities.

Figure 5: Port Stephens LGA

Figure 6: Newcastle – Maitland SUA

4.2 Social baseline

The following sections present data and information defining the social baseline for the populations forming the social localities. The data are drawn from ABS 2021 Census, except where specifically annotated as otherwise.

4.2.1 Population characteristics

Table 4: Demographic profile; population characteristics[13]

	SAL[14] (%)	LGA (%)	SUA (%)	NSW (%)
Population	**735**	**75,276**	**508,437**	**8,072,163**
Male	49.2	49.2	49.1	49.4
Female	50.8	50.8	50.9	50.6
	Count	**Count**	**Count**	**Count**
Population density[15] (people/km^2)	NR[16]	87.7	NR	10.1
Median Age	**69 years**	**47 years**	**39 years**	**39 years**
	%	**%**	**%**	**%**
0-14 years	6.3	17.1	18.3	18.2
15-29 years	6.3	15.1	19.4	18.7
30- 44 years	5.4	15.3	19.5	21.0
45-59 years	10.8	19.2	18.2	18.7
60-74 years	45.5	22.1	16.2	15.6
≥ 75 years	25.7	11.2	8.3	7.9
Country of Birth/Aboriginal & Torres Strait Islander status				
Aboriginal/Torres Strait Islander	2.3	6.5	6.1	3.4
Born in Australia	72.9	82.9	84.6	65.4
People of Australian Aboriginal descent	NR	6.2	5.9	3.2
Parents' country of birth				
Both parents born overseas	15.6	14.9	14.3	39.4
Father only born overseas	5.0	6.4	6.3	6.3
Mother only born overseas	4.6	4.6	4.5	4.6
Both parents born in Australia	61.9	68.6	69.8	43.7
Language				
English (only spoken at home)	86.1	90.8	88.6	67.6
Households where non-English language spoken	3.5	5.9	8.7	29.5
Registered marital status				
Married	68.8	48.9	43.4	47.3
Separated	1.6	3.7	3.4	3.2
Divorced	7.5	11.0	9.8	8.6
Widowed	9.7	6.5	5.7	5.1
Never married	11.9	29.9	37.6	35.7
Religious affiliation, top responses				
No religion, so described	25.7	38.7	42.3	32.8
Anglican	28.2	19.7	15.5	11.9
Catholic	15.9	19.7	19.2	22.4
Not stated	12.1	6.0	5.6	6.8
Uniting Church	5.3	3.8	3.6	2.1

[13] ABS generally advises that there may be some discrepancies in data for small areas.
[14] I.e. Fullerton Cove
[15] ABS Data by Region – 2021 assessment . < https://dbr.abs.gov.au/index.html >
[16] Not reported.

4.2.2 Observations on population characteristics

- Fullerton Cove's population is substantially older than each of the three larger populations. Median age is more than 20 years higher than for the LGA. 71.2% of the population is aged 60 years or older (33.3% for the LGA, and substantially lower again for the SUA and NSW).
- Based on personal and parental country of birth, and language spoken at home, the local and regional communities are generally culturally and linguistically homogenous.
- There is a relatively smaller population of residents of Aboriginal or Torres Strait Islander descent in the SAL, whereas there are proportionally higher populations in the LGA and SUA, when compared with NSW.
- There is substantially higher proportion of married people resident in Fullerton Cove. The notably low representation of 'never married' residents is also consistent with the low proportions of people in the younger age groups, even when taking into account that marital status in Census data applies only to people aged 15 years and older.
- As further evidence of cultural homogeneity, the largest group of residents who were born overseas, were born in England (Fullerton Cove 6.9%; LGA 4.0%; SUA 2.2%).
- The three large populations reported no religion (so described) as the most common religious affiliation, whereas the local population reported Anglicanism (28.2%) as the most common religious affiliation.

The small local (Fullerton Cove) population is distinctive in comparison to the larger populations. The most apparent characteristic is that it is substantially older. It is noted however, that, like the LGA and SUA populations, the local community is generally culturally and linguistically homogenous. As such, it is not likely that any group would be affected by the project on these bases.

4.2.3 Population projections

Current (released 2022) DPE population projections are displayed in Table 5. Data for the SUA are not reported by DPE. In lieu of these, data for the combined ABS Hunter Valley (excluding Newcastle) and Newcastle and Lake Macquarie Statistical Areas Level 4 (SA4s) are presented. The data permit an indication of projected change at regional scale. It is noted, however, that the combined SA4s accommodate a population of approximately one-third larger than the SUA[17].

Table 6 displays implied demand for additional dwellings, based on the population projections. It follows that the construction of these dwellings will have broad socioeconomic benefit from the perspective of accommodating the growing population. The implied demand also demonstrates the ongoing need for construction materials to meet this demand.

[17] SUA 2021 population 508,437; Combined SA4s (per DPE): 673,629 (i.e. + ≈ 32.5%).

Table 5: DPE population projections 2021-2041

	2021	2026	2031	2036	2041	Cumulative Δ (%)
LGA	75,253	79,870	84,694	89,284	93,658	24.5
SA4s	673,629	714,037	759,218	803,943	848,398	25.9
NSW	8,166,757	8,462,770	8,933,640	9,404,886	9,872,934	20.9

Table 6: DPE implied dwelling demand projections 2021-2041

	2021	2041	Additional dwellings	Cumulative Δ (%)
LGA	37,889	48,978	11,079	29.2
SA4s	169,471	209,169	39,698	23.4
NSW	3,425,215	3,601,383	904,260	26.4

4.2.4 Family, household, income and housing related characteristics

Table 7: Families/households, income, & housing-related data (ABS)

	SAL	LGA	SUA	NSW
Family composition	**%**	**%**	**%**	**%**
Couple family without children	77.2	46.4	39.1	37.9
Couple family with children	15.5	36.1	40.9	44.7
One parent family	7.2	16.5	18.4	15.8
Other family	0.0	1.0	1.6	1.6
Household composition				
Family households	73.5	71.6	69.7	71.2
Single or lone person households	24.2	26.0	26.3	25.0
Group households	2.3	2.4	4.0	3.8
Income	**$**	**$**	**$**	**$**
Median weekly personal income	548	671	785	813
Median weekly family income	1,211	1,714	2,089	2,185
Median weekly household income	1,062	1,372	1,661	1,829
	%	**%**	**%**	**%**
% households < $650 gross p.w.	21.1	20.0	17.6	16.3
% households > $3000 gross p.w.	9.9	16.2	22.0	26.9
Dwellings	**%**	**%**	**%**	**%**
Occupied private dwellings	90.1 (310)	84.7	93.6	90.6
Unoccupied private dwellings	10.8 (37)	15.4	6.4	9.4
Dwelling structure	**%**	**%**	**%**	**%**
Separate house	72.3	80.9	80.0	65.6
Semi-detached, row/terrace, townhouse	25.8	13.5	12.1	11.7
Flat or apartment	0.0	3.6	7.2	21.7
Other dwelling	0.0	1.6	0.5	0.7

	SAL	LGA	SUA	NSW
	%	%	%	%
Tenure type	%	%	%	%
Owned outright	76.8	31.5	32.2	31.5
Owned with a mortgage	17.4	38.5	34.9	32.5
Rented	1.3	27.3	30.1	32.6
Other tenure type	0.0	1.4	1.7	1.9
Tenure type not stated	1.3	1.4	1.2	1.5
Average people/household	3.2	2.6	2.5	2.6
Housing costs (rental)	$	$	$	$
Median weekly rent	300	370	375	420
Median monthly mortage repayment	1,873	1,733	1,890	2,167

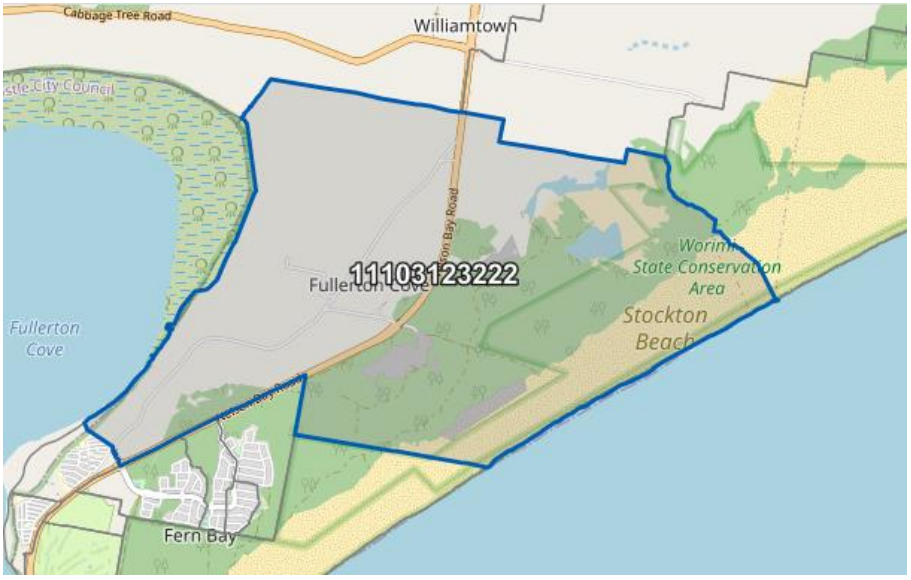
4.2.5 Observations on family, household, income and housing related characteristics

- Housing and income data provide additional evidence of the older local population. The relevant data are the substantially higher proportion of couple families without children and the high proportion of households owning their house outright, indicating the longer tenure associated with older households. These two features remain relevant in comparison with each of the larger populations.
- Additional Census data on 'place of usual residence' 5 years prior to the 2021 Census returned proportions of 60.3% remaining in the same residence for the SAL, compared with 53.6% for the LGA. This is also an indicator of longer tenure in the area that may also be associated with the older population.
- There are 310 occupied private dwellings in Fullerton Cove. The data also nominate 37 unoccupied dwellings, although the summary Census data for the area state 388 private dwellings. Based on the latter assessment, this represents approximately 1% of total private dwellings in the LGA.
- Incomes are lower in the immediate area. Again, this is likely to be associated with the older population. Workforce data in Table 9 reports 62.6 % of the population as not in the labour force, and 68.1% of couple households having both partners not working. Both of these measures are significantly high than for the larger comparison populations. ABS regional data for the SA2 recorded 19.3% of the population in the Stockton – Fullerton Cove SA2 as being aged pension recipients. This compares with 16.2% for the LGA, and 10% for NSW[18].

Supplementary to the income data presented in Table 7, Table 8 displays most recent ABS Socioeconomic Indexes for Areas (SEIFA) for the SA1 which approximates Fullerton Cove, and for the LGA (2021 Census). A diagram of the SA1 is included in Figure 7 for reference.

[18] ABS Data by Region. Most recently published data for 2021.

Figure 7: SA1 11103123222



The first two indexes in Table 8 are the Index of Relative Social Disadvantage (IRSD) and the Index of Relative Social Advantage and Disadvantage (IRSAD). These are broadly based measures of socioeconomic status (SES), constructed with multifactorial indicators of socioeconomic advantage and disadvantage. The bottom two indexes, the Index of Economic Resources (IER) and the Index of Education and Occupation (IEO) are more focused on specific predictors of SES, as indicated in their titles.

Fullerton Cove SA1 has generally higher SES than for the LGA more broadly, as indicated by index scores Fullerton Cove and the LGA share similar decile rankings in comparison with their respective comparative geographies.

Table 8: ABS SEIFA 2021

	SA1		LGA	
	Score	**Decile**	**Score**	**Decile**
IRSD[19]	1023	6	982	6
IRSAD	996	5	952	5
IER	1069	8	1004	8
IEO	975	5	928	4

[19] The four indexes are: Index of Relative Social Disadvantage (IRSD); Index of Relative Social Advantage and Disadvantage (IRSAD); Index of Economic Resources (IER); and Index of Education and Occupation (IEO).

4.2.6 Workforce profile

Table 9: Labour force data (ABS)

	SAL	LGA	SUA	NSW
Workforce participation	**%**	**%**	**%**	**%**
In the labour force	25.1	52.3	60.8	58.7
Not in the labour force	62.6	42.2	34.4	35.5
Not stated	12.3	5.6	4.7	5.9
Employment status				
Worked full time	51.4	51.5	54.4	55.2
Worked part time	35.8	34.9	33.7	29.7
Away from work	6.4	8.6	7.0	10.2
Unemployed	1.7	5.0	4.8	4.9
Occupation, top responses				
Professionals	21.6	15.5	22.5	25.8
Managers	16..2	11.2	10.7	14.6
Technicians & Trades Workers	14.4	17.1	14.7	11.9
Labourers	14.4	10.9	9.3	8.2
Clerical & Administrative Workers	11.4	12.4	12.3	13.0
Community & Personal Service Workers	10.8	14.0	13.5	10.6
Sales Workers	6.0	9.2	8.7	8.0
Machinery Operators & Drivers	4.8	7.7	6.9	6.0
Industry of employment, top responses[20]				
Hospitals[21]	7.8	0.4	5.3	4.2
Aged Care Residential Services	4.8	3.4	2.6	2.2
Other Social Assistance Services	4.8	3.1	4.0	2.4
Employment status, couple families				
Both employed, full time (FT)	5.2	15.3	21.2	21.7
Both employed part time (PT)	1.9	4.4	4.7	4.7
One FT, one PT	6.6	19.0	23.6	18.2
One FT, other not working	3.8	10.1	10.5	12.3
One PT, other not working	6.1	6.7	5.8	6.3
Both not working	68.1	32.4	22.8	22.9

4.2.7 Observations on workforce profile

- The largest employing industry for the LGA is 'Defence' (3.9%), which is clearly associated with location of the Williamtown RAAF base in the LGA. This is not recorded in these data (refer to Footnote 21).
- As was identified in Section 4.2.5, there are several workforce characteristics demonstrating the older local age profile. These can be summarised as describing a population with generally lower workforce participation, and a larger representation of age pension recipients, which is consistent with the older population.

[20] Displays only industries that are reported in 'top responses' across all four populations.
[21] Except psychiatric hospitals.

4.3 Other characteristics of the localised social locality

Section 3.2 addressed previous engagement outcomes. One relevant matter identified for consideration of the social locality was the potential for vandalism (property damage) relating to specific infrastructure on the quarry site. Given its location and distance from the nearest residential/urban areas, other potential criminal activity or antisocial behaviour, such as interpersonal violence, is not considered as being likely to be affected by quarry operations. On this basis NSW Bureau of Crime Statistics and Research (BOCSAR) data for the relevant offence 'malicious damage to property' for Fullerton Cove are presented in Annexure 6.

Fullerton Cove is identified by BOCSAR as a low population area. Per 100,000 population occurrence rates are not presented for the suburb, as the number of occurrences is very low. This is substantiated by the tabulated data in the Annexure. A total of two (2) incidents were recorded over the past two reporting years. Given the longstanding presence of the quarry, it is concluded that its ongoing operations are unlikely to result in any elevation of the risk of crime or other antisocial behaviour occurring in the social locality.

4.4 Broader social locality – LGA & SUA

The operational impacts of the proposed dry sand extraction at the quarry will generally not affect the larger social locality populations. In this respect, it is assessed as unlikely that material negative impacts would be experienced by these populations. The sand produced at the quarry will support the construction industry, which is interpreted as having generally positive socioeconomic effects for the general population of the broader social locality, with emphasis on the LGA and SUA. Some quantitative material on the extent of this benefit is presented in Section 4.5. The quarry also provides some product to the Sydney construction market, which may support further geographically dispersed benefit.

4.5 Summary comments – social locality and social baseline data

Due to proximity, the population of Fullerton Cove is the community that is notionally most vulnerable to effects of operations at the quarry. The social baseline data indicate that the population has a large representation of older residents. In addition to age, household composition and ownership status are also indicative of these older households having been resident in the area for considerable periods of time. In this respect, it is apparent that a considerable proportion of the local population has coexisted with the quarry's operations over time.

From the perspective of the larger populations that also warrant consideration as elements of the social locality, the effects are likely to be much more dispersed, and therefore less distinguishable. However, as stated in the Hunter Regional Plan 2041 (refer to Table 2), construction materials, including sand, are critical to the state and its populations. In the four quarters December 2021 to September 2022, ABS valued construction activity in NSW at approximately $43 billion. When the 'multiplier' effects of this level of activity are also considered, there is significant, broad socioeconomic benefit that is supported by the

industry, and the supporting industries that supply goods and services, such as Stockton Quarry.

The direct and indirect economic effects of this level of construction activity are substantial in the state context, and also at regional levels. Continuing supply of materials also has significant intergenerational social effects, in terms of the development of sufficient housing and infrastructure to accommodate population growth, as is evidenced in the DPE population and implied housing demand data presented in Tables 5 and 6.

In the alternative scenarios (windblown/dry extraction resource exhaustion by late 2023 and potentially expiry of the existing consent in 2028), the extent of these benefits would be significantly curtailed. As identified by Arnold Planning (2022:13), the cessation of sand quarrying at the site would reduce the total amount of sand available to the relevant markets. From a regional perspective, this would necessitate sand being obtained from other sources, some of which would be more distant from customers based in the LGA or broader SUA. This would be likely to impose additional direct costs on intermediate and final customers due to increased transportation requirements.

The need for increased haulage also imposes broader socioeconomic effects and externalised costs. Examples are higher particulate emissions levels from trucks travelling further, and notional costs including increased traffic and impacts on road infrastructure of these extended movements. Consent for the project would avoid these direct and externality costs. In addition to the notional avoidance of these impacts, Boral is committed to a target of net zero emissions by 2050[22]. Proposed operations would therefore proceed under Boral's progressive reduction in emissions across the business.

[22] https://www.boral.com/sustainability/net-zero

5 Impact assessment and prediction

5.1 Identified impacts – stakeholder engagement

As is discussed throughout Section 4, the engagement process produced limited stakeholder response in relation to the project. The two (2) responses that were recorded did not identify any matters that could be characterised as presenting a risk of material negative impacts on stakeholders.

5.2 Identified impacts – scoping process

As is stated in Section 2.2, the scoping tool prepared for the SIA for the SSD 9490 dredge extraction project was adopted for the current SSD 52984213. Given the lesser scale of the current project, the adoption of this scoping material is submitted as being conservative (i.e. likely to overestimate, rather than underestimate, the risk of effects of the dry extraction project). Element (2019:46) characterises the potential impacts under the subcategory of 'public safety'. Table 10 reports the matters within the subcategory[23].

Table 10: Scoping tool outcomes – public safety matters
Health risk and nuisance factors from particulate matter (dust)
Increased noise associated with extraction activities, including vehicular movements
Increased traffic volumes
Unauthorised access

5.3 Impact prediction

5.3.1 Impacts in immediate area

With respect to the dry sand extraction method proposed, this will be consistent with current extraction methods. Consistent with the current dredge application, the project seeks a site-wide dispatch limit of up to 750,000 tpa (i.e. the existing windblown sand extraction area and the project operations combined). This is an increase of up to 250,000 tpa on the current limit of 500,000 tpa, as detailed in Section 1.3.3.

A 50% increase in site production infers a commensurate increase in the number of truck movements to and from the site. Historically, there have been limited complaints regarding the quarry's operations, including in relation to transport related issues, including vehicle noise. No concerns were raised during engagement with community stakeholders on the project regarding current or potential noise from trucks or other vehicles. With respect to the change in extraction area and relative proximity to potential receptors, this is addressed in the noise assessment for the current project.

The increase in truck movements may also entail greater potential for impacts on traffic volumes in the immediate surrounds of the quarry. This in turn may result in perceived additional effects on road safety, for example. It is noted that no concerns of this nature

[23] Also appears as Table 9 in the SIA prepared by Element (2019:46).

were raised during engagement with the local community. However, it is recognised that B63 Nelson Bay Road users also originate from other areas.

As is the case with other impacts, there have been historically few concerns or complaints received by the quarry regarding these matters. The intersection between the quarry entrance and B63 has been designed to accommodate safe entry and exit of quarry vehicles to and from B63. The combination of existing infrastructure, enforced compliance with NSW road rules, and Boral's internal employee and contract driver conduct policy are considered as providing appropriate measures for management of any increased propensity for these impacts.

Element identified that dust generation is endemic to quarry operations, and that the quarry employs adequate dust control measures. Noting that there were no community concerns identified, Element concluded that the 'potential for significant negative air quality impacts from the project was considered to be low'(2019:46). The assessment for the current project concurs with this conclusion. This is emphasised by the fact that the proposed extraction method is consistent with current practice, and evidently this has not historically been a matter of substantial concern for local stakeholders, evidenced by limited complaints received from within the local area.

With regard to public safety issues involving unauthorised access to the quarry site, Element (2019:47) acknowledged that instances of intentional and unintentional unauthorised access have occurred and may also occur in the future. Element states that '*Boral has taken all reasonable and necessary steps to ensure the security of the site and the safety of the public. Staff efforts and quarry features include security fencing and lockable gates, high visibility line and signage, CCTV, safe batter requirements, trespass procedures, and operating hours*' (2019:91). There is no evidence to suggest that the proposed operations under SSD 52984213 will materially increase or decrease the level of risk to the safety of the very small element of the public who might access the site without authorisation.

Generally, as the quarry is an established operation, and the proposed dry sand extraction methods are consistent with current and previous activity, there is a low risk of any material changes to impact levels to result from the project.

5.3.2 Impacts on the broader social locality

As discussed in Section 4.4 and 4.5, the project is likely to be socioeconomically beneficial to communities in the broader regional social locality. It will support direct and indirect commercial activity and employment. This in turn supports the households of these employees and in some instance business operators. The further consumption and investment activities of these households then supports additional economic benefit across the two regional economies.

6 Social impact enhancement, mitigation and residual impacts

6.1 Social impact enhancement

The underlying premise for this interim project is to maintain supply of sand beyond the end of 2023. Approval of SSD 52984213 will realise the broader direct and indirect socioeconomic advantages of continued supply. Supporting ongoing public and private infrastructure development to accommodate the growing regional and state populations also has positive cumulative and intergenerational impacts. Consent for the project would facilitate the realisation of these positive outcomes.

The alternative scenario created by refusal of the project would result in the sterilisation of the resource, and the related reduction in supply of sand to economically important industry sectors, most particularly construction. In the absence of consent, Boral would have to close the quarry and rely on other sand sources regionally or further afield, depleting those resources sooner and potentially increasing costs to deliver essential housing and infrastructure projects in the Hunter and Sydney regions. As noted in Section 4.5, this may also involve negative outcomes in terms of externality impacts such as increased vehicle emissions resulting from the potentially greater haulage task. This is also inconsistent with NSW Government[24] and Boral Limited efforts to achieve net zero emissions by 2050. Consequently, it is submitted that grant of consent is the appropriate action with respect to impact enhancement.

6.2 Social impact mitigation

Engagement with local stakeholders regarding the proposed project did not identify any stated concerns or apprehension of material impacts. With the exception of the technical issue of water resource impacts raised following formal public exhibition, similar findings resulted from stakeholder engagement for the SSD 9490 dredge project.

Other effects were indicated for assessment for the dredge project through the SIA scoping process. These were also adopted for assessment for the current dry extraction project. These effects are also assessed as being unlikely to materially change as a consequence of the project.

Ongoing management of impacts was assessed in the context of the principles set out in the DPE *Social Impact Management Toolbox for State Significant Projects* [SIMT] (February 2023). Based on the evidence from current and previous engagement activity and reported historical interaction between quarry management and local stakeholders, it is considered that the quarry has established a social licence to operate at the level of 'community approval – support'.[25]

[24] https://www.energy.nsw.gov.au/nsw-plans-and-progress/government-strategies-and-frameworks/reaching-net-zero-emissions/net-zero
[25] Adopting the structure proposed by Thomson and Boutilier, as reported in the SIMT (2023:10)

As the Stockton quarry is a long established operation, there are appropriate infrastructure, operational and environmental controls in place to ensure that impacts of operations are avoided, managed and/or mitigated to the extent practicable. Evidence that the existing approaches are satisfactory is provided by direct stakeholder feedback and historically limited complaints over operations. These interactions also indicate that material cumulative impacts do not appear to have occurred. Maintaining current practices, and improving these over time in response to, for example, technological improvements, will continue to effectively address any impacts.

6.3 Residual impacts

Residual impacts of the project are consistent with those for current operations. Generally, these will be addressed under existing rehabilitation obligations, and those to be imposed relating to additional disturbance to be created for the project.

As noted in Section 6.2, two (2) rounds of stakeholder engagement and interactions between Boral Resources and local stakeholders over time did not indicate the presence of any material cumulative impacts. Continuity between previous and proposed operations indicates that any residual impact will be similar, and therefore unlikely to be perceived as material by stakeholders.

6.4 Social Impact Management Plan (SIMP)

The existing management structures for the quarry are interpreted as equating to an effective SIMP, as proposed in the DPE SIMT. As such, application of these existing structures to the proposed operations are likely to be effective to a similar extent as has historically been the case. Boral may wish to consolidate the quarry's management structures into a formal SIMP document, however it is considered that this will not necessarily contribute to greater efficacy.

7 Conclusions and recommendations

7.1 Conclusions

The Boral Stockton Quarry dry sand extraction project SSD 52984213 is proposed to ensure continuing supply of sand to the Hunter and Greater Sydney regions. The current project is based on continuing the extraction methods currently used at the quarry. As such, it is concluded that the effects would be similar to those of current operations.

Engagement with local stakeholders did not identify any material issues of concern that are likely to affect the lifestyles or amenity of the community. 130 local property occupants were notified, with direct engagement with two (2) property occupants resulting. This outcome is submitted as being consistent with previous community engagement in relation to previous and current operations, and with outcomes of consultation for the inland dredge proposal.

An assessment of other potential public safety impacts resulting from SIA scoping also did not identify any material sources of impact relating to the project. This conclusion is made in the context of the community engagement processes noted above, which did not identify matters of this nature. The quarry's records also demonstrate that there have historically been very few complaints made about operations, over an extended period.

Social impacts at the broader population or social locality levels are likely to be neutral. This is concluded on the basis of the generally limited exposure to operational effects that would be experienced by the broader population. Any such effects are likely to be significantly countered by the social and economic benefit that ongoing production at the quarry would support in industry sectors such as construction and infrastructure development. It is submitted that, on balance, the dry sand extraction project SSD 52984213 would result in positive socioeconomic outcomes. As such, grant of consent is assessed as appropriate.

7.2 Recommendations

The EIS for the current project will include technical assessments for the various environmental and operational effects involved in dry sand extraction at the quarry. This report endorses the adoption of any recommendations arising from these reports, where these technical assessments include recommendation for the avoidance, management and mitigation of effects.

It is also relevant that the quarry is a long-established operation, with correspondingly well-established operational controls. Continuing compliance with those controls is likely to maintain the evidently low-impact operations of the quarry. Continuation of existing management systems and practices is recommended. In terms of managing any effects on stakeholder that may occur, the current management systems provide communications mechanisms for the receipt and management of issues raised by third parties. It is recommended that these mechanisms continue to be made available to stakeholders.

As noted in Section 6.4, existing management structures are interpreted as being equivalent to a SIMP for the quarry's operations. These structures may be formalised as a distinctive SIMP, however this is not considered necessary to continuing effective management of potential social impacts.

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Annexure 1: Authorship & declaration

Aigis Group firm profile

Aigis Group is a small consultancy firm based in Lake Macquarie, NSW. The firm was established in 2004, although the founding partners (Scott Holmes and Mark Sargent) had worked collaboratively on projects since 2002, including social, economic and market research engagements. The firm was established on the basis of its ability to engage the skills of a group of consultants to augment the firm's internal skills as required, and maintains capacity to operate on that basis, as required.

The firm provides a range of research services, including the provision of economic and socioeconomic impact assessments to organisations in the public sector, property development, licensing, mining, and other industries.

The firm carries current Public Liability and Professional Indemnity insurance policies at all times. Evidence of these can be produced on request in relation to relevant projects.

Author profile

Dr Mark Sargent (MMktg, MBA[Merit], PhD) has been the firm's Principal Consultant since 2006, and is the author of this document. Mark's doctoral degree was in politics and specifically, regulatory policy. He has taught public policy at the University of Newcastle, and management at the TAFE Hunter Institute. He has also held a variety of past directorship roles. Mark is a past graduate of the Australian Institute of Company Directors (AICD), and an Affiliate Member (Allied Professional), of the Planning Institute of Australia (PIA).

Author declaration

The author warrants that:

1. The SIA contains all information relevant to the SIA for the project, which was known to the author at the time of preparation.
2. That none of the information in the SIA is false or misleading.

The author also requires that the reviewer/reader refers to the disclaimer forming part of the SIA (page 2).

Mark Sargent
21 June 2023

Annexure 2: DPE Guidelines & principles compliance matrices

Guidelines compliance questions matrix

General	**Location in SIA**
1 Does the lead author meet the qualification and experience requirements?	Annexure 1
2 Has the lead author provided a signed declaration?	Annexure 1
3 Would a reasonable person judge the SIA report to be impartial, transparent and suitably rigorous given the nature of the project?	Entire SIA
Project's social locality and social baseline	**Location in SIA**
4 Does the SIA report identify and describe all the different social groups that may be affected by the project?	Section 3; Section 4.
5 Does the SIA report identify and describe all the built or natural features that have value or importance for people, and explain why people value those features?	Section 3
6 Does the SIA report identify and describe historical, current, and expected social trends or social changes for people in the locality, including their experiences with this project and other major development projects?	Section 3; Section 4
7 Does the social baseline study include appropriate justification for each element, and provide evidence that the elements reflect both relevant literature and the diversity of views and likely experiences?	Section 3; Section 4
8 Does the social baseline study demonstrate social-science research methods and explain any significant methodological or data limitations?	Section 4
Identification and description of social impacts	**Location in SIA**
9 Does the SIA report adequately describe likely social impacts from the perspectives of how people may experience them, and explain the research used to identify them? When undertaken as a part of SIA scoping and initial assessment, has the plan for the SIA report been detailed?	Section 5; Section 6
10 Does the SIA report apply the precautionary principle to identifying social impacts, and consider how they may be experienced differently by different people and groups?	Section 3; Section 4; Section 5
11 Does the SIA report describe how the preliminary analysis influenced project design and EIS engagement strategy?	Section 6

Community Engagement	**Location in SIA**
12 Were the extent and nature of engagement activities appropriate and sufficient to canvass all relevant views, including those of vulnerable or marginalised groups?	Section 3
13 How have the views, concerns and insights of affected and interested people influenced both the project design and each element of the SIA report?	Section 3; Section 5; Section 6
Predicting and analysing social impacts	**Location in SIA**
14 Does the SIA report impartially focus on the most important social impacts to people at all stages of the project, without any omissions or misrepresentations?	Section 3; Section 4; Section 5; Section 6
15 Does the SIA report analyse the distribution of both positive and negative social impacts, and identify who will benefit and who will lose from the project?	Section 3; Section 5
16 Does the SIA report identify its assumptions, and include sensitivity analysis and alternative scenarios? (including 'worst-case' and 'no project' scenarios where relevant)	Section 2; Section 4; Section 6
Evaluating significance	**Location in SIA**
17 Do the evaluations of significance of social impacts impartially represent how people in each identified social group can expect to experience the project, including any cumulative effects?	Section 3; Section 4; Section 5; Section 6
18 Are the evaluations of significance disaggregated to consider the likely different experiences for different people or groups, especially vulnerable groups?	Section 4; Section 5; Section 6
Responses, monitoring and management	**Location in SIA**
19 Does the SIA report propose responses that are tangible, deliverable, likely to be durably effective, directly related to the respective impact(s) and adequately delegated and resourced?	Section 5; Section 6
20 Does the SIA report demonstrate how people can be confident that social impacts will be monitored and reported in ways that are reliable, effective and trustworthy?	Section 6
21 Does the SIA report demonstrate how the proponent will adaptively manage social impacts and respond to unanticipated events, breaches, grievances and non-compliance?	Section 6

SIA principles matrix

Principle	Location in SIA
Action-oriented	Section 6; Section 7
Adaptive	Section 1; Section 3; Section 5; Section 6.
Culturally responsive	Section 1.4; Section 3; Section 4; Section 5; Section 6
Distributive equity	Section 3; Section 4; Section 5; Section 6; Annexure 4; Annexure 7.
Impartial	Throughout
Inclusive	Section 3; Section 4; Section 6
Integrated	Throughout
Life-cycle focus	Section 3; Section 5; Section 6; Section 7
Material	Section 3; Section 5; Section 6
Precautionary	Section 5; Section 6; Section 7
Proportionate	Throughout
Rigorous	Throughout
Transparent	Throughout

Annexure 3: DPE SIA scoping tool outputs

Social matter (relevant subcategory) and scoping tool input	Social impact category (Guideline section 1.1)	Will a specialist study be conducted for the EIS?	Level of assessment for the social impact (scoping tool output)	SIA method(s) implemented for the assessment
Amenity (acoustic) Stakeholders did not raise any concerns about acoustic impacts from sources on site or from vehicles utilising the public road network	Health and wellbeing	Yes	No SIA required	Nil
Amenity (visual) Stakeholders did not raise any concerns about visual impacts associated with the project	Surroundings	No	Standard SIA	VIA Semi-structured interview
Access (road and rail network) Residents had minimal concerns with quarry related traffic[2] or the network capacity	Access to and use of infrastructure, services and facilities	Yes	No SIA required	Further engagement and adaptive research approach in relation to the results of the traffic impact assessment
Built environment (public infrastructure) No stakeholder feedback was obtained in relation to the effect of the project on the quality of public infrastructure (ie road surfaces)	Access to and use of infrastructure, services and facilities	Yes	Standard SIA	ECA
Heritage (natural features) There was no evidence to suggest that the sites current operations impact the dune system or its recreational values	Surroundings	Yes	Standard SIA	Further engagement (consultation with Worimi LALC)
Community (safety) Site records confirm unauthorised site access (attempted and actual)	Health and wellbeing	No	Standard SIA	PO
Economic (natural resource use *and* livelihood) The preliminary environmental assessment established that natural fine sand derived from the quarry will influence supplies for local and regional development projects	Personal and property rights	Yes	Desktop SIA	Desktop research
Economic (livelihood) Boral staff stated that the project would extend the employment of five, locally-based quarry employees and provide additional employment.	Personal and property rights	Yes	Desktop SIA	Desktop research

Annexure 4: Description of SSD 9490 engagement methods

Method	Description
Written methods	
Project newsletter and community drop-in sessions notification	Following its distribution, no specific feedback from stakeholders was received. It was concluded that it did not prompt a specific interest in the project. However, one community member who received the newsletter did attend the community drop-in session (see below).
Community drop-in sessions notification	70 notifications were distributed via letter-box drop in Fern Bay, and 60 were distributed in Fullerton Cove on 7 February 2019. The residential block nearest to the project site was included in the distribution area. Following its distribution, no specific feedback from stakeholders was received.
Emails	Emails were sent to project stakeholders including the PSC Mayor and ward councillors regarding the progress of the project. One Councillor replied via email to acknowledge receipt of the project team email. No specific feedback about the project was received.
Phone briefing (informal)	A member of the project team briefed the Port Stephens MP via telephone about the Project during early February 2019. The Port Stephens MP confirmed she would like to meet the project team later in the year. The Port Stephens MP did not raise specific concerns about the project.
Consultation with resident	A member of the project team had a conversation with Fern Bay resident, following the traffic query he raised with a project consultant conducting field work adjacent to the project site. The project team member explained the proposal for project related traffic, and confirmed the quantity of proposed traffic movements. The resident was satisfied with the responses. Subsequent to the conversation, the project newsletter and community drop-in sessions notification, and the community drop-in sessions notification was provided to the resident via letter-box drop
Consultation with neighbours via doorknock	See Appendix D for a summary of the consultations
Media methods	
Website	No project related feedback was received via the website feedback form or via the contact phone number listed on the webpage.
Facebook campaign	The project Facebook post (refer Appendix B) received some reply comments. Within three hours of being uploaded, the post attracted 10 'likes', one 'love', one 'share' and one positive comment from a quarry customer who was satisfied with the service he received from quarry staff. Later, it attracted one 'angry' emoji and two comments criticising sand extraction generally.

Note re 'doorknock' interviews:

These resulted in contact with ten (10) property occupants. Six (6) of these provided either positive feedback, or feedback indicating that they were unaffected by quarry operations.

Annexure 5: Stakeholder engagement notification (copy)

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The Occupant,

STATE SIGNIFICANT DEVELOPMENT (SSD-52984213) APPLICATION
BORAL STOCKTON QUARRY – DRY SAND EXTRACTION PROJECT
COXS LANE, FULLERTON COVE, NSW, 2318

Dear Sir/Madam

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry, located on Coxs Lane, Fullerton Cove. The quarry extracts and transports sand for use in the building, landscaping and construction markets. The quarry has operated since the 1970s. The current consent has been in place since 1996 and expires in 2028.

Due to several years of sustained high demand for sand, both locally and regionally, the approved resource has largely been depleted, and is expected to run out in December 2023. To address this in the longer term, Boral has lodged a State Significant Development (SSD) application SSD-9490 with the NSW Department of Planning and Environment (DPE) for dredge extraction of sand from the inland dunes area. This application process is continuing, however it may not be completed by December 2023.

To keep the quarry operating, Boral is lodging the interim SSD application addressed in this letter. The application seeks consent to extract only the remaining dry sand resource from within the same extraction area (the project). The proposed extraction method is consistent with those currently used at the quarry.

The SSD application to DPE requires preparation of an Environmental Impact Statement (EIS). As part of the EIS, a Social Impact Assessment (SIA) is being prepared by this firm. Preparation of the SIA requires that interested parties be provided with the opportunity to comment on the proposal. Matters raised can then be addressed in the SIA, and the EIS more generally. You are invited to provide any comments on the present application via this email address:

mark@mseag.com.au

Please note that this is the firm's preferred means of contact, as it provides an accurate record of engagement and will ensure prompt acknowledgement of receipt of your response. *If you are not able to respond by email, alternative contact details (mailing address and phone number) are included with the signature below should you wish to mail or discuss this notification personally.*

You are requested to respond by **Wednesday, 8 March 2023**. Please note that any comment you provide will be reported on a confidential basis. Your personal details will not be disclosed in any subsequent reference to such material. It is also advised that following lodgement of the DA, it will be placed on public exhibition by DPE through its Planning Portal (the project URL is included at the bottom of this letter). At that stage you will have the opportunity to consider the proposal in full, and provide further comment based on full project details, should you wish to do so.

Should you have any further questions regarding this notification or prior to making a submission, please contact Mark Sargent (Aigis Group) on 0423 489 284.

Yours sincerely
Aigis Group

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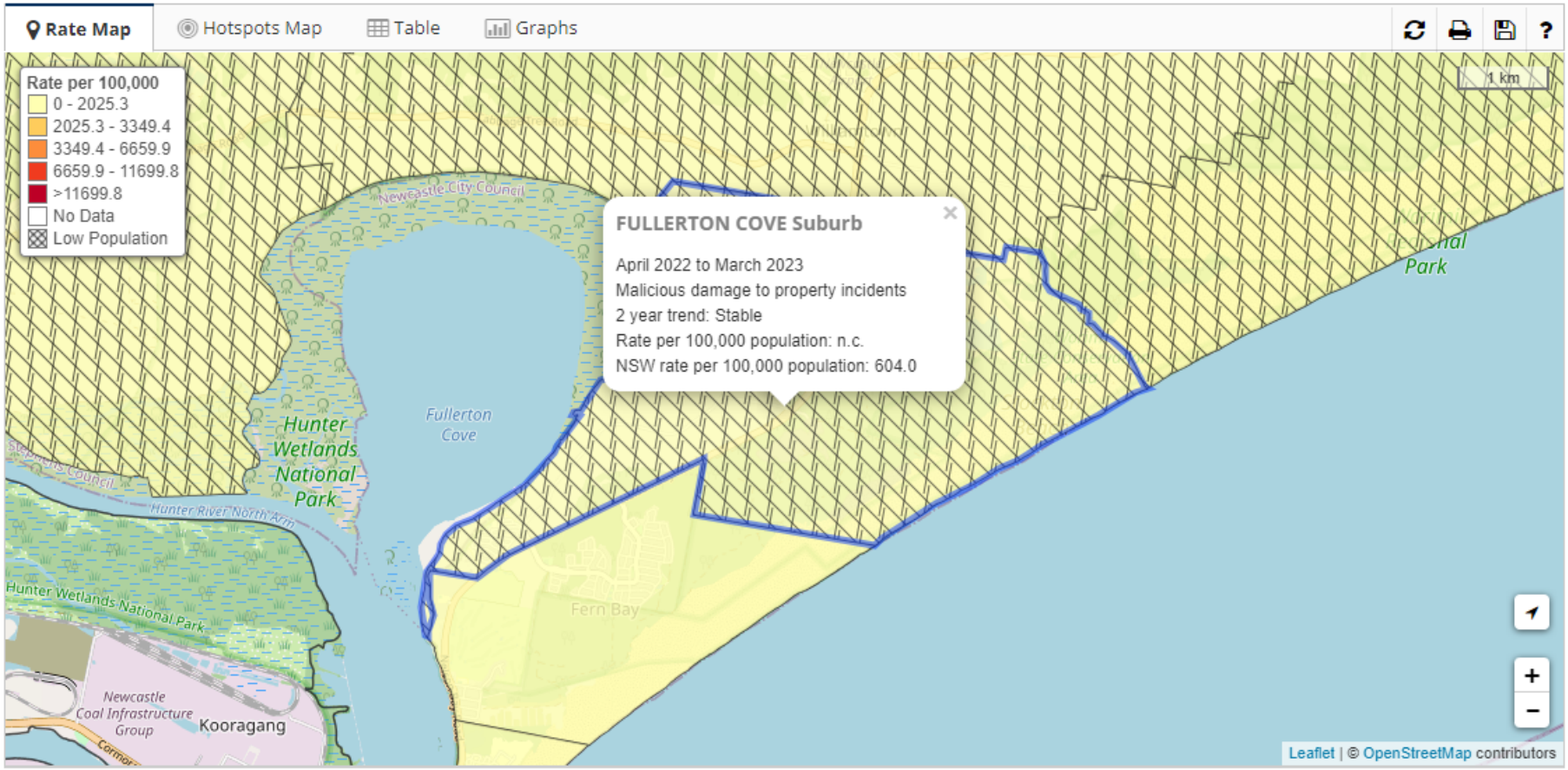
DPE PROJECT URL:

https://pp.planningportal.nsw.gov.au/major-projects/projects/stockton-dry-sand-extraction-project

Annexure 6: BOCSAR crime data – malicious damage to property – Fullerton Cove (suburb)

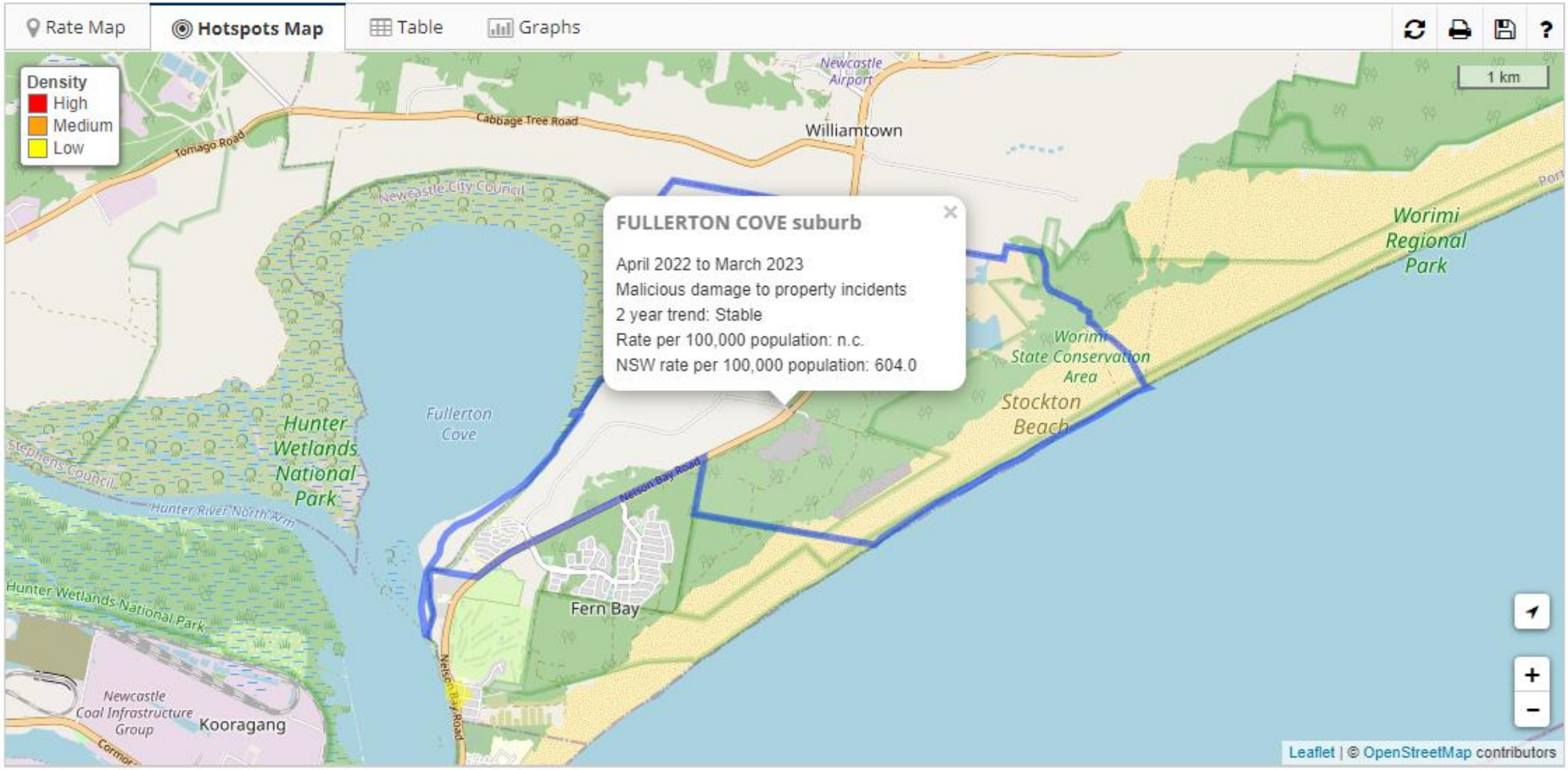
Incidence mapping

Incidents of Malicious damage to property from April 2022 to March 2023



Incidence 'hotspot' mapping

Incidents of Malicious damage to property from April 2022 to March 2023



Incidence data

Incidents of Malicious damage to property from April 2021 to March 2023

Rate Map | Hotspots Map | **Table** | Graphs

2 Years

	To March 2023	Year to March 2022		Year to March 2023	
Suburb	**Trend: 2 year**	**Count**	**Rate**	**Count**	**Rate**
New South Wales	Stable	48395	597.9	48889	604.0
FULLERTON COVE	n.c.	2	n.c.	2	n.c.

Annexure 7: Fern Bay resident engagement responses – SSD 9490 (Element 2019:44-45)[26]

Matter 1: Amenity

The first Amenity sub-category determined to be applicable to the project is 'acoustic' amenity. The preliminary environmental assessment (Element Environment, 2018) determined that the project will introduce additional noise sources from the site, potentially resulting in greater noise levels experienced at residences to the south of the site and west of Nelson Bay Road. Ahead of the quantitative noise assessment which confirms acoustic impacts, early consultation with nearby residents suggested the impacts of the current operations are not significant. Residents did not raise any concerns about acoustic impacts from sources on site or from vehicles utilising the public road network. The following examples of feedback from residents in the residential area closest to the site (i.e. Fern Bay) highlight the comfort of the community in respect to noise impacts:

- "We can't hear a thing";
- "I can't hear anything from your site, even in the early hours when coming home from night shift"; and
- "We can't hear your operations from our house".

Confidence in the scoping phase that social impacts would arise from the project acoustics was further diminished by the fact that there is a moderate distance (approximately 500 m) between the project site and its nearest receivers.

Taking both the early consultation results and the proximity of receivers into account, the scoping exercise determined that there would be no requirement to conduct a SIA in regard to acoustic amenity, alongside the quantitative noise assessment required for the project.

The second Amenity subcategory determined during the scoping phase to be applicable to the project is 'visual' amenity. The preliminary environmental assessment (Element Environment, 2018) determined there is limited visual exposure of the project to the community, and it nominated Stockton Bight Beach as an isolated viewpoint occasionally visited by recreational dune users. Early consultation activities obtained sentiment that nearby residents hold towards the project and its influence on visual amenity. The statements offered by residents living near the project during the doorknock activity were typical of those collected:

- "We don't notice it [the quarry]"; and
- "I notice absolutely nothing".

According to the above, the scoping exercise determined that a standard SIA would be required in relation to visual amenity. The SIA would focus exclusively on the perception of social impacts created for recreational dune users, in relation to the minor initial Stockton Bight Beach viewpoint.

[26] NOTE: 'Draft' watermark is included in the source document as provided.

Matter 2: Access

The scoping exercise determined that 'road and rail network' is a subcategory of Access that is applicable to the project. The additional sand (approximately 250,000 tpa until the windblown sand development consent ceases) transported both north and south on Nelson Bay Road will require the local and regional road network to support a larger quantity of truck movements. It was anticipated that the standalone traffic impact assessment planned to be conducted for the EIS would confirm the likely impacts to the road network and determine the network access and capacity implications, much less the social impacts of increased traffic volumes.

From a social impact perspective, it was considered that road users would likely experience irritation and adverse driving conditions if the volume of heavy vehicle traffic is excessive. The 2016 census data (Australian Bureau of Statistics, 2018) indicates that the majority of inhabitants of Fullerton Cove (64.8%) and Fern Bay (74%) utilised their cars (as the driver) to get to and from their place of employment. This dependency on private vehicular use over public transport, along with the increasing population in the Fern Bay area in particular, has the potential to impact negatively on the capacity of the local road network with the proposed increase in heavy vehicles associated with the quarry. This dependency on private vehicular use will increase the exposure of Fern Bay and Fullerton Cove residents to traffic along Nelson Bay Road in particular, potentially increasing their awareness of traffic volumes and congestion on the local road network.

Capacity issues and reduced access to the road network (for example, if Fern Bay or Fullerton Cove residents experienced queuing at the Nelson Bay Road and Seaside Boulevard intersection roundabout) would create stress for the travelling public. No traffic impact assessment to confirm such a scenario was available at the time the scoping exercise was conducted however, so comments from local residents collected during early engagement were relied upon to investigate the matter. Those comments highlighted a lack of concern with the current project related traffic situation. Examples of such comments include:

- "the quarry and its related traffic is not an issue";
- "we've never particularly noticed trucks as part of the Nelson Bay Road traffic flow"; and
- "I have noticed trucks in the traffic flow but I have no particular concerns with them".

Based on the fact that a standalone traffic impact assessment would be completed for the EIS and that residents appeared to have minimal concerns with quarry related traffic or the network capacity, the scoping exercise determined that a SIA would not be required to assess this matter. Nevertheless, the project team committed to an adaptive research approach in relation to the results of the traffic impact assessment. If results or ongoing community feedback isolated potential social issues, then more detailed social assessments would be required.

DRAFT

Appendix M

Aboriginal cultural heritage assessment report

STOCKTON DRY SAND EXTRACTION PROJECT (SSD 52984213)
FULLERTON COVE, NSW

Aboriginal Cultural Heritage Assessment Report

Prepared for
Boral Resources (NSW) Pty Ltd

Port Stephens Local Government Area

July 2023

Ref. 2214

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Document Information

Project Name	Stockton Dry Sand Extraction Project (SSD 52984213), Fullerton Cove NSW: Aboriginal Cultural Heritage Assessment Report
Project Number	2214
Version	0.3
Client Name	Boral Resources (NSW) Pty Ltd
Issue Date	July 2023
Prepared by	Dr Matthew Kelleher, Cristany Milicich, Ben Anderson
Approved by	Dr Matthew Kelleher

Executive Summary

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets. The quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD in the Port Stephens Local Government Area. The quarry covers an area of approximately 246 ha. Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application). The dredge application was supported by an Environmental Impact Statement (EIS) prepared by Element Environment Pty Ltd ('Element', 2020). Kelleher Nightingale Consulting Pty Ltd (KNC) undertook an Aboriginal archaeological and cultural heritage assessment (CHAR) to inform the EIS.

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (SSD 52984213) to extract only the remaining dry sand resource (the project) from within the same extraction area as SSD 9490.

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

The Project is subject to approval under under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). Boral engaged Arnold Planning to assist with the preparation of the EIS for the Project. An Aboriginal heritage assessment is required as part of the EIS. Boral engaged KNC to prepare an updated Aboriginal cultural heritage assessment report (CHAR) to inform the EIS.

The preparation of the EIS is being undertaken in accordance with the Secretary's environmental assessment requirements (SEARs) issued by the Secretary of DPE on 18/01/2023. This CHAR addresses the SEARs relating to Aboriginal heritage. The CHAR has been prepared in accordance with the EIS requirements and the Heritage NSW [formerly Office of Environment and Heritage (OEH)] requirements and guidelines for Aboriginal community consultation and archaeological assessment.

The review of background information and previous assessment, including updated Aboriginal Heritage Information Management System searches, confirmed there were no known Aboriginal archaeological sites within the study area and proposed dry sand extraction area. While sites do occur within the wider Boral property, the study area is generally highly disturbed due to the previous extraction operations and removal of the bulk of the dune mass. Site inspection with the Aboriginal community during the SSD 9490 dredge application assessment confirmed the site condition and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Subsurface archaeological deposits are considered unlikely to occur given the study area's geomorphological context and the nature and extent of prior extraction disturbance.

Updated consultation with registered Aboriginal stakeholders was undertaken for the current Project, building on the existing process undertaken for the SSD 9490 dredge application assessment. The 16 stakeholders from the SSD 9490 dredge application consultation process continue to be consulted, along with three additional stakeholder groups/individuals identified by the updated registration process. Stakeholder consultation aimed to identify Aboriginal cultural/social heritage values in the study area, assess impacts of the proposed dry sand extraction activities and develop appropriate management recommendations. Consultation with the 19 registered Aboriginal stakeholders identified that the local area has cultural heritage value to the local Aboriginal community. In particular, Aboriginal stakeholders expressed the cultural importance and significance of the vegetated hind dune landscape around the study area. No specific Aboriginal cultural values have been identified within the study area. Boral values Aboriginal community consultation and is committed to ongoing consultation with Aboriginal stakeholders for the Stockton Sand Quarry proposals.

The configuration of the proposed extraction pits has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the Project and the extent of the known resource. The Project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider property. Impact to intrinsic Aboriginal cultural values of the surrounding landscape is considered to be minimal.

In sum, no Aboriginal heritage constraints have been identified for the dry sand extraction Project. No avoidance or mitigation measures are required for the Project on Aboriginal heritage grounds.

Management measures should be implemented for adjacent areas (outside of proposed impact area and study area). Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact area and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS). Documented toolbox talks should also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

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1 Introduction

1.1 Development Context

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets. The quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD (Figure 1). The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application). The dredge application was supported by an Environmental Impact Statement (EIS) prepared by Element Environment Pty Ltd ('Element', 2020). Kelleher Nightingale Consulting Pty Ltd (KNC) undertook an Aboriginal archaeological and cultural heritage assessment (CHAR) to inform the EIS (KNC 2019).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

The Project is subject to approval under under Part 4 of the *Environmental Planning & Assessment Act 1979* (EP&A Act). Boral engaged Arnold Planning to assist with the preparation of the EIS for the Project. An Aboriginal heritage assessment is required as part of the EIS. Boral engaged KNC to prepare an updated Aboriginal cultural heritage assessment report (CHAR) to inform the EIS.

The preparation of the EIS is being undertaken in accordance with the Secretary's environmental assessment requirements (SEARs) issued by the Secretary of DPE on 18/01/2023. This CHAR addresses the SEARs relating to Aboriginal heritage. The CHAR has been prepared in accordance with the EIS requirements and the Heritage NSW [formerly Office of Environment and Heritage (OEH)] requirements and guidelines for Aboriginal community consultation and archaeological assessment.

1.2 Project location and description

The project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94, which was subject to assessment in the EIS *For a Sand Extraction Operation on Boral Resources Freehold Property at Fern Bay, Near Newcastle NSW* (ERM Resource Planning Pty Ltd ('ERM') 1994). The project site for the current proposal is the same as the project site for the dredge application. It contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The 'study area' for this CHAR comprises the proposed extraction area and impact area for the current Project. The study area is shown in Figures 1 and 2 and encompasses all areas to be disturbed by Project operations. The study area is the same as that used for the dredge application. Key features of the Project are shown in Figure 3.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to a minimum 0.7 m above the water table, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in Figure 3, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project (shown in Figure 3) mirror the first five stages of the dredge application. This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in Figure 3, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

1.3 Purpose of this report

The Project is subject to assessment by the DPE and approval under the EP&A Act which requires preparation of an EIS. This CHAR is one of a number of technical papers that form part of the EIS. The purpose of this technical paper is to identify and assess the Aboriginal heritage impacts of the Project. In doing so it responds directly to the SEARs as outlined in section 1.4 and the recommendations provided by Heritage NSW in agency advice. This report has also been prepared in accordance with the Heritage NSW requirements and guidelines relating to the assessment of Aboriginal heritage in NSW. These include:

- *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (OEH 2010a);
- *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* (OEH 2011);
- *Aboriginal cultural heritage consultation requirements for proponents 2010* (OEH 2010b); and
- *NSW Skeletal Remains: Guidelines for Management of Human Remains* (Heritage Office 1998).

This CHAR presents an update to the existing CHAR assessment for the dredge application and uses the same study area. It is specific to the proposed activity for the Project and has included updated consultation with Registered Aboriginal Stakeholders for the proposed activity.

1.4 Secretary's environmental assessment requirements

This CHAR has been prepared to address the SEARs for the Project for the purpose of seeking project approval under the EP&A Act. The SEARs were issued on 18/01/2023. Table 1 outlines the requirements relevant to this assessment and where they are addressed in the report.

Table 1. SEARs: Aboriginal Heritage

Key issue	Where addressed in this document
Heritage – including - an assessment of the potential impacts on Aboriginal heritage (cultural and archaeological), including evidence of appropriate consultation with relevant Aboriginal communities/parties and documentation of the views of these stakeholders regarding the likely impact of the development on their cultural heritage	Section 2 Section 5 Appendices A-C

The CHAR also satisfies the requirements of Heritage NSW as provided in agency advice for the project, namely to "Provide an Aboriginal Cultural Heritage Assessment Report (ACHAR), prepared in accordance with relevant guidelines, identifying, describing and assessing any impacts to Aboriginal cultural heritage sites or values associated with the site."

1.5 CHAR objectives

The objectives of the CHAR are to:

- Undertake background research and primary investigations, including ethnohistorical, landscape/environmental, archaeological and cultural, to identify Aboriginal cultural heritage places and values within the study area – addressed in Chapters 2-6;
- Involve Aboriginal stakeholders in all stages of Aboriginal heritage assessment and development of management recommendations – addressed in Chapter 2;
- Identify and assess Aboriginal archaeological and cultural heritage places and values within the study area including an assessment of significance – addressed in Chapters 2-6, Chapter 7;
- Identify and assess the actual or likely harm to Aboriginal objects or Aboriginal places from the proposed activities of the project – addressed in Chapter 8; and
- Identify any practical measures that may be taken to protect and conserve Aboriginal objects or Aboriginal places and any practical measures that may be taken to avoid or mitigate any actual or likely harm to Aboriginal objects or Aboriginal places – addressed in Chapters 8-9 (no harm identified).

The Heritage NSW *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW* provides further guidance on the preparation of a CHAR. This report has been prepared in accordance with the requirements of the *National Parks and Wildlife Regulation 2019* and the guide.

Figure 1. Location of the Stockton Sand Quarry and study area

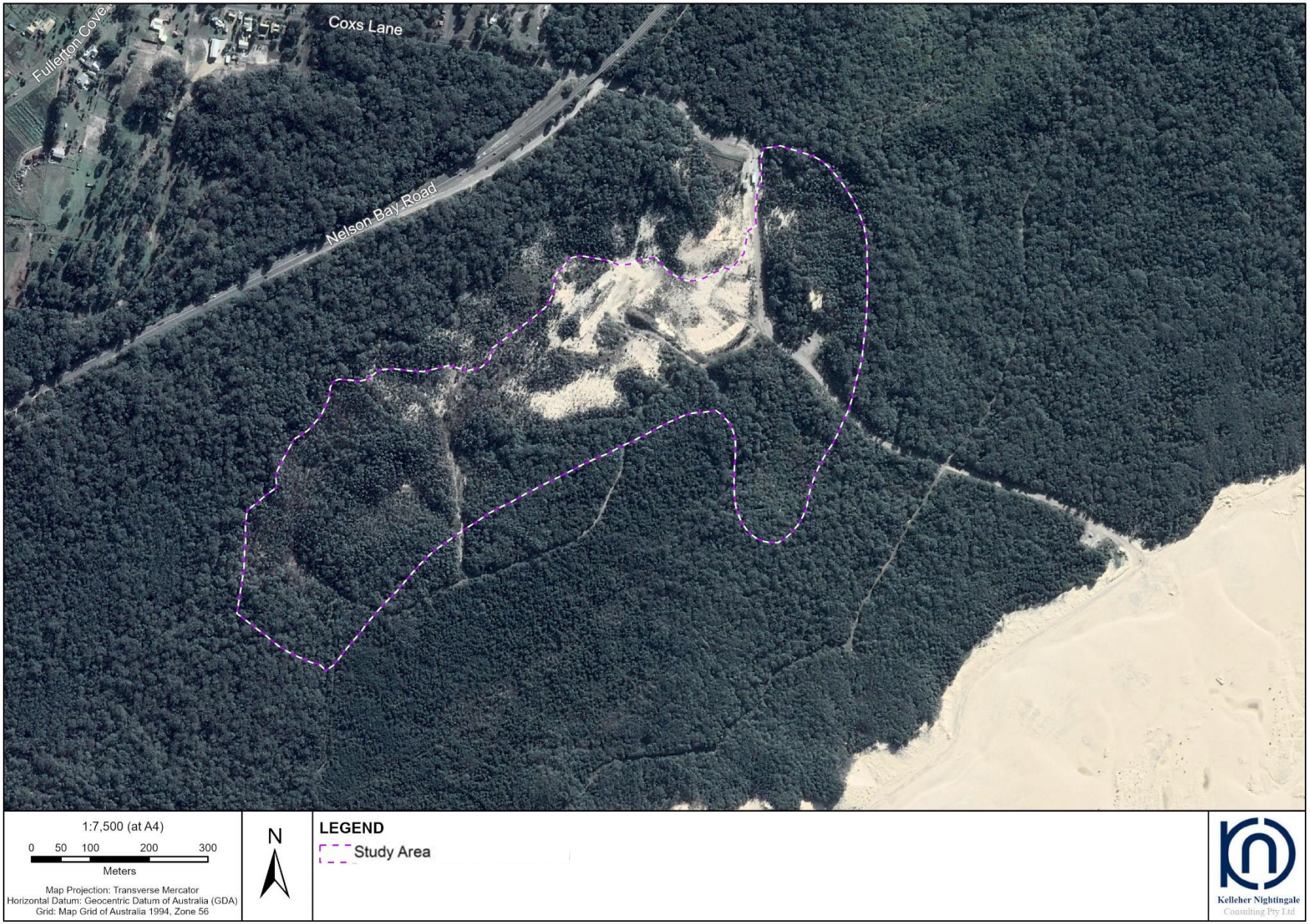

Figure 2. Detail of the study area

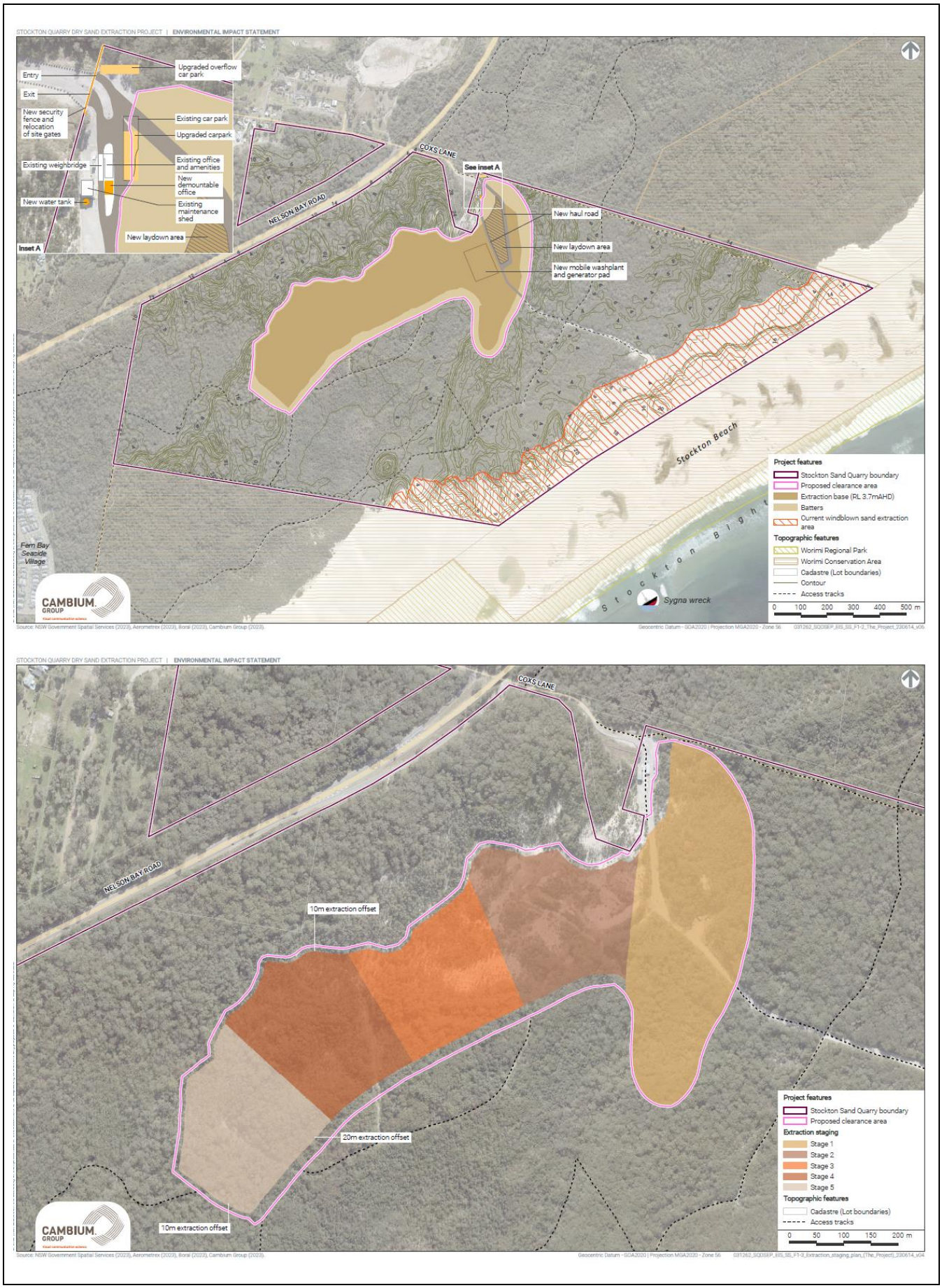

Figure 3. Key features of the Project and extraction staging plan

2 Aboriginal Community Consultation

The aim of Aboriginal community consultation is to integrate cultural and archaeological knowledge and ensure registered stakeholders have information to make decisions on Aboriginal cultural heritage. For the preparation of this CHAR, consultation with Aboriginal people has been undertaken in accordance with the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010b) and the requirements of Clause 61 of the *National Parks and Wildlife Regulation 2019*.

