Dunmore Lakes Sand Project – Stage 5

Soil and Water Management Plan

Prepared for Dunmore Sand and Soil
October 2023

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H200812 RP1

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Version	Date	Prepared by	Approved by	Comments
V1	11 February 2021	Jason O'Brien	Chris Kuczera	Draft issue for DSS review
V2	9 April 2021	Jason O'Brien	Chris Kuczera	Minor revisions following DSS review
V3	7 July 2021	Jason O'Brien	Chris Kuczera	Minor revisions to address DPIE comments
V4	3 February 2022	Jason O'Brien	Chris Kuczera	Minor revisions to address NRAR comments
V5	12 July 2023	Jason O'Brien	Chris Kuczera	Updates to include revised Stage 5B flood bund design and footprint
V6	13 October 2023	Jason O'Brien	Chris Kuczera	Final

Approved by

Chris Kuczera
Associate Water Resources Engineer
13 October 2023

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1 Introduction

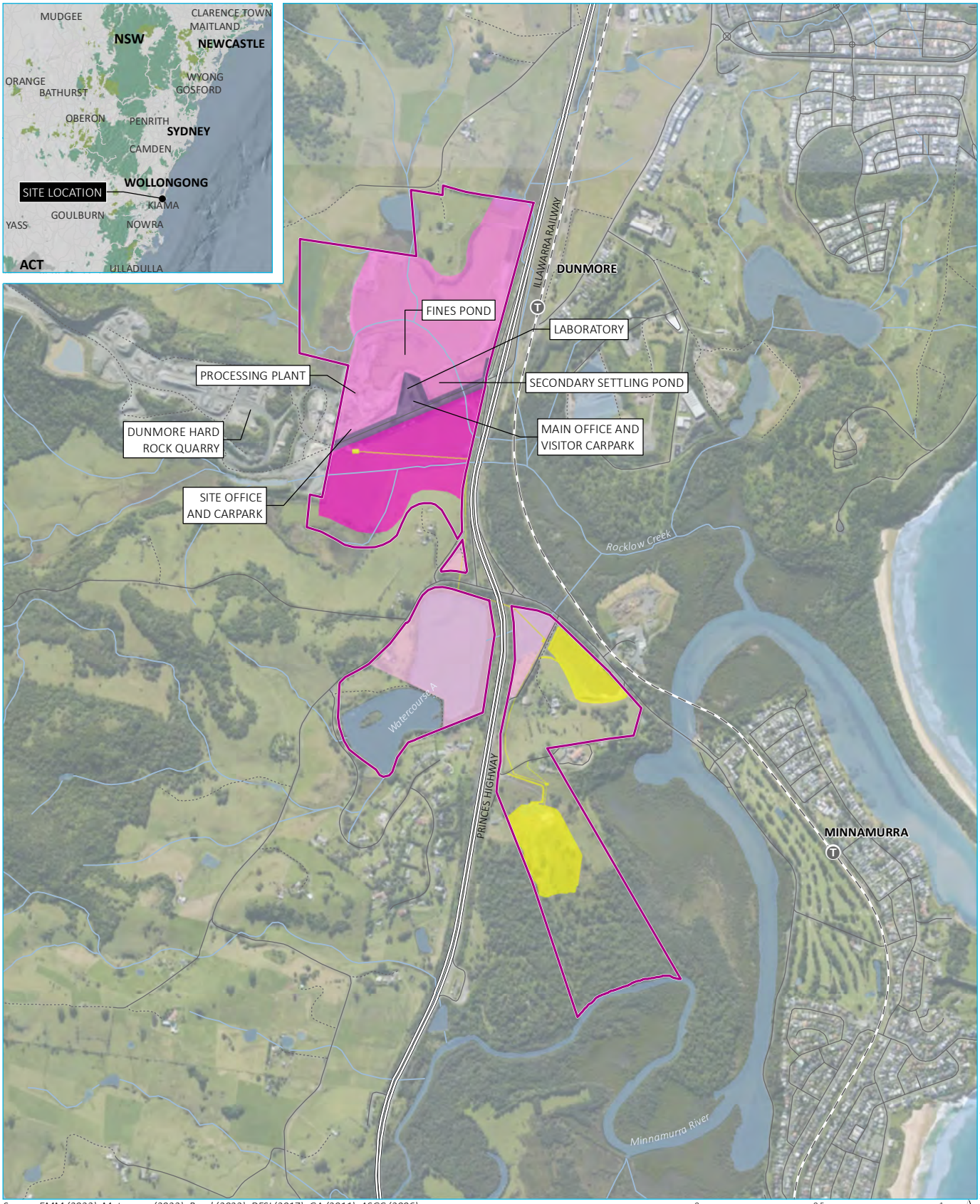
1.1 Background

Boral Resources New South Wales (NSW) Pty Ltd (Boral) own and operate Dunmore Sand and Soil Pty Ltd (DSS), who operate the Dunmore Lakes Sand Project (DLSP) located on Tabbita Road, in the Shellharbour local government area (LGA). The DLSP is approximately seven kilometres (km) north of Kiama (refer to Figure 1.1).

Development consent (DA 195-8-2004) for Stage 1 of the DLSP was granted by the Minister for Planning in 1999. An application for Stage 2 to 4 was lodged in 2004 and granted development consent in June 2005. Due to a high demand for sand in the Sydney market, most of the sand in Stage 2 and 3 has now been extracted. The Stage 4 extraction area encompasses the access road, private rail line and other supporting infrastructure to the existing DSS operation and Boral's adjacent Dunmore Hard Rock Quarry. As Stage 4 cannot be extracted until these activities are relocated, DSS has investigated other local sources of sand to allow operations to continue.

DSS sought consent (Modification 2) for an additional extraction area (Stage 5) to the south of the former Stage 1 extraction area. Stage 5 encompasses an area of 38 hectares (ha) and includes two separate extraction areas, Stage 5A and Stage 5B, hereinafter referred to as 'the site'.

Modification 2 was approved in November 2020. The consent is subject to numerous conditions, including a requirement that Boral prepare a Soil and Water Management Plan (SWMP) for the Stage 5 area. This document presents the SWMP for the Stage 5 area and is to be read in conjunction with the existing Water Management Plan (WMP) for DLSP Stages 2, 3 and 4.



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- DLSP boundary
- Train station
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody

DLSP stages

- Stage 1
- Stage 2
- Stage 3
- Stage 4
- Stage 5

Dunmore Lakes Sand Project (DLSP)

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 1.1

EMM creating opportunities

1.2 Project description

1.2.1 Stages 2 to 4

The existing operations include extraction and transportation of up to 800,000 tonnes per annum (tpa) of sand products from Stage 2 to 4 over a 25-year period. Sand and soil are extracted by excavation and dredging, followed by washing, processing and material blending. The final product is then stockpiled on site until transported to local and regional markets via road and rail. The existing operations include the following key infrastructure:

- main office and carparking;
- processing plant;
- historical Stage 1 extraction area;
- active Stage 2 and Stage 3 dredge ponds;
- fines pond; and
- secondary settling pond.

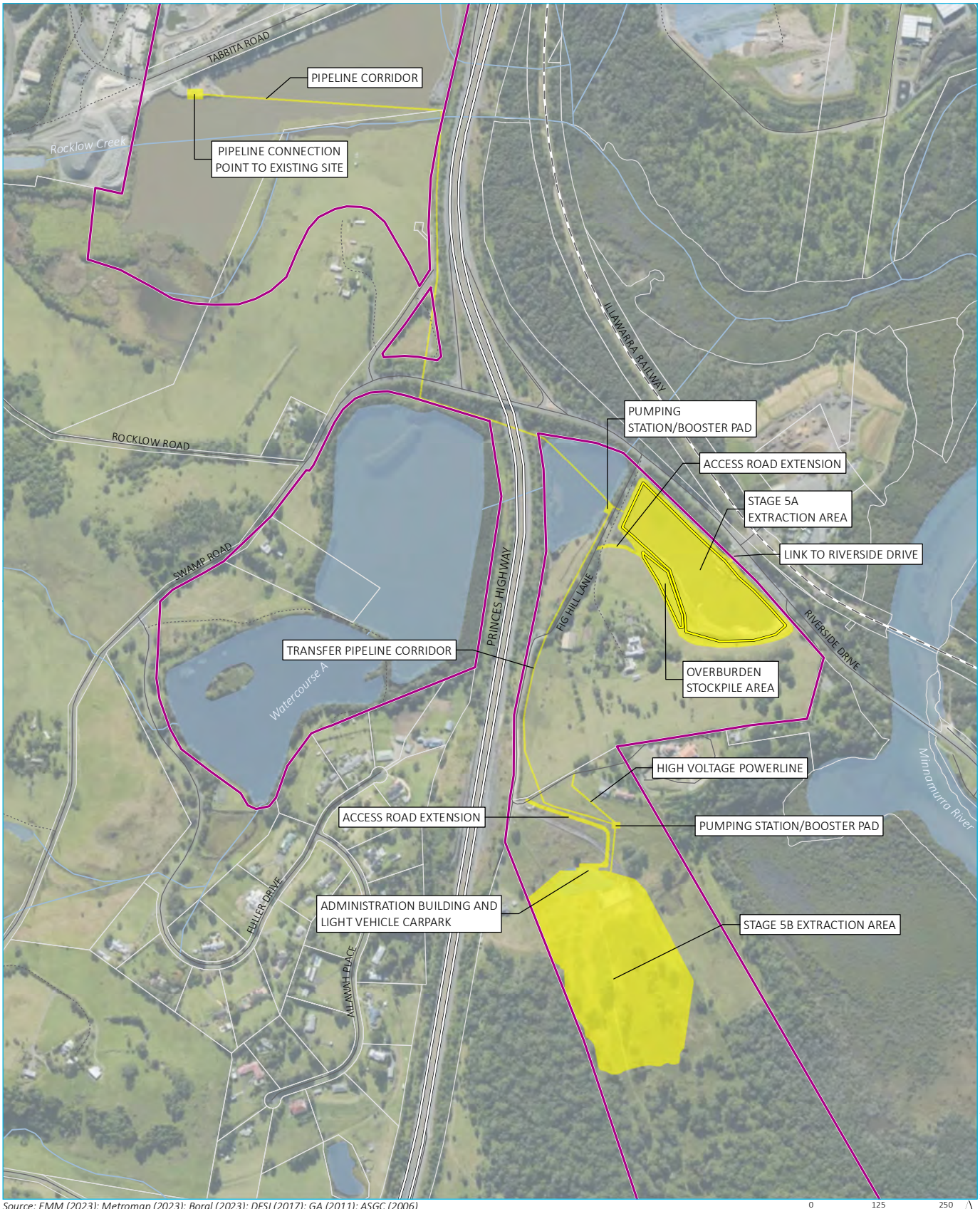
Upon completion of sand extraction, the dredge ponds are progressively backfilled with virgin excavated natural materials (VENM) to create landforms for rehabilitation in accordance with a final landform concept plan. The reconstructed landforms ultimately support lakes, wetlands and revegetated ecological communities.

1.2.2 Stage 5

Stage 5 involves the extraction of sand from additional areas on an adjoining property to the south of the historical Stage 1 area. Extraction is proposed in two separate areas, namely Stage 5A (immediately south of Riverside Drive) and Stage 5B (to the north of Minnamurra River). The resource to be extracted from Stage 5A and Stage 5B is estimated at 234, 000 tonnes and 1,123,000 tonnes, respectively. Stage 5 includes the following key activities:

- clearing and grubbing established groundcover vegetation;
- stripping and stockpiling of topsoil (in an overburden area) for use in rehabilitation;
- construction of flood mitigation bunds, access roads, site office, car parking and overland transfer pipeline;
- sand extraction via excavation and dredging;
- transportation of dredged materials from the Stage 5 to the existing Stage 2 processing area via the transfer pipeline;
- sand processing within the existing processing plant; and
- dispatch of sand material by road and rail from the existing operations area.

Sand processing and dispatch will be in accordance with existing approvals for Stage 2 to 4. No changes to the approved production volumes or operational hours are proposed. The Stage 5 extraction area and associated infrastructure is shown in Figure 1.2.



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KEY

- DLSP boundary
- DLSP stage 5
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Waterbody
- Cadastral boundary

Site layout

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 1.2

EMM creating opportunities

1.3 Purpose and objectives

The purpose of this SWMP is to describe the soil and water management strategies, procedures, controls and monitoring programs for Stage 5 of the DSS operations, including both construction and extraction. The SWMP aims to consolidate all relevant monitoring, management and reporting actions relating to soil and water from the development consent (DA 195-8-2004) and environment protection licence requirements (EPL 11147) for Stage 5 into one document. The key objectives of this SWMP include:

- address relevant consent conditions;
- describe baseline surface water and groundwater characteristics for the site;
- describe existing flood conditions and flood management controls;
- describe the surface water management system and erosion and sediment control measures;
- establish a surface water and groundwater monitoring program; and
- describe proposed actions, operating protocols and response measures.

The management and mitigation measures described in this SWMP are generally in accordance with:

- the commitments and recommendations identified in the *Dunmore Lakes Sand Project: Modification 2 Environmental Assessment* (EA) (Element Environment 2019); and
- the soil and water management principles presented within the existing approvals and WMP for DLSP Stage 2, 3 and 4.

Extraction from Stage 5 will not commence until this SWMP is approved by the Planning Secretary as per consent condition 32 of Schedule 5.

1.4 Report preparation

This SWMP has been prepared by Water Resource Engineer Jason O'Brien and reviewed by Associate Water Resource Engineer Chris Kuczera. Jason has seven years' experience as a water resource engineer preparing surface water assessments, water management plans, water balance modelling and flood risk assessments. Chris has 15 years' experience as a water resources engineer specialising in surface water assessments, water management plans, flood impact assessments and risk management studies, erosion and sediment control plans and water quality investigations.

Chris Kuczera and Jason O'Brien were endorsed by the Planning Secretary of the Department 17 June 2021 as required by consent condition 30 of Schedule 3 (refer to Appendix A).

1.5 Consultation

As required by consent condition 30 of Schedule 3, this SWMP has been prepared in consultation with:

- Environmental Protection Authority (EPA); and
- Department of Planning, Industry and Environment – Water (DPIE-Water)/Natural Resources Access Regulator (NRAR).

The EPA advised via letter on 12 May 2021 that they have no comments on the SWMP. The EPA correspondence is included in Appendix A.

NRAR were contacted for comment on the SWMP under reference number PAE-17566890 on 15 April 2021. The indicated due date for comments was 13 May 2021. A ticket was raised 18 May 2021 (FIN0481844) and a reply was provided 8 June 2021 indicating that a review will not be able to occur until mid-July 2021. As a result, a draft (v2) of the SWMP was provided to DPIE for comment without NRAR consultation under the request of DPIE. Conditional approval is being sought from DPIE in the interim of receiving comments from NRAR.

DPIE provided comments on the draft (v2) SWMP on 21 June 2021. The SWMP was revised (v3) to address DPIE comments and reissued 7 July 2021. NRAR provided comments on the 20 December 2021.

1.6 Responsibility and implementation

The Site Manager is responsible for the implementing the SWMP but may delegate responsibility of some aspects of the plan to other staff.

1.7 Alignment with other plans

This document is an extension to the WMP prepared for Stage 2 to 4 of the DLSP. This SWMP incorporates environmental monitoring data and management principals established in the Stage 2 to 4 WMP. The following management plans also apply to the DSLP and inform this SWMP:

- Rehabilitation Management Plan – This plan describes how the constructed landforms and remaining lakes will be progressively rehabilitated.
- Waste Management Plan – This plan describes the acceptance, verification procedures and monitoring of waterbodies after the placement of VENM and management of potential acid sulfate soils (PASS).
- Acid Sulfate Soils Management Plan (ASSMP) – This plan describes the potential impact of acid sulfate soils (ASS) at the site and provides mechanisms to mitigate the risks associated with the disturbance of ASS.

1.8 Document structure

This SWMP is structured as follows:

- Chapter 2 identifies relevant legislation and guidelines;
- Chapter 3 describes the existing environment;
- Chapter 4 describes flood mitigation and management measures;
- Chapter 5 provides a site water balance;
- Chapter 6 provides a surface water management plan;
- Chapter 7 provides an erosion and sediment control plan;
- Chapter 8 provides a groundwater management plan; and
- Chapter 9 describes reporting and review requirements.

2 Statutory requirements

2.1 Relevant legislation

Key legislation that is relevant to this SWMP includes:

- *Environmental Planning and Assessment Act 1979* (EP&A Act);
- Environmental Planning and Assessment Regulation 2000;
- *Protection of the Environment Operations Act 1997* (POEO Act);
- *Water Act 1912*; and
- *Water Management Act 2000*.

2.2 Development consent

Development consent for Stage 5 was issued by the Minister for Infrastructure and Planning November 2020 and is provided in Appendix B. The development consent conditions relevant to the SWMP are reproduced in Table 2.1.

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
Water Supply		
21A	The Applicant must ensure that it has sufficient water for all stages of the development prior to the take of water occurring, and if necessary, adjust the scale of the development to match its available water supply.	Section 5.2
21B	The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence. *Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain all necessary water licences for the development.*	Section 5.4
Pollution of Waters		
22	Except as may be expressly provided by an environmental protection licence (EPL), the Applicant must comply with section 120 of the Protection of the Environment Operations Act 1997 during the carrying out of the development.	Section 6.5 Section 8.4.2
Water Discharge Limit		
23	Except as may be expressly provided by an EPL, the Applicant must ensure that the discharges from any licenced discharge point/s do not cause additional exceedances of the criteria in Table 4: *Table 4: Water Discharge Pollution Limits* **Pollutant** / **Unit of Measure** / **100 Percentile Concentration Limit** Total suspended solids (TSS) / mg/L / 50 pH / pH / ±1.0[4]	Section 6.5

[4] pH concentration limit understood to be ±1.0 from the historical mean value.

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
Water Quality Objectives		
24	The Applicant must ensure that water quality in the dredge ponds and in groundwater comply with the water quality objectives in Table 5, or other such level as approved by the Planning Secretary:	Section 6.5 Section 8.4.2

Table 5: Water Quality Objectives

Pollutant	Unit of Measure	Water Quality Objective
Turbidity	NTU	5–20
pH	pH	6.5–8.5
Salinity	µS/cm	<1,500
Dissolved oxygen	mg/L	>6
Total phosphorus	µg/L	5–50
Total nitrogen	µg/L	100–500
Chlorophyll-a	µg/L	2–10
Faecal coliforms	Median No./100 mL	<1,000
Enterococci	Median No./100 mL	<230
Algae and blue-green algae	No. cells/mL	<15,000
Sodium	mg/L	400
Potassium ion	mg/L	50
Magnesium ion	mg/L	50
Chloride ion	mg/L	300
Sulphate ion	mg/L	250
Bicarbonate ion	mg/L	750
Soluble iron ion	mg/L	6
Ammonium ion	mg/L	20

Notes:

- *The objectives for dissolved oxygen, turbidity and algae are relevant to surface water only.*
- *The Department acknowledges that short term exceedances of these objectives may occur during natural events such as heavy rainfall or tidal saline water inflow.*

Stormwater Management		
25	[5]The Applicant must ensure that any pond subject to dredging or backfilling, or containing turbid water due to recent dredging or backfilling, must be maintained and operated to prevent discharges of any turbid water (as defined in Tables 4 and 5) from these ponds.	Section 6.3.3

[5] Incorporates EPA general terms of approval (GTA)

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
26	[6]The Applicant must cease backfilling activities not less than 12 hours prior to the commencement of overflow from any dredge pond. No backfilling must occur when the dredge ponds are overflowing.	Section 6.3.3
Flood Management		
27	The Applicant must ensure that the flood storage capacity of the site is no less than the pre-existing flood storage capacity at all stages of the development, unless otherwise approved in writing by the Planning Secretary. Details of the available flood storage capacity must be reported in the Annual Review.	Not applicable to Stage 5
28	[7]The access road entrance off Tabbita Road, processing and stockpile area, and the fines return pond(s) must be constructed and maintained so as to prevent inundation by floodwaters caused by the 1 in 100 year ARI[8] flood level. Prior to the commissioning of the processing area, the Applicant must provide certification to the Planning Secretary that this condition has been complied with.	Section 4.4
29	Following the cessation of dredging and backfilling operations, the Applicant must commission a suitably qualified hydrologist to define the flood-related limits of the final landform. The flood study must be undertaken in consultation with the Department and Shellharbour Council, and to the satisfaction of the Planning Secretary.	Section 4.4
Stage 5 Flood Mitigation		
29A	Prior to undertaking any development in Stage 5A, the Applicant must provide the Planning Secretary with the detailed design of the Stage 5A flood mitigation bunds which demonstrates that the bunds can prevent inundation of the Stage 5A pond by floodwaters associated with the 1 in 100 year ARI flood level.	Section 4.4
29B	Prior to undertaking any development in Stage 5B, the Applicant must provide the Planning Secretary with the detailed design of the Stage 5B flood mitigation bunds which demonstrates that the bunds can prevent inundation of the Stage 5B pond and carparking area by floodwaters associated with the probable maximum flood event. Any increase in the height of the bunds required to achieve this outcome must be accompanied by an appropriate increase in width to ensure the stability and visual aesthetics of the bunds in the landscape, to the satisfaction of the Secretary.	Section 4.4

6 Incorporates EPA GTA

7 Incorporates EPA GTA

8 Annual recurrence interval (ARI)

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
29C	The Applicant must retain and maintain the flood bunds around the Stage 5B area to prevent interactions with the probable maximum flood in perpetuity, unless otherwise agreed in writing by the Planning Secretary. Upon receiving a written request from the Applicant seeking to remove the bunds, the Planning Secretary will determine whether the flood bunds should be removed and the Stage 5B pond rehabilitated and integrated into the Minnamurra River floodplain. If the water quality in the pond meets relevant ANZECC Guidelines, water quality standards imposed under any EPL and does not represent a material environmental risk to the Minnamurra River floodplain, the Planning Secretary will provide a written approval stipulating the timing and rehabilitation requirements associated with the removal of the bunds. Alternatively, with the written approval of the Planning Secretary, the Applicant may satisfy its in perpetuity maintenance obligations under this condition through the establishment of a suitable funding agreement with an appropriate public authority. This public authority would then be responsible for the oversight and carriage of these in perpetuity works.	Section 4.4
29D	The Applicant must undertake regular monitoring of the stability of flood bunds throughout the extraction, rehabilitation and closure phases of the Stage 5 quarry operations.	Section 4.4
Soil and Water Management Plan		
30	The Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:	
	(a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;	Section 1.4
	(b) be prepared in consultation with EPA and DPIE Water;	Section 1.5
	(c) include a:	
	(i) **Site Water Balance** that includes details of:	
	• predicted annual inflows to and outflows from the site;	Section 5.1
	• sources and security of water supply for the life of the development (including authorised entitlements and licences);	Section 5.2
	• water storage capacity, use and management on the site;	Sections 5.1 and 6.3
	• licenced discharges points and limits;	Section 6.1 and 6.5
	• reporting of annual water extraction and maximum instantaneous pumping rates to the Department; and	Section 5.4
	• procedures for the annual preparation of an updated site water balance.	Section 5.4
	(ii) **Erosion and Sediment Control Plan** that:	
	• is consistent with the requirements of *Managing Urban Stormwater: Soils and Construction - Volume 1*: Blue Book (Landcom 2004) and *Volume 2E: Mines and Quarries* (DECC 2008);	Chapter 7
	• identifies activities that could cause soil erosion, generate sediment or affect flooding;	Section 7.1
	• includes a program to review the adequacy of existing flood protection works;	Section 7.4
	• describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk;	Section 7.2

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
	• describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and	Section 7.3
	• describes what measures would be implemented to maintain (or if necessary decommission) the structures over time.	Section 7.4
	(iii) **Surface Water Management Plan**, that includes:	
	• detailed baseline data on surface water flows and quality in watercourses, water bodies, wetlands and/or fish habitat that could potentially be affected by the development;	Section 6.1
	• a detailed description of the surface water management system on the site, including the: – clean water diversion system; – erosion and sediment controls; – dirty water management system; and – water storages;	Section 6.3
	• a program to monitor and evaluate: – any surface water discharges; – bank and bed stability; – the effectiveness of the water management system; – impacts on water supply for other water users; and – surface water flows and quality in watercourses, waterbodies, wetlands and/or fish habitats that could potentially be impacted by the development;	Section 6.4
	• surface water impact assessment criteria and performance measures, including trigger levels for investigating and responding to potentially adverse impacts; and	Section 6.5
	• a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events.	Section 6.6
	(iv) **Groundwater Management Plan** that includes:	
	• detailed baseline data of groundwater levels, flows and quality for groundwater resources and groundwater dependent ecosystems potentially impacted by the development;	Section 8.2
	• a detailed description of the groundwater management system;	Section 8.1
	• a program to monitor and evaluate: – water loss/seepage from water storages into the groundwater system, including from any final void; – groundwater inflows, outflows and storage volumes, to inform the Site Water Balance; – impacts on groundwater supply for other water users; – impacts on groundwater dependent ecosystems; – the hydrogeological setting of any nearby alluvial aquifers and the likelihood of any indirect impacts from the development; and – the effectiveness of the groundwater management system;	Section 8.3
	• groundwater impact assessment criteria and performance measures, including trigger levels for investigating and responding to potentially adverse groundwater impacts (or trends) associated with the development on regional and local aquifers and/or the groundwater supply for other water users such as licensed privately-owned groundwater bores;	Section 8.4

Table 2.1 Consent conditions – surface and groundwater

Condition	Description	Section(s) addressed
	• a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events; and	Section 8.5
	• a protocol to obtain appropriate water licence(s) to cover the volume of any unforeseen groundwater inflows into the extraction areas.	Section 8.5
31	The Applicant must implement the Soil and Water Management Plan approved by the Planning Secretary.	Section 1.6
32	The Applicant must not commence extraction in Stage 5 until the Soil and Water Management Plan is approved by the Planning Secretary.	Section 1.3

2.3 Permits and licences

2.3.1 Environmental protection licence

EPL No. 11147 applies to the DSS operation. The current EPL includes five reference points for which specific discharge and monitoring conditions are applied. The five EPL points do not relate to the Stage 5 but are described in Table 2.2 and shown in Figure 6.1 for context.

Table 2.2 EPL point descriptions and discharge conditions

EPL point	Description	Monitoring parameters	EPL monitoring conditions
9	Western tributary discharge to Culvert 3 or 4	pH, TSS, turbidity	Discharge quality monitoring from Stage 2 and Stage 3
10	Realigned Rocklow Creek discharge to Culvert 1	pH, TSS, turbidity	Discharge quality monitoring from realigned Rocklow Creek[1]
11	Western tributary upstream	pH, TSS, turbidity	Upstream quality monitoring
12	Northern tributary upstream	pH, TSS, turbidity	Upstream quality monitoring
13	Rocklow Creek upstream Stage 3	pH, TSS, turbidity	Upstream quality monitoring

Notes: 1. Rocklow Creek has not yet been realigned and hence this EPL monitoring point is not currently active.

2.3.2 Water licencing

Water Sharing Plans (WSPs) are statutory documents that apply to one or more water source areas. They contain the rules for sharing and managing the water resources within water source areas. The water sources relevant to the site are:

- Illawarra Rivers Water Source which is managed under the WSP for the Greater Metropolitan Region Unregulated Water Sources 2011 – includes water within the Minnamurra River and Rocklow Creek.
- Sydney Basin South Groundwater Source which is managed under the WSP for the Greater Metropolitan Region Groundwater Sources 2011 – includes groundwater within the aquifer beneath the Stage 5A extraction area.

- Metropolitan Coastal Sands Groundwater Source which is managed under the WSP for the Greater Metropolitan Region Groundwater Sources 2011 – includes groundwater within the aquifer beneath the Stage 5B extraction area.

The existing operations has a Water Access Licence (WAL) (24477) to extract 77 ML/year from the Sydney Basin South Groundwater Source. The associated works approval for WAL24477 is 10WA106714 which covers groundwater extraction works.

DSS have also acquired WAL's to extract 15 ML/year (WAL42100) and 20 ML/year (WAL42443) from the Metropolitan Coastal Sands Groundwater Source. EMM contacted NRAR on behalf of DSS on 18 June 2021 to obtain a Miscellaneous Works for WAL42100 and WAL42443. NRAR provided the Miscellaneous Works (10MW119332) on 2 July 2021. Correspondence with NRAR regarding the Miscellaneous Works and WALs is provided in Appendix C.

DSS have since acquired an additional 966 ML/year (WAL44534) WAL in the Metropolitan Coastal Sands Groundwater Source.

2.4 Aquifer Interference Policy

The purpose of the Aquifer Interference Policy (AIP) 2012 is to explain the role and requirements of the Minister administering the *Water Management Act 2000* in the water licencing and assessment process for aquifer interference activities. The AIP:

- clarifies the requirements for licensing of water intercepted during aquifer interference activities (such as mining, quarrying, and dewatering for construction); and

- defines and establishes 'minimal impacts' for water related assets (such as landholder bores and groundwater dependent ecosystems).

The minimal impact considerations defined in the AIP provide the basis for the assessment of groundwater impacts to sensitive receptors (environmental and landholder) from water table, water pressure and water quality change. The AIP categorises groundwater sources as either 'highly productive' or 'less productive'. A further division is made based on geological providence. The local groundwater of the site meets the criteria of 'highly productive' alluvial or coastal sands due to high production rates and generally low total dissolved solids concentrations (EES 2019b).

2.5 Guidelines

The guidelines relevant to the construction and operation of Stage 5 are summarised in Table 2.3.

Table 2.3 Relevant guidelines

Guideline name	Reference	Description
Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales	DEC 2004	This document lists the sampling and analysis methods to be used when complying with a requirement by, or under, environmental protection legislation or and environmental protection licence.
Australian Rainfall and Runoff: A guide to flood estimation	Ball J et al. 2019	This document provides practitioners with the best available information on design flood estimation and is widely accepted as a design guideline for all flood and stormwater related investigation and design in Australia.
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZECC 2000	These guidelines are the benchmark documents of the *National Water Quality Management Strategy* which is used for comparison of water quality monitoring data throughout Australia.

Table 2.3 Relevant guidelines

Guideline name	Reference	Description
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZG 2018	These guidelines describe water quality objectives for freshwater and marine environments, aquatic ecosystems and primary industries within Australia and New Zealand. The ANZG (2018) guidelines are a revision to the ANZECC (2000) guidelines described above.
Guidelines for riparian corridors on waterfront land	NSW DPI-Water 2014	Refers to a series of guidelines that provide information on the design and construction of a controlled activity, and other ways to protect waterfront land.
Managing Urban Stormwater: Soils and Construction, Volume 1	Landcom 2004	Describes best practice erosion and sediment control measures, including the calculation methodologies for sizing sedimentation basins.
Managing Urban Stormwater: Soils and Construction, Volume 2E – Mines and quarries	DECC 2008a	Describes best practice erosion and sediment control measures with a focus towards mines and quarries.
Managing Urban Stormwater: Soils and Construction, Volume 2C – Unsealed roads	DECC 2008b	Describes best practice erosion and sediment control measures with a focus towards the construction of unsealed roads.

3 Existing environment

3.1 Land use

The site is characterised by agricultural land that has been mostly cleared of native vegetation for the grazing of livestock. Land use surrounding the site includes:

- commercial and industrial development, including Dunmore Hard Rock Quarry and concrete batching plant to the north west and the Dunmore Resource and Recycling Facility to the north;
- residential development, including Dunmore Lakes Estate to the south west and the township of Minnamurra to the east;
- infrastructure development, including the Princes Highway to the west, and the South Coast Rail Line to the north east; and
- Minnamurra River and associated wetland (protected under State Environmental Planning Policy (Coastal Management) 2018) (Coastal SEPP) is located adjacent to the south of the site.

3.2 Topography

The regional topography rises from coastal flats to the east of the site to a north-south trending mountain range to the west. The site is in the Illawarra Coastal Plains and is characterised by flat to gently inclined low-lying alluvial land (Element Environment 2019). The low-lying areas of the site form part of the Minnamurra River floodplain.

Elevations across the Stage 5A extraction area are typically below 3 m Australian Height Datum (AHD) while the elevation of Stage 5B range from 2.5 to 4 m AHD. The two extraction areas are separated by a hill that trends east to west from Minnamurra River to the Princes Highway.

3.3 Climate

Climate at the site is characterised by warm summers and mild to cool winters. January is typically the warmest month with a mean maximum temperature of 25.2 °C while July is typically the coolest month with a mean minimum temperature of 10.1 °C as measured at Bureau of Meteorology (BoM) operated gauge Kiama (Bombo Headland) (station number 68242).

The nearest active rainfall gauge is Kiama (Bombo Headland), which is approximately 3 km south east of the site and has a rainfall record since 2001. Average climate statistics for the Kiama (Bombo Headland) gauge were obtained from the BoM and are presented in Table 3.1.

Pan evaporation data for the site was obtained as a SILO (Scientific Information for Land Owners) Point Data from the Queensland Climate Change Centre of Excellence. SILO Point Data consist of interpolated estimates based on historically observed data from the BoM weather stations. Monthly pan evaporation totals are compared with monthly rainfall totals in Table 3.1.