Boral is committed to ongoing consultation with the Aboriginal community. Given the time elapsed since the preparation of the original CHAR for the SSD 9490 dredge application and the change in the proposed activity within the project area, it was decided to undertake a fresh round of Aboriginal community consultation. The 16 stakeholders who were previously involved in the SSD 9490 dredge application assessment continued to be registered for consultation on the current project.

The updated formal consultation process has included:

- government agency notification letters (letters dated 20/01/2023);
- advertising for registered stakeholders in local media (*Port Stephens Examiner* 09/02/2023: refer Appendix A);
- notification of closing date for registration (23/02/2023);
- ongoing compilation of registrants list, through continuing to register individuals and groups for consultation on the project and updating the formal consultation process;
- provision of project information and proposed cultural heritage assessment methodology (letters dated 24/02/2023) allowing for a 28 day review period;
- provision of draft CHAR (letters dated 21/06/2023), allowing for a 28 day review period; and
- ongoing consultation with the local Aboriginal community.

Aboriginal stakeholders have been consulted throughout all stages of the assessment process. A full log of consultation will be attached as Appendix B.

2.1 Registration of interest

Aboriginal people who hold knowledge relevant to determining the cultural heritage significance of Aboriginal objects and Aboriginal places in the area were invited to register an interest in a process of community consultation. Sixteen groups or individuals previously registered an interest in the original SSD 9490 dredge application assessment process, and three new stakeholders were identified as a result of the updated consultation (Table 2). The new round of consultation also resulted in the identification of updated contact details for previously registered groups and in some cases a change in contact person.

Table 2. Registered Aboriginal stakeholders*

Registered Aboriginal Stakeholder	Representative and/or Contact Person
Worimi Local Aboriginal Land Council (LALC)	CEO
Murra Bidgee Mullangari Aboriginal Corporation	Ryan Johnson
Didge Ngunawal Clan	Paul Boyd and Lilly Carroll
Merrigarn Indigenous Corporation	Shaun Carroll
Muragadi Heritage Indigenous Corporation	Anthony Johnson
Nur-Run-Gee Pty Ltd	Leonard Anderson OAM
Lower Hunter Wonnarua Cultural Services	Lea-Anne Ball
Worimi Traditional Owners Indigenous Corporation	Candy Towers
A1 Indigenous Services	Carolyn Hickey
Murrooma Incorporated	Anthony Anderson
Karuah Indigenous Company Pty Ltd	David Feeney
Widescope Indigenous Group	Steven Hickey
Worimi Conservation Lands Board of Management	Nadine Russell
Amanda Hickey Cultural Services	Amanda Hickey
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)
Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)

Aboriginal stakeholder (details withheld)	Aboriginal stakeholder (details withheld)
Kamilaroi Yankuntjatjara Working Group	Phil Khan
Steve Talbott	Steve Talbott (individual)

*Three stakeholders specified they did not want their details released in accordance with item 4.1.5 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010*

2.2 Existing consultation

Previous consultation and assessment for the SSD 9490 proposal utilised the same study area as the current project and is summarised in this section. Cultural values identified during both rounds of consultation are discussed further in Section 2.8.

2.2.1 CHAR assessment methodology

The proposed assessment methodology was provided to all stakeholders for a 28 day review and comment period closing on 01/05/2019. An invitation was extended for Aboriginal cultural knowledge holders and stakeholders to provide comments on the proposed cultural heritage assessment methodology, including any protocols regarding the gathering of information and any matters such as issues/areas of cultural significance that might affect, inform or refine the assessment methodology.

Responses to the proposed assessment methodology were received from A1 Indigenous Services (A1), Murra Bidgee Mullangari Aboriginal Corporation (MBMAC), Muragadi Heritage Indigenous Corporation (MHIC), Murrooma Incorporated (Murrooma), Merrigarn Indigenous Corporation (Merrigarn), Widescope Indigenous Group (WIG), and Worimi Traditional Owners Indigenous Corporation (WTOIC).

A1 stated that they supported the proposed CHAR methodology and expressed interest in being involved in any potential fieldwork associated with the project (email dated 13 April 2019).

MBMAC stated they had read the project information and proposed assessment methodology and endorsed the proposed approach (email dated 3 April 2019).

MHIC stated that they endorsed KNC's assessment recommendations and had reviewed the project information and methodology (email dated 3 April 2019).

Murrooma responded via email (9 April 2019) and requested some additional information prior to making comment, including a map of the proposed dredging area. KNC responded on 9 April 2019 and provided a map. Further comment was then provided by Murrooma on 23 April 2019. Murrooma stated that they agreed with the proposed assessment methodology and consultation process for the Project, and noted their involvement with previous assessments in the area. In particular, Murrooma identified the dune ridges as traditional transit routes along the coast, and noted the presence of culturally significant Worimi sites in the surrounding area. Murrooma also stressed the importance of having local knowledge holders involved in the consultation process.

Merrigarn stated that they had read the project information and proposed assessment methodology and supported the recommendations made by KNC (email dated 3 April 2019).

WIG expressed support for the proposed methodology (email dated 19 April 2019).

WTOIC expressed that the Project area held cultural significance for the Worimi people (email dated 6 May 2019) and recommended further assessment of the area due to the potential to find artefacts. WTOIC affirmed that it was "extremely important to our Worimi people to gain the best outcome for protection and preservation of our local sites/objects".

2.2.2 Site inspection

Stakeholders were invited to attend a site inspection of the study area with the proponent and project archaeologist. All stakeholders were invited to attend (invitations sent 18 June 2019) or provide a representative. The site inspection took place on 27 June 2019.

Stakeholders attended across two sessions in the morning and afternoon. Representatives from Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands, Karuah Indigenous Corporation, Widescope Indigenous Group and Amanda Hickey Cultural Services attended the inspection and Worimi LALC, Didge Ngunawal Clan, Nur-Run-Gee Pty Ltd, Murrooma, Worimi Conservation Lands and Karuah Indigenous Corporation representatives took part in the site walkover. Representatives were accompanied by project archaeologist Dr Matthew Kelleher (KNC) and Neil Gascoyne (Quarry Manager, Boral).

The site inspection included a discussion of the site history and existing quarrying disturbance, further discussion of the Project, proposed extraction staging, remediation and archaeological context of the local area including location of nearby previously recorded sites. A site walkover was undertaken of the study area.

No Aboriginal objects were identified and representatives concurred with the assessment of existing severe disturbance within the study area and proposed extraction area.

2.2.3 Review of draft CHAR

The draft CHAR for the SSD 9490 project was provided to stakeholders with an invitation to review and provide comment (draft CHAR review package sent 9 September 2019). Stakeholders were invited to provide further comment on the Aboriginal cultural significance of the study area and the management recommendations presented in the report. A 28 day review and comment period was provided. Two responses were received from stakeholders (Appendix C).

MBMAC stated that they had received and reviewed the draft CHAR, and endorsed the recommendations made in the document (email dated 12 September 2019).

Muragadi stated that they agreed with the recommendations made in the report (email dated 13 September 2019).

2.3 Updated consultation regarding the land and proposed activity

Following on from Stage 1 of the updated consultation process undertaken by KNC (stakeholder identification and registration), project-specific consultation was undertaken for the current dry sand extraction proposal. Information regarding the proposed extraction project was provided to registered Aboriginal stakeholder groups in a letter dated 09/02/2023. Information included an outline of the Project, location of the study area, development approval context and relationship to the SSD 9490 dredge application proposal, and an invitation to consult during the assessment. Existing stakeholders were informed of the commencement of the updated consultation process and informed they would not have to re-register for inclusion in the updated consultation.

Stakeholders were then provided with the proposed assessment methodology for the CHAR, and invited to review and provide feedback. A review period of 28 days was extended, closing on 24/03/2023. An invitation was extended for Aboriginal cultural knowledge holders and stakeholders to provide comments on the proposed cultural heritage assessment methodology, including any protocols regarding the gathering of information and any matters such as issues/areas of cultural significance that might affect, inform or refine the assessment methodology.

2.4 Stakeholder responses to updated CHAR assessment methodology

Responses relating to the proposed assessment methodology were received from three stakeholder groups: A1, Amanda Hickey Cultural Services (AHCS), and MBMAC.

A1 stated that they had reviewed the project information and supported the proposed CHAR assessment methodology (email dated 06/03/2023).

AHCS expressed support for the proposed assessment methodology (email dated 06/03/2023).

MBMAC stated that they had read the project information and proposed assessment methodology and endorsed the recommended approach to the assessment (email dated 01/03/2023).

Several other responses were received from stakeholders who expressed interest in a potential on-site meeting to further discuss the project. It was considered that an on-site meeting was not required as the previous CHAR assessment for the dredge application included on site visits and there was no change in the boundary for the new CHAR.

2.5 Review of updated draft CHAR

The updated draft CHAR specific to the dry sand extraction project was provided to all stakeholders for a 28 day review and comment period. Stakeholder comments were sought on the Aboriginal cultural significance of the study area and the proposed management recommendations for the project. Responses and comments received from stakeholders are summarised below, included in the cultural significance assessment as appropriate, and attached in full in Appendix C. Appendix C also includes stakeholder comments on the SSD 9490 dredge application CHAR.

Responses on the current CHAR were received from two stakeholder groups, MBMAC and WTOIC.

MBMAC stated that they had read the project information and draft CHAR report and endorsed the recommendations made (email dated 29/06/2023).

WTOIC (email dated 25/06/2023) requested some clarification around their attendance at the previous site visit undertaken with stakeholders (see Section 2.2.2). KNC confirmed that WTOIC were invited to attend but unfortunately due to sorry business were unable to send a representative on the day (reply email dated 30/06/2023). WTOIC stated that they thought the area had high potential for Aboriginal objects and sites. KNC confirmed that the existing assessment results indicated the area is generally highly disturbed due to being previously mined and that no new impacts outside this disturbed area have been identified for the dry sand project. WTOIC also provided additional ethnographical information regarding Worimi history which has been incorporated in Section 4 of this report.

2.6 Aboriginal cultural values

It has been identified during the consultation process to date, both for the SSD 9490 dredge application project and the current dry sand extraction proposal, that the wider study area has cultural heritage value to the local Aboriginal community. Some of the Aboriginal cultural heritage values expressed by stakeholders include:

- strong association with the land;
- responsibility to look after the land, including the heritage sites, plants and animals, waterways, beaches, ocean and the land itself;
- scarred trees;
- artefact sites and middens;
- water sources, wetlands, creek lines and rivers, especially major landscape features such as the Hunter River and Fullerton Cove;
- indigenous plants and animals; and
- general concern for burials, as their locations are not always known and they can be found anywhere.

Numerous stakeholders have expressed close familial and traditional connections with the area, and stakeholders retain oral histories and cultural knowledge of the area. Stakeholders expressed the importance of education and protection of Aboriginal cultural heritage, and consideration of the landscape as a whole when assessing archaeological sites and their connections across Country. Previous Aboriginal cultural assessment for the existing windblown extraction project found that the overall landscape, native vegetation, waterholes, and archaeological sites were all significant to the Aboriginal community. Aboriginal cultural values and knowledge of the area have been provided by registered stakeholders throughout the consultation process to date for the inland extraction proposals and are summarised below.

Murrooma highlighted the importance of the general area, stating that “there are many places within this area that have significant cultural value to Worimi people and are in close proximity to the proposed project. These places of social, spiritual and cultural value are traditional areas with direct linkage to our ancestors and storylines” (letter dated 23 April 2019). Murrooma noted that traditional uses of the area included transit routes across the dune fingers and stressed that local knowledge holders and Traditional Owners from the area should be the source of specific cultural information for the study area.

WTOIC noted that the area was culturally significant to Worimi people (email dated 6 May 2019) and that the local area had high potential for Aboriginal objects and archaeological sites (email dated 25/06/2023). WTOIC also provided additional ethnographic information which has been incorporated into Section 4 of this report.

One of the stakeholders who chose to withhold their details expressed that Aboriginal people connected to Country in a myriad of ways, including through the land itself, through connection to their ancestors, and through their heritage (email dated 09/02/2023).

Nur-Run-Gee Pty Ltd provided detailed background information relating to the very high cultural heritage significance of the Stockton Peninsula as a whole for the Worimi people, with over 25,000 years of Aboriginal history connecting to the present (email dated 02/02/2023). Nur-Run-Gee Pty Ltd emphasised the importance of a holistic, Aboriginal-led approach in considering the spiritual and social considerations of developments in the area. The interconnectedness of spiritual and social values, storylines and oral histories with physical elements such as archaeology, plants and animals the land itself is highly important. Nur-Run-Gee Pty Ltd also noted that input from and consultation with the Traditional Owners and recognised Worimi groups was paramount, as was the protection of the cultural knowledge held by this community.

3 Environmental Context

3.1 Geology and geomorphology

The Stockton Sand Quarry is located within the Hunter subregion of the Sydney Basin, bordering the Pacific Ocean. The Sydney Basin is a large geological feature stretching from Batemans Bay in the south to Newcastle in the north and Lithgow in the west. The formation of the basin began between 250 to 300 million years ago when river deltas gradually replaced the ocean that had extended as far west as Lithgow (Pickett and Alder 1997). Fluctuating marine advances and regressions deposited sediment onto older basement rocks of the Lachlan Fold Belt and Late Carboniferous volcanoclastic sediments.

The Hunter subregion comprises a complex of Permian shales, sandstones, conglomerates, volcanics and coal measures, and is bounded on the north by the Hunter Thrust fault and on the south by cliffs of Narrabeen Sandstone. A Quaternary coastal barrier system is present in the Newcastle/Stockton Bight (National Parks and Wildlife Service (NPWS) 2003:191). The quarry is located within this coastal barrier system in the Stockton Bight. Stockton Bight (also known as Newcastle Bight) is a wide south facing coastal embayment bordered by Nobbys Head at Newcastle in the south and Birubi Point at Anna Bay in the north. The bedrock of Nobbys Head and the higher relief of Newcastle border the southern side of Stockton Bight, comprising the various Permian age subgroups of the Newcastle Coal Measures (coal, tuff, conglomerate, sandstone and shale) (Gorbert and Chesnut 1975).

The Hunter River has been deflected to the south by the Stockton Bight barrier system and enters the sea against Nobbys Head. The Bight sediments abut the sedimentary Permian rocks of the Tomago coal measures (shale, mudstone, sandstone, coal, tuff and clay) and Mulbring siltstone (siltstone, claystone, sandstone, conglomerate and limestone) between Raymond Terrace and Big Swan Bay, and at the northern end of the Bight abut the older Carboniferous Nerong Volcanics at Birubi Point (toscanite, dacite, andesite, ignimbrite, agglomerate, conglomerate, sandstone and siltstone). Between the Stockton training wall of the Hunter River and Birubi Point is the Stockton sand barrier system. The coastal barrier system consists of a gently curving Quaternary sand dune barrier system that comprises four major components (ERM 2005a:42):

- an inner (Pleistocene) barrier extending from the Hunter River to Lemon Tree Passage which was deposited as a series of parallel beach ridges and transgressive dunes approximately 120,000 years ago;
- a back-barrier depression backs the inner barrier and is occupied by the Hunter River - Raymond Terrace - Grahamstown Reservoir and Port Stephens;
- an interbarrier depression occupied by Fullerton Cove - Salt Ash – Tilligerry Creek; and
- an outer (Holocene) barrier that was deposited after the last post-glacial sea level rise, approximately 6,000-6,500 years ago.

Aeolian erosion and redeposition have reworked the surfaces of both barriers and in addition the morphology of the beach ridges has been modified by fluvial denudation. The Stockton Sand Quarry is located in the Holocene outer barrier system. The outer barrier includes the present beach and dune system and was initiated by waves and wind once post-glacial sea levels stabilised. The outer barrier has been through four periods of development (Short 2017:6):

1. 6,500-5,000 BP: Development of the Holocene foredune ridge plain. Waves delivered sand that progressively built the shoreline seaward by 3km, leaving a series of undulating foredune ridges. These extended the length of the bight and were fully vegetated. The only ridges visible today are located at the northeastern end of the bight, the majority having been exhumed, reworked and buried by subsequent dune movement;
2. 5,200-4,000 BP: Phase 1 dune transgression. The initial development and subsequent inland migration of the Phase 1 transgressive dune system buried the old land surface. Phase 1 dunes were then vegetated and stabilised up to 3km inland;
3. 2,000 BP: Phase 2 dune transgression. Second dune transgression moved up to 2km inland, reworking and burying earlier Phase 1 dunes. Phase 2 dunes were then vegetated and stabilised; and
4. 500 BP-ongoing: Phase 3 dune transgression. Phase 3 dunes have started moving inland as bare sand, excavating the outer foredune ridges and burying Phase 2 dunes. The Phase 3 dunes have moved several hundred metres inland since the commencement of transgression, and currently form an active, unstable and unvegetated transverse dune system along the bight.

The study area for the current Project is located atop a series of stable, vegetated dune ridges associated with the Phase 1 and 2 dune transgressions. ERM (1994) examined the age of the dune system within the previous extraction area. The study identified that the majority of the extraction area was positioned within the dune system estimated to be between 1200 and 2300 years old (Phase 2 transgression), with a small portion of the extraction area along the northern boundary of the site adjacent to Nelson Bay Road identified to be around 4500 years old (Phase 1 transgression) (Element 2019:64).

This accords with more recent coastal geomorphology assessment undertaken for the current Project (Short 2019), which confirmed that the Project area was located within the Phase 1 and 2 dunes. These are located atop the former Holocene foredune ridge plain (6,500-5,000 BP). During the initial development of the outer barrier, the prograding shoreline was capped by this series of well vegetated undulating foredune ridges and swales with an elevation between 5 and 10 metres (Short 2019:2). The foredune ridges would have provided a suitable sheltered area close to the ocean shore for Aboriginal occupation sites, albeit within a changing geomorphological system. Archaeological material located on the surface of these 5-10 metre high landforms would likely have been retained at or near the surface given the stabilising effect of vegetation but would have been vulnerable to erosion and displacement in areas of disturbance.

Old land surfaces associated with this phase of barrier development area known to contain midden sites where exposed by the ongoing Phase 3 dune transgression closer to the current shoreline (see Section 5). Further inland, successive periods of exhumation, reworking and reburial of the foredune ridges have taken place associated with the Phase 1-2 dune transgressions. Excavation to 5 metres AHD during previous extraction work associated with the inland extraction area is expected to have removed material to below the depth at which Aboriginal occupation evidence associated with either the Holocene foredune ridge plain or Phase 1-2 dunes would be expected to occur. It is therefore unlikely that the study area retains Aboriginal occupation evidence.

The remaining Phase 1-2 relict series of vegetated beach parallel dunes and intervening low profile sand sheets form a distinct geomorphological unit within the outer barrier system, and contrast with the active, mobile Phase 3 dune transgression currently taking place to the east along the margin of the sand quarry property boundary.

Recent Quaternary coastal geology mapping (Figure 4; Hashimoto and Troedson 2008) shows the geological units which underlie the Boral property at Stockton. The eastern extent of the Boral property is located atop Holocene age mobile dunes comprised of marine sand (Qhbdm), corresponding to the geomorphological unit of existing beach and unstable high dunes. The majority of the property (including the entirety of the study area) is located atop Holocene dunes of marine sand (Qhbd), corresponding to the older stable, vegetated beach parallel dunes and intervening sand sheets. Small areas to the west and north are mapped as Holocene beach ridge swales and dune deflation hollows (Qhbw) comprising marine sand, organic mud and peat. Some small areas of Holocene freshwater swamp (Qhs) have developed in these low-lying areas, comprising organic mud, peat, clay and silt with a marine sand component. Almost the entirety of the current study area has been modified by previous sand mining activity.

3.2 Topography and hydrology

The majority of Boral's property comprises relatively stable and vegetated hind dune and inter dune environments, while the south eastern property boundary encompasses the un-vegetated and mobile foredune environment. An existing and ongoing windblown sand extraction program is located along the sheltered side of this un-vegetated mobile dune. Elevations of the dunes in the vicinity of the quarry typically range from 8 to 16 metres AHD with some in excess of 20 metres AHD, while the lowest interdunal areas are approximately 4 metres AHD (RPS 2016 in Element 2019:8).

Originally, two parallel dune ridges were present on the property but large portions of these (the current study area) have been subject to previous sand quarrying and rehabilitation and do not retain a natural topography. The rehabilitated surface is undulating with steep cut slopes. Prior to previous sand extraction, the 1994 EIS described the original natural topography of the ridges. The westernmost ridge had a northeast-southwest orientation and a maximum height of 36 metres AHD along the northern Boral property boundary. The ridge comprised a series of steep-sided conical sand knolls connected by more gentle undulating areas. Slopes were variable but localised gradients were as high as 40%. The lower ridge to the east was described as diverging in a north-south direction and ranging from 20-34 metres AHD. The intervening low sand sheet separating the two ridges had an elevation of approximately 5 metres AHD. The removal of substantial sand mass is evident when comparing this to the current site topography.

No springs or permanent streams are present within the study area or the larger Boral property. Several small semi-permanent waterholes are present around the stable, vegetated dunes and shallow water pools form in the inter-dunal swales of the active transgressive dunes to the east after periods of rain, persisting when deflation reaches the water table. Shallow ponding across the sand sheets separating the older dunes also occurs as a result of naturally low lying interdunal swales where there is interaction with shallow groundwater. It is also possible that some surface runoff which does not infiltrate through the sand may accumulate in these swale areas contributing to the ponding (Element 2019:8). Previous assessments indicate the water table within the current study area fluctuates between 1.5-4 metres AHD (ERM 1994:5.10-5.11).

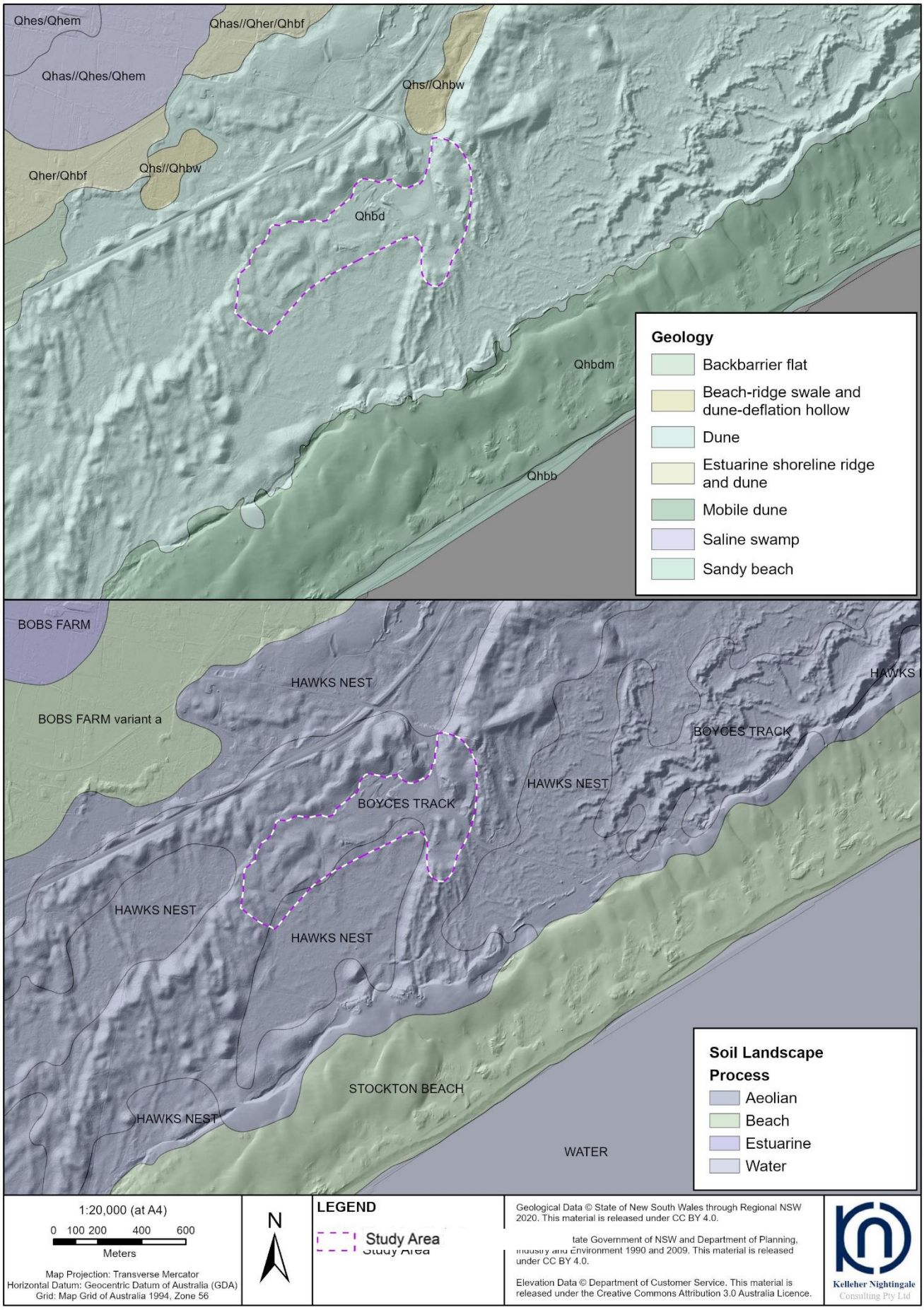

Figure 4. Geology and soils of the study area

3.3 Soil landscapes

The study area intersects two soil landscapes. The majority of the area is located atop the aeolian Boyces Track soil landscape. Boyces Track soils occur on the steep, stable Holocene transgressive aeolian dunes of the Tomago Coastal Plain, primarily arranged as two long walled ridges parallel to the shoreline between Stockton and Bobs Farm. Local relief is between 10-30 metres with slope gradient <30%. Windward dune slopes are generally longer and gentler than leeward slopes. Soils comprise deep (>300 cm), well-drained weakly developed Podzols under native vegetation with loose, loamy sand topsoils. Occurrence and relationship of soil material is generally up to 40 cm of speckled loose loamy sand (A1 horizon) overlying up to 100 cm of bleached loose light grey sand (A2 horizon), which overlies up to a 50 cm of faintly mottled sand (weak Bhs horizon) and >500 cm of loose dull yellow orange sand (C horizon (parent material).

The long ridges occupied by the Boyces Track soils are separated by a low relief sand sheet where the Hawks Nest soil landscape occurs and intersects the eastern margins of the current study area. Hawks Nest soils occur on the low Holocene sandsheets, swales and low transgressive dunes, comprising deep (>300 cm), well-drained Podzols and Siliceous Sands/Podzols on dunes and deep (>200 cm), poorly drained Humus Podzols on sandsheets (Matthei 1995:215). Local relief is <3 metres with slope gradients <10%. Low sandy dunes and swales are the dominant landform elements. Soil type is dependent on the age of the sand body (Matthei 1995). Along the coastal fringe, soil development is very poor on the younger dunes apart from some organic matter build-up on the surface and minor development of a Bhs horizon. Typical occurrences and relationship of soil materials is as follows: up to 40 cm of loose speckled grey-brown loamy sand (A1) overlies 10–150 cm of bleached loose sand (A2). This overlies 30–>100 cm of coloured mottled sand (B horizon) and over 300 cm of greyish yellow brown sand (C horizon). There are well-drained Siliceous Sand/Podzol intergrades on the seaward fringe, while Podzols occur landward.

Both soil landscapes are highly susceptible to wind erosion and mass movement if disturbed, being non-cohesive, and locally steep slopes also occur. The Boyces Track and Hawks Nest soil landscapes (which occur on the stable Phase 1 and 2 dune systems and intervening sand sheets) are gradually being engulfed by the Stockton Beach soil landscape associated with the active transgressive Phase 3 dune to the east. The stabilised dunes within the study area have previously been assessed by various mining companies for their heavy mineral content. The drilling and logging data from these assessments was considered by Boral in the 1994 EIS (ERM 1994:5.4-5.7). This included 74 holes drilled by Mineral Deposits Ltd (MDL) in 1989 and a further 175 holes by RZM Pty Ltd in 1990. In both explorations, holes were arranged along parallel lines across the Boral property. Two cross sections were prepared for the EIS based on the results. Both cross sections cover the current study area. The cross sections demonstrated fine to medium-grained, light brown to buff coloured sand to approximately 3-6 metres below sea level. Below this was a substrate of fine to coarse-grained grey sand with shell and lithic fragments. Within the paler sand (Phase 1/2 dunes) were lenses of fine to coarse-grained grey sand with a higher organic content and lithic fragments but no shell material. Areas of darker grey or brown staining were evident in association with these, and below the organic rich horizon in the low-lying sand sheet between ridgelines. These areas may be reworked remnants of the vegetated Holocene foredune ridge plain (6,000-5,000 BP). The higher dunes also displayed an organic-rich upper horizon. Quality and grading analysis determined that the sand was fine to medium-grained, generally well sorted and free of shells, shell fragments, pebbles and clay lumps.

3.4 Site history and land use

The study area and wider Boral property has a history of sand quarrying and landscape disturbance over at least the last 60 years. G. Hawkins and Sons acquired the site in the 1950s although, prior to that time, sand had already been removed from the site. Further extraction activities took place across the site from the late 1970s under a consent granted by Port Stephens Council in 1976, with sand transported along internal haul roads. Previous areas of disturbance identified in the 1994 EIS included a large portion of the eastern Phase 1-2 dune, the Crown Land at Lot 7300 DP1130730, areas around the site office, the southern part of the western Phase 1-2 dune, a large part of the sand sheet between the Phase 1-2 dunes and the active Phase 3 dune, and former haul roads and tracks (ERM 1994: Figure 5.12). In addition, the eastern section of Boral's landholding along the active Phase 3 transverse dunes was previously dredged for mineral sands by MDL between late 2000 and 2003.

Boral acquired the site in 1992 and extraction of sand on the vegetated dunes in the inland extraction area commenced in 1996 under a development consent issued by Port Stephens Council. The consent was for sand extraction above 5 metres AHD and road transport of up to 500,000 tpa for a period of 13 years. The development involved clearance of native vegetation and sand extraction by front end loader. Excavated material was then dry-screened in order to remove roots and minor naturally occurring coal fragments. Recycled road base from Boral's Kooragang Island recycling facility was imported to provide an inert stable base for haul roads and the floor of the operating extraction area. A front-end loader or excavator loaded road trucks in-pit with screened raw sand for transport off-site via the weighbridge, or was moved to the stockpile area. As each area of extraction was exhausted, topsoil and previously felled vegetation was re-spread over finished areas. The extraction areas were thus progressively rehabilitated until the approved resource was exhausted in 2008. The approved extraction area predominantly occupies the same footprint as the current study area and comprises large areas of evident disturbance despite rehabilitation (cf. Figures 2 and 5).

Figure 5. Aerial imagery from 2004 showing extent of disturbance from previous extraction (Google Earth). Study area shown in purple.

4 Ethnohistoric context

Although the specific Project area is not recorded directly in ethnographical accounts, historical accounts were made of the Aboriginal people living in the region at the time of initial European exploration and settlement in the late eighteenth and early nineteenth centuries. (cf. Brayshaw 1987; Maynard 2015). These historical accounts describe a landscape which was important to and intensively used by Aboriginal people. Contact with Europeans introduced diseases that drastically altered the size and structure of the Aboriginal population, whilst the establishment of a penal colony and later settlement at Newcastle subsumed the traditional areas used to meet subsistence needs and displaced the Aboriginal people inhabiting these areas.

Early historical observations described several Aboriginal groups within the wider Hunter region associated with particular areas of land. The study area and the wider Port Stephens area is located within the traditional lands of the Worimi. The area inhabited by the Worimi is traditionally described as bounded by the Hunter River to the south, Manning River to the north, and the Allyn and Patterson Rivers to the west (WCL 2019). Language group boundaries described by Tindale (1974) give the Worimi area as from the "Hunter River to Forster near Cape Hawke along coast; at Port Stephens; inland to near Gresford; about Glendon Brook, Dungog, head of Myall Creek and south to Maitland". Other work by W.J. Enright recorded "clear evidence that the Worimi occupied the country bounded by the seashore from the Manning to as far south as Norah Head and possibly to the Hawkesbury… as far west as the Barrington Tops, which… they visited in the summertime… they extended up the Hunter Valley as far as Singleton""(Enright 1933). Aboriginal people appear to have been organised into small groups of families or 'bands' who participated in communal subsistence gathering activities and formed part of a larger clan or descendant group that held ties to that area of Country. The Worimi around the immediate Port Stephens area were traditionally divided into four groups or *ngurras:* the Maiangal, Gamaipingal, Garuagal/Garuegal and Buraigal/Baraigal. The study area is located within the Maiangal area south of Port Stephens along the Stockton Bight to the Hunter River. To the south of the Hunter River were the Awabakal and inland, the Wonarua and Gringai.

Early European accounts indicate that the Worimi lived a mobile lifestyle, primarily in small territorial clans and local clans of extended family groups, forming larger bands through social and cultural links including marriage and communal participation in subsistence activities. Interactions with neighbouring language groups such as the Awabakal were also common. The Port Stephens area offered many lakes, estuaries, sandy beaches and intertidal zones with a diversity and abundance of resources for the local people to use. In the Port Stephens region, local Aboriginal people were identified as inland or salt water people due to their occupation of particular marine or estuarine landscapes and their use of the natural resources found in these environments. The salt water Maiangal occupied the vicinity of the study area. They would have had access to a wide range of avian, terrestrial and marine fauna along the shore while repeated firing of vegetation would have opened up foliage allowing ease of access through and between different eco zones as they moved through Country.

The shelters used by Aboriginal people at camp locations around Port Stephens were depicted in a 1826 painting by Augustus Earle (Plate 1). In the painting, the shelters can be seen as being constructed of bark sheeting while Aboriginal people are depicted gathered around fires which are situated at the entrances to the shelters. The construction was supported by three forked sticks brought together at the top to form a triangle. Dawson (1830:171 in Brayshaw 1987) recorded that "the two sides towards the wind are covered by long sheets of bark, the third is left open…When the wind shifts the gunyer is shifted also".

Plate 1. "A native camp of Australian savages near Port Stevens, [i.e. Stephens] New South Wales", by Augustus Earle. 1826. National Library of Australia; Rex Nan Kivell Collection NK12/28. http://nla.gov.au/nla.obj-134497417/view

Thomas Skottowe, Commandant of the Newcastle penal settlement from 1811 to 1814, collected several Aboriginal items from the region which were drawn by T.R. Browne (Plate 2). The items include spears, a shield, a spear-thrower, clubs, an axe with a European iron blade, a boomerang, a basket, a water-carrier, a twined dilly bag, and a fishing line with shell hook. The depicted items illustrate the use of various perishable materials including bark, wood and grasses that are rarely preserved in the archaeological record and would have constituted a large portion of the items used by past Aboriginal people.

Historical sources also recorded some of the uses that artefacts which are found within archaeological contexts would have had. Hatchets were constructed from hard stone which was chipped and then ground to an edge before being hafted while stone knives were documented as being used for cutting up meat and stone chips or shells used for skinning animals (Miller 1886: 353). Brayshaw (1987) provides a list of recorded material culture from the area, including forked poles for climbing trees, eucalypt bark canoes, bark string and netted bags, shell fish hooks, spears made with *Xanthorrhea* shafts, spear-throwers, shield, clubs, and shaped sticks for digging yams and tubers.

Plate 2. Native Arms from Select Specimens From Nature of the / Birds Animals &c &c of New South Wales, Collected and Arranged by Thomas Skottowe Esqr. The Drawings By T.R. Browne. Image from the State Library of New South Wales: http://www.sl.nsw.gov.au/collection-items/native-arms-select-specimens-nature-birds-animals-c-c-new-south-wales-collected-and

Early historical sources also note that an abundant supply of fresh water and marine resources were available in the region from the Hunter River, the estuary towards the mouth of the Hunter River and the coast of the South Pacific Ocean (cf. Grant 1803). Aboriginal people were observed exploiting marine resources of the coast and Hunter River by fishing and gathering shell fish while terrestrial resources such as kangaroos, bandicoots, snakes and lizards were hunted in the hinterland areas (Grant 1803: 55; Fawcett 1898: 152; Threlkeld in Gunson 1974:54-55). Consumption of shellfish was particularly important along the coast, and historical sources also record lobster-diving around the Port Stephens area with William Scott noting that “lobsters were caught by the women who, in the sea dived amongst the rocks for them”. Various fishing techniques were used and canoes were used for both line and spear fishing. At Port Stephens in the mid 1800s, Scott recorded that women used the hook and line and men used spears. However, one method of fishing he observed included both men and women: “the women would be on the lookout for the shining, shimmering mass of fish to come round some wooded headland, and when their shrill outcries told of the approach of the finny prey, the men would rush to the shore. Hissing into the water would hurtle the heavy spears….” (Newcastle Morning Herald Supplement 1993 in AMBS 2005). Another technique included the use of a hand net, “forming a circle in shallow waters and enclosing the fish” (Threlkeld in Gunson 1974:190). Threlkeld also noted fish traps made from twigs and poles in streams (Threlkeld in Gunson 1974:190).

The Port Stephens region remains important to local Aboriginal people, who have maintained their traditional ties to the area through the sharing of knowledge and lore down generations. The consultation process to date has identified a number of people who have indicated their interest in the area, demonstrating the tangible link that members of the contemporary Aboriginal community retain to the land.

5 Archaeological Context

5.1 AHIMS web services

The Aboriginal Heritage Information Management System (AHIMS) is a heritage database and regulated under section 90Q of the *National Parks and Wildlife Act 1974*. AHIMS contains information and records pertaining to registered Aboriginal archaeological sites (Aboriginal objects, as defined under the Act) and declared Aboriginal places in NSW.

A search of AHIMS was conducted on 25 July 2019 to identify registered (known) Aboriginal sites or declared Aboriginal places within or adjacent to the study area. An updated search was undertaken in March 2023 during preparation of the updated dry sand extraction CHAR (Appendix D) to confirm no changes since the original search.

The AHIMS Web Service database search was conducted within the following coordinates (GDA, Zone 56):

Eastings:	388850 - 393800
Northings:	6363000 - 6366500
Buffer:	0 metres (search coordinates included a buffer around the study area)

The updated AHIMS search results showed 76 Aboriginal sites recorded in or near the above location, consistent with the previous search results for the study area. No Aboriginal places had been declared in or near the search area. The locations of registered Aboriginal sites in the search area are shown on Figure 6. The frequencies of site types ('site features') are listed in Table 3.

Table 3. Frequency of site features from AHIMS database search

Site Context	Site Features	Frequency	(%)
Open Site	Aboriginal Resource and Gathering; Artefact	2	*2.6*
	Artefact	19	*25.0*
	Artefact; Shell	24	*31.6*
	Shell	24	*31.6*
	Restricted*	7	*9.2*
Total		*76*	*100*

*Seven restricted sites were present within the AHIMS search area, meaning no further information is available regarding site type, location or condition. Previous consultation with the AHIMS registrar confirmed that none of these were located within the study area and would not be impacted by any works within the Project area.

As well as determining if there are any registered (known) sites within a given area, an AHIMS search also helps to characterise local archaeology by illustrating the distribution of known sites within the local landscape. Search results for the current project indicated the predominance of open context occurrences of artefacts and shell (middens) around the study area. Sites displaying solely shell (n=24) or solely artefacts (n=18) have also been recorded. Artefacts may be identified in isolation ('isolated finds') or in association with others in an artefact scatter (open camp site). Two artefact sites have also been recorded in associated with areas of Aboriginal Resource and Gathering.

The presence of numerous recorded sites in the vicinity of the study area demonstrates physically that the local landscape was used by Aboriginal people in the past and that material traces of this landscape use have survived in the form of Aboriginal objects and archaeological deposit. No previously registered AHIMS sites are located within the study area although several are present on the wider Boral property. The wider property also contains one unregistered site (BFB 1) identified during a previous survey. These recordings are discussed further in section 5.3.

5.2 Other heritage registers and databases

A search was also undertaken of the following statutory and non-statutory heritage registers for Aboriginal heritage items within or adjacent to the study area:

- Port Stephens Local Environmental Plan (LEP) 2013;
- State Heritage Register and State Heritage Inventory;
- Section 170 Heritage and Conservation Registers;
- Commonwealth Heritage List;
- National Heritage List;
- Australian Heritage Database;
- Australian Heritage Places Inventory; and
- Register of the National Estate (N.B. the Register was closed in 2007 and is no longer a statutory list. It is maintained on a non-statutory basis as a publicly available archive and educational resource).

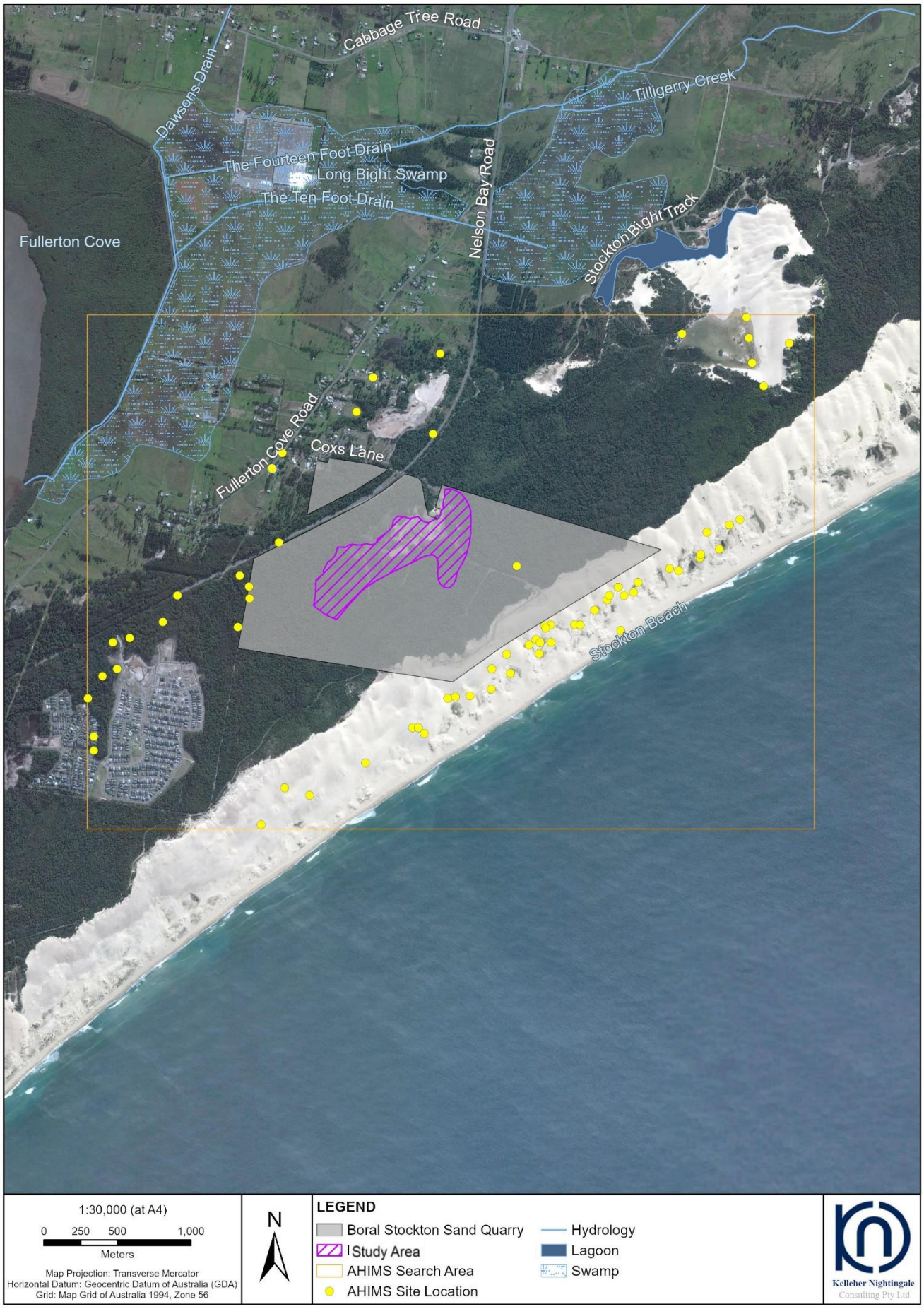

Figure 6. Registered Aboriginal sites near the study area (AHIMS results)

Three heritage items were identified on these registers. The Port Stephens LEP 2013 lists the 'Stockton Beach Dune System' within Lots 224–227 and 230 DP 1097995, Lots 216 and 218 DP 1044608, Lot 592 DP 1097992 and Lot 7033 DP 1053720. The item borders the wider Boral property to the east and north. The item is listed as a natural landscape. The listing includes 'Aboriginal site and shell middens, ship wrecks, WWII ramparts, tank traps, proofing range, rifle range and tin huts' within the Stockton Beach Dune System. The item is listed as 'I34' on Schedule 5 of the Port Stephens LEP 2013 as displaying local heritage significance. The item is located outside of the current study area.

The Register of the National Estate, a non-statutory archive which closed in 2007, lists two further recordings in the Fern Bay area. 'Newcastle Bight Coastal Area' is listed as an Indicative Place (i.e. was not accessioned onto the register prior to its closing) and was nominated for its Natural value. The statement of significance includes Aboriginal heritage values in its description, particularly "some of the largest Midden sites in NSW as well as burial and educational sites". The recording is not a listed heritage item and has no legal status as a statutory heritage item.

A second Indicative Place described only as 'Indigenous Place' is listed for the suburb of Fern Bay, with no further information available. This recording is also not a listed heritage item and has no legal status as a statutory heritage item.

No other Aboriginal heritage items or items of Aboriginal heritage significance were listed on these databases within or in the vicinity of the study area.

5.3 Previous investigations around the study area

The study area and adjacent areas have been subject to a number of detailed archaeological investigations conducted as part of the planning and approval process for previous sand extraction activities, as well as larger scale regional studies of the Newcastle Bight.

Newcastle Bight Aboriginal Sites Study

The Newcastle Bight Aboriginal Sites Study was a comprehensive and large scale assessment undertaken in the late 1980s to inform the region's future development planning (Dean-Jones 1990). The assessment area encompassed the whole of the Bight and a range of environmental and geomorphological contexts. A detailed analysis of environmental change and landscape processes through the Late Pleistocene and Holocene was formulated in order to better understand the Aboriginal archaeological record. The study also included a review of previously recorded sites and relevant ethnographical data. Prior to this study, approximately 70 Aboriginal archaeological sites had been formally recorded within the Bight's dual barrier system, primarily midden sites. While some of these were spatially extensive, including dense concentrations of stone artefacts and packed, stratified shell, the majority of middens were smaller deposits exhibiting high levels of disturbance from a combination of natural (aeolian, fluvial) factors and modern landscape use. The dynamic geomorphic context of the Bight was highlighted as a particular factor in site taphonomy, detection and distribution patterning.

A field survey was undertaken as part of the assessment and recorded over 100 archaeological sites, with a further 40-50 additional middens noted in the modern foredune/swale but not recorded in detail. Midden sites predominated, with three quarters (74%) of the newly recorded sites including at least a sparse scatter of estuarine or marine shell material. Most of these were thin and disturbed deposits, with only 12% displaying dense concentrations or lenses of packed shell. Stone artefacts were relatively rare, with fewer than five recorded at most sites where these were present. Denser concentrations of stone artefacts were associated with two particular types of site: midden complexes associated with late Holocene stable dune surfaces overlooking the deflation basin at the rear of the beach, and open campsites on Pleistocene dunes associated with Pleistocene freshwater wetlands or Holocene estuarine wetlands. It was noted that despite the presence of sites on Pleistocene dune surfaces of the inner barrier, there was no evidence that these were of an age with the substrate, and were generally similar in stone tool technology to more recent sites from the Holocene barrier. Site differences appeared to relate to differing environmental contexts and exploitation of the attendant resource zones rather than differences in site age.

An analysis of site distribution patterning was undertaken based on the results of the background research and the field survey. For the most part, newly identified sites recorded during the survey were located on the deflation basin and outer margin of active transgressive dunes. Almost all were middens. This was considered to represent intensive occupation of the deflation basin/dune area over the last 1000 years but with several caveats; namely, very active geomorphological processes. In particular, dune cycling and the movement of transgressive dunes leads to constant exposure, deflation and reburial of archaeological material. Freshwater pools in the swales and deflation basin also deflate and rework middens around their margins. Large and complex middens may only be exposed as discontinuous, disturbed scatters or recorded as several smaller sites and archaeological context was hard to ascertain where no direct association with a recognisable land surface existed.

A total of 18 sites were recorded on the stable, vegetated Phase 1 and 2 hind dunes. Most were in locations associated with modern freshwater and estuarine environments along the interbarrier depression, although eight were located in

the body of the transgressive dune field. Sites were situated on weakly to moderately podzolised sands with a light grey A1 horizon incorporating organic material and charcoal and a slightly bleached A2 horizon. Shell content of the sand was low. Sites were found on both the Phase 1 and Phase 2 dunes and it was noted that although sites were not located on the highest points or on every longitudinal dune ridge, "they conspicuously avoid the swales" (Dean-Jones 1990:97). Sites comprised thin scatters of fragmented shell, with no stone artefacts observed. Species were predominantly pipi, with a smaller component of cockle and mud whelk.

Sites located further to the west, on Phase 1 dunes bordering the interbarrier depression, tended to have a higher representation of estuarine species, especially oyster, and had larger and denser middens with stone artefacts much more frequently recorded. Archaeological sites on the seaward side of the outer barrier were located either at the interface between the deflation basin and the seaward base of the transgressive dune, or in close association with linear exposures of the older Holocene land surface (wherever this occurred). The Fern Bay sites recorded during this assessment near the current study area are located within these contexts, further to the east of the study area in the active transgressive Phase 3 dune field. Disturbed shell scatters around the margins of the freshwater soaks were considered to be lag deposits in the deflating floor of the swales and blowouts. Given the high number of sites recorded within these areas, the active transgressive dune/deflation basin margin was ascribed with high archaeological sensitivity, although it was noted that apart from the current beach/foredune, this was also the area with the greatest geomorphic instability. It was also noted that 4WD activity was impacting on numerous sites. It was recommended that this activity be better managed to minimise archaeological impact, and that the NPWS explore the possibility of increasing their landholdings in the Bight in order to capture a sample of the aeolian surfaces which dominate its complex geomorphology.

Stockton Rifle Range

An Aboriginal cultural heritage and archaeological assessment was undertaken for a proposed residential development at the Stockton Rifle Range approximately 3.4 kilometres to the south west of the current study area (Umwelt 2017). The assessment comprised a review of background information including landscape factors and archaeological context, an Aboriginal community consultation process and a field survey. The assessment focused on the proposed development lands within the vegetated stable dune system east of Fern Bay. The part of the property containing the active transgressive (unvegetated) dune field and beach front was to be rezoned as E2 Environmental Conservation land and not developed.

A review of landscape factors identified the complex geomorphology of the Stockton Bight dual barrier system and dune transgression sequence as a key factor in understanding archaeological site occurrence, visibility and preservation. In particular, it was noted that the Holocene beach ridge, strand plain and dune sequence present along the outer barrier had a maximum age of approximately 6000 BP. Within this sequence, the three phases of dune transgression have been dated to 4500 - 4000BP for Phase 1, 2300 - 1200BP for Phase 2, and the currently active Phase 3 approximately 300BP.

The environmental context of the local area was identified as having provided a wide range of resources to Aboriginal people. Flora and fauna from terrestrial, saltmarsh, estuarine and marine environments would have provided raw materials for food, medicine, and material culture. Stone resources suitable for tool-making do not occur in the immediate area but were available from outcrops at Nobbys Head to the south and various coal measures at Shortland and Tomago to the west and northwest. Coastal woodland would have been present across the earlier Phase 1 and Phase 2 stable transgressive dunes, supporting a range of mammal, reptile and bird species that provided food and other resources for Aboriginal people.

Review of archaeological context confirmed that shell middens were the most commonly recorded site type in the area. A previous analysis of archaeological patterning by Umwelt (2003) identified that sites recorded within the vegetated dune field (stable Phase 1 and 2 transgressive dunes) were primarily small scatters of stone artefacts or small (likely single event) pipi middens. Sites within the vegetated dunes tended to be buried and only visible in disturbed areas, resulting from a combination of bioturbation, occupation processes (e.g. trampling) and natural slope movement processes. This exposure of material that previously would have been in a subsurface context suggested that deposits were not deep within the dune profile (<1 metre). However, it was also noted that stabilised dunes are still subject to erosion moving sands downslope (degrading) or the addition of new wind-blown sand or ongoing podsol formation (aggrading). The stable Phase 1/2 dunes may therefore have both aggrading and degrading surfaces through time, which may affect the location and integrity of any archaeological deposits they contain.

Sites within the deflation basin between the foredune and the active, un-vegetated Phase 3 dunes included both small scatters and middens along with more complex sites, with identification and exposure of archaeological material "at least partially dictated by the history of deposition and deflation in the location and the destructive forces of aeolian abrasion" (Umwelt 2003). It was also noted that most sites in the Outer Barrier had not been subject to dating, and that while sites were known to occur on the buried soil surfaces of the Holocene foredune ridge plain, the archaeological material was not necessarily of the same age.

Field survey was undertaken of the proposed residential development area located within the western vegetated area. Eleven previously unrecorded sites were identified and the locations of two previously recorded sites within the area were revisited. Sites comprised disturbed, low density artefact scatters with shell midden material. Artefact raw material was primarily Nobbys tuff with occasional silcrete. Shell material was generally in poor condition, weathered and highly fragmented. The archaeological sensitivity and potential of the remainder of the vegetated dunes was linked to disturbance factors.

Sites were identified in areas of exposure and disturbance associated with the decommissioning and remediation of the former rifle range and Defence lands, or along recreational vehicle tracks. The location of four further registered sites (presumed but unconfirmed burials registered as a result of anomalous results on a Ground Penetrating Radar survey) were confirmed to be outside the proposed development area, along the Popplewell Road reserve to the west. In general, the recorded middens displayed low integrity and low research potential due to previous disturbance. The cultural values assessment conducted by the Aboriginal community identified that the more intact, vegetated stable dunes north of the access road, known site locations and the potential burials displayed high significance.

Stockton Sandpit Sand Extraction – Archaeological Assessment (1994)

In 1994, Resource Planning Pty Ltd undertook an archaeological assessment and survey to inform the EIS being prepared for the proposed sand extraction area in the centre of the Boral property. The study area for this assessment is the same as the previous sand extraction area and the current study area. The assessment included a review of background archaeological and environmental context, review of previous investigations both in and around the study area, development of site predictions, archaeological field survey and an impact assessment/recommendations for the sand extraction proposal. The assessment was undertaken with the Worimi LALC.

The study area was confirmed to be located on the Phase 1/2 stable hind dunes, across an area of low, stabilised sandy swamp and an area of higher stable dunes. Several vegetation species in the area were identified as having being used by Aboriginal people as food and medicinal resources, as well as for material culture such as string, baskets and containers. Stone resources were found to be scarce on the outer barrier, only known to be present at Nobbys Head (fine cherty tuffs) and Tomago (silicified crystalline tuffs). It was suggested that Aboriginal people living around the study area would have accessed these via water craft. A review of previous investigations and recorded sites identified that the majority of known archaeological sites in the local area sites were middens and were mostly located within the active Phase 3 dune system, deflation basin and foredune along the current beach. Middens were also known to occur on the landward side of the stabilised Phase 1 dunes facing the interbarrier depression. Based on background information review, these two landscape contexts appeared to be the most archaeologically sensitive, with fewer recordings known from the Phase 2 dune field. Stone artefacts were found to be generally rare in small midden sites but were common at the larger, stratified sites.

Previous assessments undertaken in the Phase 1/2 dune field immediately to the south of Boral's holdings indicated that midden material was primarily identified in areas of disturbance. In particular, Koettig (1987) stated that midden material was present 10-20cm below the present ground surface and thus would only be identified in areas where ground disturbance extended to at least this depth. A shovel testing program was also undertaken by Dean-Jones in the area, which concluded that midden material was consistently identified on ridges between 30-50cm below the present ground surface (ERM 1994:5.30).

It was established that two previously recorded AHIMS sites were present on the wider Boral property. Both were recorded during a previous survey assessment of the Boral property in 1992 (Resource Planning 1992). 38-4-0321 comprised an open artefact scatter recorded on the edge of the Phase 1 stabilised dune along the Boral property boundary along Nelson Bay Road. Eight tuff flakes were identified along the southern side of the road, with a further 40 located along the northern side of the road. The second site (38-4-0322) was identified within the former deflation basin landward of the active transgressive dune field. The site comprised a small, disturbed shell midden of crushed pipi fragments in the vicinity of three waterholes. Neither site was located in the proposed extraction area (current study area) and neither was to be affected by the proposed quarrying. Two further locations of potential were identified during the 1992 survey. The first of these was a sparse scatter of fragmented rock oyster and whelk located on the dune face of the Phase 2 dune, and the second was scattered fragments of oyster shell on the dune slope near Nelson Bay Road. Neither of these locations were recorded as archaeological sites.

Archaeological field survey was undertaken of the proposed extraction area with the Worimi LALC, with a particular focus on areas of exposure and ground disturbance that could be expected to reveal archaeological material (e.g. vehicle and animal tracks, areas of natural exposure). No archaeological material was identified within the study area and it was confirmed that previously recorded sites would not be affected by the proposal. The potential for subsurface midden sites was assessed as low and it was noted that previous drilling programs across the property did not detect any subsurface shell deposits or archaeological material. Given the indications from previous studies that midden material occurred within the top ~50cm of the profile in the Phase 1/2 dune field, the study area was considered unlikely to contain any buried deposits. It was concluded that there was low site potential in the Phase 2 dunes where the extraction was proposed.

The fragmented material previously identified on the Phase 2 dune in 1992 was considered to display low to no archaeological value and was not considered to be a constraint. The report provided by the Worimi LALC confirmed that no archaeological material was found within the study area despite an intensive field survey. Overall, it was recommended that the sand extraction could proceed with no objection on Aboriginal archaeological grounds. Port Stephens Council subsequently gave development consent for the project in 1996 and extraction was undertaken until the approved resource was exhausted in 2008. Extraction activities completed under this development consent have impacted the majority of the current study area (cf. Figures 2 and 5).

Stockton Sandpit Windblown Sand Extraction - Archaeological Assessment (2005)

Aboriginal heritage assessment also formed part of the EIS prepared for the subsequent Windblown Project to the east of the current study area (ERM 2005b). This assessment included the overall Boral property but focussed on the proposed Windblown extraction area, primarily the active transgressive dune previously dredged for mineral sands by MDL. The assessment included background research to provide an assessment of the potential for the study area to contain cultural material, a site inspection to assess Aboriginal cultural heritage and areas of potential cultural heritage, and consultation with the Aboriginal community (Worimi LALC and Maaiangal Aboriginal Heritage Incorporation).

Environmental assessment confirmed that the proposed windblown sand extraction area was located in a geomorphically complex and dynamic context. Three periods of dune transgression were noted for the outer barrier, described by ERM as follows: the first occurred approximately 4000 years ago, the second approximately 1200 years ago and the third, which is still active and is overriding the 1200 year old outer transgressive dune, began approximately 300 years ago. The entirety of the Windblown Project was located on the active, 300 year old transgressive dune. Analysis and discussion of the previous MDL mineral sand extraction operation concluded that the entirety of the previously dredged area had been subject to severe disturbance to a level several metres below the water table. It was noted that shell and gravel material occurred throughout the processed sands and were occasionally left as lag deposits on the 'dune' surfaces. Ongoing disturbance from recreational 4WD activity along the active dunes was also considered likely to have impacted on cultural material.

Review of background archaeological information indicated that the majority of the sites recorded along the Stockton Bight were located on or near the deflation basin between the frontal dune and the main transgressive dune mass; however it was noted that this patterning may have been the result of better visibility and exposure in comparison to the stable, vegetated Phase 1 and 2 dunes. This accorded with the findings of the Newcastle Bight Aboriginal Sites Study, which identified this as a particularly archaeologically sensitive part of the outer barrier. Previous assessment had recorded few sites on the active Phase 3 transgressive dune mass landward of the deflation basin.

It was identified during background information review that several previously recorded AHIMS sites near Boral's property boundary were likely located slightly further seaward than their registered coordinates. There were no recorded sites within the proposed Windblown extraction area, and recent dredging meant there was considered to be almost no archaeological potential (ERM 2005a:82). There was considered to be low to moderate archaeological potential in the corridor between the dredge path and native vegetation on the Phase 1/2 dunes, and one new site (named BFB 1) was recorded here during the subsequent field survey. The site comprised a shell midden of moderate density, highly fragmented pipi on an exposure of the darker old Holocene land surface. No artefacts were recorded. The proposed windblown sand project impact area was changed in order to avoid the site, which has not been registered on AHIMS.

The Aboriginal cultural assessment found that the overall landscape, native vegetation, waterholes, and archaeological sites were all significant to the Aboriginal community. Significance assessment for BFB 1 found the site to have low archaeological significance. Following modification of the proposed extraction area to avoid BFB 1, impact assessment considered that the Windblown project would not impact on any Aboriginal cultural heritage. In particular, the potential for Aboriginal cultural material to occur in the area previously subject to dredging was assessed as minimal given the severe levels of disturbance. No further archaeological work was recommended, and the project was granted consent from the then Minister for Planning in 2006.

Summary

The review of background information revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area associated with the Project. Previous assessment for the original extraction EIS (1994) in consultation with the Worimi LALC did not identify any Aboriginal archaeological sites or project constraints within the study area. The potential for subsurface Aboriginal archaeological material in the current study area is low and has not been indicated by previous investigations including an extensive drill sampling program. The current study area is generally highly disturbed due to the existing extraction operation.

6 Site Inspection

A site inspection was carried out as part of the Aboriginal heritage assessment of the study area for the SSD 9490 project. The visual inspection included a pedestrian walkover and assessment of the study area. Inspection was undertaken by Dr Matthew Kelleher (KNC) accompanied by Neil Gascoyne (Boral) and Registered Aboriginal Stakeholders for the Stockton Sand Quarry property. Aboriginal community participation in the site inspection is detailed in Section 2.

The site inspection aimed to identify Aboriginal objects or sites (if present), assess the archaeological potential and sensitivity of the study area, and confirm the nature and extent of previous disturbance.

The majority of the study area was confirmed to be severely disturbed following the previous sand extraction program. Large sections of the former dunes are absent, with the expansion of the central low-lying basin landform following extraction. The adjoining slopes to the west have also been modified as part of the rehabilitation program, which included shaping and contouring of the finished batters to merge more harmoniously with the remaining portion of the adjacent unworked dune body. A revegetation program has also been undertaken and the reinstated higher elevation slopes and crests to the south and west are heavily vegetated with native regrowth, primarily from the Coastal Sand Apple – Blackbutt open forest vegetation community. Ferns, grasses and stripped saplings provide ground cover and leaf litter is abundant. The aerial imagery from 2004 (Figure 5) indicates the widespread nature of extraction disturbance in this area despite the currently good-looking rehabilitated conditions.

Plate 3. Typical regrowth vegetation cover in south western part of study area

Plate 4. Patchy exposures in vegetated south western part of study area

Topsoil has been reintroduced to a number of areas in order to support the vegetation. Ground surface exposures were infrequent, and where present the visibility was generally low. Exposures were primarily of clean, cream- to buff-coloured sand with little podzol development or organic A horizon evident. No shell midden material or Aboriginal objects were observed in these areas. Scattered introduced fill and other rubble (used onsite to construct haul roads) was present on the surface in some of the larger exposures.

Plate 5. Typical cleared area with scattered fill material on surface in former extraction area

Plate 6.View to north east from south western elevation showing central basin extraction area

The central basin formed by the previous extraction program is undulating and vegetated with a mixture of cereal grasses (stabiliser crop introduced to protect against immediate aeolian erosion) and scattered spinifex, as well as regrowth shrubs and smaller native saplings around the margins of the basin. Ground disturbance from tracks and the former haul roads was evident. Areas of lower apparent disturbance along the southern margin of the study area where the future haul road is proposed were closely inspected but no archaeological sites or areas of potential were identified.

Plate 7. View to south west from edge of central basin looking towards vegetated higher dunes to the south

Plate 8.View to north across central basin

The eastern portion of the study area was also closely inspected due to the presence of small areas of remnant landform with lower apparent disturbance and larger mature regrowth trees. These were present in between larger areas of disturbance associated with previous extraction activities and vegetation clearance (cf. Figure 5). Ground surface visibility was generally low due to thick vegetation cover, restricted to small areas around trees and on the slopes where downhill sand movement had created exposures. No shell material or archaeological sites were identified.

Plate 9. View up slope north of current haul road showing exposures

Plate 10. View to south from crest above current haul road showing vegetation coverage and landform

Summary

Visual inspection confirmed the extent and nature of previous extraction disturbance within the study area. These areas have little to no archaeological potential given the previous removal of the dune mass to 5 metres AHD. Ground surface exposure within the study area varied from high to low, with archaeological visibility obscured by vegetation and disturbed sands.

Areas of lower apparent disturbance (i.e. apparent remnant slope/crest landforms on the edges of the former extraction area) were closely inspected but no archaeological material was identified despite frequent exposures and localised disturbance of the ground surface.

No archaeological sites, Aboriginal objects or areas of Aboriginal archaeological potential were identified. No shell material was identified. Archaeological potential for subsurface archaeological deposits was assessed as very low to nil given the extent of previous disturbance and the findings of previous assessments.

7 Cultural heritage values and statement of significance

7.1 Significance assessment criteria

One of the primary steps in the process of cultural heritage management is the assessment of significance. Not all sites are equally significant and not all are worthy of equal consideration and management (Sullivan and Bowdler 1984, Pearson and Sullivan 1995:7). The determination of significance can be a difficult process as the social and scientific context within which these decisions are made is subject to change (Sullivan and Bowdler 1984). This does not lessen the value of the heritage approach, but enriches both the process and the long-term outcomes for future generations, as the nature of what is conserved and why, also changes over time.

Significance assessments can generally be described under three broad headings (Pearson and Sullivan 1995:7):

- value to groups such as Aboriginal communities;
- value to scientists and other information gatherers; and
- value to the general public in the context of regional, state and national heritage.

The assessment of significance is a key step in the process of impact assessment for a proposed activity as the significance or value of an object, site or place will be reflected in resultant recommendations for conservation, management or mitigation.

The *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (OEH 2010a) requires significance assessment according to criteria established in the *Australia ICOMOS Burra Charter* (Australia ICOMOS 2013). The *Burra Charter* and its accompanying guidelines are considered best practice standard for cultural heritage management, specifically conservation, in Australia. Guidelines to the *Burra Charter* set out four criteria for the assessment of cultural significance:

- Aesthetic value - relates to the sense of the beauty of a place, object, site or item;
- Historic value - relates to the association of a place, object, site or item with historical events, people, activities or periods;
- Scientific value - scientific (or research) value relates to the importance of the data available for a place, object, site or item, based on its rarity, quality or representativeness, as well as on the degree to which the place (object, site or item) may contribute further substantial information; and
- Social value - relates to the qualities for which a place, object, site or item has become a focus of spiritual, political, national or other cultural sentiment to a group of people. In accordance with the *Guide to investigating, assessing and reporting on Aboriginal cultural heritage in NSW*, the social or cultural value of a place (object, site or item) may be related to spiritual, traditional, historical or contemporary associations. "Social or cultural value can only be identified though consultation with Aboriginal people" (OEH 2011:8).
- Spiritual value - refers to the intangible values and meanings embodied in or evoked by a place which make it important to the spiritual identity, traditional knowledge, art or practices of a cultural group. Spiritual value is strongly connected to social value and may incorporate both tangible (material, physical) and intangible (non-physical, meta-physical) components.

Significance assessment focusses on the social/spiritual, historic, scientific and aesthetic significance of Aboriginal heritage values as identified in *The Burra Charter* (Australia ICOMOS 2013). The identification of significance is developed in consultation with the registered Aboriginal stakeholders. Assessed values for the study area are detailed below.

Cultural / social significance
This area of assessment concerns the value(s) of a place, feature or site to a particular community group, in this case the local Aboriginal community. Aspects of social significance are relevant to sites, objects and landscapes that are important or have become important to the local Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites generally and their continued protection. Aboriginal cultural significance may include social, spiritual, historic and archaeological values and is determined by the Aboriginal community.

It has been identified during the consultation process that the general area has high cultural heritage value (social and spiritual value) to the local Aboriginal community. The area forms part of an interconnected cultural landscape which is highly significant. Cultural or social values provided by the registered Aboriginal stakeholders are discussed in Section 2. No specific cultural values for the study area have been identified to date.

Historic significance

Community consultation and historical research has not identified any information regarding specific historical significance of the study area. No specific historical significance for the project area has been provided by the registered Aboriginal stakeholders to date. Archaeologically, the study area does not contain these values in relation to Aboriginal heritage.

Scientific / archaeological significance

For archaeologists, scientific significance refers to the potential of a site to contribute to current research questions. Alternately, a site may be an in situ repository of demonstrably important information, for example rare artefacts of unusually high antiquity. Scientific significance is assessed using criteria to evaluate the contents of a site, state of preservation, integrity of deposits, representativeness of the site type, rarity/uniqueness and potential to answer research questions on past human behaviour. Recommended criteria for assessing archaeological significance include:

- Archaeological Research Potential - significance may be based on the potential of a site or landscape to explain past human behaviour and can incorporate the intactness, stratigraphic integrity or state of preservation of a site, the association of the site to other sites in the region (connectivity), or a datable chronology;

- Representativeness - all sites are representative of those in their class (site type/subtype) however the issue here relates to whether particular sites should be conserved to ensure a representative sample of the archaeological record is retained. Representativeness is based on an understanding of the regional archaeological context in terms of site variability in and around the study area, the resources already conserved and the relationship of sites across the landscape; and

- Rarity – which defines how distinctive a site may be, based on an understanding of what is unique in the archaeological record and consideration of key archaeological research questions (i.e. some sites are considered more important due to their ability to provide certain information). It may be assessed at local, regional, state and national levels.

High significance is usually attributed to sites which are so rare or unique that the loss of the site would affect our ability to understand an aspect of past Aboriginal use/occupation of an area. In some cases a site may be considered highly significant because it is now rare due to destruction of the archaeological record through development. Moderate (medium) significance is attributed to sites which provide information on an established research question. Sites with moderate significance are those that offer the potential to yield information that will contribute to the growing holistic understanding of the Aboriginal cultural landscape of the project area. Archaeological investigation of moderately significant sites will contribute knowledge regarding site type interrelationships, cultural use of landscape features and occupation patterns. Low significance is attributed to sites which cannot contribute new information about past Aboriginal use/occupation of an area. This may be due to site disturbance or the nature of the site's contents.

The study area comprises a highly disturbed landscape which has been heavily modified by the former extraction activities. It does not display any scientific/archaeological significance as it does not contain any identified Aboriginal archaeological sites or areas of potential. The area displays no archaeological research potential and is not representative of the wider Phase 1-2 Holocene dune landscape bordering the Stockton Bight due to the extent of previous disturbance.

Aesthetic Values

Aesthetic values are often closely related to the social values of a site or broader cultural landscape. Aspects may include scenic sights, smells and sounds, architectural fabric and creative aspects of a place. No specific aesthetic values for the study area have been identified by registered Aboriginal stakeholders to date. Archaeologically, the study area does not contain these values in relation to Aboriginal heritage due to the extent of previous disturbance. Neighbouring landforms (outside the study area) retain aesthetic values representative of the Phase 1-2 Holocene dune landscape along the Stockton Bight.

7.2 Statement of significance

The wider local area has cultural value for the local Aboriginal community. The identified cultural value is a feeling of attachment and responsibility for the land. Registered Aboriginal stakeholders have expressed that traditional knowledge indicates significant areas in the surrounding dune field (outside of the Boral property and proposed impact area). To date, no specific areas of Aboriginal cultural significance have been identified within the study area. Stakeholders concurred with the assessment of existing severe disturbance within the study area and proposed extraction area. The study area does not display any identified archaeological, historic or aesthetic significance in relation to Aboriginal heritage values.

8 Discussion and impact assessment

Boral is seeking approval for continued operations at the site through a pending SSD application (SSD 9490) to the DPE. Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the proposed SSD 9490 dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim application will be required. The interim application seeks consent to extract only the remaining dry sand resource from within the same extraction area as SSD 9490. The dry sand extraction project comprises the proposed activity for the current assessment.

Boral propose to extract this sand from the former sandpit by excavator. This assessment has considered the impact to Aboriginal heritage values within the study area as a result of the proposed surface disturbance and dry sand extraction activities as described in Section 1.2.

The review of background information revealed there were no known Aboriginal archaeological sites within the study area and proposed extraction area. Previous assessment for the original extraction EIS (1994) in consultation with the Worimi LALC and the CHAR assessment undertaken for the SSD 9490 dredge application (KNC 2019) did not identify any Aboriginal archaeological sites or project constraints within the study area. The potential for Aboriginal archaeological material in the current study area is low and has not been indicated by previous investigations.

The potential for subsurface midden sites has consistently been assessed as low to minimal and it was noted that extensive previous drilling programs across the property did not detect any subsurface shell deposits or archaeological material.

The previous extraction program removed the dune bodies within the extraction area to a depth of 5 metres AHD. Extraction to this depth is likely to have removed any once present archaeological material associated with the earlier Holocene foredune ridge plain at 5-10 metres AHD. Given the indications from previous studies that midden material within the Phase 1-2 dune field occurs within the top ~50cm of the profile, potential for deposit associated with these geomorphological elements has also been removed. The Project area is therefore considered unlikely to contain any buried deposits associated with Aboriginal occupation.

The study area is generally highly disturbed due to the previous operations associated with the inland extraction area. Site inspection confirmed the extent and nature of previous disturbance and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Areas of lower apparent disturbance (i.e. apparent remnant slope/crest landforms on the edges of the former extraction area) were closely inspected but no archaeological material was identified despite frequent exposure and localised disturbance of the ground surface.

The study area does not display any scientific/archaeological significance as it does not contain any identified Aboriginal archaeological sites or areas of potential. The wider landscape encompassing the Boral property retains Aboriginal cultural value and significance, including nearby traditional areas, movement routes, flora and fauna communities, natural landscape values and the linkages the landscape provides to ancestors and storylines.

The configuration of the Project has been developed having regard to the constraints of the land, the desire to mitigate and avoid impacts where possible, whilst balancing the commercial viability of the Project and the extent of the known resource. The Project seeks to capitalise on sand availability within the area of existing and previous operations, maximising output from existing production facilities. This results in a smaller disturbance footprint and minimises environmental impacts compared to expansion into un-quarried adjacent areas within the wider property. Impact to intrinsic Aboriginal cultural values of the surrounding landscape is also minimal.

No Aboriginal heritage constraints have been identified for the Project. No avoidance or mitigation measures are required for the Project on Aboriginal heritage grounds.

Management measures should be implemented for adjacent areas (outside of proposed impact area and study area). Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact area and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS) for the quarry. Documented toolbox talks should also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

9 Management and Recommendations

The following management recommendations have been made for the Project, based on the findings of the CHAR assessment and in consultation with Registered Aboriginal Stakeholders.

No impact to Aboriginal heritage was identified for the Project.

The management measures detailed below provide an additional process to manage Aboriginal cultural heritage through the operation lifetime of the extraction area.

9.1 Heritage Training and Induction Process

- **Aboriginal heritage management procedures will be included in quarry personnel training and induction processes.**

Aboriginal heritage management procedures and responsibilities for compliance will form part of the project induction for quarry personnel (employees, contractors, subcontractors and/or agents). This will include site identification (including heritage site map) to ensure all personnel are aware of Aboriginal heritage management responsibilities, issues affecting their activities and procedures for dealing with unexpected finds including human remains.

9.2 Avoiding Impact to Adjacent Areas

The CHAR and recommendations made herein are specific to the area assessed for the Project as described in this report and referred to as the 'study area' (refer Figures 1 and 2). All works associated with the Project should be contained within the study area. Additional archaeological or Aboriginal heritage assessment would be required for any proposed impacts outside the current study area.

Aboriginal objects are known to occur in adjacent landforms and these must be avoided by all proposed extraction activities. Management measures to be implemented should include clear delineation of the boundary of the approved impact zone and the inclusion of Aboriginal heritage in the existing Environmental Management Strategy (EMS) for the quarry. Documented toolbox talks will also be held to ensure all on-site staff and contractors are aware of obligations and requirements regarding the protection of Aboriginal heritage.

9.3 Unexpected Finds Procedure

- **Any unexpected Aboriginal heritage items (Aboriginal objects) will be managed appropriately.**

In the event that an unexpected find (Aboriginal object) is encountered the following procedure will apply:

1. Stop work and protect find area and report to environmental manager;
2. Contact heritage advisor for identification;
    a. No further action if the find is not an Aboriginal object; and
    b. If the find is an Aboriginal object proceed to next step;
3. Undertake relevant regulatory requirements and contact with DPE where required;
4. Implement conservation or mitigation strategy;
5. Obtain approval if required and comply with conditions; and
6. Recommence work.

9.4 Procedures for Handling Human Remains

- **Note that Project Approvals do not include the destruction of human remains**
- **Any potential human remains encountered will be protected and managed appropriately.**

This section outlines the procedure for handling human remains in accordance with the Skeletal Remains – Guidelines for the Management of Human Skeletal Remains under the *Heritage Act 1977* (NSW Heritage Office 1998) and the Aboriginal Cultural Heritage Standards and Guidelines Kit (NPWS 1997). In the event that quarry operations reveal possible human skeletal material (remains), the following procedure is to be followed:

1. as soon as remains are exposed, all work is to halt at that location immediately and the Quarry Manager on site is to be immediately notified to allow assessment and management;
    i. stop all activities;
    ii. secure the site; and
    iii. not further harm the remains.

2. contact police: the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic;
3. DPE, as the approval authority, will be notified when human remains are found;
4. once the police process is complete and if remains are not associated with a contemporary crime, DPE will determine the process:
    i. if the remains are identified as Aboriginal, the site is to be secured and all Aboriginal stakeholders are to be notified in writing; or
    ii. if the remains are identified as non-Aboriginal (historical) remains then DPE heritage division will be contacted as appropriate;
5. once the police process is complete and/or if the remains are identified as not being human work can recommence once the appropriate clearances have been given.

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Appendix A Updated advertisement for registration of interest

Public Notices

Notice for Registration of Interest

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Sand Quarry, located on Coxs Lane, Fullerton Cove, NSW in the Port Stephens local government area. Boral submitted a State significant development application (Ref: SSD 9490) to the NSW Department of Planning and Environment (DPE) in 2020. Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source combined with water availability, Boral has determined an interim application would be required, seeking consent to extract only the remaining dry sand resource from within the same extraction area.

The proponent is Boral (Elissa Martino, Property Planning & Approvals Coordinator: PO Box 6041, North Ryde NSW 2113). Boral proposes to carry out consultation with Aboriginal communities in accordance with the Heritage NSW Aboriginal cultural heritage consultation requirements for proponents 2010. The purpose of this consultation process is to inform the preparation of environmental assessment documentation and to assist the DPE in its consideration of the project. Kelleher Nightingale Consulting Pty Ltd has been engaged by Boral to facilitate the consultation process.

Boral invites Aboriginal groups and/or Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places at Fullerton Cove to register interest in a process of community consultation with the contact shown below (on behalf of Boral):

Kelleher Nightingale Consulting

Suite 505-507, 155 King Street

Sydney NSW 2000

phone 02 9232 5373

The closing date for registration is 23 February 2023.

Please be advised that in accordance with Heritage NSW requirements, we are required to record the names and contact details of each Aboriginal person who has registered an interest in this project and provide a copy of that record to the relevant Heritage NSW office and Local Aboriginal Land Council. If you are registering your interest, please let us know if you do not want your details forwarded to these organisations.

Appeared in: *Port Stephens Examiner* (Thursday 9 February 2023, p.28)

Appendix B Aboriginal community consultation log

Aboriginal cultural heritage consultation requirements for proponents 2010 (OEH)
STOCKTON DRY SAND EXTRACTION PROJECT (SSD 52984213)

Step	Task Requirement	Action	Outcome
4.1.1	Identify if native title exists in relation to the project area.	Conducted National Native TitleVision (NNTV) search on 20/01/2023. Wrote to National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements (letter dated 20/01/2023).	NNTV search showed no native title holders or registered Indigenous Land Use Agreements in the project area. 20/01/2023 NNTT: Provided data for the Port Stephens LGA. No native title holders or registered Indigenous Land Use Agreements for the project area.
4.1.2	Ascertain, from reasonable sources of information, the names of Aboriginal people who may hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places. Compile a list of Aboriginal people who may have an interest for the proposed project area and hold knowledge relevant to determining the cultural significance of Aboriginal objects and/or places	Wrote to various government agencies to obtain names and contact details of parties that may have an interest or hold cultural knowledge for the project area (letters dated 20/01/2023): Port Stephens Council (PSC); Heritage NSW (formerly OEH); Worimi Local Aboriginal Land Council (WLALC); The Registrar, *Aboriginal Land Rights Act 1983* for a list of Aboriginal owners (ORALRA); The National Native Title Tribunal (NNTT) for a list of registered native title claimants, native title holders and registered Indigenous Land Use Agreements; Native Title Services Corporation (NTSCORP Limited); and Local Land Services (LLS). (Letters dated 20/01/2023).	Responses received from: 20/01/2023 NNTT: Provided data for the Port Stephens LGA. No native title holders or registered Indigenous Land Use Agreements for the project area. 30/01/2023 Heritage NSW: Provided a list of Aboriginal stakeholders known to HNSW for the Port Stephens LGA that may have an interest in the project. LLS 20/01/2023: Advised that LLS did not maintain a list of stakeholders and recommended contacting WLALC and NNTT. 01/02/2023 ORALRA: Advised that a search of the Register of Aboriginal Owners returned no results for the project area. Noted proximity of Worimi Conservation Lands (WCL). Suggested contacting WCL and WLALC for further assistance. 02/02/2023 PSC: Suggested contacting WLALC for further assistance.
4.1.3	Written notification and advertisement: Write to the Aboriginal people whose names were obtained in step 4.1.2 and the relevant LALC(s) to notify them of the proposed project. Place a notice in the local newspaper circulating in the general location of the proposed project, explaining the project and its exact location.	Notification letters (dated 09/02/2023) and invitation to register interest sent to people and groups identified in step 4.1.2. AGA Services Carol Ridgeway-Bissett Cacatua Culture Consultants Crimson-Rosie Gomery Cultural Consultants Hunters and Collectors Kawul Pty Ltd T/A Wonn1 Sites Kamilaroi-Yankuntjatjara Working Group Lower Hunter Aboriginal Incorporated Lakkari NTCG	A total of 16 existing previous stakeholders registered for the project. The updated consultation process resulted in the identification of an additional three stakeholder groups. Responses for registration of interest from written notification and advertisement were received from: Kamilaroi-Yankuntjatjara Working Group (via email 10/02/2023) Steve Talbott (via phone call 14/02/2023)

Step	Task Requirement	Action	Outcome
4.1.3 contd.	Notification by letter and newspaper must include: (a) the name and contact details of the proponent (b) a brief overview of the proposed project that may be the subject of an application for an AHIP, including the location of the proposed project (c) a statement that the purpose of community consultation with Aboriginal people is to assist the proposed applicant in the preparation of an application for an AHIP and to assist the Director-General of OEH in his or her consideration and determination of the application (d) an invitation for Aboriginal people who hold cultural knowledge relevant to determining the significance of Aboriginal object(s) and/or place(s) in the area of the proposed project to register an interest in a process of community consultation with the proposed applicant regarding the proposed activity (e) a closing date for the registration of interests.	Michael Green Cultural Heritage Consultant Robert Syron Steve Talbott Tamara Towers Wonnarua Elders Council Previous existing stakeholders for the SSD 9490 dredging project were contacted (letters dated 09/02/2023) and informed about the new round of consultation for the dry sand extraction project. Stakeholders were informed they would be included in the new round of consultation unless they wished to withdraw their registration of interest. Existing stakeholders included: A1 Indigenous Services Amanda Hickey Cultural Services Didge Ngunawal Clan Karuah Indigenous Corporation Lower Hunter Wonnarua Cultural Services Murra Bidgee Mullangari Aboriginal Corporation Muragadi Heritage Indigenous Corporation Murrooma Incorporated Merrigarn Indigenous Corporation Nur-Run-Gee Pty Ltd Worimi Conservation Lands Widescope Indigenous Group Worimi LALC Worimi Traditional Owners Indigenous Corporation Two additional stakeholders registered for consultation did not want their details released, in accordance with Step 4.1.5. No previous stakeholders withdrew their registrations. Advertisement inviting people to register interest in consultation published in the *Port Stephens Examiner* on 09/02/2023. Advertisement attached as CHAR Appendix A. Closing date for registration of interest was 23/02/2023.	One additional stakeholder registered for the project but advised they did not want their details released, in accordance with Step 4.1.5. In total, consultation for the dry sand extraction project has included 19 registered Aboriginal stakeholder groups/individuals.
4.1.4	A minimum of 14 days from the date the letter was sent or notice published in the newspaper to register an interest.	Closing date for registration of interest included in the notification letters and notice in the newspaper was at least 14 days from the date the letters were sent and notice appeared in the newspaper. Closing date for registration of interest was 23/02/2023.	A minimum of 14 days was provided. Letters were sent on 09/02/2023, advertisement was published on 09/02/2023, and the closing date for registration of interest was 23/02/2023.

Step	Task Requirement	Action	Outcome
4.1.5	Must advise Aboriginal people who are registering an interest that their details will be forwarded to OEH and the LALC unless they specify that they do not want their details released.	Groups informed by letters (dated 09/02/2023), in the advertisement or verbally over the phone if they registered by phone.	Two registered Aboriginal stakeholder groups from the previous consultation and one group from the updated consultation specified that they did not want their details to be released.
4.1.6	Make a record of the names of each Aboriginal person who registered an interest. Provide a copy of that record and copy of the notification from step 4.1.3 to the relevant OEH EPRG regional office and LALC	List of registered stakeholders compiled. A total of 19 stakeholders were registered for the project. Three registered Aboriginal stakeholder group specified that they did not want their details to be released.	Letters sent to Heritage NSW and Worimi LALC with list of registered Aboriginal stakeholders (letters dated 08/03/2023). Three registered Aboriginal stakeholder group specified that they did not want their details to be released.
4.1.7	LALCs holding cultural knowledge relevant to determining the significance of Aboriginal objects and places in the proposed project area who wish to register an interest to be involved in consultation must register their interest as an Aboriginal organisation rather than individuals.	Worimi LALC registered interest to be involved in consultation.	Worimi LALC registered interest as an organisation. Provided contact details for the LALC and the name of a LALC representative to act as contact person (Jamie Merrick).
4.1.8	Where an Aboriginal organisation representing Aboriginal people who hold cultural knowledge has registered an interest, a contact person for that organisation must be nominated. Aboriginal cultural knowledge holders who have registered an interest may indicate they have appointed a representative to act on their behalf. Where this occurs, the registered Aboriginal party must provide written confirmation and contact details of those individuals to act on their behalf.	Responses received from organisations and individuals registering interest in the project. Contact details and names of representatives were also provided.	Aboriginal stakeholders have registered as an organisation name or as individuals. Contact details and names of representatives for the organisations were provided and confirmed during the registration of interest process. Updated contact details for existing registered stakeholders confirmed during the fresh round of consultation for the dry sand extraction project.
4.2	Presentation of information about the proposed project	Information regarding the proposed project provided throughout the consultation process including letters sent on 09/02/2023 and 24/02/2023. Information included an outline of the Project, location of the study area, development approval context and an invitation to consult during the assessment. Informal discussions also held during the registration of interest period.	No specific responses to the provision of project information.

Step	Task Requirement	Action	Outcome
4.3.1-4.3.2 .	Notification of proposed assessment methodology	Copy of the proposed assessment methodology sent to all registered stakeholders with an invitation to provide comment (letters dated 24/02/2023). A 28 day review period was provided.	Responses to the proposed assessment methodology were received from three stakeholder groups: A1, Amanda Hickey Cultural Services (AHCS), and Murra Bidgee Mullangari Aboriginal Corporation (MBMAC). A1 stated that they had reviewed the project information and supported the proposed CHAR assessment methodology (email dated 06/03/2023). AHCS expressed support for the proposed assessment methodology (email dated 06/03/2023). MBMAC stated that they had read the project information and proposed assessment methodology and endorsed the recommended approach to the assessment (email dated 01/03/2023). Several other responses were received from stakeholders who expressed interest in a potential on-site meeting to further discuss the project. It was considered that an on-site meeting was not required as the previous CHAR assessment for the dredge application included on site visits and there was no change in the boundary for the new CHAR. Discussion of the previous assessment methodology review for the dredge application and the site visits is included in Section 2.2.1 and 2.2.2 of the CHAR.
4.3.3	Gathering information about cultural significance	Aboriginal stakeholders invited to provide information about cultural significance of the area (letters dated 09/02/2023, 24/02/2023 and 21/06/2023)). Previous comments recognised and additional comments sought.	Throughout the assessment process, cultural knowledge regarding the Aboriginal cultural/social values of the study area and identified archaeological sites was sought from registered stakeholders. Numerous stakeholders have expressed close familial and traditional connections with the area, and stakeholders retain oral histories and cultural knowledge of the area. Stakeholders expressed the importance of education and protection of Aboriginal cultural heritage, and consideration of the landscape as a whole when assessing archaeological sites and their connections across Country. Aboriginal cultural values and knowledge of the area have been provided by registered stakeholders throughout the consultation process to date and are summarised below.

Step	Task Requirement	Action	Outcome
4.3.3 contd.			Murrooma highlighted the importance of the general area, stating that "there are many places within this area that have significant cultural value to Worimi people and are in close proximity to the proposed project. These places of social, spiritual and cultural value are traditional areas with direct linkage to our ancestors and storylines" (letter dated 23/04/2019). Murrooma noted that traditional uses of the area included transit routes across the dune fingers and stressed that local knowledge holders and Traditional Owners from the area should be the source of specific cultural information for the study area. WTOIC noted that the area was culturally significant to Worimi people (email 06/05/2019) and that the local area had high potential for Aboriginal objects and archaeological sites (email dated 25/06/2023). WTOIC also provided additional ethnographic information which has been incorporated into Section 4 of this report. One of the stakeholders who chose to withhold their details expressed that Aboriginal people connected to Country in a myriad of ways, including through the land itself, through connection to their ancestors, and through their heritage (email dated 09/02/2023). Nur-Run-Gee Pty Ltd provided detailed background information relating to the very high cultural heritage significance of the Stockton Peninsula as a whole for the Worimi people, with over 25,000 years of Aboriginal history connecting to the present (email dated 02/02/2023). Nur-Run-Gee Pty Ltd emphasised the importance of a holistic, Aboriginal-led approach in considering the spiritual and social considerations of developments in the area. The interconnectedness of spiritual and social values, storylines and oral histories with physical elements such as archaeology, plants and animals the land itself is highly important. Nur-Run-Gee Pty Ltd also noted that input from and consultation with the Traditional Owners and recognised Worimi groups was paramount, as was the protection of the cultural knowledge held by this community.

Step	Task Requirement	Action	Outcome
4.4	Review of draft cultural heritage assessment report	Stakeholders were provided with a copy of the draft CHAR for the dry sand extraction project and invited to review and provide comments/feedback (review package sent 21/06/2023). A 28 day review period was provided, ending on 19/07/2023.	Two responses to the draft CHAR were received from stakeholders (Appendix C), MBMAC and WTOIC. MBMAC stated that they had read the project information and draft CHAR report and endorsed the recommendations made (email dated 29/06/2023). WTOIC (email dated 25/06/2023) requested some clarification around their attendance at the previous site visit undertaken with stakeholders (see CHAR Section 2.2.2). KNC confirmed that WTOIC were invited to attend but unfortunately due to sorry business were unable to send a representative on the day (reply email dated 30/06/2023). WTOIC stated that they thought the area had high potential for Aboriginal objects and sites. KNC confirmed that the existing assessment results indicated the area is generally highly disturbed due to being previously mined and that no new impacts outside this disturbed area have been identified for the dry sand project. WTOIC also provided additional ethnographical information regarding Worimi history which has been incorporated in Section 4 of the CHAR. Responses to the previous dredge application CHAR are discussed in Section 2.2.3 of the CHAR and also attached in Appendix C.

Appendix C Aboriginal stakeholder comments on draft CHAR

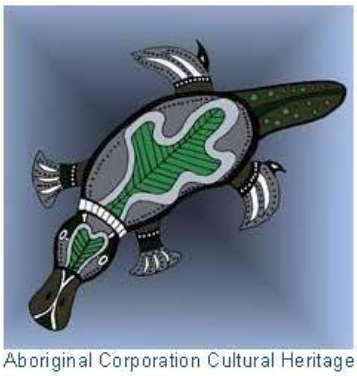
SSD 9490 dredge application draft CHAR

Zac Thomas

From: Ryan Johnson <murrabidgeemullangari@yahoo.com.au>
Sent: Thursday, 12 September 2019 3:22 PM
To: Zac Thomas
Subject: RE: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MBMAC

Hi Zac,
I have read the Draft Char review for the above project, I endorse the recommendations made by Kelleher Nightingale.
Kind regards
Darleen Carroll Johnson

Ryan Johnson | **Murra Bidgee Mullangari**



Aboriginal Corporation Cultural Heritage

A: PO Box 246, Seven Hills, NSW, 2147
E: murrabidgeemullangari@yahoo.com.au
ICN: 8112

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From: Zac Thomas [mailto:zac.thomas@knconsult.com.au]
Sent: Monday, 9 September 2019 4:25 PM
To: Ryan Johnson <murrabidgeemullangari@yahoo.com.au>
Subject: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MBMAC

Dear Registered Aboriginal Stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed Stockton Sand Quarry Dredging Project at Stockton, NSW.

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Zac Thomas

From: Muragadi <muragadi@yahoo.com.au>
Sent: Friday, 13 September 2019 4:19 PM
To: Zac Thomas
Subject: RE: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MHIC

Hi Zac,
I agree with the recommendations made by Kelleher Nightingale for the above project.
Thanks
Anthony
0418970389

From: Zac Thomas [mailto:zac.thomas@knconsult.com.au]
Sent: Monday, 9 September 2019 4:26 PM
To: Muragadi <muragadi@yahoo.com.au>
Subject: 1828 Draft CHAR Review - Stockton Sand Quarry Dredging Project - MHIC

Dear Registered Aboriginal Stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed Stockton Sand Quarry Dredging Project at Stockton, NSW.

No impact to Aboriginal heritage was identified for the project. While sites do occur within the wider Boral property, the proposed extraction area is highly disturbed due to the previous quarrying operations and removal of the bulk of the dune mass.

Aboriginal objects that are known to occur in adjacent landforms must be avoided by all proposed extraction activities. We have included management measures for protecting these areas (outside of proposed impact area) and an Unexpected Finds Procedure for the project has also been included.

As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback you may have.

Please forward any comments to myself or the office by **7 October 2019**. Thank you and we look forward to receiving your comments.

Kind regards,

Zac Thomas
Heritage Administration Assistant
Kelleher Nightingale Consulting Pty Ltd
Level 10, 25 Bligh St
Sydney NSW 2000
p 02 9232 5373

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SSD 52984213 dry sand project draft CHAR (this report)

Zac Thomas

From: Darleen Johnson <murrabidgeemullangari@yahoo.com.au>
Sent: Thursday, 29 June 2023 3:25 PM
To: Zac Thomas
Subject: Re: Draft CHAR Review - 2214 Boral Stockton Sand Quarry - MBMAC

Hi Zac,
I have read the project information and draft CHAR for the above project, I endorse the recommendations made.
Kind regards
Darleen Johnson
0490051102

On Wednesday, 21 June 2023 at 04:56:53 pm AEST, Zac Thomas <zac.thomas@knconsult.com.au> wrote:

Dear registered Aboriginal stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed dry sand extraction project at the Boral Stockton Sand Quarry in Stockton, NSW.

No impact to Aboriginal heritage was identified for the project. While sites do occur within the wider Boral property, the proposed extraction area is highly disturbed due to the previous quarrying operations and removal of the bulk of the dune mass.

Aboriginal objects that are known to occur in adjacent landforms must be avoided by all proposed extraction activities. We have included management measures for protecting these areas (outside of proposed impact area) and an Unexpected Finds Procedure for the project has also been included.

As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback you may have.

Please forward any comments to myself or the office by **Wednesday 19 July 2023**. Thank you and we look forward to receiving your comments.

Kind regards,

Zac Thomas

Heritage Administration Assistant

Kelleher Nightingale Consulting Pty Ltd

Suite 505-507, 155 King Street, Sydney NSW 2000

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Zac Thomas

From: Zac Thomas
Sent: Friday, 30 June 2023 4:21 PM
To: Worimi TOC
Subject: RE: Draft CHAR Review - 2214 Boral Stockton Sand Quarry - WTOIC

Hi Candy,

Thanks for your email. Yes, Worimi TOIC was invited to attend the site survey. You and I emailed about it at the time (2019) and you had organised a representative to attend the following day, unfortunately your site officer was unable to attend on the day and you let us know it was sadly due to an Elder passing away. We did send through the results for you too in that initial report, which are the same for this new report – the area is generally highly disturbed due to being previously mined (no new impacts outside this disturbed area have been identified) .

Thank you also for sending through the W.J. Enright material – we will be happy to review this and include it in the next update to the report.

Kind regards,

Zac Thomas
Heritage Administration Assistant
Kelleher Nightingale Consulting Pty Ltd
Suite 505-507, 155 King Street, Sydney NSW 2000
p 02 9232 5373

From: Worimi TOC <worimitoc@hotmail.com>
Sent: Sunday, 25 June 2023 1:51 PM
To: Zac Thomas <zac.thomas@knconsult.com.au>
Cc: tam1937@outlook.com
Subject: Re: Draft CHAR Review - 2214 Boral Stockton Sand Quarry - WTOIC

Good Afternoon Zac,

Was Worimi TOIC invited to attend the site survey 2.2.2 of the report ?

We have not surveyed the project area so we do not support the recommendations as we strongly believe the area does hold high potential for Aboriginal objects and Aboriginal sites.

The boundaries you have in report are inaccurate for the Worimi peoples, please see attached W.J Enright notes.

I'll say cheerio for now,

Candy

Candy Towers

Worimi Cultural Advisor

1

Worimi Traditional Owners Indigenous Corporation

ph: 0412 475 362

e: worimitoc@hotmail.com

WORIMI TOIC

Guudji Yiigu, I am a Worimi and Yorta Yorta woman from Newcastle NSW, I acknowledge and pay my respects to the traditional owners and custodians of the land on which I live and work, to their continuing connection to land, water, culture and community and pay my respects to the Elders past, present and to our future generations.

From: Zac Thomas <zac.thomas@knconsult.com.au>
Sent: Wednesday, 21 June 2023 5:00 PM
To: Worimi TOC <worimitoc@hotmail.com>
Subject: Draft CHAR Review - 2214 Boral Stockton Sand Quarry - WTOIC

Dear registered Aboriginal stakeholder,

Please find attached a cover letter and a copy of the draft Aboriginal Cultural Heritage Assessment Report for the proposed dry sand extraction project at the Boral Stockton Sand Quarry in Stockton, NSW.

No impact to Aboriginal heritage was identified for the project. While sites do occur within the wider Boral property, the proposed extraction area is highly disturbed due to the previous quarrying operations and removal of the bulk of the dune mass.

Aboriginal objects that are known to occur in adjacent landforms must be avoided by all proposed extraction activities. We have included management measures for protecting these areas (outside of proposed impact area) and an Unexpected Finds Procedure for the project has also been included.

As a registered Aboriginal stakeholder for this project, we would like to invite you to review the report and provide us with any comments or feedback you may have.

Please forward any comments to myself or the office by **Wednesday 19 July 2023**. Thank you and we look forward to receiving your comments.

Kind regards,

Zac Thomas
Heritage Administration Assistant
Kelleher Nightingale Consulting Pty Ltd
Suite 505-507, 155 King Street, Sydney NSW 2000
p 02 9232 5373

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Appendix D AHIMS extensive search results (updated March 2023)

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 2214 Boral Stockton 2
Client Service ID : 764022

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
38-4-0951	Fern Bay Estate 18	AGD	56	389035	6364110	Open site	Valid	Shell : 2, Artefact : 81		
	Contact: T Russell	Recorders: ERM Australia Pty Ltd- Sydney CBD						Permits		
38-5-0158	Fullerton Site 2;Newcastle Bight;	AGD	56	390260	6363040	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders: Liam Dagg,Liam Dagg						Permits	845,916	
38-4-1035	Fullerton Cove Extraction 1	AGD	56	391149	6366046	Open site	Valid	Artefact : 100		
	Contact: Searle	Recorders: Ms.Penny Mccardle						Permits	3033	
38-4-0262	Fern Bay_6;	AGD	56	391500	6363900	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders: Pam Dean-Jones,Mr.Luke Godwin,M Heath						Permits		
38-4-0566	Fullerton 5	AGD	56	392065	6364201	Open site	Valid	Shell : 1		
	Contact	Recorders: Umwelt (Australia) Pty Limited - Individual users						Permits		
38-4-1873	Worimi RVA 033	GDA	56	392600	6364679	Open site	Valid	Shell : 1		
	Contact	Recorders: Mr.Warren Mayers						Permits		
38-4-1861	Worimi RVA 021	GDA	56	393027	6364869	Open site	Valid	Shell : 1		
	Contact	Recorders: Mr.Warren Mayers						Permits		
38-4-0645	Fullerton Site 37	AGD	56	393117	6364880	Open site	Valid	Shell : 1		
	Contact	Recorders: Umwelt (Australia) Pty Limited - Individual users						Permits		
38-4-0571	Fullerton 11	AGD	56	393188	6364916	Open site	Valid	Shell : 1		
	Contact	Recorders: Umwelt (Australia) Pty Limited - Individual users						Permits		
38-4-1856	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders: Mr.Warren Mayers						Permits		
38-4-0948	Fern Bay Estate 15	AGD	56	389847	6364460	Open site	Valid	Artefact : 1		
	Contact: T Russell	Recorders: ERM Australia Pty Ltd- Sydney CBD						Permits		
38-4-0129	NBR7;	AGD	56	389850	6364380	Open site	Valid	Artefact : -	Open Camp Site	1269,101086
	Contact	Recorders: Margrit Koettig,Rex Silcox						Permits		
38-5-0157	Fullerton Site 1;Newcastle Bight;	AGD	56	389930	6362840	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders: Liam Dagg						Permits	845,916	
38-4-0321	Newcastle Bight 2;	AGD	56	390050	6364760	Open site	Valid	Artefact : -	Open Camp Site	2250,101086
	Contact	Recorders: Mr.Matthew Barber						Permits		
38-5-0161	Fullerton Site 5;Newcastle Bight;	AGD	56	390090	6363090	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders: Liam Dagg						Permits	916	
38-4-0130	NBR6;	AGD	56	389260	6364220	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders: Margrit Koettig,Rex Silcox						Permits		
38-4-2011	George St 1	GDA	56	390796	6366074	Open site	Valid	Artefact : -		
	Contact	Recorders: Umwelt (Australia) Pty Limited - Individual users,Miss.Nicola Roche						Permits	4398	

Report generated by AHIMS Web Service on 15/03/2023 for Matthew Kelleher for the following area at Datum :GDA, Zone : 56, Eastings : 388850.0 - 393800.0, Northings : 6363000.0 - 6366500.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 76

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 2214 Boral Stockton 2
Client Service ID : 764022

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
38-5-0160	Fullerton Site 4;Newcastle Bight;	AGD	56	390960	6363500	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg					Permits	916	
38-4-0261	Fern Bay_5;	AGD	56	391200	6363700	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1872	Worimi RVA 032	GDA	56	391356	6363899	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0644	Fullerton Site 36	AGD	56	391496	6363762	Open site	Valid	Artefact : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-0263	Fern Bay_7;	AGD	56	391600	6364000	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1860	Worimi RVA 020	GDA	56	393069	6365020	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1855	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1853	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0861	Fern Bay Estaet 9	AGD	56	388790	6363440	Open site	Valid	Shell : 1		
	Contact T Russell	Recorders	Jim Wheeler					Permits		
38-4-0340	Williamtown 1;WT-1;	AGD	56	391100	6365500	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	Giles Hamm Archaeology					Permits		
38-4-0264	Fern Bay_8;	AGD	56	391800	6364100	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1870	Worimi RVA 030	GDA	56	391926	6364193	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1867	Worimi RVA027	GDA	56	391965	6364382	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers,Mr.Matthew Kelleher,Kelleher Nightingale Consulting Pty Ltd ((					Permits		
38-4-0567	Fullerton 7	AGD	56	392285	6364371	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-1864	Worimi RVA 024	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0068	Newcastle Bight;3;	AGD	56	392795	6366181	Open site	Valid	Artefact : -	Open Camp Site	
	Contact	Recorders	M Dodkin					Permits		
38-4-0950	Fern Bay Estate 17	AGD	56	389785	6364535	Open site	Valid	Artefact : -, Shell : -		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		

Report generated by AHIMS Web Service on 15/03/2023 for Matthew Kelleher for the following area at Datum :GDA, Zone : 56, Eastings : 388850.0 - 393800.0, Northings : 6363000.0 - 6366500.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 76

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 2214 Boral Stockton 2
Client Service ID : 764022

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
38-4-0789	Fern bay Estate 11	AGD	56	388850	6363850	Open site	Valid	Artefact : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0127	NBR9;	AGD	56	389360	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1269,101086
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-0563	Fullerton 1	AGD	56	391352	6363717	Open site	Valid	Shell : -		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-1871	Worimi RVA 031	GDA	56	391731	6364059	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0266	Fern Bay_10;	AGD	56	392100	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0569	Fullerton 9	AGD	56	392710	6364583	Open site	Valid	Artefact : 19, Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-1863	Worimi RVA 023	GDA	56	392876	6364757	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1858	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1857	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-1030	Lagoons 4	AGD	56	393233	6366293	Open site	Valid	Aboriginal Resource and Gathering : 1, Artefact : 3000		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1859	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0056	Freshwater Lagoons;	AGD	56	393351	6365825	Open site	Valid	Artefact : -	Open Camp Site	315,703
	Contact	Recorders	ASRSYS					Permits		
38-4-0791	Fern Bay Estate 8	AGD	56	388750	6363700	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits		
38-4-0131	NBR5;	AGD	56	388920	6364080	Open site	Valid	Artefact : -	Open Camp Site	1269
	Contact	Recorders	Margrit Koettig,Rex Silcox					Permits		
38-4-1868	Worimi RVA 028	GDA	56	391971	6364367	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0265	Fern Bay_9;	AGD	56	391900	6364200	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0054	Newcastle Bight;	AGD	56	392377	6364161	Open site	Valid	Artefact : -	Open Camp Site	

Report generated by AHIMS Web Service on 15/03/2023 for Matthew Kelleher for the following area at Datum :GDA, Zone : 56, Eastings : 388850.0 - 393800.0, Northings : 6363000.0 - 6366500.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 76

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 2214 Boral Stockton 2
Client Service ID : 764022

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	J.A Starling					Permits		
38-4-0949	Fern Bay Estate 16	AGD	56	389772	6364185	Open site	Valid	Artefact : 4		
	Contact T Russell	Recorders	ERM Australia Pty Ltd- Sydney CBD					Permits		
38-4-0787	Fern Bay Estate 9	AGD	56	388790	6363344	Open site	Valid	Artefact : -		
	Contact	Recorders	Jim Wheeler					Permits	2026	
38-4-0788	Fern Bay Estate 10	AGD	56	388950	6363900	Open site	Valid	Shell : -		
	Contact	Recorders	Pam Dean-Jones					Permits	2355	
38-5-0159	Fullerton Site 3;Newcastle Bight;	AGD	56	390640	6363260	Open site	Valid	Shell : -, Artefact : -	Midden,Open Camp Site	
	Contact	Recorders	Liam Dagg,Liam Dagg					Permits	845,916	
38-4-1869	Worimi RVA 029	GDA	56	391857	6364253	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0267	Fern Bay_11;	AGD	56	392200	6364300	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1854	Restriction applied. Please contact ahims@environment.nsw.gov.au.					Open site	Valid			
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-5-0162	Fullerton Site 6;Newcastle Bight;	AGD	56	391040	6363460	Open site	Valid	Shell : -, Artefact : -	Midden	
	Contact	Recorders	Liam Dagg					Permits	916	
38-4-0322	Newcastle Bight 1;	AGD	56	391670	6364600	Open site	Valid	Shell : -, Artefact : -	Midden	2250
	Contact	Recorders	Mr.Matthew Barber					Permits		
38-4-0564	Fullerton 3	AGD	56	391828	6364079	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-0269	Fern Bay_13;	AGD	56	392400	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1032	Lagoons 3	AGD	56	393250	6366153	Open site	Valid	Artefact : 2		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-1033	Lagoons 1	AGD	56	393272	6365983	Open site	Valid	Artefact : 2100, Aboriginal Resource and Gathering : 1		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-2047	Fullerton Cove - IF1	GDA	56	390114	6365473	Open site	Valid	Artefact : -		
	Contact	Recorders	Eco Logical Australia Pty Ltd - Sydney - Individual users,Mr.Tyler Beebe					Permits		
38-4-1645	Fullerton Cove Midden 2	GDA	56	390179	6365560	Open site	Valid	Artefact : -, Shell : -		
	Contact	Recorders	Ms.Erin Mein					Permits	4398	
38-4-0706	FC 1	AGD	56	390580	6365650	Open site	Valid	Artefact : 9		
	Contact	Recorders	Mary Dallas Consulting Archaeologists (MDCA)					Permits		
38-4-0260	Fern Bay_4;	AGD	56	391000	6363500	Open site	Valid	Artefact : -	Open Camp Site	1845

Report generated by AHIMS Web Service on 15/03/2023 for Matthew Kelleher for the following area at Datum :GDA, Zone : 56, Eastings : 388850.0 - 393800.0, Northings : 6363000.0 - 6366500.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 76

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 2214 Boral Stockton 2
Client Service ID : 764022

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status **	SiteFeatures	SiteTypes	Reports
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-0565	Fullerton 4	AGD	56	391904	6364081	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-0268	Fern Bay_12;	AGD	56	392300	6364400	Open site	Valid	Shell : -, Artefact : -	Midden	1845
	Contact	Recorders	Pam Dean-Jones,Mr.Luke Godwin,M Heath					Permits		
38-4-1865	Worimi RVA 025	GDA	56	392464	6364646	Open site	Valid	Shell : 1		
	Contact	Recorders	Mr.Warren Mayers					Permits		
38-4-0568	Fullerton 8	AGD	56	392465	6364420	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-1807	RVA site 1	GDA	56	393021	6364846	Open site	Valid	Shell : -, Artefact : -		
	Contact	Recorders	NPWS - Hunter District					Permits		
38-4-0570	Fullerton 10	AGD	56	393049	6364716	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		
38-4-1034	Lagoons 2	AGD	56	393271	6365983	Open site	Valid	Artefact : 3		
	Contact Searle	Recorders	Mr.Peter Anderson					Permits		
38-4-0572	Fullerton 12	AGD	56	393525	6366116	Open site	Valid	Shell : 1		
	Contact	Recorders	Umwelt (Australia) Pty Limited - Individual users					Permits		

**** Site Status**

Valid - The site has been recorded and accepted onto the system as valid

Destroyed - The site has been completely impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There is nothing left of the site on the ground but proponents should proceed with caution.

Partially Destroyed - The site has been only partially impacted or harmed usually as consequence of permit activity but sometimes also after natural events. There might be parts or sections of the original site still present on the ground

Not a site - The site has been originally entered and accepted onto AHIMS as a valid site but after further investigations it was decided it is NOT an aboriginal site. Impact of this type of site does not require permit but Heritage NSW should be notified

Report generated by AHIMS Web Service on 15/03/2023 for Matthew Kelleher for the following area at Datum :GDA, Zone : 56, Eastings : 388850.0 - 393800.0, Northings : 6363000.0 - 6366500.0 with a Buffer of 0 meters.. Number of Aboriginal sites and Aboriginal objects found is 76

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Appendix N

Surface water assessment

Surface Water Impact Assessment Stockton Quarry – Dry Sand Extraction Project

Report Prepared for: Boral Resources (NSW) Pty Ltd
August 2023

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1.0 INTRODUCTION

1.1. Background and document purpose

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in Figure 1.1, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area) granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown Project) located on the transgressive dunes adjoining Stockton Beach granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source combined with water availability, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the Project).

Consistent with the originally proposed and exhibited dredge application, the Project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown Project and the Project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the Project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 1.4 shows the quarry, the Project, and the existing windblown Project.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the Project on 18 January 2023. This Surface Water Assessment has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the Project.

1.2. Site Description

1.2.1. Locality

The site is at Fullerton Cove, between Nelson Bay Road and Stockton Beach, about 4.3km south of Williamtown. The entrance to the quarry is off Coxs Lane. The Worimi State Conservation Area bounds the site to the northeast and southwest, along with several private properties. Nelson Bay Road forms the northern site boundary. Towards the east is Stockton Beach which is part of the Worimi Regional Park, and beyond is Stockton Bight and the South Pacific Ocean.

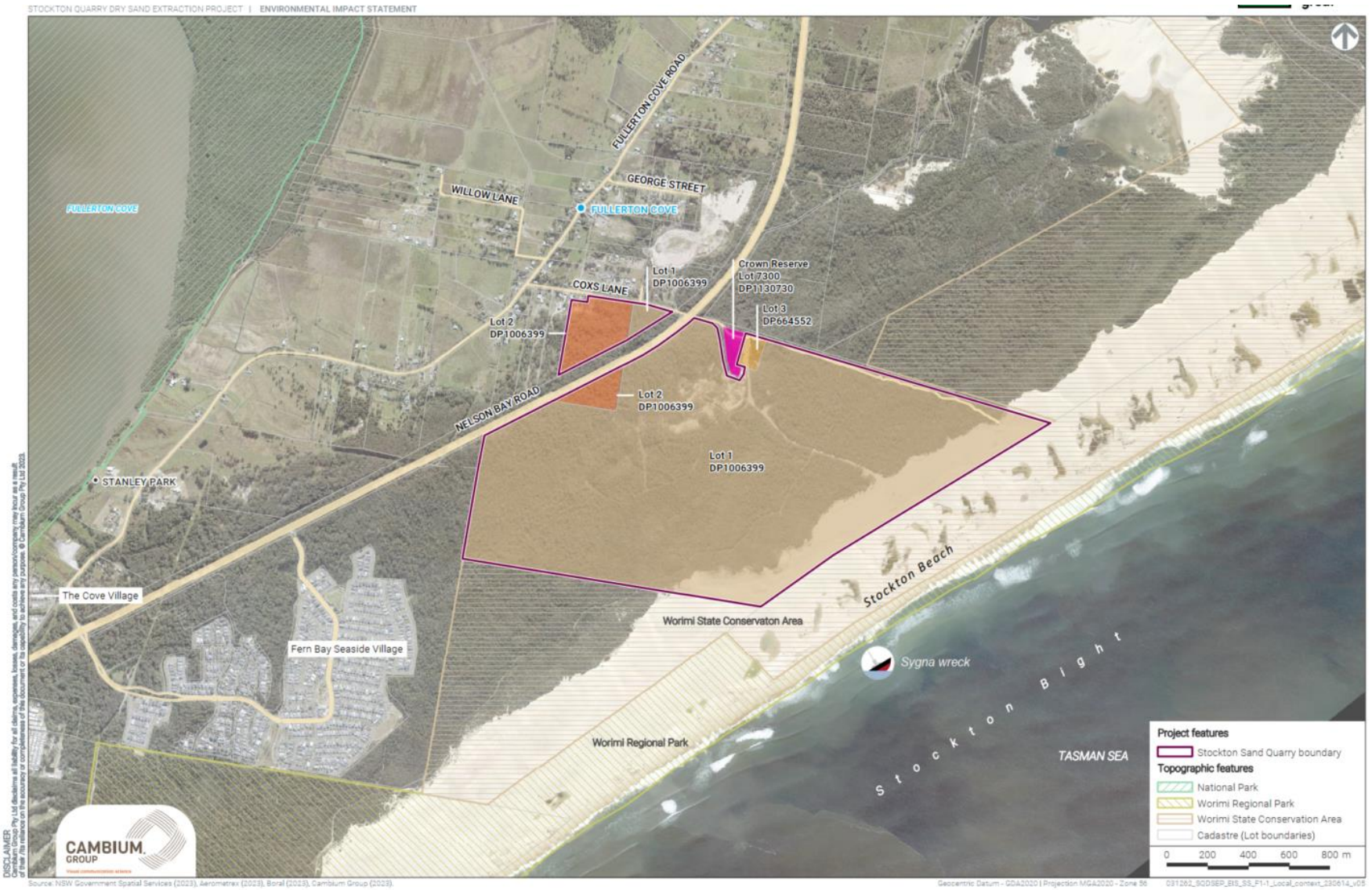


Figure 1.1 Local Context

1.2.2. Landscape

The Project area is located generally over a previous inland extraction area which followed a northeast to southwest orientated dune ridge. The area now consists of an undulating landscape with a well-defined low area within the dunes down to about 4 m AHD in places where the proposed extraction will take place. Levels over the proposed Project area range from a dune peak at the eastern end of up to 26.5 m AHD and other high points of around 10 to 16 m AHD at the south western end, with the majority of the site at about 5 to 6 m AHD.

The Project area has been rehabilitated since completion of the previous inland extraction, and vegetation is well established in the older parts (Figure 1.2) of the extraction area, and less so where extraction was more recently completed (Figure 1.3).

Figure 1.2 Proposed extraction areas looking over Stage 1

Figure 1.3 proposed extraction area looking south-west over stages 2-5

1.3. Project Description

As shown in Figure 1.4, the Project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the Project site for the dredge application.

The Project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road and a pad for a wash plant and water recycling and filter press.

The Project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) down to approximately 3.7 m AHD (maintaining a minimum 0.7 m buffer above the water table), using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the Project area is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in Figure 1.5, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the Project (shown in Figure 1.5) mirror the first five stages of the dredge application (shown in Figure 1.6). This has been designed so that, should the dredge application be approved, the dry sand extraction could transition into dredging, irrespective of what stage the Project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource within the Project site and above the water table. Consistent with the originally proposed and exhibited dredge application, the Project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown Project and the Project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the Project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the Project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1 and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in Figure 1.4, the existing site depot would also be reconfigured for the Project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

t

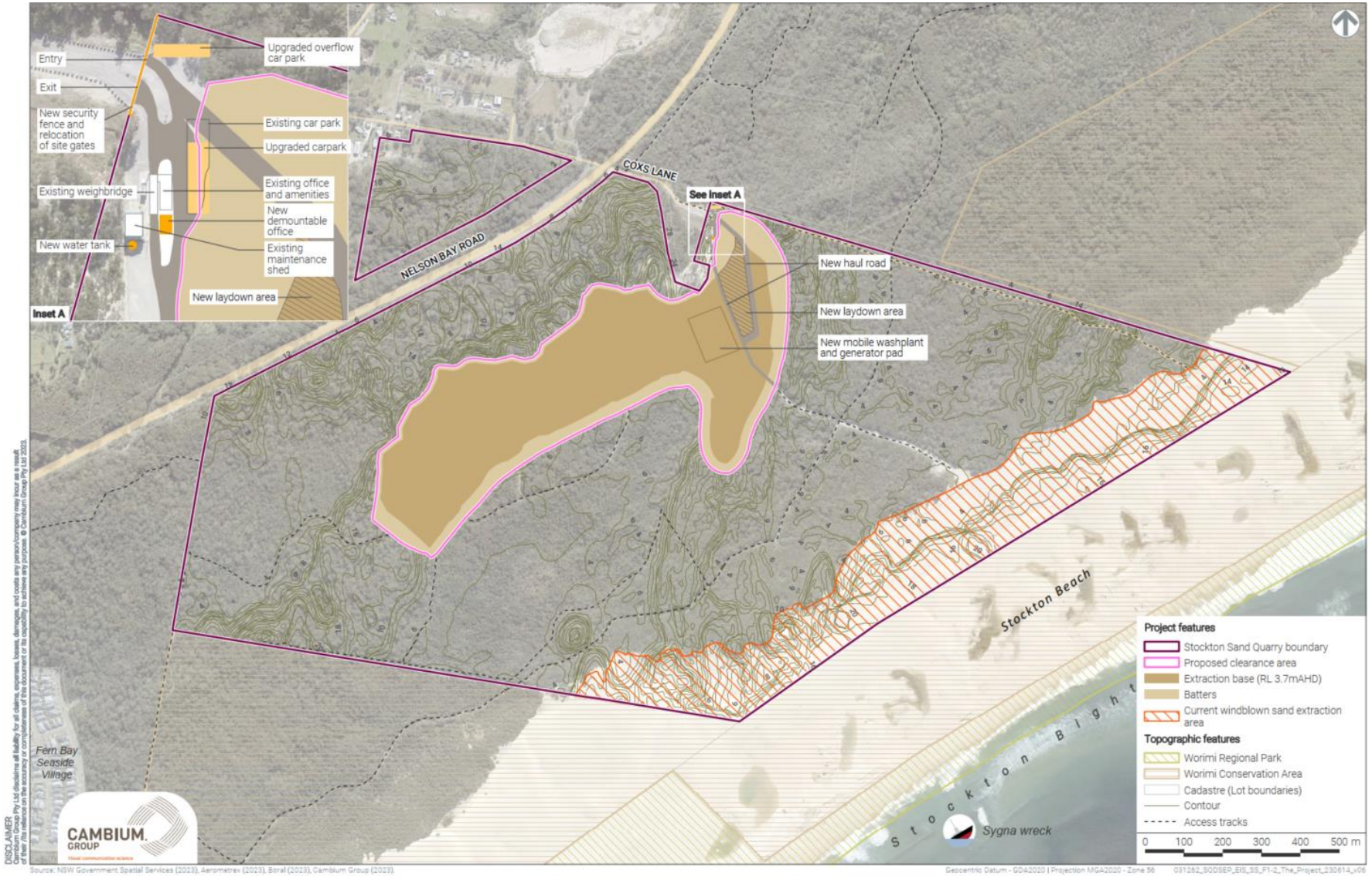


Figure 1.4 Project layout

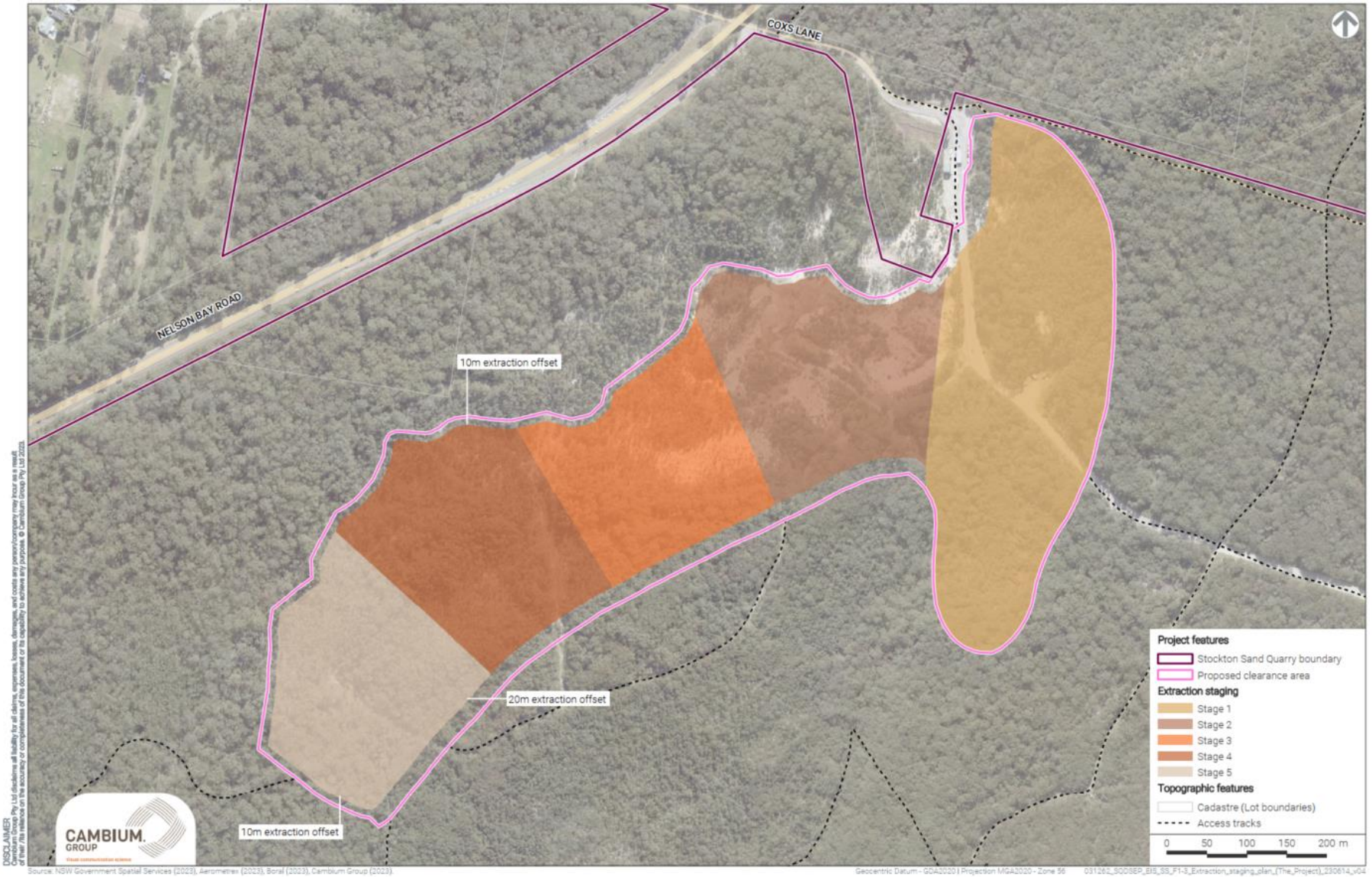


Figure 1.5 Extraction staging plan (The Project)

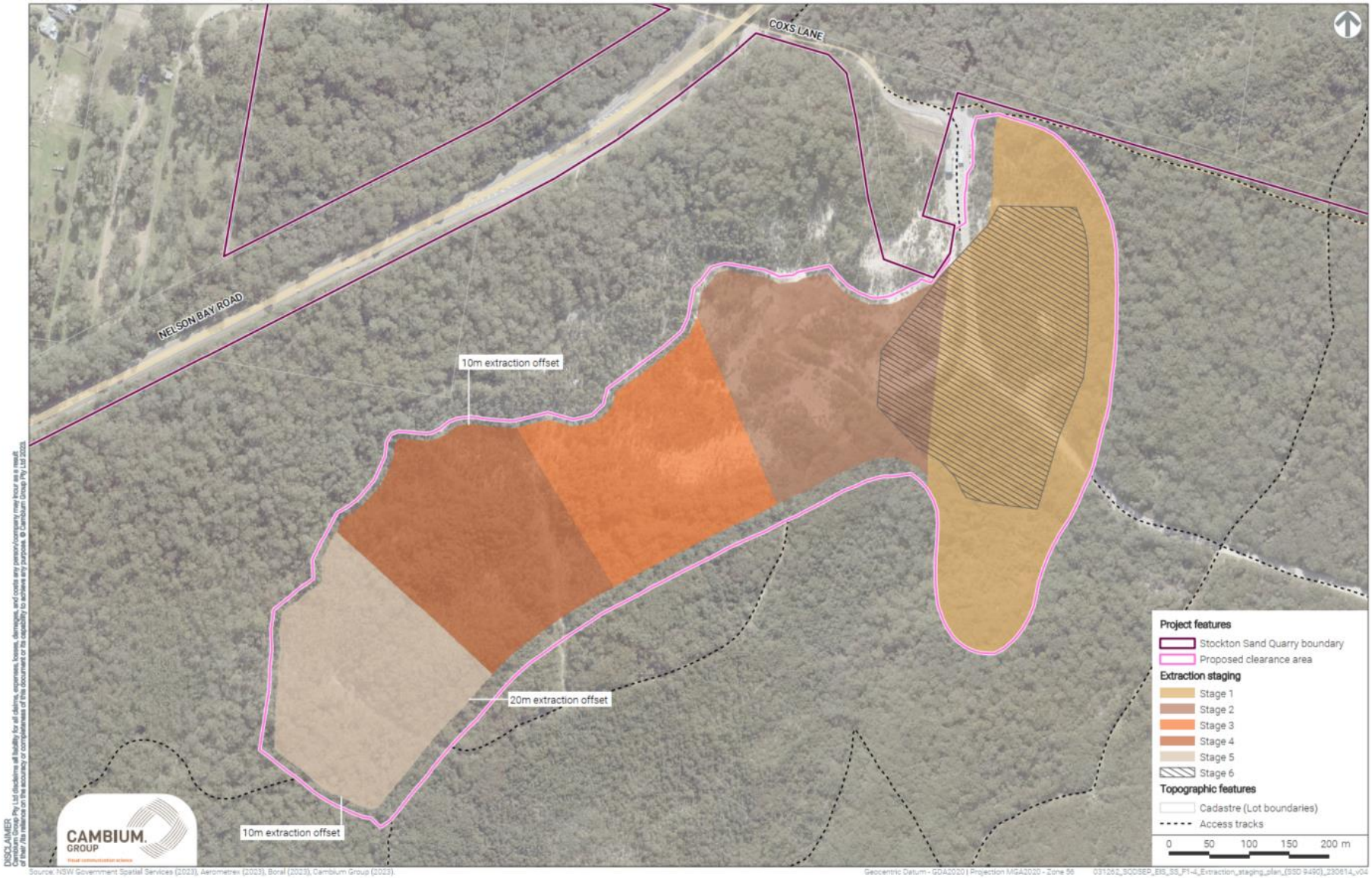


Figure 1.6 Extraction staging plan (SSD 9490)

Table 1.1 Proposed program for dry sand extraction (above RL 3.7m AHD)

Stage	Reserve (tonnes)	Duration (years)	Approximate dates
Existing windblown sand consent	1.5 million tonnes (Mt) (max.)	3 – 9 years	2019 - 2028
1	1,570,000	2.5	2024-2026
2	268,000	1	2026-2027
3	151,000	1	2027-2028
4	153,000	1	2028-2029
5	940,000	2	2029-2031
Total	*3,100,000*	*7.5*	2024-2031

1.4. Water use and management

1.4.1. Water Access Licence and allocation

Boral has obtained a number of Water Access Licences with a range of allocations, the most recent of which is still to be registered, as outlined in Table 1.2 below. The available nominated works has a permitted 16ML/y extraction currently available. The bore associated with this is not currently constructed, but is planned to be installed in last half of 2023.