Table 3.1 Average climate statistics – Kiama (Bombo Headland)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean max temp (°C)	25.2	24.7	23.9	22.2	19.8	17.7	17.3	18.0	20.2	21.5	22.6	23.9	21.4
Mean min temp (°C)	19.1	18.8	17.9	15.7	13.1	11.4	10.1	10.6	12.1	14.0	15.7	17.3	14.6
Rainfall (mm/month)	82.4	134.6	144.9	85.9	41.5	108.2	69.6	68.9	50.5	79.8	67.3	73.2	1,038
Mean no. rainfall days	7.6	10.0	10.0	8.9	4.4	8.3	5.7	4.8	6.1	7.4	7.0	8.4	89
Pan evaporation (mm/month)	201	150	134	95	72	53	62	88	121	152	170	195	1,495

Source: BoM Climate Data Online

Notes: Red denotes the maximum monthly total.
Blue denotes the minimum monthly total.

Monthly rainfall totals are shown to be variable across all months but are generally higher in summer and lower during winter and early spring. Average monthly evaporation totals typically exceed monthly rainfall totals throughout the year. Average annual rainfall and evaporation totals are estimated to be 1,038 mm/year and 1,495 mm/year, respectively.

DSS have been collecting rainfall data at the quarry since January 2002. The average annual rainfall total at the DSS operated gauge is 1,048 mm/year which correlates well with the Kiama (Bombo Headland) average annual rainfall of 1,038 mm/year. A comparison of monthly rainfall totals since 2010 is presented in Figure 3.1.

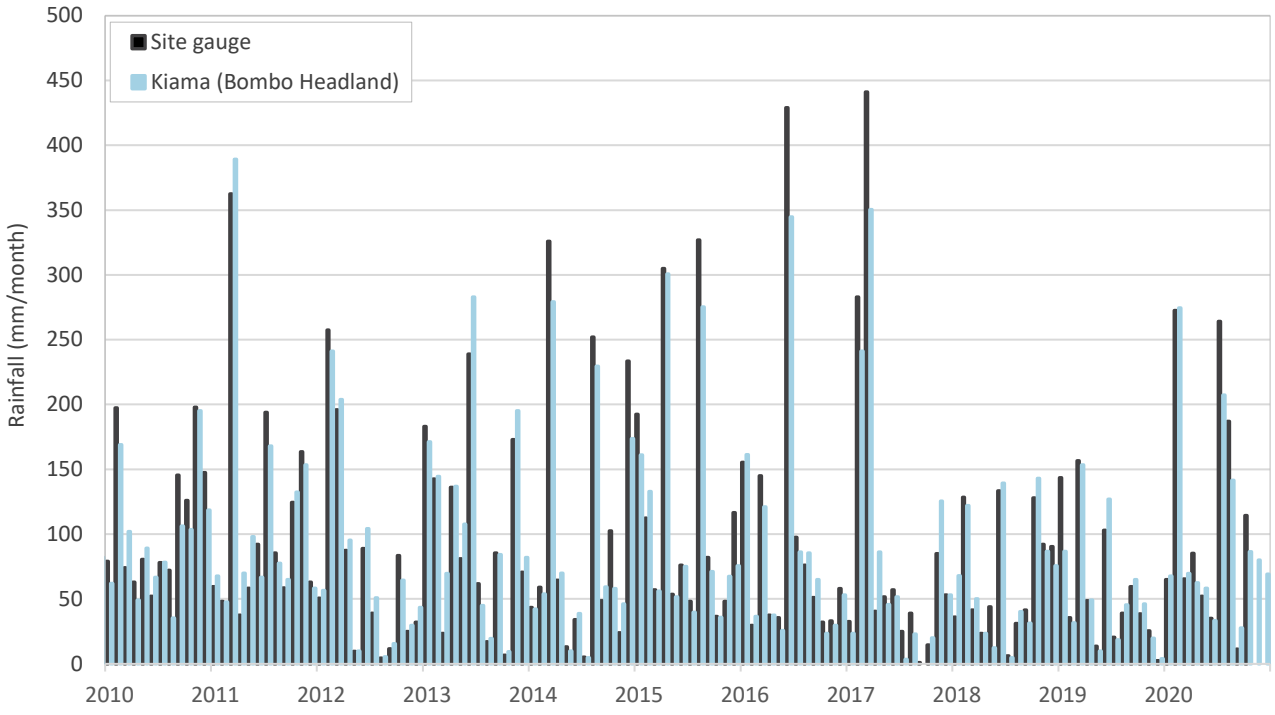


Figure 3.1 Historical monthly rainfall totals – 2010 to present

3.4 Watercourses and drainage

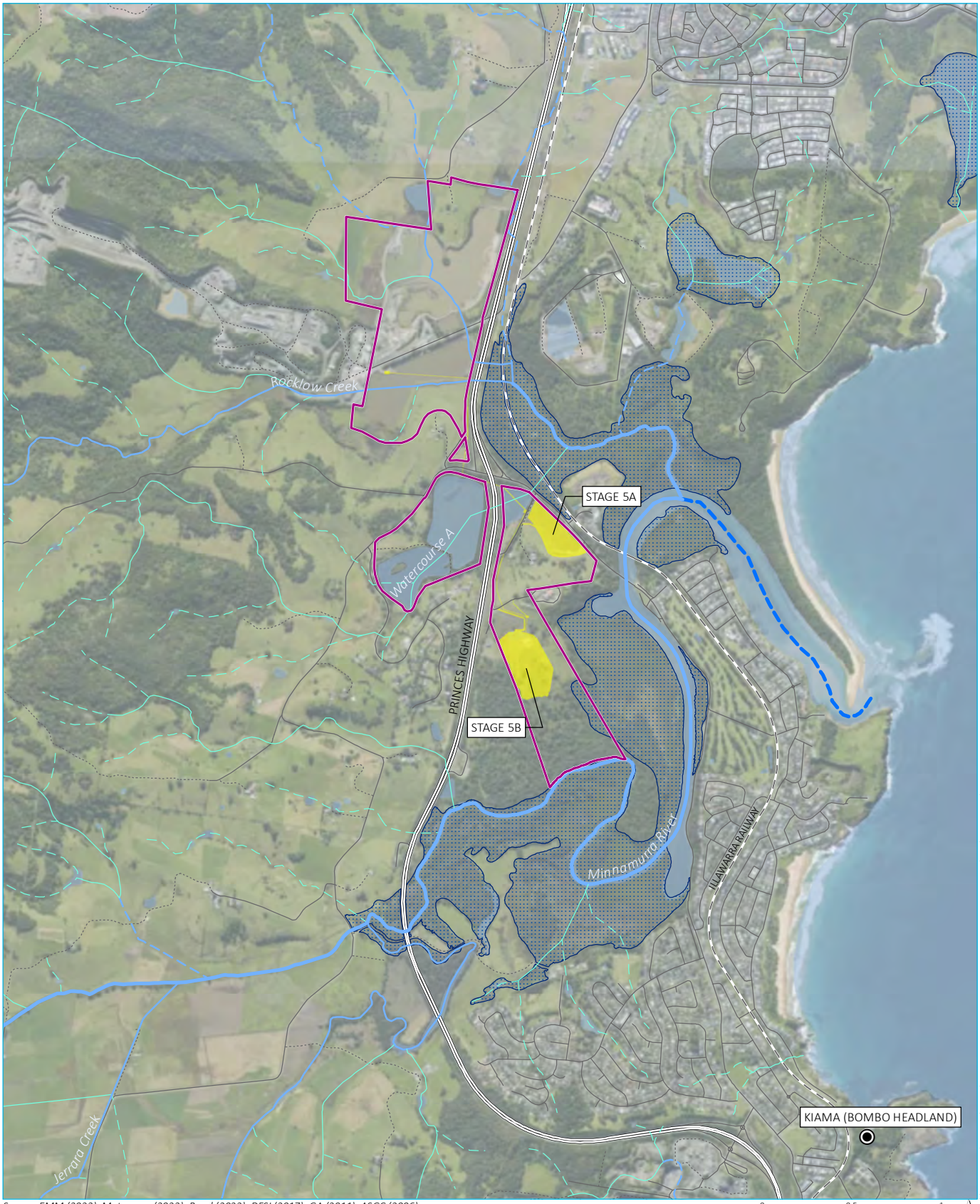
3.4.1 Watercourses

The site is in the estuarine zone of the Minnamurra River catchment (Hydrosphere 2015). The Minnamurra River catchment has an area of 117 km^2 (DPIE 2018) and extends from the Illawarra Ranges in the west to the Pacific Ocean in the east. The catchment is comprised of steep forested headwaters with undulating cleared rural land, trending to cleared agricultural floodplains in the lower catchment. The lower portion of the Minnamurra River catchment is subject to tidal influences and includes areas of 'coastal wetland' as classified in the NSW State Environmental Planning Policy (Coastal Management) 2018.

The Minnamurra River flows approximately 400 m south of Stage 5B before meandering north and flowing approximately 200 m east of Stage 5A. The river discharges to the Pacific Ocean about 2.5 km downstream of Stage 5A.

Rocklow Creek, a tributary to the Minnamurra River, rises to the west of the existing operations and has a catchment area of approximately 21 km^2 (EMM 2017). Rocklow Creek flows west to east through the southern portion of Stage 3 before flowing downstream of the Princes Highway via a series of culverts. Rocklow Creek joins the Minnamurra River approximately 1.5 km downstream of the Princes Highway and about 500 m downstream of Stage 5A.

The hydrologic context of the site including key watercourses and the extent of the Minnamurra River coastal wetlands is shown in Figure 3.2.



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- DLSP boundary
- DLSP stage 5
- BoM monitoring location
- Rail line
- Major road
- Minor road
- Vehicular track
- Waterbody
- Coastal wetland

Strahler stream order

- 1st order
- 2nd order
- 3rd order
- 4th order
- 5th order
- 6th order

Hydrologic context

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 3.2

EMM creating opportunities

3.4.2 Local drainage network

i Stage 5A

Local drainage within Stage 5A is influenced by runoff from the adjacent hillside to the south, runoff from the catchment to the west, and backwater flooding associated with Rocklow Creek and Minnamurra River. The catchment to the west drains an area of approximately 315 ha and includes a series of ponds associated with the historical Stage 1 extraction area. Runoff from the catchment drains via a second order (Strahler 1952) watercourse (herein after referred to as Watercourse A) through two of the ponds before traversing the Princes Highway via four 2.7 wide x 2.4 high box culverts (SEEE 2019a) and draining into a third pond. Flows then traverse Riverside Drive via three 2.7 m wide x 2.4 m high culverts before flowing beneath the Illawarra Railway and discharging to Rocklow Creek and ultimately Minnamurra River (SEEE 2019a).

The hillside catchment to the south drains an area of 6 ha that is primarily comprised of cleared grassland. Runoff from this catchment drains to a constructed channel on the southern side of Riverside Drive before flowing north-west beneath Fig Hill Lane (via twin 900 mm diameter culverts) and into the adjacent historical Stage 1 extraction pond. Flows from the southern catchment join flows from the western catchment within the historical Stage 1 extraction pond, upstream of Riverside Drive.

Backwater flooding associated with Rocklow Creek and Minnamurra River is described in Chapter 4.

ii Stage 5B

Local drainage within Stage 5B is influenced by runoff from the adjacent hillside to the north and from a relatively flat area between the extraction area and Princes Highway to the west. Local drainage within Stage 5B is also affected by flooding from the Minnamurra River (SEEE 2019a).

The catchment to the north and west of Stage 5B drains an area of approximately 12 ha and is comprised of cleared grassland to the north and vegetation to the west. Currently, overland flows drain west to east through Stage 5B via a series of local depressions and low points. Local drainage discharges to the Minnamurra River to the south east of the site.

Flooding associated with the Minnamurra River is described in Chapter 4.

3.4.3 Wetlands

The NSW SEPP (Coastal Management) 2018 classifies Rocklow Creek and Minnamurra River as ‘coastal wetland’ adjacent to and downstream of Stage 5. These wetlands also contain areas of Type 1 highly sensitive fish habitat and Class 1 waterways for fish passage as defined in the policy and guidelines for fish habitat conservation and management (DPI 2013). The Minnamurra River estuary is also classified as a high priority groundwater dependant ecosystem (GDE) under the WSP for the Greater Metropolitan Region Groundwater Sources 2011.

Water quality in the Minnamurra River wetlands and adjacent area are managed under the Coastal Zone Management Plan (CZMP) for the Minnamurra River Estuary (Hydrosphere 2015). Water quality data presented in the CZMP indicates water quality within the Minnamurra River estuary generally complies with ANZECC 2000 water quality guideline values. However, upstream land use pressures have the potential to reduce water quality for some parameters including nitrogen and phosphorus. Rocklow Creek has also been observed as having highly eutrophic conditions (Hydrosphere 2015) which may be an indication of algal blooms resulting from high nutrient concentrations (SEEE 2019a).

3.5 Geology and soils

The local geology comprises Quaternary Alluvium overlying Permian aged Bumbo Latite (an igneous hard rock). The Quaternary Alluvium forms the coastal plain and valley floors of the Minnamurra River and its major tributaries, including Rocklow Creek. The local geology of the site is shown in Figure 3.3.

The general geological profile of the site comprises sandy topsoil and weathered sand soil profiles overlying fresh tsunami deposits of medium and fine sand. The underlying bedrock consists of latite. However, large clay deposits sit above the rock forming the base of the sand deposits (Element Environment 2019).

The soil of the area is formed from alluvial, colluvial or aeolian deposition of medium to fine well sorted sands. The dominant soil landscape group in the Stage 5 extraction area is Mangrove Creek, which is typically described as vegetated Holocene sediments of silty to peaty quartz sand, silty and clay with shell layers in sandy mud. The soils may also be sodic and strongly acid (EES 2019b).

The Shellharbour Local Environmental Plan (LEP) 2013 indicates Stage 5A is located within a 'Class 2' acid sulfate soil management zone, while Stage 5B is located within a 'Class 4' zone. Hence, there is a potential that soils within the Stage 5 area may form acid upon oxidation, through water table lowering or bulk excavation. Acid sulfate risks associated with the site are described further in the ASSMP (EES 2019c).

3.6 Groundwater

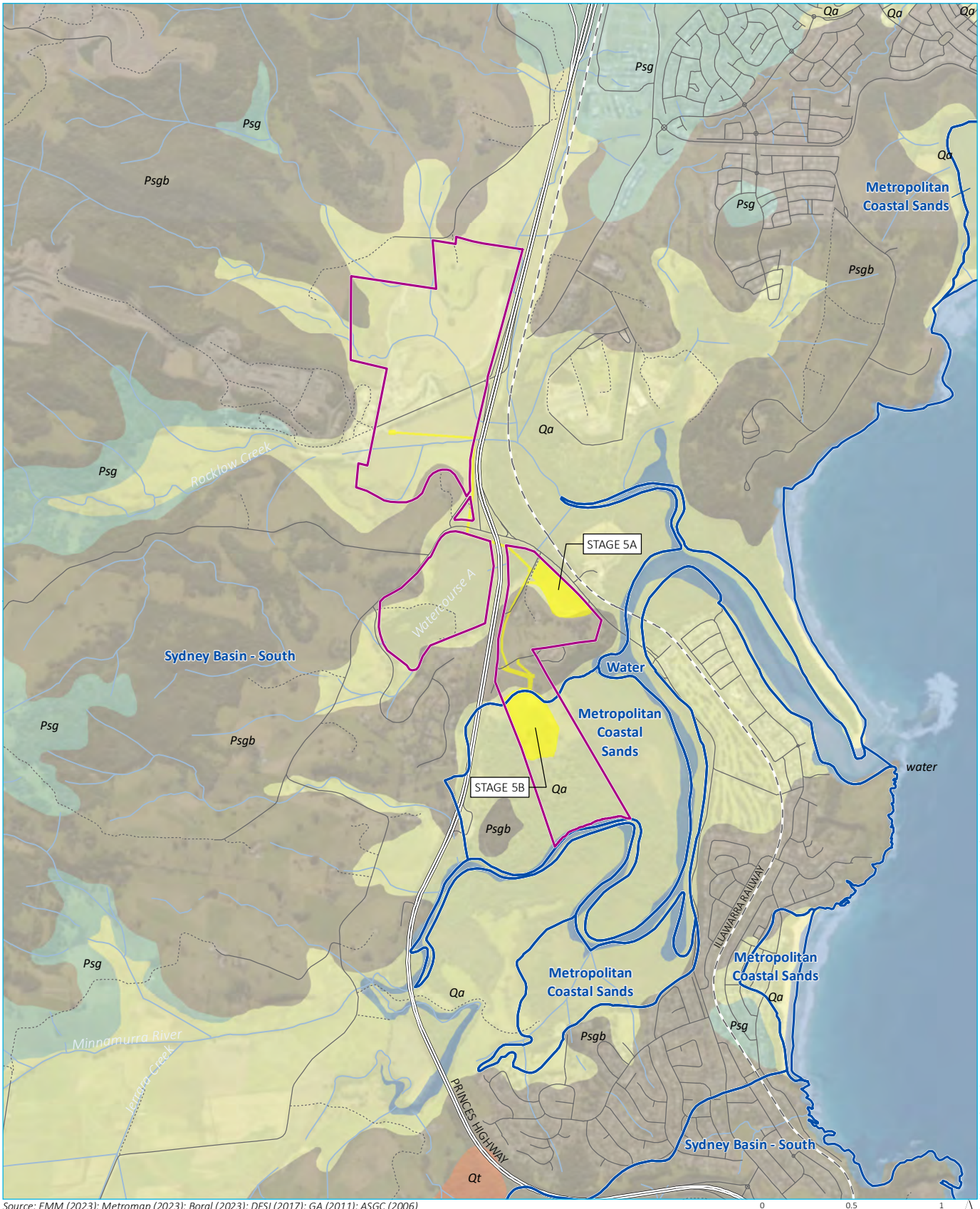
The regional groundwater system flows south-east, governed by the dip in the strata and topography. Recharge to the regional groundwater system is via infiltration from the overlying sedimentary units to the west of the site. Regional groundwater discharges to the Pacific Ocean (Cohen 2006).

The alluvial sands which dominate the geological setting of the site, coupled with low-lying topography, have combined to create an unconfined aquifer system overlying bedrock (with some associated silt and clay) to 18 m or more below the surface. The alluvial groundwater is relatively shallow and fresh as the water table responds rapidly to recharge via rainfall (EES 2019b).

The hydraulic gradient is typically to the north east for both Stage 5A and Stage 5B extraction areas resulting in groundwater flowing towards the Minnamurra River. The outcrop of latite bedrock to the north of the Stage 5B extraction area is likely to behave as a no flow boundary (EES 2019b).

The position of the piezometric surface close to ground level, particularly in the northern areas of the Stage 5A and Stage 5B extraction areas, means very little groundwater movement is likely to occur (EES 2019b). Only the upper one to two metres of the aquifer are likely to experience groundwater movement. Deep groundwater below this depth is unlikely to move significantly. Therefore, there will be very little groundwater movement in the central area of the Stage 5B extraction area, where the aquifer is deepest (EES 2019b).

Overall, the water table surface is a subdued form of the topography, which is typical of all local and regional groundwater flow systems. Depths to groundwater are greatest in areas of groundwater recharge and shallowest in areas of groundwater discharge.



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- DLSP stage 5
- DLSP boundary
- Groundwater sharing plan boundary
- Rail line
- Major road
- Minor road
- Vehicular track

Lithology

- Quaternary Alluvium (Qa)
- Quaternary Talus (Qt)
- Shoalhaven Group, Bumbo Latite (Psgb)
- Shoalhaven Group, undifferentiated siltstone (Psg)
- Water

Local groundwater context

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 3.3

EMM creating opportunities

3.7 Surface water-groundwater connectivity

The permeable nature of the soils, high water table, low hydraulic gradient and high estimated rainfall recharge combine to create a strong hydraulic connection between surface and groundwater sources (EES 2004). Due to the high permeability of site soils, little to no runoff is expected during light to moderate rainfall events. Moderate to high intensity rainfall events are expected to fully recharge the underlying aquifer resulting in 100% runoff. Substantial waterlogging of the site is expected to occur following such rainfall events (EES 2019b).

Tidal effects may influence groundwater levels and quality in areas adjacent to the Minnamurra River estuary. Tidal effect is typically limited to between 5 and 50 m from a tidal creek, depending on soil permeability. A dampening effect would occur on tidal effects with distance from the Minnamurra Estuary. However, there is a possibility that groundwater in proximity to the Stage 5 dredge ponds may experience localised tidal influences such as increased in salinity (as measured by electrical conductivity) as a result of tidal inflows (EES 2019b).

4 Flood mitigation and management

4.1 Flooding mechanisms

The Stage 5 extraction area is subject to inundation due to the following three flooding mechanisms:

1. local tributary flooding along Watercourse A;
2. backwater flooding from Rocklow Creek; and
3. backwater flooding from Minnamurra River.

Stage 5A is impacted by flooding associated with Watercourse A and Rocklow Creek, while Stage 5B is impacted by flooding from the Minnamurra River.

4.2 Existing flood conditions

4.2.1 Sources of data

Existing flood conditions for the Stage 5 extraction area are established in the *Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand Project* (SEEE 2019a). The Southeast Engineering & Environmental (SEEE) (2019) assessment built on an early study completed by Cardno (2019) to inform the *Flood and Coast Study, Stage 2 Report, Minnamurra River Boardwalk*.

4.2.2 Description of flooding conditions

The Stage 5A area is low lying with ground surface levels ranging from 1.3 m AHD in the north-west to approximately 10 m AHD in the south-east. Most of the Stage 5A area has ground surface levels below 3 m AHD and is expected to experience inundation of up to 1.3 m deep for a flood event of 20% annual exceedance probability (AEP) magnitude under pre-construction conditions. The probable maximum flood event (PMF) is predicted to inundate all but the far south-east corner (where elevations are highest) of Stage 5A. A flood mitigation bund will be established to prevent inundation of the Stage 5A pond by floodwaters associated with the 1% AEP flood level as required by accordance with consent condition 29A (refer to Table 4.2).

The Stage 5B area has a lower risk of flooding due to the topography predominately being over 4 m AHD. Flood inundation of Stage 5B is relatively shallow with depths across most of the extraction area ranging from 0.1–0.2 m for a flood event of 1% AEP magnitude under pre-construction conditions. The majority of Stage 5B remains flood free in smaller more frequent flood events. The PMF event is predicted to inundate the entire Stage 5B area with flood depths of approximately 1 m AHD across most of the extraction area under pre-construction conditions. A flood mitigation bund will be established to prevent inundation of the Stage 5B pond by floodwaters associated with the PMF flood level in accordance with consent condition 29B (refer to Table 4.2).

The maximum flood level within the Stage 5A and Stage 5B extraction areas for a range of design flood events is provided in Table 4.1. The flood levels provided for Stage 5A are associated with local runoff from Watercourse A and backwater flooding from Rocklow Creek. The flood levels provided for Stage 5B are associated with Minnamurra River flooding.

Flood maps completed by Southeast Engineering and Environmental (SEEE 2019b) for the Stage 5 extraction area are provided in Appendix D.

Table 4.1 Existing flood levels

Flood event	Maximum flood level within extraction area (m AHD)	
	Stage 5A (Rocklow Creek and Watercourse A)	Stage 5B (Minnamurra River)
20% AEP	2.61	2.36
5% AEP	2.95	2.97
1% AEP	3.42	4.12
PMF	4.36	5.15

Source: Table 3.2 of *Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand Project* (SEEE 2019a).

4.2.3 Flood risk characterisation

Southeast Engineering & Environmental (2019a) classified the majority of Stage 5A and Stage 5B as low flood hazard for events up to the PMF for both existing and proposed scenarios. A small portion of the Stage 5A dredge pond footprint is considered high flood hazard for the PMF under existing conditions. This area is downgraded to low flood hazard under proposed conditions.

The hazard classification is based on a velocity and depth product of less than 0.55 being low hazard and greater than 0.55 as high hazard (SEEE 2019a).

4.3 Potential flood impacts

Potential flood impacts associated with Stage 5 are identified and addressed in the surface water assessment (SEEE 2019a) prepared for the Modification 2 EA (Element Environment 2019). This section provides a summary of the flood impacts described in the Modification 2 EA.

Floodwaters that inundate the Stage 5A or Stage 5B extraction areas have the potential to mix with dirty water within the active dredge pond or entrain sediments from stockpile areas before flowing further downstream and ultimately into the Minnamurra River. Flood bunds are proposed (refer to Section 4.4) to reduce the risk of flood waters entering the Stage 5 extraction areas and transporting potentially dirty water into receiving water ways.

Flood impacts are expected to occur due to the construction of the proposed flood bunds. The SEEE (SEEE 2019a) study predicted the Stage 5A and Stage 5B flood bunds would result in a maximum increase in flood level of up to 45 mm when designed to the 1% AEP flood level. The largest increase in flood level for Stage 5A is experienced along the western boundary while the largest increase for Stage 5B is experienced along the southern boundary. Localised velocity increases of up to 0.3 m/s are experienced adjacent to both flood bunds (SEEE 2019a).

The Stage 5B flood mitigation bund was revised in May 2023 (SEEE 2023) to provide flood protection up to and including the PMF event in accordance with consent condition 29B. The revised Stage 5B flood bund is predicted to increase flood levels during the PMF event by up to 170 mm along the western boundary of the bund. The resulting flood impacts are primarily confined to the surrounding bush and wetland areas. No material changes to flood impacts are expected to result from the revised design for flood events up to the 1% AEP event.

Flood impacts resulting from the construction of the Stage 5A and Stage 5B flood mitigation bunds are shown in Appendix D (SEEE 2019b). The revised flood assessment for the Stage 5B flood mitigation bund level and design is provided in Appendix H (SEEE 2023).

4.4 Flood management controls

Flood mitigation and management measures to reduce flood related impacts and risks for Stage 5 are described in the Modification 2 EA (Element Environment 2019). Flood mitigation and management measures for the existing operations are described in the WMP for DLSP Stage 2 to 4. A summary of the flood mitigation and management measures described in these documents is provided in Table 4.2. The Stage 5A and Stage 5B flood mitigation bund alignment and design are shown in Figure 4.1 and Figure 4.2 respectively.

Table 4.2 Flood mitigation and management

Activity	Potential flood impacts/risks	Existing and proposed controls based on Modification 2 EA commitments and existing operations WMP	Condition
Flood management			
Site access	• The existing site access road off Tabita Road, processing and stockpile area, and fines returns pond are inundated by floodwaters.	• Consent condition 28 relates to the construction of the existing site access road and infrastructure has been addressed as part of the Stage 2 to 4 Water Management Plan. • The existing access road off Tabbita Road, processing and stockpile area and confining bunds for the fines return pond(s) have been constructed above the 1 in 100 year ARI (1% AEP) flood level which was determined to be 3.6 m AHD (Bewsher 2004). • The Planning Secretary will be provided the final site survey.	28
Cessation of quarrying	• Dredging and backfilling may alter flood characteristics within and downstream of the extraction areas.	• A qualified hydrologist will be commissioned to prepare a flood study to define the flood-related limits of the final landform. • The Department and Shellharbour City Council will be consulted during the preparation of the study. • The endorsement of the Planning Secretary will be obtained prior to the cessation of activities on the site.	29
Stage 5 flood mitigation			
Material extraction within existing Stage 5A flood extent	• Floodwaters inundate Stage 5A extraction area resulting in the mixing of dredge pond water and flood waters.	• A flood mitigation bund will be established to prevent inundation of the Stage 5A pond by floodwaters associated with the 1 in 100-year ARI flood level. • Detailed design of the Stage 5A flood bund will be provided to the Planning Secretary.	29A
Material extraction within existing Stage 5B flood extent	• Floodwaters inundate Stage 5B extraction area resulting in the mixing of dredge pond water and flood waters.	• A flood mitigation bund will be established to prevent inundation of the Stage 5B pond and carpark area by floodwaters associated with PMF flood level. Note the Modification 2 EA committed to providing 1% AEP flood protection for Stage 5B. • Any increase in the height of the bund required to achieve PMF flood protection will be accompanied by an appropriate increase in width. • The Stage 5B flood mitigation bund will be retained and maintained until otherwise agreed with the Planning Secretary. • Detailed design of the Stage 5B flood bund will be provided to the Planning Secretary.	29B/C

Table 4.2 Flood mitigation and management

Activity	Potential flood impacts/risks	Existing and proposed controls based on Modification 2 EA commitments and existing operations WMP	Condition
Establishment of flood bund	• Flood bunds become structurally unstable allowing ingress of flood waters or discharge of dredge water from extraction area.	• Regular monitoring of the stability of Stage 5A and Stage 5B flood bunds will be undertaken throughout the extraction, rehabilitation, and closure phases of Stage 5. • Once resource extraction is complete, the Stage 5 flood bunds will be decommissioned to reinstate floodplain storage and reduce the risk of flood bunds becoming structurally unstable over time.	29D

Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

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KEY

- DLSP boundary
- DLSP stage 5 (refer to inset)
- Rail line
- Minor road
- Vehicular track
- Clean water diversion
- Existing drainage line
- Watercourse/drainage line
- Contours (1 m)
- Waterbody

Floodbund footprint

- Bank
- Batter
- Spillway
- Stockpile
- Extraction Pond

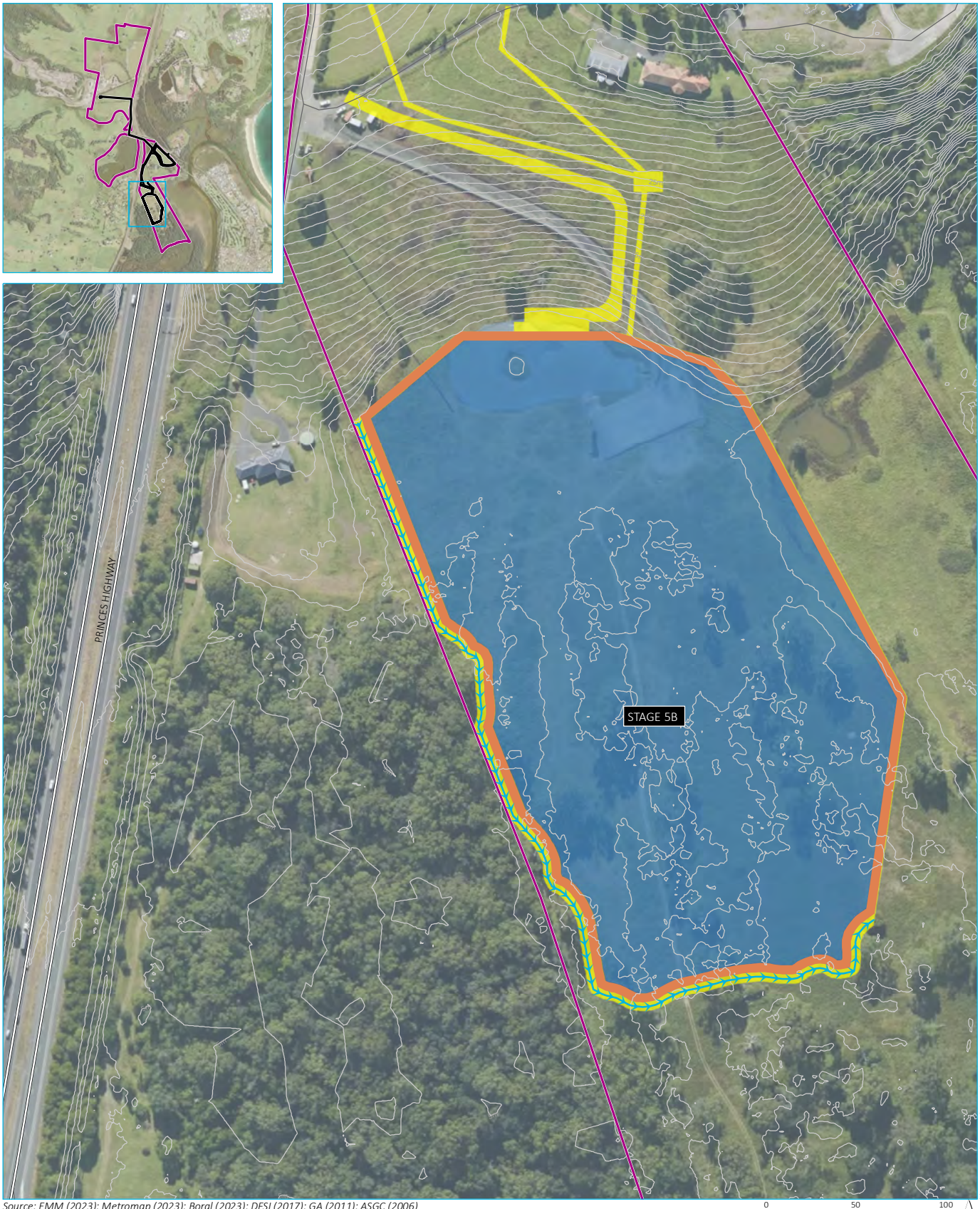
Floodbund contours

- Major
- Minor

Flood mitigation and management
Stage 5A extraction area

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 4.1

EMM
creating opportunities



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

0 50 100 m

GDA 1994 MGA Zone 56

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KEY

- DLSP boundary
- Extraction pond
- Stage 5 boundary
- Stage 5B flood bund
- Clean water diversion
- DLSP stage 5 (refer to inset)
- Major road
- Minor road
- Contours (1 m)
- Waterbody

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Flood mitigation and management
Stage 5B extraction area

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 4.2

EMM
creating opportunities

5 Site water balance

5.1 Inflows and outflows

The Stage 5 site water balance includes inflows and outflows associated with rainfall, evaporation, groundwater flows, water extracted for dust suppression and water exported within the quarry material. The estimated annual volumes for each inflow and outflow are described below.