Table 1.2 Current Boral water allocations

Site Name	WAL No.	WAL Reference No.	Extraction / Category	Nominated Works	Shares / Volume (ML)
Stockton Quarry	37223	20AL213136	Aquifer	No WSW nominated	0
Stockton Quarry	43827	20AL220991	Aquifer	20WA221084	100
Stockton Quarry	44499	20AL221243	Aquifer	No WSW nominated	320
Stockton Quarry	-	20AL221416	Aquifer	No WSW nominated	104*
				Total	**524**

*Allocation made, but WAL No. currently not known.

1.4.2. Haul Roads

Dust suppression using water carts is carried out on the existing unpaved haul roads from the site office through to Stockton Beach. Water is currently purchased directly from mains supply and applied onsite with a Boral owned/operated Water cart. Dust suppression water use over the 2018 year was 15.2 megalitres (ML) over an area of approximately 3ha, equating to about 5 megalitres per hectare (ML/ha) over the year. The historical average water usage for dust suppression is approximately 12ML per annum varying according to adjustments to haul roads, and climatic variations.

Table 1.3 Dust suppression water use over 2018.

Month	Water use (ML)
Jan	1.60
Feb	1.65
Mar	1.56
Apr	1.54
May	1.46
Jun	0.14
Jul	1.06
Aug	1.48
Sep	0.90
Oct	1.15
Nov	1.73
Dec	0.93
Total	*15.20*

1.4.3. Office facilities and water management.

Apart from drinking water, which is supplied in 20 litre containers from a bottled water contractor, the remainder of water use for the office buildings and toilet facilities is supplied from a 10 kilolitre (kL) rainwater tank, collecting office and shed roof water. Since installation in 2017, the tank has not required supplementary filling from a water contractor, although this is possible, if required.

Wastewater is treated via a septic system and collected in pump out tanks which are regularly emptied by a contractor and disposed off-site. Currently, approximately 5000 litres are collected every 7 weeks. There will be 6 full time and 2 casual employees on site. Any increase in wastewater production can be accommodated by an increase in pump out volume, or more frequent pump outs.

1.5. Proposed water management and use

1.5.1. Stormwater

Stormwater runoff will generally be confined to roof areas, hardstand areas, paved roads and constructed haul roads. The sandy soils over the remainder of the site, including disturbed areas where extraction occurs will generate little surface runoff, except for exposed slopes in heavy rain. Exposed slopes within the extraction area that generate runoff may cause localised sand movement and possible slumping, however these will be restricted to extraction areas, and areas draining to the extraction area. Any runoff will be collected within local low areas where it will either infiltrate or be lost as evaporation/evapotranspiration.

The existing office will continue to drain to the rainwater tank. Where possible any new roof areas should also be plumbed to the tank. The entrance area will continue to drain to the pervious landscape adjacent to this part of the site.

A new rainwater tank will be installed adjacent to the existing maintenance shed, and roof water from the shed directed to it. This will provide 20kL of static firefighting supply.

Haul roads will be constructed from imported material to support the necessary traffic loads. Road design, including longitudinal and crossfall grading will divert stormwater runoff from the road surface to the adjoining landscape sheet runoff, or into shallow table drains. Runoff from haul roads will either infiltrate directly in areas adjacent or flow to low points within the landscape where it will infiltrate. Haul roads adjacent to the extraction area should be graded away where possible to separate sediment in runoff from the extraction area into low points adjacent to the road.

1.5.2. Extraction area and groundwater table interference

Extraction will be undertaken at the surface above the groundwater table. Statistical analysis of groundwater level data from monitoring bores around the site has been undertaken (Umwelt, 2023) with a suggested extraction depth of the 99th percentile groundwater level, plus 0.7m buffer (DPIE, 2021) to the shallow groundwater water table. This equates to a lower extraction level of 3.7m AHD.

The extraction area is shown in Figure 1.5. Removal of vegetation will occur progressively both within stages and stage by stage. This will minimise habitat impacts, will help reduce water losses by maintaining surface cover and shading as long as possible and limit sand product losses though wind erosion.

Sand will first be removed via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand will then be either be dry screened and stockpiled, or screened and passed through the wash plant and water recycling and filter press to remove fines then stockpiled, before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge.

1.5.3. Processing

Sand extracted in Stage 1 will leave the site as dry sand, either raw, or dry screened. This dry screened sand will leave the site with a moisture content of around 3% based on laboratory testing of extracted material undertaken by Coffey Partners and provided by Boral.

Sand extracted within stages 2 to 5 will either be dry screened or screened, and passed through the wash plant and water recycling and filter press then stockpiled. For the purpose of the surface water assessment, a worst case of 100% of stage 2-5 sand going through wash-plant has been assumed

The wash plant and filter press operates using wash screens followed by cyclonic separation of water with fines and the remaining sand product. Water within the plant is recycled, with top up required to replace water lost as the moisture content of washed and stockpiled sand product. The system produces dewatered sand and fines with a moisture content of about 12% in total. This water is replaced within the wash-plant to maintain the process.

Assuming maximum extraction of 750,000 T/y, with 100% of extraction passing through the wash plant, replacement water within the wash plant would equate to 12% of 750,000T, or 90,000kL/y (90ML/y). This amount of processing is unlikely, primarily as a significant proportion of the 750,000T/y would be made up of wind blown sand which does not require washing due to lack of fines. By 2028, the maximum dispatch proposed would be 500,000T/y, of which it is possible all could be screened and washed, requiring 60ML/y.

1.5.4. Haul road and dry extraction area dust suppression

The existing haul road accessing the wind blown area will be adjusted to allow for extraction within the Stage 1 area. Adjustments will also be made to the entrance alignments to the weigh bridge.

The new haulage route would be constructed to create a one-way entry to and one-way exit from the site, with a new laydown area in between. The haulage route would become two-way south of the laydown area providing access to the extraction stages to the south-west and continued access to the existing windblown Project to the south-east. The haul road would be up to 10 m wide and when complete (at the end of Stage 5) and would be used to support access for rehabilitation works and future site management.

The haul roads require intermittent dust suppression, depending on climatic conditions (temperature/soil surface moisture and wind) and vehicle movements. Haul roads will be progressively constructed to avoid soil/vegetation disturbance and loss of sand to wind erosion.

Refer to Figure 1.4 showing site haul roads and haul road staging. Total existing haul road area is approximately 3 hectares including both the wind blown area and the existing access through proposed Stage 1. There will be an additional access road area of approximately 0.85ha for Stages 1 to 5.

Operations within each Stage may require dust suppression over the extraction area at a particular time. For the purpose of this assessment, we have allowed for 4ha (200m x 200m) within each extraction Stage to require dust suppression over the duration of the Project.

As a worst case scenario, with existing access road, including the wind blown area access, and access road extending to Stage 5 and 4ha of dry extraction operation area, equating to 7.85ha at 5ML/ha/y equating to 39.25ML/y. Boral has the available allocations to meet this demand if required.

2.0 PLANNING SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS

Table 2.1 Issued SEARS (surface water) and relevant report section.

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
A detailed site water balance for the life of the development, including a description of site water demands, water take from any water source, water disposal methods (inclusive of anticipated volumes, quality and frequency of any water discharges), water supply infrastructure and water storage structures as defined by the relevant Water Sharing Plan and in accordance with the Australian Groundwater Modelling Guidelines (Commonwealth, 2012)	Refer to Section 6 which covers a range of water balances on the site based on demand and supply source.
Identification of any licensing requirements or other approvals under the Water Act 1912 and/or the Water Management Act 2000	Refer to Section 3.1, legislation
Demonstration that water required for the construction and operation of the development can be obtained and maintained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP)	Refer to section 1.4.1 for a summary of allocations owner by Boral. Refer to section 3.1.2 for a summary of the relevant WSP.
A description of the measures proposed to ensure the development can operate in accordance with the requirements of any relevant WSP or water source embargo with consideration to any water supply restrictions or water entitlement limitations	Refer to section 1.4.1 as well as the water balance in section 5.0
An assessment of any likely flooding impacts of the development	Refer to section 4.4 and section 7.3
An assessment of the likely impacts (including cumulative impacts) on the quality and quantity of existing surface and ground water resources, including a detailed assessment of proposed water discharge quantities and quality against receiving water quality and flow objectives	No surface water discharge.
An assessment of the likely impacts (including cumulative impacts) of the development on aquifers, watercourses, riparian land, water-related infrastructure, and other water users. This assessment must include a strategy for managing potential impacts during the life of the development and identify any conservation outcomes	Refer to section
An assessment of the potential water quality hazards surrounding the site including acidity, metals, salinity and contaminants including poly-fluoroalkyl substances (PFAS). This assessment must include: - measures proposed to reduce or manage the hazards and potential interactions on the development and surrounding water users; and - detailed description of the proposed water management system (including sewage), surface and ground water monitoring program and other measures to mitigate surface and groundwater impacts.	Water quality hazards and groundwater monitoring are addressed in the groundwater assessment. Refer to section 5.2 for information on the on-site wastewater system.
DPE - BCD (water and soils)	

Table 2.1 Issued SEARS (surface water) and relevant report section.

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
The EIS must map the following features relevant to water and soils including: • acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map)	Refer to Acid Sulfate Soil Assessment and the Groundwater assessment
• rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method)	Refer to the ecological assessment
• wetlands as described in s4.2 of the Biodiversity Assessment Method	Refer to the ecological assessment
• groundwater	Refer to the groundwater assessment
• groundwater dependent ecosystems	Refer to the groundwater assessment
• proposed intake and discharge locations	Refer to the groundwater assessment for intake locations (bores) No discharge
• The EIS must describe background conditions for any water resource likely to be affected by the development, including: • existing surface and groundwater	Refer to 6.2.1 for potential surface water impacts. Refer to the Groundwater assessment for potential groundwater impacts.
• hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	Refer to the water balance in section 5.0
• water quality objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters	No surface water discharge or surface receiving
• indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government	No surface water discharge
The EIS must assess the impacts of the development on water quality, including: • the nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction	Refer to the Groundwater assessment for potential groundwater impacts.
• identification of proposed monitoring of water quality	Refer to the Groundwater assessment
The EIS must assess the impact of the development on hydrology, including: • water balance including quantity, quality and source	Refer to the water balance in section 5.0

Table 2.1 Issued SEARS (surface water) and relevant report section.

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
• effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas	No discharge from site
• effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems	Bo surface water discharge. Refer to the Groundwater assessment for impacts on GDEs.
• impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)	No discharge from site
• changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water	Refer to 1.4.1 and 3.1.2
• mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and reuse options	No discharge
• identification of proposed monitoring of hydrological attributes	No discharge
The EIS must map the following features relevant to flooding as described in the *Floodplain Development Manual 2005* (NSW Government 2005) including: • flood prone land	Refer to section 4.4
• flood planning area, the area below the flood planning level	Refer to section 4.4
• hydraulic categorisation (floodways and flood storage areas)	Development external to floodplain
The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 1 in 10 year, 1 in 100 year flood levels and the probable maximum flood, or an equivalent extreme event	Not applicable.
The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenarios: • current flood behaviour for a range of design events as identified in 11 above. This includes the 1 in 200 and 1 in 500 year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change	Site located beyond the PMF extents, refer to section 4.4
Modelling in the EIS must consider and document: • the impact on existing flood behaviour for a full range of flood events including up to the probable maximum flood	Not applicable
• impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow velocities, flood levels, hazards and hydraulic categories	Not applicable
• relevant provisions of the NSW Floodplain Development Manual 2005	Not applicable

Table 2.1 Issued SEARS (surface water) and relevant report section.

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
The EIS must assess the impacts on the proposed development on flood behaviour, including: • whether there will be detrimental increases in the potential flood affectation of other properties assets and infrastructure	Not applicable
• consistency with Council floodplain risk management plans	Not applicable
• compatibility with the flood hazard of the land	Not applicable
• compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land	Not applicable
• whether there will be adverse effect to beneficial inundation of the floodplain environment, on adjacent to or downstream of the site	Not applicable
• whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses	Not applicable
• any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the SES and Council	Not applicable
• whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the SES and Council	Not applicable
• emergency management, evacuation and access, and contingency measures for the development considering the full range or flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of Council and the SES	Not applicable
• any impacts the development may have on the social and economic costs to the community as consequence of flooding	Not applicable
The EIS must describe the potential effects of coastal processes and hazards (within the meaning of the Coastal Management Act 2016), including sea level rise and climate change: • on the proposed development • arising from the proposed development	Refer to section 4.4
The EIS must consider have regard to any certified Coastal Management Program (or Coastal Zone Management Plan) and be consistent with the management objectives described in the Coastal Management Act 2016 and development controls for coastal management areas mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021*	Refer to the coastal hazard assessment
EPA (Water)	
The EIS must demonstrate how the proposed development will meet the requirements of section 120 of the POEO Act. The EIS must include a water balance for the development including water requirements (quantity, quality and source(s)) and proposed storm and wastewater	No discharge. Refer to section 5.0

Table 2.1 Issued SEARS (surface water) and relevant report section.

Relevant SEARs	Where addressed in EIS
DPE – Planning (water)	
disposal, including type, volumes, proposed treatment and management methods and re-use options	
If the proposed development intends to discharge waters to the environment, the EIS must demonstrate how the discharge(s) will be managed in terms of water quantity, quality and frequency of discharge and include an impact assessment of the discharge on the receiving environment. This should include: description of the proposal including position of any intakes and discharges, volumes, water quality and frequency of all water discharges	No discharge
description of the receiving waters including upstream and downstream water quality as well as any other water users	No receiving surface waters. Refer to Groundwater assessment for hydrogeology description
demonstration that all practical options to avoid discharge have been implemented and environmental impact minimised where discharge is necessary	No discharge
The EIS must refer to Water Quality Objectives for the receiving waters and indicators and associated trigger values or criteria for the identified environmental values of the receiving environment. This information should be sourced from the ANZECC (2018) Guidelines for Fresh and Marine Water Quality, available at: https://www.waterquality.gov.au/anzguidelines	No surface water discharge
The EIS must describe how stormwater will be managed in all phases of the project, including details of how stormwater and runoff will be managed to minimise pollution. Information should include measures to be implemented to minimise erosion, leachate and sediment mobilisation at the site. The EIS should consider the guidelines *Managing urban stormwater: soils and construction, vol. 1* (Landcom 2004) and vol. 2 (A. Installation of services; C. Unsealed roads; D. Main Roads; E. Mines and quarries) (DECC, 2008)	Refer to section 7.2
The EIS must describe any water quality monitoring programs to be carried out at the project site. Water quality monitoring should be undertaken in accordance with the Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (2004) which is available at: • https://www.epa.nsw.gov.au/-/media/epa/corporatesite/ resources/water/approvedmethodswater.pdf	Refer to the Groundwater assessment and refer to section 7.5

3.0 RELEVANT LEGISLATION, POLICY AND GUIDELINES

Approval is sought as a State Significant Development (SSD) under part 4 of the NSW *Environmental Planning & Assessment Act 1979* (EP&A Act). Legislation, policy and guidelines applicable to the surface water impacts and management associated with the Project are outlined below.

3.1. Legislation

3.1.1. Environmental Planning and Assessment Act 1979

The Project is categorised as State Significant Development in accordance with section 4.36 of the EP&A Act 1979. Section 4.41 of the EP&A Act 1979 does not require certain authorisations for State Significant Developments including a water use approval under section 89, a water management work approval under section 90 or an activity approval (**other than an aquifer interference approval)** under section 91 of the Water Management Act 2000 (WM Act). The Project will not intercept and expose the groundwater table, through keeping extraction above the groundwater surface level. Nevertheless, the activity (extraction of sand) is listed as an aquifer interference activity, requiring an aquifer interference approval. The Project does require extraction for the processing of sand extracted on site which would, for the purpose of the WM Act, trigger section 91 of the WM Act.

There is no provision within the EP&A Act 1979 to limit the provisions of the *Water Act 1912* with respect to licensing. However, it is noted that pursuant to the provisions of section 129A the Water Act 1912 does not apply as the site is located within a part of the State to which Part 3 of Chapter 3 applies.

3.1.1.1. Port Stephens Local Environmental Plan

The site is located in LGA of Port Stephens, a review of the Port Stephens Local Environmental Plan 2013 has identified the following planning control maps that can be used to determine whether assessment against these areas of interest is necessary and the potential likelihood of impact. Given the following::

- The site is located outside any flood planning area;
- No wetlands are located on or within proximity to the site;
- The site is not located within the drinking water catchment; and
- The site is not located in the Williams River Catchment,

Impacts on these areas or land uses will not occur.

3.1.2. Water Management Act (WM Act) 2000

The Project involves extraction of water from the aquifer to undertake dust management and for the processing of and extracted on site. This operation meets the definition of an "aquifer interference activity" through the taking of water in the course of carrying out mining as listed in the dictionary of the WM Act and as such will require an aquifer interference approval under section 91.

The Project is located within the Stockton Groundwater Source (SGS) as mapped within the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016 which is adopted under section 50 of the WM Act. The WSP is discussed in section 3.1.2.3.

The Project has 4 Water Access Licences (WALs) for the location, with a total of 524 allocated shares. The Project has a single Water Supply Work (WSW 20WA221084) linked to WAL43827 currently licenced for 16ML/y . An additional WSW or linking of additional WALs to the existing WSW, and increase to the WSW permitted capacity may be necessary and can be nominated under section 71W of the WM Act.

3.1.2.1. Basic landholder rights

Under Part 1, Basic landholder rights, the WM Act allows for landholders to construct water supply works and extract water for domestic consumption and stock watering as outlined in Division 1. Under Division 2, harvestable rights, landholders may construct water supply works to collect surface flows, and extract certain amounts based on specified calculations on maximum harvestable rights.

As no stock or domestic consumption is proposed for the site, Division 1 does not apply. Under Division 2, no surface flows (runoff) are proposed to be collected at the site (as site geology is predominantly sand), therefore harvestable rights are not able to be practically implemented.

3.1.2.2. Water Management (General) Regulation 2018

The Water Management (General) Regulations 2018 (the WM Regulations) support the implementation of the WM Act 2000. Part 3 specifically addresses the requirements for aquifer interference approvals.

Section 24 (a) of the Water Management (General) Regulation 2018 specifically defines the extraction of sand as an *aquifer interference activity* as such it is taken that the provisions of Part 3 apply.

Section 28 sets out the matters affecting the consideration of applications for approvals and states the following.

> *For the purposes of section 96 (a) of the Act, the matters to be taken into consideration by the Minister in considering whether or not to grant an aquifer interference approval include whether the amount of water taken in the course of carrying out the aquifer interference activity to which the approval relates will exceed the total extraction limit for the aquifer set out in any relevant management plan.*

The provisions of the relevant plan are addressed in section 3.1.2.3 of this report. The assessment of potential impacts is set out in sections **Error! Reference source not found.** and 6.3.

A Water Supply Works (WSW) approval, or construction or use of a water supply work is not necessarily required, as sections 36 and 39 of the regulation exempts those carrying out an aquifer interference activity associated with mining or extraction from being guilty of an offence if operating without a WSW or water use approval (section 91B and 91A of the WM Act).

3.1.2.3. Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources 2016.

The site is located over the Stockton Groundwater Source (SGS) which is regulated by the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016 (Figure 3.2).

Water sharing plans are adopted under section 50 of the WM Act and operate as a statutory instrument. The relevant provisions of the plan include:

- Section 26 (11) that permits a long term annual extraction limit of 14,000ML/year from the SGS;
- Section 28 states that average annual extractions measured against long term average extraction limits in the SGS will include the preceding three water years;
- Section 36 outlines a range of rules around accounting for water use including:
    - (2) extracted volume must not exceed water allocations (either held, traded or carried over)
    - (3) a maximum of 20% of the previous year's allocation to be carried over
- Section 41 that outlines rules relating to the proximity of water supply works to Groundwater Dependent Ecosystems (GDEs), in particular:
    - (c) that a water supply works approval must not be granted within 800m of a high priority GDE.

Water shares and allocations

The WSP specifies the planned environmental water provisions, water for basic landholder rights, share components of existing aquifer access licences and long term average annual extraction limits for this water source (Table 3.1). As of April 2023, 1,827.5 shares have been allocated, leaving approximately 11,919 megalitres per year (ML/y) unassigned, which may be made available under Section 65 of the WM Act as controlled allocations.

Table 3.1 Stockton Groundwater Source summary

Groundwater component	Annual volume (ML/y)
Total recharge[1]	21,000
Planned Environmental Water[2]	7,000
Long Term Average Annual Extraction Limit (LTAAEL)	14,000
Basic Landholder Rights	254
Aquifer Access Licence[3]	1,827.5shares at 1ML/share

[1]22% of average annual rainfall as per *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources (DPI, 2016).*
[2]33% of long term recharge *(DPI, 2016).*
[3]NSW Water Register as of 26/04/2023

Groundwater Dependent Ecosystems

Section 10 (a) of the WSP states an objective of the Plan is to:

> *protect, preserve, maintain and enhance the important high priority Groundwater Dependent Ecosystems (GDEs) of these groundwater sources.*

Known high priority GDEs have been mapped and included in the WSP (Figure 3.2), The location of the aquifer interference activity to the mapped high priority GDEs is in well in excess of the proximity distance of up to 800m that preclude approval (Figure 3.2).

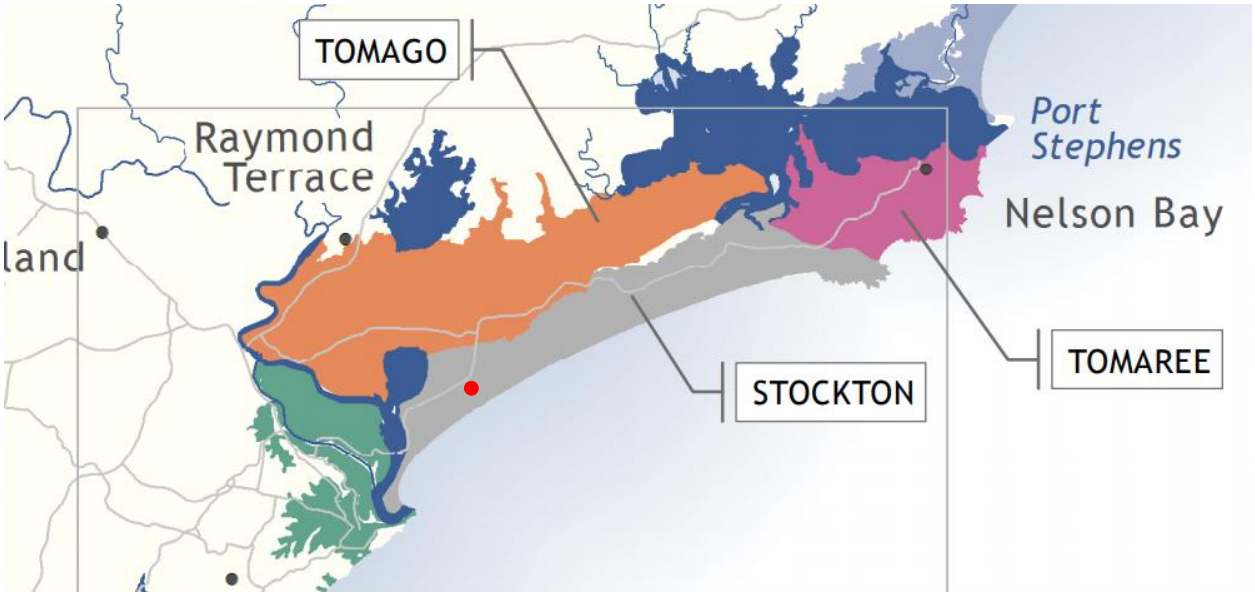


Figure 3.1 Zoomed extraction from WSP Map showing Stockton groundwaters source extents (grey) and Project location (red dot)

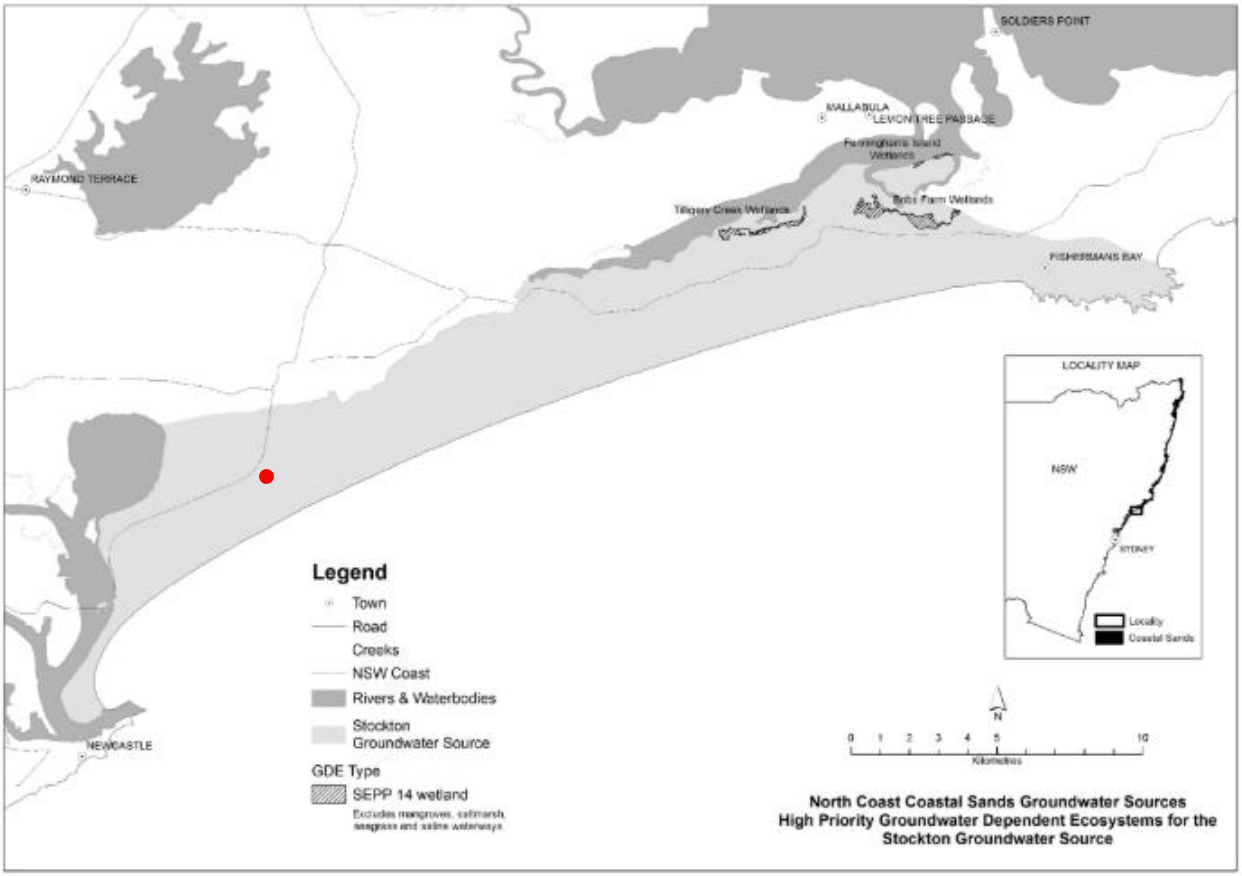


Figure 3.2 Stockton Groundwater Source mapped High Priority GDEs, approximate site location shown in red.

3.1.3. Hunter Water Act 1991 No 53

The Hunter Water Act establishes the Hunter Water Corporation (HWC) and outlines a range of activities and controls related to the extraction and provision of water. These include the requirement for a consent authority to notify the HWC of applications of developments that have the potential to impact water quality. Specifically, Section 51:

> (*2) If a consent authority within the area of operations or a special area receives a development application or building application in relation to any matter that, in the opinion of the consent authority, may:*
>
> *(a) significantly damage or interfere with the Corporation's works, or*
>
> *(b) significantly adversely affect the Corporation's operations, or*
>
> *(c) significantly adversely affect the quality of the water from which the Corporation draws its supply of water in a special area,*
>
> *the consent authority must, within 7 days of the receipt of the application, give the Corporation notice of the application.*

In this case, although the Project is not itself located within a 'special area', see section 3.1.3.1 below, there is potential for the Project to impact water quality as the Stockton aquifer extends beyond the special area boundary, however, as extraction is being undertaken above the groundwater table, significant impacts are highly unlikely. The determining authority may decide to provide notice to the HWC.

3.1.3.1. Hunter Water (Special Areas) Regulation 2003

The Hunter Water (Special Areas) regulation specifies catchment area boundaries within which specific development referrals and pollution controls apply to protect drinking water sources. The Project is located beyond the catchment area boundaries specified for the Stockton Sandbeds aquifer reserve. As such the Hunter Waters (Special Areas) regulation does not apply to this Project.

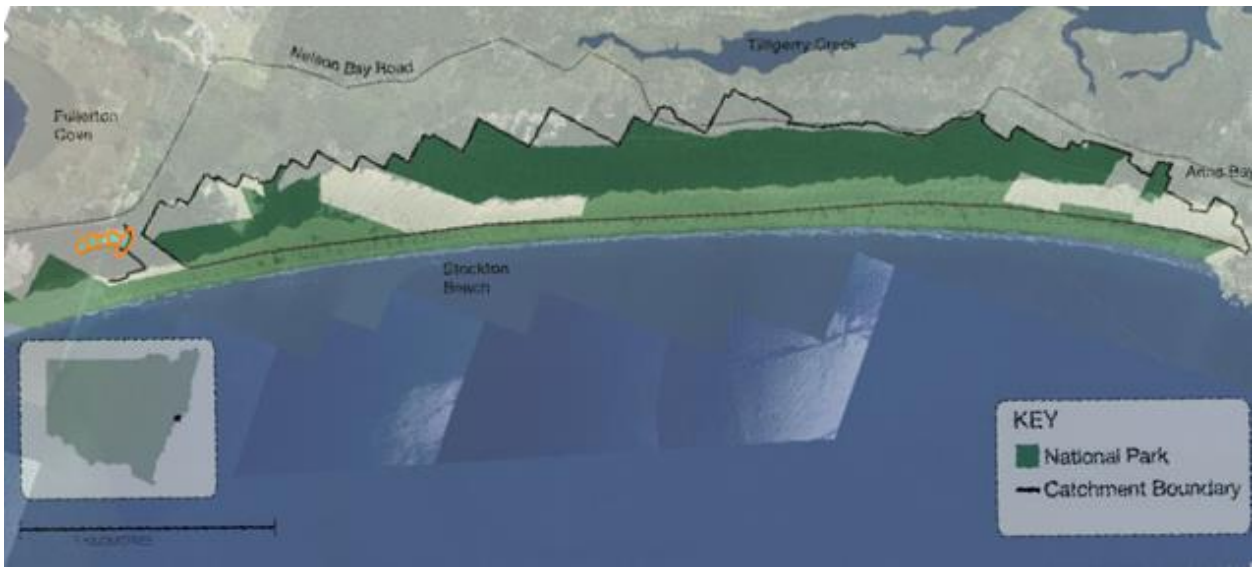


Figure 3.3 Project location (orange) in relation to Stockton Sandbeds aquifer reserve as specified in the Hunter Water (Special Areas) Regulation 2003

3.1.4. Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (PoEO Act) and the NSW Protection of the Environment Operations (General) Regulation 2009 set out the general obligations for environmental protection. In relation to surface and groundwater management, Section 120 prohibits the pollution of waters.

The existing operation has an Environment Protection License (EPL), however there are no aspects of the current EPL relating to surface water management or discharge.

An EPL for surface water discharge will not be required for the Project as it is confined within the dune landscape and due to the high infiltration rates there is no surface water discharge from the site, refer to Sections 4.3 and 4.4

3.2. Guidelines and Policies

3.2.1. NSW Water Extraction Monitoring Policy

The NSW Water Extraction Monitoring Policy outlines the procedures necessary to ensure that accurate measurement of water extractions is undertaken and that licence conditions and the objectives of Water Sharing Plans are being met.

Monitoring is undertaken at the source level, as well as an individual licence level. At the individual level monitoring is generally undertaken using a variety of flow metering approaches or through secondary measures such as electricity consumption or as a pumping diary. All monitoring will be undertaken in line with licence requirements as stipulated in the NSW Non-urban Water Metering Policy

3.2.2. NSW State Rivers and Estuaries Policy

The *NSW State Rivers and Estuaries Policy* (NSW Water Resources Council, 1993) contains state-wide objectives for the protection and enhancement of watercourses. The proposed surface water management should be consistent with the *NSW State Rivers and Estuaries Policy* objectives which are to:

- *manage the rivers and estuaries of NSW in ways which slow, halt or reverse the overall rate of degradation in their systems;*
- *ensure the long term sustainability of their essential biophysical functions; and*
- *maintain the beneficial use of these resources.*

The Project has no direct impacts on nearby rivers or estuaries. There is a broader connection via the groundwater table to local estuaries. Impacts on the groundwater resource are managed through the Water Act and WM Act, and any approvals though these acts would meet the objectives of the *NSW State Rivers and Estuaries Policy*.

3.2.3. National Water Quality Management Strategy, Water Quality Objectives and ANZECC guidelines.

The National Water Quality Management Strategy (NWQMS) provides guidance on water quality planning and management at a federal level. From that framework, the NSW government has set out policies and objectives for water quality management over the state. Water Quality Objectives (WQOs) have been established for catchments throughout NSW, using the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines to set trigger values for a range of parameters, based on the water use, for example; protecting aquatic ecosystems or providing drinking water. These trigger values may be refined based on local catchment conditions, monitoring and research.

In this case, direct discharge to surface waters will not occur as part of the Project. Many of the WQOs for aquatic ecosystems set out for the Hunter River catchment for surface waters will also be relevant for the protection of groundwater quality. This is discussed further within Section 7.5.

3.2.4. NSW Aquifer Interference Policy (DPI, 2012)

The NSW Aquifer Interference Policy (DPI, 2012) explains the requirements for obtaining licences for aquifer interference activities and defines the considerations for assessing whether the interference is considered a minimal impact.

The policy outlines the framework for assessing the impacts and the key tests that the Project should meet when the approval for aquifer interference is being assessed, including:

- Demonstrating the ability to obtain necessary licences;
- Demonstrating that the minimal impact considerations can be met; and
- Proposing remedial actions should the impacts of the approval be greater than predicted.

In this case, the Project has been designed to prevent creation of a window to the aquifer by locating extraction 0.7m above the maximum recently recorded (2018-2022) groundwater table level.

Boral have water allocations of up to 524 shares from the SGS, in excess of the maximum demand required for this Project.

A Water Supply Works (WSW) approval, or construction or use of a water supply work is not necessarily required, as sections 36 and 39 of the regulation exempts those carrying out an aquifer interference activity associated with mining or extraction from being guilty of an offence if operating without a WSW or water use approval (section 91B and 91A of the WM Act).

Consideration of the minimal impacts is covered within the *Groundwater assessment* (Umwelt, 2023)

3.2.5. Erosion and sediment control guidelines

Given the site geology, surface water runoff from the in-situ landscape is negligible. Erosion risks are confined to construction with imported material such as the access road and hardstand areas. Movement of sediment in runoff that is not controlled through erosion and sediment management would be confined to adjacent sandy areas with high infiltration within the site.

The following erosion and sediment control guidelines provide guidance for preventing erosion and protecting surface waters from suspended sediment:

- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment control on mines and quarries based on the principles set out in Managing Stormwater: Soils and Construction, Volume 1 (Landcom 2004); and
  Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction (DECC 2008) provide guidance on road design and design of erosion and sediment control measures for the construction of the proposed access and haul roads over the site.

3.3. Summary of licensing/entitlement requirements

The extraction of sand will require an aquifer interference approval under section 91 of the WM Act and as defined under section 24 of the WM Regulation.

The primary consideration for the aquifer interference approval, as outlined in the WM Regulation under section 28 is whether the extraction associated with the aquifer interference approval is less than the total water available for extraction as outlined in the relevant water management plan. The Project is located within the SGS as mapped in the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater Sources 2016, which is adopted under section 50 of the WM Act. The WSP identifies the water available for extraction from the SGS at 14,000ML/y, of which 1,827.5ML is allocated. The maximum extraction associated with the Project could be up to 129ML, although unlikely for reasons outlined in Section 1.5.3, and which is well within the current water allocations that Boral owns.

4.0 SURFACE WATER ENVIRONMENT

4.1. Climate

A review of climatic data from Bureau of Meteorology (BOM) Newcastle Nobbys Signal Station (061055) indicates that the climate over the site is temperate with annual average rainfall of 1,123 millimetres per year (mm/y) skewed towards late summer and autumn (Figure 4.1). Annual areal actual evapotranspiration is estimated at between 811mm/y from the BOM (1961-1990) to 966mm/y from the Scientific Information for Land Owners (SILO) climate database (1900-2019). Average annual evaporation, as estimated using a Class A Evaporation pan measurements, is 1,474mm/y (BOM), and the Morton's lake evaporation is 1,369mm/y (SILO database).

As can be seen from the spread between the 5th and 95th percentile rainfall data, rainfall distribution is skewed towards the drier end, with infrequent large rainfall events leading to the larger difference between the average and 95% percentile.

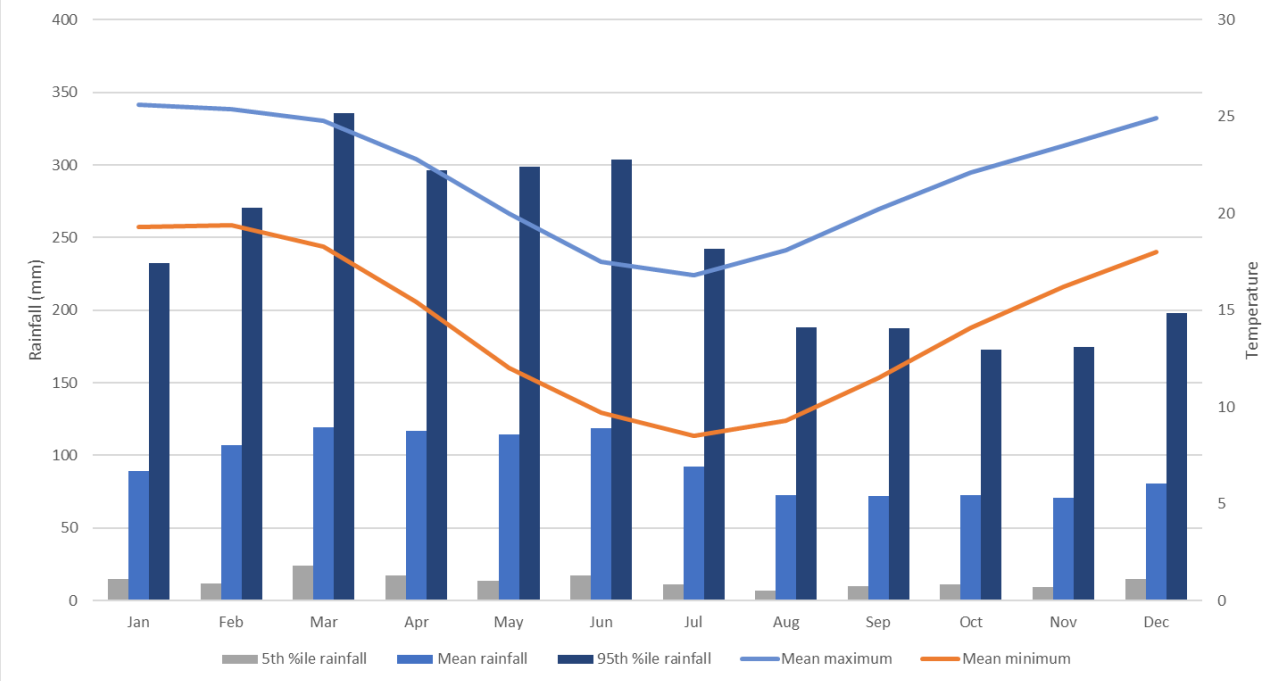


Figure 4.1 Monthly rainfall and temperature

Average annual rainfall exceeds evapotranspiration for the site for both the Morton's Areal Actual evapotranspiration for the BOM period of estimation from 1961 to 1990, as well as a longer period estimation from 1900 to 2019 as taken from the SILO database, suggesting that the Project site is likely to be a net importer of water to the groundwater table on average. Class A pan evaporation, and Morton's lake evaporation estimates exceed average annual rainfall.

4.2. Regional hydrology and hydrogeology

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources – Background document* (DPI, 2016) describes the Stockton Groundwater Source (SGS) (Figure 3.2) as follows:

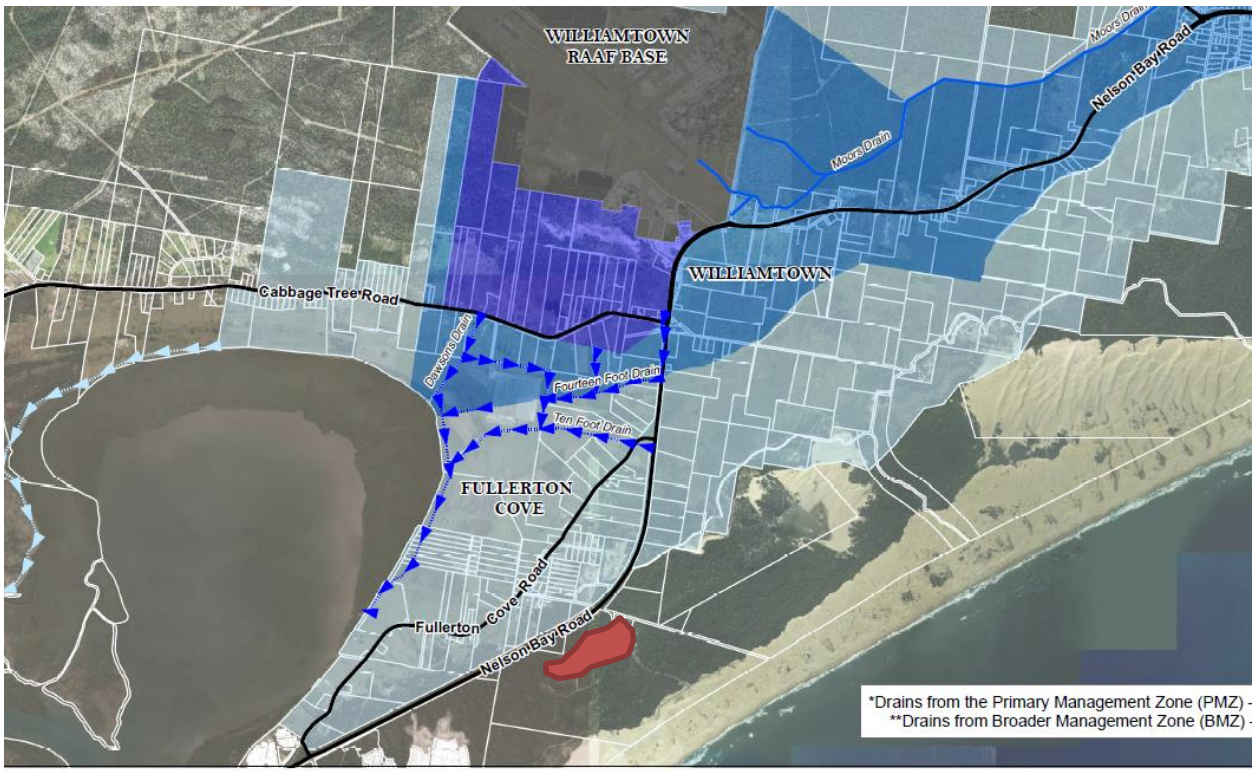
> *The Stockton Groundwater Source is located on the Lower North Coast between the villages of Stockton and Anna Bay. It consists of a series of parallel small dune ridges with intervening lowland swales tending to swamps. The Stockton Groundwater Source is located between the coastline and Tilligerry Creek. It extends from the Hunter River at Stockton in the south, to the drainage complex of Bobs Farm Creek, Fenninghams Island Creek, and Murrumburrimbah Swamp near Anna Bay in the north. The area of the Stockton Groundwater Source has been updated since the plan was first developed as a result of improved mapping methods. The area now totals approximately 113 km².*
>
> *Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. Some entitlement is also used for irrigation and commercial purposes.*
>
> *Located within the groundwater source are the Worimi Conservation Lands which cover the Worimi National Park, Worimi State Conservation Area, and Worimi Regional Park.*

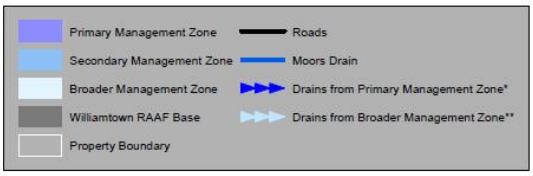
Recharge of the groundwater source is from direct rainfall over the area. Recharge calculations assume an infiltration rate of 0.22 (22% of rainfall) for the sand aquifer components of the resource and an infiltration rate of 0.02 (2% of rainfall) for the residual aquifer component, which is about one third of the area, and is separated from the sand aquifer for a range of reasons. Table 3.1 summarises total recharge and available water for extraction. Recharge estimates are based on site specific recharge studies undertaken on the adjacent Tomago and Tomaree groundwater sources (DPI, 2016).

The SGS is bounded to the south by the influence of the Tasman Sea, and to the north by the Tomago groundwater source (183 km^2). The Tomago groundwater source is an exposed sand body of accumulated sand and shelly sands overlaying clay. This groundwater source is an important source of municipal water supply for Hunter Water Corporation, which has an extensive extraction bore field in the eastern part of the groundwater source within the Tilligerry State Conservation Area.

From the locality of Salt Ash heading west to Fullerton Cove is an area identified as the Williamtown management area, an area either contaminated or potentially contaminated with by Per – and Poly Fluoroalkyl Substances (PFAS) from previous operations at the Williamtown RAAF Base. The NSW EPA has identified Primary, Secondary and Broader Management Zones in which there are recommendations to not use groundwater, bore water of surface water for any purpose in the Primary management zone, and to not use groundwater, bore water of surface water for drinking or cooking in the Secondary and Broader management zones.

The Project site is located approximately 250 m from the Broader Management Zone in the separate SGS (Figure 4.2), and therefore is not impacted by the EPA requirements in the Primary, Secondary and Broader Management Zones.





Williamtown Management Area

Map Created: 19/12/2017

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EPA and its employees disclaim liability for any act done on the
information in the map and any consequences of such acts or omissions.

Base imagery: Nearmap 17 November 2017

Figure 4.2 Williamtown PFAS management area and Project site (red). (https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/community/williamtownmanagementareamap.pdf, accessed 09/07/2019)

4.3. Surface drainage and groundwater interaction

Surface runoff, surface ponding and exposure of the groundwater table at the surface is a function of rainfall intensity, groundwater table depth and ocean influences. Infiltration rates are a function of surface condition and previous rainfall (ie. soil moisture).

Recorded groundwater levels during low rainfall (March 2018) and high rainfall (April 2022) periods record groundwater levels of between 1.0 to 1.4m AHD and 2.0 to 3.0m AHD respectively. As the 2018 groundwater records outlined above show, the aquifer responds rapidly to rainfall. Records over the period of late 2016 to late 2022 show that several rainfall events ≥40 mm occurring within a fortnight can raise standing water levels across all bores at the quarry by approximately 0.5m (Figure 4.3).

The Project site is a basin, with no surface flow connection to adjacent areas and the lowest surface level located around the edge of the Project site to the south east, towards Stockton Beach is at about 6m AHD. There are no springs or permanent streams within the proposed extraction area. Local hydrology is driven by the high infiltration rates associated with the sands over the site, the confined nature of the landscape and the interaction with the groundwater table and underground geology.

Surface runoff is limited to periods where the groundwater table reaches surface levels, the soil moisture store is fully saturated, where rainfall intensity exceeds infiltration rates, or a combination of the three. Ocean conditions, including storm surge, large tides and the wave climate also influence groundwater levels. During what is known as the 'Pasha Bulker storm' of June 2007, the associated storm surge and rainfall caused inundation up to about 3.5m AHD over the current Project site where excavation depths had extended down to about 2.5m AHD. Although, dependent on locality, this storm generally produced flood levels equivalent to a 100 year ARI event (Verdon-Kidd et al, 2010).

The *Stockton Dry Extraction Project groundwater assessment report* (Umwelt, 2023) provides a conceptual ecohydrological model for the site which neatly outlines surface water and groundwater interactions over the site, and the relationship with the proposed sand extraction. A summary of key points are as follows:

- Groundwater flows are generally to the north-west and away from the coast due to rainfall recharge along the unvegetated Stockton dune area (Figure 4.4)
- Recharge is from direct rainfall infiltration, higher where there is less vegetation, and associated evapotranspiration groundwater investigations undertaken over the site show a 99th percentile water groundwater level of about 3.0m AHD over the proposed extraction area, based on monitoring data (Umwelt, 2023).

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The ‘special area’ as mapped for Stockton water supply aquifer under the Hunter Water (Special Areas) Regulation 2003, is approximately 150m to the north east of the site. The groundwater flow direction is generally to the northwest. .

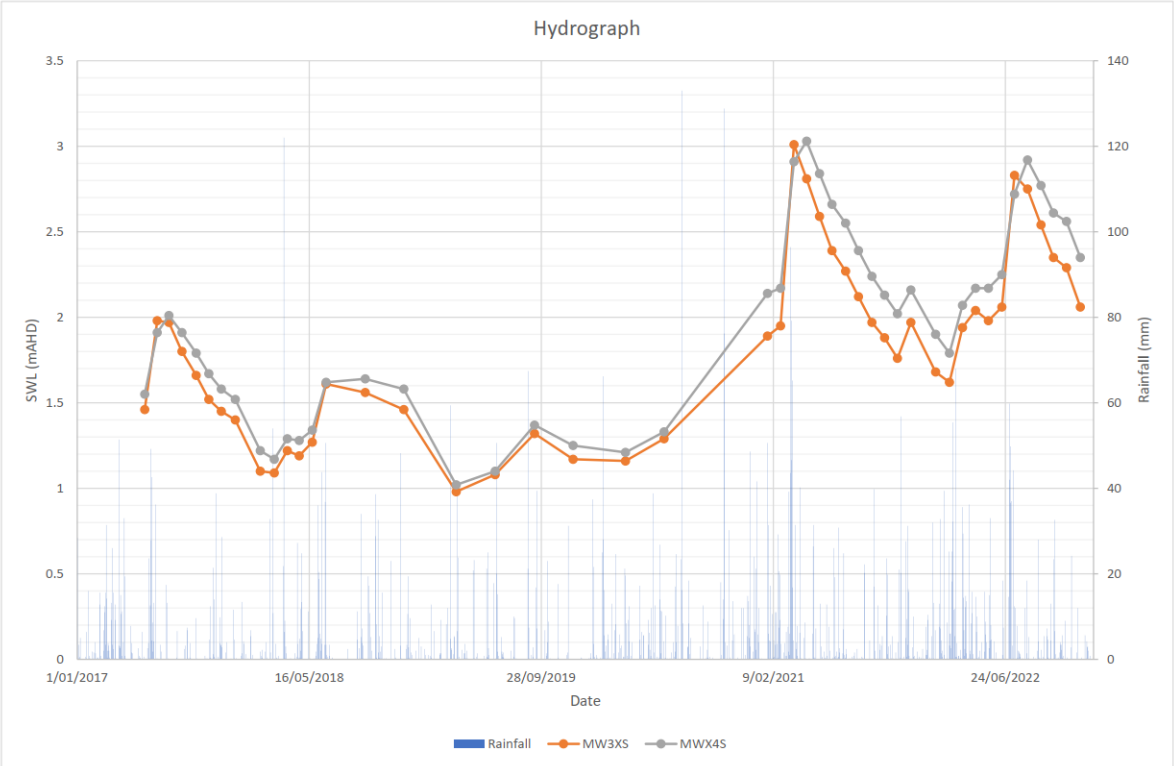

Figure 4.3 Recorded Rainfall and groundwater level (EES, 2023)

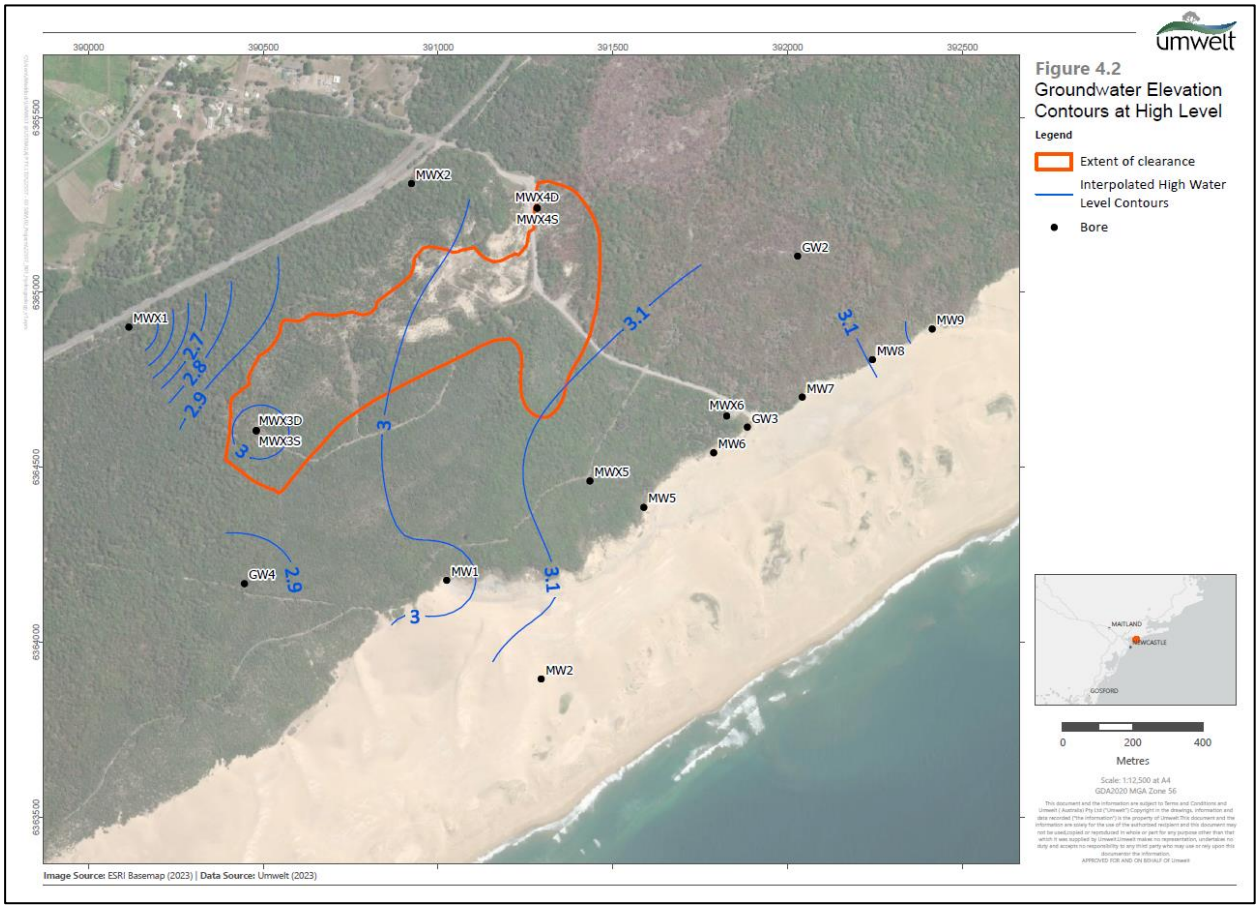

Figure 4.4 Groundwater levels in high rainfall (Umwelt, 2023)

4.4. Flooding and coastal hazards

4.4.1. Flooding and inundation

The *Williamtown – Salt Ash Floodplain Risk Management Study & Plan* (BMT WBM, 2017) consolidates previous flood studies and reviews over the Williamtown and Salt Ash districts and covers the Project site. The *Williamtown – Salt Ash Floodplain Risk Management Study & Plan* also considers impacts associated with climate change, including increased ocean inundation levels and increased rainfall intensity.

Flooding in the vicinity of the Project site is driven primarily by floodwaters from the Hunter River that overtop the Fullerton Cove levee, and the severity is a function of the magnitude of flooding within the Hunter River, which in turn is a combination of sea level impacts and catchment runoff. For the purposes of floodplain risk management, Port Stephens Council have decided the 1% AEP design flood is assumed to be a 50% AEP sea level and 10% AEP local catchment runoff event (BMT WBM, 2017).

The Project site is located beyond the Williamtown - Salt Ash floodplain Probable Maximum Flood (PMF) extents, and therefore smaller flood events, and is located beyond Port Stephens Council's flood hazard mapping extents (Figure 4.5). These estimates include allowances for climate change impacts. Estimates of the 1% AEP flood level and PMF flood level in the vicinity of the site are 1.5m, and 5.2m AHD respectively. Direct surface flood impacts from the Hunter River on the Project site for the PMF or more frequent events are not expected. Surface floodwaters for the PMF will impact on access to and from the site.

As outlined in section 4.3 above, potential water ponding within the site is primarily due to raised groundwater levels which can be exacerbated by ocean inundation and localised heavy rainfall. As outlined above, the relatively recent Pasha Bulker storm in 2007 produced groundwater levels of about 3.5 m AHD, approximately a 100 year ARI event.

Recorded groundwater levels from monitoring stations in and around the project site show maximum values of between 2.10 to 3.63 m AHD over the monitoring period (Umwelt, 2023) which for some stations includes the Pasha Bulker storm in 2007, approximately a 100 year ARI event.

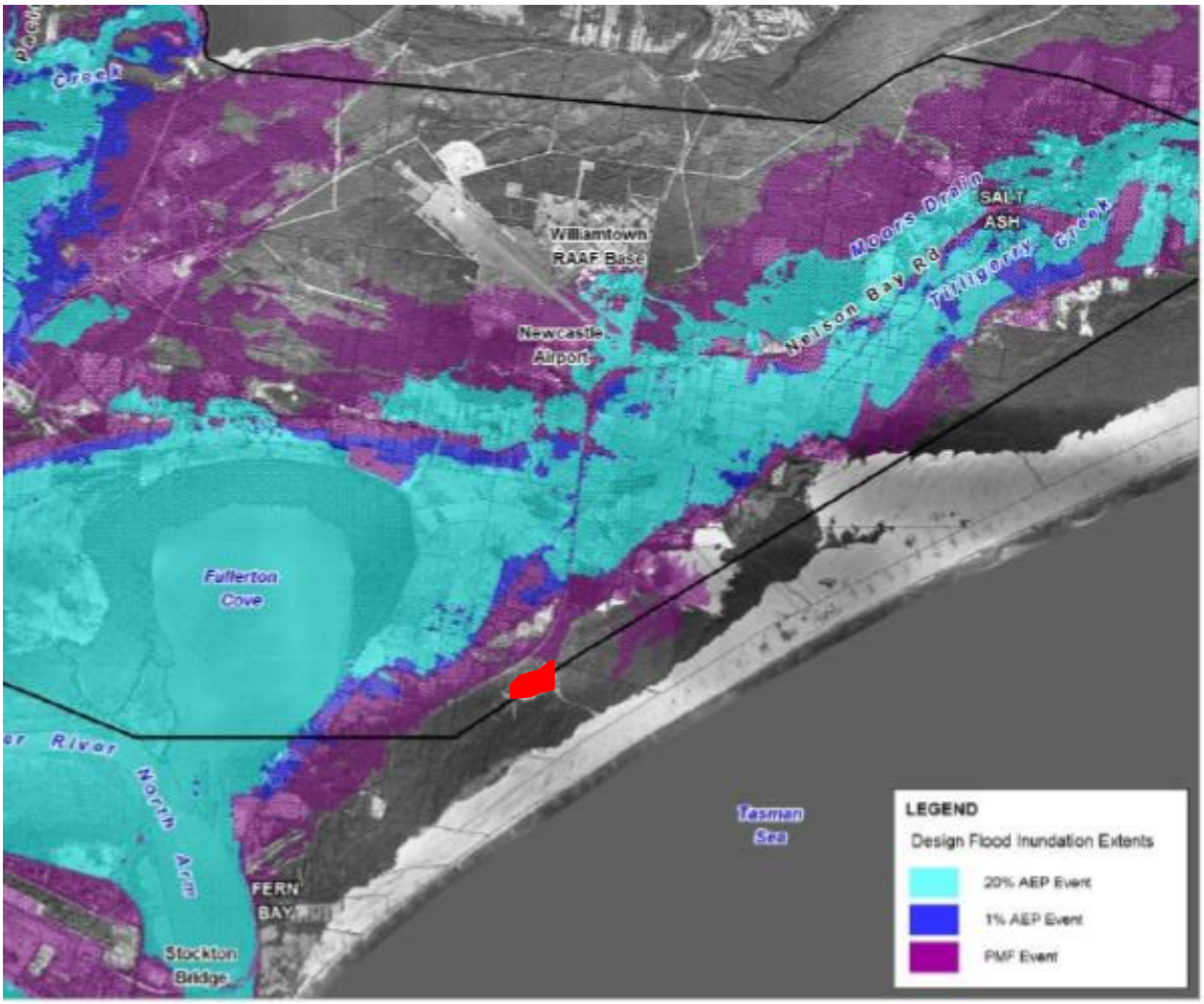

Figure 4.5 Design flood extents and Project site in red - extracted from *Williamstown – Salt Ash Floodplain Risk Management Study & Plan* (Cardno, 2017)

4.4.2. Coastal Hazards

Coastal hazards consist of erosion and wave runup along Stockton Beach. Coastal erosion and recession estimates out to the year 2100 have been estimated as part of Coastal zone management planning by Newcastle Council (BMT WBM, 2014). These estimates extend up to the Council boundary at Fern Bay about 3km to the southwest of the Project site, and represent a similar aspect and coastal exposure to that of the Project site. Likely beach erosion and recession in a large ocean inundation event by 2100 is about 250m (Figure 4.6). The Project site is well beyond Projected coastal erosion extents, and is expected to be completed before 2050. Coastal hazards are not an issue at the site.

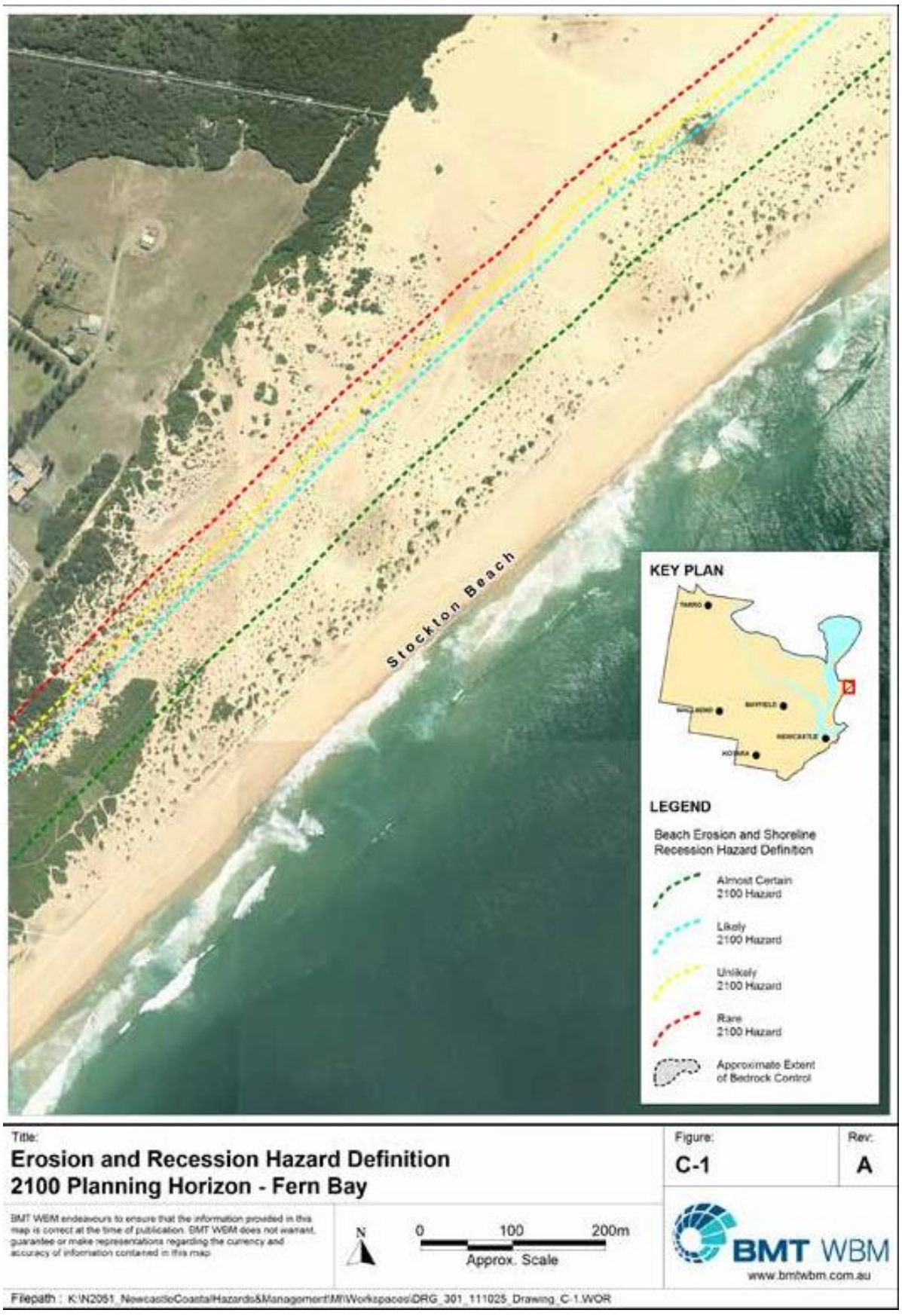

Figure 4.6 Erosion and rececion 2100 year planning horizon (BMT WBM, 2014).

4.5. Water quality

There is no surface water or surface water quality monitoring within, or nearby to the site. Groundwater quality monitoring does take place within and around the site.

Groundwater samples are collected on a quarterly basis, with field analysis of pH and EC and laboratory analysis of major ions, TDS, total alkalinity, nitrate, total phosphorus and metals.

The site bores have recorded relatively freshwater quality generally ranges between 200 µS/cm and 1,000 µS/cm. Most bores is slightly acidic to neutral, with pH between 6 and 7.6. Bores MW5 and MW1 have recorded a general decline in pH compared to results from 2007, with bore MW1 recording the lowest pH of between 5 and 6.5 since 2019.

shows most bores record iron concentrations of less than 4 mg/L, with the exception of bores MW7 and MW8. Bore MW7 and MW8 record the higher concentrations of iron, up to around 21 mg/L; however these have been reducing since 2020.

Groundwater quality monitoring will continue as part of the existing program.

5.0 SITE WATER BALANCE

5.1. Background

The water balance for the site has three separate components:

1. Water use and wastewater generation associated with the office and weighbridge facility;
2. Water use associated with dust suppression as required over the site; and
3. Water use associated with sand processing and losses associated with the moisture content of extracted material leaving the site.

5.2. Direct demands

5.2.1. Office and weighbridge facility

Water demand at the office and weighbridge facility are not expected to change significantly over the Project, and employment levels will remain similar to existing conditions. Any changes to water demand or wastewater generation associated with the office and weighbridge area can be managed through purchase of additional mains water from water contractors if required and additional wastewater removal contractors. Currently, rainfall is sufficient for site demands and approximately 37kL of collected wastewater is removed each year.

The Project will increase staff numbers to up to six full time staff and two casual staff. The existing wastewater system can accommodate this additional load, and pump out frequency can be increased when required.

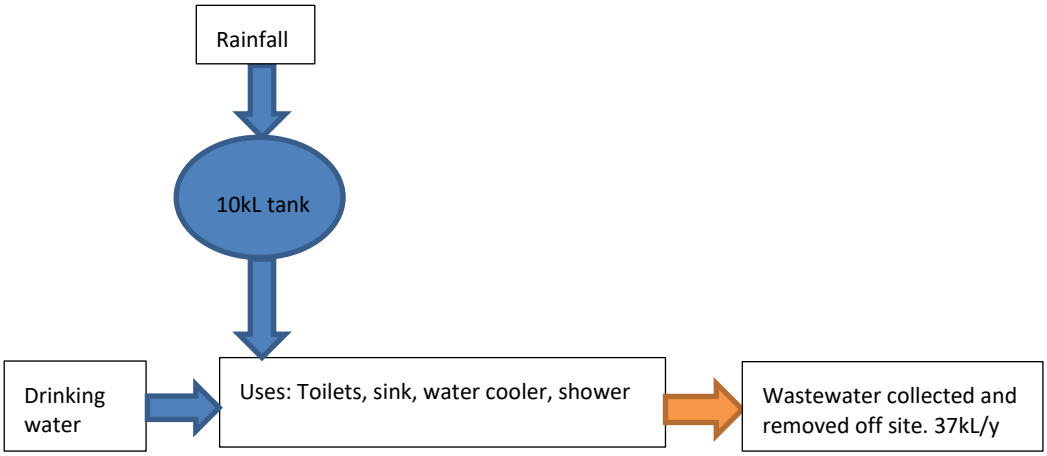

Figure 5.1 Conceptual Site office and weighbridge facility water balance

5.2.2. Fire fighting

In order to accommodate fire fighting demands at the site, 20kL of static storage in a rainwater tank is proposed adjacent to the existing maintenance shed. Roof water from the maintenance shed will be diverted into the storage tank, and retained for firefighting purposes. An onsite bor will be used to maintain this supply (WAL: 43827. WSW: 20AL220991).

5.2.3. Dust Suppression

Water is currently sourced from mains supply. However, given the significant allocations that Boral have available, this will shift to supply from the SGS via extraction on site.

Water use for dust suppression is a function of rainfall, wind and truck and other vehicle movements. The quarry currently uses approximately 15.2ML/y to manage dust suppression on around 3 ha of unsealed haul roads within the site (about 5ML/ha/y). Refer to Figure 1.4 for a schematic showing existing and future haul road areas and potential dust producing areas (laydown).

As outlined in the Project description, dust suppression will be required for the new access servicing Stages 1 to 5 and operational areas within the dry extraction zones where an area 200m x 200m (4ha) has been assumed. Although the wind-blown access road is unlikely to be in use when the full length of access road is created for the dry extraction area, this has been included in the total dust suppression area to present a 'worst case' scenario for dust suppression. Table 5.1 includes a summary of areas potentially requiring dust suppression.

Table 5.1 Dust suppression areas

Location	Area (ha)
Wind blown access, including through existing stage 1	3
Stages 2 to 5 access	0.85
Operational area within dry extraction stage plus laydown area (0.7ha).	4
Total	7.85

Using an demand of 5ML/ha/y based on existing records, suggests a potential maximum demand for dust suppression of **39.25ML/y**. This area would reduce at the end of 2028 when the wind blown access is no longer in use, reducing the potential area by about 2ha to 5.85ha, and associated water use for dust suppression to **29.25ML/y**.

5.3. Sand extraction and processing water balance

5.3.1. Background and assumptions

The Project restricts sand extraction to 3.7m AHD to prevent interaction with the groundwater table. Recent records, which include the recent La Nina period of high rainfall show maximum groundwater levels of approximately 3.0m at this site (Figure 4.3). As such, water use associated with extraction is limited to:

- Moisture content associated with dry screened material leaving the site
- Process water within the wash and separation plant for washed sand at the site.

For dry extracted material, moisture content is estimated to be 3% for material excavated from above the water table, based on laboratory testing carried out by Coffey Partners and provided by Boral.

For processed sand passing through the wash and separation plant, sand leaves the wash plant with a moisture content of approximately 12% based on processing flows as provided by Boral and the process machinery company. This water needs to be added to the plant to continue the process. Washed sand will be stockpiled on the site and some of the accumulated moisture will infiltrate into the sand profile and some will evaporate. For the purpose of this assessment, it is assumed that all 12% leaves the site and must be replaced.

Although Boral has indicated that the average annual extraction over the Project will be approximately 413,000 T/y over 7.5 years, for the purpose of this assessment we have assumed the maximum dispatch of 750,000T/y from the site for the purpose of the water balance. Further, to present maximum use, it is assumed that all extracted sand will be screened, washed and separated, not just directly exported as a dry product.

Therefore, maximum water use associated with processing would be 12% of 750,000T/y equating to **90ML/y**. This could only occur until 2028, when the wind blown approval will lapse, and as per this Project description, extraction and dispatch would reduce to 500,000T/y, and an associated maximum water use in processing reduced to 12% of 500,000T/y, which is 60ML/y.

Sand will be transported from the site after the stockpiles reach a moisture content of 3 to 5%, dependent on climactic conditions, with the water lost through evaporation or infiltration to groundwater. For the purpose of this water balance infiltrated water has been assumed to have left the system.

5.3.2. Results

Maximum water use from the SGS for the Project is the sum of dust suppression water use (39.25ML) and sand processing water use (90ML), a total of **129.25ML/y**. This is a worst-case water use estimate as it includes a maximum area requiring dust suppression, and maximum extraction with all sand being washed, further, water leaving the washed stockpiles at the site has been assumed to leave the system, even though a portion will return to groundwater as infiltration. After the existing windblown Project approval lapses in 2028, maximum water use from the SGS would be no more than **89.25ML/y** when extraction is reduced to 500,000T/y and associated areas requiring dust are reduced.

5.3.3. Discussion

The water balance considers a worst case situation of maximum extraction (750,000T/y) and 100% of extracted sand passing through the wash plant along with a significant allowance for dust suppression over the both the wind blown road, as well as completed access from Stages 1 to 5 and operational areas of the extraction. All water is assumed to be extracted from the SGS.

Boral currently has allocations of 524 shares from the SGS. The estimated maximum demand is 129.25ML/y. Boral allocations well in excess of the demand required to undertake the Project. Further, there is still a large amount, approximately 11,000ML/y, of available, but un allocated water, after environmental demands are allowed for within the SGS.

When potential maximum demand, which is highly unlikely, is considered in the context of both Boral's water allocations, the Long Term Average Annual Extraction Limit (LTAAEL) and unallocated water of the SGS it is clear that the requirements in the *NSW Aquifer Interference Policy* relating to the demonstration of access to necessary water are met.

When the dredge operation commences the additional losses associated with evaporation will need to be accounted for. As has been clarified by DPI water, immediate returns from the dredge can be credited back to the water source. In summary, water use once the dredge operation commences will be a function of:

- Evaporation as a function of dredge pond surface area, nominally up to a maximum of about 380ML/y.
- Water used within the screen and wash plant, similar to this project; and
- Dust suppression, similar to this project.

6.0 IMPACT ASSESSMENT

6.1. Evaluation

In order to evaluate potential surface water impacts associated with the Project, the risk of impact has been assessed. In this case, risk is a combination of the likelihood of an impact and the consequences of that impact occurring based on the matrix outlined in Table 6.1. Where the risk is estimated to be medium or higher, mitigation and management measures are discussed. Surface water impact assessment is summarised in Table 6.2.

Table 6.1 Risk assessment matrix

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Catastrophic
Remote	Low	Low	Low	Medium	Medium
Unlikely	Low	Low	Medium	High	High
Possible	Low	Medium	High	Very High	Very High
Likely	Medium	High	Very High	Very High	Extreme
Almost certain/Inevitable	Medium	High	Very High	Extreme	Extreme

6.2. Surface water impacts

6.2.1. Construction

The site is predominantly sand with high infiltration rates, and additionally the quarry operations are self-contained with no surface discharge. Given the confined nature of the extraction area erosion of the sand landscape in the Project site during heavy rainfall is unlikely to be an issue. However, haul roads, and some areas of stabilisation may require virgin excavated natural material (VENM) or other road base material for construction that will contain clays and other soil types of smaller particle sizes that are more erodible than existing sand material on site. Although surface runoff is contained within the site, erosion and sediment controls for areas where VENM or other material have been brought into the site for foundations, haul roads and stabilisation are necessary to limit sediment movement onto the adjoining landscape, where exotic vegetation can establish.

6.2.2. Operation

Haul roads present a continuing source of sediment in periods of high rainfall. The nature of the site landscape means that any eroded material from the haul road surface is contained in close proximity to the road. There are no surface water connections from the site to watercourses off site.

The Project includes construction of a new processing area that includes a diesel generator as well as continuing use of the existing maintenance shed. There are potential impacts from the areas associated with refueling or chemical spills reaching surface or groundwater, particularly during rainfall events.

As discussed in Section 4.4, there is no direct connection from the site to surface floodwaters. However, inundation of the proposed extraction area has occurred previously due to increased groundwater levels associated with heavy rainfall, adjacent flooding and possibly ocean inundation. During what is known as the 'Pasha Bulker storm' of June 2007, the associated storm surge and rainfall caused inundation up to about 3.5m AHD over the current Project site where excavation depths had extended down to above 2.5m AHD. Although dependent on locality, this storm generally produced flood levels equivalent to a 100 year ARI event (Verdon-Kidd et al, 2010).

Permanent (existing and proposed) infrastructure on the site is located at 4.0m and above.

Processed and washed sand will be stockpiled on site for moisture content to reduce prior to transport off site. Sand will leave the processing system at approximately 12% moisture content. Some of this water will drain from the stockpiles to adjacent low areas where it will pool before mostly evaporating and percolating into the sand layers below.

6.3. Water balance and groundwater impacts

Groundwater impacts are covered in detail within the Groundwater assessment (Umwelt, 2023). Water demands for the operation may be up to 129ML/y from dust suppression and processing of sand in the wash plant. It is expected that some, or all of this water supply will come from the SGS. Boral currently have allocations of 524 shares, nominally 524ML/y from this aquifer, as such more than enough to accommodate the maximum demands expected from this Project.

Of the 14,000ML of water available in the aquifer as the Long Term Average Annual Extraction Limit (LTAAEL), approximately 11,919 shares remains unallocated, suggesting that the aquifer is not in a position of high stress.

The mapped boundary to the Stockton aquifer as specified in the Hunter Water (Special Areas) Regulation 2003, is approximately 150m to the north east at its closest point. Groundwater monitoring shows that groundwater flow direction is away from the aquifer spreading towards the site and to the north west ands south west. Movement of groundwater and any potential contaminants from the site to the Stockton aquifer is highly unlikely.

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Table 6.2 Surface water environmental impact assessment

Project component		Potential surface water impacts	Likelihood of impact	Consequence of impact	Risk rating pre mitigation/management	Comment
Site establishment	Changes to entry road and parking relocation	Localised change to surface runoff.	Possible	Negligible	Low	Negligible impact, local stormwater discharge to adjacent sand landscape.
	Construction of pad for wash plant and diesel generators	Localised change to surface runoff.	Possible	Negligible	Low	Negligible impact, local stormwater discharge to adjacent sand landscape.
Internal access roads	Modification of existing haul road for stage 1	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Possible	Negligible	Low	Haul road construction will require road base material from off site. Potential for erosion of this material, however if not controlled. confined to extraction area and immediately adjacent.
	Construction of haul road alongside extraction area.	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Possible	Negligible	Low	Haul road construction will require road base material from off site. Potential for erosion of this material, however if not controlled, confined to extraction area and immediately adjacent.
		Water use for dust suppression on the haul roads.	Unlikely	Negligible	Low	Water supply for dust suppression to be sourced from the SGS using Boral's allocations and licenced WSW.
Sand extraction	Progressive vegetation removal and extraction associated with Stages 1 to 5, and establishment of wash plant and diesel generators	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Possible	Negligible	Low	Small changes to hydrology in context of larger groundwater source. Site clearing to be limited, should erosion occur, confined to extraction area.
		Potential water quality impacts associated with fuel and oil spills associated with wash plant and generators.	Unlikely	Moderate	Medium	Potential for fuel spills during refueling, or through failure of fuel storage.

Project component		Potential surface water impacts	Likelihood of impact	Consequence of impact	Risk rating pre mitigation/management	Comment
		Water extraction associated with moisture content lost in material and water use associated with sand processing.	Unlikely	Negligible	Low	Water losses from the site associated with moisture content of material leaving the site and processing is considered an extraction from the groundwater resource. Boral has sufficient allocations from the aquifer to meet these demands.
		Increase in groundwater table due to ocean inundation, heavy rainfall and/or local flooding.	Possible	Minor	Medium	Increased groundwater levels associated with flooding may require pausing of extraction and movement of plant and equipment.
Sand processing	Wash plant will use to wash tank, thickener and floating of fines (<75µm) then through a filter press	Fines and associated wash water reaching existing surface water, or reaching groundwater.	Unlikely	Minor	Low	Fines collected within the sand separation process. Fines pass through thickener then dewatered in a filter press for re-use off site. Wash water is retained and recycled within the sand process.

7.0 MANAGEMENT AND MITIGATION OF SURFACE WATER RISKS

Table 7.1 Management and Mitigation measures

Project component		Potential surface water impacts	Management and Mitigation
Site establishment	Changes to entry road and parking relocation	Localised change to surface runoff.	Refer 7.2
	Construction of pad for wash plant and diesel generators	Localised change to surface runoff.	Refer 7.1, 7.3
Internal access roads	Modification of existing haul road for stage 1	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Refer 7.2
	Construction of haul road alongside extraction area	Localised change to surface runoff, erosion and sedimentation during construction of haul road.	Refer 7.2
		Water use for dust suppression on the haul roads.	Refer 7.2
Sand extraction	Progressive vegetation removal and extraction associated with Stage 1, and establishment of wash plant and diesel generators	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Refer 7.2
		Potential water quality impacts associated with fuel and oil spills associated with wash plant and generators.	Refer 7.1
		Water extraction associated with moisture content lost in material.	Refer 0
		Increase in groundwater table due to ocean inundation, heavy rainfall and/or local flooding.	Refer 7.3,
	Stage 2 to 5 progressive vegetation removal and surface material extraction.	Changes to surface hydrology associated with vegetation removal. Localised erosion depending on surface slope.	Refer 0, 7.4, **Error! Reference source not found.**
		Water extraction associated with moisture content lost in material either through dry extraction or wash plant.	Refer 0, 7.4, **Error! Reference source not found.**, 7.5
Sand processing	Transfer to wash plant and floating of fines (<75µm). Pass through thickener then through a filter press	Fines and associated wash water reaching existing surface water, or reaching groundwater.	Refer 7.4

7.1. Refueling, hydrocarbon and chemical spills

Standard hydrocarbon and chemical storage, handling and management techniques should be implemented for the proposed diesel generator and wash plant areas, along with the existing maintenance shed. The existing Environmental Management Strategy for the site should be updated to accommodate these changes to operations on the site.

7.2. Sediment and erosion control

Constructed areas such as haul roads and hardstand areas present the largest risk for erosion and sediment generation given the potential small particle sizes associated with the imported material necessary for these areas. Erosion prevention and sediment controls should be implemented through the design of the haul roads and hardstand areas to limit concentrated flow paths and through the use of erosion and sediment controls during construction and operation. Refer to the following guidelines when preparing haul road designs and undertaking construction at the site:

- Managing Stormwater: Soils and Construction, Volume 2E – Mines and Quarries (DECC, 2008) provides guidelines to specifically address requirements for erosion and sediment control on mines and quarries based on the principles set out in Managing Stormwater: Soils and Construction, Volume 1 (Landcom 2004); and
- Managing Urban Stormwater: soils and construction, Volume 1 and Volume 2C: Unsealed roads and 2D: main road construction (DECC 2008) provide guidance on road design and design of erosion and sediment control measures for the construction of the proposed access and haul roads over the site.

7.3. Flooding and inundation

Modelled maximum groundwater levels and reported maximum groundwater levels for the Project site are 3.5m AHD associated with the 'Pasha Bulker storm' of June 2007, generally accepted a 100 year ARI event. . All fixed infrastructure such as the weighbridge, offices, diesel generators and wash plant are located well above these levels.

During surface extraction processes, machinery and portable screens can be moved prior to increased groundwater levels. To predict these periods, rainfall and ocean level conditions should be monitored through the BoM, including storm warnings for heavy rain and high seas. In conjunction, groundwater levels should be monitored and rates of movement noted. Based on this information the Quarry Manager should decide on precautionary measures to remove machinery from areas where groundwater flooding may occur. Mobile plant will be stored in the maintenance depot when not in use.

Management of this risk should include a groundwater inundation management plan that includes monitoring of existing bores, flood and storm warnings as well as specific triggers for the movement of machinery and equipment and temporary storage locations.

Extractions, and water access licencing

The water extraction from the SGS necessary for the sand extraction as part of the Project necessitate an aquifer interference approval under section 91 of the WM Act. Boral currently has sufficient water allocations to account for extractions from the SGS for processing of sand on site, dust suppression and moisture content of material leaving the site. This is demonstrated through the water balance calculations outlined in section 5.3.

7.4. Fines management

Limited fines are expected within the extracted material due to the nature of the sand deposit. Fines that are extracted from the processed sand are expected to pass through a filter press where they can be dewatered and retained as a product to be used off site.

Water is recycled and retained within the wash plant process.

7.5. Water quality and quantity monitoring

Water monitoring within should follow the recommendations outlined in the Groundwater assessment (Umwelt, 2023). This includes both water level and water quality analysis at and around the site, with hourly water level logging and quarterly water quality testing.

In addition to groundwater level and quality monitoring, monitoring of water extraction and water use on site shall also be undertaken. To gather an accurate understanding of extractions from the groundwater source, monitoring of extractions for use on site, along with measurement of moisture content of sand material, and sand material export are required. The following monitoring is recommended:

- Metering of all extraction bores on site
- Metering of water inputs to the sand processing wash plant
- Fortnightly measurements of moisture content in exported material through stockpile measurements; and
- Records of material leaving site

8.0 SUMMARY AND RECOMMENDATIONS

8.1. Water supply and licensing

Water demands and supplies for the Project include:

- Water for office toilets showers and drinking, supplied from a rainwater tank and bottled water;
- Water for dust suppression on haul roads; and
- Water added to replace moisture lost with material in the wash plant process
- Water leaving with material as moisture content with dry extracted material

A maximum extraction scenario of 750,000T/y, plus 7.85ha of dust suppression per year have been assumed, with water extraction to support these operations from the SGS. This requires 129.25ML/y. Boral have allocations of 524 shares (ML) from the aquifer, as such have more than the maximum necessary to undertake this Project. Further, the available, but un-allocated, water within the aquifer of approximately 11,000ML. It is clear that the requirements in the *NSW Aquifer Interference Policy* relating to the demonstration of access to necessary water are met.

8.2. Management and mitigation

Beyond ensuring that correct licensing and sufficient water allocations are available for the Project, a number of other management and mitigation measures are recommended to provide protection of groundwater and surface water, including:

- Updating existing Environmental Management Strategy to provide protection of surface waters for the new diesel generators, screens and wash plant;
- Preparing a groundwater inundation management plan to deal with raised groundwater levels during periods of high ocean level and high rainfall. This should include:
    - Monitoring systems (BOM, bore groundwater levels); and
    - Triggers for the movement of machinery and equipment and temporary storage locations;
- Undertaking continued water quality monitoring of using monitoring bores as outlined in Section 7.6.1;
- Undertaking monitoring and measurements to enable estimation of water extractions including:
    - Metering of any extraction bores used on the site;
    - Fortnightly measurements of moisture content in exported material through stockpile measurements; and
    - Recording quantities of material leaving site.

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Appendix O

Economic assessment

Stockton Quarry Dry Sand Extraction Project

Economic Assessment

Prepared for

Boral Resources (NSW) Pty Ltd

By

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August 2023

Disclaimer

All surveys, forecasts, projections, findings, and recommendations made in this report are made in good faith on the basis of information available at the time; and achievement of objectives, projections or forecasts set out in this report will depend among other things on the actions of the NSW Government and their agents, over which we have no control. Notwithstanding anything contained therein, neither Gillespie Economics nor its servants or agents will, except as the law may require, be liable for any loss or other consequences arising out of the project.

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EXECUTIVE SUMMARY

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping, and construction markets.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to the Department of Planning and Environment (DPE) in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

This Economic Assessment relates to the preparation of each of the following types of analyses:

- a Cost Benefit Analysis (CBA) of the project; and
- a Local Effects Analysis (LEA), including using input-output (IO) analysis, for the Local Area regional economy of the combined Port Stephens, Maitland, and Newcastle Local Government Areas (LGAs).

CBA

A CBA of the project indicated that it would have net social benefits to Australia of $19M, and net social benefits to NSW of $9M. Hence the project is desirable and justified from an economic efficiency perspective. Environmental, social, and cultural impacts of the project have been minimised through project design and mitigation, offset and compensation measures. In particular, Boral already owns sufficient Water Access Licences, will purchase required biodiversity offsets and will establish required bushfire hazard reduction measures. The costs of these actions are included in the estimate of the net social benefits of the project. The economic value of residual impacts is considered to be immaterial from an aggregated economic efficiency perspective.

While the main environmental, social, and cultural impacts have been quantified and included in the project CBA, any other residual environmental, cultural, or social impacts that remain unquantified would need to be valued at greater than $19M for the project to be questionable from an Australian economic efficiency perspective, and greater than $9M for the project to be questionable from NSW economic efficiency perspective.

LEA

At maximum production, the project will provide continued quarry employment for approximately five (four full time and one casual) employees currently on-site and additional employment for another three (two full time and one casual) i.e. eight quarry jobs in total all residing in the Local Area.

At maximum production, the project is also estimated to provide continued transport employment for 13 people from the Local Area (and seven from outside the Local Area), plus employment for an additional six people from the Local Area (and four from outside the Local Area) i.e. 30 transport jobs in total with 19 sourced from the Local Area.

Quarry production at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- 26M in annual direct and indirect regional output or business turnover;
- $17M in annual direct and indirect regional value added;
- $2M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

This is a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

Transportation of quarry product at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $48M in annual direct and indirect regional output or business turnover;
- $18M in annual direct and indirect regional value added;
- $7M in annual direct and indirect household income; and
- 127 direct and indirect jobs.

This is also a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

1 INTRODUCTION

1.1 Project overview

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping, and construction markets.

The quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

This Economic Assessment has been prepared to inform the preparation of an environmental impact statement (EIS) for the project and address relevant regulatory requirements.

1.2 Legislative Context and Guidelines[1]

This Economic Assessment has been carried out in accordance with:

- the Secretary's Environmental Assessment Requirements (SEARs), issued by the NSW DPE on 31 March 2023, that require:
  - a detailed assessment of the likely economic impacts of the development, paying particular attention to:
    - the significance of the resource;
    - the costs and benefits of the project; identifying whether the development as a whole would result in net benefits to NSW, including consideration of fluctuation in commodity markets and exchange rates; and
    - the demand on local infrastructure and services.
  - the reasons why the development should be approved having regard to…..the biophysical, **economic** and social **impacts** of the project, including the principles of ecologically sustainable development.

- Section 4.15 (1) of the EP&A Act which requires the following two matters to be taken into consideration by the consent authority in determining a development application:
  - the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and ***economic impacts in the locality***; and
  - the public interest (taken as the collective public interest of households in NSW).

- Clause 192(1)(f) of the *Environmental Planning and Assessment Regulation 2023* which requires that an environmental impact statement contains *"the reasons justifying the carrying out of the development, activity or infrastructure, considering biophysical, economic and social factors, including the principles of ecologically sustainable development set out in section 193."* Note to Clause 192 (1) (f) states that "*A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure.*"

- the following standard*s,* guidelines, and policies: [2]
  - NSW Government (2015) *Guideline for the economic assessment of mining and coal seam gas proposals*;
  - NSW Government (2018) *Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*;

To meet the above requirements two types of analysis are needed:

- a cost benefit analysis (CBA) which is the primary way that economists evaluate the net benefits of projects and policies, provide economic justification for a project and addresses the public interest;

- a local effects analysis (LEA) to assess the impacts of the project in the locality, specifically:
  - effects relating to local employment;

[1] Refer to Attachment 1 for the legislative context for economic methods in Environmental Impact Assessment (EIA) in NSW.

[2] While specifically relevant to mining, rather than extractive industry, the guidelines provide relevant information on how to address the public interest and economic impacts in the locality.

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- effects relating to non-labour project expenditure; and
- environmental and social impacts on the local community.[3]

Economic analysis tools of CBA and LEA are not mechanised decision-making tools, but rather a means of analysis that provides useful information for decision-makers to consider alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

1.3 Report Outline

Section 2 outlines the scope of the project, as assessed in the EIS[4]. This is the information on which the Economic Assessment is based. Section 3 provides an overview of the CBA and LEA approach used in this study. Section 4 and 5 document the CBA and LEA of the project, respectively. Section 6 provides a supplementary LEA using input-output (IO) analysis. Conclusions are provided in Section 7.

Table 1.1 lists the matters identified in the SEARs and where they are addressed in this report.

Table 1.1 Relevant matters raised in SEARs

Requirement	Section addressed
The significance of the resource	2.1
The costs and benefits of the project; identifying whether the development as a whole would result in net benefits to NSW, including consideration of fluctuations in the commodity markets and exchange rates	4
The demand on local infrastructure and services	5
the reasons why the development should be approved having regard to biophysical, economic and social impacts of the project, including the principles of ecologically sustainable development	4

[3] Refer to Attachment 2 for an introduction to economic methods.

[4] The reader should refer to the EIS for more detailed qualitative consideration of the scope of the project, project impacts and mitigation measures.

2 PROJECT DESCRIPTION

2.1 Economic Context and Significance of the Resource

Demand for sand is a derived demand. That is, demand for sand is dependent on there being a demand for some other product, such as concrete, cement, asphalt and construction materials, which in turn is dependent on demand for construction. With the significant increase in approved infrastructure projects in Sydney and other parts of NSW, the leading suppliers of sand are under pressure to meet this increased demand.

Supply of sand is constrained by geology and geomorphology as well as distance to the location of construction. Sand is a high bulk-low cost commodity and hence it is preferable for it to be located close to markets to minimise transport costs. A shortage in the supply of construction sand for the Sydney market has been predicted for many years as access to local onshore sources of construction sand has become increasingly difficult through resource depletion e.g. Penrith Lakes, and increasing land use constraints surrounding potential alternative sources. In the short term, demand for construction sand can be met by increasing production from existing sources (NSW Department of Trade and Investment, 2016), including Stockton Quarry.

As Stockton quarry is one of Boral's few remaining natural sand quarries in NSW, Boral propose to meet part of this increased demand in natural sand by extracting sand from within generally the same area as the inland extraction quarry pit approved under the 1996 development consent. Pending consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area, as an interim solution to enable Boral to continue its operations, Boral is seeking to extract only the remaining dry sand resource from within the same extraction area.

2.2 Description

The project site is in the central portion of the quarry and covers an area of approximately 38 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to 3.7 m AHD, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

Sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project mirror the first five stages of the dredge application. This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure, and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

The existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

2.3 Mitigation Measures

Boral aims to maximise the benefits of the project to the region while minimising adverse impacts, as far as possible.

In this respect, a range of general and specific economic impact mitigation and management measures are proposed and would include:

Potential Environmental, Cultural and Social Impacts

- A range of measures to mitigate, offset and compensate for potential environmental, social, and cultural impacts of the project. A full outline of these is provided in the EIS.

Potential Workforce Impacts

- Provision of ongoing employment for the existing workforce which would be made redundant if the project is not approved;
- Employment of regional residents preferentially where they have the required skills and experience and demonstrate a cultural fit with the organisation; and
- Participating, as appropriate, in business group meetings, events or programs in the regional community.

Potential Business Impacts

- Purchasing local non-labour inputs to production preferentially where local producers can be cost and quality competitive, to support local industries.

3 ECONOMIC ASSESSMENT METHODS

3.1 Introduction

The economic methods used to assess the project and its impacts are outlined below.

3.2 Cost Benefit Analysis

3.2.1 Background

Economic assessment is primarily concerned with identifying changes in aggregate wealth, from a national perspective, associated with alternative resource use patterns. CBA is the standard technique applied to estimate these wealth changes.

CBA has its theoretical underpinnings in neoclassical welfare economics. CBA applications in NSW are guided by these theoretical foundations as well as the NSW Treasury (2023). CBA applications within the NSW EIA framework are further guided by the NSW Government (2015) *Guidelines for the economic assessment of mining and coal seam gas proposals* and NSW Government (2018) *Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals*. While specifically relevant to mining, rather than extractive industry, the guidelines and technical notes provide relevant information on how to address the public interest and economic impacts in the locality, that are relevant to all projects.

CBA is concerned with a single objective of the EP&A Act and governments, i.e. economic efficiency.
It provides a comparison of the present value of aggregate benefits to society, because of a project, policy or program, with the present value of the aggregate costs. These benefits and costs are defined and valued based on the microeconomic underpinnings of CBA. In particular, it is the values held by individuals in the society that are relevant, including both financial and non-financial values. Provided the present value of aggregate benefits to society exceed the present value of aggregate costs (i.e. a net present value of greater than zero), the project is considered to improve the well-being of society and hence is desirable from an economic efficiency perspective.

3.2.2 Definition of society

CBA includes the consideration of costs and benefits to all members of society i.e. consumers, producers and the broader society as represented by the government.

The most inclusive definition of society includes all people, no matter where they live or to which government they owe allegiance to (Boardman et al. 2001). However, in practice most analysts define society at the national level based on the notion that the citizens of a country share a common constitution that sets out fundamental values and rules for making collective choices and that the citizens of other countries have their own constitutions that make them distinct societies (Boardman et al. 2001).

While most applications of CBA are performed at the national level, "*to incorporate national distinctions in a CBA is far easier said than done. Thus, many CBAs end up estimating the net benefits for global society, if only implicitly*" (Bureau of Transport Economics 1999, p. 2).

With respect to the application of CBA in relation to mining and coal seam gas proposals, NSW Government (2015) guidelines define the public interest, and hence society, as the households of NSW. This definition of society is relevant to all projects undertaken under the EPA Act.

CBA undertaken at a sub-national perspective requires attribution of primary costs and benefits to different geographic scales and results in several costs and benefits that accrue to people outside the region of analysis being excluded (Boardman *et al.* 2001). It may also result in additional costs and benefits, such as secondary net benefits, that are normally omitted from CBA, being included.

For this study, the CBA is initially undertaken from a global perspective i.e. including all the costs and benefits of a project, no matter who they accrue to, and then truncated to assess whether there are net benefits to Australia and NSW.

3.2.3 Definition of the project scope

The definition of the project for which approval is being sought has important implications for the identification of the costs and benefits of a project. Even when a CBA is undertaken from a global perspective and includes costs and benefits of a project that accrue outside the national border, only the costs and benefits associated with the defined project are relevant. For extractive industry projects, typically only the costs and benefits from resource extraction and delivery to domestic customers, are relevant.

Sand quarry products are intermediate goods i.e. are inputs to other production processes such as production of concrete. However, these other production processes themselves require approval and, in CBA, would be assessed as separate projects (NSW Treasury, 2007). The project definition, including mitigation measures, are summarised in Section 2.

3.2.4 Net production benefits

CBA of quarry proposals invariably involves a trade-off between the:

- net production benefits of a project; and
- environmental, social, and cultural impacts (most of which are costs of quarrying but some of which may be benefits) including economic benefits to existing landholders, economic benefits to workers, net public infrastructure costs and economic benefits to suppliers (NSW Government, 2015).

Net production benefits can be estimated based on market data on the projected financial[5] value of the resource less the capital and operating costs of projects, including opportunity costs of capital and land already in the ownership of proponents. This is normally commercial-in-confidence data provided by the proponent. Production costs and benefits over time are discounted to a present value.

3.2.5 Environmental, social, and cultural impacts

The consideration of non-market impacts in CBA relies on the assessment of other experts contributing information on the biophysical impacts. The EIS process results in detailed (non-monetary) consideration of the environmental, social, and cultural impacts of a project and the proposed means of mitigating the impacts. Only where some physical impacts are identified by other experts can economists attempt to consider the economic consequences of these impacts.

At its simplest level, CBA may summarise the consequences of the environmental, social, and cultural impacts of a project (based on the assessments in the EIS), for people's well-being. These qualitatively

[5] In limited cases the financial value may not reflect the economic value and therefore it is necessary to determine a shadow price for the resource.

described impacts can then be considered alongside the quantified net production benefits, providing important information to the decision-maker about the economic efficiency trade-offs involved with a project.

At the next level of analysis, attempts may be made to value some of the environmental, social, and cultural impacts. These environmental, social, and cultural impacts generally fall into three categories, those which:

- can be readily identified, measured in physical terms and valued in monetary terms;
- can be identified and measured in physical terms but cannot easily be valued in money terms; and
- are known to exist but cannot be precisely identified, measured, or valued (NSW Treasury, 2007).

Impacts in the first and second category can potentially be valued in monetary terms using benefit transfer or, subject to available resources, primary non-market valuation methods. Benefit transfer involves using information on the physical magnitude of impacts and applying per unit value estimates obtained from non-market valuation studies undertaken in other contexts.

Primary non-market valuation methods include choice modelling and the contingent valuation method where a sample of the community is surveyed to ascertain their willingness to pay to avoid a unit change in the level of a biophysical attribute. Other methods include the property valuation approach where changes in environmental quality may result in changes in property value.

In addition to biophysical externalities, payments to landholders or workers over and above their opportunity cost can represent an economic benefit to landholders and workers, respectively. Where this occurs, it can be estimated using market data on payments to be made and opportunity costs.

Where a project imposes a cost on public infrastructure in excess of payments made for that infrastructure there is an additional social cost for inclusion in CBA. These costs can potentially be estimated based on analysis of infrastructure costs and payments.

In attempting to value the impacts of a project on the well-being of people, there is also the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (NSW Government, 2012). NSW Government (2012) suggests that values that are less than 5% of the quantified net present value of a project are unlikely to be material. Where benefits and costs cannot be quantified these items should be included in the analysis in a qualitative manner (NSW Treasury, 2007; NSW Government, 2015).

3.2.6 Consideration of net social benefits

The consideration of the net social benefits of a project combines the value estimate of net production benefits and the qualitative and quantitative estimates of the environmental, social, and cultural impacts.

In combining these considerations, it should be noted that the estimates of net production benefits of a project generally include accounting for costs aimed at mitigating, offsetting, or compensating for the main environmental, social and cultural impacts. This includes the costs of providing ecological offsets and the cost of purchasing groundwater and surface water entitlements in the water market. Including these costs in the capital and operating costs of a project effectively internalises the environmental, social, and cultural costs of a project. To avoid double counting of impacts, only residual impacts, after mitigation, offset and compensation, require additional consideration.

Even when no quantitative valuation is undertaken of the environmental, social, and cultural impacts of a project, the threshold value approach can be utilised to inform the decision-maker of the economic efficiency trade-offs. The estimated net production benefits of a project provide the threshold value that the non-quantified environmental, social, and cultural impacts of a project (based on the assessments in the EIS), after mitigation, offset and compensation by the proponent, would need to exceed for them to outweigh the net production benefits.

Where the main environmental, social and cultural impacts of a project are valued in monetary terms, stronger conclusions can be drawn about the economic efficiency of a project i.e. the well-being of society.

Any other residual environmental, cultural, or social costs that remain unquantified in the analysis[6] can also be considered using the threshold value approach. The costs of these unquantified environmental, cultural, and social impacts would need to be valued by society at greater than the quantified net social benefit of a project to make it questionable from an economic efficiency perspective.

3.2.7 Consideration of the distribution of costs and benefits

While CBA, undertaken at different scales, can provide qualitative and quantitative information on how costs and benefits are distributed, welfare economics and CBA are explicitly neutral on intra and intergenerational distribution of costs and benefits. There is no welfare criterion in economics for determining what constitutes a fair and equitable distribution of costs and benefits. Judgements about intra and intergenerational equity are subjective and are therefore left to decision-makers.

Nevertheless, it should be noted that the costs and benefits in CBA are defined and valued based on the values held by individuals in the current generation. There is no way to measure the value that future generations hold for impacts of current day projects as they are not here to express it. However, as identified by Boardman et al., (2001), this is not considered a serious problem for CBA because:

- few policies involve impacts that only appear in the far future. Consequently, the willingness to pay of people alive today can be used to predict how future generations will value them;
- most people alive today care about the well-being of their children, grandchildren, and great grandchildren, whether or not they have yet been born. They are therefore likely to include the interests of these generations to some extent in their own valuations of impacts. Because people cannot predict with certainty the place that their future offspring will hold in society, they are likely to take a very broad view of future impacts; and
- discounting used in CBA also reduces the influence of costs and benefits that occur a long way into the future.

Furthermore, increased wealth (e.g. royalties and taxes) generated by projects that have a net benefit to the current community can be used to improve the services (e.g. health, school and community services) and environment (e.g. protected areas) that are passed on to future generations.

As identified by the Productivity Commission (2006), a policy option that provides the highest net benefit, as indicated by CBA, would also be consistent with the principles of ecologically sustainable development.

[6] Including potential impacts that were unknown at the time of the preparation of the EIS or arise during the EIA process due to differences in technical opinions.

3.2.8 Consideration of other objectives of Government

CBA does not address other objectives of the EP&A Act and governments. Decision-makers therefore need to consider the economic efficiency implications of a project, as indicated by CBA, alongside the performance of a project in meeting other conflicting goals and objectives of the EP&A Act and government.

3.2.9 Key steps in Cost Benefit Analysis

The key steps in CBA are summarised in Box 1.

Box 1: Key steps in a CBA
Step 1: Establish the base case against which to assess the potential economic, social and environmental impacts of changes due to the project.
Step 2: Define the project including all significant inputs required to achieve the project's objectives.
Step 3: Quantify the changes from the base case resulting from the project. This will focus on the incremental changes to a range of factors (for example, environmental, economic, social) resulting from the project.
Step 4: Estimate the monetary value of these changes and aggregate these values in a consistent manner to assess the outcomes. Where market prices exist, they are a starting point for valuations of both outputs and of inputs used for production. For non-market goods, as for many environmental impacts and some social impacts, the aim is to value them as they would be valued in money terms by the individuals who experience them.
Step 5: Estimate the Net Present Value (NPV) of the project's future net benefits, using an appropriate discount rate.
Step 6: Undertake sensitivity analysis on the key range of variables, particularly given the uncertainties related to specific benefits and costs.
Step 7: Assess the distribution of costs and benefits across different groups.
Step 8: Report CBA results, including all major unquantified impacts so the appraisal addresses and incorporates all material relevant to the decision maker**.**

Source: NSW Government (2015)

Section 4 reports on the CBA of the project at different geographic scales based on the financial, technical, and environmental advice provided by Boral and its' specialist consultants.

3.3 Local Effects Analysis

3.3.1 Introduction

LEA aims to address the consequences of the proposal in its "locality" as required by Section 4.15 of the EP&A Act. It is intended to complement CBA by translating effects at the NSW level to impacts on the communities located near the project site. It also provides additional information to describe changes that are anticipated within a locality, such as employment changes. LEA is intended to inform the scale of change rather than being representative of costs and benefits to the local community.

NSW Government (2015) identifies that for the purpose of a LEA the locality is defined as the Statistical Area Level 3[7] (SA3) that contains the proposed project. The relevant population group is defined as those people ordinarily resident in the locality at the time of the proposal.

The local effects required to be analysed in a LEA are:

[7] In this case the Port Stephens, Maitland and Newcastle LGAs have been chosen to represent the locality.

- local employment and income effects;
- other local industry effects, for example on suppliers; and
- environmental and social change in the local community.

3.3.2 Direct effects relating to local employment

The *Guidelines for the economic assessment of mining and coal seam gas proposals* (NSW Government 2015) identify that only employment of people ordinarily resident in the region at the time of the proposal can be included in the initial estimation of direct local employment increases.[8]

The guidelines assume that these people would otherwise be employed in the region and so the increased disposable wages for the region because of a project is the difference between the average net income of these people in the project industry and the average net income in other industries.[9]

The incremental full-time equivalent direct employment from a project to the locality is estimated as the increase in net income divided by the average net income in the project sector.

The aim of this approach is to gauge the incremental impacts for existing residents of the locality. However, as a direct measure of regional employment and wages for existing residents it is likely to understate effects because it assumes that:

- existing local residents employed by a project are already employed in the region i.e. they are not unemployed or coming from new participants in the labour force; and
- jobs vacancies in the region created by those filling the positions in a project remain unfilled for the duration of the project i.e. it essentially assumes that the regional economy and the wider Australian economy is at full employment. Refer to Attachment 3 for a discussion of the job chain effect and a comparison to input-output (IO) analysis.

From a regional economy perspective (rather than focused on existing residents), it is also likely to understate effects since it does not consider the income spending of those who may migrate into the region to live during the life of a project.

3.3.3 Estimating effects related to non-labour project expenditure

In addition to the incremental direct regional employment and wages generated by a project, the other major economic effect will be expenditure in the region on other, non-labour, inputs. These can be estimated for construction and operation phases of a project. Identified local expenditure may not all accrue to the region, particularly for margin sectors such as wholesale and retail trade purchases where only the margin would accrue to the regional business entities unless products are also manufactured locally.

3.3.4 Second round/flow-on effects

The Guidelines (NSW Government 2015) identify that flow-on effects can also be extremely important for local communities and should therefore also be considered either qualitatively or using techniques

[8] Employment filled by those migrating into a region to live are excluded, as are jobs filled by those who reside outside the region.
[9] Wages paid to those migrating into a region to live are excluded as a wages benefit to the region.

such as IO analysis and for larger projects computable general equilibrium (CGE) modelling, provided the assumptions and limitations of the methods are identified.

3.3.5 Effects on other local industries

The LEA should also consider potential impacts such as:

- displacement of other land uses, where the project uses land that would otherwise be used for other purposes;
- where the project affects choices of external parties, particularly tourism and business travel; and
- where the project creates temporary effects on other industries that cause short run market adjustments in the cost of living for residents, particularly food and housing markets.

3.3.6 Environmental and social impacts on the local community (Externalities)

Finally, every LEA should assess positive and negative externalities created by the proposed project on the locality, with a focus on material, unmitigated effects. This information is available from the CBA.

3.3.7 Input-output analysis

Section 5 undertakes a LEA as identified above and consistent with the NSW Government Guidelines (2015). In addition, an IO analysis (refer to Attachment 4) of the project is undertaken to identify the gross regional economic activity that the project will provide to the region. As identified in Attachment 3, incorporation of consideration of the "job chain" effect means that the direct incremental employment and income to a region approximates the total income of those employed in the region who already reside in the region or migrate into the region to live i.e. the gross footprint of economic activity estimated using IO analysis is also an indicator of the net effect.

IO analysis essentially involves two steps:

- construction of an appropriate IO table (regional transaction table) that can be used to identify the economic structure of the region and multipliers for each sector of the economy; and
- identification of the initial impact or stimulus of the project (construction and/or operation) in a form that is compatible with the IO equations so that the IO multipliers and flow-on effects can then be estimated (West, 1993).

The IO method is based on several assumptions that are outlined in Attachment 5. Most notably IO analysis assumes that the regional economy has access to sufficient labour and capital resources (from both inside and outside the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the same region. Any "crowding" out is assumed to occur outside the region where the project is concentrated and the regional impact analysis is focused. A dynamic CGE approach may overcome the limitation of IO analysis but is unlikely to be warranted at local or regional scale or with small scale impacts.

The consequence of the assumptions of IO analysis, is that IO modelling results provide an upper bound economic activity impact estimate.

IO analysis identifies the economic activity of a project on the economy in terms of four main indicators:

- ***Gross regional output*** – the gross value of business turnover;

- ***Value-added*** – the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output. These costs exclude income costs;
- ***Income*** – the wages paid to employees including imputed wages for self-employed and business owners; and
- ***Employment*** – the number of people employed (including self-employed, full-time, and part-time).

These indicators of economic activity are not equivalent to the economic measures of consumer and producer surplus that are relevant in the CBA framework.

Gross regional output is a measure of total revenue or turnover. All costs of production would need to be subtracted from total revenue to make it approximate the measure of producer surplus. Value-added is an indicator of net value to producers, but unlike the producer surplus measure, it does not take account of all production costs – only non-labour costs are subtracted from revenue. Income or wages paid to employees is a cost to the producer in the CBA framework and is one of the costs subtracted from revenue or output to calculate the producer surplus or net benefit to producers. Employment is a non-financial indicator identifying the physical number of jobs associated with an activity.

Unlike CBA there are no decision rules to identify whether an increase or decrease in economic activity is desirable, although it is often implicitly assumed that more economic activity is good and less economic activity is bad. However, not all economic activity is desirable from a community welfare perspective since it may be associated with say environmental degradation, crime, etc.

As well as providing an indication of gross economic activity in a region, economic activity analysis can have important links to social impact assessment since changes in income and employment levels can impact population levels and their ability to maintain community infrastructure (schools, hospitals, housing etc), broader community and cultural value systems and inter-relationships.

4 COST BENEFIT ANALYSIS OF THE PROJECT

4.1 Introduction

This Section reports on a CBA of the project based on financial, technical, and environmental advice provided by Boral and its' specialist consultants.

4.2 Identification of the Base Case and the Project

Identification of the "base case" or "without" project scenario is required to facilitate the identification and estimation of the incremental economic benefits and costs of the project.

Under the base case, Boral would operate under the current approval over the windblown sand extraction area for a period to 2028, which permits extraction of up to 500,000 tpa. However, the current available resources under this consent are expected to run out in December 2023 and hence the base case is for no extraction of sand from the end of 2023 onwards. On expiry of this consent (2028) some final rehabilitation of the windblown extraction area will occur. However, this will occur regardless of the project, as the project is located in a different part of the site – the inland extraction area.

With the project, Boral proposes to extract approximately 3.1 million tonnes (Mt) of sand from above the water table and seeks a site wide extraction limit of 750,000 tpa, until either the existing windblown project consent lapses in 2028 or the dredge application is commenced, after which time the extraction limit would reduce to 500,000 tpa.

At a maximum extraction limit of 750,000 tpa until 2028 and then 500,000 tpa thereafter, the reserve would last for approximately seven and a half years. However, Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

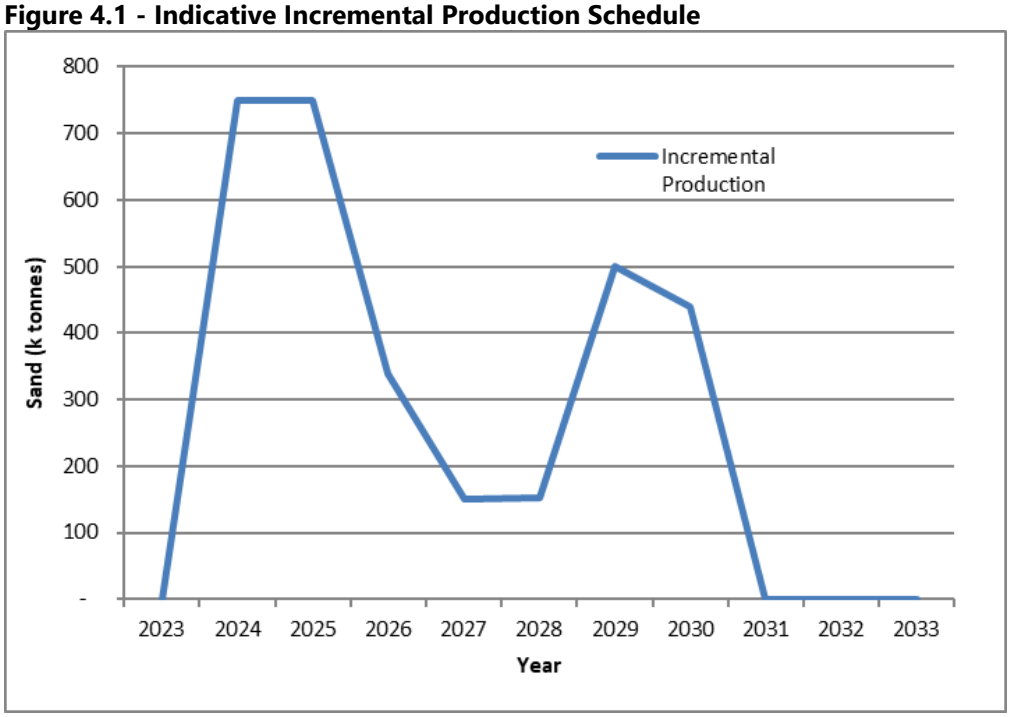
The indicative schedule for the five stages of the project is summarised in Table 4.1. The table is based on the extraction occurring at maximum capacity every year over each stage of the project.

Table 4.1 - Indicative Production Schedule

Stage	Reserve (tonne)	Duration (years)	Approximate dates
1	1,570,000	2.5	2024-2026
2	268,000	1	2026-2027
3	151,000	1	2027-2028
4	153,000	1	2028-2029
5	940,000	2.0	2029-2030
Total (Stages 1-5)	**3,100,000**	**7.5**	**2024-2030**

The incremental indicative production profile of the project is provided in Figure 4.1

Figure 4.1 - Indicative Incremental Production Schedule



4.3 Identification of Benefits and Costs

Relative to the base case or "without" project scenario, the project may have the potential incremental economic benefits and costs shown in Table 4.2. The main potential economic benefit is the producer surplus (net production benefits) generated from sand extraction, producer surplus generated from ex-quarry transportation to customers, and any wage benefits to employment. The main potential economic costs relate to any environmental, social, and cultural costs of quarrying and product transportation.

Table 4.2 – Potential Incremental Economic Benefits and Costs of the Project

Category	Costs	Benefits
Net production benefits from quarrying	Opportunity costs of capital equipment in 2024 Opportunity cost of land in 2024 Development costs including labour, capital equipment and any acquisition costs for impacted properties and biodiversity offsets Operating costs of quarry including labour and mitigation, offsetting, and compensation measures Rehabilitation and decommissioning costs at end of the project life	Value of additional sand supply Residual value of capital equipment and land at end of project life
Net production benefits from ex-quarry transport	Capital and operating costs	Revenues
Potential environmental, social, and cultural impacts of extraction, processing and	Greenhouse impacts Noise impacts Air quality impacts Surface water and groundwater impacts Ecological impacts	Wage benefits to employment

transportation, after mitigation, offsetting and compensation	Transport impacts Aboriginal heritage impacts Economic benefits to existing landholders Net public infrastructure costs Loss of surplus to other industries	

It should be noted that the potential environmental, social, and cultural costs listed in Table 4.2 are only economic costs to the extent that they affect individual and community well-being through direct use of resources by individuals or non-use. If the potential impacts do not occur or are mitigated, compensated or offset to the extent where community wellbeing is insignificantly affected (i.e. costs are borne by the proponent), then no environmental, social, or cultural economic costs should be included in the project CBA apart from the mitigation, compensation or offsetting costs.

4.4 Quantification/Valuation of Benefits and Costs

Consistent with NSW Government (2015), the analysis was undertaken in real values with discounting at 7 percent (%) and sensitivity testing at 4%, 7% and 10%.

The analysis period is eight years, coinciding with the period from the present until the end of the indicative production schedule for the project. Any impacts that occur after this period are included in the final year of the analysis as a terminal value.

Where competitive market prices are available, they have generally been used as an indicator of economic values. Environmental, cultural, and social impacts have initially been left unquantified and interpreted using the threshold value method.

An attempt has also been made to estimate environmental, cultural, and social impacts using market data and benefit transfer[10] and incorporate them into an estimate of the net social benefit of the project. However, even with the inclusion of these values, the estimated net social benefits of the project provide another threshold value that any residual or non-quantified economic costs would need to exceed to make the project questionable from an economic efficiency perspective.

4.4.1 Production costs and benefits of quarrying[11]

Production Costs

Opportunity Cost of Land and Capital

Most of the land required for the project is owned by Boral (38 ha) with a small area leased from the Crown for access to the quarry. Under the base case, this land proposed for the project would remain as vegetated coastal land zoned RU2 - Rural Landscape. There is an opportunity cost associated with using the land as a quarry. This opportunity cost is equivalent to its undeveloped land value, which according to the NSW Valuer General – NSW Land Values and Property Sales Map is in the order of $0.24M for 38 ha.

[10] Benefit transfer refers to borrowing economic values that have been determined for other study sites.

[11] All values reported in this section are undiscounted Australian dollars unless otherwise specified.

Similarly, there is potentially an opportunity cost in 2024 if capital equipment from the quarry in the windblown sand extraction area is used for the project.. However, for the purpose of the analysis, the residual value of the capital equipment from the windblown sand extraction area in 2024 is assumed to be zero.

Development Cost of the Project

The incremental development costs of the project are largely associated with site infrastructure. These costs are estimated at $$18M and assumed to occur in 2024 with sustaining capital costs of $0.9M per annum (Altus Group, 2023)

Additional costs included in the development costs of the project include:

- an allowance for staged purchase of biodiversity credits ($4.7M); and
- opportunity cost of groundwater water access licences (WALs) ($0.6M) included in 2024
- .

Annual Operating Costs of the Project

The annual incremental operating costs of the project (average annual incremental operating costs of $3.52M) include those associated with extraction, stockpiling, progressive rehabilitation and administration and environmental monitoring. These costs include labour costs, which reflect the value of labour resources in their next best use.

Depreciation has been omitted from the estimation of operating costs since depreciation is an accounting means of allocating the cost of a capital asset over the years of its estimated useful life. The economic capital costs are included in the development costs of the project in the years in which they occur.

Rehabilitation and Decommissioning Costs

At the end of the project life, the quarry site will be decommissioned and rehabilitated at an estimated cost of $100,000. Other annual rehabilitation costs are included in the annual operating costs of the project.

Production Benefits

Value of Sand

The main economic benefit of the pproject is the market value of additional sand production. Most of the sand produced is sold internally with the remainder sold in the market. All sales are at market prices. An average unit price has been applied to the output of the quarry based on advice from Boral. It has not been reported for reasons of commercial confidentiality.

There is uncertainty around future sand prices and hence assumed values have been subjected to sensitivity testing (see Section 4.6).

Residual Value at End of the Evaluation Period

At the end of the project, capital equipment and land (excluding offsets which are required to be protected in perpetuity) may have some residual value that could be realised by sale or alternative use.

It is assumed that rehabilitated land (not including the biodiversity offsets) has a residual value of $0.24M in accordance with its current land value, and that capital equipment has no residual value.

4.4.2 Production costs and benefits of product transport

The costs and benefits of quarrying considered in Section 4.4.1 include costs and revenues/benefits of activities up to the quarry gate. Since product transport externalities are a consideration of the EIS, economic benefits associated with transportation of quarry product to customers also needs to be considered. These net production benefits essentially relate to the net revenue that accrues to transport provider.

The annual net production benefits of product transport have been estimated based on assumed incremental sand production, an average annual per tonne transport cost ($30), and the percentage of total revenue that is net revenue (8.9%[12]).

4.4.3 Environmental, social, and cultural costs and benefits

The environmental, social, and cultural impacts of the project are assessed in the EIS. This Section considers these impacts from an economic perspective. Attachment 6 summarises the treatment of the environmental, social, and cultural impacts of the project in the CBA.

Greenhouse

The Air Quality Impact Assessment estimated total scope 1 and 2 emissions from the project at maximum production of 1,286 t CO2-e per year. To obtain an annual emissions profile this quantity of emissions was adjusted for the annual production levels in Figure 4.1

To place an economic value on CO2-e emissions, a shadow price of CO2-e is required. The NSW Treasury (2023) Guide recommends using prices from the European Union Emissions Trading Scheme (EU ETS). The Technical Note to the Guide (NSW Treasury 2023b) provides an Australian dollar value estimate for the year 2023 of $123/t CO2-e increasing in real terms by 2.5% per annum.

Under this shadow price the present value of greenhouse gas emission costs is $1M dollars, present value (at 7% discount rate). However, the EU ETS permit price is an "exchange price" that reflects the regulations and rules of the trading scheme. It is also a financial price rather than an economic value i.e. no real resources are exchanged for payment. This price is therefore far removed from the appropriate value for CBA, which is the value of emission impacts to households and businesses of NSW. Notwithstanding, in an efficiently designed scheme the permit price may be a proxy for the global damage cost of carbon (i.e. the cost of carbon emissions to the population of the whole world).