5.1.1 Rainfall and evaporation

Construction of the Stage 5A and Stage 5B dredge ponds will alter the surface water/groundwater interactions by creating a 'window' to the groundwater table. Groundwater recharge via infiltration will be replaced with direct inflow from rainfall over the pond footprint and losses associated with evaporation from the pond surface. An average annual rainfall depth of 1,038 mm/year is established for the site in Section 3.3.

The average annual evaporation depth expected to occur from the dredge ponds has been calculated using Morton's shallow lake evaporation obtained as SILO Point Data from the Queensland Climate Change Centre of Excellence. The average annual evaporation expected to occur from the Stage 5 dredge ponds is 1,296 mm/year. A comparison between average annual rainfall and evaporation indicates an annual deficit of 258 mm.

Runoff to the dredge ponds will also occur following rainfall from stockpiles, carparks, haul roads and areas that cannot be diverted around the ponds. The contributing catchment area to Stage 5A is 4.3 ha (SEEE 2019). The contributing catchment area to Stage 5B is comprised only of the pond surface area due to the proposed flood bund level being designed for the PMF event (refer to Section 4.4).

Runoff has been calculated from the Stage 5A contributing catchment area less the pond surface area (ie 1.2 ha). Only direct rainfall was applied to the Stage 5B pond surface area as there is no upstream catchment. For water balance purposes, an annual runoff coefficient of 0.3 has been assumed to estimate the volume of rainfall that turns into runoff annually.

5.1.2 Surface water flows

The Stage 5 extraction areas will be bunded to prevent surface water inflows from entering the dredge ponds. Hence, surface water inflows from upstream catchments are not expected to result in a significant contribution to the site water balance. All surface water flows from upstream of the Stage 5B dredge pond will be diverted around the pond.

Overflows from the Stage 5A and Stage 5B dredge ponds are not anticipated to impact the site water balance as overflows would occur infrequently due to the design requirements of the flood mitigation bunds (refer to Section 4.4) and substantial available storage (refer to Section 6.3.3). Overflows from the Stage 5 dredge ponds are not anticipated to occur under typical operating conditions.

5.1.3 Groundwater flows

Groundwater inflow and outflow estimates for Stage 5A and Stage 5B were established in the Hydrogeological Impact Assessment (HIA) (EES 2019b). EES (2019b) estimated the groundwater inflow beneath Stage 5A and Stage 5B to be 53 ML/year and 220 ML/year, respectively. Groundwater discharges from the total Stage 5 area were estimated to be similar to groundwater inflows (ie 275 ML/year). Hence, minimal net take of groundwater is predicted.

5.1.4 Dust suppression

Water will be used for dust suppression within the existing operations area, access roads and stockpile areas. Water for existing operations dust suppression is currently sourced at a rate of approximately 4.5 ML/ha/year. The existing dust suppression application area of 7.6 ha requires approximately 34.2 ML/year of water.

The Stage 5A and Stage 5B access roads and stockpile areas cover an area of approximately 0.7 ha (SEEE 2019a). Applying the same dust suppression rate as existing operations increases the annual demand from 34.2 ML/year to approximately 37.4 ML/year.

Dust suppression for the existing application area will continue to be sourced from the existing operations area. The additional 3.2 ML/year of dust suppression water that is required for the Stage 5 area may be sourced from the Stage 5A and Stage 5B dredge ponds as needed.

5.1.5 Processing losses

Water will be extracted with the quarried material during dredging. The water will form a sand slurry that facilitates the transfer of quarried material from the Stage 5 extraction pond to the processing plant. The maximum pump rate for extracting the sand slurry from the Stage 5 dredge ponds is estimated at 250 L/s or 10.8 ML/day based on a 12-hour workday. Most of the water extracted during dredging will be returned to the Stage 5 extraction pond following processing. Some residual water will remain within the sand product and exported offsite.

Water exported within the sand product is estimated to be 8% (by weight) of total production. The quarry is approved to extract up to 800,000 tpa which would result in an estimated 64 ML/year of water being exported with the quarry product. Extraction at the maximum approved rate (800,000 tpa) is unlikely due to the lower processing capacity of current infrastructure. Current extraction rates range between 400,000 and 500,000 tpa. Extraction of the Stage 5 material is expected to continue at a similar rate. Based on an average extraction rate of 450,000 tpa and a product moisture content of 8%, it is estimated that approximately 36 ML/year will be exported with the quarry product. The water balance presented in Section 5.1.7 considers water demands for both the maximum approved extraction rate (800,000 tpa) and the average extraction rate (450,000 tpa). If production is scaled up from the current rates in the future, DSS will obtain additional WAL allocations as needed (refer to Section 5.3).

Additional losses will also occur due to evaporation and seepage of water entrained in tailings that are stockpiled within the existing operations area. Fine tailings from the wash plant are directed to the fines pond while oversized material is stockpiled adjacent to the fines pond to allow the material to drain. Seepage from the stockpiled tailings ultimately drains into the fines pond prior to draining to the secondary settling pond and Stage 3 pond before being transferred back to the Stage 5 extraction area (refer to Section 6.3). Losses associated with tailings are expected to be relatively small and have been estimated at 0.5 ML/year for water balance purposes.

5.1.6 Potable water use

Potable water from mains supply will be used for amenities in the site office building. The site office will be staffed by approximately 11 personnel. Mains water will not be used for extraction or dust suppression.

It is expected the potable water demand for the site office will be relatively small. Hence, potable water demand has not been included in the water balance summary provided in Section 5.1.7.

5.1.7 Water balance summary

Inflows and outflows to the Stage 5 extraction area in an average rainfall year are summarised in Table 5.1. Water demands are provided for both the current and expected production rate of 450,000 tpa and the maximum production rate of 800,000 tpa.

For a 450,000 tpa production rate, the water balance indicates a water deficit of 79 ML/year and 92 ML/year for the Stage 5A and Stage 5B ponds, respectively. Most of the deficit is associated with outflows due to water exported in the product (36 ML/year) and dust suppression (38 ML/year), which result in combined deficit of 74 ML/year. The remaining deficit is associated with evaporation from the pond surface and water lost in tailings. A larger annual deficit is experienced for the 800,000 tpa production rate due to the additional water exported in the product.

Table 5.1 Summary of inflows and outflows

		Stage 5A		Stage 5B		
Water balance component	**Units**	**450,000 tpa**	**800,000 tpa**	**450,000 tpa**	**800,000 tpa**	**Source**
Contributing catchment	ha	4.3	4.3	6.4	6.4	SEEE 2019
Extraction pond area	ha	3.1	3.1	6.4	6.4	SEEE 2019
Average annual rainfall	mm/year	1,038	1,038	1,038	1,038	Section 3.3
Average annual evaporation	mm/year	1,296	1,296	1,296	1,296	Section 3.3
Inflows						
Rainfall on to pond surface[1]	ML/year	32	32	66	66	-
Runoff from adjacent land	ML/year	4	4	0	0	-
Groundwater inflow	ML/year	53	53	220	220	EES 2019a
Total inflows	ML/year	**89**	**89**	**286**	**286**	-
Outflows						
Pond evaporation	ML/year	40	40	83	83	-
Water exported in product	ML/year	36	64	36	64	Section 5.1.5
Dust suppression	ML/year	38	38	38	38	Section 5.1.4
Groundwater outflows	ML/year	53	53	220	220	EES 2019a
Tailings losses	ML/year	0.5	0.5	0.5	0.5	Section 5.1.5
Total outflows	ML/year	**168**	**196**	**378**	**406**	-
Difference	ML/year	**-79**	**-107**	**-92**	**-120**	-

Notes: 1. Storage capacity is estimated at 78 ML and 270 ML for the Stage 5A and Stage 5B ponds, respectively. Storage capacities are described further in Table 6.5.

5.2 Water supply

Water used for dust suppression and sand processing is currently sourced from the existing fines pond and dredge pond under groundwater WAL24477 and associated works approval 10WA106714 (refer to Section 2.3.2). WAL24477 allows for the extraction of up to 77 ML/year from the Sydney Basin South Groundwater Source.

DSS have also acquired WAL42100 to extract 15 ML/year and WAL42443 to extract 20 ML/year from the Metropolitan Coast Sands Groundwater Source. A Miscellaneous Works (10MW119332) for these WALs was obtained on 2 July 2021 (refer to Section 2.3.2 and Appendix C).

DSS acquired 966 ML/year (WAL44534) of groundwater entitlement in the Metropolitan Coastal Sands Groundwater Source as part of the 2021 controlled allocation order.

5.3 Water licencing requirements

5.3.1 Background

Stage 5 will require water take from the Sydney Basin South Groundwater Source and the Metropolitan Coastal Sands Groundwater Source. Water take from Stage 5A is from the Sydney Basin South Groundwater Source while water take from Stage 5B is from the Metropolitan Coast Sands Groundwater Source.

5.3.2 Government advice

NRAR advised 20 December 2021 that water licences are required for the gross volume of water extracted from the Stage 5A and Stage 5B extraction areas (estimated at 1,179 ML/year). Gross water take is significantly higher than actual water take as groundwater intercepted by the extraction pond is recycled through the process system (and extraction ponds) multiple times. It is understood that DPIE, DPIE-Water and NRAR are in discussions to agree on a path forward regarding licensing requirements for gross water take (ie no return water policy). However, no such policy is in place.

DPIE advised 14 January 2022 that the SWMP should be updated with a commitment to obtain the required number of water entitlements in the next controlled allocation order, should sufficient entitlements be made available.

5.3.3 Water market summary

The Sydney Basin South Groundwater Source has 4,444 ML water entitlement distributed across 104 WALs while the Metropolitan Coast Sands Groundwater Source has 1,609 ML water entitlement distributed across 58 WALs. Given the gross extraction volume makes up a significant portion of the available entitlements in each groundwater source, it is unlikely sufficient water entitlements can be obtained via temporary or permanent trade.

The 2021 controlled allocation order released 1,170 ML and 1,032 ML of water entitlements for the Sydney Basin South Groundwater Source and Metropolitan Coast Sands Groundwater Source respectively. Hence, substantial additional water entitlements may be obtained via controlled allocation order if similar entitlements are released to recent years.

5.3.4 Proposed approach

DSS propose to review a range of methods for calculating water take and establish a preferred approach and methodology in consultation with DPIE and NRAR. Gross water take will be included as one of the options (as suggested by NRAR). The objective of this process will be to establish an agreed approach and methodology to calculating water take.

The agreed approach and methodology will be applied to calculate the water take entitlement on an annual basis and the calculated annual water take will be reported in the Annual Review. DSS will seek to obtain the required number of water entitlements in the next round of controlled allocation orders, should sufficient entitlement be released.

5.3.5 Actions to date

DSS acquired 966 ML/year (WAL44534) of groundwater entitlement in the Metropolitan Coastal Sands Groundwater Source as part of the 2021 controlled allocation order. DSS now hold WAL's to extract up to 1,001 ML/year from the Metropolitan Coastal Sands Groundwater Source.

5.4 Preparation of annual water balance

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

- rainfall volume flowing into the Stage 5 dredge ponds;
- evaporation losses from the surface of the Stage 5 dredge ponds; and
- net process water use for dust suppression and water exported in product.

As groundwater inflows and discharges from the Stage 5 area are expected to be similar (EES 2019a; EES 2019b), the annual water take can be calculated as:

Groundwater extraction = Process water use + dust suppression + evaporation - rainfall

The results of the annual site water balance will be reported in the DSS Annual Review.

6 Surface water management plan

6.1 Surface water monitoring network

DSS have been monitoring water quality for several years in accordance with the quarry WMP and EPL conditions. Monitoring locations have been discontinued and new monitoring locations introduced as quarrying has progressed through DLSP stages 1 to 4. Data from the historical monitoring locations has been used to inform the description of baseline surface water data presented in Section 6.2.

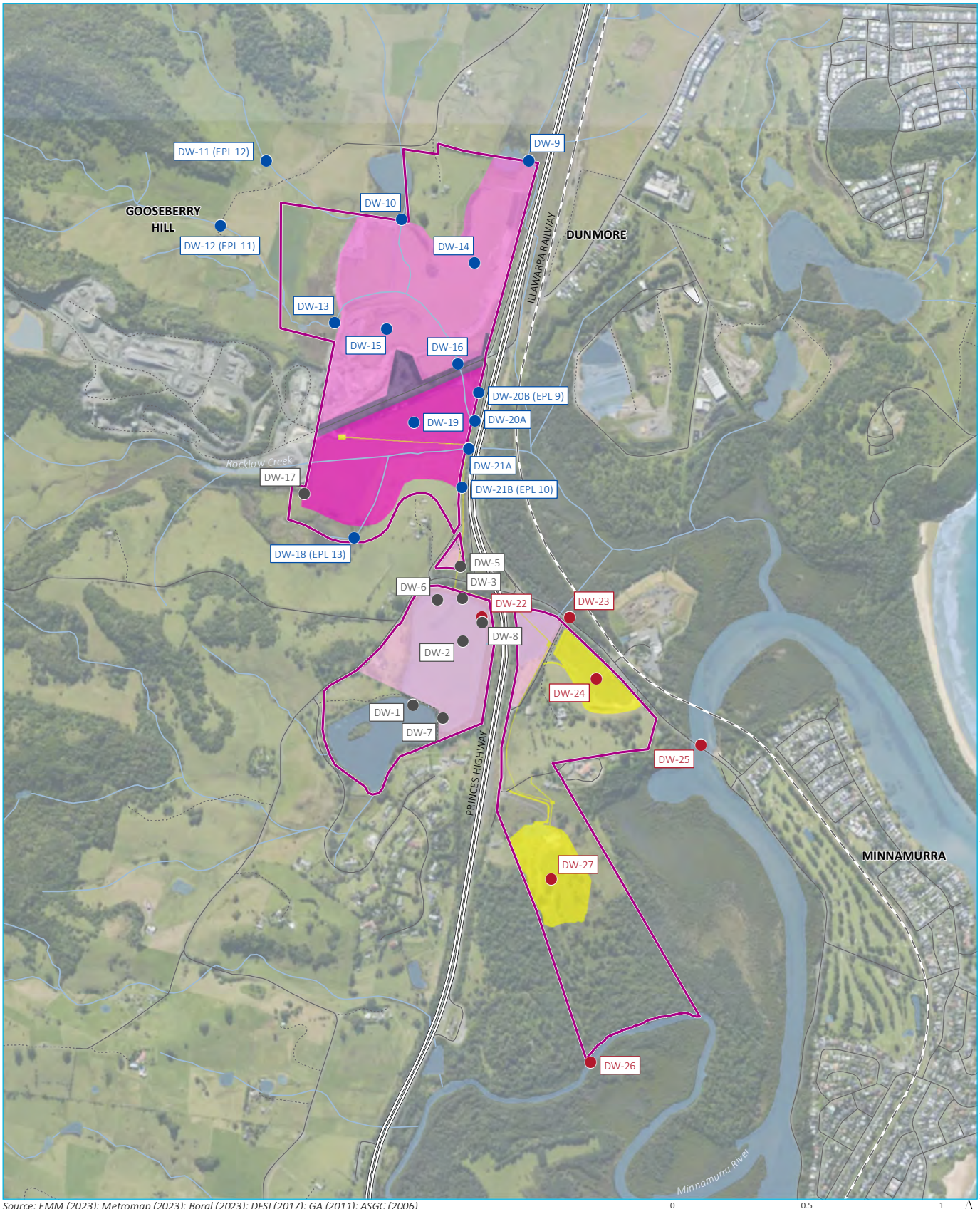
An additional six surface water quality monitoring locations are to be added to the monitoring program during construction and operation of the Stage 5 area. These include four additional locations that are upstream and downstream of the site, and two additional locations within the Stage 5A and Stage 5B dredge ponds.

Historical, current, and proposed surface water quality monitoring locations are summarised in Table 6.1 and shown in Figure 6.1.

Table 6.1 Surface water quality monitoring locations

Location ID	EPL ID	Stage	Status	Monitoring period	Water quality monitored	Requirement
DW-1 to DW-8	-	Stage 1	Discontinued	2001–2016	Historical water quality	-
DW-9	-	Stage 2	Active	2005–2019	Background water quality	-
DW-10	-	Stage 2	Active	2005–present	Background water quality	-
DW-11	EPL 12	Stage 2	Active	2007–present	Background water quality	Operational compliance
DW-12	EPL 11	Stage 2	Active	2007–present	Background water quality	Operational compliance
DW-13	-	Stage 2	Active	2005–present	Background water quality	-
DW-14	-	Stage 2	Active	2007–present	Dredge pond	Operational compliance
DW-15	-	Stage 2	Active	2007–present	Fines pond	Operational compliance
DW-16	-	Stage 2	Active	2007–present	Stage 2 to Stage 3	-
DW-17	-	Stage 3	Discontinued	2007–2019	Background water quality	-
DW-18	EPL 13	Stage 3	Active	2007–present	Background water quality	Operational compliance
DW-19	-	Stage 3	Active	2016–present	Dredge pond	Operational compliance
DW-20A/B	EPL 9	Stage 3	Active	2007–present	Surface water discharge	Operational compliance
DW-21A	-	Stage 3	Active	2017–present	Background water quality	-
DW-21B	EPL 10	Stage 3	-[1]	-	Surface water discharge	Operational compliance
DW-22	-	Stage 5	Proposed	-	Background water quality	-
DW-23	-	Stage 5	Proposed	-	Surface water discharge	Operational compliance
DW-24	-	Stage 5	Proposed	-	Dredge pond	Operational compliance
DW-25	-	Stage 5	Proposed	-	Surface water discharge	Operational compliance
DW-26	-	Stage 5	Proposed	-	Background water quality	-
DW-27	-	Stage 5	Proposed	-	Dredge pond	Operational compliance

Notes: 1. Sampling location associated with realigned Rocklow Creek which is yet to happen. Hence, this site is not currently active.



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

0 0.5 1 km

GDA 1994 MGA Zone 56

N

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KEY

DLSP boundary
Rail line
Major road
Minor road
Vehicular track
Watercourse/drainage line
Waterbody

DLSP stages
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5

Surface water monitoring locations
Active
Discontinued
Stage 5

Surface water monitoring locations

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 6.1

EMM creating opportunities

6.2 Baseline surface water data

6.2.1 Surface water flow

The stage 5 extraction area does not intersect any watercourses or defined drainage lines (refer to Figure 3.2). The majority of runoff upstream and within the site is characterised by overland flow. Hence, baseline streamflow data immediately upstream and within the Stage 5 extraction area is not available. Streamflow data is available for Minnamurra River which flows south and east of the site.

Minnamurra River streamflow is measured at DPIE operated Minnamurra River at Browns Lane (214010) stream gauge. The gauge is located approximately 4 km upstream of the site and has an available streamflow record from 2001 to present day. Minnamurra River streamflow from 2015 to 2021 is shown in Figure 6.2.

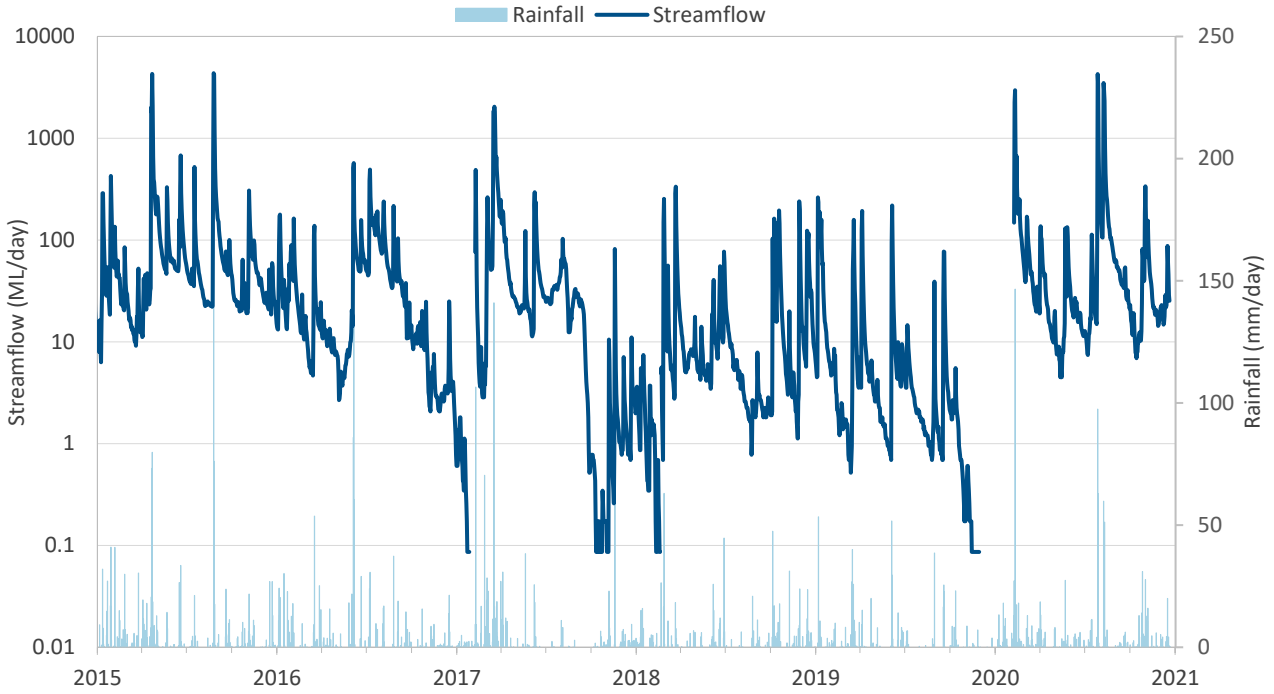


Figure 6.2 Minnamurra River at Browns Lane streamflow from 2015 to 2021

Figure 6.2 indicates Minnamurra River experiences a broad range of daily streamflow totals with observed values ranging from less than 0.1 ML/day to 4,400 ML/day. Streamflow at the Minnamurra River at Browns Lane gauge typically ranges between 5 ML/day and 50 ML/day.

The Minnamurra River is subject to tidal influences downstream and adjacent to the site (refer to Section 3.4). Tidal water level in the Minnamurra River is monitored at Manly Hydraulics Laboratory (MHL) operated Minnamurra (214442) tidal gauge. Tidal data can be obtained from MHL on an as needs basis.

6.2.2 Surface water quality

No baseline surface water quality data is available for the Stage 5 extraction area as operations are yet to commence. Baseline surface water quality data is available for the existing operations area and includes background, operational, and discharge water quality (refer to Section 6.1). Baseline surface water quality for the existing operations area is expected to be similar to that of Stage 5 and is described below.

A program to progressively characterise and monitor water quality upstream, downstream and within the Stage 5 extraction area is provided in Section 6.4.

i Background water quality

The existing operation's background water quality has been used to provide an indicative description of background water quality for Stage 5. While background water quality sites are located upstream of the existing operations disturbance area and are not impacted by quarry activities, the water quality at the sites may be influenced by catchment land uses such as agriculture.

The existing operations background water quality is associated with Rocklow Creek and its tributaries. The background water quality of Watercourse A and the Minnamurra River is expected to be comparable to the water quality of Rocklow Creek and its tributaries as land use in these catchments is similar. Background water quality for Stage 5 should be reviewed as data becomes available.

Background water quality statistics for pH, electrical conductivity, total suspended solids (TSS) and turbidity are provided in Table 6.2. The statistics include the 20th percentile (20P), 80th percentile (80P) and average (mean) values for each water quality parameter over the monitoring period identified in Table 6.1. Average annual water quality results since 2006 are presented in Appendix E. Further information on individual sampling events and exceedance is available in the DSS Annual Reviews and Annual Reports.

Table 6.2 Background water quality

	pH			Electrical conductivity (µS/cm)			TSS (mg/L)			Turbidity (NTU)		
	WQO 6.5–8.5			WQO <1,500 µS/cm			Discharge limit 50 mg/L			WQO 5–20 NTU		
	20P	80P	Mean	20P	80P	Mean	20P	80P	Mean	20P	80P	Mean
DW-9	6.9	7.5	7.2	300	696	531	6	78	73	5	107	70
DW-10	6.6	7.6	7.1	283	685	466	4	29	28	7	40	33
DW-11	6.8	7.5	7.2	410	811	636	3	22	21	8	68	46
DW-12	6.3	7.6	7.0	200	454	340	1	8	26	2	31	28
DW-13	6.7	7.7	7.2	497	751	619	4	19	25	4	36	39
DW-17	6.7	7.5	7.1	330	1,625	2,221	11	40	65	19	89	137
DW-18	6.6	7.6	7.2	344	973	1,586	9	30	36	17	52	43
DW21a	7.1	8.0	7.6	1,559	34,656	16,734	5	21	16	5	35	23
Total	**6.7**	**7.6**	**7.2**	**323**	**817**	**1,632**	**5**	**31**	**38**	**8**	**53**	**54**

Notes: Orange denotes the water quality value exceeds the discharge limits specified in consent condition 23.
Red denotes water quality value exceeds the WQO value specified in consent condition 24.

ii Operational water quality

The existing operations dredge pond water quality has been used to provide an indicative operational water quality within Stage 5. However, the Stage 5 dredge pond water quality may vary from the description provided below. Hence, operational water quality for Stage 5 should be reviewed as data becomes available.

Operational water quality statistics for pH, electrical conductivity, total suspended solids (TSS) and turbidity are provided in Table 6.3. Average annual water quality results since 2006 are presented in Appendix E. Further information on individual sampling events and exceedance is available in the DSS Annual Reviews and Annual Reports.

Table 6.3 Operational water quality

	pH WQO 6.5–8.5			Electrical conductivity (µS/cm) WQO <1,500 µS/cm			TSS (mg/L) Discharge limit 50 mg/L			Turbidity (NTU) WQO 5–20 NTU		
	20P	**80P**	**Mean**	**20P**	**80P**	**Mean**	**20P**	**80P**	**Mean**	**20P**	**80P**	**Mean**
DW-14	7.2	8.3	7.7	601	2,167	1,332	10	41	47	19	69	49
DW-19	7.5	8.1	7.9	1,848	6,204	6,180	10	34	26	6	46	50
Total	**7.2**	**8.3**	**7.8**	**698**	**2,693**	**2,251**	**10**	**39**	**43**	**13**	**65**	**49**

Notes: Orange denotes the water quality value exceeds the discharge limits specified in consent condition 23.
Red denotes water quality value exceeds the WQO value specified in consent condition 24.

iii Discharge water quality

Discharge water quality from the existing operations area is described in this section. The water quality of discharges from the Stage 5 dredge ponds is expected to vary from the water quality of existing operations (Stage 2 to 4) discharges. This is due to the variance of natural groundwater conditions in Stage 2 to 4 with most of the Stage 3 pond being located within the Rocklow Creek tidal zone. The Stage 2 to 4 environmental impact statement observed that slightly brackish (total dissolved solids (TDS) concentrations greater than 2,500 mg/L) groundwater was present in the southern section of Stage 3 prior to the commencement of Stage 2 to 4 operations. In addition, the existing (Stage 2 to 4) operations ponds are online with adjacent watercourses (ie watercourse flow through the ponds) while the Stage 5 ponds are offline. Furthermore, uncontrolled discharges from the Stage 5A and Stage 5B dredge ponds are unlikely as the proposed flood mitigation bunds:

- prevent flood waters mixing with receiving waters for flooding up to the 1% AEP flood event for Stage 5A;
- prevent flood waters mixing with receiving waters for flooding up to the PMF flood event for Stage 5B; and
- provide substantial storage (refer to 6.3.3) within the dredge ponds to capture local rainfall and allow for variations in flow transfers (ie between the dredge ponds and processing plant).

While a description of the existing operations discharge water quality is provided below, it is expected that should discharge occur from the Stage 5 dredge ponds, the water quality would be similar to that stored within the pond during operation. Hence, operational water quality data to be obtained as part of the surface water monitoring program described in Section 6.4 would be more representative of Stage 5 discharges (should they occur).

Discharge water quality statistics for pH, electrical conductivity, total suspended solids (TSS) and turbidity are provided in Table 6.4. Average annual water quality results since 2006 are presented in Appendix E. Further information on individual sampling events and exceedance is available in the DSS Annual Reviews and Annual Reports.

Table 6.4 Discharge water quality

	pH			Electrical conductivity (µS/cm)			TSS (mg/L)			Turbidity (NTU)		
	WQO 6.5–8.5			WQO <1,500 µS/cm			Discharge limit 50 mg/L			WQO 5–20 NTU		
	20P	80P	Mean	20P	80P	Mean	20P	80P	Mean	20P	80P	Mean
DW-20a/b	6.6	8.0	7.3	521	2,074	1,951	5	24	21	10	65	59
Total	6.6	8.0	7.3	521	**2,074**	**1,951**	5	24	21	10	**65**	**59**

Notes: Orange denotes the water quality value exceeds the discharge limits specified in consent condition 23.
Red denotes water quality value exceeds the WQO value specified in consent condition 24.

iv Baseline water quality summary

The water quality data presented in Table 6.2 to Table 6.4 and Appendix E indicates:

- pH is generally within the WQO range, however both upper and lower bound exceedances occur.
- Electrical conductivity is generally below the WQO value for most background monitoring locations. Electrical conductivity is observed to frequently exceed the WQO values for locations adjacent to Rocklow Creek where 80th percentile values of greater than 30,000 µS/cm were observed at DW-21a. High electrical conductivity concentrations indicate the presence of tidal influence.
- TSS is generally below the specified discharge limit of 50 mg/L. However, exceedances have been observed for background, operational and discharge water quality locations. Turbidity frequently exceeds the WQO value for all monitoring locations. Mean TSS and Turbidity values are observed to be greater than 80th percentile values at some monitoring locations. This is due to infrequent, high concentration results that are occasionally observed at these locations.
- Annual average concentrations of total nitrogen and total phosphorus are generally elevated above WQO values and are similar for background, operational and discharge water streams.
- Annual average concentrations of sulphate and chloride are frequently observed to exceed the WQO values at operational water quality monitoring locations.

Background water quality is generally fresher with lower electrical conductivity concentrations than operational and discharge water quality. TSS is observed to be generally higher for background water quality locations while turbidity is similar for all monitoring sites. Elevated concentrations of TSS, turbidity and nutrients may be associated with upstream land use (agricultural) and disturbance of soils during the dredging process. Tidal influences are evident in most locations adjacent to Rocklow Creek, particularly at monitoring locations DW-19, DW-20 and DW-21 which are also the furthest downstream towards the Rocklow Creek estuary.

6.3 Surface water management

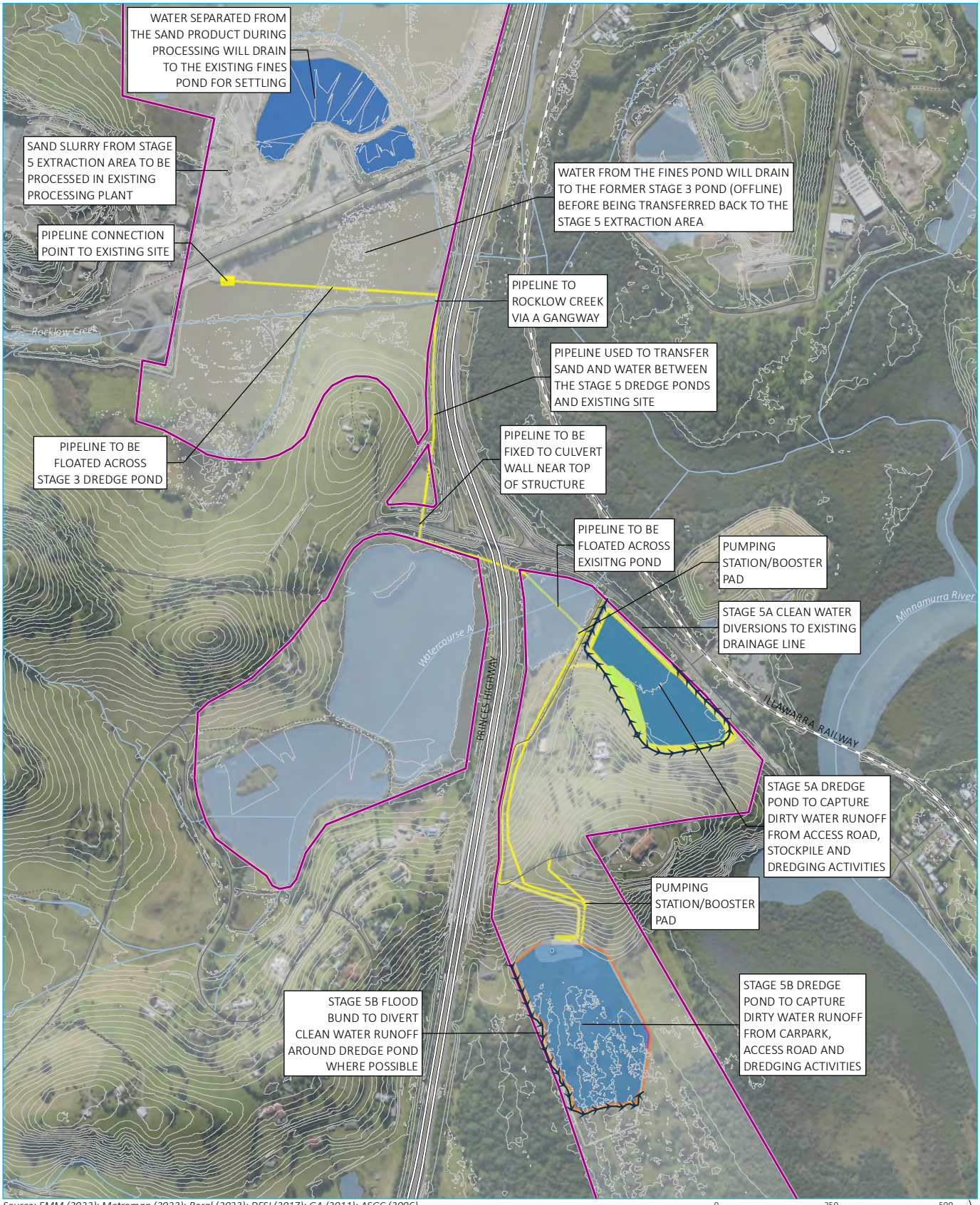
Surface water management for the existing operations area is undertaken in accordance with the WMP for DSLP Stage 2, 3 and 4. The existing operations area will be used to process, wash, and stockpile quarry material extracted from Stage 5. Hence, the existing operations area surface water management system will be retained and managed in accordance with the existing WMP. Surface water management infrastructure and measures to be implemented as part of Stage 5 are described below.