Consistent with the NSW Government (2015) Guidelines, and the NSW Government (2018) Technical Notes, the focus of CBA is on costs and benefits to the population of NSW. In the absence of any studies that have focused on the social damage cost of carbon emissions to NSW residents or the willingness to pay of NSW households to avoid these impacts, some means of apportioning global damage costs is required. For the Economic Assessment, this has been undertaken using Australia's share of the global population (around 0.32%) and NSWs share of the Australian population (32%). NSW DP&E has previously supported this approach (NSW DP&E, 2017).

[12] Based on the ratio of gross operating surplus to revenue for the road transport sector in the 2019-20 National Input-Output Table, adjusting for mixed income.

On this basis, the present value of the cost of greenhouse gas emissions from the project to Australia and NSW is estimated at $1,700 and $539 dollars (present value), respectively.

Noise

The impact of the project noise on nearby properties can potentially be valued using the property value method, where the change in property value because of the noise impacts are estimated, or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

The Noise Impact Assessment identified that:

- during project operation the predicted noise levels at sensitive receptors comply with the established project noise trigger levels (PNTLs) and in accordance with the Noise Policy for Industry and Voluntary Land Acquisition and Mitigation Policy, no further noise mitigation measures or controls are warranted.

- during project construction noise impacts are expected to comply with noise management levels (NMLs) in accordance with the Interim Construction Noise Guideline.

- operational and construction noise levels are sufficiently low such that cumulative levels remain below the construction NMLs and the operational noise PNTLs.

- the predicted relative increase in noise levels due to heavy vehicle movements are within the allowable limits outlined in the Road Noise Policy on all designate access routes.

Hence, noise impacts are immaterial from an aggregate economic efficiency perspective. No residual economic costs are included in the CBA.

Air Quality

The impact of the project dust emissions can potentially be valued using the property value method, where the change in property value as a result of the air quality impacts are estimated, the cost of illness method where changes in health episodes as a result of emissions are estimated and/or the defensive expenditure method and damage cost method where the costs of mitigation are estimated.

The Air Quality Impact Assessment undertook air dispersion modelling to predict the potential for offsite particulate matter and crystalline silica impacts in the surround area due to the construction and operation of the project. Using conservative assumptions that are likely to overstate impacts, the Assessment predicted that all the assessed air pollutants generated by the construction and operation of the project would comply with the relevant assessment criteria at the applicable receptor locations and therefore would not lead to any unacceptable level of environmental harm or impact in the surrounding area. Nevertheless, the site would apply appropriate dust and odour management measures to minimise air emissions from the site.

Consequently, impacts are immaterial from an aggregate economic efficiency perspective and no residual economic costs are included in the CBA apart from the costs of proposed general mitigation and monitoring measures.

Surface Water and Groundwater

Surface water and groundwater are potential inputs into numerous alternative production processes and so its use for extractive industry has an opportunity cost, i.e. its value in the next best alternative use. In

NSW the government has established a market framework to facilitate the allocation of surface water. Water access and use is only permissible with possession of a WAL (except in the case of harvestable rights, native title rights and some stock and domestic rights). Water Sharing Plans that are prepared under the *Water Management Act 2000* set the rules by which water is shared between all users, including the environment, in each water management area in NSW. These plans also set rules for water trading, that is, the buying and selling of water licences and also annual water allocations (Montoya 2010). Consequently, the market value for surface water can be considered to give a reasonable indication of its economic value in alternative uses such as agriculture, i.e. its opportunity cost.

The Surface Water Impact Assessment identifies that with respect to surface water the site is self-contained. The project will result in some localised changes to surface runoff, erosion and sedimentation during construction and operation requiring implementation of sedimentation and erosion control measures.

The Groundwater Assessment identifies that sand excavation will remain above the groundwater table by at least 0.7 metres and hence no lowering of the groundwater table will occur as a result of extraction.

The project will extract water from the Stockton Groundwater Source. At a maximum the project will require 129.25 ML/yr. Boral have allocations of 524 shares (ML) from the aquifer, and as such have more than the maximum necessary to undertake this project. The currently unassigned water volume for the Stockton Groundwater Source is over 12,500 ML/year. Therefore, the planned extraction volumes under the existing licenses held for the project are unlikely to affect the overall source volume. It is not anticipated that any water will be required post closure.

The opportunity cost of 129.25 ML/year extracted from Stockton Groundwater Source has been included in the CBA by applying an assumed market value of water of $5,000/ML.

Ecology

The main ecological impact of the project is associated with the clearing of an estimated 38.14 ha of native vegetation and habitat, which is predominately rehabilitation land from the former quarry pit. No threatened flora is likely to be impacted by the project. However, some threatened fauna recorded within the site during the field survey or likely to occur with the site may be impacted.

The impacted vegetation, and associated fauna, is likely to have non-use values to the community that would be lost because of the project. These values could potentially be estimated using non-market valuation methods. However, it is government policy that biodiversity offsets are provided that improve or at least maintain biodiversity values. The provision of offsets is also likely to have non-use values to the community that would be gained because of the project. Provided the values held by the community for the offsets are equal or greater than values that would be lost then no additional economic costs warrant inclusion in the CBA apart from the costs of providing offsets. Credit costs are estimated at up to $4.7M and included in the capital costs of the project in the year that credits would be required.

Road Transport

The Traffic and Transport Impact Assessment found that the surrounding road network will experience small increases to the average delay during morning and evening peak periods, however, will still provide spare capacity. All intersections will operate satisfactorily (with Level of Service A or B) under both the 'Existing' and 'Existing plus Development' scenarios. No discernible pattern is recognised amongst historic crashes, and therefore, no intersection treatment or remedial measures are proposed.

The Traffic and Transport Impact Assessment concluded that the subject application is supportable on traffic planning grounds. Consequently, there are no additional economic costs that warrant inclusion in the CBA.

Aboriginal Heritage

Impacts on Aboriginal cultural heritage can have use and non-use values to both Aboriginal and non-Aboriginal people that can be potentially estimated used nonmarket valuation methods such as choice modelling.

A review of background information undertaken for the Aboriginal Cultural Heritage Assessment Report revealed there were no known Aboriginal archaeological sites within the study area and proposed dry sand extraction area. While sites do occur within the wider Boral property, the study area is generally highly disturbed due to the previous extraction operations and removal of the bulk of the dune mass. Site inspection with the Aboriginal community during the SSD 9490 assessment confirmed the site condition and no Aboriginal objects, archaeological sites or areas of archaeological potential were identified. Subsurface archaeological deposits are considered unlikely to occur given the study area's geomorphological context and the nature and extent of prior extraction disturbance.

Updated consultation with registered Aboriginal stakeholders was undertaken for the current project, building on the existing process undertaken for the SSD 9490 assessment. No specific Aboriginal cultural values have been identified within the study area.

Hence, there are no material economic costs for inclusion in the CBA.

Bushfire Hazard Assessment

The Bushfire Hazard Assessment establishes that the project is capable of complying with the acceptable solutions of Planning for Bush Fire Protection (2019). However, Boral would need to install a 20,000 litre static water supply with firefighting fittings. This is included in the capital costs of the project.

Other Potential Impacts

The project is not considered likely to have any material historic heritage, visual or groundwater impacts for inclusion in the CBA.

Market Benefits to Workers

The project will result in all five existing jobs at the quarry being retained together with an additional two new full-time jobs and two casual jobs at the quarry. In addition, jobs associated with the transportation of quarry material will also be retained and additional transport jobs generated.

In standard CBA, the wages associated with employment are considered an economic cost of production with this cost included in the calculation of net production benefits (producer surplus). This approach

assumes labour markets clear, with no involuntary unemployment i.e. full employment, and no other distortions (Bartik, 2012). Conservatively, this approach is adopted in this analysis.

Economic Benefits to Existing Landholders

All land required for the project is owned by the proponent. No benefits to other landholders via land prices in excess of the opportunity cost of the land will occur.

Economic Benefits to Suppliers

The focus of CBA is generally on primary costs and benefits i.e. first round impacts. Secondary net benefits that accrue to firms that sell to or buy from a project are ignored. Conservatively, this convention is adopted and hence no secondary benefits to the economic are included.

Net Public Infrastructure Impacts

No net infrastructure costs to government are envisaged because of the project. Given that additional employment will likely be sourced from existing residents of NSW no additional demand for community infrastructure is envisaged.

Loss of Surplus to Other Industries

No loss of surplus to other industries is envisaged because of the project.

4.5 Consolidation of Value Estimates

The present value of costs and benefits, using a 7% discount rate, is provided in Table 4.3. The top half of the Table identifies production costs and benefits of the project associated with quarrying and product transportation. Quarrying production costs includes capital and operating costs associated with the mitigation, offset and compensation of environmental, social, and cultural impacts. The bottom of the Table summarises the residual environmental, social, and cultural impacts of the project after mitigation, offset and compensation.

The project is estimated to have total net production benefits (quarrying and product transportation) of $22M. Assuming 75% Australian ownership of Boral and 100% Australian ownership of transport providers, $19M of these net production benefits would accrue to Australia[13]. The estimated net production benefits that accrue to Australia can be used as a threshold value or reference value against which the relative value of the residual environmental impacts of the project, after mitigation, compensation and offset, may be assessed. This threshold value is the opportunity cost to society of not proceeding with the project. The threshold value indicates the price i.e. $19M, that the Australian community must value any residual environmental impacts of the project (be willing to pay) to justify in economic efficiency terms the no development option.

However, from Table 4.3 it can be seen that there are few external environmental, social or cultural impacts of the project, and those that do exist e.g. ecological impacts and surface water impacts, are internalised into the capital costs of the proponent via payment for ecological offsets and WALs, and hence are incorporated into the estimate of net production benefits. Residual impacts are immaterial. This includes GHG emissions which using a price reflective of the global social cost of carbon (SCC), rather than the SCC of carbon emissions to Australia, amounts to $1M present value.

[13] This is the net production benefits of the Project minus the residual producer surplus accruing overseas.

Consequently, the project is estimated to have net social benefits to Australia of approximately $19M present value and hence is desirable and justified from an economic efficiency perspective.

Table 4.3 - Global and National Cost Benefit Analysis Results of the Project (Present Values @7% discount rate)

	Costs		Benefits	
	Description	**Value ($M)**	**Description**	**Value ($M)**
Net production benefits from quarrying	Opportunity cost of land	$0	Value of sand	$58
	Opportunity cost of capital	$0	Residual value of land	$0
	Development costs	$23	Residual value of capital	$0
	Operating costs	$18		
	Decommissioning and rehabilitation costs	$0		
	Sub-total	***$42***	***Sub-total***	***$58***
	Net Production Benefits			**$16 ($13)**
Net production benefits from ex-quarry transport	Transport costs	$63	Transport revenue	$69
	Net Production Benefits			**$6 ($6)**
	Total Net Production Benefits			**$22M ($19M)**
Environmental, social and cultural impacts	Noise impacts	No properties impacted by exceedances	Market values of employment	NQ
	Air quality impacts	No properties impacted by exceedances	Economic benefits to existing landholders	NA
	Surface water and groundwater	Cost of WALs included in capital costs	Economic benefits to suppliers	NQ
	Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs		
	Road transport impacts	No material network, level of service or safety impacts.		
	Aboriginal heritage	No material impacts		
	Bushfire hazard	Additional cost of water storage and fire fighting equipment included in capital costs		
	Historic heritage	No material impacts		
	Visual	No material impacts		
	Greenhouse gas	$1 ($0.002)		
	Net public infrastructure costs	No material impacts		
	Loss of surplus to other industries	No material impacts		
	Residual non-market impacts sub-total	**$1 ($0.002)**		**$0**
NET SOCIAL BENEFITS				**$21 ($19)**

Note: totals may have minor discrepancies due to rounding. When impacts accrue globally, the numbers in brackets relates to the level of impact estimated to accrue to Australia

Residual net producer surplus to Boral Shareholders i.e. producer surplus less company tax, is apportioned by 75% in accordance with the estimated level of Australian shareholdings.

Road transport providers are assumed to be 100% Australian owned.

No material impacts does not mean that there will be no impacts but that aggregated immaterial impacts are not likely to amount in aggregate to more than 5% of the quantified net production benefits of the project.

4.6 NSW Costs and Benefits

The NSW Government (2015) guidelines have a particular focus on the costs and benefits to NSW. Table 4.4 identifies the costs and benefits to NSW. Impacts that have a national dimension are apportioned to NSW, in particular:

- 32% of the estimated company tax generated from the project (quarrying and product transport) is attributed to NSW (NSW Guidelines 2015);
- 32% of the residual net producer surplus from the quarry is apportioned to NSW i.e. Australian share ownership assumed to be distributed in line with the population;
- 100% of residual net producer surplus of transport provision is apportioned to NSW i.e. ownership is NSW based; and
- all other potential environmental, social, and cultural impacts would accrue to NSW households. However, in accordance with Government policy and regulation these impacts are largely mitigated, compensated, or offset by the proponent. The exception is the impacts of GHG emissions which accrue to the world. As identified above the price used for GHG emissions reflects a global SCC and hence these impacts have been apportioned to NSW based on share of population.

On this basis, the costs and the benefits of the project to NSW are summarised in Table 4.4. The estimated Net Social Benefits of the project to NSW are estimated at $9M, present value at 7% discount. Consequently, as well as resulting in net benefits to Australia, the project would also result in net benefits to NSW.

Any unquantified residual impacts of the project after mitigation, offset and compensation would need to be valued at greater than $9M, present value for the project to be questionable from an NSW economic efficiency perspective.

Table 4.4 - Cost Benefit Analysis Results of the Project - NSW (Present Values @7% discount rate)

COSTS	VALUE ($M)	BENEFITS	VALUE ($M)
Environmental, social and cultural impacts		***Net Production Benefits of Quarrying***	
Noise impacts	No properties impacted by exceedances	Direct company tax	$1
Air quality impacts	No properties impacted by exceedances	Residual net production benefits	$3
Surface water and groundwater	Cost of WALs included in capital costs	***Sub-total***	**$4**
Ecology	Some loss of values but offset. Cost of biodiversity offset included in capital costs	***Net Production Benefits of Product Transport***	
Road transport impacts	No material network, level of service or safety impacts.	Direct company tax	$1
Aboriginal heritage	No material impacts	Residual net production benefits	$4
Bushfire hazard	Additional cost of water storage and firefighting equipment included in capital costs	***Sub-total***	**$5**
Historic heritage	No material impacts	Market values of employment	NQ
Visual	No material impacts	Economic benefits to existing landholders	NA
Greenhouse gas	No material impacts ($0.0005)	Economic benefits to suppliers	NQ
Net public infrastructure costs	No material impacts		
Loss of surplus to other industries	No material impacts		
Sub-total	***$0***	***Sub-total***	***$9***
NET SOCIAL BENEFITS to NSW			**$9**

The approach used in this section is that where impacts do not exist, are offset, or compensated for, it is assumed that they are immaterial. Immaterial does not mean that there will be no impacts, but aggregate immaterial impacts are not likely to amount to more than 5% in aggregate of the quantified net production benefits of the project.

It should be noted that residual net production benefit is not equivalent to profit and hence should not be used to infer profitability of the project.

4.7 Distribution of NSW Costs and Benefits

As identified in Section 3, CBA is only concerned with the single objective of economic efficiency. CBA and welfare economics provide no guidance on what is a fair, equitable or preferable distribution of costs and benefits. Nevertheless, CBA can provide qualitative and quantitative information for the decision-maker on how economic efficiency costs and benefits are distributed.

The costs and benefits of the project to NSW are potentially distributed among a range of stakeholders as identified in Table 4.5.

Table 4.5 - Incidence of NSW Costs and Benefits

BENEFITS AND COSTS	INCIDENCE OF COSTS AND BENEFITS	MAGNITUDE OF IMPACT ($M)
Net Production Benefits of Quarrying		
Direct company tax	NSW Government and NSW households	$1
Residual net production benefits	Boral and its NSW shareholders	$3
Net Production Benefits of Product Transport		
Direct company tax	NSW Government and NSW households	$1
Residual net production benefits	Transport providers and their owners/shareholders	$4
Additional benefits		
Wage benefits to employment	Employees of the project who reside in NSW	NQ
Economic benefits to existing landholders	Local landholders who sell land required for project including buffer land	NA
Economic benefits to suppliers	Regional and State suppliers of inputs to production	NQ
Environmental, social and cultural costs*		
Noise impacts	Adjoining landholders	No properties impacted by exceedances
Air quality impacts	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	$0.6M Cost of WALs included in capital costs
Ecology	Local and NSW households	$4.7M Some loss of values but offset. Cost of costs
Road transport impacts	Local residents	No material network, level of service or safety impacts.
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts*
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*
Greenhouse gas	Local and NSW households	No material impacts*
Net public infrastructure costs	NSW Government and NSW households	No material impacts*
Loss of surplus to other industries	Local industries adversely impacted by the project	No material impacts*

* NSW regulations require many impacts to be borne by the proponent via mitigation, offset and compensation. Where these measures perfectly mitigate, offset or compensate then no residual impacts occur, and all impacts are borne by the proponent. This table identifies who bears residual impacts if they did occur because of the project and mitigation, offset and compensation was imperfect.

4.8 Risk and sensitivity analysis

The main areas of environmental risks associated with quarry projects relate to:

- the financial viability of a project from unexpected downturns in prices and any consequent environmental impacts from premature cessation of operations;
- ecological risk associated with whether the biodiversity offsets will adequately compensate for the direct ecological impacts; and
- other environmental, social and cultural impacts estimations and required mitigation measures.

The Independent Planning Commission has previously identified that the financial viability of projects is a risk assumed by the project proponents. Nevertheless, it should be noted that the project is the continuation of an existing financially viable operation. Boral is willing to invest in the project and has a fiduciary responsibility to its shareholders. It is highly unlikely Boral's investment would take place and then operations would cease, leaving residual environmental impacts at the site. Strong current and foreseeable demand for sand is also likely to underpin the financial viability of the project.

The provision of biodiversity offsets can be associated with a number of risks, including in relation to the biodiversity benefits of additional management of offsets, success in reconstruction of ecological communities, time-lags between impacts and provision of offsets as well as between management actions and achievement of ecological outcomes. These risks are mitigated through offset ratio requirements in the calculation of offsets requirements or fund payments, and commitment to the provision/payment for offset actions prior to the commencement of works that impact biodiversity.

There is some risk associated with the estimation of environmental, social, and cultural impacts of the project and the level of mitigation measures proposed. However, it should be noted that impacts have generally been assessed based on the maximum annual levels of production and hence are likely to be overstated. Ongoing monitoring will ensure that appropriate mitigation measures are implemented as required.

The net present values (NPVs)[14] of the project presented in Table 4.3 and Table 4.4 are based on a range of assumptions around which there is some level of uncertainty. Uncertainty in a CBA can be dealt with through changing the values of critical variables in the analysis (James and Gillespie, 2002) to determine the effect on the NPV[15].

In this sensitivity analysis, the CBA results for NSW were tested for changes to the following variables at a 4%, 7% and 10% discount rate:

- Opportunity costs of land;
- Quarry capital costs including offsets, WALs and firefighting requirements;
- Quarry operating costs;
- Quarry decommissioning costs;
- Value of sand;
- Quarry production levels;
- Residual value of quarry land; and
- Net transport revenue.

[14] NPV is the present value of benefits less the present value of costs. Present values are calculated using a discount rate that reflects peoples time preferences.

[15] Quantitative risk analysis could also potentially be undertaken. However, this requires information on the probability distributions for input variables in the analysis. This information is not available and so the sensitivity testing is limited to uncertainty analysis.

Results are reported in Table 4.6. What this analysis indicates, is that CBA results at the NSW level are not very sensitive to changes in assumptions. However, they are most sensitive to reductions in the value of sand and reductions in production volume.

The project is in an area that has previously been quarried and hence the geological environment and volume estimates are known. The strong demand for sand that underpins the project suggests that sustained reductions in sand value and annual production levels is highly unlikely.

The sensitivity analysis also indicated that the CBA results are not sensitive to changes in capital costs, operating costs, opportunity costs of land or environmental costs that have not already been internalised into production costs, such as WALs and offsets. Since mitigation, offset and compensation costs are small components of the capital and operating costs of the project, it is unlikely that large changes in these cost levels would have any significant impact on the CBA results.

Under all scenarios examined, the project has net social benefits to NSW.

Table 4.6 - NSW CBA Results Sensitivity Testing (Present Value $Millions)

	4% Discount Rate	7% Discount Rate	10% Discount Rate
CENTRAL ANALYSIS	**$10**	**$9**	**$8**
INCREASE 20%			
Opportunity cost of quarry land	$10	$9	$8
Quarry development costs	$9	$8	$7
Quarry operating costs	$9	$8	$7
Quarry decommissioning costs	$10	$9	$8
Value of sand	$14	$12	$11
Volume of quarry production	$14	$12	$11
Residual value of land	$10	$9	$8
Transport net revenue	$10	$10	$8
Global Greenhouse Impacts Attributed to Project	$10	$8	$7

	4% Discount Rate	7% Discount Rate	10% Discount Rate
DECREASE 20%			
Opportunity cost of quarry land	$10	$9	$8
Quarry development costs	$12	$10	$9
Quarry operating costs	$12	$10	$9
Quarry decommissioning costs	$10	$9	$8
Value of sand	$7	$6	$5
Volume of quarry production	$7	$6	$5
Residual value of land	$10	$9	$8
Transport net revenue	$10	$8	$8

5 LOCAL EFFECTS ANALYSIS

5.1 Introduction

The CBA in Section 4 is concerned with whether the incremental benefits of the project exceed the incremental costs and therefore whether the community would, in aggregate, be better off 'with' the project compared to 'without' it. This Section and Section 6 examines local effects using two different methods.

The Local Area is defined as the LGA of Port Stephens (within which the project is located) as well as the adjoining LGAs of Maitland and Newcastle. This is the local region that primarily benefits from and supplies inputs to the project.

5.2 Direct Effects Related to Employment

All current and prospective quarry employment is likely to be sourced from the Local Area while 64% of transport employment is estimated to be sourced from the Local Area.

In the absence of the project employment at the site would reduce to zero at the end of 2023 as the available resources is depleted. At maximum production, the project will provide continued quarry employment for approximately five (four full time and one casual) employees currently on-site and employment for another three (two full time and one casual) i.e. eight quarry jobs in total all residing in the Local Area.

At maximum production, the project is also estimated to provide continued transport employment for 13 people from the Local Area (and seven from outside the Local Area), plus employment for an additional six people from the Local Area (and four from outside the Local Area) i.e. 30 transport jobs in total with 19 sourced from the Local Area.[16]

Based on estimated wages for quarry workers and average wage from the input-output table for the road transport sector, the project is estimated to provide incremental net income to the local area of up to $1.6M. Incremental net income to the region would be lower in years of lower levels of production.

The above level of benefit to the Local Area economy, may be reduced if people employed by the project would otherwise have been employed elsewhere in the Local Area and the increased demand for labour as a result of the project has no job chain effects i.e. it is assumed that employment in the quarry and transport, simply substitutes for other jobs in the region.

Table 5.1 - Analysis of Income and Job Effects to the Local Area at 750,000tpa

	Project Employment
a) Direct employment during operations phase sourced from Local Area	
Quarry	8 (6 FT, 2 P/T)
Road Transport	19 (FT)
Total	***27***
b) Net income in quarrying and transport sector	
Quarry	$454,950
Road Transport	$1,170,496
Total	***$1,625,448***

[16] Transport employment estimates are based estimated truck movements to the Hunter and Sydney regions and the proportion estimated to be sourced from the Local Area (64%).

5.3 Direct Effects Related to Non-labour Expenditure

The total annual non-labour expenditure (after subtraction of wages to quarry and transport workers) is estimated at $15.5M per annum when production is at 750,000 tpa. This was estimated based on the ratio of local expenditure to total (non-labour) expenditure in the regional input-output table for the *non-metallic mineral mining sector* and the *road transport sector*. Refer to Section 6.

5.4 Second Round and Flow-on Effects

The incremental expenditure by employees and non-labour expenditure that is captured by the local area provides flow-on economic activity to the local economy, which can be estimated in terms of economic activity indicators of output, value-added, income and employment. Section 6 provides a full assessment of flow-on effects arising from both labour expenditure and non-labour expenditure.

5.5 Effects on Other Industries

5.5.1 Wage impacts

In the short-run, increased regional demand for labour as a result of the project (relative to the situation of no project) could potentially result in some increased pressure on wages in other sectors of the economy. The magnitude and duration of this upward wages pressure would depend on the additional level of demand for labour, the availability of labour resources in the region and the availability and mobility of labour from outside the region. However, the additional level of labour demand is low, there are substantial labour resources available in the Local Area and from outside the local area. Wage impacts are therefore not likely to be significant. Where upward pressure on regional wages occurs, it represents an economic transfer between employers and owners of skills and would attract skilled labour to the region leading to downward pressure on wages.

5.5.2 Housing impacts

The project is a continuation and extension of an existing quarry operation. All quarry employment is anticipated to be sourced from the Local Area with 64% of transport employment sourced from the Local Area. No substantial migration of labour is anticipated and hence there will be no additional demand for housing or community infrastructure.

5.5.3 Displacement of other land uses

The project will not displace any other land uses and will have no significant impact on tourism or recreation.

5.6 Environmental, Cultural and Social Impacts on the Local Community (Externalities)

The main externalities that potentially accrue from the project and the magnitude of these to the local area are summarised in Table 5.2.

Table 5.2 - Environmental and Social Impacts on the Local Community ($M)

Environmental, social and cultural costs	Incidence of Impacts	Magnitude of Local Impact
Noise impacts	Adjoining landholders	No properties impacted by exceedances
Air quality impacts	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	$0.6M Cost of WALs included in capital costs
Ecology	Local and NSW households	$4.7M Some loss of values but offset. Cost of costs
Road transport impacts	Local residents	No material network, level of service or safety impacts
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*
Greenhouse gas	Local and NSW households	No material impacts*
Net public infrastructure costs	NSW Government and NSW households	No material impacts*
Loss of surplus to other industries	Local industries adversely impacted by the project	No material impacts*

5.7 Summary of Local Effects

A summary of local effects of the project is provided in Table 5.3.

Table 5.3 - Summary of Local Effects

	Project Employment	
Direct employment during operations phase sourced from **Local Area**		
Quarry	8	
Road Transport	19 (30 in total)	
Total	***24***	
Net income to **Local Area** from quarrying and transport sector		
Quarry	$454,950	
Road Transport	$1,170,496	
Total	***$1,625,448***	
Second round and flow-on effects	Refer to Section 6	
Contraction in other sectors	No material impact	
Displaced activities	Not applicable	
Wage price impacts	No material impact	
Housing price impacts	No material impact	
Externality impacts	**Incidence of Impacts**	**Magnitude of Impact**
Noise impacts	Adjoining landholders	No properties impacted by exceedances
Air quality impacts	Adjoining landholders	No properties impacted by exceedances
Surface water and groundwater	Local surface water users	$0.6M Cost of WALs included in capital costs
Ecology	Local and NSW households	$4.7M Some loss of values but offset. Cost of costs
Road transport impacts	Local residents	No material network, level of service or safety impacts.
Aboriginal heritage	Aboriginal people and other local and NSW households who value Aboriginal heritage	No material impacts
Historic heritage impacts	Local and NSW households who value heritage	No material impacts*
Visual impacts	Adjoining landholders and those travelling past the site	No material impacts*
Greenhouse gas	Local and NSW households	No material impacts*
Net public infrastructure costs	NSW Government and NSW households	No material impacts*
Loss of surplus to other industries	Local industries adversely impacted by the project	No material impacts*

6 SUPPLEMENTARY LOCAL EFFECTS ANALYSIS

6.1 Introduction

This Section uses IO analysis to identify the gross economic activity footprint associated with the project on the Local Area economy.

6.2 Structure of the Local Area Economy

For the purpose of the analysis the Local Area is defined as the Port Stephens, Maitland and Newcastle LGA.

A 2019-20 IO table of the regional economy was developed using the Generation of Input-Output Tables (GRIT) procedure (Attachment 7) using a 2019-20 IO table of the National economy as the parent table and 2021Census employment by industry data for NSW and the region. The 114 sector IO table of the regional economy was aggregated to 50 sectors and 8 sectors for the purpose of describing the economy.

A highly aggregated 2019-20 IO table for the regional economy is provided in Table 6.1. The rows of this table indicate how the gross regional output of an industry is allocated as sales to other industries, to households, to exports and other final demands (OFD) (which includes stock changes, capital expenditure and government expenditure). The corresponding column shows the sources of inputs to produce that gross regional output. These include purchases of intermediate inputs from other industries, the use of labour (household income), the returns to capital or other value-added (OVA) (which includes gross operating surplus and net indirect taxes and subsidies) and goods and services imported from outside the region. The number of people employed in each industry is also indicated in the final row.

Output for the regional economy is estimated at $92,098M. Value-added for the regional economy is estimated at $25,367M, comprising $14,423M to households as wages and salaries (including payments to self-employed persons and employees) and $10,944M in OVA.

The employment total working in the regional economy was 172,893.

The economic structure of the regional economy can be compared with that for NSW through a comparison of results from the respective IO models (Figures 6.1 and 6.2). This reveals that the mining, manufacturing, utilities and public personal services sectors in the regional economy are of greater relative importance than they are to the NSW economy, while the business services sectors and agriculture, fishing and forestry sectors are of less relative importance than they are to the NSW economy.

Figures 6.3 to 6.5 provide a more expansive sectoral distribution of gross regional output, employment, household income, value-added, exports and imports, and can be used to provide some more detail in the description of the economic structure of the regional economy.

In terms of output, the metal manufacturing, public administration, investment and insurance, and coal mining are the most significant sectors to the regional economy. In terms of value-added the public administration, coal mining, education, health and community care services sectors are the most significant sectors. The public administration, education, health and community care services sectors are the most significant sector for income while the health, retail and education sectors are the most significant sectors for employment. The metal manufacturing sector is the most significant sector for both imports and exports, with the coal mining sector being the second most significant sector for exports.

Table 6.1 - Aggregated Transactions Table: Regional Economy 2019-20 ($M)

	Ag, forestry, fishing	Mining	Manuf.	Utilities	Building	Trade/ Accom	Bus. Srvcs	Public/ Pers. Srvcs	TOTAL	Household Expenditure	OFD	Exports	Total
Ag, forestry, fishing	11	1	110	0	2	24	3	5	155	37	20	132	344
Mining	0	143	432	22	28	3	12	8	649	5	59	2,800	3,512
Manuf.	14	133	498	31	619	142	162	194	1,794	461	258	5,517	8,029
Utilities	7	26	188	506	53	48	140	128	1,096	270	147	834	2,347
Building	9	82	32	79	1,571	50	394	348	2,566	19	2,978	999	6,561
Trade/Accom	12	93	197	33	205	145	250	318	1,253	2,373	214	(87)	3,752
Bus.Srvcs	32	391	653	279	707	686	3,265	1,217	7,231	4,411	846	2,958	15,447
Public/Pers Srvcs	3	82	68	30	84	39	359	344	1,008	1,954	6,536	1,504	11,002
TOTAL	**88**	**949**	**2,179**	**980**	**3,269**	**1,138**	**4,584**	**2,561**	**15,749**	**9,529**	**11,058**	**14,658**	**50,994**
Household Income	54	425	1,101	300	1,402	1,491	3,548	6,102	14,423	-	-	-	14,423
OVA	110	1,496	512	637	606	544	4,919	809	9,633	974	339	(2)	10,944
Imports	92	642	4,238	430	1,283	578	2,395	1,530	11,188	3,337	868	344	15,737
TOTAL	**344**	**3,512**	**8,029**	**2,347**	**6,561**	**3,752**	**15,447**	**11,002**	**50,994**	**13,840**	**12,264**	**15,000**	**92,098**
Employment (no.)	1,263	2,490	11,363	2,381	14,107	33,826	35,216	72,248	**172,893**				

Figure 6.1 - Summary of Aggregated Sectors: Regional Economy (2019-20)

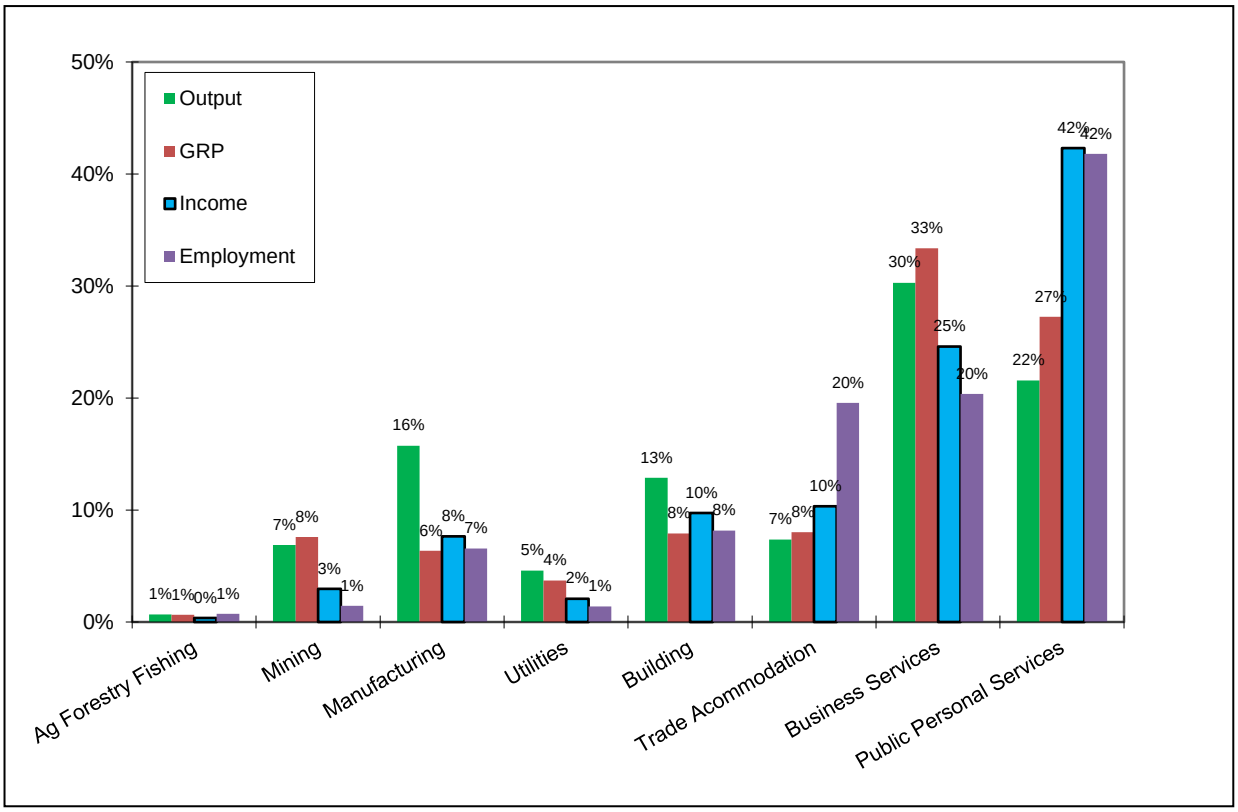


Figure 6.2 - Summary of Aggregated Sectors: NSW Economy (2019-20)

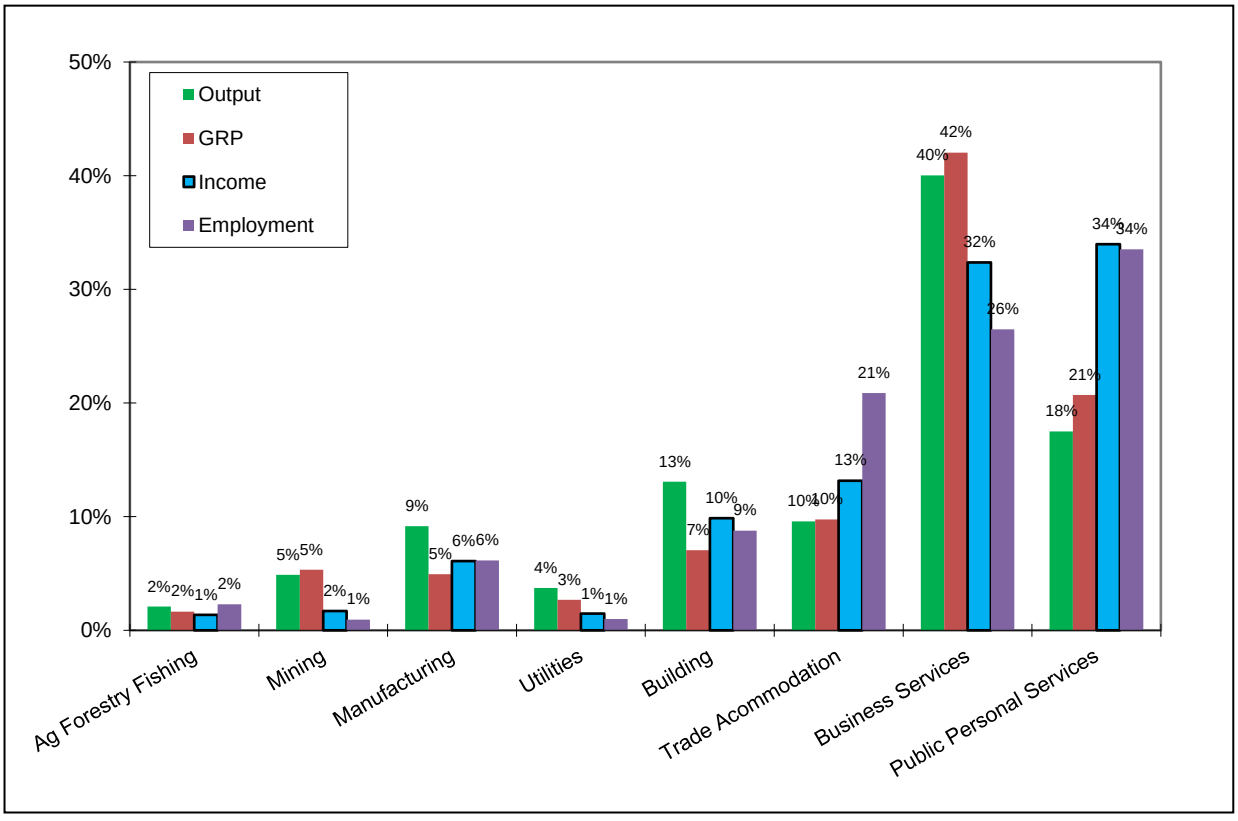


Figure 6.3 Sectoral Distribution of Gross Regional Output and Value Added ($M)

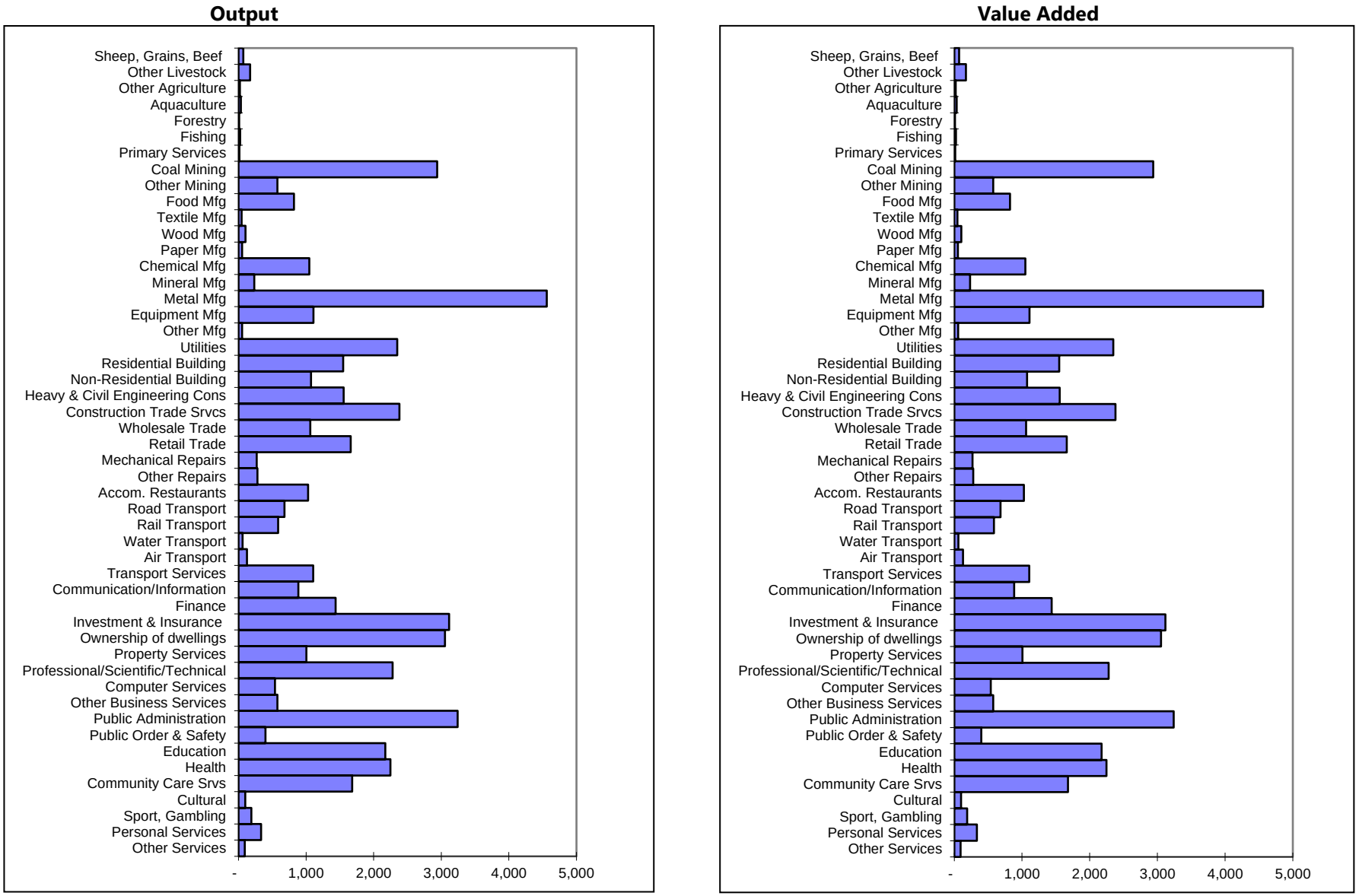


Figure 6.4 Sectoral Distribution of Income ($M) and Employment (No.)

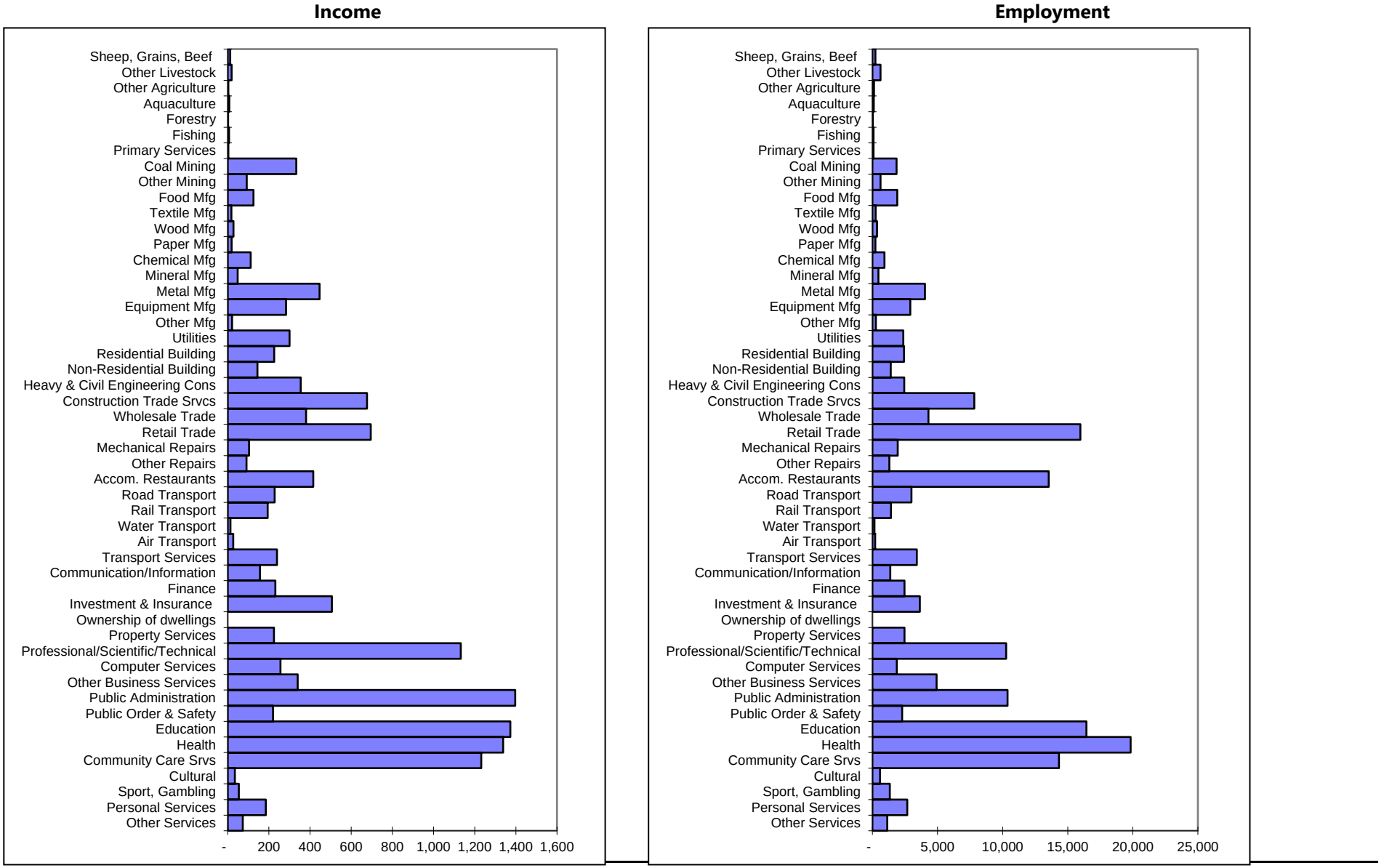
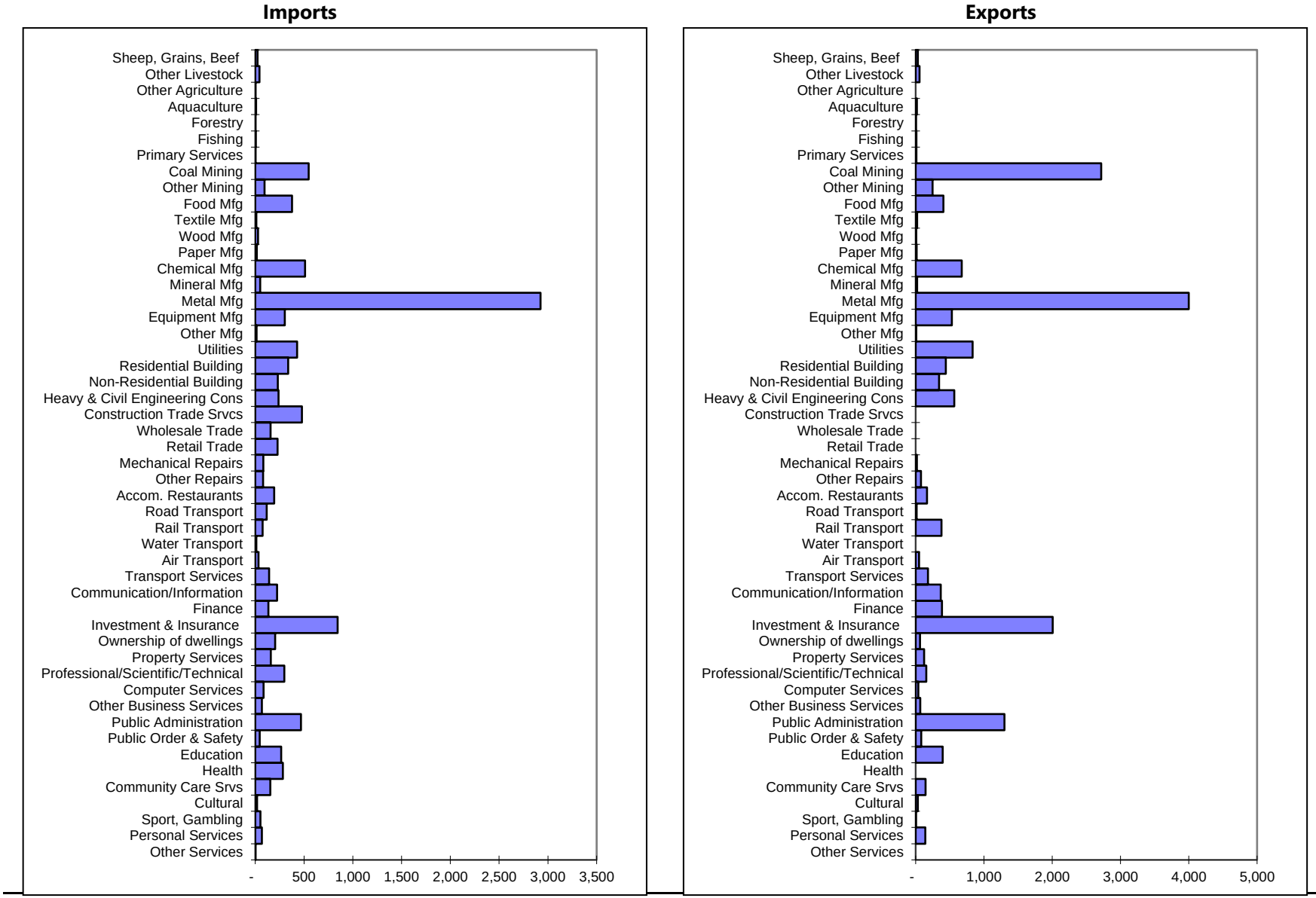


Figure 6.5 Sectoral Distribution of Imports and Exports ($M)



6.3 Local Area Impacts of the Project

6.3.1 Introduction

There is no substantive construction phase associated with the project and hence this assessment focuses on the economic activity to the Local Area economy i.e. the output, value-added, income and employment associated with the quarrying operation and delivery of quarry products. All other things being equal, the economic activity arising from the project will depend on:

- the expenditure profile in the regional economy that is associated with the quarry and transport.
- the expenditure profile and residential location of the quarry and transport workforce.
- the size of the regional economy and the ability of local businesses to supply inputs to production demanded by quarry and transport operators and the workforce.

Impacts are reported separately for quarrying and transport components of the project

6.3.2 Quarry Operation

Introduction

For the analysis of the quarry operation, a new project sectors was inserted into the regional IO table reflecting quarry operation at 750,000 tpa. The annual revenue, operating costs, and gross profit for the project sector was obtained from financial information provided by Boral. For this new sector:

- the estimated gross annual revenue from the region was allocated to the *Output* row.
- gross profit was allocated to the *Other Value Added* row.
- the estimated wage bill of employees residing in the region was allocated to the *household wages* row (100% live in the region).
- non-wage expenditure was allocated between *intermediate* sectors in the regional economy and *imports* based on expenditure profile in the *non-metallic mineral mining sector*[17] of the regional input-output table.
- direct employment by the project in the region was allocated to the *employment* row.

Impacts

The total and disaggregated annual impacts of the quarry operation on the regional economy (in 2023 dollars) at 750,000 tpa is shown in Table 6.2.

Table 6.2 - Economic Impacts of Quarry Operation on the Regional Economy ($2023)

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($M)	18.8	5.0	1.8	6.8	25.6
Type 11A Ratio	1.00	0.27	0.09	0.36	1.36
VALUE ADDED ($M)	13.3	2.3	1.0	3.3	16.7
Type 11A Ratio	1.00	0.17	0.08	0.25	1.25
INCOME ($M)	0.6	1.0	0.3	1.3	1.9
Type 11A Ratio	1.00	1.67	0.60	2.27	3.27
EMPL. (No.)	8.0	15.4	6.9	22.3	30.3
Type 11A Ratio	1.00	1.93	0.87	2.79	3.79

[17] This the industry sector that sand quarrying is located.

Quarry production at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $26M in annual direct and indirect regional output or business turnover;
- $17M in annual direct and indirect regional value added;
- $2M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

This is a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

Main Sectors Affected

Production induced and consumption induced flow-on impacts from the project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added, income and employment flow-ons are likely to be the:

- Professional, Scientific and Technical Services.
- Construction Services.
- Retail Trade sector.
- Wholesale Trade sector.
- Employment, Travel Agency, and Other Administrative Services.

Businesses that can provide the inputs to the quarrying process required by the project and/or the products and services required by employees would directly benefit from the project by way of economic activity. However, because of the inter-linkages between sectors, many indirect businesses also benefit.

6.3.3 Transportation of Quarry Products

Introduction

For the analysis of the transportation of quarry products, the revenue accruing to transport operators from the transport of 750,000 tpa was estimated. This was then adjusted by 64% on the advice of Boral that 36% of transport operators are located outside the region. The impact of this level of final demand on the regional economy was then calculated using the *EconImp* program.

Impacts

The total and disaggregated annual impacts of the transportation of quarry products on the regional economy (in 2023 dollars) at 750,000 tpa is shown in Table 6.3.

Table 6.3 - Economic Impacts of the Quarry Product Transport on the Regional Economy ($2023)

	Direct Effect	Production Induced	Consumption Induced	Total Flow-on	TOTAL EFFECT
OUTPUT ($M)	22.5	18.6	6.5	25.1	47.6
Type 11A Ratio	1.00	0.83	0.29	1.11	2.11
VALUE ADDED ($M)	5.0	8.7	3.8	12.5	17.5
Type 11A Ratio	1.00	1.74	0.76	2.50	3.50
INCOME ($M)	1.5	4.2	1.3	5.5	7.0
Type 11A Ratio	1.00	2.90	0.87	3.77	4.77
EMPL. (No.)	30.0	71.4	25.5	96.9	126.9
Type 11A Ratio	1.00	2.38	0.85	3.23	4.23

Transportation of quarry product at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $48M in annual direct and indirect regional output or business turnover;
- $18M in annual direct and indirect regional value added;
- $7M in annual direct and indirect household income; and
- 127 direct and indirect jobs.

This is a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

Main Sectors Affected

Production induced and consumption induced flow-on impacts from the project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the:

- Professional, Scientific and Technical Services;
- Retail Trade sector;
- Wholesale Trade sector.
- Automotive Repairs and Maintenance sector;
- Road Transport sector;
- Transport Support Services and Storage; and
- Employment, Travel Agency and Other Administrative Services.

Businesses that can provide the inputs to the road transport sector and/or the products and services required by employees would directly benefit from the project by way of economic activity. However, because of the inter-linkages between sectors, many indirect businesses also benefit.

6.4 Potential Contraction in Other Sectors

Economic impacts for the Local Area economic modelled using IO analysis represent only the gross or positive economic activity associated with the project. Where employed and unemployed labour resources in the region are limited and the mobility of in-migrating or commuting labour from outside the region is restricted there may be competition for regional labour resources, because of the individual project, that drives up regional wages. In these situations, there may be some 'crowding out' of economic activity in other sectors of the regional economy.

'Crowding out' would be most prevalent if the regional economy was at full employment and it was a closed economy with no potential to use labour and other resources that currently reside outside the region. However, the regional economy has access to external labour resources. Also the incremental demand for labour is small. Consequently, 'crowding out' of economic activity in other sectors because of the project would not be expected to be significant at the regional level.

However, even where there is some 'crowding out' of other economic activities this does not indicate losses of jobs but the shifting of labour resources to higher valued economic activities. This reflects the operation of the market system where scarce resources are reallocated to where they are most highly valued and where society would benefit the most from them. This reallocation of resources is therefore considered a positive outcome for the economy not a negative.

7 CONCLUSION

A CBA of the project indicated that it would have net social benefits to Australia of $19M, and net social benefits to NSW of $9M. Hence the project is desirable and justified from an economic efficiency perspective. Environmental, social, and cultural impacts of the project have been minimised through project design and mitigation, offset and compensation measures. In particular, Boral already owns sufficient Water Access Licences, will purchase required biodiversity offsets and will establish required bushfire hazard reduction measures. The costs of these actions are included in the estimate of the net social benefits of the project. The economic value of residual impacts is considered to be immaterial from an aggregated economic efficiency perspective.

While the main environmental, cultural, and social impacts have been quantified and included in the project CBA, any other residual environmental, cultural, or social impacts that remain unquantified would need to be valued at greater than $19M for the project to be questionable from an Australian economic efficiency perspective, and greater than $9M for the project to be questionable from NSW economic efficiency perspective.

At maximum production, the project will provide continued quarry employment for approximately five (four full time and one casual) employees currently on-site and additional employment for another three (two full time and one casual) i.e. eight quarry jobs in total all residing in the Local Area.

At maximum production, the project is also estimated to provide continued transport employment for 13 people from the Local Area (and seven from outside the Local Area), plus employment for an additional six people from the Local Area (and four from outside the Local Area) i.e. 30 transport jobs in total with 19 sourced from the Local Area.

Quarry production at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $26M in annual direct and indirect regional output or business turnover;
- $17M in annual direct and indirect regional value added;
- $2M in annual direct and indirect household income; and
- 30 direct and indirect jobs.

This is a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

Transportation of quarry product at 750,000 tpa is estimated to make up to the following incremental contribution to the regional economy:

- $48M in annual direct and indirect regional output or business turnover;
- $18M in annual direct and indirect regional value added;
- $7M in annual direct and indirect household income; and
- 127 direct and indirect jobs.

This is also a maximum annual incremental regional economic impact because the indicative production profile for the project ranges from 151,000 tpa to 750,000 tpa.

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ATTACHMENT 1 – LEGISLATIVE CONTEXT FOR ECONOMIC ANALYSIS IN EIA

Environmental Planning and Assessment Act 1979 and Environmental Planning and Assessment Regulation

- The basis for economic analysis under the *Environmental Planning and Assessment* (EP&A) *Act 1979* emanates from:
    - the definition of the term "environment" in the EP&A Act which is broad and includes the social and **economic** environment, as well as the biophysical environment;
    - the "objects" of the EP&A Act which includes *"promoting the social and **economic welfare** of the community"*; and
    - Clause 7(1)(f) of Schedule 2 of the EP&A Regulations which requires environmental assessment to provide "*the reasons **justifying** the carrying out of the development, activity or infrastructure in the manner proposed, having regard to biophysical, **economic** and social considerations…"*
    - *Section 4.15 of the EP&A Act requires the following two matters to be taken into consideration by the consent authority in determining a development application:*
        - the public interest (taken as the collective public interest of households in NSW); and
        - the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and ***economic impacts in the locality***.
- Objects of promoting economic welfare and requirements to justify a project having regard to economic considerations are consistent with the use of CBA. A Note to Clause 7 (1) (f) states that "A cost benefit analysis may be submitted or referred to in the reasons justifying the carrying out of the development, activity or infrastructure."
- A cost benefit analysis is consistent with the consideration of the public interest, although the limitation of public interest to NSW households requires consideration of the costs and benefits to NSW households, whereas CBA would normally be undertaken at the National level.
- Elements of CBA can provide information on the economic impacts in the locality, although CBA should not be undertaken at the local level. This can be supplemented by other forms of analysis to examine economic impacts in the locality such as the consideration of:
    - effects relating to local employment;
    - effects relating to non-labour project expenditure; and
    - environmental and social impacts on the local community.

Secretary's Environmental Assessment Requirements

- The project SEARs include a requirement for:

- an assessment of the likely economic impacts of the development, paying particular attention to:

    - the significance of the resource;
    - the economic benefits of the project for the State and region; and
    - the demand for the provision of local infrastructure and services.

- the reasons why the development should be approved having regard to biophysical, **economic** and social **considerations**, including the principles of ecologically sustainable development.

Other Economic Guidelines

- In 2015 the NSW Government prepared *Guidelines for the economic assessment of mining and coal seam gas proposals*. This provides an outline of how to undertake a CBA and local effects analysis of mining and coal seam gas proposals.

- NSW Government (2018) Technical Notes Supporting the Guidelines for the Economic Assessment of Mining and Coal Seam Gas Proposals. This provides guidance on how to value environmental, social and cultural impacts of projects.

- NSW Treasury (2023) *NSW Government Guide to Cost-Benefit Analysis*, provides guidance for Government agencies on how to undertake CBA of significant spending proposals, including proposed capital works, projects and new programs across all public sector agencies. However, many of the principles have broader application.

- NSW Treasury (2023) *Technical note to NSW Government Guide to Cost-Benefit Analysis TPG23-08 Carbon value in cost-benefit analysis.* This provides guidance on how to value GHG emissions in CBA.

ATTACHMENT 2 – INTRODUCTION TO ECONOMIC METHODS

Benefit Cost Analysis

- Cost Benefit Analysis (CBA) is the primary way that economists evaluate projects and policies.
- CBA evaluates whether the well-being (**economic welfare**) of the community is in aggregate improved by a project. It does this by comparing the costs and benefits of a project to the community.
- The community whose welfare is included is broadly defined as anyone who bears significant costs and benefits of a project. However, in practice most CBA is undertaken at a national level. CBA at a sub-national level is not recommended however if undertaken at this level should provide decision-makers with estimates of all significant effects, including those to non-residents of the sub-national region.
- CBAs undertaken under NSW legislation is generally undertaken from a NSW perspective focusing on the costs and benefits to NSW consumers and producers.
- It is not possible to justify a project on economic grounds without doing a CBA.

Economic Activity Analysis

- Economists also often provide information to decision-makers on the **economic activity** that a project will provide to the regional, state or national economy. This is particularly relevant at the regional level since many regions and towns are experiencing long term decline as a result of structural change in the economy. Additional economic activity can help the prosperity of these regions.
- **Direct** economic activity provided by a project can be estimated from financial and labour estimates for a project. Methods that can be used to estimate **direct** and **indirect** economic activity include IO analysis and CGE modelling. Refer to Attachment 3 for a comparison of these methods and their assumptions.
- While economic activity measures from IO analysis and CGE modelling e.g. direct and indirect output, value-added and income, are generally not measures of benefits and costs relevant to a CBA this information can be of interest to decision-makers[18].

Economic Analysis and Decision-Making

- CBA and local effects analysis (including IO/CGE analysis) are not mechanised decision-making tools, but rather means of analysis that provide useful information to decision-makers.

[18] It should be noted that it is possible to analyse industry benefits and costs within a general equilibrium framework where impacts are of a sufficient scale that they flow through into multiple sectors in the economy. However, for individual projects a partial equilibrium framework is the preferred approach for the estimation of costs and benefits (US EPA (2010) Guidelines for Preparing Economic Analyses, US EPA).

- Decision-making is multi-dimensional. CBA is concerned with the single objective of **economic efficiency** (economic welfare) while IO analysis and CGE are concerned with the objective of **economic activity** (growth). They do not address equity and other objectives of government. Decision-makers therefore need to consider the economic efficiency and economic activity implications of a project, as indicated by CBA and IO/CGE analysis respectively, alongside the performance of a project in meeting other, often conflicting, government goals and objectives.

ATTACHMENT 3 – COMPARISON OF INPUT-OUTPUT ANALYSIS AND THE LEA METHOD

IO analysis begins with identification of the direct gross regional economic activity footprint of a project for the region. If a project provides 100 jobs then all these jobs are counted in IO analysis as a direct effect i.e. direct employment in the region, because the jobs are located in the region. However, in IO analysis only the income of employees living in the region are counted as direct income effects since it is only wages expenditure of those living in the region that flows through the regional economy. In IO analysis, if 40% of a projects jobs are filled by people who already reside in the region then the **total** wages of these people is counted as a direct regional income effect of the project. Similarly, if 40% of the new jobs are taken by people who migrate into the region this is also counted as direct income for the region, as it is income that will accrue to people living in the region even though they are new residents. In IO analysis, the income of those residing outside the region is excluded as most of their income will be taken home after shift and spent where they live or elsewhere.

These direct employment and income effects for the region are those **associated** with the project i.e. the gross footprint, rather than specifically an assessment of **incremental** effects. This is partly because assessment of incremental effects becomes highly contentious and difficult. However, as will be shown below, these gross direct effects associated with a project can also be a reasonable approximation of incremental effects when "trickle down" or "job chain" effects are considered.

However, first is a comparison between how IO analysis treats direct employment and income effects (as explained above) and that in the NSW (2015) guideline.

The guideline splits labour into those ordinarily resident in the region and those not ordinarily resident in the locality. For those ordinarily resident in the region the guideline suggests calculation of incremental income as the difference between a mining (including quarrying) income and the average level of income in other industries in the region. Incremental direct employment is then calculated by dividing this incremental income by the average wage in mining.