6.3.1 Clean water diversions

The clean water management system will consist of a series of diversion bunds and drains that intercept clean runoff prior to it entering the Stage 5A and Stage 5B dredge ponds. The objective of the clean water management system is to:

- minimise the mixing of clean and dirty water runoff; and
- minimise the volume of runoff that requires management within the Stage 5 extraction areas.

Clean water diversions to be implemented as part of Stage 5 are shown in Figure 6.3.



Source: EMM (2023); Metromap (2023); Boral (2023); DFSI (2017); GA (2011); ASGC (2006)

0 250 500 m

GDA 1994 MGA Zone 56

N

KEY

- DLSP boundary
- Stage 5 boundary
- Extraction pond
- Stage 5B flood bund
- Bank
- Spillway
- Stockpile
- Clean water diversion
- Rail line
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- Contours (2 m)
- Waterbody

Stage 5 surface water management system

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 6.3

EMM creating opportunities

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6.3.2 Erosion and sediment control

Erosion and sediment control measures will be implemented during the construction and operation of Stage 5. Erosion and sediment control measures are described in Chapter 7.

6.3.3 Dirty water management system

The Stage 5A and Stage 5B dredge ponds will provide the primary mechanism for dirty water management and sediment control during the operation of Stage 5. The dredge ponds will capture dirty water runoff from haul roads (where possible), stockpiles and disturbance areas within the dredge pond footprint.

The contributing dirty water catchment and dredge pond storage volume for the Stage 5A and Stage 5B extraction areas is provided in Table 6.5. The equivalent sediment basin volume using the methodology outlined in *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2E – Mines and Quarries* (DECC 2008) has been calculated by SEEE (2019) and is provided for context. The available storage within each Stage 5 dredge pond will exceed the recommended sediment basin volumes by more than an order of magnitude.

Table 6.5 Dirty water management storages

Dredge pond	Description	Catchment area	Dredge pond volume[1]	Required basin size
Stage 5A	• Captures dirty water runoff from the Stage 5A dredge pond, internal haul roads and stockpile area.	4.3 ha	78 ML	3 ML
Stage 5B	• Captures rainfall and dirty water runoff from within the Stage 5B dredge pond area.	6.4 ha	270 ML	6 ML[2]

Source: *Surface Water Assessment for Modification 2 of the Dunmore Lakes Sand* (SEEE 2019a).

Notes: 1. Bunded dredge pond volume above 1 m AHD. Stage 5B pond volume based on bund height at 1% AEP flood level.
2. The revised Stage 5B flood bund design reduces the contributing catchment area and hence the required basin size would be smaller than the 6 ML presented in SEEE (2019a). Regardless, the dredge pond volume still exceeds the required basin size.

In addition to providing ample storage to capture and treat dirty water runoff, the following stormwater management measures will also be implemented:

- Dredge ponds will be maintained and operated to prevent the discharge of any turbid water as defined in consent conditions 23 and 24 during dredging and backfilling. This will be achieved by:
  - establishing flood bunds to contain turbid water resulting from dredging and backfilling within the Stage 5 extraction areas (refer to Section 4.4); and
  - implementing ongoing environmental monitoring to identify and remedy operational practices that may lead to the discharge of turbid water during dredging and backfilling (refer to Sections 6.4 to 6.6).
- Backfilling operations will be ceased if water levels within operational ponds reduce freeboard to 0.3 m below the pond overflow level. This will assist in complying with consent condition 26 which requires backfilling operations to cease at least 12 hours prior to the commencement of overflow.

Dirty water management associated with material processing and stockpiling will be undertaken within the existing operations area and in accordance with the existing WMP for DSLP stages 2 to 4.

6.3.4 Transfer pipeline

An overland transfer pipeline is to be constructed from the Stage 5A and Stage 5B extraction areas to the existing processing area (refer to Figure 6.3). The pipeline will comprise twin 355 mm diameter polyethylene pipes, one to transfer dredged material to the processing area and the other to return treated water to the Stage 5A and Stage 5B ponds.

Water transfer volumes will be recorded by a flow meter to monitor extracted volumes and the equivalent treated water returned to the ponds to minimise net water take. Booster pumps will be located adjacent to the Stage 5A dredge pond and above the Stage 5B dredge pond.

The transfer pipeline alignment will traverse the Princes highway and Swamp Road via a series of existing culverts before crossing Rocklow Creek and connecting to the existing processing area. The pipeline will be floated across the existing pond to the west of Stage 5A and secured to the side wall of culverts using brackets. The pipeline will cross Rocklow Creek via a gangway that will be constructed approximately 1.5 m above the creek level. The gangway will be approximately 12 m long and is not expected to require piers within the watercourse extent (SEEE 2019a).

The floating sections of pipeline will be designed and constructed with consideration of the hydraulic forces associated with flooding, including both velocity of flow and variation in water levels.

There is a risk of pipeline leakage or failure, either through mechanical failure or damage from an external cause. The pipeline will comprise a double skinned high-density polyethylene pipe to reduce and mitigate risks associated with leakage or failure. Monitoring and maintenance of the pipeline will be undertaken to promptly identify and remedy any failure should it occur.

The transfer pipeline is temporary infrastructure and will be removed on completion of dredging within Stage 5.

6.3.5 Processing

Processing of the extracted material will be undertaken at the existing processing plant and in accordance with the existing WMP for DSLP Stage 2 to 4. Water extracted from the Stage 5 dredge ponds will undergo the following:

1. Sand and water extracted from the Stage 5 dredge ponds will be transferred to the existing processing plant via the transfer pipeline (refer to Section 6.3.4).

2. Water used during the transfer and processing of sand material will drain to the existing fines pond and secondary settling pond. Some water will be retained in the exported sand product (refer to Section 5.1.5).

3. Decanted water in the secondary settling ponds will drain to the former Stage 3 pond (offline) before being pumped back to the Stage 5A and Stage 5B dredge ponds via the transfer pipeline.

Pumped water volumes will be recorded by a flow meter and the same volume of water (less losses) will be returned to the Stage 5 dredge ponds.

6.3.6 PASS management

PASS may be encountered within the Stage 5 extract areas due to the following:

- during excavation of the Stage 5A and Stage 5B quarry material; and

- during backfilling of the Stage 5A excavation area with VENM.

The Stage 5A area will be reinstated with non-PASS VENM to mitigate the risk of acidification during the backfilling process. Acid sulfate soil management for Stage 5, including PASS that may be present with in the extraction areas, is further described in the Stage 5 ASSMP (EES 2019c). The PASS management strategy described in the Stage 5 ASSMP is summarised as follows:

1. Commence excavation works by mining the shallow sand material (above the water table) and work to depth.

    - This strategy will ensure excavation works commence away from areas of PASS and groundwater ingress, hence there will be no restrictions on the excavation process other than standard environmental management practices such as the erosion and sediment controls listed in the erosion and sediment control plan (ESCP) checklist in Appendix G.

2. Once the excavation extends in depth greater than 1–2m below the ground surface some groundwater ingress may commence.

    - Instigate a system of controlling groundwater discharges within the excavation area (eg creation of a flood bund within the excavation area).

3. Manage the excavation of sand materials (containing PASS) by sieving the fines out of the excavated material and returning fines to the fines pond located in the Stage 2 extraction area, immediately as per existing operations.

    - Ongoing monitoring of pH as per the groundwater management plan (refer to Section 8) will confirm controls are effective. In the case that monitoring indicates a pH change outside of consented parameters, the Trigger Action Response Plan (TARP) described in Table 8.7 will be enacted.

6.4 Surface water monitoring program

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

- provide an ongoing characterisation of baseline water quality upstream and downstream of the site;
- determine whether surface water discharging from the Stage 5 dredge ponds complies with relevant criteria; and
- determine whether the quality of water contained in the Stage 5 dredge ponds complies with the nominated WQOs.

An overview of the Stage 5 surface water monitoring program is provided in Table 6.6. Monitoring locations are shown in Figure 6.1. Surface water quality monitoring will be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC 2004). The analytical suite to be tested in each surface water quality monitoring round is provided in Table 6.7.

Table 6.6 Surface water monitoring program overview

Monitoring aspect	Objective	Monitoring locations	Monitoring description
Upstream water quality	Characterise water quality upstream of the Stage 5 extraction area.	• DW-22 and DW-26.	Water quality will be undertaken via grab samples at each location on a quarterly basis.
Downstream water quality	Determine whether quarry operations are impacting downstream receiving water environment.	• DW-23 and DW-25.	Water quality will be undertaken via grab samples at each location on a quarterly basis.

Table 6.6 Surface water monitoring program overview

Monitoring aspect	Objective	Monitoring locations	Monitoring description
Operational water quality	Characterise quality of water returned from the Stage 3 pond (processing area)	• DW-19[1].	Water quality will be undertaken via grab samples at each location on a quarterly basis.
	Determine whether Stage 5 dredge pond water quality meets relevant surface water assessment criteria.	• DW-24 and DW-27.	

Notes: 1. DW-19 is an existing location monitored as part of the Stage 2 to 4 WMP monitoring and reporting program.

Table 6.7 Surface water quality analytical suite

Category	Analyte to be tested	Analysis method
General	• Temperature, pH, electrical conductivity, dissolved oxygen, turbidity.	To be measured using a portable water quality meter in the field.
	• Total suspended solids, total dissolved solids.	Analysis to be undertaken by a NATA certified laboratory
Nutrients	• Ammonia, nitrate, nitrite, total kjeldahl nitrogen, total nitrogen, total phosphorus.	
Major ions	• Potassium, magnesium, chloride, sodium, sulphate, bicarbonate.	
Biological	• Faecal coliforms, chlorophyll-a, enterococci, total algae, blue-green algae, E.coli.	
Dissolved metals	• Iron.	

6.5 Surface water assessment criteria and trigger values

Surface water assessment criteria and trigger values for site discharges and dredge pond water quality are provided in DA 195-8-2004 condition 23 and 24 respectively. Surface water discharges from the Stage 5A and Stage 5B dredge ponds must remain within the limits presented in Table 6.8. Water contained within the dredge ponds will be benchmarked with the WQOs provided in Table 6.9.

Table 6.8 Water discharge pollution limits

Pollutant	Unit of measure	100 percentile concentration limit
Total suspended solids	mg/L	50
pH	pH	±1.0 from baseline value of 7.2[1]

Source: DA 195-8-2004 condition 23.

Notes: 1. Baseline value determined from background water quality data for existing operations provided in Table 6.2. The baseline value should be revised once Stage 5 specific monitoring data is available.

Table 6.9 Surface water quality objectives

Pollutant	Unit of measure	Water quality objective
Turbidity	NTU	5–20
pH	pH	6.5–8.5
Salinity (as electrical conductivity)	µS/cm	<1,500
Dissolved oxygen	mg/L	>6
Total phosphorus	µg/L	5–50
Total nitrogen	µg/L	100–500
Chlorophyll-a	µg/L	2–10
Faecal coliforms	Median No./100 mL	<1,000
Enterococci	Median No./100 mL	<230
Algae and blue-green algae	No. cells/mL	<15,000
Sodium	mg/L	400
Potassium ion	mg/L	50
Magnesium ion	mg/L	50
Chloride ion	mg/L	300
Sulphate ion	mg/L	250
Bicarbonate ion	mg/L	750
Soluble iron ion	mg/L	6
Ammonium ion	mg/L	20

Source: DA 195-8-2004 condition 24.

Notes: 1. The objectives for dissolved oxygen, turbidity and algae are relevant to surface water only.
2. The Department acknowledges that short term exceedances of these objectives may occur during natural events such as heavy rainfall or tidal saline water inflow.

6.6 Surface water trigger action response

Surface water monitoring will be undertaken upstream, downstream and from within the Stage 5 dredge ponds. Exceedances of the assessment criteria will be identified and addressed as described in Table 6.10.

The TARP provided in Table 6.10 establishes methods to identify the source of water quality exceedances and if necessary, establish actions to either improve water management or further investigate the exceedance.

Table 6.10 Surface water Trigger Action Response Plan

Trigger	Action required	Follow up action
Discharges		
Discharge occurs from the Stage 5A or Stage 5B dredge ponds.	All uncontrolled discharges from the Stage 5 dredge ponds are to be reported to the Planning Secretary, NSW EPA and other relevant agencies.	1. If safe to do so, undertake water quality sampling of the discharge for the water quality suite provided in Table 6.7. 2. If water quality exceeds the discharge water quality criteria described in Table 6.4 then the exceedance protocol described in Appendix F is to be followed.
Water quality		
WQOs in Table 6.9 are exceeded at downstream monitoring location DW-23 or DW-25.	Identify if exceedance is naturally occurring or due to the quarry operations by: 1. retesting the sample result; 2. reviewing upstream sample location data to determine if exceedance naturally occurring; 3. reviewing baseline sampling data to determine if similar exceedances are known to occur; and 4. reviewing dredge pond and groundwater monitoring data to determine if similar exceedance occur.	1. If the source of exceedance is determined or identified as occurring naturally, the occurrence will be recorded in the Annual Review and no other further action is required. 2. If the source of exceedance is undetermined or identified as potentially due to quarry activities, the exceedance will be recorded for consideration in future monitoring rounds. If ongoing (2 out of 3 monitoring rounds) water quality anomalies are detected, advise NSW EPA and DPIE-Water within 7 days of the second anomaly being confirmed for further action. The details of any water quality exceedances are to be documented in the Annual Review.
WQOs in Table 6.9 are exceeded within Stage 5A or Stage 5B dredge pond.	Identify if exceedance is due to the quarry operations by reviewing: 1. retesting the sample result; 2. reviewing quarry operations prior to and at the time the exceedance occurred; 3. reviewing upgradient groundwater monitoring data to identify if exceedance is resulting from groundwater inflow; and 4. reviewing nearby environmental conditions and incidents that may have impacted the Stage 5 dredge pond water quality.	1. If the source of exceedance is determined not to be associated with quarry operations, the occurrence will be recorded in the quarry Annual Review and no other further action is required. 2. If the source of the exceedance is undetermined or identified as potentially due to quarry activities, further investigation into the source of the exceedance and potential water management improvements will be undertaken to reduce the risk of the exceedance reoccurring. If ongoing (2 out of 3 monitoring rounds) water quality anomalies are detected, advise NSW EPA and DPIE-Water within 7 days of the second anomaly being confirmed for further action. The details of any water quality exceedances are to be documented in the Annual Review.

7 Erosion and sediment control plan

This section provides an erosion and sediment control plan that is generally in accordance with *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom 2004) and *Volume 2E – Mines and Quarries* (DECC 2008a).

7.1 Activities that may cause erosion and generate sediment, or affect flooding

The primary activities that may cause erosion and generate sediment during the construction and operation of Stage 5 include:

- land disturbance and earthworks required to establish extraction areas and ancillary infrastructure such as access roads, site office and parking, and the transfer pipeline;
- land disturbance associated with ongoing dredging in the Stage 5A and Stage 5B extraction areas;
- uncontrolled surface water run-on to the site from upstream catchment areas;
- concentrating flows within drainage diversions and channels; and
- stripping and stockpiling of topsoil prior to extraction.

Most of the sediment that is generated by the above processes will be contained within the Stage 5A and Stage 5B dredge ponds as a way to managed any sediment that may be generated. Management measures to reduce the risk of erosion and sediment transport for during construction and operation are described in Section 7.2. Erosion and sediment control structures are described in Section 7.3.

Construction and operation of the Stage 5 dredge ponds may affect flooding of the Minnamurra River, Rocklow Creek or Watercourse A due to:

- floodwaters inundating the active extraction areas and mixing with dirty water within dredge ponds or entraining sediments from stockpile areas before flowing further downstream;
- the establishment of flood protection bunds resulting in localised increases in flood level and velocity; and
- an increased risk of erosion from flood waters contacting potentially unstable flood protection bund banks and diversion drains.

Flood affecting activities and impacts are described further in Section 4.3. Flood management controls to reduce the risk of flood water inundating the active dredge ponds are described in Section 4.4. A program to monitor the performance and stability of the flood protection works is provided in Section 7.5.

7.2 Erosion and sediment control management

The following management measures will be implemented to minimise soil erosion and the transport of sediment during the construction and operation of Stage 5:

- Minimisation of disturbed areas to reduce the potential of erosion.
- Diversion of clean water from upstream catchments to reduce the risk of run-on and the mixing of clean and sediment laden water. Clean water diversions also reduce the volume of water required to be managed in the active extraction area.

- Maximise the retention of dirty water runoff within the active dredge pond where practical to prevent discharge to downstream receiving waters.
- Maximise retention of existing vegetation and soil cover where possible.
- Prompt stabilisation and rehabilitation of disturbed areas to minimise erosion and the generation of sediment.
- Management of fines material within the existing DSLP water management system fines and secondary settling ponds.
- Sheeting material (aggregates) to be used on high traffic haul roads to minimise erosion.
- Wheel-wash facilities to be provided for trucks exiting the site.
- Ongoing monitoring and management of erosion and sediment controls to ensure correct functionality.

The following management measures outlined in *Guidelines for laying pipes and cable in watercourses on waterfront land* (DPI–Water 2012) will be implemented when constructing the transfer pipeline (refer to Section 6.3.4):

- minimise or avoid disturbance to channel bed and banks;
- minimise the time of construction disturbance;
- minimise or avoid stopping the flow of permanent watercourses by staging works across the channel if works cannot be completed while water is still flowing; and
- remove and recover all construction plant and materials immediately following construction.

Most of the transfer pipeline will be constructed on the surface and secured to the ground using star pickets. Some clearing of vegetation may be required at the edges of existing ponds to secure the pipeline prior to floating it across the pond. Groundcover vegetation will be maintained near the pond edges to reduce the risk of erosion and sediment transport directly into the water body. A gangway structure is proposed where the pipeline crosses Rocklow Creek channel to avoid disturbing the channel bed during construction and operation.

7.3 Erosion and sediment control structures

The proposed Stage 5 dredge ponds and associated flood mitigation bunds are the primary mechanism for erosion and sediment control. The construction of flood bunds around the Stage 5A and Stage 5B extraction areas essentially creates a large erosion and sediment control basin. The erosion and sediment control structures proposed for the Stage 5A and Stage 5B dredge ponds are described in Table 7.1.The erosion and sediment control structures described in Table 7.1 are temporary will be rehabilitated following extraction from Stage 5.

The design criteria for the erosion and sediment control structures described in Table 7.1 are based on recommendations in Table 6.1 of *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries* (DECC 2008a). The design criteria are for a disturbance duration of greater than three years and a sensitive receiving environment.

Table 7.1 Erosion and sediment control structures

Control	Purpose	Design criteria	Location
Stage 5A			
Flood mitigation bund	• Prevent dirty water within the Stage 5A dredge ponds mixing with floodwaters in adjacent watercourses. • Capture and store dirty water runoff from Stage 5A extraction area, stockpile, and access roads.	• 1% AEP flood protection. • Required basin size based on 5 day, 95th percentile rainfall (SEEE 2019a).	Refer to Figure 4.1
Drainage diversions	• Prevent surface water run-on from upstream catchments, reducing mixing of clean and sediment laden water and volume of water that requires management.	• Designed to have non-erosive hydraulic capacity to convey flows from the 5% AEP storm event.	Refer to Figure 4.1
Stage 5B			
Flood mitigation bund	• Prevent dirty water within the Stage 5B dredge pond mixing with floodwaters in Minnamurra River. • Capture and store dirty water runoff from Stage 5B extraction area.	• PMF flood protection • Required basin size based on 5 day, 95th percentile rainfall (SEEE 2019a).	Refer to Figure 4.2
Drainage diversions	• Prevent surface water run-on from upstream catchments, reducing mixing of clean and sediment laden water and volume of water that requires management.	• Designed to have non-erosive hydraulic capacity to convey flows from the 5% AEP storm event.	Refer to Figure 4.2

Construction staging to build the flood mitigation bunds prior to excavation and dredging, construction of ancillary infrastructure, and stockpiling will ensure sediment that is produced during these activities is captured and contained within the Stage 5 dredge ponds. The Stage 5 dredge ponds are described further in Section 6.3.3.

The erosion and sediment control structures implemented on site are expected to change over time in response to construction and operational activities, and in response to the outcomes of the monthly ESCP checklist described in Section 7.4. Therefore, an adaptive approach will be applied where the most appropriate erosion and sediment control structures are implemented on a case by case basis. The following temporary erosion and sediment control structures will be implemented as needed during both construction and operation of Stage 5:

- clean water diversions to reduce the volume of runoff entering disturbance areas;
- mitre drains to divert and disperse concentrated flows where appropriate;
- check dams to reduce flow velocities and capture sediment within any diversion drains until fully stabilised;
- sediment fencing and sediment traps to reduce suspended sediment in runoff leaving the disturbance areas.

The applicable design criteria for the above temporary erosion and sediment control structures varies according to the disturbance duration. The temporary erosion and sediment control structures will be designed to be hydraulically stable and structurally sound for flows up to:

- the 20% AEP storm event for disturbance durations of less than 6 months;
- the 10% AEP storm event for disturbance durations between 6 to 12 months; and

- the 5% AEP storm event for disturbance durations greater than 12 months.

The above design criteria are based on the recommendations in DECC (2008a; 2008b) for sensitive receiving environments.

7.4 Management of erosion and sediment controls

An ESCP checklist (as part of the environmental inspection checklist) will be completed monthly or after 50 mm of rainfall in 48 hours. The ESCP checklist provides a means for assessing the effectiveness of controls and identifying opportunities for progressive improvement. All corrective, improvement and maintenance actions will be documented in the Site Incident Management Systems.

The ESCP checklist has been updated to include monitoring and implementation of the erosion and sediment control structures described in Section 7.3. The ESCP checklist is included in Appendix G. The provided checklist may change over time due to changes in quarry operations.

7.5 Monitoring of flood protection works

The condition of existing flood protection works is reviewed as part of the ESCP checklist. The ESCP checklist provides a program to review the adequacy of the existing flood protection works to reduce or prevent erosion and sediment transport from the existing operations area.

The ESCP checklist has been updated to include monitoring of the Stage 5 flood protection works described in Section 4.4. This includes monitoring the bed and bank stability of the drainage diversions and flood bunds shown in Figure 4.1 and Figure 4.2.

The management and decommissioning of the flood mitigation bunds and associated Stage 5 dredge ponds are described in Section 4.4.

8 Groundwater management plan

8.1 Groundwater monitoring network

DSS have monitored groundwater level and quality since 2004 in accordance with the quarry WMP and consent conditions. The overall monitoring network comprises 35 bores (including nested locations) located within both shallow and deep portions of the underlying aquifer from which the sand resource is obtained. Groundwater monitoring locations have been discontinued (due to dredge pond expansion) and new monitoring locations introduced as quarrying has progressed through DLSP stages 1 to 4.

A description of the active groundwater monitoring network has been sourced from EES (2020) and is provided in Table 8.1. The location of all monitoring bores associated with the DSS operation including those that have been discontinued are shown in Figure 8.1. Baseline groundwater monitoring data obtained from the Stage 5 bores is provided in Section 8.2.

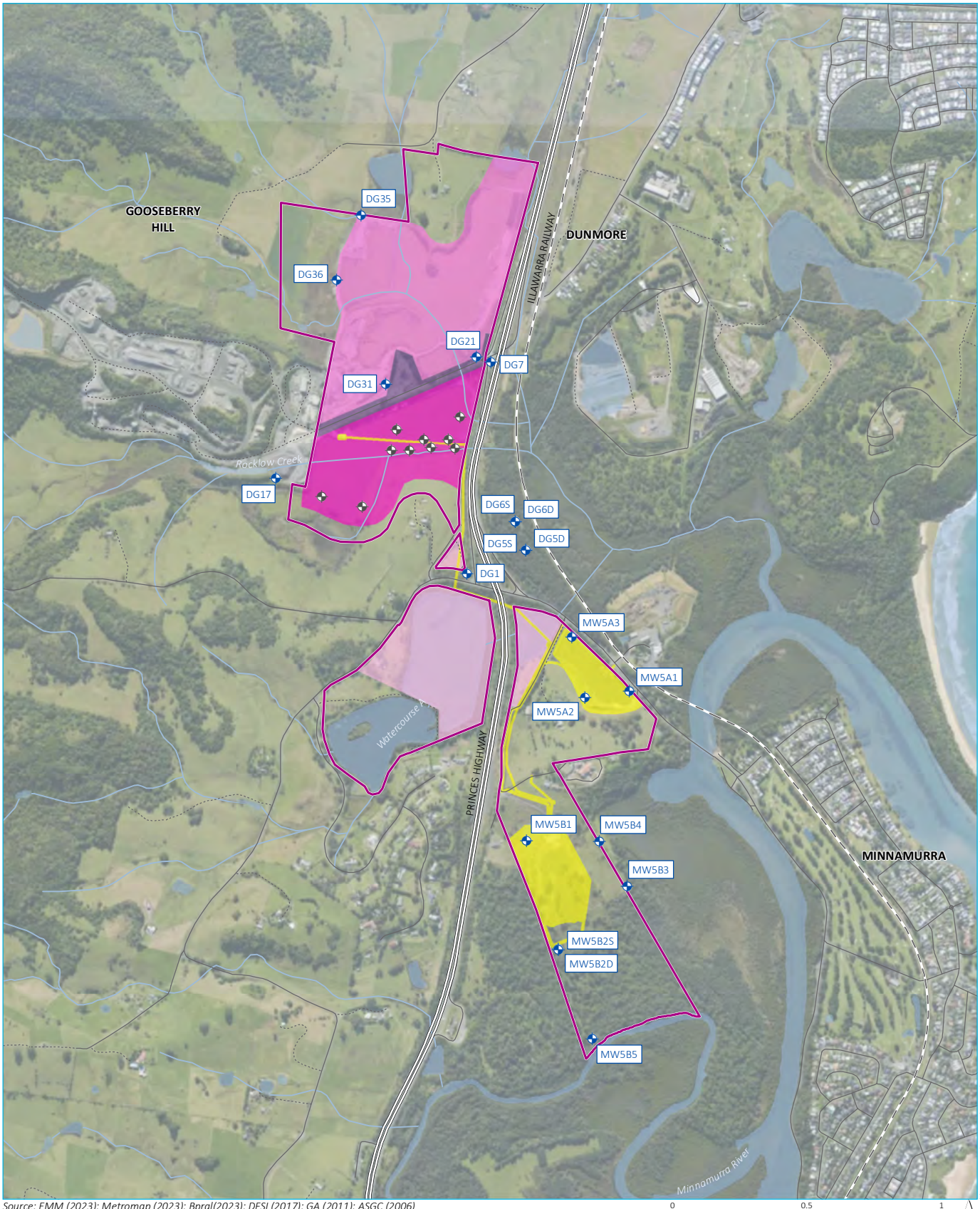
Table 8.1 Monitoring bore network

Bore ID	Easting	Northing	Elevation (m AHD)	Depth (m)	Screen interval (m)	Logger installed
Existing operations monitoring bores						
DG1	301665	6167434	2.225	-	-	Yes
DG17	300955	6167789	3.49	6	2.8–6.0	Yes
DG21	301699	6168236	2.12	5	2.0–5.0	Yes
DG31	301363	6168137	3.05	5.5	2.5–5.5	Yes
DG35	301271	6168764	3.84	8	4.0–8.0	-
DG36	301180	6168523	2.31	8	5.0–8.0	-
DG5d	301883	6167521	1.717	15	11.0–15.0	Yes
DG5s	301883	6167521	1.717	7	4.0–7.0	-
DG6d	301844	6167628	1.647	14.3	10.0–14.3	-
DG6s	301844	6167628	1.647	6.7	4.0–6.7	Yes
DG7	301753	6168221	3.17	5	2.0–5.0	Yes
Stage 5 monitoring bores						
MW5A1	302269	6166996	4.31	7.25	3.25–7.25	Yes
MW5A2	302103	6166973	3.24	6	2.0–6.0	-
MW5A3	302054	6167198	1.74	12	3.0–6.0/9.0–12.0	Yes
MW5B1	301887	6166442	4.07	6	2.0–6.0	-
MW5B2 – deep	302004	6166038	4.12	10.25	6.5–10.25	Yes
MW5B2 – shallow	302004	6166039	3.93	6.69	2.0–6.0	Yes
MW5B3	302261	6166272	2.06	11.2	3.0–6.0/8.5–11.2	-
MW5B4	302157	6166438	2.56	6.33	2.0–6.0	-

Table 8.1 Monitoring bore network

Bore ID	Easting	Northing	Elevation (m AHD)	Depth (m)	Screen interval (m)	Logger installed
MW5B5	302131	6165707	4.63	12	3.0–6.0/ 9.0–12.0	-

Source: 1. *2019-2020 Annual Report of Groundwater Monitoring at 38 Tabbita Road, Dunmore NSW* (EES 2020).



Source: EMM (2023); Metromap (2023); Bpral(2023); DFSI (2017); GA (2011); ASGC (2006)

0 0.5 1 km

GDA 1994 MGA Zone 56

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KEY

DLSP boundary
Rail line
Major road
Minor road
Vehicular track
Watercourse/drainage line
Waterbody

DLSP stages
Stage 1
Stage 2
Stage 3
Stage 4
Stage 5

Groundwater monitoring location
Active
Discontinued

Groundwater monitoring network

Dunmore Lakes Sand Project – Stage 5
Soil and water management plan
Figure 8.1

EMM creating opportunities

8.2 Baseline groundwater data

8.2.1 Groundwater level and flow

Baseline groundwater level data for Stage 5 is available at the nine monitoring bore locations identified in Table 8.1. Groundwater levels have been measured since October 2018 and include spot levels obtained manually and continuous data obtained using data loggers at 60 minute intervals. Baseline groundwater level data is used to assess the natural variability in groundwater level and characterise groundwater flows.

Groundwater level information for Stage 5 has been obtained from several Environmental Earth Science reports including the Modification 2 EA and annual reporting undertaken as part of the broader DSS operation. Standing water levels for the Stage 5 extraction area are presented in Table 8.2. Groundwater levels for bores that contain data loggers are shown in Figure 8.2.

Table 8.2 Stage 5 baseline standing water levels

		Standing water level (m AHD)[3]							
Monitoring bore	**Datum (m AHD)[3]**	**Oct 2018[1]**	**Nov 2018[1]**	**Jan 2019[1]**	**May 2019[2]**	**Aug 2019[2]**	**Nov 2019[2]**	**Feb 2020[2]**	**May 2020[2]**
MW5A1	4.31	0.86	0.72	0.87	0.28	0.64	0.34	1.08	0.65
MW5A2	3.24	0.99	0.75	0.93	0.65	0.645	0.55	1.14	0.63
MW5A3	1.74	0.8	0.69	0.84	0.61	0.64	0.44	0.97	0.7
MW5B1	4.07	1.62	-	1.66	-	1.17	1.01	1.73	1.27
MW5B2 – shallow	3.93	0.12	-	1.22	0.96	0.9	0.83	1.35	0.85
MW5B2 – deep	4.12	1.11	-	1.22	0.92	0.86	0.79	1.51	1.05
MW5B3	2.06	0.69	-	0.76	0.57	0.528	0.43	0.7	0.56
MW5B4	2.56	0.72	-	0.78	0.25	0.48	0.4	0.61	0.16
MW5B5	4.63	0.33	-	0.39	dry	dry	dry	dry	dry

Source: 1. *Hydrogeological Impact Assessment, Dunmore Lakes Sand Extraction Project Modification 2 (Stage 5), Dunmore, NSW* (EES 2019b).
2. 2019-2020 Annual Report of Groundwater Monitoring at 38 Tabbita Road, Dunmore NSW (EES 2020).
Notes: 3. Standing water levels have been calculated from groundwater datum information and measured water levels in metres below ground level provided in sources 1 and 2 above.

The baseline groundwater level data in Table 8.2. and Figure 8.2 indicate:

- Monitoring bores within Stage 5 exhibit a rapid rainfall response pattern with fluctuations in the water-table level up to 0.5 m during significant rainfall events or periods of extended rainfall indicating recharge to aquifer is primarily via direct infiltration from the surface.
- Groundwater flow is typically to the east and north-east for both Stage 5A and Stage 5B areas towards the Minnamurra River.