The guideline ignores workers who migrate into the region to work. However, using the rationale of the guideline, workers who migrate into the region to take jobs in a project provide a greater level of incremental income and spending in the region than those to take jobs in a project and who already reside in the region. The entire wage of those migrating into the region is additive to regional income in comparison to wage increments for those already residing in the region.

Table 1 provides an example of incremental wages using the guideline method and when income from those migrating into the region is counted. If only the incremental wages of those who already reside in the region are counted the incremental impact is $1.4M in annual wages. However, if the incremental wages to the region from those who migrate into the region are included, this increases to $5.4M.

Table 1 - Incremental Income when Immigrating Workforce is Included

Categories of Workers	Direct Empl	Current Wages @$65k	New Wages @$100k	Incremental New Wages for Workers	Incremental New Wages to the Region
Already Live in Region	40	2,600,000	4,000,000	1,400,000	1,400,000
Migrate into Region to Live	40	2,600,000	4,000,000	1,400,000	4,000,000
Commute from outside	20	1,300,000	2,000,000	700,000	0
Total Direct Empl	**100**	**6,500,000**	**10,000,000**	**3,500,000**	**5,400,000**

Even for those already living in the region who are already employed, the incremental income estimated using the guideline will substantially understate additional regional income effects. This is because new jobs in a region create a chain of job opportunities (referred to in the literature as the "trickle down" effect or "job chain" - see Persky et al, 2004 What are jobs worth?, Employment Research Vol. 11 , p. 3).

An already employed person in the region moving into a mining (including quarrying) job, creates a job vacancy, which can be filled by those in the region (already employed, unemployed or attracted into the labour force) or by in-migration. Where this job is filled by those already employed in the region this in turn creates another vacancy etc. Following the entire chain through, the cumulative increase in wages to a region would approach the wages of the total direct jobs. It would only be discounted if the chain ends with employment of those from local residents in the unemployment pool (who are receiving an allowance and hence already are spending income in the region) or if jobs remain unfilled. In periods of higher unemployment rates, jobs along the job chain remaining unfilled is unlikely. If the chain ends with in-migrating employment or employment of those in the region that are new to the workforce then the incremental wages is equal to the total wages of the new jobs.

Table 2 demonstrates the "trickle down" effect in relation to 40 new mining/quarrying jobs filled by already employed local workers. It shows that the total annual wages of the new mining/quarrying jobs is $4M. Under the trickle down approach where all jobs are backfilled including ultimately by 40 local residents from the unemployment pool the incremental wages to the region are $3.5M. If some of these jobs filled from the unemployment pool are ultimately filled by in-migration the difference between the incremental wages to the region and the total annual mining jobs wages will lessen.

The guideline does not take account of the "trickle down" effect and essentially assumes that the previous jobs of "job movers" in the region remain vacant for the life of the project.

Incorporation of consideration of the "trickle down" effect means that the direct incremental income to a region approximates that assumed in IO analysis (i.e. the gross footprint of economic activity estimated using IO analysis is also an indicator of the net effect).

Table 2 - Demonstration of the Trickle Down Effect for 40 Jobs Filled by Locals Who are Already Employed in the Region

	Total wages	Increment Wages Gain to Region
1. New mining wage for 40 workers @$100k	$4,000,000	$1,400,000 (1-2)
2. Current Wages for 40 workers @$65k	$2,600,000	$1,000,000 (2-3)
3. Wage of people filling above 40 positions @$40k	$1,600,000	$800,000 (3-4)
4. Wage of people filling above 40 positions @$20k	$800,000	$ 255,664 (4-5)
5. Wages of the unemployed filling above 40 positions (Newstart - single no children)	$544,336	
Total		**$3,455,664**

ATTACHMENT 4 – INPUT-OUTPUT ANALYSIS AND COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

Input-Output Analysis

- IO analysis is a cost effective and simple method for estimating the gross market economic activity i.e. financial transactions and employment, in a specified region that is associated with a project.
- IO analysis is the most widely used model for regional impact assessment (West and Jackson 2005).
- IO analysis can be undertaken at the LGA or aggregation of LGAs level.
- IO analysis can provide disaggregation of economic activity impacts across many sectors – 111 sectors based on current National IO tables.
- IO analysis was developed by Wassily Leontief for which he received the Nobel Prize in Economics.
- IO analysis is a static analysis that looks at economic activity impacts in a particular year e.g. a typical year of a projects operation.
- IO analysis has historically been applied at the regional level to assess the economic activity impacts of individual projects.
- IO analysis involves the development of an IO table representing the buying and selling of goods and services in the economy. These fixed average ratios are used to estimate the direct and indirect impacts of a change in expenditure in a region.
- IO analysis identifies the gross direct and indirect additional (positive) regional economic activity associated with a project in terms of a number of indicators of economic activity – output, income, value-added[19] and employment.
- Economic activity measures used in IO are not measures of benefits and costs relevant to a CBA.
- IO analysis does not attempt to examine non-market environmental, social or cultural impacts.
- IO analysis does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region as suggested by a Land and Environment Court Judgement.
- The estimation of economic activity impacts in IO analysis are based on a number of simplifying assumptions – most notable is that the regional economy has **access to** sufficient labour and capital resources (from both **inside** and **outside** the region) so that an individual project does not result in any regional price changes e.g. wages in other industries or house rentals, which would lead to contractions ("crowding out") of economic activity in other sectors in the region.
- For the assessment of the impacts of individual projects on small open regional economies, this is a reasonable assumption.
- Nevertheless, the results of IO modelling can be seen as representing an upper bound for the net economic activity associated with a project.

[19] Value-added is the difference between the gross value of business turnover and the costs of the inputs of raw materials, components and services bought in to produce the gross regional output.

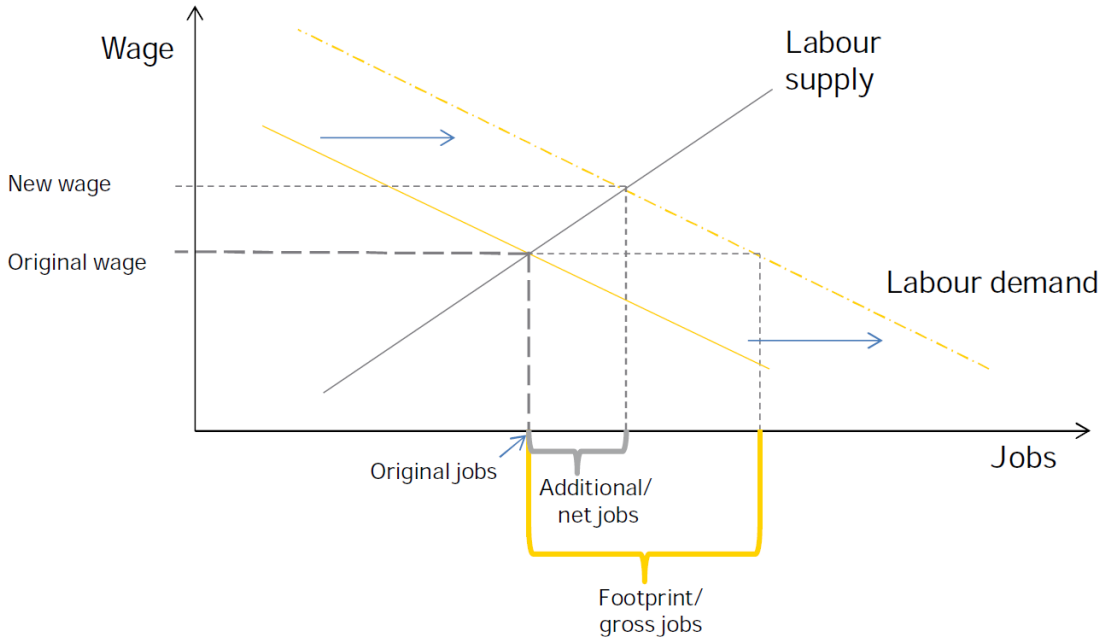
Computable General Equilibrium Modelling

- CGE modelling is an alternative more expensive, complicated but theoretically more sophisticated method for estimating the economic activity associated with a project.
- CGE modelling can be dynamic or comparative static[20] and has historically been applied at the State and National level for determining the potential economic activity associated with the introduction of major government policy changes and investment in large infrastructure projects.
- CGE modelling can also be undertaken at a regional level but normally at no finer scale than the Statistical Subdivision level.
- CGE modelling estimates the additional net (positive and negative) economic activity associated with a project in terms of a number of economic indicators – including value-added and employment – but also real income, government tax revenue and components of value-added.
- Economic activity measures used in CGE modelling are not generally measures of benefits and costs relevant to a CBA, although CGE modelling can also be used to estimate market costs or market benefits, as part of a CBA, where the magnitude of a project will affect a large number of sectors and the effects will be spread more broadly throughout the economy.
- Economic activity impacts can be disaggregated by sector but this is not normally as disaggregated as in IO analysis.
- CGE modelling does not attempt to examine non-market environmental, social or cultural impacts.
- CGE modelling is underpinned by an IO database as well as a system of interdependent behaviour and accounting equations which are based on economic theory (but mostly without econometric backing at the regional level).
- The equations in CGE models ensure that any change in demand in a region, no matter how small, translates into some change in prices and hence there is always some 'crowding out' of other economic activity in the region.
- At the regional level, CGE results can be very sensitive to changes in these behavioural assumptions.
- 'Crowding out' of other economic activities estimated via CGE modelling does not reflect losses of jobs but the shifting of labour resources to higher valued economic activities.

[20] Comparative static models compare one equilibrium point with another but do not trace the impact path along the way. Dynamic models give year by year impacts of a shock.

Comparison of IO Analysis and CGE Modelling

Figure A4.1 – Comparison of Employment Estimates in IO Analysis and CGE Modelling



Source: Ernst Young (2014) Capital Metro Job Creation Analysis, p. 30.

- Figure A4.1 illustrates the difference between the output of IO analysis and the output of CGE with respect to employment. IO analysis estimates the employment footprint or gross jobs from a project. It can also be taken as an indicator of net jobs from a project where there is no or little upward pressure on wages for the region in question as a result of the individual project and hence no or little crowding out of other economic activity[21]. CGE modelling assumes upward pressure on wages and hence some crowding out of other economic activity in the region. Under this assumption CGE estimates additional net jobs as being less than the employment footprint/gross jobs.
- Which modelling approach best represents the true situation depends on whether and to what extent price changes occur at a regional level as a result of individual projects. This is an empirical issue and would depend on the migration of labour into the region, commuting of labour and timely management of land releases by Councils. Few studies exist that examine this issue.
- IO analysis provides decision-makers with information on the relative employment footprint/gross jobs of different projects, without going to the second and more complicated stage of trying to model wage rises and "crowding out" across all other sectors in the economy.
- Regional economic activity, estimated by IO analysis or CGE modelling, is just one piece of information that decision-makers may take into account in considering a project.

[21] This is akin to the marginal assumption in CBA.

Guidelines

- Both IO analysis and CGE modelling are identified in the DP&I's *draft Guideline for Economic Effects and Evaluation in EIA* (James and Gillespie 2002) as appropriate methods for examining regional economic impacts i.e. impacts on economic activity – the size and structure of an economy.
- NSW Treasury (2009) *Guidelines for estimating employment supported by the actions, programs and policies of the NSW Government*, supports the use of IO for deriving estimates for employment supported by NSW Government actions, programs and policies, and clarifies the interpretation of such estimates.
- Other guidelines to recognise the role of IO analysis include:
  - US Environment Protection Agency (2010) *Guidelines for Preparing Economic Analyses*;
  - Australian Bureau of Rural Science (2005) *Socio-economic Impact Assessment Toolkit: A guide to assessing the socio-economic impacts of Marine Protected Areas in Australia*.
- NSW Treasury (2007) identify that IO analysis is commonly used to assess the regional impacts of a project. However, IO analysis is concerned with measuring economic activity, and is not a tool for the evaluation of projects (in the way that CBA is).
- World Bank economist Mustafa Dinc (2015) Introduction to Regional Economic Development: Major Theories and Basic Analytical Tools, Edward Elgar, UK, identifies IO as one of the most widely used models around the world for undertaking regional economic impact analysis and a solid framework to analyse the interdependence of industries in an economy.

Government Applications of IO Analysis

- Applications of IO analysis commissioned by Government agencies include:
  - Department of Sustainability, Environment, Water, Population and Communities (2011) *Assessing the Socio-Economic Impacts of Sustainable Diversion Limits and Water for the Future Investments: An Assessment of the Short-Term Impacts at a Local Scale*
  - NSW Natural Resources Commission (2009) *River Red Gum Assessment: Socio-economic impact assessment*;
  - Victorian Environmental Assessment Council (2007) *River Red Gum Forests Investigation – Socio-Economic Assessment*.
  - Resource and Conservation Division of the NSW Department of Urban Affairs and Planning (1999) Regional Impact Assessments as part of the NSW Comprehensive Regional Assessments under the National Forestry Policy.
  - Reserve Bank of Australia (2012) *Industry Dimensions of the Resource Boom: An Input-Output Analysis*.
  - DECCW (2009) Economic benefits of national parks and other reserves in New South Wales - Summary report, reports the results of numerous studies it and its' predecessors have commissioned on the regional economic impacts of national parks and protected areas.
  - DECCW (2006) *Socio Economic Assessment of the Batemans Bay Marine National Park*
  - DECCW (2006) *Socio Economic Assessment of the Port Stephens – Great Lakes Marine Park*
  - National Parks Service, US Department of the Interior (2014) *2012 National Parks Visitor Spending Effects: Economic Contribution to Local Communities, States and the Nation*.

Criticisms Misrepresented

- The main concern that economists e.g. the Productivity Commission, NSW Treasury and ABS (as quoted by The Australia Institute in numerous submissions to mining projects in NSW) have with IO is its use as a substitute for CBA, not its use for estimating direct and indirect regional economic activity impacts.

    - NSW Treasury (2009) "*Model based economic impact assessment [such as IO analysis] is not a substitute for a thorough economic analysis of a policy. The appropriate method for analysing policy alternatives is benefit cost analysis (CBA)"*.

    - The main "abuse" reported by the Productivity Commission is using IO analysis to *"make the case for government intervention"* when CBA is the appropriate method for doing this.

    - ABS's concerns with IO being "*biased*" refer to it being a "*biased estimator of the benefits or costs of a project"*. IO does not estimate benefits and costs but economic activity.

    - Concerns of the Warkworth Judgement with IO analysis being "deficient" related to the data (industry data from surveys undertaken in 2001 and assumptions used (see next dot point)), but more fundamentally for not *"assisting in weighing the economic factors relative to the various environmental and social factors, or in balancing economic, social and environmental factors"*. This is an inappropriate criticism of the IO method, since it does not pretend to do this.

    - IO analysis does not depend on the assumption *"that there is a ghost pool of highly skilled yet unemployed people"* in a region as suggested in the Warkworth Judgement. It allows for labour to come from within or outside the region.

Use of IO Analysis

- BAEconomics (2014) in its Economic Impact Assessment for Warkworth Continuation 2014 and Mt Thorley Operations 2014 justifies the use of IO analysis to estimate economic activity associated with the project.

- Dr Brian Fisher, the Managing Director of BAEconomics is a highly respected resource economist who previously held the positions of Executive Director of the Australian Bureau of Agricultural and Resource Economics (ABARE) and Associate Commissioner of the Productivity Commission. He received an Order of Australia in the Queen's Birthday Honours List in 2007.

ATTACHMENT 5 – UNDERLYING ASSUMPTIONS AND INTERPRETATIONS OF INPUT-OUTPUT ANALYSIS AND MULTIPLIERS

1. "The *basic assumptions* in IO analysis include the following:

   - there is a fixed input structure in each industry, described by fixed technological coefficients (evidence from comparisons between IO tables for the same country over time have indicated that material input requirements tend to be stable and change but slowly; however, requirements for primary factors of production, that is labour and capital, are probably less constant);
   - all products of an industry are identical or are made in fixed proportions to each other;
   - each industry exhibits constant returns to scale in production;
   - unlimited labour and capital are available at fixed prices; that is, any change in the demand for productive factors will not induce any change in their cost (in reality, constraints such as limited skilled labour or investment funds lead to competition for resources among industries, which in turn raises the prices of these scarce factors of production and of industry output generally in the face of strong demand); and
   - there are no other constraints, such as the balance of payments or the actions of government, on the response of each industry to a stimulus.

2. The multipliers therefore describe *average effects, not marginal effects*, and thus do not take account of economies of scale, unused capacity or technological change. Generally, average effects are expected to be higher than the marginal effects.

3. The IO tables underlying multiplier analysis only take account of one form of *interdependence***,** namely the sales and purchase links between industries. Other interdependence such as collective competition for factors of production, changes in commodity prices which induce producers and consumers to alter the mix of their purchases and other constraints which operate on the economy as a whole are not generally taken into account.

4. The combination of the assumptions used and the excluded interdependence means that IO multipliers are higher than would realistically be the case. In other words, they tend to *overstate* the potential impact of final demand stimulus. The overstatement is potentially more serious when large changes in demand and production are considered.

5. The multipliers also do not account for some important pre-existing conditions. This is especially true of Type II multipliers, in which employment generated and income earned induce further increases in demand. The implicit assumption is that those taken into employment were previously unemployed and were previously consuming nothing. In reality, however, not all 'new' employment would be drawn from the ranks of the unemployed; and to the extent that it was, those previously unemployed would presumably have consumed out of income support measures and personal savings. Employment, output and income responses are therefore overstated by the multipliers for these additional reasons.

6. The most *appropriate interpretation* of multipliers is that they provide a relative measure (to be compared with other industries) of the interdependence between one industry and the rest of the economy which arises solely from purchases and sales of industry output based on estimates of

transactions occurring over a (recent) historical period. Progressive departure from these conditions would progressively reduce the precision of multipliers as predictive device" (ABS 1995, p.24).

Multipliers indicate the total impact of changes in demand for the output of any one industry on all industries in an economy (ABS, 1995). Conventional output, employment, value-added and income multipliers show the output, employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

Components of the conventional output multiplier are as follows:

Initial effect - which is the initial output stimulus, usually a $1 change in output from a particular industry (Powell and Chalmers, 1995; ABS, 1995).

First round effects - the amount of output from all intermediate sectors of the economy required to produce the initial $1 change in output from the particular industry (Powell and Chalmers, 1995; ABS, 1995).

Industrial support effects - the subsequent or induced extra output from intermediate sectors arising from the first round effects (Powell and Chalmers, 1995; ABS, 1995).

Production induced effects - the sum of the first round effects and industrial support effects (i.e. the total amount of output from all industries in the economy required to produce the initial $1 change in output) (Powell and Chalmers, 1995; ABS, 1995).

Consumption induced effects - the spending by households of the extra income they derive from the production of the extra $1 of output and production induced effects. This spending in turn generates further production by industries (Powell and Chalmers, 1995; ABS, 1995).

The *simple multiplier* is the initial effect plus the production induced effects.

The *total multiplier* is the sum of the initial effect plus the production-induced effect and consumption-induced effect.

Conventional employment, value-added and income multipliers have similar components to the output multiplier, however, through conversion using the respective coefficients show the employment, value-added and income responses to an initial output stimulus (Jensen and West, 1986).

For employment, value-added and income, it is also possible to derive relationships between the initial or own sector effect and flow-on effects. For example, the flow-on income effects from an initial income effect or the flow-on employment effects from an initial employment effect, etc. These own sector relationships are referred to as ratio multipliers, although they are not technically multipliers because there is no direct line of causation between the elements of the multiplier. For instance, it is not the initial change in income that leads to income flow-on effects, both are the result of an output stimulus (Jensen and West, 1986).

A description of the different ratio multipliers is given below.

$$\text{Type 1A Ratio Multiplier} = \frac{\text{Initial + First Round Effects}}{\text{Initial Effects}}$$

Type 1B Ratio Multiplier = $\frac{\text{Initial + Production Induced Effects}}{\text{Initial Effects}}$

Type 11A Ratio Multiplier = $\frac{\text{Initial + Production Induced + Consumption Induced Effects}}{\text{Initial Effects}}$

Type 11B Ratio Multiplier = $\frac{\text{Flow-on Effects}}{\text{Initial Effects}}$

Source: Centre for Farm Planning and Land Management (1989).

REFERENCES

Australian Bureau of Statistics (1995) *Information Paper Australian National Accounts Introduction to Input-Output Multipliers*. Cat. No. 5246.0.

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Powell, R. and Chalmers, L. (1995) *The Regional Economic Impact of Gibraltar Range and Dorrigo National Park*. A Report for the NSW National Parks and Wildlife Service.

ATTACHMENT 6 – CBA AND ASSESSMENT OF EXTERNALITIES

Consideration of Externalities in the Economic Assessment

Introduction

- The "perfect" CBA is an ideal. Different situations call for different styles and depths of analysis.
- Valuation of all environmental impacts is neither practical nor necessary.
- In attempting to value impacts, there is the practical principle of materiality. Only those impacts which are likely to have a material bearing on the decision need to be considered in CBA (NSW Government 2012). The guideline gives an example of impacts of less than $1M being immaterial for a project with an estimated net present value of $20M.
- The CBA of the project took three approaches to the consideration of environmental costs:
  - Threshold value analysis;
  - Qualitative consideration of impacts and valuation of the main impacts based on market data and benefit transfer; and
  - Additional threshold value analysis to recognise that some impacts may not have been fully valued and incorporated into the analysis.

Threshold Value Analysis

- The first approach used to consider the environmental impacts of the project was the threshold value method.
- Threshold value analysis is a recognised approach to CBA where it is not possible or pragmatic to attempt to value potential external impacts.
- Threshold value analysis was developed by Krutilla and Fisher (1975)[22]. It is specifically referred to as an appropriate approach in the DP&I's (2002) *Draft Guideline for Economic Effects and Evaluation in EIA,* and is a widely recognised approach.
- Threshold value analysis avoids the sometimes contentious matter of physically quantifying environmental impacts and then placing dollar values on them.
- Threshold value analysis leaves the trade-off between quantified economic benefits and unquantified environmental costs for the decision-maker.
- In the Economic Assessment of the project, the estimated net production benefits provide a threshold value or reference value against which the relative value of the residual environmental, social and cultural impacts of the project, after mitigation, offset and compensation, may be

[22] Krutilla, J.V. and A.C. Fisher (1975) *The Economics of Natural Environments*, Johns Hopkins University Press, Baltimore.

assessed. The threshold value indicates the price that the community must value any residual environmental impacts of the project (be willing to pay) to justify in economic efficiency terms the 'no development' option.

Qualitative consideration of impacts and valuation of the main impacts based on market data and benefit transfer

- The second approach used was to qualitatively consider, and where possible value, the main environmental, cultural, and social impacts of the project for the well-being of people.

- Qualitative consideration of potential impacts and any subsequent valuation of impacts relied on the assessment of biophysical impacts provided in the project EIS by technical specialists.

- The approach to valuing environmental impacts in the Economic Assessment of the project is summarised in Table A6.1.

Table A6.1 – Method for Valuing Environmental Impacts in the Economic Assessment of the Project

Impact	Potential Valuation Method	Comment
Greenhouse gas emissions	Damage cost method	Inclusion of proxy for the global SCC prorated to Australia and NSW
Noise impacts		
Significant	Property valuation method	Cost of acquiring properties encompasses property value impacts due to noise - but no impacts of the project and hence no acquisitions required.
Moderate and low	Defensive expenditure	Noise mitigation costs at properties - but no impacts of the project.
Significant air quality impacts	Property valuation method	Cost of acquiring properties encompasses property value impacts due to air quality impacts. However, no properties impacted by exceedances.
Use of surface water	Market value of water	Cost of Water Access Licences reflects marginal value product of water. However, no surface WALs required.
Use of groundwater	Market value of water	Cost of Water Access Licences reflects marginal value product of water. Opportunity cost of WALs included in the capital costs of the project.
Groundwater drawdown	Defensive expenditure	No material impacts on private bores predicted.
Water discharges		Regulated under the Protection of Environment Operations Act 1997.
Ecology	Replacement cost	Costs of offsets (credits) have been included in capital costs. Assumes that offsets levels are sufficient to compensate the community for values lost. This is a requirement of Govt. Policy.
Road transport impacts	Defensive expenditure	Cost of road investment required as a result of the project. However, no material impacts and hence no road investment required.
Aboriginal heritage	Defensive expenditure	Costs of actions to mitigate impacts. However, no material Aboriginal heritage impacts predicted.

Historic heritage	Defensive expenditure Benefit transfer of CM data	Costs of mitigation or values from community willingness to pay studies. However, no historic heritage impacts predicted.
Visual	Defensive expenditure	Costs of mitigation measures. However, no material impacts predicted.

Additional Threshold Value Analysis

- To the extent that there may be some disagreement about the estimated economic values of the environmental impacts of the project, the estimated net benefits of the project provides another threshold value that the residual environmental impacts of the project after mitigation, compensation and offset would need to exceed to make the project questionable form and economic efficiency perspective. This again allows the decision-maker to consider any material impacts that it identifies in the course of its consideration that were not valued in the Economic Assessment.

ATTACHMENT 7 – THE GRIT SYSTEM FOR GENERATING INPUT-OUTPUT TABLES

The Generation of Regional Input-Output Tables (GRIT) system was designed to:

- combine the benefits of survey based tables (accuracy and understanding of the economic structure) with those of non-survey tables (speed and low cost);
- enable the tables to be compiled from other recently compiled tables;
- allow tables to be constructed for any region for which certain minimum amounts of data were available;
- develop regional tables from national tables using available region-specific data;
- produce tables consistent with the national tables in terms of sector classification and accounting conventions;
- proceed in a number of clearly defined stages; and
- provide for the possibility of ready updates of the tables.

The resultant GRIT procedure has a number of well-defined steps. Of particular significance are those that involve the analyst incorporating region-specific data and information specific to the objectives of the study. The analyst has to be satisfied about the accuracy of the information used for the important sectors; in this case the other mining sector. The method allows the analyst to allocate available research resources to improving the data for those sectors of the economy that are most important for the study.

An important characteristic of GRIT-produced tables relates to their accuracy. In the past, survey-based tables involved gathering data for every cell in the table, thereby building up a table with considerable accuracy. A fundamental principle of the GRIT method is that not all cells in the table are equally important. Some are not important because they are of very small value and, therefore, have no possibility of having a significant effect on the estimates of multipliers and economic impacts. Others are not important because of the lack of linkages that relate to the particular sectors that are being studied. Therefore, the GRIT procedure involves determining those sectors and, in some cases, cells that are of particular significance for the analysis. These represent the main targets for the allocation of research resources in data gathering. For the remainder of the table, the aim is for it to be 'holistically' accurate (Jensen, 1980). This means a generally accurate representation of the economy is provided by the table, but does not guarantee the accuracy of any particular cell. A summary of the steps involved in the GRIT process is shown in Table A7.1 (Powell and Chalmers, 1995).

Table A7.1
The GRIT Method

Phase	Step	Action
PHASE I		ADJUSTMENTS TO NATIONAL TABLE
	1	Selection of national input-output table (106-sector table with direct allocation of all imports, in basic values).
	2	Adjustment of national table for updating.
	3	Adjustment for international trade.
PHASE II		ADJUSTMENTS FOR REGIONAL IMPORTS
		(*Steps 4-14 apply to each region for which input-output tables are required*)
	4	Calculation of 'non-existent' sectors.
	5	Calculation of remaining imports.
PHASE III		DEFINITION OF REGIONAL SECTORS
	6	Insertion of disaggregated superior data.
	7	Aggregation of sectors.
	8	Insertion of aggregated superior data.
PHASE IV		DERIVATION OF PROTOTYPE TRANSACTIONS TABLES
	9	Derivation of transactions values.
	10	Adjustments to complete the prototype tables.
	11	Derivation of inverses and multipliers for prototype tables.
PHASE V		DERIVATION OF FINAL TRANSACTIONS TABLES
	12	Final superior data insertions and other adjustments.
	13	Derivation of final transactions tables.
	14	Derivation of inverses and multipliers for final tables.

Source: Bayne and West (1988).

REFERENCES

Bayne, B. and West, G. (1988) *GRIT – Generation of Regional Input-Output Tables: Users Reference Manual*. Australian Regional Developments No. 15, Office of Local Government, Department of Immigration, Local Government and Ethnic Affairs, AGPS.

Jensen, G. (1980) The concept of accuracy in regional input-output models. *International Regional Science Review*, 5:2, pp.139-54.

Powell, R. and Chalmers, L. (1995) *The Regional Economic Impact of Gibraltar Range and Dorrigo National Park*. A Report for the NSW National Parks and Wildlife Service.

Appendix P

Rehabilitation strategy

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

REHABILITATION STRATEGY FOR STOCKTON SAND QUARRY, DRY SAND EXTRACTION, COXS LANE, FULLERTON COVE, NSW

ARNOLD PLANNING PTY LTD O/B BORAL RESOURCES (NSW) PTY LTD

26 JUNE 2023
122091 RP01
VERSION 3

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

26 June 2023

Arnold Planning Pty Ltd
o/b Boral Resources (NSW) Pty Ltd
Suite 282
Ground Floor 1 Market Street
Newcastle NSW 2300

Attention: **John Arnold**
Director

Stockton Quarry Dry Sand Extraction Project - Rehabilitation Strategy

Please find enclosed a copy of our report entitled as above. Thank you for the opportunity to undertake this work. Should you have any queries, please do not hesitate to contact us on (02) 9922 1777.

For and on behalf of
Environmental Earth Sciences NSW

Project Manager
Natalie Eldridge
Environmental Scientist

Project Director / Internal Reviewer
Mark Stuckey
Senior Principal Soil Scientist,
Hydrogeologist and Risk Assessor

Internal Reviewer
Chris Newland
Principal

122091RP01V03

EXECUTIVE SUMMARY

Introduction and objectives

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in **Figure 1.1**, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

- DA 2010/94: 'the inland extraction area' (also known as the former inland extraction area), granted by Port Stephens Council in 1996; and
- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or

- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 1.2 shows the quarry, the project, and the existing windblown project.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the project on 18 January 2023. This rehabilitation strategy report has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project.

This report has been prepared to review rehabilitation efforts undertaken at the site to date and document a rehabilitation strategy specific to the project through addressing the SEARs, including the following aspects:

- Summary of existing environment.
- Rehabilitation management strategy.
- Integration with existing rehabilitation activities.
- Final landform description.
- Vegetation species selection and management.
- Management controls and measures.
- Inspection schedule.
- Performance criteria.
- Suggested timeframe and endpoint.
- Continual improvement.

Findings will be used to supporting the new development application DA and inform preparation of the project environmental impact statement (EIS).

It is noted that should the original dredge application be approved, the following document for rehabilitation should be referred to and supersedes this report:

> Environmental Earth Sciences (2020), *Rehabilitation Strategy for Stockton Sand Quarry Dredging, Coxs Lane, Fullerton Cove, NSW* (ref: 717041_Rehabilitation Plan_V3; dated 24 November 2020).

ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

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1 INTRODUCTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

As shown in **Figure 1.1**, the quarry is located at Stockton Beach in the suburb of Fullerton Cove, approximately 10.5 km north-east of the Newcastle CBD. The quarry covers an area of approximately 246 ha. Boral's land holding is identified as Lot 1 and Lot 2 DP 1006399 and Lot 3 DP 664552. The site is accessed via Coxs Road over an adjacent Crown Reserve (Lot 7300 DP 1130730) under licence agreement with the NSW Department of Planning and Environment - Crown Lands.

Under Boral's ownership of the quarry, there have been two primary development consents granted, comprising:

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- DA 140-6-2005: 'the windblown sand extraction area' (also known as the existing windblown project) located on the transgressive dunes adjoining Stockton Beach, granted by the NSW Department of Planning and Environment (DPE) in 2006.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Figure 1.2 shows the quarry, the project, and the existing windblown project.

Secretary's Environmental Assessment Requirements (SEARs) were issued by DPE for the project on 18 January 2023. This rehabilitation strategy report has been prepared to address the relevant SEARs and inform the preparation of an environmental impact statement (EIS) for the project.

It is noted that should the original dredge application be approved, the following document for rehabilitation should be referred to and supersedes this report:

> Environmental Earth Sciences (2020), *Rehabilitation Strategy for Stockton Sand Quarry Dredging, Coxs Lane, Fullerton Cove, NSW* (ref: 717041_Rehabilitation Plan_V3; dated 24 November 2020).

This report should be read in conjunction with specific limitations provided in **Section 5** and General Limitations at the rear of this document.

1.1 Project description

As shown in **Figure 1.2**, the project site is in the central portion of the quarry and covers an area of approximately 37 ha. It is generally consistent with the former inland extraction area footprint approved under DA 2010-94 and is the same as the project site for the dredge application.

The project site contains the proposed clearance area, which comprises all areas to be disturbed by vegetation clearing and sand extraction operations as well as new entry/exit roads, a two-way haul road, a laydown area, and a pad for a wash plant and water recycling and filter press.

The project would generally involve the extraction of sand above the water table from approximately 26.5 m Australian height datum (AHD) (in Stage 1) to a minimum 0.7 m above the water table, using dozer, excavator, haul trucks and front-end loader, within the same extraction area identified for the dredge application. Vegetation within the project site is predominantly rehabilitation vegetation and would be removed progressively in line with extraction.

As shown in **Figure 1.3**, sand would be extracted from five stages, starting in Stage 1. Due to the quality of sand anticipated to be found in Stage 1, this material would be dry screened before being dispatched. Sand extracted from Stages 2-5 (inclusive) would be processed through a wash plant and water recycling and filter press due to the higher volume of organics likely to be found.

The five stages of the project (shown in **Figure 1.3**) mirror the first five stages of the dredge application (shown in **Figure 1.4**). This has been designed so that, should the dredge application commence, the dry sand extraction could transition into dredging, irrespective of what stage the project is at.

There is an estimated 3.1 million tonnes (Mt) of dry sand resource above the water table, within the project site. Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 140-6-2005) lapses in 2028, after which the site-wide extraction and dispatch limit would reduce to no more than 500,000 tpa.

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;
- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

As illustrated in **Figure 1.2**, the existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for potential firefighting efforts.

1.2 Management procedures

1.2.1 Documented plans

Existing and previous rehabilitation and landscape management plans (RLMPs) for the site are summarised below:

- RW Corkery & Co Pty Ltd (2018), *Rehabilitation and Landscape Management Plan for the Stockton Transgressive Dune Quarry*. Prepared for Boral Resources (NSW) Pty Ltd. September 2018.
- Environmental Compliance Services (2017), *Stockton Transgressive Dune Quarry, Rehabilitation and Landscape Management Plan.* Prepared for Boral Resources (Country) Pty Ltd. March 2017.
- Environmental Resources Management Australia (ERM, 2010b), *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry*, Prepared for Boral Resources (NSW) Pty Ltd. August 2010.

1.2.2 Use of materials

Similar to previous operations of the inland extraction area, sand extraction would involve clearing and grubbing of established vegetation from previous rehabilitation and possible screening of accumulated leaf litter and organic matter. Vegetation would be cleared progressively to limit the exposure of bare sand. Cleared vegetation would be mulched and reused during rehabilitation works. As vegetation clearance and reuse is progressive, it is anticipated that minimal excess, residual mulch would be generated during site activities and this excess would be taken off-site.

Boral is currently in discussion with other business operators (including landscaping suppliers) to better understand the demand for mulch as a potential re-use option. Re-using mulch onsite (including in the rehabilitation of Pit 7) would be in-line with the fundamental principles of the waste hierarchy and minimise disposal as waste. Where no reuse options can be identified, excess material would be disposed offsite to landfill.

Any stripped topsoil would also be retained for use in rehabilitation efforts across the site.

Sand would first be removed via a front-end loader which pushes into the exposed sand face. As the sand is relatively free-flowing, material falls towards the front-end loader at the natural angle of repose.

The sand would then be screened and stockpiled before a front-end loader then loads road trucks in-pit with screened raw sand for transport off-site via the weighbridge. Material obtained from Stages 2-5 would be sand washed onsite prior to removal.

1.3 Objectives

The objective of this report is to review the current rehabilitation efforts at the site and to prepare a rehabilitation strategy specific to the project through addressing the SEARs and informing preparation of the EIS.

1.4 Secretary's Environmental Assessment Requirements

This rehabilitation strategy addresses the requirements of the SEARs for land rehabilitation for the project. The SEARs are:

Rehabilitation – including the proposed rehabilitation strategy for the site having regard to the key principles in the Strategic Framework for Mine Closure, including:

- *rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria;*
- *nominated final land use, having regard to any relevant strategic land use planning or resource management plans or policies; and*
- *the potential for integrating this strategy with any other rehabilitation and/or offset strategies in the region.*
- *a detailed description of the measures that would be put into place to ensure sufficient resources are available to implement the proposed rehabilitation measures, and the ongoing management of the site following the cessation of quarrying activities.*

The requirements of the SEARs with reference to locations within this rehabilitation plan are presented in **Table 1**.

Table 1: Requirement of the SEARs

SEARs	Location in rehabilitation plan
Rehabilitation objectives	Sections 4.1
Rehabilitation methodology	Section 4.0
Rehabilitation monitoring programs	Section 4.7
Rehabilitation performance standards	Section 4.8
Proposed completion criteria	Section 4.9
Nominated final land use	Section 4.3
Integration of rehabilitation strategy	Section 3.4
Ongoing management of the site post closure	Section 4.7.3

2 EXISTING ENVIRONMENT

2.1 Topography and vegetation

The project site is generally consistent with the same disturbance footprint associated with the former inland extraction area approved and rehabilitated under the 1996 development consent, except for areas to east and south east of Lot 3 DP 664552 (refer **Figure 1.1**) and along the southern edge to allow for the construction of new haul roads.

A site inspection of rehabilitated areas within the project site identified that the majority had been revegetated by planting of trees. Areas of more recent revegetation had established dense growth of young trees and shrubs. Where rehabilitation has been less successful, growth of trees and shrubs remains stunted, and areas of open sand remain.

The surrounding natural woodland vegetation was identified to consist predominantly of:

- Swamp Mahogany (*Eucalyptus robusta*); and
- Coastal Wattle (*Acacia sophorae)*; with
- Beach Fescue (*Austrofestuca littoralis)*; and
- Pig Face (*Carpobrotus glaucescens*) in open areas.

2.2 Site hydrogeology

Site hydrogeology information has been adopted from Environmental Earth Sciences (2023), *Stockton Quarry Sand Extraction Project – Acid Sulfate Soils and Groundwater Advice Letter* (ref: 122091L01V04 draft, dated 27 March 2023). Refer to this document for more detailed information. Based upon these findings the hydrogeological model at the project site is characterised by the following two aquifers, with features presented below:

- **Stockton Sandbeds and transgressive sand dunes**:
    - Main aquifer directly underlying the Project Area and comprises the Stockton Groundwater Source of the Water Sharing Plan (WSP) for the North Coast Coastal Sands Groundwater sources.
    - Unconfined / shallow (10 – 30 m thick).
    - Overlies eastern extremity of deeper Tomago Sandbeds Aquifer.
    - Aquifer testing confirmed aquifer is very permeable (hydraulic conductivity (K) values between 6 and 55 m / day.
    - Transmissivity (KD) values up to between 50 and 4,627 m^2/day.
    - Due to the low hydraulic gradient (0.002 m/m or 0.2%).
    - Groundwater velocities accordingly low (12.6 – 116 m/year).

  - Monitoring records identify two primary flow directions for groundwater, either to the north west towards Fullerton Cove, and the Tomago Groundwater Source, or to the south east towards Stockton Beach.

  - Groundwater flux through the area of the proposed extraction area has been estimated at 600 m^3/day (219 megalitres (ML) per annum), equating to a groundwater flux of approximately 18 ML/month.

- **Tomago Sandbeds**:

  - Shallow, unconfined, rainfed aquifer.

  - Runs parallel to the coast which contributes to the lower Hunter drinking water supply.

  - There is a groundwater divide which runs in a northeast to southwest direction to the southeast of the proposed windblown sand extraction area.

  - Groundwater monitoring records identify two primary flow directions for groundwater, either to the north west towards Fullerton Cove, and the Tomago Groundwater Source, or to the south east towards Stockton Beach.

A search of registered groundwater licenses surrounding the project site indicates seven boreholes within a 3 km radius of the site that are registered for any purpose other than monitoring. Two are registered for domestic use and are located approximately 1.4 km and 1.5 km to the north and west of the site respectively, and one is located 3 km to the south-west and is registered for use as irrigation.

Within the project site are two shallow monitoring bores (ID: MW_X3 shallow and MW_X4 shallow) one to the south and north respectively. During historical monitoring between 2017 and 2020, the static water levels (SWLs) appear to be very similar at these points, with groundwater interpreted to flow from east to west across the site.

A study using hydrographs demonstrated that a high quantity of rainfall was required to raise the SWL, and also demonstrated the rate at which it then dropped back down.

Utilising data from surrounding off-site bores, a variance in hydraulic head of approximately 0.5 mAHD is inferred across the site, from east to west. Therefore, it can be conservatively assumed that the maximum level of groundwater onsite will be to the eastern boundary and be approximately 3.0 mAHD.

For the dredge application, to be in accordance with DPIE Water and the Natural Resources Access Regulator (NRAR) requirements (DPIE 2021), the sand extraction would need to occur with a 0.7 m buffer above the water-table with the final landform to be a minimum of 1 m above the groundwater table, consistent with other approved projects in the area.

3 ASSESSMENT OF EXISTING REHABILITATION ACTIVITIES

3.1 General

To assess the efficacy of the rehabilitation activities completed (and currently ongoing) at the site, identify areas of potential improvement, and inform future rehabilitation strategies (proposed to be implemented to support site revegetation), Environmental Earth Sciences completed the following activities:

- Site inspection (7 June 2019) to assess the status of rehabilitation works undertaken in the former inland extraction area. The inspection aimed to assess the efficiency of rehabilitation strategies used to date, with consideration of time since rehabilitation and any localised site conditions which may have influenced vegetation establishment. The findings of the inspection were then used to inform recommendations for rehabilitation of the project site.

- Review of existing, available rehabilitation and landscape management plans with respect to site observations and success (or otherwise) of rehabilitation activities completed at the site to date.

Details of the site inspection and rehabilitation review findings are provided in **Section 3.2** and **Section 3.3**.

3.2 Site inspection observations

Rehabilitation activities have generally been successful at the quarry to date. The degree of vegetation establishment largely depends on the duration since sand extraction activities ceased, with the western portion of the former inland extraction area having well established tree cover, while the eastern portion of the former inland extraction area had smaller trees and shrubs. The following observations were made at the time of the site inspection:

- The successful species in rehabilitated areas consisted predominantly of:
    - Trees – Swamp Mahogany (*Eucalyptus robusta*);
    - Shrubs – Coastal Wattle (*Acacia sophorae*);
    - Grasses – Beach Fescue (*Austrofestuca littoralis*); and
    - Ground cover – Pig Face (*Carpobrotus glaucescens*).
- Poor vegetation establishment has occurred in some areas. This has been attributed to:
    - Areas exposed to high winds which disturb surface soil, particularly on elevated slopes;
    - Areas where nutrient deficiency limits plant growth – this has been observed due to utilisation of coal by-product (chitta) for construction of the haul road resulting

in depleting the landscape of nitrogen and other nutrients. Areas of 'pure' sand are also subject to nutritional deficiencies; and

Limited water availability, observed on high exposed dunes, and potentially the cause of poor vegetation establishment over former haul roads due to soil compaction.

Environmental Earth Sciences was advised by Boral that weed management has progressed from blanket treatment and now focuses on physical removal of re-grown weeds. The noxious weed Bitou bush was not observed during the site inspection.

A summary of the inspected areas is presented in **Table 2** below. Photographs are presented in **Appendix A**.

Table 2: Rehabilitation areas summary

Rehabilitation area	Observations
Stage 1	Photograph 1. Successful revegetation across a large portion of the area, establishment of a variety of tree species and grass understory. Photograph 2. Small area of exposed sand east of haul road. Poor establishment due to windblown sand.
Stage 2	Photographs 3 & 4. Areas of poor tree establishment and patchy soil cover. Windblown sand. Rehabilitation more recent in this area.
Stage 3 / 4	Photograph 5. Large areas of successful revegetation with young trees and dense shrubs. Photographs 6 & 7. Successful revegetation across the majority of the area. Patchy regrowth in some areas, particularly along a former haul road – attributed to nitrogen deficiency related to use of coal by-product for road construction.
Stage 5	Photograph 8. Established trees with shrub understory. Leaf litter layer on ground surface. Photograph 9. Patchy understory and lack of soil cover in small areas within Stage 5.

3.3 Review of current rehabilitation methodology

Based on the findings of the rehabilitation review, and the rehabilitation requirements of the project, the following recommendations have been made:

- Aspects of the existing rehabilitation process that are considered successful and should continue:
    - Species selection has facilitated establishment of a diverse and robust ecological environment which is representative of local native vegetation; and
    - Weed management has been successful in removing targeted species and preventing infestation.
- Aspects of the existing rehabilitation process that could be improved for future works:

- Areas subject to high winds, such as elevated dunes, require additional stabilisation to allow vegetation establishment. These areas may also require use of more robust species, such as spinifex to stabilise soil;
- Areas subject to compaction and heavy impact, such as haul roads, may require deep ripping prior to rehabilitation to improve soil water availability and allow root penetration of soil;
- Targeted application of suitable fertilizer, and/or use of nitrogen fixing plant species may improve plant establishment in some areas; and
- Species selection should facilitate development of understorey vegetation adjacent to retained coastal woodland community, with low ongoing maintenance.

4 REHABILITATION MANAGEMENT STRATEGY

4.1 General

The following sections detail proposed additions and/or updates to the existing rehabilitation management/ landscape management actions to ensure an appropriate strategy is maintained and managed for the progressive rehabilitation of terrestrial areas at the site.

To assist in the preparation of the rehabilitation strategy for the project, the NSW Department of Trade and Investment (ESG3) *Mining Operations Plan (MOP) Guidelines* (September 2013) guideline has been referred to.

It is noted, whilst the project does not involve mining, that is, the project is a quarrying operation, this guidance is a suitable guide to preparing an appropriate rehabilitation strategy.

Note: The following sections have been prepared to provide information and guidance in-line with the rehabilitation strategy. This information should be considered to inform preparation / update of any associated management plan(s).

4.2 Integration with existing rehabilitation

The post-quarrying landscapes associated with the former inland extraction area have been rehabilitated in accordance with the ERM (2010b), *Rehabilitation and Landscape Management Plan, Stockton Transgressive Dune Quarry*. Boral Resources (NSW) Pty Ltd, dated August 2010 (ref: 0119396 RLMP Final).

While the rehabilitation of these areas has been largely successful, some aspects of the rehabilitation indicate areas where improvements and efficiencies can be made. These findings have been incorporated into the development of this rehabilitation strategy.

This rehabilitation strategy aims not only to integrate the successful aspects of the previous strategies in the ongoing works to provide the benefit of consistency in approach for site operators, consistent use of rehabilitation species and continuity for site suppliers.

4.3 Rehabilitation timeline

A summary and timeline for mitigation, rehabilitation, monitoring and maintenance works for the project has been set out in **Table 3** below.

Table 3: Proposed rehabilitation and management timeline

Site section	Mitigation / Rehabilitation measure	Timeframe
Entire site	Topographical survey of current landform levels to inform rehabilitation, vegetation and monitoring.	Prior to site establishment.
Site periphery	Maintain vegetative screen between project site and site boundaries.	Ongoing
	Monitor vegetative screen to ensure it remains intact and sufficient to provide screening function for operations.	During sand extraction and ongoing
	Removal of undesirable weed species and vegetation not consistent with the local vegetative succession.	Ongoing maintenance
	Revegetation of any disturbed areas by way of selective planting with species native to the locality	Ongoing

4.4 Final landform – terrestrial areas

The proposed final land use of the project site once dry sand extraction operations cease is to re-plant species endemic to coastal woodland. Environmental Earth Sciences note that should the dredging SSD also be approved, then the original Rehabilitation Strategy (ref: 717041_Rehabilitation Plan_V3, dated 24 November 2020) can be referred to in place of this document.

As the land would be cleared for the purposes of quarrying the sand resource to a maximum depth of 0.7 m above the groundwater table, there would be a requirement to revegetate post completion.

The following terrestrial areas on completion of the proposed expanded extraction activities would require specific rehabilitation/ revegetation:

- Where native vegetation has been cleared across the entire inland dry sand extraction area; and
- Where native vegetation has been cleared for project-specific infrastructure (e.g., haul road corridors/ accessways).

Rehabilitation activities in these areas would comprise soil preparation (i.e., deep ripping haul road corridors) and establishment of native vegetation in disturbed areas to minimise soil erosion and establish slope stability.

4.5 Vegetation management

It is recommended that a screen or buffer zone of native trees remains on site between the project site and the quarry property boundaries to ensure minimal disruption to the greater community through visual amenity, noise, dust etc.

An offset zone of 10 m is proposed along the northern perimeter of the proposed extraction area and a 20 m offset zone, including a 10 m haul road, is proposed to the east, south and south west of the proposed extraction area. The two-way haul road would provide access for routine rehabilitation / maintenance works, and for safety purposes to provide access for fire services etc. The offset zones would require routine management and maintenance throughout the life of the project.

4.6 Species selection for landscape position

Within the project site, species selection should consider landscape position in relation to beach dune vegetation zones (**Figure 1**). The beach dune vegetation zones are specifically relevant to high exposed dunes, whereby relatively high winds impact soil stabilisation. A summary of suitable revegetation species is presented in **Table 4**. Note that the list provides a wide range of potential species for use but is not exhaustive. Use of **all** species listed is not required.

4.6.1 Stabilisation and revegetation of disturbed areas

It is recommended that a project-specific Rehabilitation and Landscape Management Plan (RLMP) is prepared for the project as a post-approval requirement. The RLMP should address:

- the landscape units within each rehabilitation area;
- species and numbers of plants required for each rehabilitation area;
- site preparation requirements – including earthworks and deep ripping;
- soil stabilisation, erosion control and plant protection requirements for each stabilisation area; and
- watering and maintenance requirements until plants are established.

Species selection for each area should also address species diversity and succession over time. While some species, such as wattles, may perform well in the short term, they may result in a monoculture which inhibits establishment of other species. Wattles are also relatively short lived and may die out and create a bushfire hazard.

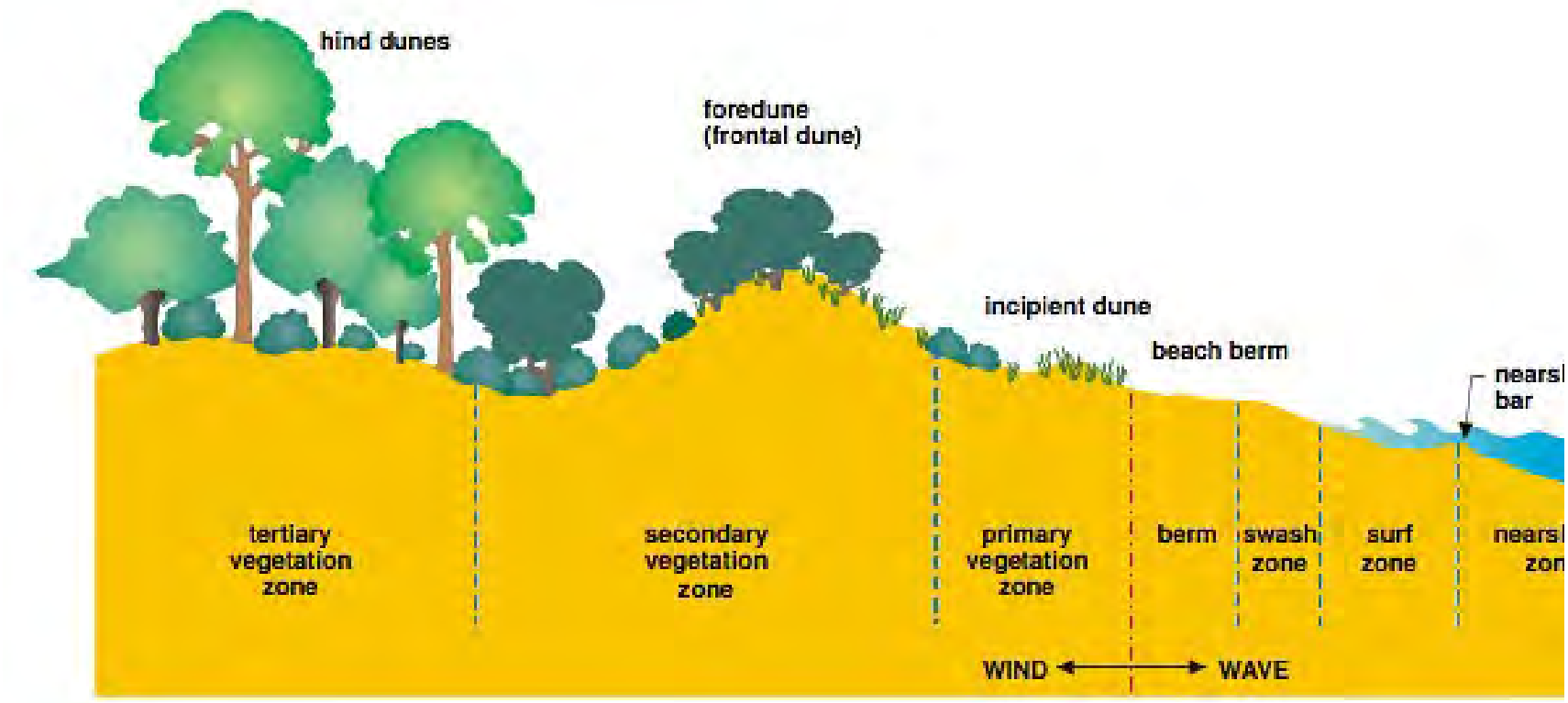

Figure 1: Identification of beach dune vegetation zones (NSW Department of Land and Water Conservation 2001)

Table 4: Tertiary vegetation zone - revegetation species

Species	Vegetation class	Vegetation zone (Terrestrial)				Suitability notes	
		Riparian	Emergent	Fore Dune	Hind Dune	Commentary	Successful previous use on site?
Broad leaved Paperbark (*Melaleuca quinquenervia*)	Tree	✓	✓		✓	Grows in swampy conditions and can regenerate within weeks of a bushfire.	✓
Swamp Mahogany (*Eucalyptus robusta*)	Tree	✓			✓	Grows in swampy sandy conditions and is tolerant of waterlogging.	✓
Smooth-barked Apple (*Angophora costata*)	Tree				✓	Large tree, suitable for elevated, but not exposed locations.	
Blackbutt (*Eucalyptus pilularis*)	Tree	✓			✓	Large tree common in grassy coastal forests.	
Red bloodwood (*Corymbia gummifera*)	Tree	✓			✓	Common to coastal flats and low hills. Tolerant of poorer, sandy soils.	
Coastal Wattle (*Acacia sophorae*)	Shrub	✓		✓	✓	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Wattles may have relatively short lifespan.	✓
Sydney Golden wattle (*Acacia longifolia*)	Shrub	✓		✓	✓	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Subspecies of Coastal wattle. Wattles may have relatively short lifespan.	
Sweet wattle (*Acacia suaveolens*)	Shrub	✓		✓	✓	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas. Nitrogen fixing species. Wattles may have relatively short lifespan.	

Species	Vegetation class	Vegetation zone (Terrestrial)				Suitability notes	
		Riparian	Emergent	Fore Dune	Hind Dune	Commentary	Successful previous use on site?
Coastal Teatree (*Leptospermum laevigatum*)	Shrub			✓	✓	Salt and drought tolerant.	✓
Coastal Banksia (*Banksia integrifolia*)	Shrub			✓	✓	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients.	✓
Old Man Banksia (*Banksia serrata*)	Shrub			✓	✓	Thrives in sandy conditions and suitable for the stabilisation of sand and enables the solubilisation of nutrients.	
Tree Broom Heath (*Monotoca elliptica*)	Shrub			✓	✓	Long lived and hardy dune species. May be difficult to propagate from seeds – cuttings may perform better.	
Common Bush Hop (*Dodonaea triquetra*)	Shrub	✓			✓	Forest understory.	
Pig Face (*Carpobrotus glaucescens*)	Ground cover			✓#	✓	Has the capacity to capture windblown sands resulting in the formation of hummocks. Beneficial for windblown and exposed areas.	✓
Beach Fescue (*Austrofestuca littoralis*)	Grass			✓#	✓	Endemic beach grass species.	✓
Blue Flax Lily (*Dianella caerulea*)	Understory	✓		✓	✓	Hardy and long-lived. Tolerant of a range of moisture conditions.	
Kangaroo Grass (*Themeda australis*)	Grass			✓#		Widespread native grass, tolerant of a range of conditions.	
Bracken Fern (*Pteridium esculentum*)	Understory			✓#	✓	Quick to colonise disturbed areas. Common in coastal woodlands. May be invasive.	

Species	Vegetation class	Vegetation zone (Terrestrial)				Suitability notes	
		Riparian	Emergent	Fore Dune	Hind Dune	Commentary	Successful previous use on site?
Spiny Headed Mat-Rush (*Lomandra longifolia*)	Rush	✓	✓			Tolerant of wet and drought conditions.	
Cogon Grass (*Imperata cylindrica*)	Grass			✓#		Tolerant grass used for ground cover and erosion control. May be invasive and difficult to control. Highly flammable.	
Beach Spinifex (*Spinifex sericeus*)	Grass			✓#		Deep roots to stabilise sand and prevent moisture loss. Recommended for locations where establishment of other vegetation has proven unsuccessful.	✓

Notes:

1. Information regarding collection of seed and runners, germination and planting, fertilisation and watering are provided in the Stockton Transgressive Dune Quarry Rehabilitation and Landscape Management Plan (2010).
2. # Including exposed dune.

4.6.2 Pest and weed management

The following procedures should be considered for continued pest / weeds management:

- Regular inspections should be conducted to assess the presence of pests and weeds;
- Manual removal has been successful in maintaining control over populations at the quarry;
- Targeted spraying or removal may be required during the project; and
- Potential for animal or insect pest infestation should be monitored and managed as required.

Specifically, bitou bush has previously been a problem at the quarry, however recent management strategies have substantially reduced occurrence.

4.7 Management and control methods

4.7.1 Erosion and sediment control

Due to the porous nature of sand at the project site, there is deemed a low likelihood of significant overland surface water movement and/or formation of drainage pathways. However, in the unlikely event such is observed within the project lifespan, erosion and sediment controls should be implemented and maintained. This should be undertaken on an “as needs” basis through the project lifespan and until rehabilitated areas have adequately established.

Mechanisms for the control of surface water movement may include the following (as necessary):

- Diversion of ‘clean’ overland flow to the project site away from ‘dirty’ areas;
- Vegetation and maintenance of drainage pathways to minimise erosion and sediment accumulation in flowing water;
- Corrective actions, relating specifically to:
    - maintaining, repairing and cleaning out sediment control structures in order to maintain compliance with the erosion and sediment control plan for the project (i.e., vegetated bund); and
    - repairing eroded areas.

4.7.2 Dust control

Dust suppression methods should be used on the existing and proposed haul roads for the project and except for Stage 1, progressive sand extraction within Stages 2 - 5 should seek to limit exposed ground surfaces to a maximum of 200 - 300 m at any one time to ensure that resource is not lost through exposure to prevailing winds.

4.8 Rehabilitation inspection schedule

As discussed above, the rehabilitation process should involve regular inspections to monitor the progress of rehabilitation activities, and proactively identify any problems with the remediation process. Monthly and annual inspections are recommended as detailed in the sections below.

4.8.1 Monthly site monitoring

Monthly monitoring of areas relevant to progressive site rehabilitation should continue, as outlined in **Table 5**. Monitoring should focus on identification of any issues relating to terrestrial plant health or establishment and invasive species.

Monthly monitoring is recommended to commence from the establishment of revegetation and continue for three years.

Table 5: Monthly monitoring areas

Area/ item	Monitoring requirement
General site	• Occurrence of weeds or pests. • General health of vegetation.
Established revegetation areas	• Occurrence of weeds or pests. • Health and growth of plants. • Extent of vegetation cover. • Suitability of plant stock for seed or runner collection.
Trial plantings / Rehabilitation areas	• Occurrence of weeds or pests • Health and growth of plants.

4.8.2 Annual site inspection

An independent inspection of the rehabilitation process from Stage 1 should be conducted by a suitably experienced ecologist or environmental restoration consultant annually, from the commencement of rehabilitation activities.

It is recommended that a series of indicator sites (minimum of 10 randomly distributed sites across the project) are monitored to assess the progress of revegetation, with photographs taken to record site condition. The inspection should assess the site for compliance with the performance criteria, particularly the 50% LFA target (Landscape Function Analysis). The inspection should also assess occurrence of any weed species that may be present to facilitate management.

4.8.3 Long term monitoring of vegetation

It is anticipated that the management and monitoring of the rehabilitation process could extend to a period of up to 10 years from the commencement of rehabilitation of each section of the project area. The point of commencement is considered to be the site preparation and initial planting of those areas. The success of initial site preparation and vegetation establishment is likely to significantly reduce the management requirements for each area over time.

The duration of short to medium term management and monitoring period is estimated to require 1-5 years. This stage involves ensuring landscape stabilisation, vegetation establishment, erosion control and weed management.

If the short to medium term rehabilitation works are successful, monitoring should be substantially reduced over the long term. For the period between 5 - 10 years post rehabilitation monitoring frequency could be reduced. During this period the monitoring should focus on weed management, and species diversity and succession.

Annual site inspections by an ecologist should be maintained until criteria have been met.

4.9 Rehabilitation performance criteria

Performance criteria during rehabilitation of sand extraction landform should aim to meet the following:

- Stabilisation of the disturbed areas with re-established coverage of endemic species of vegetation; and
- Having a landscape function analysis (LFA) level of natural regeneration greater than 50% of the previously assessed National Bushland Control site, located within the quarry property.

4.10 Endpoint for rehabilitation

Rehabilitation would be deemed to be complete when the criteria in Section 4.9 have been achieved, specifically demonstrating that re-established vegetation communities are mature and free of significant weed and/or pest colonisation, requiring minimal to zero human intervention over a minimum period of 3 years.

It is anticipated that most of these criteria are likely to be fulfilled between 5 - 10 years post rehabilitation for each project stage. This would be assessed by the ecologist or environmental restoration consultant completing the annual inspections, who may then provide recommendation that ongoing inspections are no longer required.

4.11 Process of continual improvement

Based upon results and findings of monitoring and management during operations, there should be an aim to identify how both existing and new rehabilitation strategies could be improved, providing recommendations for updating RLMPs.

5 LIMITATIONS

This report has been prepared by Environmental Earth Sciences NSW ACN 109 404 006 in response to and subject to the following limitations:

1. The specific instructions received from Arnold Planning o/b Boral;

2. The specific scope of works set out in Variation 1 (ref: 122091_VAR1, dated 11 November 2022) of PO122180_V2 issued by Environmental Earth Sciences NSW for and on behalf of Boral, and current comments provided by Arnold Planning (emailed 21 March 2023);

3. May not be relied upon by any third party not named in this report for any purpose except with the prior written consent of Environmental Earth Sciences NSW (which consent may or may not be given at the discretion of Environmental Earth Sciences NSW);

4. This report comprises the formal report, documentation sections, tables, figures and appendices as referred to in the index to this report and must not be released to any third party or copied in part without all the material included in this report for any reason;

5. The report only relates to the site referred to in the scope of works being located at Stockton Sand Quarry, Cox's Lane Fullerton Cove NSW ("the site");

6. The report relates to the site as at the date of the report as conditions may change thereafter due to natural processes and/or site activities;

7. No warranty or guarantee is made in regard to any other use than as specified in the scope of works and only applies to the depth tested and reported in this report;

8. Fill, soil, groundwater and rock to the depth tested on the site may be fit for the use specified in this report. Unless it is expressly stated in this report, the fill, soil and/or rock may not be suitable for classification as clean fill, excavated natural material (ENM) or virgin excavated natural material (VENM) if deposited off site;

9. This report is not a geotechnical or planning report suitable for planning or zoning purposes; and

10. Our General Limitations set out at the back of the body of this report.

6 REFERENCES

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ENVIRONMENTAL EARTH SCIENCES
CONTAMINATION RESOLVED

ENVIRONMENTAL EARTH SCIENCES GENERAL LIMITATIONS

Scope of services
The work presented in this report is Environmental Earth Sciences response to the specific scope of works requested by, planned with and approved by the client. It cannot be relied on by any other third party for any purpose except with our prior written consent. Client may distribute this report to other parties and in doing so warrants that the report is suitable for the purpose it was intended for. However, any party wishing to rely on this report should contact us to determine the suitability of this report for their specific purpose.