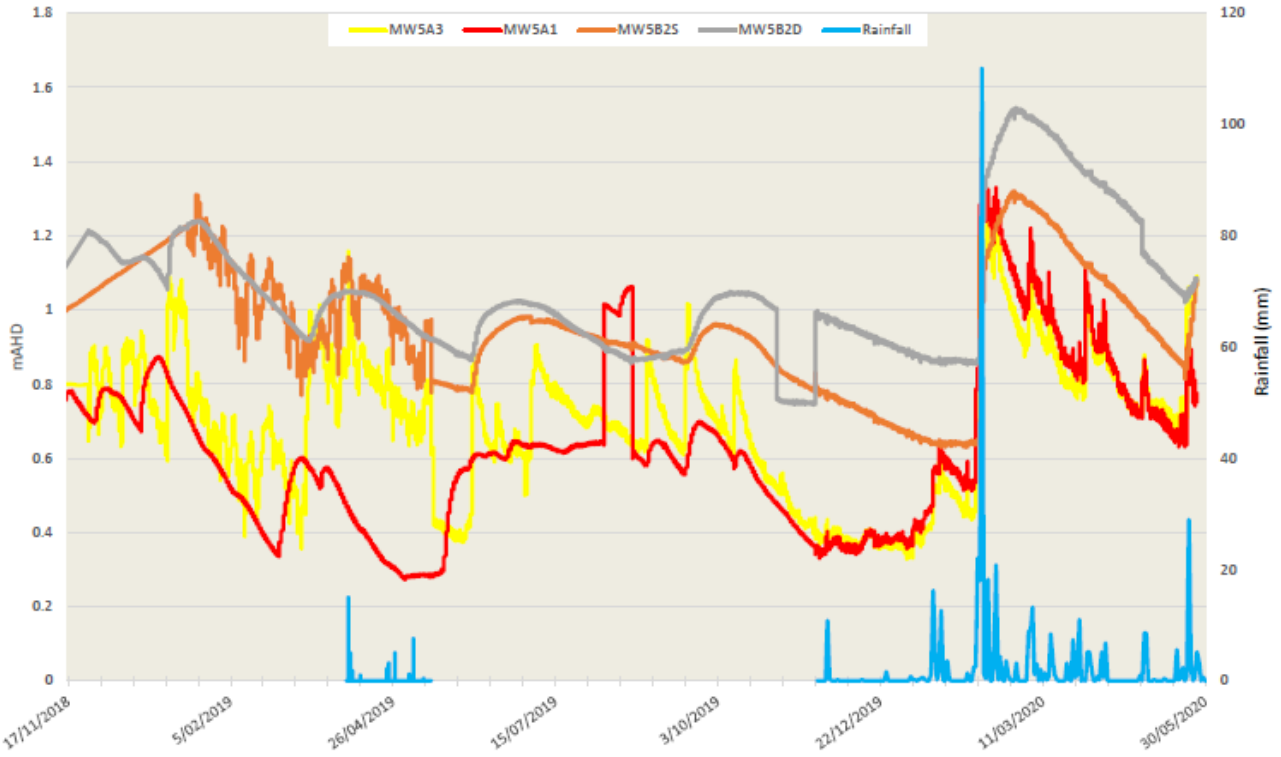

Figure 8.2 **Stage 5 baseline groundwater levels – November 2018 to May 2020 (source: EES 2020)**

8.2.2 Groundwater quality

Baseline groundwater quality data for Stage 5 is available at the nine Stage 5 monitoring bore locations identified in Table 8.1. Groundwater quality has been measured since October 2018 and includes a range of physical and chemical parameters.

Minimum, maximum and mean groundwater quality results for pH, electrical conductivity, and TDS are provided in Table 8.3. Individual sampling results for the Stage 5 monitoring bores area Appendix E. Further information on individual sampling events and exceedance is available in the DSS Annual Reviews and Annual Reports.

Table 8.3 **Baseline groundwater quality**

	pH WQO 6.5–8.5			Electrical conductivity (µS/cm) WQO <1,500 µS/cm			TDS (mg/L) AIP 'highly productive' <1,500 mg/L		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
MW5A1	5.8	7.2	6.4	187	935	371	92	240	143
MW5A2	6.6	6.9	6.7	294	965	721	365	365	365
MW5A3	6.3	7.4	7.0	733	1,215	902	475	1,090	665
MW5B1	7.6	7.7	7.7	387	417	400	205	205	205
MW5B2 – shallow	7.1	7.6	7.4	633	742	710	385	440	418
MW5B2 – deep	7.3	8.0	7.6	676	688	681	355	355	355
MW5B3	7.6	7.8	7.7	546	620	576	260	260	260

Table 8.3 Baseline groundwater quality

	pH WQO 6.5–8.5			Electrical conductivity (µS/cm) WQO <1,500 µS/cm			TDS (mg/L) AIP 'highly productive' <1,500 mg/L		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
MW5B4	7.3	7.7	7.5	533	603	576	315	390	355
MW5B5	7.2	7.5	7.4	-	-	-	580	650	615

Notes: Red denotes water quality value exceeds the WQO value specified in consent condition 24.

Stage 5 baseline groundwater quality is described as:

- pH is generally within the WQO range, however lower bound exceedances occur.
- Electrical conductivity is below the WQO value of 1,500 µS/cm in all monitoring samples indicating that tidal influences were not affecting water quality at these bores at the time of sampling.
- TDS is consistently below the AIP criteria value of 1,500 mg/L for 'highly productive' groundwater sources.
- Total nitrogen and total phosphorus concentrations frequently exceed the WQO values at all Stage 5 monitoring bore locations.
- Major ions are generally below WQO values except for chloride concentrations within MW5A3.
- Dissolved metal concentrations are generally low and within typical guideline values (EES 2019b).

8.3 Groundwater monitoring program

The objective of the groundwater monitoring program is to collect data to:

- provide an ongoing record of groundwater level and quality data in proximity of the site;
- identify changes to groundwater level and flow regimes due to quarrying within the Stage 5 extraction area;
- identify changes to groundwater quality due to quarrying within the Stage 5 extraction area; and
- identify any influences groundwater inflows into the dredge ponds may have on water quality.

An overview of the Stage 5 groundwater monitoring program is provided in Table 8.4. Monitoring locations are shown in Figure 8.1. The analytical suite to be tested in each groundwater quality monitoring round is provided in Table 8.5.

Monitoring bores MW5A1, MW5A2, MW5A3, MW5B1 and MW5B2 are within or adjacent to the proposed Stage 5A and Stage 5B dredge pond footprints and may be destroyed as quarrying progresses. Should this occur, three additional bores will be installed to the north, south and east of the Stage 5A dredge pond. An additional bore will be installed to the north of the Stage 5B dredge pond. Additional bores will be installed to a minimum depth of 6 m (where practical). Any additional monitoring bores that are constructed will be subject to the groundwater monitoring program described in Table 8.4 and water quality assessment criteria described in Section 8.4.2.

Table 8.4 Groundwater monitoring program overview

Monitoring aspect	Frequency	Monitoring description
Standing water level – manual measurement	• Monthly during extraction and rehabilitation. • Quarterly following rehabilitation.	Manual water level measurements are to be taken at all active groundwater bores identified in Table 8.1. Standing water levels are to be measured to the survey point on casing and recorded in site database.
Standing water level – data loggers	• Logger at 60 minute intervals. • Quarterly download.	Data loggers are installed to continuously measure groundwater level in select monitoring bores identified in Table 8.1. Continuous data loggers will also be installed in MW5B1, MW5B4, and MW5B5 prior to the Stage 5B works commencing. Data loggers are to be downloaded and analysed quarterly by suitably qualified groundwater personnel.
Groundwater quality	• Quarterly.	Groundwater sampling will be undertaken at all active monitoring bores identified in Table 8.1. Groundwater quality monitoring will be undertaken in accordance with the *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC 2004) and the following methodology: 1. field parameters are to be measured by a calibrated water quality meter; 2. bores will be purged until three bore volumes have been removed or until field parameters have stabilised over three successive readings; 3. a representative groundwater sample will be collected in laboratory supplied bottles, appropriately preserved and submitted under chain-of custody for analysis of the water quality suite identified in Table 8.5; and 4. sampling equipment will be decontaminated between subsequent bores.

Table 8.5 Groundwater quality analytical suite

Category	Analyte to be tested	Analysis method
General	• pH, electrical conductivity, dissolved oxygen, oxidising reduction potential.	To be measured using a portable water quality meter in the field.
Nutrients	• Ammonia, nitrate, nitrite, total kjeldahl nitrogen, total nitrogen, total phosphorus.	Analysis to be undertaken by a NATA certified laboratory.
Major ions	• Potassium, magnesium, chloride, sodium, sulphate, bicarbonate, calcium, fluoride.	
Biological	• Faecal coliforms, enterococci, E.coli.	
Dissolved metals	• Iron.	

8.4 Groundwater assessment criteria and trigger values

8.4.1 Groundwater level

A significant decrease in the water table is not expected to occur due to extraction of the Stage 5 sand resources as the majority of water extracted during dredging will be returned to the dredge ponds and the aquifer will be rapidly recharge via rainfall (EES 2019a; EES 2019b). The annual groundwater report will assess water level data, establish trends and correlate with quarry activities and climatic data to determine if groundwater level impacts are occurring. Impacts to groundwater level will be established by:

- applying statistical analysis to available monitoring data to assess trends; and
- comparing data from the Stage 5 monitoring bores against unimpacted monitoring bores (DG5) established as part of the existing operations.

If groundwater level changes are observed a management response will be instigated in accordance with the groundwater TARP provided in Section 8.5.

8.4.2 Groundwater quality

Groundwater assessment criteria and trigger values are provided in DA 195-8-2004 Condition 24 and reproduced in Table 8.6. Groundwater quality assessment criteria will also be applied to any groundwater monitoring bores that are constructed to replace bores that are destroyed as quarrying progresses (refer to Section 8.1).

Table 8.6 Groundwater quality objectives

Pollutant	Unit of measure	Water Quality Objective
pH	pH	6.5–8.5
Salinity (as electrical conductivity)	µS/cm	<1,500
Total phosphorus	µg/L	5–50
Total nitrogen	µg/L	100–500
Chlorophyll-a	µg/L	2–10
Faecal coliforms	Median No./100 mL	<1,000
Enterococci	Median No./100 mL	<230
Sodium	mg/L	400
Potassium ion	mg/L	50
Magnesium ion	mg/L	50
Chloride ion	mg/L	300
Sulphate ion	mg/L	250
Bicarbonate ion	mg/L	750
Soluble iron ion	mg/L	6
Ammonium ion	mg/L	20

Source: DA 195-8-2004 Condition 24.

Notes: 1. The Department acknowledges that short term exceedances of these objectives may occur during natural events such as heavy rainfall or tidal saline water inflow.

8.5 Groundwater trigger action response

Monitoring will be undertaken at locations that represent the groundwater condition upstream, downstream and within the Stage 5 dredge ponds. As described in Section 8.3, groundwater bores may need to be replaced as dredging progresses. The TARP described in Table 8.7 will apply to any additional groundwater bores that are established as quarrying progresses.

The TARP provided in Table 8.7 establishes methods to identify assessment criteria exceedances and if necessary, establish actions to either improve water management or further investigate the exceedance via the implementation of the exceedance protocol provided in Appendix F.

Table 8.7 Groundwater Trigger Action Response Plan

Trigger	Action required	Follow up action
Water Level		
Annual groundwater report identifies quarry activities are significantly impacting groundwater levels.	1. Continue to monitor and assess water level data to confirm trends, using Mann Kendall analysis (or other similar methodology) with consideration of cumulative deviation rainfall analysis. 2. DSS is to notify DPIE-Water within 7 days if drawdown is found to be likely attributed to quarry operations to determine if further investigation is required.	1. The outcomes of the annual groundwater report and any further investigation will be documented in the Annual Review. 2. Mitigation measures to be implemented if necessary.
Water quality		
WQOs in Table 8.6 are exceeded in groundwater monitoring bore downstream of Stage 5 dredge ponds.	Identify if exceedance is naturally occurring or due to the quarry operations by reviewing: 1. baseline sampling data to determine if similar exceedances are known to occur; 2. monitoring data from nearby bores to determine if similar exceedances occur; 3. surface water monitoring data to identify any potential sources of the exceedance from the quarry activities; and 4. tidal data to determine if water quality is being affected by tidal influences.	1. If the source of exceedance is determined or identified as occurring naturally then the occurrence will be recorded in the quarry Annual Review and no other further action is required. 2. If the source of exceedance is undetermined or identified as potentially due to quarry activities, the exceedance will be recorded for consideration in future monitoring rounds. If ongoing (2 out of 3 monitoring rounds) water quality anomalies are detected, advise NSW EPA and DPIE-Water within 7 days of the second anomaly being confirmed for further action. The details of any water quality exceedances will be documented in the Annual Review.

Table 8.7 Groundwater Trigger Action Response Plan

Trigger	Action required	Follow up action
WQOs in Table 8.6 are exceeded in the Stage 5 dredge pond groundwater monitoring bores.	Identify if exceedance is due to the quarry operations by reviewing: 1. quarry operations prior to and at the time the exceedance occurred; 2. dredge pond surface water quality results for similar exceedances; and 3. upgradient groundwater monitoring data.	1. If the source of exceedance is determined not to be associated with quarry operations, the occurrence will be recorded in the quarry Annual Review and no other further action is required. 2. If the source of the exceedance is undetermined or identified as potentially due to quarry activities, further investigation into the source of the exceedance and potential water management improvements will be undertaken to reduce the risk of the exceedance reoccurring. If ongoing (2 out of 3 monitoring rounds) water quality anomalies are detected, advise NSW EPA and DPIE-Water within 7 days of the second anomaly being confirmed for further action. The details of any water quality exceedances will be documented in the Annual Review.
Groundwater flow		
Annual groundwater report identifies groundwater flow into the extraction ponds is greater than predicted in the Modification 2 EA	1. Continue to monitor and assess water level data to confirm trends. 2. DSS is to notify DPIE-Water within 7 days of the additional groundwater inflows being identified to determine if further investigation is required.	1. DSS will consult with government agencies to establish licencing arrangements. 2. The annual water balance will be updated accordingly.
Groundwater take greater than the licenced volume	If water balance calculations indicate that net groundwater take exceeds the licenced volume, DSS will: 1. investigate the reason for the groundwater take exceeding the licenced volume including production rates and estimated climate conditions. 2. identify ways to reduce the volume of groundwater water take to within the licenced volume; and 3. notify DPIE-Water within 7 days of identifying the annual groundwater take will exceed the licenced volume.	1. DSS to determine (in consultation with relevant agencies) if additional water access licence share entitlements are needed to be obtained.

9 Reporting and review

9.1 Reporting

9.1.1 Incident and non-compliance reporting

i Incident notification

DSS will immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification will be in writing through the Department's Major Projects Website and will identify the development (including the development application number and name) and set out the location and nature of the incident. Notification of other agencies such as the EPA and NRAR will be via their relevant reporting systems.

ii Non-compliance notification

DSS will notify the Department of non-compliances in accordance with the TARPS provided in Section 6.6 and Section 8.4. The notification will be provided in writing through the Department's Major Projects Website and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the noncompliance.

A non-compliance which has been notified as an incident will not also be notified as a non-compliance.

9.1.2 Annual Review

DSS will prepare an Annual Review report each year. The report will:

- describe the development (including rehabilitation) that was carried out in the previous financial year, and the development that is proposed to be carried out over the current financial year;
- include a comprehensive review of the monitoring results and complaints records of the development over the previous financial year, which includes a comparison of these results against:
  - the relevant statutory requirements, limits or performance measures/criteria;
  - requirements of any plan or program required under the consent;
  - the monitoring results of previous years; and
  - the relevant predictions in the documents listed in condition 2I of Schedule 2 (ie the Modification 2 EA and associated technical studies);
- identify any non-compliance or incident which occurred in the previous financial year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;
- evaluate and report on:
  - the effectiveness of the water management systems; and
  - compliance with the performance measures, criteria and operating conditions of this consent;

- identify any trends in the monitoring data over the life of the development;
- identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies;
- describe what measures will be implemented over the current financial year to improve the environmental performance of the development; and
- provide the outcomes of the annual water balance assessment described in Section 5.4.

9.2 Review

9.2.1 Independent environmental audit

An independent environmental audit will be undertaken every three years, unless the Planning Secretary directs otherwise. This audit will:

- be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary;
- include consultation with the relevant agencies and the Community Consultative Committee (CCC);
- assess the environmental performance of the development and whether it is complying with the relevant requirements in the development consent and any relevant EPL and/or water licence (including any assessment, plan or program required under these approvals);
- review the adequacy of any approved strategy, plan or program required under these approvals; and
- recommend measures or actions to improve the environmental performance of the development, and/or any assessment, plan or program required under these approvals.

9.2.2 Ongoing review

DSS will review the SWMP and make any necessary updates (should updates be required) within three months of submitting an:

- incident report;
- Annual Review;
- independent audit report; and
- any modifications to DA 195-8-2004.

If any of the triggers outlined above occur in proximity to the Annual Review then DSS may request Planning Secretary approval to combine these updates.

If necessary to either improve environmental performance, cater for a modification or comply with a direction, the SWMP will be revised, to the satisfaction of the Planning Secretary and submitted to the Planning Secretary for approval within three months of the review.

Ongoing review of monitoring data will be undertaken to identify if the monitoring program described in this SWMP is adequate. Monitoring frequency may be increased or decreased depending on the outcomes of the data review.

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Abbreviations and units

Abbreviation/unit	Definition
µg	microgram
µS	micro-siemens
AHD	Australian Height Datum
AIP	Aquifer Interference Policy
ANZECC	Australian and New Zealand Environment and Conservation Council
ARI	annual recurrence interval
ASS	acid sulfate soils
ASSMP	Acid Sulfate Soils Management Plan
BoM	Bureau of Meteorology
Boral	Boral Resources Pty Ltd
CCC	Community Consultative Committee
cm	centimetre
CZMP	Coastal Zone Management Plan
DLSP	Dunmore Lakes Sand Project
DPIE	Department of Planning Industry and Environment
DSS	Dunmore Sand and Soil Pty Ltd
EA	Environmental Assessment
EPA	Environmental Protection Agency
EPL	environmental protection licence
ESCP	erosion and sediment control plan
GDE	groundwater dependant ecosystem
GTA	general terms of approval
HIA	Hydrogeological Impact Assessment
ha	hectares
km	kilometres
L	litre
LEP	Local Environmental Plan
LGA	local government area
m	metre
MER	NSW Natural Resources Monitoring, Evaluation and Reporting program
mg	milligram
mL	millilitre
ML	megalitre
mm	millimetre

Abbreviation/unit	Definition
NSW	New South Wales
NTU	Nephelometric Turbidity Unit
PASS	potential acid sulfate soils
SEPP	State Environmental Planning Policy
SILO	Scientific Information for Land Owners
SWMP	Soil and Water Management Plan
SSTV	site specific trigger value
tpa	tonnes per annum
TDS	total dissolved solids
TSS	total suspended solids
VENM	virgin excavated natural materials
WAL	Water Access Licence
WMP	Water Management Plan
WSP	Water Sharing Plan

Appendix A

Department correspondence

DOC21/291776-2

Mr Ben Williams
Boral Resources (NSW) Pty Ltd
PO Box 6041
NORTH RYDE NSW 2113
Via email: ben.williams@boral.com.au

12 May 2021

Dear Mr Williams

PAE-17566889 – Soil and Water Management Plan
Dunmore lakes Quarry (DA195-8-2004-PA-13)

I am writing in reply to your invitation to the Environment Protection Authority (EPA) to provide comments on Soil and Water Management Plan April 2021 (Plan) for the Dunmore Lakes Sand Project – Stage 5. The EPA regulates Dunmore Sand & Soil Pty Limited (DSS) under Environment Protection Licence No. 11147 (Licence). The plan is required to be prepared as per Schedule 3 Condition 30 of DA 195-8-2004 MOD 2 (Consent).

The EPA emphasises that it does not generally review or endorse environmental management plans or similar. The EPA supports the development of Environmental Management Plans (EMPs) as part of good environmental management but does not generally approve specific EMP's for industry operations. I acknowledge however, that Schedule 3 Condition 30 of the Consent states that the Plan must be prepared "in consultation with" the EPA.

As such, the EPA has reviewed the Plan in accordance with Schedule 3 Condition 30 of the Consent and we have no comments on the Plan at this time.

If you have any questions about this matter, please contact Matthew Davidson on 02 4224 4104.

Yours sincerely

LARA BARRINGTON
Unit Head
Regulatory Operations

Phone 131 555
Phone +61 2 9995 5555
(from outside NSW)

TTY 133 677
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Kate Jackson
Regional Manager – NSW/ACT
Boral Land & Property Group
Boral Australia
Level 18, 15 Blue Street
North Sydney, NSW, 2059

17/06/2021

Dear Ms Jackson

Dunmore Lakes Quarry Project (DA195-8-2004)
Endorsement of Experts – Soil and Water

I refer to your request (DA195-8-2004-PA-26) for the Planning Secretary's approval of suitably qualified persons to prepare the Soil and Water Management Plan for the Dunmore Lakes Quarry Project (DA195-8-2004).

The Department has reviewed the nominations and information you have provided and is satisfied that the experts are suitably qualified and experienced. Consequently, I can advise that the Planning Secretary approves the appointments of Chris Kuczera and Jason O'Brien, both of EMM Consulting, to prepare the Soil and Water Management Plan.

If you wish to discuss the matter further, please contact Nagindar Singh on 8289 6873 or via email at nagindar.singh@planning.nsw.gov.au.

Yours sincerely

Matthew Sprott
Director
Resource Assessments (Coal & Quarries)

as nominee of the Planning Secretary

Appendix B

Development consent

Development Consent

Section 80 of the *Environmental Planning & Assessment Act 1979*

I, the Minister for Infrastructure and Planning, approve the Development Application referred to in Schedule 1, subject to the conditions in Schedules 2 to 5.

These conditions are required to:

- prevent, minimise, and/or offset adverse environmental impacts;
- set standards and performance measures for acceptable environmental performance;
- require regular monitoring and reporting; and
- provide for the on-going environmental management of the development.

Craig Knowles, MP
Minister for Infrastructure and Planning
Minister for Natural Resources

Sydney 2005

SCHEDULE 1

Development Application:	DA 195-8-2004.
Applicant:	Dunmore Sand and Soil Pty Limited (ABN: 62 003 497 229).
Consent Authority:	Minister for Infrastructure and Planning.
Land:	Part Lot 6 in DP 611159; Part Lot 3 and Lots 4 & 5 in DP 1030504; Part Lots 5 & 6 in DP1001931; and Lot 1 in DP 213575; and Lot 501 DP 1174897 and Lot 51 DP 1012246 Parish of Terragong, County of Camden.
Proposed Development:	Dunmore Lakes Sand Extraction Project (Stages 2, 3, 4, 5A and 5B).
State Significant Development:	The proposal is classified as State significant development under section 76A(7)(d) of the *Environmental Planning and Assessment Act 1979*, by virtue of a direction made by the Minister under section 89 of the Act on 11 November 2004.
Integrated Development:	The proposal is classified as integrated development under section 91 of the *Environmental Planning and Assessment Act 1979*, as it requires additional approvals under the: • *Protection of the Environment Operations Act 1997;* • *Water Act 1912; and* • *Rivers and Foreshores Improvement Act 1948.*
Designated Development:	The proposal is classified as designated development under section 77A of the *Environmental Planning & Assessment Act 1979*, as it is for an extractive industry that meets the criteria for designated development in schedule 3 of the *Environmental Planning & Assessment Regulation 2000*.

Note:

- *To find out when this development consent becomes effective, see Section 83 of the Environmental Planning and Assessment Act 1979* (EP&A Act);
- *To find out when this development consent is liable to lapse, see Section 95 of the EP&A Act; and*
- *To find out about appeal rights, see Section 97 of the EP&A Act.*

TABLE OF CONTENTS

Blue type represents June 2016 modification
Red type represents March 2020 modification
Green type represents November 2020 modification

DEFINITIONS

Aboriginal object / Aboriginal place	Has the same meaning as the definition of the term in section 5 of the NP&W Act
Annual Review	The review required by condition 9 of Schedule 5
Applicant	Dunmore Sand and Soil Pty Ltd or any other person or persons who rely on this consent to carry out the development that is subject to this consent
Approved disturbance area	The area identified as such on the development layout plans, as modified by the conditions of this consent
ARI	Average Recurrence Interval
BC Act	Biodiversity Conservation Act 2016
BCA	Building Code of Australia
BCD	Biodiversity Conservation Division within the Department
BCT	Biodiversity Conservation Trust
CCC	Community Consultative Committee
Conditions of this consent	Conditions contained in Schedules 2 to 5
Construction	All physical works to enable quarrying operations to be carried out, including demolition and removal of buildings or works, and erection of buildings and other infrastructure permitted by this consent
Council	Shellharbour City Council
DA	Development Application
Day	Day is defined as the period from 7am to 6pm on Monday to Saturday, and 8am to 6pm on Sundays and Public Holidays
Decommissioning	The deconstruction or demolition and removal of works installed as part of the development
Demolition	The deconstruction and removal of buildings, sheds and other structures on the site
Department	Department of Planning, Industry & Environment
Development	The development described in the documents listed in condition 2(c) of Schedule 2
Development Layout Plans	The plans in Appendix 1
DPIE Crown Lands	Crown Lands Group within the Department
DPIE Water	Water Group within the Department
EA Mod 1	Modification application Mod 1 and the accompanying Environmental Assessment titled *Dunmore Lakes Sand Project (DA 195-8-2004) – Modification 1* dated 26 April 2016
EA Mod 2	Modification application Mod 2 and the accompanying Environmental Assessment titled *Dunmore Lakes Sand Extraction Project Modification 2 Environmental Assessment* dated April 2019 and associated Response to Submissions dated June 2019
EIS	Environmental Impact Statement for the *Dunmore Lakes Sand Extraction Proposal, Stages 2, 3 and 4: Environmental Impact Statement, Volumes 1 & 2*, dated August 2004 and supplementary information titled *Dunmore Lakes Sand Extraction Proposal, Stages 2, 3 and 4: Response to EIS Issues*, dated February 2005
Environment	Includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings
EPA	Environment Protection Authority
EPL	Environment Protection Licence issued under the *Protection of the Environment Operations Act 1997*
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
Evening	Evening is defined as the period from 6pm to 10pm
Feasible	Means what is possible and practical in the circumstances
Financial year	A period of 12 months from 1 July to 30 June
Fisheries NSW	Fisheries Branch of the Primary Industries Group within the Department
GTA	General Term of Approval
Heritage NSW	Heritage NSW within the Department of Premier and Cabinet

Heritage Item	An Aboriginal object, an Aboriginal place, or a place, building, work, relic, moveable object, tree or precinct of heritage significance, that is listed under any of the following: • the *National Parks and Wildlife Act 1974;* • the State Heritage Register under the *Heritage Act 1977*; • a state agency heritage and conservation register under section 170 of the *Heritage Act 1977*; • a Local Environmental Plan under the EP&A Act; • the World Heritage List; • the National Heritage List or Commonwealth Heritage List under the EPBC Act; or • anything identified as a heritage item under the conditions of this consent.
Incident	An occurrence or set of circumstances that causes or threatens to cause material harm and which may or may not be or cause a non-compliance
Laden trucks	Trucks transporting materials or products to or from the site
Land	As defined in the EP&A Act, except where the term is used in the noise and air quality conditions in Schedules 3 and 4 of this consent, where it is defined as the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this consent.
Material harm	Is harm to the environment that: • involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial; or • results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment) This definition excludes "harm" that is authorised under either this consent or any other statutory approval
MEG	Regional NSW - Mining, Exploration and Geoscience
Minimise	Implement all reasonable and feasible mitigation measures to reduce the impacts of the development
Minister	NSW Minister for Planning and Public Spaces, or delegate
Modification 2	The modification described in EA Mod 2
Negligible	Small and unimportant, such as to be not worth considering
Night	Night is defined as the period from 10pm to 6am on Monday to Saturday, and 10pm to 8am on Sundays and Public Holidays
Noise sensitive areas	Areas where quarrying operations are being carried out that have potential to lead to increased noise at privately-owned residences, such as elevated areas or areas near the boundary of the site
Non-compliance	An occurrence, set of circumstances or development that is a breach of this consent
Privately-owned land	Land that is not owned by a public agency, a quarrying company or its subsidiary; or where relevant, land that is not covered by a private agreement between the Applicant and the land owner that specifically allows for variances to criteria for environmental performance in this consent
Planning Secretary	Secretary of the Department, or nominee
POEO Act	Protection of the Environment Operations Act 1997
Public infrastructure	Linear and related infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc
Quarrying operations	The extraction, processing, stockpiling and transportation of extractive materials carried out on the site and the associated removal of vegetation, topsoil and overburden

Reasonable	Means applying judgement in arriving at a decision, taking into account: mitigation benefits, costs of mitigation versus benefits provided, community views, and the nature and extent of potential improvements
Registered Aboriginal Parties	Means the Registered Aboriginal Parties for the project who were determined in accordance with the *National Parks and Wildlife Regulation 2019*
Rehabilitation	The restoration of land disturbed by the development to a good condition, to ensure it is safe, stable and non-polluting
Residence	Existing or approved dwelling at the date of grant of this consent
RFS	NSW Rural Fire Service
SEE Mod 3	Modification application Mod 3 and the accompanying Statement of Environmental Effects titled *Dunmore Sand and Soil: DA195-8-2004 Proposed Modification 3* dated 24 June 2019, associated Response to Submissions dated 31 October 2019 and responses to information requests dated 21 January 2020 and 11 February 2020
Shoulder	Time interval from 6am to 7am, Monday to Saturday
Site	Land to which the DA applies
TfNSW	Transport for NSW
VENM	Virgin Excavated Natural Material, as defined in the *Protection of the Environment Operations Act 1997*
Waste	Has the same meaning as the definition of the term in the Dictionary to the POEO Act

SCHEDULE 2
ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

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

Terms of Approval

2. The Applicant must carry out the development:
   a) in compliance with the conditions of this consent;
   b) in accordance with all written directions of the Planning Secretary;
   c) generally in accordance with the EIS, EA Mod 1, SEE Mod 3 and EA Mod 2; and
   d) generally in accordance with the Development Layout in Appendix 1.

   Note: The Development Layout Plan is included in Appendix 1.

3. If there is any inconsistency between the documents identified in condition 2(c), the more recent document shall prevail to the extent of the inconsistency. The conditions of this consent shall prevail to the extent of any inconsistency with the documents identified in condition 2(c).

4. The Applicant must comply with any reasonable requirement/s of the Planning Secretary arising from the Department's assessment of:
   a) any strategies, plans, programs, reviews, audits, reports or correspondence that are submitted in accordance with this consent (including any stages of these documents);
   b) any reviews, reports or audits commissioned by the Department regarding compliance with this consent; and
   c) the implementation of any actions or measures contained in these documents.

Limits on Approval

3. Quarrying operations may be carried out on the site until 15 May 2031.

Notes:

- *Under this consent, the Applicant is required to decommission and rehabilitate the site and carry out other requirements in relation to quarrying operations. Consequently, this consent will continue to apply in all respects other than to permit the carrying out of quarrying operations until the rehabilitation of the site and other requirements have been carried out to the required standard.*
- *Any on-going use of the site for processing and blending activities after quarrying operations cease would be the subject of a separate application.*

6. The Applicant must not produce or transport more than 800,000 tonnes of product each financial year from the site.

Structural Adequacy

7. The Applicant must ensure that any new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

Notes:

- *Under Part 6 of the EP&A Act, the Applicant is required to obtain construction and occupation certificates for any building works.*
- *Part 8 of the EP&A Regulation sets out the detailed requirements for the certification of development.*

Demolition

8. The Applicant must ensure that all demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures* (Standards Australia, 2001), or its latest version.

Protection of Public Infrastructure

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

a) repair, or pay the full costs associated with repairing, any public infrastructure that is damaged by the development; and
b) relocate, or pay the full costs associated with relocating any public infrastructure that needs to be relocated as a result of the development.

Note: This condition does not apply to any damage to roads caused as a result of general road usage or otherwise addressed by the Road Pavement Dilapidation Report required by condition 53B of Schedule 3 of this consent.

Operation of Plant and Equipment

10. The Applicant must ensure that all plant and equipment at the site, or used in connection with the development, are:
a) maintained in a proper and efficient condition; and
b) operated in a proper and efficient manner.

Notification of Commencement

11. The Department must be notified in writing of the date of commencement of any of the following phases of the development, at least two weeks before that date:
a) construction activities associated with Modification 2;
b) quarrying operations in each of Stages 5A and 5B;
c) cessation of quarrying operations (i.e. quarry closure); and
d) any period of suspension of quarrying operations (i.e. care and maintenance).

Staging, Combining and Updating Strategies, Plans or Programs

12. With the approval of the Planning Secretary, the Applicant may:
a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);
b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined);
c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development); and
d) combine any strategy, plan or program required by this consent with any similar strategy, plan or program required by an adjoining quarrying consent or approval, in common ownership or management.

13. If the Planning Secretary agrees, a strategy, plan or program may be staged without addressing particular requirements of the relevant condition of this consent if those requirements are not applicable to the particular stage.

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

Application of Existing Strategies, Plans or Programs

15. The Applicant must continue to apply existing management strategies, plans or monitoring programs required under this consent prior to the approval of Modification 2, until the approval of a similar plan, strategy or program following the approval of Modification 2.

Compliance

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

Applicability of Guidelines

17. References in the conditions of this consent to any guideline, protocol, Australian Standard or policy are to such guidelines, protocols, Standards or policies in the form they are in as at the date of inclusion (or later update) in the condition.

18. However, consistent with the conditions of this consent and without altering any limits or criteria in this consent, the Planning Secretary may, in respect of ongoing monitoring and management obligations,

agree to or require compliance with an updated or revised version of such a guideline, protocol, Standard or policy, or a replacement of them.

Crown Land

19. The Applicant must consult with DPIE – Crown Lands prior to undertaking any development on Crown Land or Crown Roads.