Data should not be separated from the report
A report is provided inclusive of all documentation sections, limitations, tables, figures and appendices and should not be provided or copied in part without all supporting documentation for any reason, because misinterpretation may occur.

Subsurface conditions change
Understanding an environmental study will reduce exposure to the risk of the presence of contaminated soil and or groundwater. However, contaminants may be present in areas that were not investigated, or may migrate to other areas. Analysis cannot cover every type of contaminant that could possibly be present. When combined with field observations, field measurements and professional judgement, this approach increases the probability of identifying contaminated soil and or groundwater. Under no circumstances can it be considered that these findings represent the actual condition of the site at all points.

Environmental studies identify actual sub-surface conditions only at those points where samples are taken, when they are taken. Actual conditions between sampling locations differ from those inferred because no professional, no matter how qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden below the ground surface. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from that predicted. Nothing can be done to prevent the unanticipated. However, steps can be taken to help minimize the impact. For this reason, site owners should retain our services.

Problems with interpretation by others
Advice and interpretation is provided on the basis that subsequent work will be undertaken by Environmental Earth Sciences NSW. This will identify variances, maintain consistency in how data is interpreted, conduct additional tests that may be necessary and recommend solutions to problems encountered on site. Other parties may misinterpret our work and we cannot be responsible for how the information in this report is used. If further data is collected or comes to light we reserve the right to alter their conclusions.

Obtain regulatory approval
The investigation and remediation of contaminated sites is a field in which legislation and interpretation of legislation is changing rapidly. Our interpretation of the investigation findings should not be taken to be that of any other party. When approval from a statutory authority is required for a project, that approval should be directly sought by the client.

Limit of liability
This study has been carried out to a particular scope of works at a specified site and should not be used for any other purpose. This report is provided on the condition that Environmental Earth Sciences NSW disclaims all liability to any person or entity other than the client in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by any such person in reliance, whether in whole or in part, on the contents of this report. Furthermore, Environmental Earth Sciences NSW disclaims all liability in respect of anything done or omitted to be done and of the consequence of anything done or omitted to be done by the client, or any such person in reliance, whether in whole or any part of the contents of this report of all matters not stated in the brief outlined in Environmental Earth Sciences NSW's proposal number and according to Environmental Earth Sciences general terms and conditions and special terms and conditions for contaminated sites.

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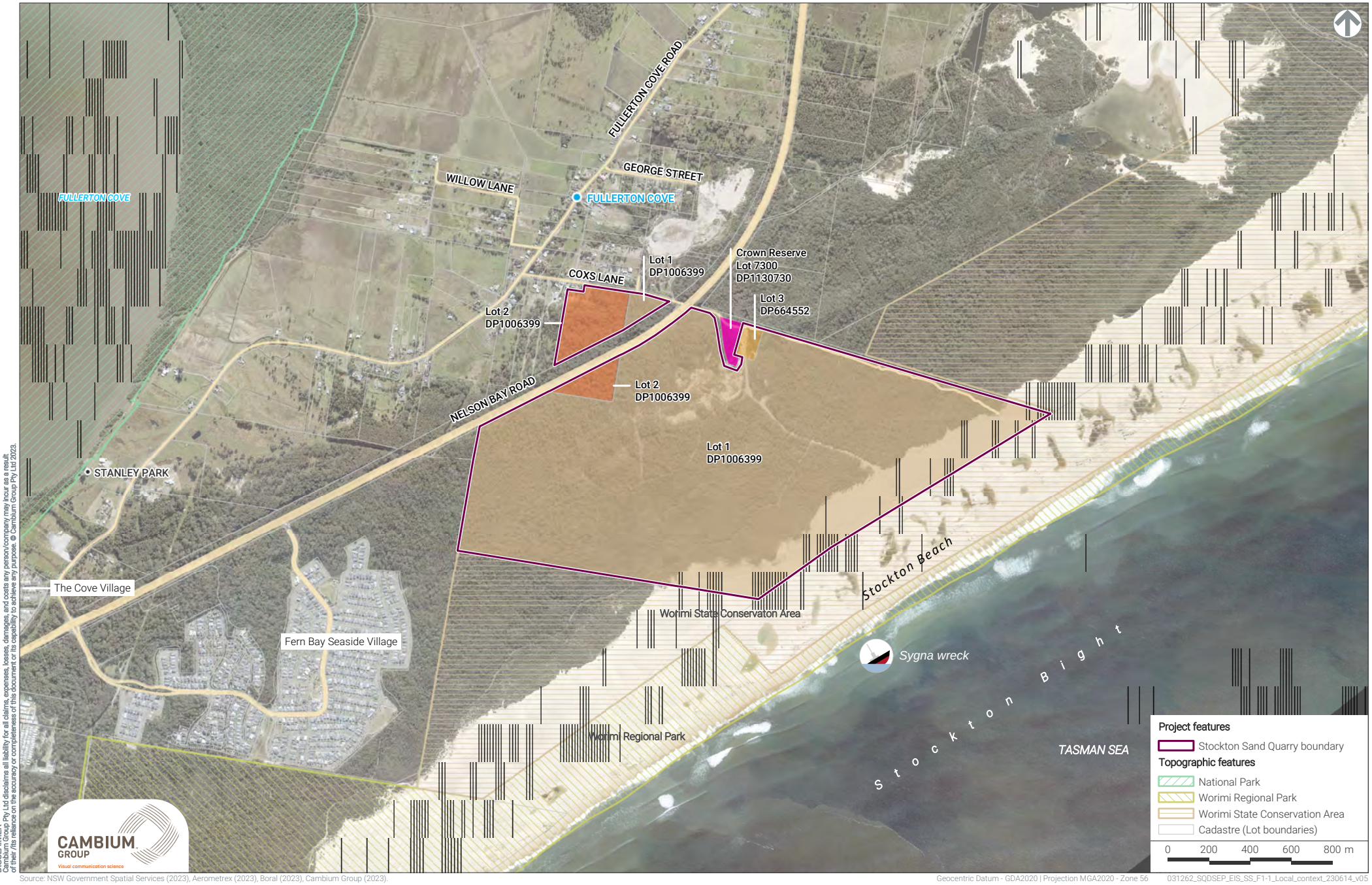
FIGURES

Figure 1.1
Local context



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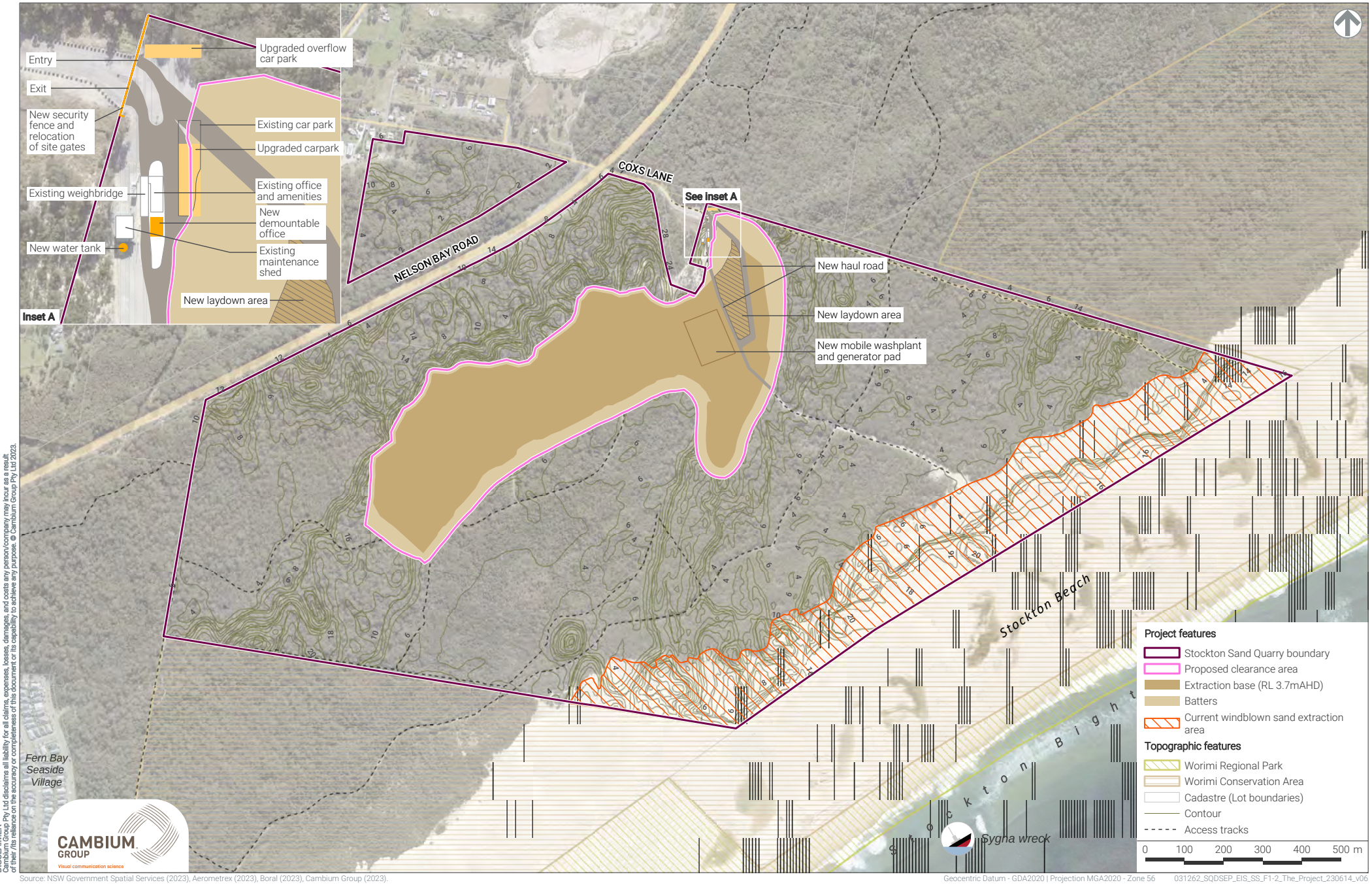
Geocentric Datum - GDA2020 | Projection MGA2020 - Zone 56 031262_SQDSEP_EIS_SS_F1-1_Local_context_230614_v05

Figure 1.2
The Project



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Source: NSW Government Spatial Services (2023), Aerometrex (2023), Boral (2023), Cambium Group (2023).

Figure 1.3
Extraction staging plan (The Project)

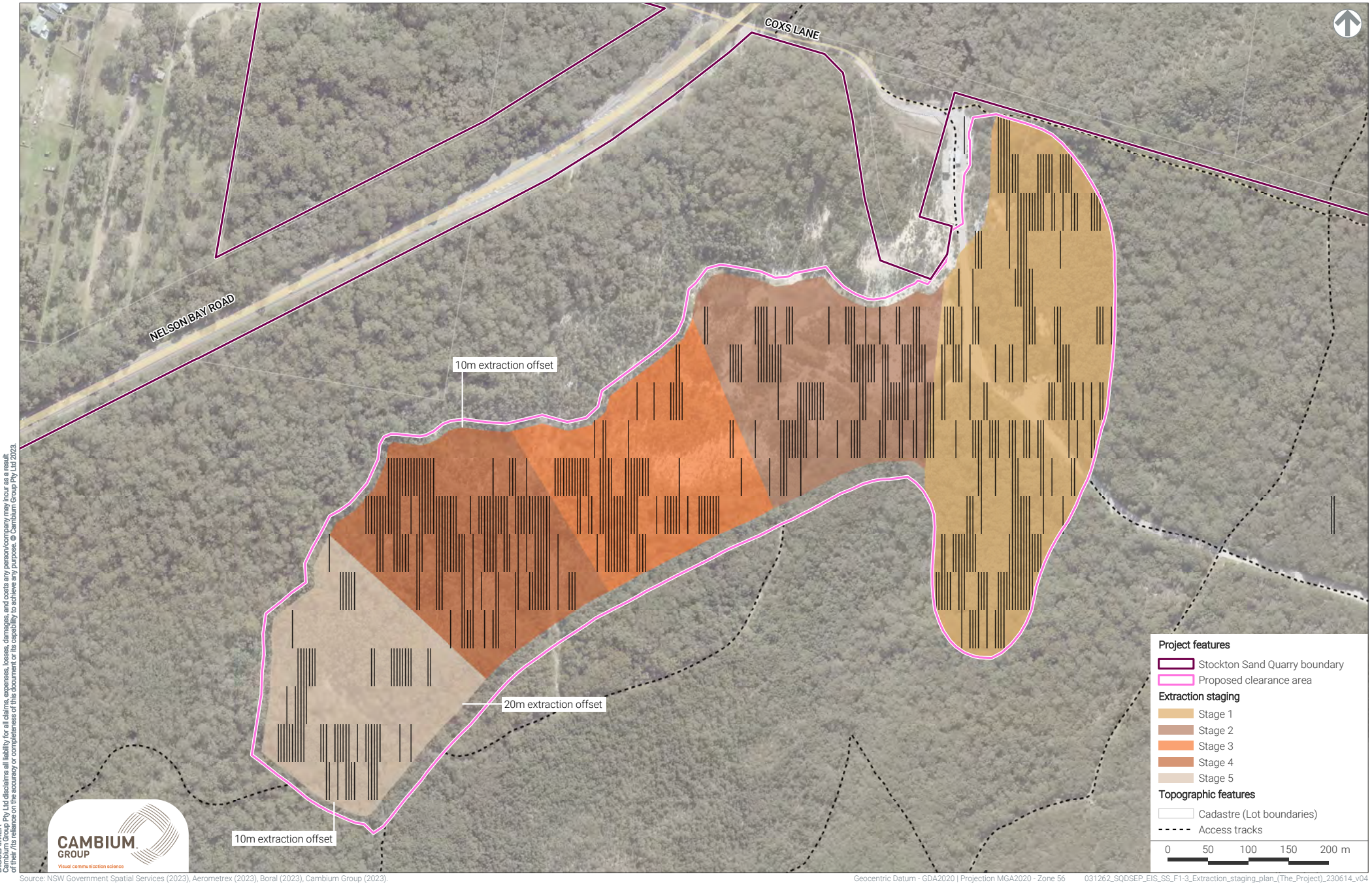

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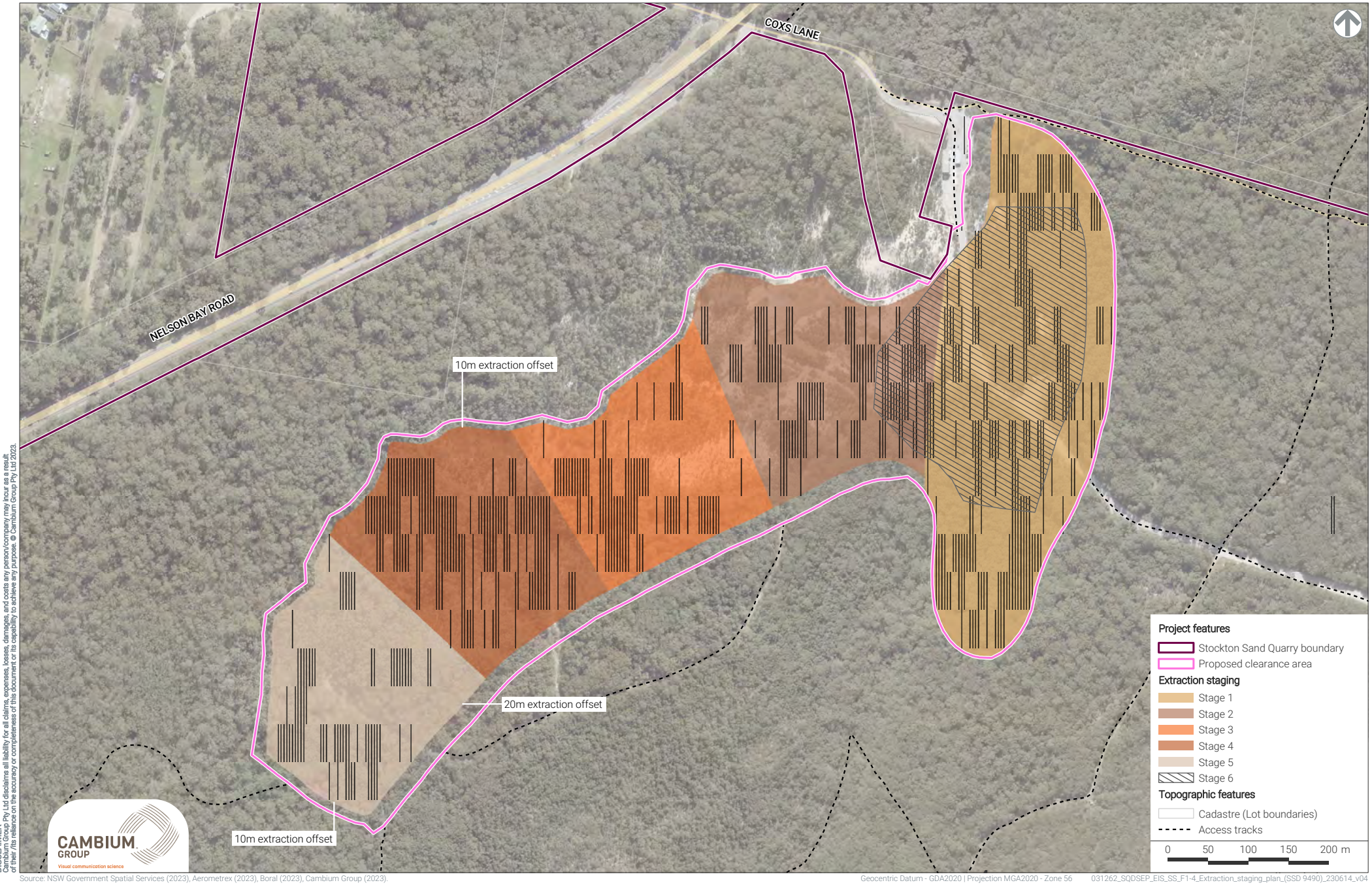
Figure 1.4
Extraction staging plan (SSD 9490)



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APPENDIX A: PHOTO PLATES

1. Successful rehabilitation in Stage 1

2. Rehabilitation poor surface stabilisation in one small area - east of the haul road.

3. Areas of stunted growth in Stage 1 and Stage 2

4. Areas of stunted growth in Stage 1 and Stage 2

5. Successful rehabilitation in remaining areas of Stage 4

6. Northern boundary between Stage 3 and Stage 4

7. Northern boundary between Stage 3 and Stage 4

8. Successful rehabilitation of Stage 5

9. Slow growth in small area of Stage 5

Appendix Q

Bushfire assessment report

BUSHFIRE ASSESSMENT REPORT

STOCKTON SAND EXTRACTION
INTERIM LAND USE PROPOSAL

LOT 3 DP 664552, Lots 1 and 2 DP 1006399
Coxs Lane, Fullerton Cove

Date: **23/6/2023**

Prepared for: **Boral**

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Document Status

Revision No.	Issue	Description	Reviewed	Approved by Director
1	14/2/2023	Final	C.Couch	P.Couch
2	27/2/2023	Rev A – corrected project description	C.Couch	P.Couch
3	9/3/2023	Rev B – identification of the site as a smoke free site and vehicle parking	C.Couch	P.Couch
4	25/5/2023	Rev C – modification to haul road width	C.Couch	P.Couch
5	23/6/2023	Rev D – rewording of multiple sections of the report at client request	C.Couch	P.Couch

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1.0 EXECUTIVE SUMMARY AND COMPLIANCE TABLES

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).
Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 1)

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

This report has assessed the project against the requirements of section 4.14 of the NSW E*nvironmental Planning and Assessment Act 1979*, AS3959 (2018) Building in Bushfire-Prone Areas and Planning for Bush Fire Protection (2019).

This report establishes that the project is capable of complying with the acceptable solutions of Planning for Bush Fire Protection (2019).

TABLE 1 – PROPERTY DETAILS AND TYPE OF PROPOSAL

Applicant Name	Boral Resources (NSW) Pty Ltd		
Site Address	Coxs Lane, Fullerton Cove	**Lot/Sec/DP**	Lot 3 DP664552, Lots 1 and 2 DP 1006399
Local Government Area	Port Stephens	**FDI**	100
Bushfire Prone Land	Yes, mapped bushfire prone land		
Type of development	Extractive Industry	**Type of Area**	Existing sand quarry within forest
Special Fire Protection Purpose	No	**Flame Temperature**	1090K
Application Complies with Acceptable Solutions	Yes. Relevant specifications and requirements are satisfied	**Referral to RFS required**	Approval authority to determine referral

TABLE 2 – BUSHFIRE THREAT ASSESSMENT PORTABLE OFFICE BUILDING

	North	**East**	**South**	**West**
AS3959 (2018) Vegetation Structure	Forest	Forest	Forest	Scrub
Asset Protection Zone	65 metres	25 metres	25 metres	25 metres
Accurate Slope Measure	8 degrees downslope	12 degrees upslope	12 degrees upslope	12 degrees upslope
Slope Range	6 to 10 degrees downslope	Level/Upslope	Level/Upslope	Level/Upslope
AS3959 (2018) Bushfire Attack Level (BAL)	BAL-19	BAL-29	BAL-29	BAL-19

TABLE 3 – PLANNING FOR BUSHFIRE PROTECTION (2019) COMPLIANCE

Performance Criteria	Proposed Development Determinations	Method of Assessment
Asset Protection Zone	Asset Protection Zones have been determined in accordance with Planning for Bush Fire Protection (2019). The Asset Protection Zone will be maintained for the life of development and defendable space is provided onsite.	Acceptable Solution
Siting and Design	Buildings have been designed to minimise the risk of bushfire attack.	Acceptable Solution
Construction Standards **AS3959 – 2018**	Bushfire Attack Levels have been determined in accordance with Planning for Bush Fire Protection (2019). The highest Bushfire Attack Level to the proposed building was determined to be BAL-29. Non-residential Class 5 to 8 buildings require no specific level of construction in accordance with AS3959 (2018) and National Construction Code 2019. Structural fire protection measures are deemed adequate if located outside the flame zone.	Acceptable Solution
Private and or Public Road Infrastructure	The public road system is not affected or changed as part of this application.	Acceptable Solution
Property Access	Property access complies with Planning for Bushfire Protection (2019).	Acceptable Solution
Water and Utility Services	Water, electricity and gas services offer compliance with Planning for Bush Fire Protection (2019).	Acceptable Solution
Landscaping	Landscaping to comply with Planning for Bush Fire Protection (2019), appendix 4.	Acceptable Solution

TABLE 4 – REVIEW OF SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS (SEARS) FOR BUSHFIRE

Assessment Criteria	Compliance
The aims and objectives of Planning for Bushfire Protection (2019)	The aims and objectives are addressed in section 3.4 of this report.
Identification of potential ignition sources during construction and operation of the development	Potential ignition sources are detailed in section 7.0 of this report.
Handling and use of hazardous or dangerous goods (e.g. explosives for blasting and fuel)	The storage of fuels and hazardous materials are detailed in section 7.0 of this report.
Proposed bushfire protection measures for the development including vegetation management and fire suppression capabilities	Asset protection zones are based on Planning for Bushfire Protection (2019) and have the buildings located outside BAL-FZ. Fire response procedures from staff have been included in section 8.0 of this report.
Operational access for firefighting appliances to the site	Property access to the buildings complies with Planning for Bush Fire Protection (2019). Recommendations have been made on the safe access and egress of workers and firefighters along the haul road with adequate road widths and turning bays provided.
Emergency and evacuation planning	An emergency management plan shall be prepared for the site which considers bushfire.

2.0 INTRODUCTION

2.1 PROJECT DESCRIPTION

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

At present, there is an existing quarry located on the windblown sand extraction area, which transports up to 500,000 tonnes per annum (tpa) of product, with the consent (DA 140-6-2005) due to lapse in 2028. Owing to several years of sustained demand for sand, both locally and regionally, the resource has largely been depleted, with the current available resource expected to run out in December 2023. In anticipation of this, Boral submitted a State significant development (SSD) application (Ref: SSD 9490) to DPE in 2020, seeking consent to extract and dredge up to 9 million tonnes (Mt) of sand from the former inland extraction area (the dredge application).

Due to the ongoing delay in resolving outstanding water matters, in particular the effects of the dredging operation on the groundwater source, Boral has determined that to keep the quarry operating, an interim solution is required, and is seeking SSD consent (Ref: SSD 52984213) to extract only the remaining dry sand resource from within the same extraction area (the project).

Consistent with the originally proposed and exhibited dredge application, the project seeks a site-wide extraction and dispatch limit (i.e. the existing windblown project and the project combined) of no more than 750,000 tpa, until either:

- the dredge application is commenced, after which extraction under the project would transition to dredging at the approved rates; or
- the dredge application is not approved and the existing windblown consent (DA 1)

Boral is seeking consent to operate the project for 10 years, which provides for a contingency should the dredge application not be approved, as well as allowing for fluctuations in market demand.

Minimal site establishment works would be required given the existing operation, infrastructure and services at the site. Where new or augmented infrastructure is required, this would be delivered as part of Stage 1, and would generally include:

- construction of a new entry road and separate exit road to allow exiting vehicles to cross the existing weighbridge;

- construction of a new two-way haul road in the north-east part of the site (in the Stage 1 extraction area), which would provide access to the extraction stages to the south-west and continued access to the existing windblown project to the south-east;
- construction of a laydown area in the middle of the two-way haul road;
- construction of a pad between Stage 1 and Stage 2 and installation of the wash plant and water recycling and filter press;
- reconfiguration of the parking area to the south and inclusion of an overflow car parking area to the north on the existing hard stand; and
- relocation of the security gates northward across the entry road (which would enclose the parking area and the new entry road), and relocation of the docketing kiosk used to register vehicles entering the site.

The existing site depot would also be reconfigured for the project and would include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 litre water storage tank for bushfire fighting supply.

2.2 PURPOSE OF REPORT

The purpose of this report is to establish suitable bushfire mitigation measures for the proposed continued sand quarry operations on lands identified as Lot 3 DP664552, Lots 1 and 2 DP 1006399, Coxs Lane, Fullerton Cove, in order for the approval authority to make determination of the proposed development pursuant to the requirements of section 4.14 of the *NSW Environmental Planning and Assessment Act 1979*.

Development on Bush Fire Prone Land must satisfy the aim and objectives of Planning for Bush Fire Protection (2019). The aim of Planning for Bush Fire Protection is to use the NSW development assessment system to provide for the protection of human life (including firefighters) and to minimise impacts on property from the threat of bush fire, while having due regard to development potential, onsite amenity and protection of the environment.

More specifically, the objectives are to:

(i) Afford occupants of any building adequate protection from exposure to a bush fire;
(ii) Provide for a defendable space to be located around buildings;
(iii) Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition;
(iv) Ensure that safe operational access and egress for emergency service personnel and residents is available;
(v) Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ); and
(vi) Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting).

This report addresses the matters identified in A4.1 of appendix 4 of Planning for Bush Fire Protection (2019) and demonstrates that the proposal satisfies the aims and objectives of Planning for Bush Fire Protection (2019) by satisfying the performance criteria within section 4.3 of the document. The specific objectives for infill development are as follows:

- Ensure that the bushfire risk to adjoining lands is not increased;
- Provide minimum defendable space;
- Provide better bushfire protection, on a re-development site, than the existing situation. This should not result in new works being exposed to greater risk than an existing building;
- Ensure that the footprint of the proposed building does not extend towards the hazard beyond existing building lines on neighbouring land;
- Not result in an increased bushfire management and maintenance responsibility on adjoining landowners, unless they have agreed to the development; and
- Ensure building design and construction enhances the chances of occupant and building survival.

The recommendations within this report address the aims and objectives of Planning for Bush Fire Protection (2019) to reduce the risk of ignition of the buildings in a bushfire event and provide a safe working environment.

2.2 EXISTING INFRASTRUCTURE

Boral established a fenced depot as part of the previous inland extraction area project, this compound has been maintained as part of the ongoing operation. The fenced depot contains the following infrastructure:

- an amenities/office building providing an office, lunchroom, toilet and shower;

- weighbridge;
- designated parking area for employees and visitors; and
- maintenance shed for the front-end loader and a 4,200 litre above ground bunded fuel tank.

The existing site depot will be reconfigured to support the Project and will include the following:

- installation of a new prefabricated office building;
- relocation of onsite materials storage;
- replacement of roofing for the workshop; and
- installation of a 20,000 L water storage tank for bushfire fighting efforts.

3.0 BUSHFIRE ATTACK ASSESSMENT

3.1 VEGETATION CLASSIFICATION

Potential bushfire hazards were identified from Port Stephens Council's Bushfire Prone Mapping as occurring within the investigation area. Aerial mapping and inspection of the site reveals that the bushfire prone land map is reasonably accurate in respect to the current bushfire hazard.

The major vegetative threats have been determined using Keith (2004) to derive vegetation structures listed in Planning for Bush Fire Protection (2019). General vegetation structures have been translated to AS3959 (2018) groupings.

Primary Vegetation Structures have been identified in Figure 1 – Site Constraints Map and separation distances shown in Table 2 – Bushfire Attack Assessment.

3.2 EFFECTIVE SLOPE

Effective slope was measured using 2 metre contour data obtained from NSW Spatial Services and verified by a laser hypsometer on site. The laser hypsometer verified slope within the vegetation calculating effective fire run slope from 5 separate measurements in each dominant direction.

Effective Slopes have been identified in Figure 1 – Site Constraints Map and slope ranges are shown in Table 2 – Bushfire Threat Assessment.

3.3 BUSHFIRE ATTACK LEVELS

Bushfire attack levels and relevant construction levels in accordance with AS3959 (2018) have been demonstrated in Section 1 Executive Summary and Compliance Tables.

Features on or adjoining the site that may mitigate the impact of a high intensity bushfire on the proposed development
The bushland in close proximity to the buildings, is located upslope, which will result in reduced fire intensity and rate of spread. A large portion of the site near the buildings has been mined previously, with a significantly reduced fuel load.

Likely environmental impact of any proposed bushfire protection measures
Significant clearing is required for the proposed sand mine expansion with environmental studies to be completed.

3.4 COMPLIANCE WITH AIMS AND OBJECTIVES OF PLANNING FOR BUSHFIRE PROTECTION

The aims and objectives of Planning for Bushfire Protection (2019) are addressed below for a non-combustible industrial building.

Afford occupants of any building adequate protection from exposure to a bush fire
Following the establishment of an asset protection zone, the buildings within the existing site depot will have a reduced exposure to bushfire. Evacuation planning in the event of bushfire should clearly indicate to workers to evacuate early in a direction away from the fire.

Provide for a defendable space to be located around buildings
Defendable space is available around the buildings in the existing site depot. In the event of bush fire, firefighters will have direct access to the bushland via the internal road network of the quarry which will support firefighting efforts. In the event a fire front impacts on the buildings, defendable space is available surrounding the buildings from where the fire would be fought. A minimum 24 metre asset protection zone is recommended around the buildings.

Provide appropriate separation between a hazard and buildings which, in combination with other measures, prevent direct flame contact and material ignition
Following establishment of the asset protection zones the buildings in the existing site depot will be outside of BAL-FZ and exposed to BAL-29. The buildings excepting the relocatable office building are existing with the primary vulnerability being the subfloor.

Ensure that safe operational access and egress for emergency service personnel and building users is available

The property access to the buildings offers compliance with Planning for Bush Fire Protection access requirements. The road will be designed for the movements of large vehicles which exceeds the minimum widths of Planning for Bush Fire Protection.

Provide for ongoing management and maintenance of bush fire protection measures, including fuel loads in the asset protection zone (APZ)

The Quarry Manager shall maintain landscaping and fuel management in accordance with Appendix 4 of Planning for Bush Fire Protection 2019 and the NSW Rural Fire Service's document Standards for Asset Protection Zones.

Ensure that utility services are adequate to meet the needs of firefighters (and others assisting in bush fire fighting)

A 20,000 litre static water supply is required for the Project and should be equipped with firefighting fittings. Electrical supplies are located underground.

4.0 UTILITY SERVICES AND INFRASTRUCTURE

4.1 WATER SERVICES

The quarry is greater than a hectare in size with no hydrant access. A static water supply with provision for a minimum 20,000 litres shall be provided for the Project.

The following requirements should be adhered to for the water supply:

- The water source shall be made available or located within the inner protection area (IPA) and away from the structure.
- A hardened ground surface for truck access is to be supplied up to and within 4 metres of the water source.
- A 65mm metal Storz outlet with a gate or ball valve shall be provided.
- The water tank if located above ground shall be of a non-combustible material.
- Tanks and associated fittings on the hazard side of the building shall be provided with adequate shielding to mitigate the impact of flame contact and radiant heat and provide safe access for fire fighters.
- The gate or ball valve, pipes and tank penetration are adequate for full 50mm inner diameter water flow through the Storz fitting and are metal.
- All associated fittings to the tank shall be non-combustible.
- An 'SWS' marker shall be obtained from the local NSW Rural Fire Service and positioned for ease of identification by brigade personnel and other users of the SWS. In this regard:
    a) Markers must be fixed in a suitable location so as to be highly visible; and
    b) Markers should be positioned adjacent to the most appropriate access for the static water supply.

4.2 ELECTRICITY SERVICES

The existing electrical transmission lines are located underground and require no additional protection measures.

4.3 GAS SERVICES

No gas is presently stored onsite and no gas is proposed to be stored.

5.0 PROPERTY ACCESS

Property access is by way of Coxs Lane, providing access from the public road system to the quarry via a right of way on crown land.

The existing property access roads onsite shall comply with section 7 of Planning for Bush Fire Protection (2019). The new property access shall comply with the following:

- a minimum carriageway width of four metres
- a minimum vertical clearance of four metres to any overhanging obstructions, including tree branches.
- internal roads for rural properties provide a loop road around any dwelling or incorporate a turning circle with a minimum 12 metre outer radius.
- curves have a minimum inner radius of six metres and are minimal in number to allow for rapid access and egress.
- the minimum distance between inner and outer curves is six metres.
- the crossfall is not more than 10 degrees.
- maximum grades for sealed roads do not exceed 15 degrees and not more than 10 degrees for unsealed roads.
- Haul roads onsite are 10 metres in width with no additional passing bays required.

A perimeter road will be constructed progressively along the southern edge of the Project area.

PHOTOGRAPH 1 – SITE OFFICE PHOTO

View of the existing site office, amenities, workshop and weighbridge looking south. A processing plant will be located south of the cluster of buildings within the Stage 1 extraction area.

PHOTOGRAPH 2 – WESTERN VEGETATIVE THREAT

View of coastal scrub located west of the workshop with coastal dune forest located further west. The forest is dominated by eucalypts and banksias with an understorey of native shrubs and grasses.

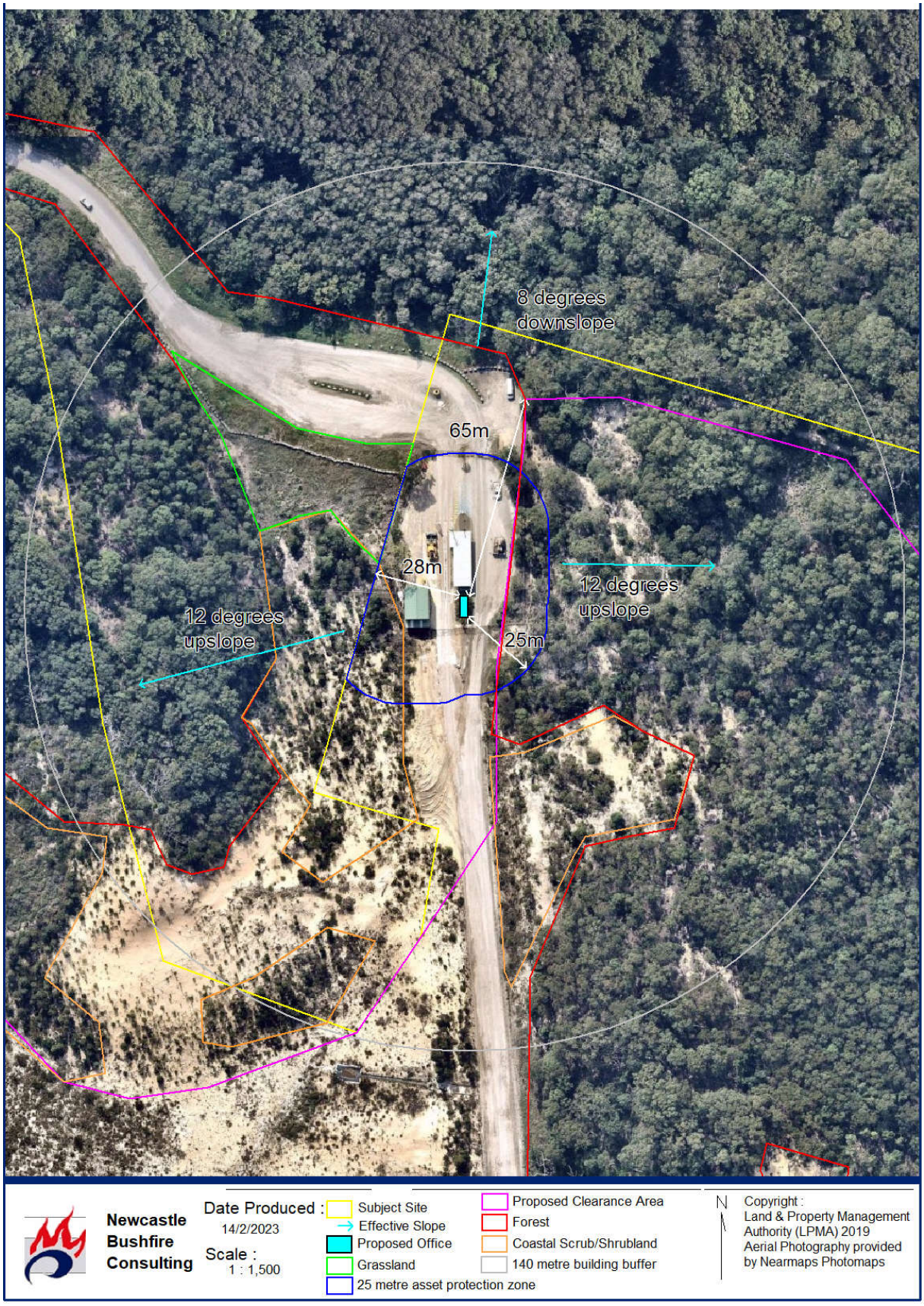

FIGURE 1 – SITE CONSTRAINTS MAP

FIGURE 2 – LOCALITY MAP
Courtesy of OpenStreetMap

PHOTOGRAPH 3 – SITE ACCESS

View of property access to Coxs Lane which provides good access and egress to the site. The current and future access is designed for trucks larger than a medium rigid vehicle with good access to fight fire.

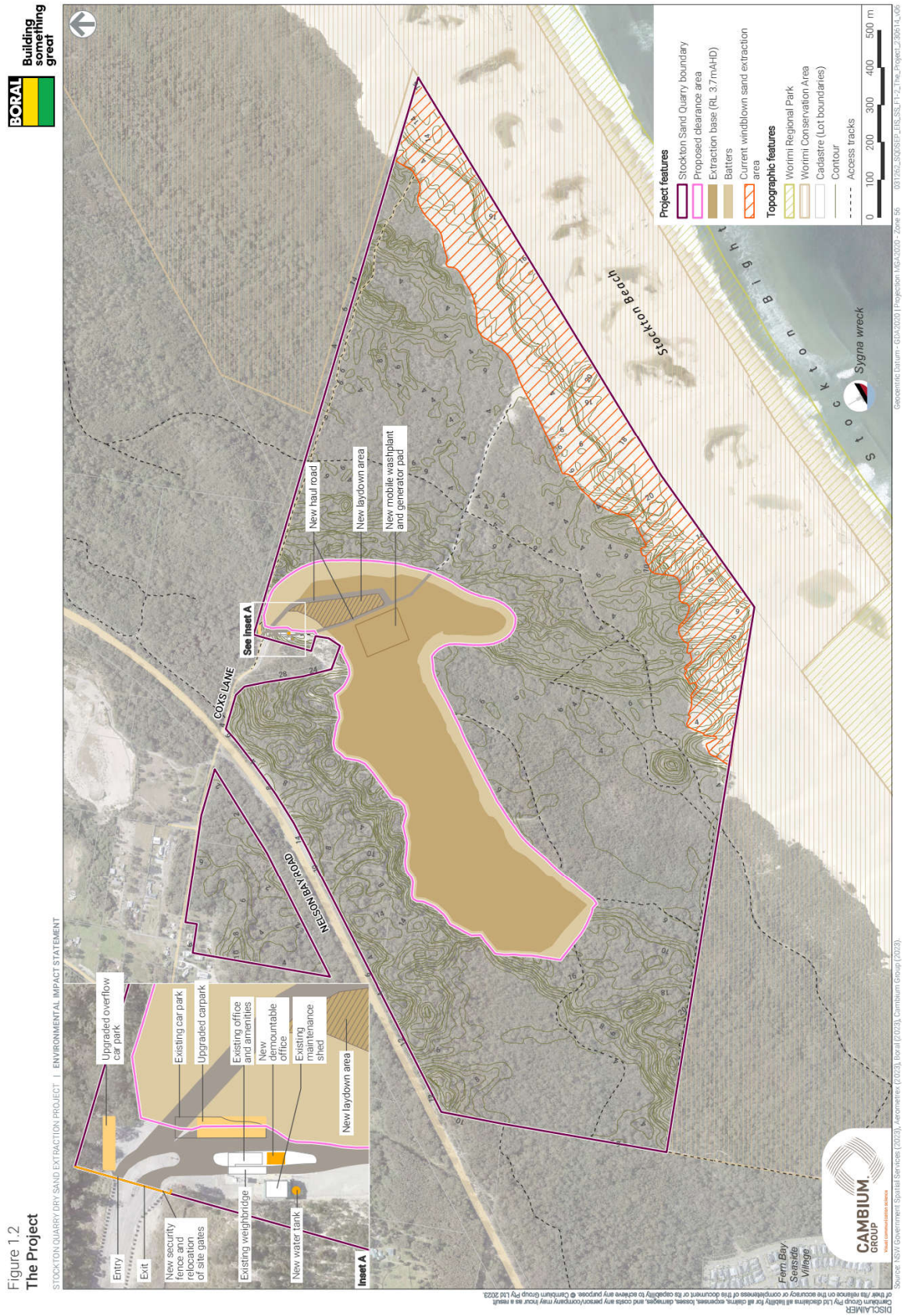

FIGURE 3 – SITE MAP EXPANSION AREA

6.0 LANDSCAPING MAINTENANCE

It is recommended that landscaping is undertaken for the site depot in accordance with Appendix 5 of Planning for Bush Fire Protection (2019) and maintained for the life of the development.

Trees should be located greater than 2 metres from any part of the roofline of a building. Garden beds of flammable shrubs are not to be located under trees and should be no closer than 10 metres from an exposed window or door. Trees should have lower limbs removed up to a height of 2 metres above the ground.

The landscaped area should be maintained free of leaf litter and debris. The gutter and roof should be maintained free of leaf litter and debris. Landscaping should be managed so that flammable vegetation is not located directly under windows.

Ground fuels such as fallen leaves, twigs (less than 6mm in diameter) and branches should be removed on a regular basis, and grass needs to be kept closely mown and, where possible, green.

7.0 POTENTIAL IGNITION SOURCES DURING CONSTRUCTION AND OPERATION

The following potential ignition sources are identified that could affect the occurrence and growth of a fire:

- Equipment faults, such as electrical short circuit or fuel leak on a machine;
- Lightning strike;
- Hazard reduction burn;
- Intentional arson; and
- Lit cigarettes or matches being carelessly thrown on the ground.

The site is a smoke free site which should reduce the potential for bushfire starting from a discarded cigarette.

The proposed development includes the quarrying of sand which is an inert material. The varying stages of the development will involve clearing of bushland with limited opportunity for fire to start if machinery is maintained and the bushland is not burned.

Storage of Hazardous Materials
The existing workshop within the site depot holds a number of hazardous and flammable materials, with the building locked up when no workers are onsite. The following flammable items and mitigation strategies have been utilised onsite:

- 4,500 litre diesel storage tank. Additional metal cowling provided between the shed wall and the tank;
- the site has an approved flammables cabinet for flammable items to be stored in;
- This is an approved cabinet for pressurised spray cans; and
- The fuel ute has a 400 litre diesel tank with a quick hitch connector that will reduce fuel spillage.

There are no explosives stored onsite. The fuel ute is recommended to be parked a minimum 6 metres from a building, when the site is unmanned.

Recommended Upgrade. The workshop is recommended to have the polycarbonate roofing to be replaced with metal roof sheeting.

8.0 FIRE RESPONSE PROCEDURE FROM STAFF

An emergency management plan shall be prepared for the site. The following procedure is recommended to be incorporated within the emergency management plan relating to bushfire. The following details initial response to a fire:

- Ensure the safety and wellbeing of oneself.
- Removing where possible any further danger(s).
- Ensuring the safety of uninjured people and preventing where possible further injury to victims.
- Informing the fire warden and any firefighters of the nature and the location of the emergency.
- Administer or organise first aid care for the injured if trained.
- Search area if practicable.
- Keep doors and windows closed to minimise fire spread.
- Close window shutters.
- Consider the risk of further fire, explosions or of the fire spreading.

The fire warden shall be contacted in the first instance, where possible, due to having greater experience of the site and specific fire training.

Mechanical tools, or plant machinery may be used to extinguish a small fire. The existing water cart may assist firefighters in extinguishing small fires.

Any fires shall be responded to as quickly as possible if they are deemed safe to extinguish.

Employees are not trained as firefighters and any larger fires which may place the health of staff in danger, shall not be fought. NSW Fire and Rescue or NSW Rural Fire Service may respond to the site. Employees may assist the firefighters through the use of heavy machinery.

9.0 RECOMMENDATIONS

Based upon an assessment of the plans and information received for the Project, it is recommended that development consent be granted subject to the following conditions:

1. Following the approval of the development and for the life of the development, the property around the buildings (excepting the bag shed), shall be maintained to a distance of 24 metres where onsite as an inner protection area (IPA) as outlined within Appendix 4 of Planning for Bush Fire Protection 2019 and the NSW Rural Fire Service's document Standards for Asset Protection Zones.
2. The workshop is recommended to have the polycarbonate roofing to be replaced with metal roof sheeting.
3. The new haul roads shall comply with section 7 of Planning for Bush Fire Protection 2019 with the roads being a minimum 6.5 metres in width with a turning bay at the termination of the road, having a minimum 12 metre outer radius.
4. Water, electricity and gas are to comply with section 7 of Planning for Bush Fire Protection (2019).
   Water Services
   a. A 20,000 litre static water supply with firefighting fittings is required.
5. Landscaping for the site depot is to be undertaken in accordance with Appendix 4 of Planning for Bush Fire Protection (2019) and managed and maintained in perpetuity.
6. It is recommended that the Quarry Manager incorporate the new building into the existing emergency management plans prepared for the workplace with specific consideration of bushfire evacuation planning.

10.0 CONCLUSION

The final recommendation is that the project offers compliance with Planning for Bush Fire Protection (2019). There is potential for bushfire attack at the quarry and a list of recommendations has been included in the above assessment to reduce that risk. The provision of a static water supply for firefighting purposes, increase in asset protection zones and emergency management planning will result in a better bushfire outcome than if the development did not proceed.

11.0 APPENDIX 1.0 – ASSET PROTECTION ZONES SUMMARY

Below is a summary of Asset Protection Zones outlined in appendix 4 of Planning for Bush Fire Protection (2019) and the NSW Rural Fire Services "Standards for Asset Protection Zones". The property owner(s) should obtain these two documents and familiarise themselves with their content.

Generally
Asset Protection Zones (APZ) refer to the area between the bushfire threat and the asset (i.e. building). The APZ may contain two areas; the Inner Protection Area (IPA) and the Outer Protection Area (OPA). Some areas should be managed entirely as an Inner Protection Area (IPA). Refer to the plans for locations of APZ and distances from Assets.

Inner Protection Area (IPA)
The inner protection area is located adjacent to the asset and is identified as a fuel-free zone.

A. Shrubs (consisting of plants that are not considered to be trees)

1. Create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings should be provided;
2. Shrubs should not be located under trees;
3. Shrubs should not form more than 10% ground cover; and
4. Clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.

B. Trees: Maintain a minimum 2-5 metre canopy separation.

1. Tree canopy cover should be less than 15% at maturity;
2. Trees at maturity should not touch or overhang the building;
3. Lower limbs should be removed up to a height of 2m above the ground;
4. Tree canopies should be separated by 2 to 5m; and
5. Preference should be given to smooth barked and evergreen trees.

Outer Protection Area (OPA)
The Outer Protection Area (OPA) is located adjoining the vegetation. The OPA should be maintained as a fuel-reduced area. This assumes trees may remain but with a significantly reduced shrub, grass, and leaf litter layer. In many situations leaf litter and the shrub layer may not require maintenance at all.

A. Shrubs:

1. Shrubs should not form a continuous canopy;
2. Shrubs should form no more than 20% of ground cover.

B. Trees:

1. Existing trees can be retained.
2. Tree canopy cover should be less than 30%; and
3. Canopies should be separated by 2 to 5m.

Grass (throughout the entire asset protection zone)
Grass should be kept mown (as a guide grass should be kept to no more than 100mm in height); and leaves and vegetation debris should be removed.

12.0 REFERENCES AND DISCLAIMER

References

Standards Australia (2018) AS3959 Construction of Buildings in Bushfire-Prone Areas

Keith D. (2004) "Ocean Shores to Desert Dunes," Department of Environment and Conservation, Sydney.

Environmental Planning and Assessment Act (1979)

New South Wales Rural Fire Service (2019) Planning for Bush Fire Protection

Disclaimer

Despite the recommendations in this report, it is impossible to remove the risk of fire damage to the building entirely. This report assesses and provides recommendations to reduce that risk to a manageable level. It is of paramount importance that the recommendations are adhered to for the life of the structure and that all maintenance is performed, to ensure a level of protection is provided to the building, occupants and firefighters.

Planning for Bush Fire Protection (2019) states that notwithstanding the precautions adopted, it should always be remembered that bushfires burn under a wide range of conditions and an element of risk, no matter how small, always remains.

AS3959 (2018) Building in Bushfire-Prone Areas states that the standard is designed to lessen the risk of damage to buildings occurring in the event of the onslaught of bushfire. There can be no guarantee, because of the variable nature of bushfires, that any one building will withstand bushfire attack on every occasion.

Appendix R

Management action plan (preliminary clearing)

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Stockton Dry Sand Extraction Project

Due Diligence Checklist

Prepared Boral Resources NSW Pty Ltd

8 August 2023

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Document control

Project number	Client	Project manager	LGA
3706	Boral Resources (NSW)	Luke Baker	Port Stephens

Version	Author	Review	Status	Comments	Date
D1	Luke Baker	John Arnold (Arnold Planning); Boral Resources	Draft 1		7 August 2023
Final	Luke Baker		Final		8 August 2023

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1. Ecology Due Diligence Assessment & Management

1.1 Purpose and Scope

Boral Resources (NSW) Pty Ltd (Boral) owns and operates the Stockton Quarry (the quarry), a long-standing operation that extracts and transports sand for use in the building, landscaping and construction markets.

Boral is currently seeking consent for the Stockton Quarry Dry Sand Extraction Project (the Project), which would allow for the extraction of sand from above the water table within the former inland dunes extraction area.

As part of the project, preliminary clearing of approximately 0.5 ha of vegetation is proposed across the project site prior to extraction, to facilitate a widespread drilling program, which would enable Boral to:

- monitor the level of the water table over the life of the project; and
- provide an accurate representation of the quality of the sand resource across the site.

Further details of the proposed drilling program, which includes a series of boreholes and associated access tracks, is provided in the environmental impact statement (EIS) (Arnold Planning 2023), and the vegetation/habitat impacts associated with the boreholes and associated access tracks is assessed in this BDAR.

The purpose of this Ecological Due Diligence Assessment is to provide Boral and its subcontractors and consultants with biodiversity management measures for them to follow when carrying out the scope of work associated with the borehole and access track works. This will allow them to manage direct and indirect impacts to terrestrial biodiversity values prior to and during borehole and access track construction.

A biodiversity management plan for the vegetation and habitat impacts associated with the extraction and on-going Stockton Dry Sand Extraction Project would be prepared following the development consent conditions which would ensure appropriate environmental management throughout construction and operational phase of the project.

1.2 Responsibilities

Key environmental management roles and responsibilities are described in Table 1.

Role	Responsibility
Project Manager	• Ensure all works comply with relevant regulatory and Project requirements. • Ensure the requirements of this due diligence process are implemented. • Ensure all personnel and contractors have completed a site induction and orientation. • Ensure that all personnel receive appropriate induction training including details of the environmental and community requirements. • Stop work immediately where there is an actual or potential risk of harm to the environment that has not been accounted for in the BDAR.
Site Manager	• Plan construction works in a manner that avoids or minimises impact to environment. • Ensure construction personnel manage construction works in accordance with statutory and approval requirements.

Role	Responsibility
	• Ensure environmental management procedures and protection measures are implemented. • Ensure all Project personnel attend an induction prior to commencing works. • Stop work immediately where there is an actual or potential risk of harm to the environment. • Conduct site environmental inspections. • Undertake scheduled and non-scheduled environmental audits.
Project Ecologist	• Conduct Pre-clearing Assessment. • Manage fauna during tree clearing. • Possess suitable fauna licences and permits. • Provide tree clearing report upon completion of clearing.

1.3 Due Diligence Assessment

The proposed boreholes and associated access tracks have been designed to minimise as much vegetation disturbance as possible by locating in areas that primarily have been historically cleared, and have some flexibility to avoid mature trees and habitat features (Niche 2023).

Due-diligence field inspections of the proposed boreholes and associated access tracks will be undertaken by an appropriately qualified ecologist prior to commencement of works. This is to ensure the potential for localised impacts and risks are minimised and, where necessary, appropriately managed.

A Due-diligence checklist has been provided (attached) that would be completed by the ecologist during the inspection process.

The core tasks associated with the site inspection include the following:

1. Ensure that the area of clearing for both the boreholes and access tracks aligns with that assessed in the BDAR.
2. Ensure that the process of vegetation clearing for the boreholes and access tracks avoids the removal of hollow-bearing trees and significant habitat features where practical.
3. Provide safeguard recommendations to minimise indirect impacts during the construction and operation of the boreholes and access tracks.

1.3.1 Demarcation of disturbance areas

The borehole and access track locations would be clearly marked using suitable flagging to prevent encroachment into surrounding areas. As described in EIS, preliminary clearing of approximately 0.5 ha of vegetation is proposed across the project site, to facilitate a widespread drilling program.

Figure 1 shows the location of existing and proposed boreholes and indicates the areas of proposed vegetation clearance, to allow for access tracks a maximum 2.6 m wide and with turn around areas a maximum 10 m by 4 m. A systematic grid approach has been adopted; however, preference has been given to locating the proposed boreholes in low lying areas and areas of cleared vegetation, to minimise vegetation clearing where possible.

Flagging of the areas of disturbance would assist in preventing encroachment of vegetation clearing into surrounding areas.

1.3.2 Pre-clearance procedure

Pre-clearing inspections are carried out prior to clearing of vegetation and habitat, no more than 48 hours prior to the clearing of vegetation.

As part of this process, a suitably qualified ecologist will inspect the area proposed for disturbance prior to the clearing with the key purpose being identifying key habitat features and the presence of fauna (i.e. hollow bearing trees, nests). Such habitat features would be clearly marked and georeferenced, and where possible avoided by slightly shifting the disturbance area (example: avoiding the removal of a hollow-bearing tree by slightly deviating the borehole or the access track).

The following steps are to be completed as part of the Pre-clearing Procedure:

- The extent of the work site is designated visibly (e.g. through temporary bunting or survey pegs) in the field to ensure the extent of clearing is known and inadvertent clearing is avoided.
- Within the disturbance area, an ecologist or suitably qualified person is to identify and mark all habitat trees (being those containing hollows, cracks, splits, spouts, large amounts of peeling bark sheets, active bird nests, and possum dreys) using spray paint and flagging tape and, using a GPS, record the location. Such trees are regarded as hollow/habitat trees and would be subject to section 1.3.4.

1.3.3 Tree Felling Procedure (non-hollow/habitat tree)

Where trees are to be felled, the following process would be carried out:

- Complete a visual inspection of the area to be cleared for fauna species and nests that may have become active since pre-clearing inspections.
- Shake or knock the tree for at least 30 seconds, or as appropriate, prior to felling to encourage fauna to abandon the tree.
- Lower the habitat tree as gently as possible, noting in some situations manual felling by chainsaw may be appropriate.
- Capture of any displaced or injured fauna. Unharmed fauna are to be released into a nearby location which is not subject to future disturbance by the Project, on the same day. Injured fauna are to be triaged immediately, humanely euthanised if required (i.e. if injuries are deemed too substantial, making it inhumane to keep the injured animal alive), or taken to a veterinarian or wildlife carer for further attention if required. All personnel who are involved in the capture/handling/housing and/or transport of native fauna species (injured or uninjured) must be suitably qualified.

1.3.4 Tree felling procedure (hollow-bearing trees/Habitat trees)

A two-staged approach to vegetation clearing is to be carried out for the removal of hollow-bearing trees/trees containing disused nests.

The first stage is the removal of trees that do not contain any hollow and active nests (described above).

Following a period of 48 hours, the second stage of clearing is for trees with hollows/habitat. Such trees may be cleared in the presence of an ecologist.

The process would entail the following:

- Complete a visual inspection of the hollow-bearing trees/habitat trees that remain after stage 1 clearing process has occurred.

- Shake or knock the habitat tree for at least 30 seconds, or as appropriate, prior to felling to encourage fauna to abandon the tree.
- Lower the habitat tree as gently as possible, noting in some situations manual felling by chainsaw may be appropriate.
- Inspect the hollows and nests, prior to moving the tree.
- Capture of any displaced or injured fauna. Unharmed fauna are to be released into a nearby location which is not subject to future disturbance by the Project, on the same day. Injured fauna are to be triaged immediately, humanely euthanised if required (i.e. if injuries are deemed too substantial, making it inhumane to keep the injured animal alive), or taken to a veterinarian or wildlife carer for further attention if required. All personnel who are involved in the capture/handling/housing and/or transport of native fauna species (injured or uninjured) must be suitably qualified.

1.4 Revegetation of Temporary Disturbance Areas

For the most part, the boreholes and access tracks will occur within areas that contained scattered shrubs, grasses, and bare sand. As the areas for the boreholes and access tracks will eventually be cleared for the extraction, it is proposed that revegetation be minimal, being:

- Ensuring the site is left tidy, with all rubbish and debris removed.
- Area is left in a safe manner, with all holes and trenching filled in.

Suitable native timber felled from the area will be retained for use as habitat for ground dwelling reptiles and mammals within the adjacent residual land, and for future rehabilitation of the extraction area.

1.5 Records management and reporting

The checklists for each borehole and access track would be provided to Boral for record keeping.

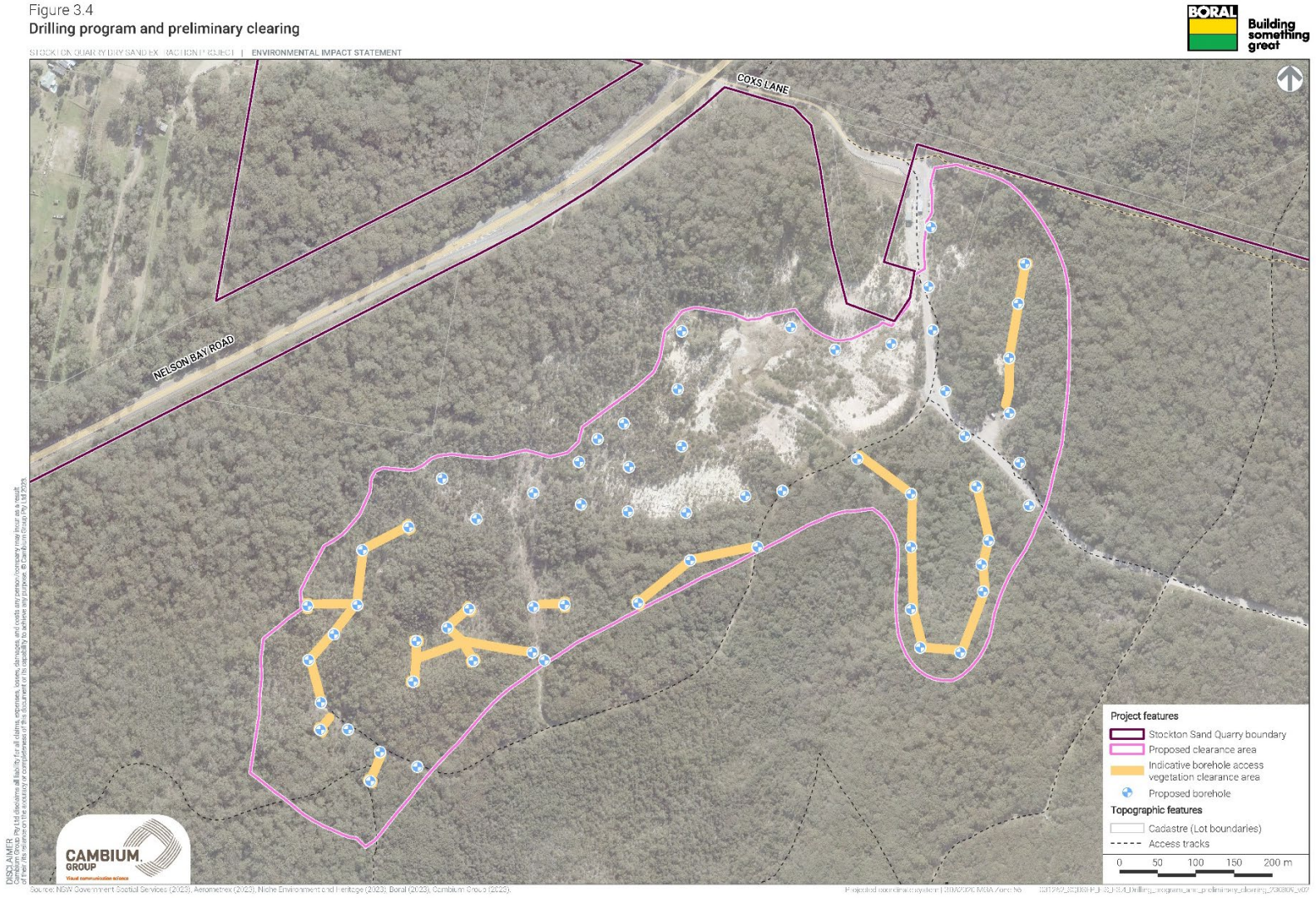
The team is to also track the progress of the vegetation clearing and include a log of the amount of vegetation clearing accounted for during the drilling program, along with any fauna captures and fauna incidents.

Furthermore, Boral would keep a record of the condition of the site prior to, and after decommissioning of the access tracks. A compliance report is to be maintained to ensure that the vegetation clearing has not exceeded that specified in the BDAR (ie. approximately 0.5 ha), and that the boreholes and access tracks are decommissioned in a manner that is safe and free of rubbish.

1.6 Conclusion

This due diligence management approach would assist in minimise as much vegetation disturbance as possible during the drilling program. A separate Biodiversity Management Plan would be prepared for the extraction areas.

Figure 1. Proposed boreholes and access tracks



Attachment: Due Diligence Checklist

Borehole details	Site notes and access	Existing environment and impacts	Site-specific Environmental Safeguards
Borehole name: **Location details:** Easting / Northing / MGA **Site Photo No. or Reference:** Insert photograph of borehole site and access **Survey Date:** Date of site inspection **Survey inspection team:** List personnel and ecologist	**Site Notes:** Area of vegetation clearing Area of vegetation for access **Brief Site description** (and any specific layout required) **Access to Site:** Vegetation clearing required? If so provide details (area, type) **Journey Management Notes/Constraints:** Hollowing-bearing trees, mature trees, habitat features, rocks, large logs Details, including coordinates to be provided	**Topography:** Describe the site. eg. Relatively flat borehole location **Vegetation:** Vegetation community to be impacted **Threatened flora and Fauna:** Any specified threatened species constraints identified.	**Environmental Controls:** Insert any specific controls, mitigation. Example: two-stage clearing process