SCHEDULE 3
SPECIFIC ENVIRONMENTAL CONDITIONS

GENERAL EXTRACTION AND PROCESSING PROVISIONS

Identification of Boundaries

1. Within 6 months of the date of this consent and prior to the commencement of extraction operations in each of Stage 5A and Stage 5B, the Applicant must:
   a) engage a registered surveyor to mark out the boundaries of the approved limits of extraction for Stages 2, 3, 4, 5A and 5B (as set out conceptually in Appendix 1 and as amended by the conditions of this consent);
   b) submit a survey plan of these boundaries and their GPS coordinates to the Planning Secretary; and
   c) ensure that these boundaries are clearly marked at all times in a permanent manner that allows operating staff and inspecting officers to clearly identify those limits.

Stages 2 – 4 Extraction Areas

2. The Applicant must not undertake extraction within 3 metres of the project site boundary for Stages 2 - 4. Batter slopes from this extraction limit must be no steeper than 1:3 (V:H).

3. The Applicant must not undertake any stockpiling of material in the area marked 'Potential Future Stockpiling Area' on Figure 2.2 of the EIS.

Stage 4 – Tabbita Road Corridor

4. The Applicant must not undertake any extraction in Stage 4 without the prior approval of the Planning Secretary. An application to undertake extraction in Stage 4 must be accompanied by an extraction management plan that must:
   a) detail the proposed realignment and rehabilitation of Tabbita Road and associated infrastructure;
   b) assess the environmental impacts of the proposed realignment; and
   c) include appropriate agreements with affected parties,
   to the satisfaction of the Planning Secretary.

Western, Northern and Eastern Tributaries

Note: The Applicant is required to obtain a Controlled Activity Approval from DPIE Water under the Water Management Act 2000 prior to undertaking any works within 40 metres of Rocklow Creek or the Western, Northern and Eastern Tributaries, or any water feature connected to these protected waters.

5. The Applicant must not undertake extraction within 3 metres of the bank of the Eastern Tributary. Batter slopes from this extraction limit must be no steeper than 1:3 (V:H).

6. The Applicant must maintain the integrity of the Northern and Western Tributaries for as long as practicable. In this regard, the Applicant must only extract sand within 3 metres of the bank of the tributaries in accordance with an approved Riparian Area Management Plan (see condition **Error! Reference source not found.**). Batter slopes from this extraction limit must be no steeper than 1:2 (V:H).

Southern, North-eastern and North-western Wetlands

7. The Applicant must not undertake extraction within 10 metres of the bank of the southern or north-eastern wetlands. Batter slopes from this extraction limit must be no steeper than 1:2 (V:H).

8. The Applicant must commission a suitably qualified ecologist, whose appointment has been endorsed by the Planning Secretary, to mark out the extraction limit to the southern and north-eastern wetlands.

   Note: The southern and north-eastern wetlands are defined as the area that constitutes Freshwater Wetlands on Coastal Floodplains, an endangered ecological community under the former Threatened Species Conservation Act 1995.

9. The Applicant must ensure that extraction within 40m of the southern, north-eastern and north-western wetlands occurs towards the end of dredging when the dredge pond water volume is maximised, and in accordance with an approved Riparian Area Management Plan (see condition **Error! Reference source not found.**). The plan must include an assessment by a suitably qualified hydrogeologist justifying the extraction limit referred to in condition 7, based on data obtained from the site.

Rocklow Creek Realignment

10. Prior to the commencement of extraction in Sub-Stage 3C1 (see Appendix 1), the Applicant must complete the realignment and rehabilitation of Rocklow Creek, to the satisfaction of the Planning Secretary. The realignment must be undertaken in accordance with an approved Riparian Area Management Plan (see condition 45). The realigned channel must be designed so as to safely convey, without bed or bank erosion, the 1 in 20 year ARI peak flow.

11. The Applicant must not undertake extraction within 3 metres of the bank of the realigned Rocklow Creek. Batter slopes from this extraction limit must be no steeper than 1:2 (V:H).

12. The Applicant must provide for the ultimate redirection of the realigned Rocklow creek into the lake in Stage 3, unless otherwise approved by the Planning Secretary. The redirection must be undertaken in accordance with an approved Riparian Area Management Plan (see condition **Error! Reference source not found.**).

Stage 5 Extraction Areas

12A. The Applicant must not undertake extraction within 3 metres of the project boundary for Stage 5A adjacent to Riverside Drive or the project boundary for Stage 5B adjacent to the private property at 79 Fig Hill Lane.

12B. The Applicant is not permitted to undertake any vegetation clearance, construction or extraction activities within lands zoned as E3 under the *Shellharbour Local Environment Plan 2013*. In this regard, the Applicant must adjust its final flood bund design and extraction footprint for Stage 5B and the location of ancillary infrastructure (including water management infrastructure) to stand off these lands.

NOISE

Operational Noise Criteria

13. Except for the carrying out of approved construction works, the Applicant must ensure that the noise generated by the development does not exceed the criteria specified in Table 1.

***Table 1**: Noise impact assessment criteria dB(A)*

Residential Location	Shoulder $L_{Aeq\ (15\ mins)}$	Day $L_{Aeq\ (15\ mins)}$	Evening $L_{Aeq\ (15\ mins)}$	Night $L_{Aeq\ (15\ mins)}$
Dunmore Village residences – 31 Shellharbour Road	47	49	44	41
R20	47	49	44	38
R3, R11, R12, R13, R14, R15, R16, R17, R18, 79 Fig Hill Lane	48	48	43	38
R19	46	47	43	38
R4, R5, R6, R7, R8, R9, R10	43	47	43	38
Renton (183 James Road Dunmore)	46	46	43	37
All other residences	35	40	35	35

13A. Noise generated by the development must be monitored and measured in accordance with the relevant procedures and exemptions (including certain meteorological conditions) of the *NSW Noise Policy for Industry* (EPA, 2017).

13B. The noise criteria in Table 1 do not apply if the Applicant has an agreement with the owner/s of the relevant residence or land to exceed the noise criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Operating Hours

14. [1] The Applicant must comply with the operating hours in Table 2:

Table 2: Operating Hours

Activity	Day	Time
Dredging and processing	Monday – Saturday	6:00am to 6:00pm
	Sunday and Public Holidays	8:00am to 4:00pm
Excavator extraction	Monday – Saturday	6:30am to 6:00pm
	Sunday and Public Holidays	Nil
Delivery, distribution and maintenance	Monday – Friday	5:00am to Midnight
	Saturday	6:00am to 6:00pm
	Sunday and Public Holidays	8:00am to 4:00pm
Delivery and distribution via Shellharbour Road and Riverside Drive	Monday – Friday	7:00am to 10:00pm
	Saturday	7:00am to 6:00pm
	Sunday and Public Holidays	8:00am to 4:00pm
Maintenance (if inaudible at neighbouring residences)	Anytime	Anytime

15. [2]The following activities may be carried out at the premises outside the hours specified in Table 2:
a) the delivery or dispatch of materials as requested by Police or other public authorities for safety reasons; and
b) emergency work to avoid the loss of lives, property and/or to prevent environmental harm.
In such circumstances the Applicant must notify the Department and affected residents prior to undertaking the works, or within a reasonable period in the case of emergency.

Construction Hours

15A. Approved construction works must be undertaken during standard construction hours (7 am to 6 pm, Monday to Friday and 8 am to 1 pm on Saturdays), unless the Planning Secretary agrees otherwise.

Noise Operating Conditions

16. The Applicant must:
a) take all reasonable steps to minimise noise from construction and operational activities, including low frequency noise and other audible characteristics, as well as road noise associated with the development;
b) implement reasonable and feasible noise attenuation measures on all plant and equipment that will operate in noise sensitive areas;
c) operate a noise management system to guide day to day planning of quarrying operations and implementation of both proactive and reactive noise mitigation measures to ensure compliance with the relevant conditions of this consent;
d) take all reasonable steps to minimise the noise impacts of the development during noise-enhancing meteorological conditions;
e) carry out regular attended noise monitoring to determine whether the development is complying with the relevant conditions of this consent; and
f) regularly assess the noise monitoring data and modify or stop operations on the site to ensure compliance with the relevant conditions of this consent.

Noise Management Plan

17. The Applicant must prepare a Noise Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
a) be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;
b) describe the noise management system and measures to be implemented to ensure:
- compliance with the noise criteria and operating conditions in this consent;
- leading practice management is being employed;
- noise impacts of the development are minimised during noise-enhancing meteorological conditions;

[1] Incorporates EPA GTA
[2] Incorporates EPA GTA

c) include a protocol for distinguishing noise emissions of the development from other nearby or neighbouring developments; and
d) include a monitoring program that:
- is capable of evaluating the performance of the development against the construction and operational noise criteria;
- monitors noise at the nearest and/or most affected residences or other representative monitoring locations set out in the Noise Management Plan;
- adequately supports the noise management system; and
- includes a protocol for identifying any noise-related exceedance, incident or non-compliance and notifying the Department and relevant stakeholders of any such event.

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

AIR QUALITY

Air Quality Criteria

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

Table 3: Air quality criteria

Pollutant	Averaging period	Criterion
Particulate matter < 10 µm (PM_{10})	Annual	[a, c] 25 µg/m³
	24 hour	[b] 50 µg/m³
Particulate matter < 2.5 µm ($PM_{2.5}$)	Annual	[a, c] 8 µg/m³
	24 hour	[b] 25 µg/m³
Total suspended particulate (TSP) matter	Annual	[a, c] 90 µg/m³

Notes:
[a] *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).*
[b] *Incremental impact (i.e. incremental increase in concentrations due to the development on its own).*
[c] *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary.*

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

Air Quality Operating Conditions

20A. The Applicant must:
a) take all reasonable steps to:
- minimise odour, fume and particulate matter (including PM_{10} and $PM_{2.5}$) emissions of the development;
- minimise visible off-site air pollution generated by the development; and
- minimise the extent of potential dust generating surfaces exposed on the site at any given point in time;

b) operate an air quality management system to guide the day to day planning of quarrying operations and implementation of both proactive and reactive air quality mitigation measures to ensure compliance with the relevant conditions of this consent;
c) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events;
d) carry out regular air quality monitoring to determine whether the development is complying with the relevant conditions in this consent; and
e) regularly assess meteorological and air quality monitoring data and relocate, modify or stop operations on the site to ensure compliance with the relevant conditions of this consent.

Air Quality Management Plan

20B. The Applicant must prepare an Air Quality Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
a) be prepared by a suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;

b) describe the measures to be implemented to ensure:
- compliance with the air quality criteria and operating conditions in this consent;
- leading practice management is being employed (including in respect of minimisation of greenhouse gas emissions from the site); and
- air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events;

c) describe the air quality management system; and

d) include an air quality monitoring program that:
- is capable of evaluating the performance of the development against the air quality criteria;
- adequately supports the air quality management system; and
- includes a protocol for identifying any air quality-related exceedance, incident or non-compliance and notifying the Department and relevant stakeholders of any such event.

20C. The Applicant must implement the Air Quality Management Plan as approved by the Planning Secretary.

Odour

21. [3] The Applicant must not cause or permit the emission of offensive odour from the site.

Note: 'Offensive odour' is defined in the Protection of the Environment Operations Act 1997.

SURFACE AND GROUND WATER

Water Supply

21A. The Applicant must ensure that it has sufficient water for all stages of the development prior to the take of water occurring, and if necessary, adjust the scale of the development to match its available water supply.

21B. The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under each water licence.

Note: Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain all necessary water licences for the development.

Pollution of Waters

22. Except as may be expressly provided by an EPL, the Applicant must comply with section 120 of the *Protection of the Environment Operations Act 1997* during the carrying out of the development.

Water Discharge Limit

23. Except as may be expressly provided by an EPL, the Applicant must ensure that the discharges from any licenced discharge point/s do not cause additional exceedances of the criteria in Table 4:

Table 4: Water Discharge Pollution Limits

Pollutant	Unit of Measure	100 Percentile Concentration Limit
Total Suspended Solids	mg/L	50
pH	pH	± 1.0

Water Quality Objectives

24. The Applicant must ensure that water quality in the dredge ponds and in groundwater comply with the water quality objectives in Table 5, or other such level as approved by the Planning Secretary:

Table 5: Water Quality Objectives

Pollutant	Unit of Measure	Water Quality Objective
Turbidity	NTU	5-20
pH	pH	6.5 – 8.5
Salinity	µS/cm	<1,500
Dissolved oxygen	mg/L	>6
Total phosphorus	µg/L	5-50
Total nitrogen	µg/L	100-500

[3] Incorporates EPA GTA

Pollutant	Unit of Measure	Water Quality Objective
Chorophyll-a	µg/L	2-10
Faecal coliforms	Median No./100mL	<1000
Enterococci	Median No./100mL	<230
Algae and blue-green algae	No.cells/mL	<15,000
Sodium	mg/L	400
Potassium ion	mg/L	50
Magnesium ion	mg/L	50
Chloride ion	mg/L	300
Sulphate ion	mg/L	250
Bicarbonate ion	mg/L	750
Soluble Iron ion	mg/L	6
Ammonium ion	mg/L	20

Notes:

- *The objectives for dissolved oxygen, turbidity and algae are relevant to surface water only;*
- *The Department acknowledges that short term exceedances of these objectives may occur during natural events such as heavy rainfall or tidal saline water inflow.*

Stormwater Management

25. [4] The Applicant must ensure that any pond subject to dredging or backfilling, or containing turbid water due to recent dredging or backfilling, must be maintained and operated to prevent discharges of any turbid water (as defined in Tables 4 and 5) from these ponds.

26. [5] The Applicant must cease backfilling activities not less than 12 hours prior to the commencement of overflow from any dredge pond. No backfilling must occur when the dredge ponds are overflowing.

Flood Management

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

28. [6]The access road entrance off Tabbita Road, processing and stockpile area, and the fines return pond(s) must be constructed and maintained so as to prevent inundation by floodwaters caused by the 1 in 100 year ARI flood level. Prior to the commissioning of the processing area, the Applicant must provide certification to the Planning Secretary that this condition has been complied with.

29. Following the cessation of dredging and backfilling operations, the Applicant must commission a suitably qualified hydrologist to define the flood-related limits of the final landform. The flood study must be undertaken in consultation with the Department and Shellharbour Council, and to the satisfaction of the Planning Secretary.

Stage 5 Flood Mitigation

29A. Prior to undertaking any development in Stage 5A, the Applicant must provide the Planning Secretary with the detailed design of the Stage 5A flood mitigation bunds which demonstrates that the bunds can prevent inundation of the Stage 5A pond by floodwaters associated with the 1 in 100 year ARI flood level.

29B. Prior to undertaking any development in Stage 5B, the Applicant must provide the Planning Secretary with the detailed design of the Stage 5B flood mitigation bunds which demonstrates that the bunds can prevent inundation of the Stage 5B pond and carparking area by floodwaters associated with the probable maximum flood event. Any increase in the height of the bunds required to achieve this outcome must be accompanied by an appropriate increase in width to ensure the stability and visual aesthetics of the bunds in the landscape, to the satisfaction of the Secretary.

29C. The Applicant must retain and maintain the flood bunds around the Stage 5B area to prevent interactions with the probable maximum flood, unless otherwise agreed in writing by the Planning Secretary.

Upon receiving a written request from the Applicant seeking to remove the bunds, the Planning Secretary will determine whether the flood bunds should be removed and the Stage 5B pond rehabilitated and integrated into the Minnamurra River floodplain. If the water quality in the pond meets relevant ANZECC

[4] Incorporates EPA GTA

[5] Incorporates EPA GTA

[6] Incorporates EPA GTA

Guidelines, water quality standards imposed under any EPL and does not represent a material environmental risk to the Minnamurra River floodplain, the Planning Secretary will provide a written approval stipulating the timing and rehabilitation requirements associated with the removal of the bunds.

Alternatively, with the written approval of the Planning Secretary, the Applicant may satisfy its maintenance obligations under this condition through the establishment of a suitable funding agreement with an appropriate public authority. This public authority would then be responsible for the oversight and carriage of these in perpetuity works.

29D. The Applicant must undertake regular monitoring of the stability of flood bunds throughout the extraction, rehabilitation and closure phases of the Stage 5 quarry operations.

Soil and Water Management Plan

30. The Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
    a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;
    b) be prepared in consultation with EPA and DPIE Water; and
    c) include a:
        (i) **Site Water Balance** that includes details of:
            - predicted annual inflows to and outflows from the site;
            - sources and security of water supply for the life of the development (including authorised entitlements and licences);
            - water storage capacity, use and management on the site;
            - licenced discharges points and limits; and
            - reporting of annual water extraction and maximum instantaneous pumping rates to the Department; and
            - procedures for the annual preparation of an updated site water balance; and
        (ii) **Erosion and Sediment Control Plan** that:
            - is consistent with the requirements of *Managing Urban Stormwater: Soils and Construction - Volume 1: Blue Book* (Landcom, 2004) and *Volume 2E: Mines and Quarries* (DECC, 2008);
            - identifies activities that could cause soil erosion, generate sediment or affect flooding;
            - includes a program to review the adequacy of existing flood protection works;
            - describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk;
            - describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and
            - describes what measures would be implemented to maintain (or if necessary decommission) the structures over time;
        (iii) **Surface Water Management Plan**, that includes:
            - detailed baseline data on surface water flows and quality in watercourses, water bodies, wetlands and/or fish habitat that could potentially be affected by the development;
            - a detailed description of the surface water management system on the site, including the:
                - clean water diversion system;
                - erosion and sediment controls;
                - dirty water management system; and
                - water storages;
            - a program to monitor and evaluate:
                - any surface water discharges;
                - bank and bed stability;
                - the effectiveness of the water management system;
                - impacts on water supply for other water users; and
                - surface water flows and quality in watercourses, waterbodies, wetlands and/or fish habitats that could potentially be impacted by the development;
            - surface water impact assessment criteria and performance measures, including trigger levels for investigating and responding to potentially adverse impacts; and
            - a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events;

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

- detailed baseline data of groundwater levels, flows and quality for groundwater resources and groundwater dependent ecosystems potentially impacted by the development;
- a detailed description of the groundwater management system;
- a program to monitor and evaluate:
  - water loss/seepage from water storages into the groundwater system, including from any final void;
  - groundwater inflows, outflows and storage volumes, to inform the Site Water Balance;
  - impacts on groundwater supply for other water users;
  - impacts on groundwater dependent ecosystems;
  - the hydrogeological setting of any nearby alluvial aquifers and the likelihood of any indirect impacts from the development; and
  - the effectiveness of the groundwater management system;
- groundwater impact assessment criteria and performance measures, including trigger levels for investigating and responding to potentially adverse groundwater impacts (or trends) associated with the development on regional and local aquifers and/or the groundwater supply for other water users such as licensed privately-owned groundwater bores;
- a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events; and
- a protocol to obtain appropriate water licence(s) to cover the volume of any unforeseen groundwater inflows into the extraction areas.

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

32. The Applicant must not commence extraction in Stage 5 until the Soil and Water Management Plan is approved by the Planning Secretary.

Stage 5 Acid Sulfate Soils Management

33. Prior to commencing extraction in Stage 5, the Applicant must prepare an Acid Sulfate Soils Management Plan for Stage 5 operations, to the satisfaction of the Planning Secretary. The plan must:
    a) be prepared in consultation with EPA and by a suitably qualified person whose appointment has been approved by the Planning Secretary;
    b) describe the measures that would be implemented to limit the risk of acid sulfate soils being mobilised during Stage 5 operations;
    c) describe the measures that would be implemented to limit the risk of acid sulphate soils being imported with the VENM; and
    d) include a Trigger Action Response Plan with a hierarchy of actions to avoid, mitigate and manage acid sulfate soils impacts.

34. *Deleted*

35. *Deleted*

METEOROLOGICAL MONITORING

36. Prior to the commencement of construction within the Stage 5 areas and for the life of the development, the Applicant must ensure that there is a suitable meteorological station operating in close proximity to the site that:
    a) complies with the requirements in the *Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007); and
    b) is capable of measuring meteorological conditions in accordance with the *NSW Noise Policy for Industry* (EPA, 2017),

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

BIODIVERSITY

Endangered Ecological Community Compensatory Habitat

37. The Applicant must establish, conserve and maintain at least:
    a) 6 ha of Freshwater Wetlands on Coastal Floodplains (which may include areas of associated wetland pondage); and
    b) 3 ha of Swamp Oak Floodplain Forest;

    in rehabilitation and visual screening plantings on the site, in a manner that integrates the compensatory habitats with existing similar habitats on and near the site.

Stage 5 Biodiversity Offsets

37A. Prior to any clearing of vegetation in Stage 5B, or other timeframe agreed by the Planning Secretary, the Applicant must retire the biodiversity credits listed in Table 6. The retirement of credits must be carried out in accordance with the Biodiversity Offsets Scheme of the BC Act, to the satisfaction of the BCT.

Table 6: Stage 5 Biodiversity credit requirements

Credit Type	***Credits Required***
Ecosystem Credits	
Bangalay Sand Forest of the Sydney Basin and South East Corner Bioregions *(PCT659 – Bangalay – Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion)*	71
Species Credits	
Southern Myotis *(Myotis Macropus)*	19
Masked Owl *(Tyto novaehollandiae)*	71
Barking Owl *(Ninox connivens)*	71

Flora and Fauna Management Plan

38. Prior to undertaking any vegetation clearing associated with Modification 2, the Applicant must update the Flora and Fauna Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
    a) be prepared by suitably qualified ecologist and experienced person/s whose appointment has been endorsed by the Planning Secretary;
    b) be prepared in consultation with Shellharbour Council, Kiama Council and Fisheries NSW;
    c) describe the short, medium and long-term measures to be undertaken to manage remnant vegetation and fauna habitat on the site;
    d) describe the measures to be implemented within the approved disturbance areas to:
        (i) minimise the amount of clearing where practicable (eg through adaptive management of ancillary infrastructure) and delineate the areas of vegetation to be cleared;
        (ii) ensure that clearing is undertaken progressively;
        (iii) minimise impacts on fauna, including undertaking pre-clearance surveys;
        (iv) provide for the reasonable salvage, transplanting and/or propagation of threatened flora found during pre-clearance surveys, in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Vallee et al., 2004); and
        (v) maximise the salvage of resources, including tree hollows, vegetation and soil resources, for beneficial reuse, including fauna habitat enhancement;
    e) describe the measures to be implemented on the site to:
        (i) minimise impacts to threatened ecological communities listed under the BC Act and contribute to conservation strategies for these communities;
        (ii) minimise impacts on fauna habitat resources such as hunting and foraging areas, habitat trees, fallen timber, hollow-bearing trees and downstream fish habitats;
        (iii) enhance the quality of vegetation, vegetation connectivity and wildlife corridors including through the revegetation of appropriate canopy, sub-canopy, understorey and ground strata within the wetland vegetation to be established around the pond verges;
        (iv) introduce naturally scarce fauna habitat features such as nest boxes and salvaged tree hollows in the final landform and promote the use of these introduced habitat features by threatened fauna species;
        (v) manage any potential conflicts with Aboriginal heritage values;
        (vi) protect vegetation and fauna habitat outside of the approved disturbance areas;
        (vii) manage the collection and propagation of seed from the local area;
        (viii) control weeds, including measures to avoid and mitigate the spread of noxious weeds;
        (ix) control feral pests with consideration of actions identified in relevant threat abatement plans;
        (x) control erosion;
        (xi) manage any grazing and agriculture;

(xii) control access to vegetated or revegetated areas; and

(xiii) manage bushfire hazards;

f) include a seasonally based program to monitor and report on the effectiveness of the above measures, progress against the detailed performance indicators and completion criteria, and identify any improvements that could be implemented to improve biodiversity outcomes;

g) include a Compensatory Habitat Management Plan that:

(i) describes the compensatory habitat proposal;

(ii) justifies why the proposed area(s) is suitable for the compensatory habitat proposal, including how the area will integrate with existing habitat areas on and near the site;

(iii) establishes baseline data for the existing habitat in the proposed area(s);

(iv) describes how the compensatory habitat proposal would be implemented;

(v) sets completion criteria for the compensatory habitat proposal; and

(vi) describes how the performance of the compensatory habitat proposal would be monitored over time;

h) include detailed performance and completion criteria for evaluating the performance of the compensatory habitat and offset requirements of conditions 37 and 37A and rehabilitation of the site, including triggers for remedial action, where these performance or completion criteria are not met; and

i) include details of who would be responsible for monitoring, reviewing, and implementing the plan.

39. The Applicant must implement the Biodiversity Management Plan as approved by the Planning Secretary.

HERITAGE

Protection of Heritage Items

40. The Applicant must ensure that the development does not cause any direct or indirect impact on any identified heritage item located outside of the approved disturbance areas, beyond those impacts predicted in the documents listed in condition 2(c) of Schedule 2.

Heritage Management Plan

41. Prior to undertaking any development in Stage 5, the Applicant must prepare a Heritage Management Plan for the development to the satisfaction of the Planning Secretary. This Plan must:

a) be prepared by suitably qualified and experienced persons whose appointment has been endorsed by the Planning Secretary;

b) be prepared in consultation with Registered Aboriginal Parties and Heritage NSW;

c) include consideration of the Aboriginal and non-Aboriginal cultural context and significance of the site;

d) describe the procedures and management measures to be implemented on the site to:

(i) ensure all workers receive suitable Aboriginal cultural heritage inductions prior to carrying out any activities which may cause impacts to Aboriginal objects or Aboriginal places, and that suitable records are kept of these inductions;

(ii) protect, monitor and manage identified non-Aboriginal heritage, Aboriginal objects and Aboriginal places (including any archaeological investigations of potential subsurface objects and salvage of objects within the approved disturbance areas, including 52-5-0907 (DLS Boral AFT 1) and 52-5-0908 (DLS Boral AFT 2) in accordance with the commitments made in the documents listed in condition 2(c) of Schedule 2;

(iii) protect non-Aboriginal heritage, Aboriginal objects and Aboriginal places located outside the approved disturbance area from impacts of the development;

(iv) manage the discovery of suspected human remains and any new Aboriginal objects or Aboriginal places, including provisions for burials, over the life of the development;

(v) maintain and manage reasonable access for relevant Aboriginal stakeholders to Aboriginal objects and Aboriginal places (outside of the approved disturbance area); and

(vi) facilitate ongoing consultation and involvement of Registered Aboriginal Parties in the conservation and management of Aboriginal cultural heritage on the site;

e) include a strategy for the care, control and storage of Aboriginal objects salvaged on site, both during the life of the development and in the long term;

f) include a protocol for managing interactions with the curtilage of the State heritage listed Dunmore House and identifying how this area would be rehabilitated to ensure the Dunmore House curtilage is restored without impacting the integrity or heritage values of the site; and

g) describe the measures to be implemented on the site to manage interactions with the Flora and Fauna Management Plan.

41A. The Applicant must implement the Heritage Management Plan approved by the Planning Secretary.

REHABILITATION

Rehabilitation

42. The Applicant must progressively rehabilitate the site to the satisfaction of the Planning Secretary, in a manner that is generally consistent with the concept final landform in the documents listed in condition 2(c) of Schedule 2 (see Appendix 2), and in accordance with the conditions of this consent.

Rehabilitation Management Plan

43. Prior to commencing extraction in Stage 5, the Applicant must update the Rehabilitation Management Plan for the development to the satisfaction of the Planning Secretary: This plan must:
    a) be prepared:
        (i) by suitably qualified consultants, including a specialist hydrologist, wetlands ecologist and landscape architect, whose appointments have been approved by the Planning Secretary;
        (ii) in consultation with Shellharbour Council, Kiama Council, BCD and the Department; and
        (iii) in accordance with extant guidelines including the *Constructed Wetlands Manual, Volumes 1 & 2 and the Shellharbour Visual Management Plan User Manual;*
    b) provide detailed plans of the final landform based on current backfill estimates;
    c) set detailed performance indicators and completion criteria for the rehabilitation of all areas disturbed by the development;
    d) describe the measures that would be implemented to achieve the criteria in paragraph (c) and triggers for remedial actions;
    e) include detailed design plans and scheduling for progressive rehabilitation to be initiated, undertaken and/or completed in the next 5 years;
    f) include a program to monitor, independently audit and report on progress against the criteria in paragraph (c) and the effectiveness of the measures in paragraph (d); and
    g) include any Riparian Area Management Plan/s prepared in accordance with condition 45 for those riparian areas to be disturbed/rehabilitated in the next 5 years.

44. The Applicant must implement the Rehabilitation Management Plan as approved by the Planning Secretary.

Riparian Area Management Plan

45. The Applicant must prepare a Riparian Area Management Plan in consultation with BCD and to the satisfaction of the Planning Secretary. For works involving:
    a) disturbance within 3m of an existing riparian area, the plan must:
        - describe the broader extraction staging and justify the need for extraction in the Riparian Area;
        - describe in detail the methods and timing for extraction within the Riparian Area;
        - provide for construction and stabilisation of appropriate diversion channels to divert the waterbody around the disturbance area, unless otherwise approved by BCD and the Planning Secretary; and
        - describe the methods for rehabilitation of the Riparian Area and diversion channels; and
    b) construction/rehabilitation of Riparian Areas, the plan must:
        - detail proposed channel/bed designs, including scour protection measures;
        - include hydraulic modelling supporting the proposed design;
        - where applicable, include measures to replicate pre-existing tidal-estuarine conditions;
        - include detailed plans for rehabilitation and revegetation of the Riparian Area using locally endemic species;
        - describe measures for the protection, enhancement and integration with adjacent threatened communities, including *Freshwater Wetlands on Coastal Floodplains, Swamp Oak Floodplain Forest* and *Bangalay Sand Forest of the Sydney Basin and South East Corner Bioregions.*

46. The Applicant must implement the Riparian Area Management Plan as approved by the Planning Secretary.

47. *Deleted*

Rehabilitation and Conservation Bond

48. Within 6 months of the approval of Modification 2, the Applicant must lodge an updated Conservation and Rehabilitation Bond with the Department to ensure that the biodiversity offset, compensatory habitat and rehabilitation requirements of the site are implemented in accordance with the performance and

completion criteria set out in the Flora and Fauna Management Plan, Rehabilitation Management Plan and the relevant conditions of this consent. The sum of the bond must be an amount agreed by the Planning Secretary and determined by:

a) calculating the full cost of implementing the biodiversity offset and compensatory habitat requirements of the consent at third party rates (other than land acquisition costs);
b) calculating the cost of rehabilitating all disturbed areas of the site, taking into account the likely surface disturbance over the next 3 years of quarrying operations; and
c) employing a suitably qualified, independent and experienced person to verify the calculated costs.

49. The calculation of the Conservation and Rehabilitation Bond must be submitted to the Department for approval at least 2 months prior to the lodgement of the bond.

49A. The Conservation and Rehabilitation Bond must be reviewed and if required, an updated bond must be lodged with the Department within 3 months following:

a) any update or revision to the Flora and Fauna, Rehabilitation or Riparian Area Management Plans;
b) the completion of an Independent Environmental Audit in which recommendations relating to the implementation of the biodiversity or rehabilitation requirements have been made; or
c) in response to a request by the Planning Secretary.

49B. If the biodiversity offset, compensatory habitat and rehabilitation requirements are completed generally in accordance with the relevant performance and completion criteria, to the satisfaction of the Planning Secretary, the Planning Secretary will release the bond.

49C. If the Biodiversity Offset Strategy or rehabilitation is not completed generally in accordance with the relevant performance and completion criteria, the Planning Secretary will call in all, or part of, the bond, and arrange for the completion of the relevant works.

LONG TERM MANAGEMENT

Long Term Management Strategy

50. Within 12 months of the date of this consent the Applicant must prepare a Long Term Management Strategy for the site to the satisfaction of the Planning Secretary. The strategy must:

a) be prepared in consultation with Shellharbour Council, Kiama Council and the CCC;
b) define the objectives and criteria for quarry closure and post-extraction management;
c) investigate options for the future use of the site;
d) describe the measures that would be implemented to minimise or manage the ongoing environmental effects of the development; and
e) describe how the performance of these measures would be monitored over time.

Note: The Long Term Management Strategy may be prepared as part of the Rehabilitation Management Plan.

51. Within 3 years of providing the Long Term Management Strategy to the Planning Secretary, and every 4 years thereafter, the Applicant must review and update the strategy to the satisfaction of the Planning Secretary.

Long Term Management Trust

52. Within 4 years of the date of this consent the Applicant must establish a trust fund (or other mechanism as agreed by the Planning Secretary), that has available by the end of year 20 a minimum of $300,000 for the long term management of the site, to the satisfaction of the Planning Secretary. Every 4 years following establishment of the trust, the Applicant must review, and if necessary revise, the trust sum to the satisfaction of the Planning Secretary. This review must consider:

a) the effects of inflation;
b) any changes to the total area of disturbance; and
c) the performance of the rehabilitation to date.

TRAFFIC AND TRANSPORT

North Kiama Bypass

53. The Applicant must not undertake any product despatch from the development until the completion of the 'Stage 2 – Kiama Bypass' by the TfNSW.

Note: 'Stage 2' refers to the north bound traffic carriageway due for completion in late 2005.

Stage 5 Access

53A. Prior to any heavy vehicle access to the Stage 5 extraction areas, the Applicant must construct a channelised right turn intersection with appropriate line marking from Riverside Drive to the Stage 5A extraction area, to the satisfaction of the relevant roads authority and in accordance with the AustRoads *Guide to Road Design Part 4: Intersections and Crossings –General.*

Road Pavement Dilapidation Report

53B. Prior to the construction of the intersection upgrade described in Condition 53A, the Applicant must:

a) undertake a pre-construction road pavement survey for the section of Riverside Drive that would be subject to heavy vehicle movements associated with the development;
b) identify the likely risk of road pavement failure on Riverside Drive associated with the development;
c) prepare a post-dilapidation survey of the section of Riverside Drive that would be subject to heavy vehicle movements associated with the development within 1 month of the completion of VENM haulage to the Stage 5 area, or other timeframe agreed by the applicable roads authority; and
d) rehabilitate and/or make good any development-related damage identified in the post-dilapidation survey prepared under paragraph (c) within 3 months of completing the post-dilapidation survey, or other timing as may be agreed by the applicable roads authority,

to the satisfaction of the applicable roads authority.

53C. If there is a dispute about the scope of any remedial works or the implementation of works required under condition 53B, then either party may refer the matter to the Planning Secretary for resolution.

Works within the Road Reserve

53D. Prior to the construction of the pipeline within the within the Princes Highway road reserve (including within the culvert), the Applicant must enter into a legally binding agreement with TfNSW, for the construction, operation and decommissioning of the pipeline. The Applicant must pay for the drafting and execution of this legally binding agreement.

53E. The applicant must obtain a Section 138 consent under the *Roads Act 1993* from TfNSW for works associated within the pipeline within the Princes Highway road reserve.

Parking

54. The Applicant must provide sufficient parking on-site for all quarry-related traffic, in accordance with Shellharbour Council's parking codes, and to the satisfaction of the Planning Secretary. All vehicular and pedestrian facilities must be in accordance with the TfNSW's *Guide to Traffic Generating Developments*.

Transport Operating Conditions

55. The Applicant must:

a) keep accurate records of all laden truck movements and rail transport to and from the site (including time of arrival and dispatch);
b) ensure that all laden trucks and trains entering or exiting the site have their loads covered;
c) ensure that all laden trucks exiting the site are cleaned of material that may fall from vehicles, before leaving the site;
d) take all reasonable steps to minimise traffic safety issues and disruption to local road users; and
e) take all reasonable steps to ensure that appropriate signage is displayed on all trucks used to transport quarry products from the development so they can be easily identified by other road users.

Traffic Management Plan

56. Prior to undertaking any construction transportation activities relating to Modification 2, the Applicant must prepare a Traffic Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:

a) be prepared by suitably qualified and experienced person/s whose appointment has been endorsed by the Planning Secretary;
b) be prepared in consultation with TfNSW, Shellharbour Council and Kiama Council;
c) include details of all transport routes and traffic types to be used for development-related traffic;

d) describe the processes in place for the control of truck movements entering and exiting the site;
e) include details of the measures to be implemented to minimise traffic safety issues and disruption to local road users associated with quarry operations;
f) detail the specific protocols to be observed for the construction of ancillary site infrastructure and site preparation works, including hours of operation, traffic controls and mitigation measures to ensure traffic on Riverside Drive is not significantly impeded by site traffic during construction;
g) include a Drivers' Code of Conduct that includes procedures to ensure that drivers:
(iv) adhere to posted speed limits or other required travelling speeds;
(v) adhere to designated transport routes; and
(vi) implement safe and quiet driving practices;
h) describe the measures to be put in place to ensure compliance with the Drivers' Code of Conduct;
i) propose measures to minimise the transmission of dust and tracking of material onto the surface of public roads from vehicles exiting the site;
j) propose measures (such as the installation of inclinometers) to monitor detect any ground movement adjacent to the Princes Highway as a result of the extraction in Stage 5B; and
k) outline the procedures that would be implemented to respond to and address any material ground movements detected under paragraph (j) and demonstrate the long-term stability and safety of stage 5B extraction area on the Princess Highway road reserve.

56A. The Applicant must implement the Traffic Management Plan as approved by the Planning Secretary.

Rail Transport

57. The Applicant must maximise the use of rail transport for delivery/despatch outside the Illawarra Region, to the satisfaction of the Planning Secretary. Details of transportation modes and measures to assess and encourage rail transport must be provided in the Annual Review.

VISUAL IMPACT

58. The Applicant must minimise the visual impacts of the development to the satisfaction of the Planning Secretary.

Tree Screens

59. Prior to the commencement of any works, the Applicant must establish and subsequently maintain a tree screen along the eastern boundary (and northeastern and southeastern boundaries) of Stages 2-4, to the satisfaction of the Planning Secretary.

60. Within 2 months of completing construction of the processing area, the Applicant must establish and subsequently maintain a tree screen around the processing area to the satisfaction of the Planning Secretary.

Landscaping Plan

61. The Applicant must establish the tree screens identified in conditions 59 and 60 in accordance with a Landscaping Plan that has been prepared in consultation with Shellharbour Council and Kiama Council, and to the satisfaction of the Planning Secretary. The plan must be prepared by a suitably qualified ecologist/landscape architect and must:
a) be prepared in accordance with the *Shellharbour Visual Management Plan User Manual*;
b) comprise a full range of Swamp Oak Floodplain Forest species;
c) provide for the planting of trees of sufficient maturity that will ensure the prompt screening of the site;
d) provide for a sufficient planting width and density to ensure that the site will be effectively screened when viewed from the Princes Highway and residential areas.

Lighting Emissions

62. The Applicant must take all practicable measures to prevent and/or minimise any off-site lighting impacts from the development.

63. All external lighting associated with the development must comply with *Australian Standard AS4282 (INT) 1995 – Control of Obtrusive Effects of Outdoor Lighting*.

WASTE MANAGEMENT

Waste Minimisation

64. The Applicant must
   a) manage on-site sewage treatment and disposal in accordance with the requirements of an applicable EPL, and to the satisfaction of EPA and Shellharbour Council;
   b) minimise the waste generated by the development;
   c) ensure that the waste generated by the development is appropriately stored, handled, and disposed of; and
   d) report on waste minimisation and management in the Annual Review.

Backfilling Material

65. [7] The Applicant must use VENM for the purpose of void backfilling.

Note: The definition of VENM may include soil that has been assessed by a certified practicing soil scientist in accordance with the Acid Sulfate Soil Management Advisory Council guidelines and determined to be Potential Acid Sulfate Soil (PASS) and which satisfies all of the requirements for classification as VENM, except that it contains sulfidic soils, that has been approved by EPA for disposal on the site, and that is managed in accordance with the procedures in the EPL for the development.

66. [8]Backfilling of the voids must be undertaken in a manner, and with material with suitable physical characteristics, so that it does not significantly affect the direction or rate of groundwater flow from the site.

67. [9]All fines separated from the dredged sand must be placed below the permanent water table within 12 hours of processing the dredged sand.

VENM Receipt and Processing

67A. The Applicant must not process and/or blend more than 120,000 tonnes of VENM per annum.

67B. Except as expressly permitted in an applicable EPL, specific resource recovery order or exemption under the *Protection of the Environment Operations (Waste) Regulation 2014*, the Applicant must not receive waste at the site for storage, treatment, processing or reprocessing.

Waste Management Plan

68. [10]Within 12 months of the date of this consent the Applicant must prepare and subsequently implement a Waste Management Plan for the development, in consultation with EPA, and to the satisfaction of the Planning Secretary. The plan must include:
   a) VENM receival and acceptance, processing and blending procedures;
   b) procedures for the management of fines from the processing plant;
   c) procedures for managing potential acid sulfate soils; and
   d) procedures for minimising and managing other wastes generated by the development.

68A. The Applicant must implement the Waste Management Plan as approved by the Planning Secretary.

BUSHFIRE MANAGEMENT

69. The Applicant must:
   a) ensure that the development:
      (i) provides for asset protection in accordance with the relevant requirements in *the Planning for Bushfire Protection* (RFS, 2019) guideline; and
      (ii) ensure that there is suitable equipment to respond to any fires on the site; and
   b) assist the RFS and emergency services to the extent practicable if there is a fire in the vicinity of the site.

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[7] Incorporates EPA GTA
[8] Incorporates EPA GTA
[9] Incorporates EPA GTA
[10] Incorporates EPA GTA

EMERGENCY AND HAZARDS MANAGEMENT

Dangerous Goods

70. The Applicant must ensure that the storage, handling, and transport of dangerous goods is conducted in accordance with the relevant Australian Standards, particularly AS1940 and AS1596, and the Dangerous Goods Code.

Safety

71. The Applicant must secure the development to ensure public safety to the satisfaction of the Planning Secretary.

PRODUCTION DATA

72. The Applicant must:
    a) provide annual production data to the MEG using the standard form for that purpose; and
    b) include a copy of this data in the Annual Review.

SCHEDULE 4
ADDITIONAL PROCEDURES

ADDITIONAL MITIGATION UPON REQUEST

1. Upon receiving a written request from the owner of any residence on the land listed in Table 7, the Applicant must implement additional noise mitigation measures (such as double-glazing, insulation and/or air conditioning) at the residence in consultation with the landowner.

Table 7: Land subject to additional mitigation upon request

Mitigation Basis	***Land***
Noise	79 Fig Hill Lane, Dunmore

Note: To interpret the land referred to in Table 7, see the applicable figure in Appendix 3.

These measures must be reasonable and feasible, consistent with the measures outlined in the *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Development (NSW Government, 2014),* proportionate to the level of predicted impact and directed towards reducing the noise impacts of the development.

2. If within 3 months of receiving this request from the owner, the Applicant and the owner cannot agree on the measures to be implemented, or there is a dispute about the implementation of these measures, then either party may refer the matter to the Planning Secretary for resolution.

NOTIFICATION OF LANDOWNERS/TENANTS

3. Within one month of the date of this consent, the Applicant must notify in writing the owner of the residences on the land listed in Table 7 that they are entitled to ask the Applicant to install additional mitigation measures at the residence.

4. Prior to entering into any tenancy agreement for any land owned by the Applicant that is predicted to experience exceedances of the recommended dust and/or noise criteria, the Applicant must:
   a) advise the prospective tenants of the potential health and amenity impacts associated with living on the land, and give them a copy of the fact sheet entitled “Mine Dust and You” (NSW Health, 2017); and
   b) advise the prospective tenants of the rights they would have under this consent,

   to the satisfaction of the Planning Secretary.

NOTIFICATION OF EXCEEDANCES

5. As soon as practicable and no longer than 7 days after obtaining monitoring results showing an exceedance of any noise or air quality criterion in Schedule 3 of this consent, the Applicant must provide the details of the exceedance to any affected landowners, tenants and the CCC.

6. For any exceedance of any air quality criterion in Schedule 3 of this consent, the Applicant must also provide to any affected land owners and/or tenants a copy of the fact sheet entitled “Mine Dust and You” (NSW Health, 2017).

INDEPENDENT REVIEW

7. If a landowner considers the development to be exceeding any relevant noise or air quality criterion in Schedule 3 of this consent, they may ask the Planning Secretary in writing for an independent review of the impacts of the development on their residence or land.

8. If the Planning Secretary is not satisfied that an independent review is warranted, the Planning Secretary will notify the landowner in writing of that decision, and the reasons for that decision, within 21 days of the request for a review.

9. If the Planning Secretary is satisfied that an independent review is warranted, within 3 months, or other timeframe agreed by the Planning Secretary and the landowner, of the Planning Secretary’s decision, the Applicant must:
   a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:
      (i) consult with the landowner to determine their concerns;
      (ii) conduct monitoring to determine whether the development is complying with the relevant criterion in Schedule 3 of this consent; and

(iii) if the development is not complying with the relevant criterion, identify measures that could be implemented to ensure compliance with the relevant criterion; and

b) give the Planning Secretary and landowner a copy of the independent review; and

c) comply with any written requests made by the Planning Secretary to implement any findings of the review.

SCHEDULE 5
ENVIRONMENTAL MANAGEMENT, REPORTING AND AUDITING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. If the Planning Secretary requires, the Applicant must prepare an Environmental Management Strategy for the development to the satisfaction of the Planning Secretary. This strategy must:
   a) be submitted to the Planning Secretary for approval within 6 months of the Planning Secretary requiring preparation of the strategy by notice to the Applicant;
   b) provide the strategic framework for the environmental management of the development;
   c) identify the statutory approvals that apply to the development;
   d) describe the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the development;
   e) describe the procedures that would be implemented to:
      - keep the local community and relevant agencies informed about the operation and environmental performance of the development;
      - receive, handle, respond to, and record complaints;
      - resolve any disputes that may arise during the course of the development;
      - respond to any non-compliance and any incident; and
      - respond to emergencies; and
   f) include:
      - references to any strategies, plans and programs approved under the conditions of this development consent; and
      - a clear plan depicting all the monitoring to be carried out under the conditions of this consent.

1A. The Applicant must implement the Environmental Management Strategy as approved by the Planning Secretary.

Management Plan Requirements

2. The Applicant must ensure that the Management Plans required under this consent are prepared in accordance with any relevant guidelines, and include:
   a) detailed baseline data;
   b) a description of:
      - the relevant statutory requirements (including any relevant approval, licence or lease conditions);
      - any relevant limits or performance measures/criteria; and
      - the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;
   c) any relevant commitments or recommendations identified in the document/s listed in condition 2(c) of Schedule 2;
   d) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;
   e) a program to monitor and report on the:
      - impacts and environmental performance of the development; and
      - effectiveness of any management measures (see (c) above);
   f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;
   g) a program to investigate and implement ways to improve the environmental performance of the development over time;
   h) a protocol for managing and reporting any:
      - incidents;
      - complaints;
      - non-compliances with statutory requirements; and
      - exceedances of the impact assessment criteria and/or performance criteria; and
   i) a protocol for periodic review of the plan.

   Note: The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.

Revision of Strategies, Plans & Programs

3. Within 3 months of:
   a) the submission of an incident report under condition 7 below;
   b) the submission of an Annual Review under condition 9 below;
   c) the submission of an audit report under condition 10 below; and
   d) the approval of any modifications to this consent (unless the conditions require otherwise),

   the Applicant must review the suitability of existing strategies, plans, and programs required under this consent.

4. If necessary to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans, and programs required under this consent must be revised, to the satisfaction of the Planning Secretary and submitted to the Planning Secretary for approval within six weeks of the review.

Note: This is to ensure the strategies, plans and programs are updated on a regular basis, and incorporate any recommended measures to improve the environmental performance of the development.

Adaptive Management

5. The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the criteria and/or performance measures in Schedule 3. Any exceedance of these criteria and/or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.

Where any exceedance of these criteria and/or performance measures has occurred, the Applicant must, at the earliest opportunity:

a) take all reasonable and feasible measures to ensure that the exceedance ceases and does not recur;
b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
c) implement remediation measures as directed by the Planning Secretary,

to the satisfaction of the Planning Secretary.

COMMUNITY CONSULTATIVE COMMITTEE

6. The Applicant must operate a Community Consultative Committee (CCC) for the development, to the satisfaction of the Planning Secretary. This CCC must be operated in general accordance with the *Guidelines for Establishing and Operating Community Consultative Committees for Mining Projects* (Department of Planning, 2007, or its latest version)

Notes:

- *The CCC is an advisory committee. The Department and other relevant agencies are responsible for ensuring that the Applicant complies with this consent.*
- *In accordance with the guideline, the committee should be comprised of an independent chair and appropriate representation from the Applicant, Council, and the local community.*
- *The requirement for this CCC may be fulfilled by a regional CCC for any two or more of Boral's quarrying operations in the South Coast area.*

REPORTING

Incident Notification

7. The Applicant must immediately notify the Department and any other relevant agencies immediately after it becomes aware of an incident. The notification must be in writing through the Department's Major Projects Website and identify the development (including the development application number and name) and set out the location and nature of the incident.

Non-Compliance Notification

7A. Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The notification must be in writing through the Department's Major Projects Website and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, why it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

Note: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.

Regular Reporting

8. The Applicant must provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this consent.

ANNUAL REVIEW

9. By the end of September each year, or other timing as may be agreed by the Planning Secretary, the Applicant must review the environmental performance of the development to the satisfaction of the Planning Secretary. This review must:

a) describe the development (including rehabilitation) that was carried out in the previous financial year, and the development that is proposed to be carried out over the current financial year;
b) include a comprehensive review of the monitoring results and complaints records of the development over the previous financial year, which includes a comparison of these results against:
   - the relevant statutory requirements, limits or performance measures/criteria;

- requirements of any plan or program required under this consent;
- the monitoring results of previous years; and
- the relevant predictions in the documents listed in condition 2(c) of Schedule 2;

c) identify any non-compliance or incident which occurred in the previous financial year, and describe what actions were (or are being) taken to rectify the non-compliance and avoid reoccurrence;

d) evaluate and report on:
- the effectiveness of the noise and air quality management systems; and
- compliance with the performance measures, criteria and operating conditions of this consent;

e) identify any trends in the monitoring data over the life of the development;

f) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and

g) describe what measures will be implemented over the current financial year to improve the environmental performance of the development.

The Applicant must ensure that copies of the Annual Review are submitted to the Planning Secretary and Council and are available to the Community Consultative Committee (see condition 6 of Schedule 5) and any interested person upon request.

INDEPENDENT ENVIRONMENTAL AUDIT

10. By 30 September 2017, and every 3 years thereafter, unless the Planning Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development. This audit must:
    a) be conducted by suitably qualified, experienced and independent team of experts whose appointment has been endorsed by the Planning Secretary;
    b) include consultation with the relevant agencies and the CCC;
    c) assess the environmental performance of the development and whether it is complying with the relevant requirements in this consent and any relevant EPL and/or Water Licence (including any assessment, plan or program required under these approvals);
    d) review the adequacy of any approved strategy, plan or program required under these approvals; and
    e) recommend measures or actions to improve the environmental performance of the development, and/or any assessment, plan or program required under these approvals.

    Note: This audit team must be led by a suitably qualified auditor and include experts in any fields specified by the Planning Secretary.

11. Within 6 weeks of commissioning this audit, or as otherwise agreed by the Planning Secretary, the Applicant must submit a copy of the audit report to the Planning Secretary, Council, EPA and any other NSW agency that requests it, together with its response to any recommendations contained in the audit report, and a timetable for the implementation of the recommendations. The recommendations must be implemented to the satisfaction of the Planning Secretary.

ACCESS TO INFORMATION

12. By 30 November 2016, unless otherwise agreed by the Planning Secretary, the Applicant must:
    a) make the following information publicly available on its website:
    - the documents listed in condition 2(c) of Schedule 2;
    - current statutory approvals for the development;
    - approved strategies, plans or programs;
    - a summary of the monitoring results of the development, which have been reported in accordance with the various plans and programs approved under the conditions of this consent;
    - minutes of CCC meetings;
    - a summary of the current phase and progress of the development;
    - contact details to enquire about the development or to make a complaint;
    - a complaints register, which is to be updated on a monthly basis;
    - the Annual Reviews of the development;
    - reports prepared as part of any independent environmental audit, and the Applicant's response to the recommendations in any audit report;
    - any other matter required by the Planning Secretary; and

    b) keep this information up-to-date,

    to the satisfaction of the Planning Secretary.

APPENDIX 1

DEVELOPMENT LAYOUT PLAN

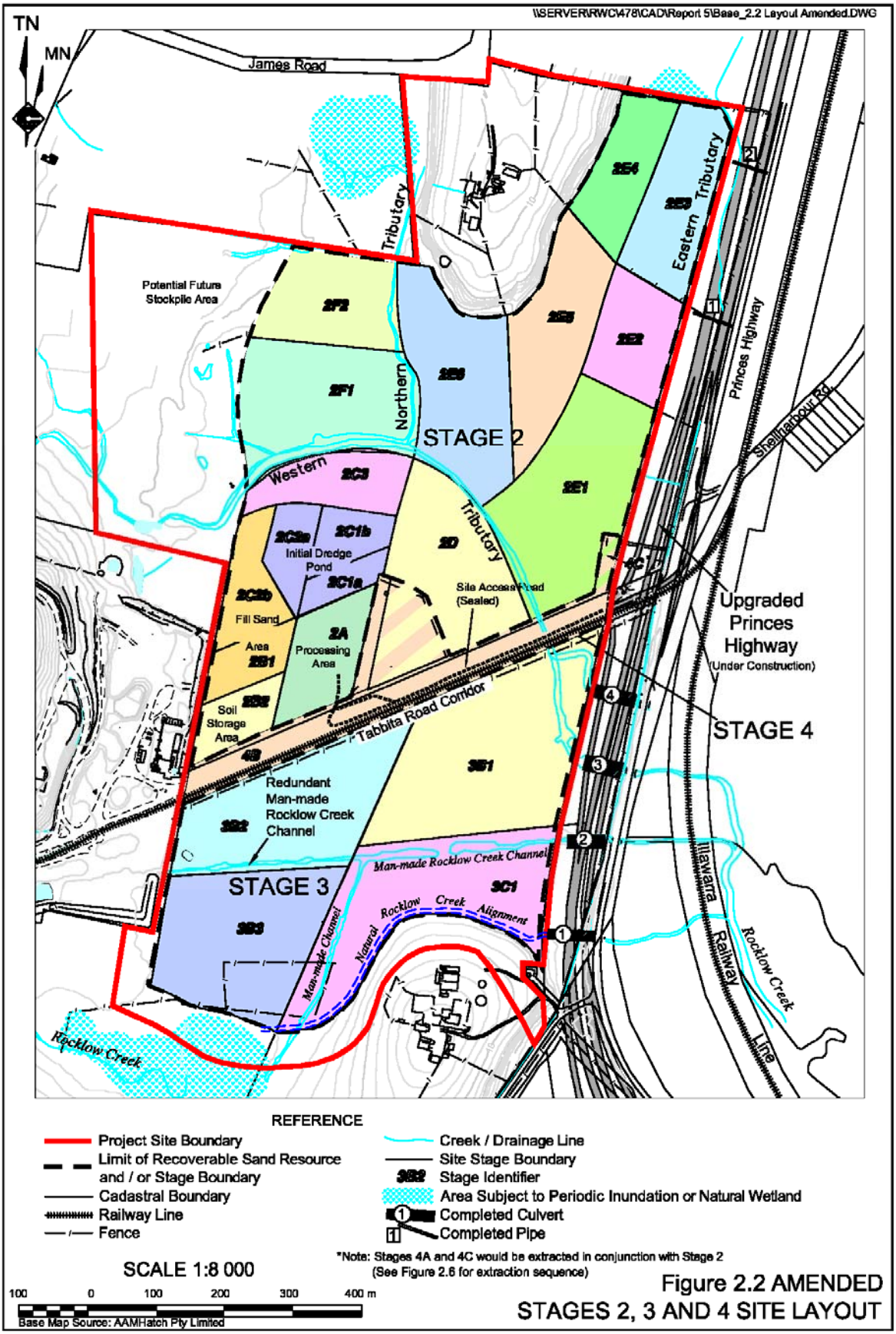
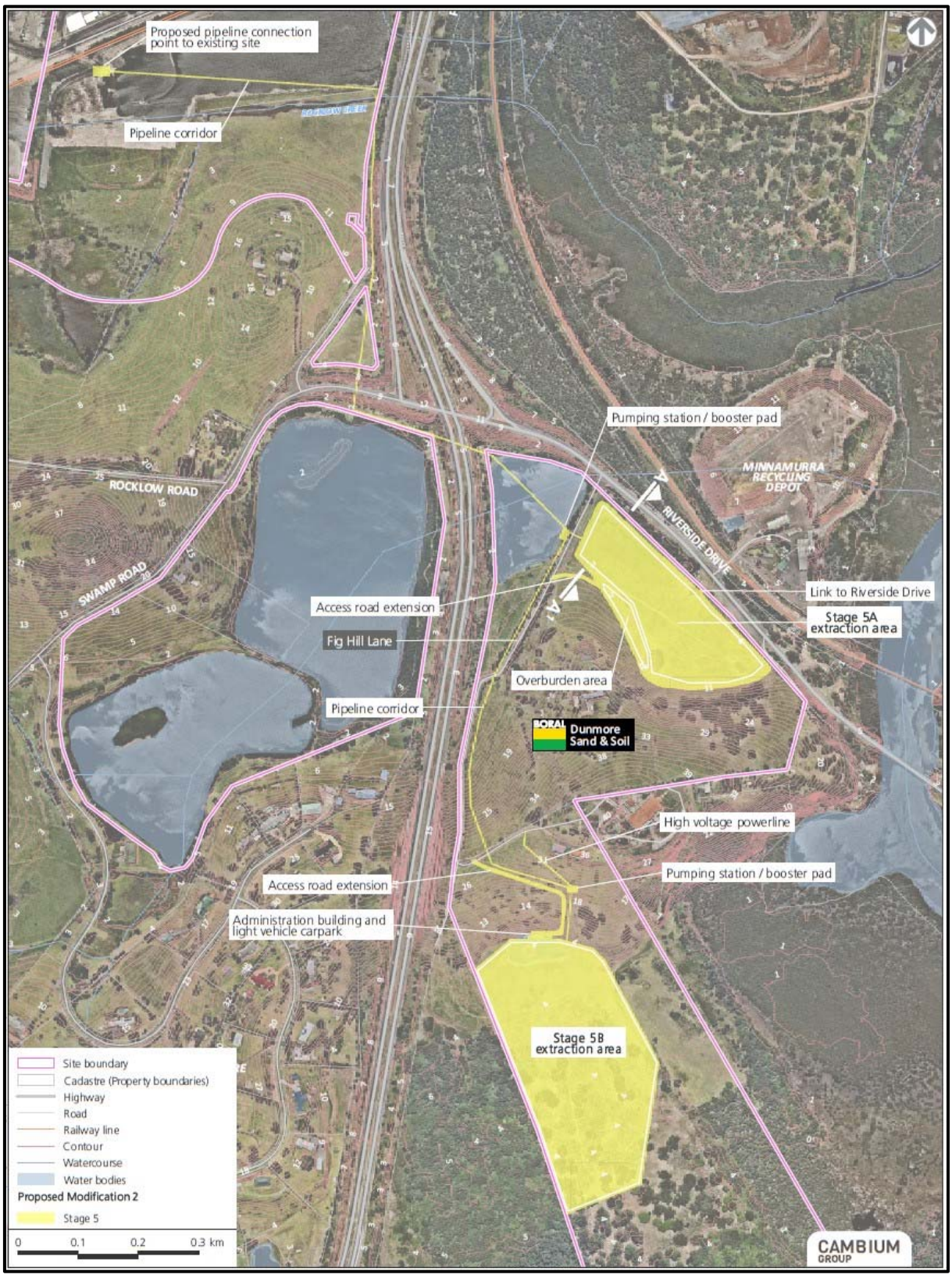


Figure 2.2 AMENDED STAGES 2, 3 AND 4 SITE LAYOUT


Proposed pipeline connection point to existing site
Pipeline corridor
ROCKLOW ROAD
SWAMP ROAD
Pumping station / booster pad
MINNAMURRA RECYCLING DEPOT
RIVERSIDE DRIVE
Link to Riverside Drive
Stage 5A extraction area
Access road extension
Fig Hill Lane
Overburden area
Pipeline corridor
BORAL Dunmore Sand & Soil
High voltage powerline
Pumping station / booster pad
Access road extension
Administration building and light vehicle carpark
Stage 5B extraction area
Site boundary
Cadastre (Property boundaries)
Highway
Road
Railway line
Contour
Watercourse
Water bodies
Proposed Modification 2
Stage 5
0
0.1
0.2
0.3 km
CAMBIUM GROUP

APPENDIX 2

CONCEPT FINAL LANDFORM

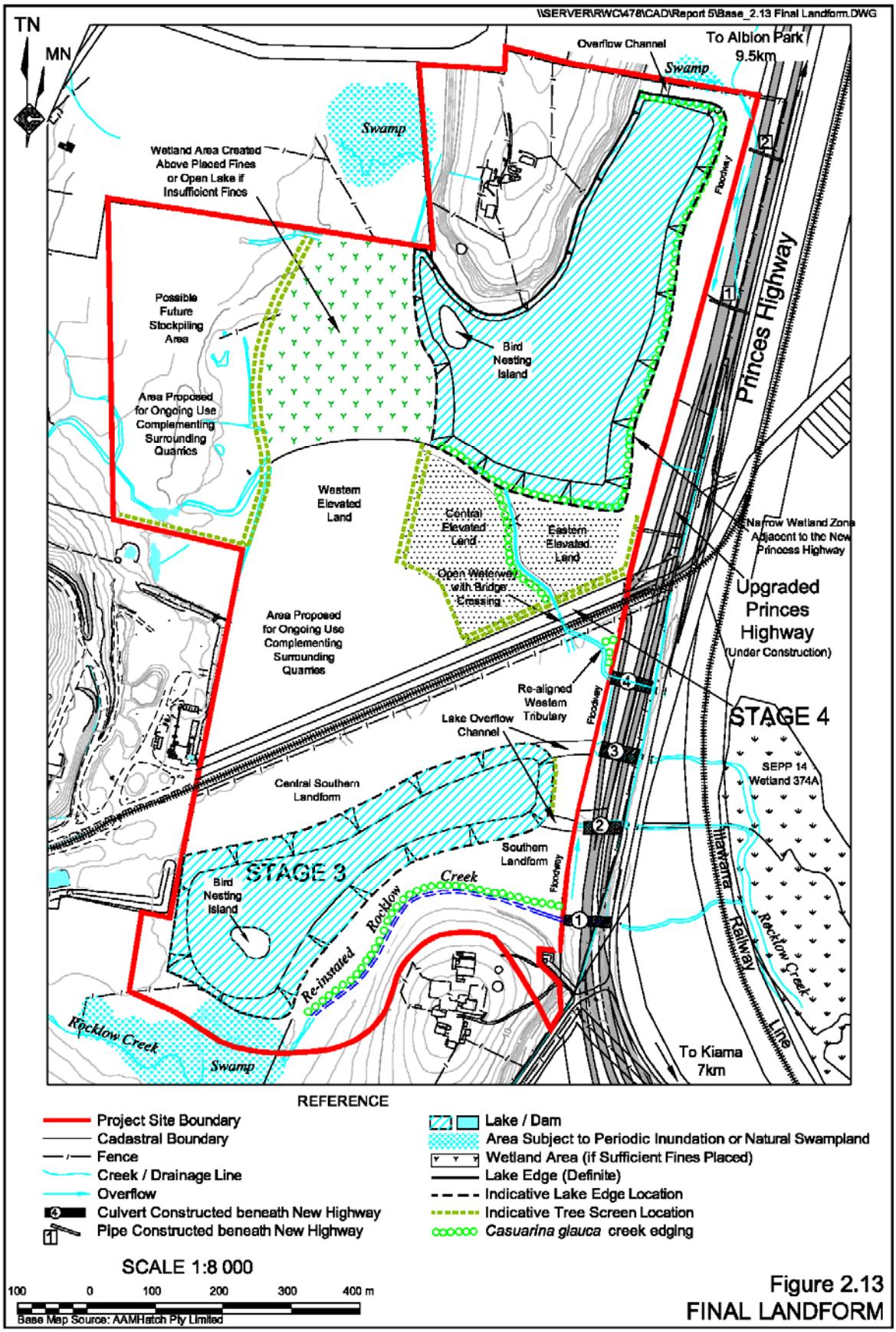
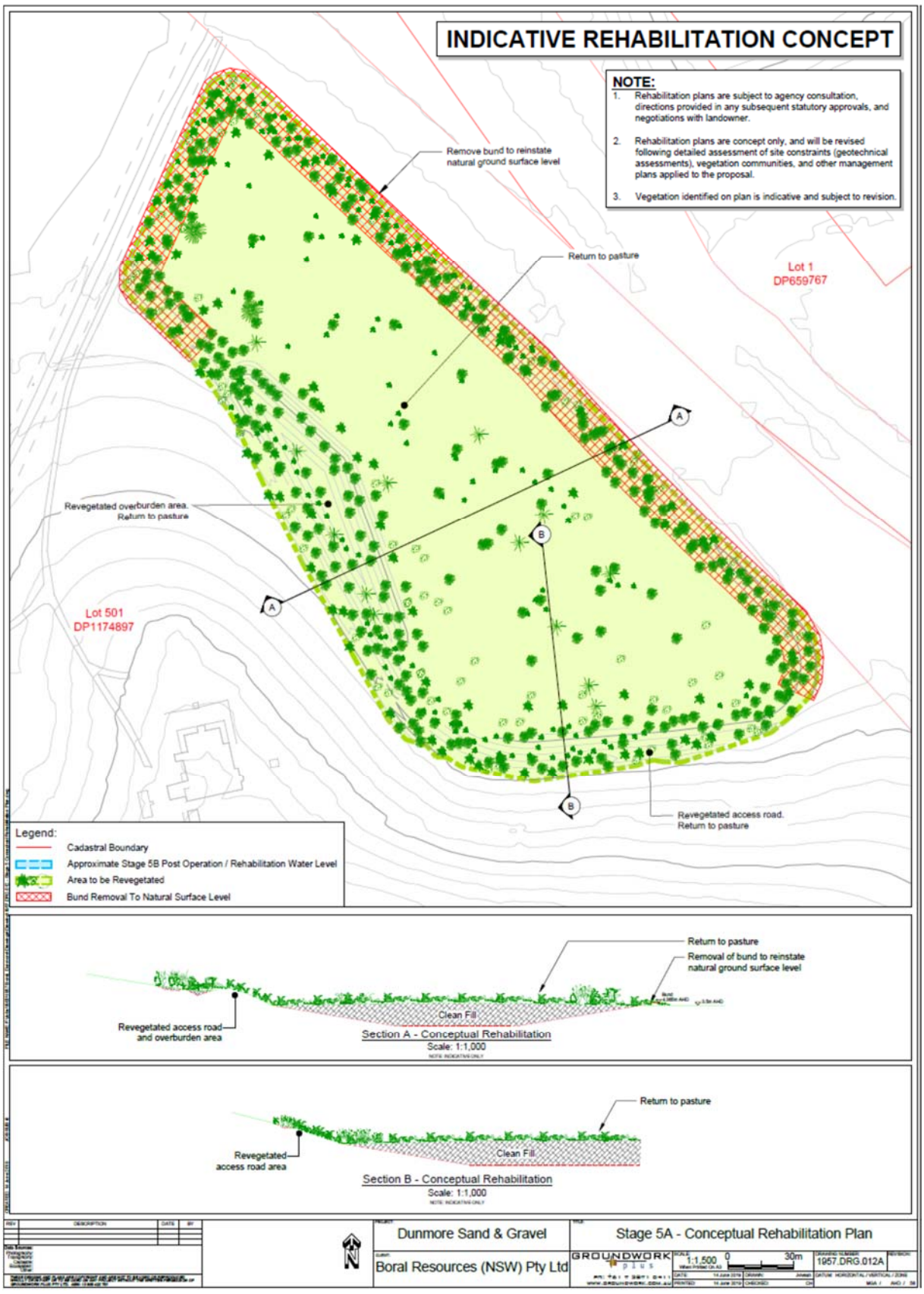
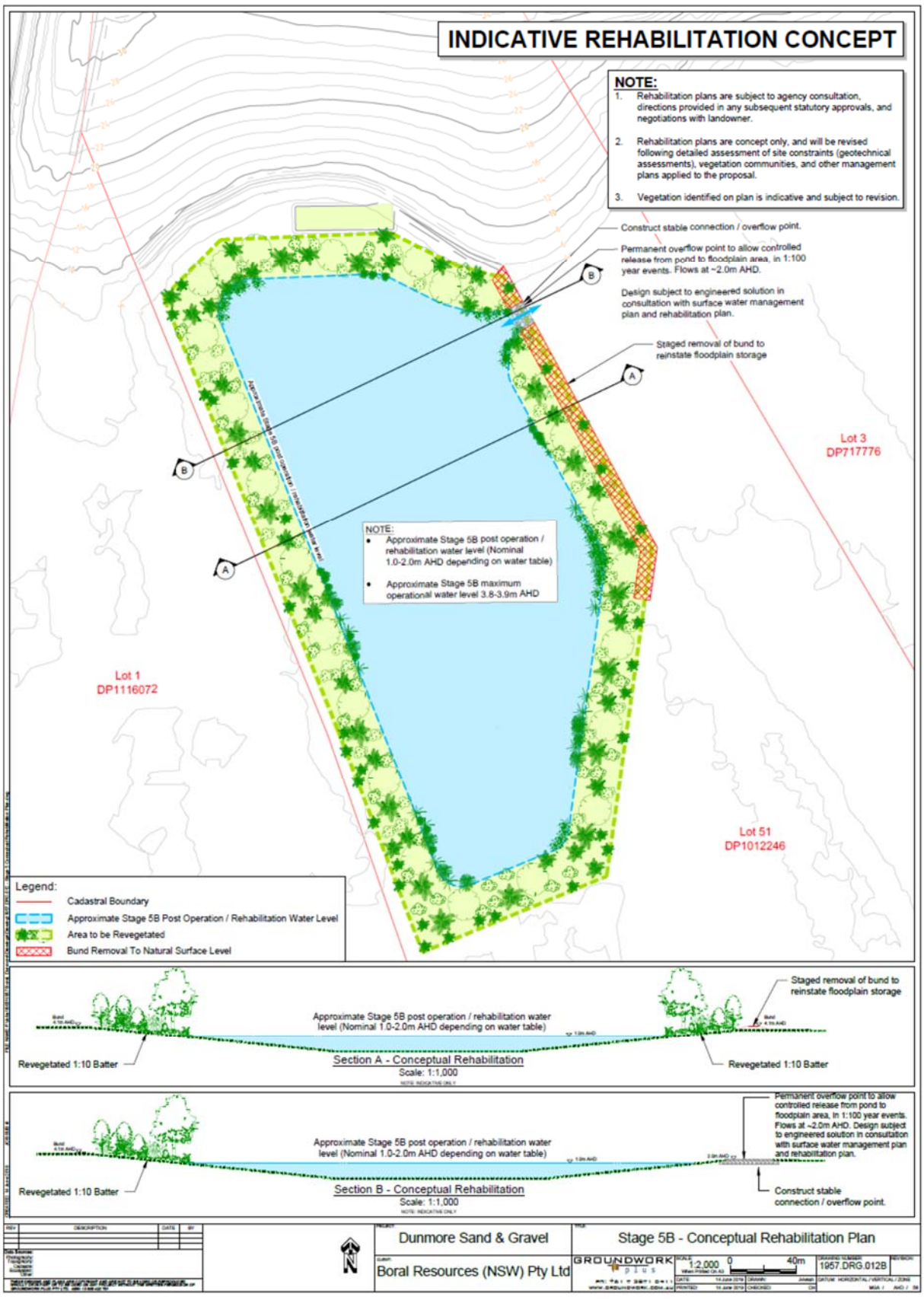


Figure 2.13
FINAL LANDFORM


INDICATIVE REHABILITATION CONCEPT
NOTE:
1. Rehabilitation plans are subject to agency consultation, directions provided in any subsequent statutory approvals, and negotiations with landowner.
2. Rehabilitation plans are concept only, and will be revised following detailed assessment of site constraints (geotechnical assessments), vegetation communities, and other management plans applied to the proposal.
3. Vegetation identified on plan is indicative and subject to revision.
Remove bund to reinstate natural ground surface level
Return to pasture
Lot 1 DP659767
Revegetated overburden area. Return to pasture
Lot 501 DP1174897
Revegetated access road. Return to pasture
A
B
Legend:
Cadastral Boundary
Approximate Stage 5B Post Operation / Rehabilitation Water Level
Area to be Revegetated
Bund Removal To Natural Surface Level
Return to pasture
Removal of bund to reinstate natural ground surface level
Clean Fill
Revegetated access road and overburden area
Section A - Conceptual Rehabilitation
Scale: 1:1,000
Return to pasture
Clean Fill
Revegetated access road area
Section B - Conceptual Rehabilitation
Scale: 1:1,000
Dunmore Sand & Gravel
Boral Resources (NSW) Pty Ltd
Stage 5A - Conceptual Rehabilitation Plan
GROUNDWORK plus
1:1,500
0
30m
1957.DRG.012A


INDICATIVE REHABILITATION CONCEPT
NOTE:
1. Rehabilitation plans are subject to agency consultation, directions provided in any subsequent statutory approvals, and negotiations with landowner.
2. Rehabilitation plans are concept only, and will be revised following detailed assessment of site constraints (geotechnical assessments), vegetation communities, and other management plans applied to the proposal.
3. Vegetation identified on plan is indicative and subject to revision.
Construct stable connection / overflow point.
Permanent overflow point to allow controlled release from pond to floodplain area, in 1:100 year events. Flows at ~2.0m AHD.
Design subject to engineered solution in consultation with surface water management plan and rehabilitation plan.
Staged removal of bund to reinstate floodplain storage
Lot 3 DP717776
NOTE:
• Approximate Stage 5B post operation / rehabilitation water level (Nominal 1.0-2.0m AHD depending on water table)
• Approximate Stage 5B maximum operational water level 3.8-3.9m AHD
Lot 1 DP1116072
Lot 51 DP1012246
Legend:
Cadastral Boundary
Approximate Stage 5B Post Operation / Rehabilitation Water Level
Area to be Revegetated
Bund Removal To Natural Surface Level
Staged removal of bund to reinstate floodplain storage
Approximate Stage 5B post operation / rehabilitation water level (Nominal 1.0-2.0m AHD depending on water table)
Revegetated 1:10 Batter
Section A - Conceptual Rehabilitation
Scale: 1:1,000
Revegetated 1:10 Batter
Permanent overflow point to allow controlled release from pond to floodplain area, in 1:100 year events. Flows at ~2.0m AHD. Design subject to engineered solution in consultation with surface water management plan and rehabilitation plan.
Approximate Stage 5B post operation / rehabilitation water level (Nominal 1.0-2.0m AHD depending on water table)
Revegetated 1:10 Batter
Section B - Conceptual Rehabilitation
Scale: 1:1,000
Construct stable connection / overflow point.
Dunmore Sand & Gravel
Boral Resources (NSW) Pty Ltd
Stage 5B - Conceptual Rehabilitation Plan
GROUNDWORK plus
1:2,000
0
40m
1957.DRG.012B

APPENDIX 3
STAGE 5 NOISE RECEIVER LOCATIONS

Appendix C

NRAR correspondence – works approvals

Jason O'Brien

To: Brian Gardoll
Subject: RE: Dunmore Sand and Soil Pty Limited - Miscellaneous Work - 10MW119332

From: Heather Dewson <heather.dewson@dpie.nsw.gov.au>
Sent: Friday, 2 July 2021 4:11 PM
To: Brian Gardoll <bgardoll@emmconsulting.com.au>
Subject: Dunmore Sand and Soil Pty Limited - Miscellaneous Work - 10MW119332

Hi Brian

I confirm that miscellaneous work **10MW119332** is created and ready for the dealing to link the water access licence.

Kind regards

Heather Dewson | Water Regulation Officer

Natural Resources Access Regulator

Department of Planning, Industry & Environment

6 Stewart Ave Newcastle NSW 2300

T: 1800 633 362

E: heather.dewson@dpie.nsw.gov.au

W: www.industry.nsw.gov.au

Jason O'Brien

To: Brian Gardoll
Subject: RE: Dunmore Sand and Soil Pty Limited - Miscellaneous Work

---

From: Brian Gardoll <bgardoll@emmconsulting.com.au>
Sent: Thursday, 1 July 2021 12:12 PM
To: Heather Dewson <heather.dewson@dpie.nsw.gov.au>
Cc: Ben Williams <Ben.Williams@boral.com.au>; Jason O'Brien <jobrien@emmconsulting.com.au>
Subject: RE: Dunmore Sand and Soil Pty Limited - Miscellaneous Work

Hi Heather

Yes all good here thanks and thanks for the update.

Details requested for Dunmore are;

Dunmore Sand and Soil Pty Limited
38 Tabbita Road
Dunmore NSW 2529

Cheers
Brian

Brian Gardoll
Associate Director Water Regulation

T 02 4907 4800
M 0409 151 596
www.emmconsulting.com.au

From: Heather Dewson <heather.dewson@dpie.nsw.gov.au>
Sent: Thursday, 1 July 2021 10:36 AM
To: Brian Gardoll <bgardoll@emmconsulting.com.au>
Subject: Dunmore Sand and Soil Pty Limited - Miscellaneous Work

Hi Brian

I hope you are well.

Re the miscellaneous work, could you please confirm the exact name and address of the company?

We are having difficulties with our database system and will not be able to produce the miscellaneous work until it is fixed. I am hoping it will be within the next week, but I will let you know if it is taking any longer.

Regards

Heather Dewson | Water Regulation Officer

Natural Resources Access Regulator

Department of Planning, Industry & Environment

6 Stewart Ave Newcastle NSW 2300

T: 1800 633 362

E: heather.dewson@dpie.nsw.gov.au

W: www.industry.nsw.gov.au

From: NRAR Service Desk Mailbox <nrar.servicedesk@dpie.nsw.gov.au>
Sent: Thursday, 1 July 2021 10:26 AM
To: Brian Gardoll <bgardoll@emmconsulting.com.au>
Subject: RE: [ADVICE O365 - NEW] FIN0504367 : NRAR- Dunmore Sand and Soil Pty Limited - Miscellaneous Work trk:01440000021

Dear Brian

Thank you for contacting the Natural Resources Access Regulator (NRAR). We have registered your request , reference number is V19/2184#6 . Please include this reference number for any future communications.

Should you require any further assistance or information, please do not hesitate to contact our team nrar.servicedesk@dpie.nsw.gov.au

Yours sincerely

Shailja

---------- Original Message ----------
From: nrar.servicedesk@dpie.nsw.gov.au <nrar.servicedesk@dpie.nsw.gov.au>;
Received: Mon Jun 21 2021 09:46:58 GMT+1000 (Australian Eastern Standard Time)
To: nrar.servicedesk@dpie.nsw.gov.au <nrar.servicedesk@dpie.nsw.gov.au>; NRAR Service Desk <nrar.servicedesk@dpie.nsw.gov.au>;
Subject: [ADVICE O365 - NEW] FIN0504367 : NRAR- Dunmore Sand and Soil Pty Limited - Miscellaneous Work

Reg Coord - Service Support Team
Natural Resources Access Regulator | Lands & Water Division | Department of Planning, Industry & Environment

Locked Bag 5022, Parramatta NSW 2124

T: 1800 633 362

E: nrar.servicedesk@dpie.nsw.gov.au
W: www.industry.nsw.gov.au/nrar

To contact the NRAR Hotline and make a suspicious activity report call: 1800 633 362

Read the NRAR Progress Report 2019-20

The Department of Planning, Industry and Environment acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically

---

From: CS Connect Service Centre <cspconnect@service-now.com>
Sent: Friday, 18 June 2021 10:31 AM
To: NRAR Service Desk Mailbox <nrar.servicedesk@dpie.nsw.gov.au>
Subject: FIN0504367 : NRAR- Dunmore Sand and Soil Pty Limited - Miscellaneous Work

received from: bgardoll@emmconsulting.com.au

EMM Consulting make the following representation on behalf of our client Dunmore Sand and Soil Pty Limited (Dunmore), just north of Kiama.

Dunmore have been granted Development Consent for quarrying operations as a State Significant Development under section 76A(7)(d) of the Environmental Planning and Assessment Act, 1979 (refer to DA 195-8-2004).

Under 4.41(1)(g) of that Act, Dunmore are exempt from requiring either Water Use Approval or Water Management Work Approval under the Water Management Act, 2000.

However to allow for the "take" of water and the accounting and billing requirements a work must be nominated on their existing Water Access Licences (WALs).

We therefore request the issue of a Miscellaneous Work number to facilitate the processes to meet these requirements.

Please contact the undersigned by mobile in the first instance if further information or clarification is required.

Regards
Brian

Brian Gardoll
Associate Director Water Regulation

[cid:image001.png@01D76394.378483E0]<http://www.emmconsulting.com.au/>

T 02 4907 4800
M 0409 151 596

[https://lh6.googleusercontent.com/KDjD48DQ_ukPTPFURZtu9D-hy3jVpuxohANts_N87B0E_hILTU9siWq2DBLB4kZaQ2O1Dw5YQ9bMtESUa5EFDu8qtgukuiHgckViU8n1krguSj8flAJEfmpdjzfUfA17g]<https://au.linkedin.com/company/emm-consulting-pty-limited> Connect with us

NEWCASTLE | Level 3, 175 Scott Street, Newcastle NSW 2300

Ref:MSG3203029_XSAhMmMJkgBpmrFdZAdp

Appendix D

Flood mapping (SEEE 2019b)

southeast
engineering+environmental
PO Box 96 Moruya NSW 2537
Tel. 02 44744 439 - Mbl. 0450 154 441

20 September 2019

Adnan Voloder

Boral Land & Property Group
PO Box 6041
North Ryde NSW 2113

Re: DPIE Submissions for proposed Modification 2 of the Dunmore lakes Sand Project – Email from Boral 14/08/2019

Background

DPIE and Shellharbour Council have provided submissions regarding the proposed Modification 2 of the Dunmore Lakes Sand Project. This submissions relate to water quality and flooding issues addressed in the Surface Water Assessment prepared by Southeast Engineering and Environmental. (Table 1).

Table 1 Summary of submission issues and response.

Party	Issue outlined in submission.	Response
DPIE (29/07/19)	*Consideration to be given to dam break scenarios.*	A risk assessment and consequence category has been estimated for the Stage 5A embankment, and D1 form submitted to DSC. Preliminary consequence category for both sunny day and flood failure are low to very low. Awaiting response from DSC. Refer to attached email correspondence and D1 form.
	Quantification of changes in flood levels under the different ARI events;	The 5, 20, 100 year ARI and PMF events have been modelled for the existing and proposed conditions for both Stage 5A and 5B. Key impacts are: • For 5A, a 16mm increase over Riverside Drive in the 5 year ARI event and smaller increases in other events. Refer to Appendix A. • For 5B, no impacts beyond the site boundary. Approximately 45mm increase in flood height for the 100 year ARI event at the southern end of the bunded dredge pond. A large (1.6m/s) increase in flood velocity over the dredge pond spillway will occur in a PMF event. Appendix A contains comparison of pre and post flood characteristics. Refer to sections 3 and 4 of the Surface Water Assessment for more detail.
	Identification of any new areas that would be subject to flooding;	Refer to flood mapping provided in Appendix A. These include Figures 41 – 44 which show the extent of flooding for the 5, 20, 100 ARI and PMF events. The largest changes are within the proposed basins, this is due to the starting conditions of the model runs which start with the ponds overflowing slightly. Beyond the basins the largest change in extents is associated with the 5year ARI event, refer to figure 37 which shows the largest change in depth to the west of Stage 5A of between 40-50mm. Figure 41 shows the associated slight change in extents. For the large events changes to flood extents are confined to the pond areas and are due to the aforementioned model starting conditions.
	Discussion of the impact of any introduced hardstand areas	The hardstand (carpark) area proposed to the north of the Stage 5B dredge pond is located above the PMF flood level at approximately 5.5m AHD. The PMF peak flood level is 5.2m AHD. The introduced hardstand area has no impact on flooding.
	Discussion of potential flood impacts having regard to any applicable Council requirements.	Updated flood modelling has been undertaken making use of a hydrologic and hydraulic model commissioned by Kiama Municipal Council for the proposed Minnamurra River shared user pathway. The model assumes 100% blockage at Riverside Drive. Model background and

		assumptions used can be found in *Flood and Coastal Study, Stage 2 Report, Minnamurra River Boardwalk* (Cardno, 2019). Spillway design will be undertaken to accommodate 100 year ARI and PMF flood depths and velocities. Water levels within bunded areas will generally be similar to adjacent water levels though ground water or flood flow overtopping impacts. Periods of difference in water level between dredge ponds and outer environment will be limited as ponds will be emptied to allow for dredge operations to resume. *Shellharbour Council DCP.* *A9.6 – Filling of Floodprone land* *a. There is no significant increase in flood levels up to the PMF event.* Refer to figures in Appendix A. Largest change is increase in the 5 year ARI event by 50mm over rural land to the west, and 16mm increase in flood level over the Riverside Drive in the 5 year ARI event. Smaller changes for larger events. Not significant in the context of change in height and land use. *b. There is no significant impacts upon flood behaviour on other properties* As outlined in the Surface Water Assessment and this letter, changes in flood height, extents and velocities are not significant. *c. There is no increase in risk to life up to the PMF event* The largest change in flood behaviour over land where people are likely to be located is a 16mm increase in flood level over Riverside Drive in the 5 year ARI event. Changes to flood level in this area for larger events are negligible. Refer to sections 3.0 and 4.0 of the SWA (Version F) for detail on the updated flood modelling, and Appendix A of this letter for flood modelling results.
Shellharbour Council (Appendix 1, 09/08/19) .	1. Hazard maps for the PMF missing.	Pre and post development maps for the PMF hazard attached (Fig 45 and 46).
	2. Vehicle stability assessment	Car park above PMF level.
	3. Vehicles as nuisance in PMF event	Car park above PMF level.

<table>
<tr><td></td><td>4. Spillway to be designed to pass PMF event</td><td>Will be incorporated into detailed design as required.</td></tr>
<tr><td></td><td>5. Are there Flood modelling results to support comment that the proposal, upon completion of rehabilitation activities, will result in no increase in flooding in downstream and upstream flood levels.
Embankment break risk assessment recommended. Risks considered and managed. Referral to DSC to determine if should be prescribed under the Dam Safety Act.</td><td>5A will be rehabilitated to replicate existing surface levels, as such pre development flood levels and flood behaviour will be replicated.

A risk assessment and consequence category has been estimated for the Stage 5A embankment, and D1 form submitted to DSC. Preliminary consequence category for both sunny day and flood failure are low to very low. Awaiting response from DSC. Refer to attached email correspondence and D1 form.</td></tr>
<tr><td></td><td>6. Freeboard required. Proposed freeboard of 100mm is suitable.</td><td>Freeboard of 100mm will be provided as part of detailed design.</td></tr>
<tr><td></td><td>7. Losses used in the hydrological modelling not included in the report.</td><td>Hydrological modlleing undertaken by Cardno as part of the Flooding and Coastal Study Stage 2 Report Minnamurra River Boardwalk (Cardno, 2019). Values used in that model provided below.
3.4.3 Adopted Hydrological Parameters for Design Storm
Adopted hydrological parameters are shown in Table 3-4. These parameters were then used to simulate design storms.
Table 3-4 Adopted WBNM parameters
<table>
<tr><th>Parameter</th><th>Values</th></tr>
<tr><td>Initial loss (pervious surface)</td><td>0 mm</td></tr>
<tr><td>Initial loss (impervious surface)</td><td>0 mm</td></tr>
<tr><td>Continuing loss (pervious surface)</td><td>2.0 mm/hr</td></tr>
<tr><td>C (Catchment Lag parameter)</td><td>1.3</td></tr>
<tr><td>Impervious Lag</td><td>0.1</td></tr>
<tr><td>Stream Lag</td><td>1.0</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td>8. …there is no evidence of blockage scenario in the report prepared by the consultant.</td><td>Hydraulic modelling undertaken by Cardno based on existing model prepared for the Flooding and Coastal Study Stage 2 Report Minnamurra River Boardwalk (Cardno, 2019) As is outlined in section 4.1.3 of that report, the culverts beneath the Princes Highway and the Southern Railway line were included in the model, as were the bridges across the Minnamurra River. The culverts beneath Riverside Drive adjacent to the Dunmore House entrance were not included, therefore were assumed be 100% blocked for the purposes of modelling.</td></tr>
<tr><td></td><td>9. Mannings roughness to be provided.</td><td>Table of mannings roughness from section 4.1.4 in Flooding and Coastal Study Stage 2 Report Minnamurra River Boardwalk (Cardno, 2019) outlined below and attached.
4.1.4 Roughness
Manning's roughness values were applied to the model based on aerial imagery, LEP zoning and Cadastre boundaries. The roughness values adopted in the model are presented in Table 4-1. The delineation of the materials in the TUFLOW model is shown in Figure 4-2. The default material type applies to all other area of the model not delineated in the figure below as passive material.
Table 4-1 Adopted roughness values
<table><tr><th>Surface Type</th><th>Manning's n Value</th></tr><tr><td>Pasture (Default Value)</td><td>0.05</td></tr><tr><td>Road</td><td>0.025</td></tr><tr><td>Vegetation</td><td>0.08</td></tr><tr><td>Creek</td><td>0.03</td></tr><tr><td>Water body</td><td>0.06</td></tr><tr><td>Urban block</td><td>0.1</td></tr></table></td></tr>
<tr><td></td><td>10. Approximation of invert levels</td><td>Invert levels used in model were based on dimensions collected in a site inspection as part of in Flooding and Coastal Study Stage 2 Report Minnamurra River Boardwalk (Cardno, 2019) (Section 4.3.1) and ALS data of surface levels at the culvert entrance and exits. Site inspections confirmed that there are no significant level changes between the adjacent surface and the culvert inverts themselves, therefore the ALS levels were assumes as proxies for invert levels. The modelling purpose is to provide an impact assessment between existing and proposed conditions, the structure details are maintained between the two scenarios. Any minor changes to invert levels are unlikely to affect flood levels in the events modelled or the impacts stated in the report.</td></tr>
</table>

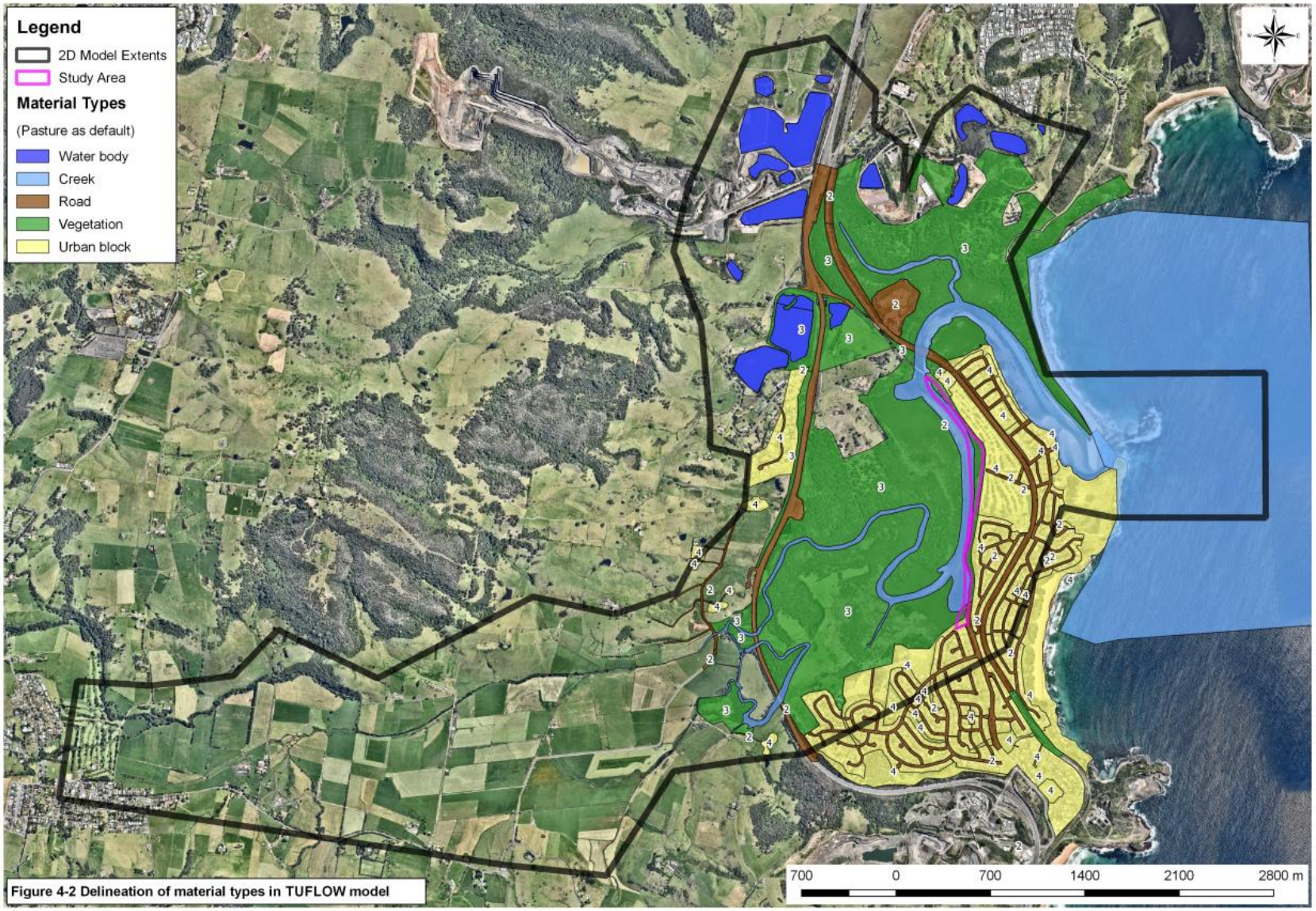


Figure 4-2 Delineation of material types in TUFLOW model

Please contact the undersigned if you have any questions regarding this letter.

Yours sincerely,

Lachlan Bain
Environmental Engineer BEng (Env) MEM.

APPENDIX A

Lachlan Bain <lachlan@south-east.com.au> Sep 11, 2019, 11:54 AM (6 days ago)
to Heather, Adnan

Hi Heather,

Regarding 5B, Council submissions have not raised any concerns about this in relation to Dam saftety.
In the event of bund failure for 5B, flows discharge into the Minnamurra River estuary. The outlflow from a failed bund is small in relation to natural flood flows.
Peak flow (total discharge over 5 mins) = 74000sqm x 2m/5min = 493cumecs.
This is less than the 1 in 5 year ARI peak flow for this part of the Minamurra River, therefore there are no people at risk should failure occur. (recreation areas, roads and housing well above the 5 year ARI flood level).
The Princes Highway is located above the PMF flood level, therefore there are no impacts on the highway should failure occur.

Regarding 5A. Please find the D1 form attached. At the moment I dont have the ANCOLD Guidelines on Consequence Categories. My estimates for Severity of Damage and Loss (Minor, med, Major or Catastrophic) are based on a comparison with Appendix A of DSC3A. Assumed at Minor to medium.

For the SDCC (no flooding), I have classified the Stage 5A pond as Very Low as water levels will be below the surrounding ground level (at natural Groundwater level), therefore in event of embankment failure flow out would be zero to minimal.

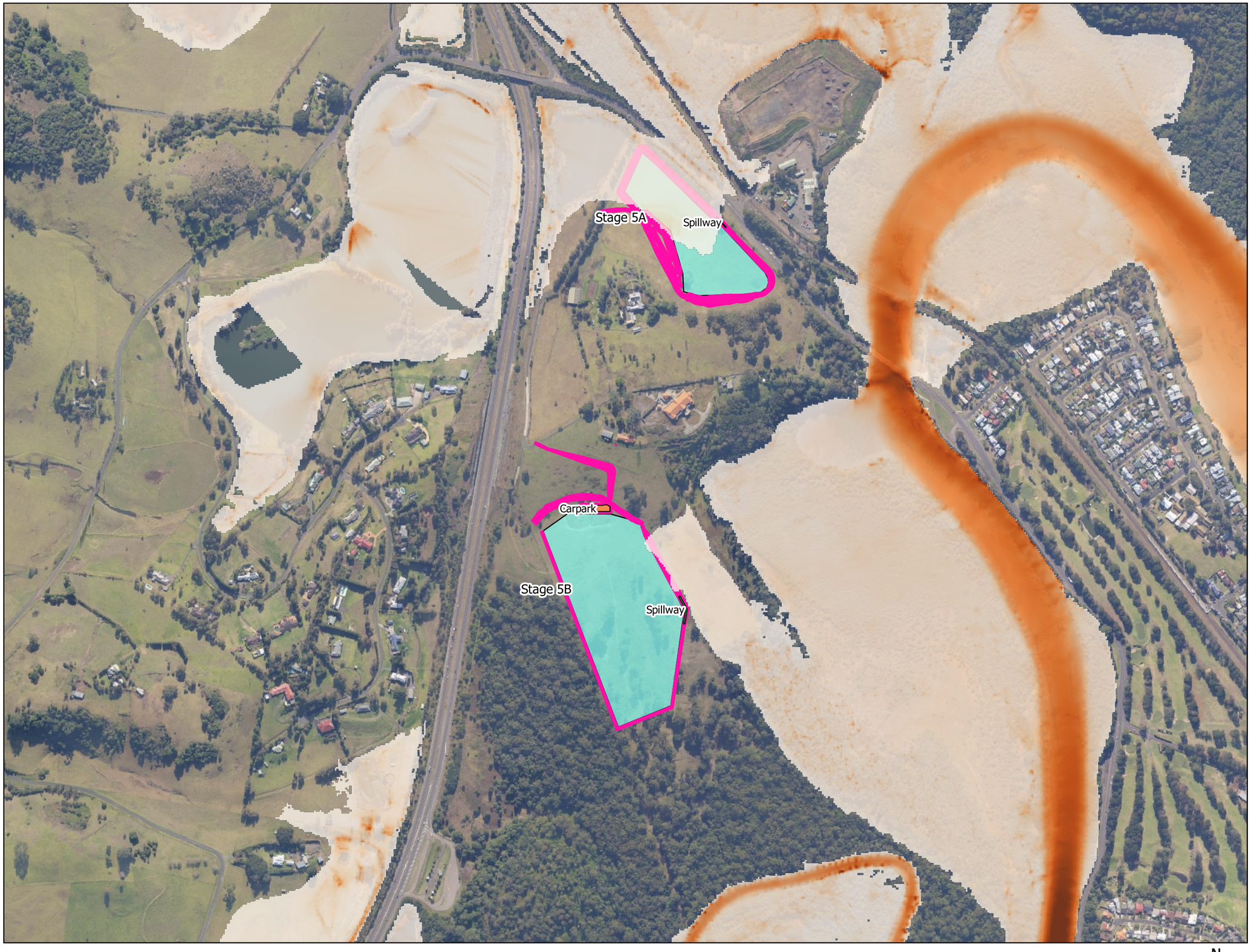
For the flood consequence, I have listed the adjacent peak flow rate for the PMF and 100 year event as the basin itself is off line. I have used the DSO-99-06 to estimate the PLL. I have assumed 5 people on the section of road that will be inundated (the low point on Riverside Drive) and applied the appropriate fatality rate (0.015), assuming 15-60 minute warning and vague understanding of flood severity, although this is probably more at the precise end, and Low severity. Flow VD is probably around 2.5 to 3 m2/s over the road. (assumes spread over a 50m low point in the road).

This equates to a PLL of <0.1, and from that a Low to Very Low Consequence category.
Once flows from dam failure reach the Minamurra River, they will have spread and will be confined within the River.

Given that an event >100 year ARI flood is required to fill the bunded area of Stage 5A, and that Riverside Drive is overtopped in around a 20 year ARI flood. Riverside Drive is likely to be closed in the event of a flood that overtops the Stage 5A bund. In the event of a flood, road closure could be maintained until water levels in the bunded area at safe levels.

I have attached a screen shot showing the 1% AEP flood extents for Rocklow Creek and the Minnamurra River.

Happy to chat if more information is required.



Legend

Dredge pond bunds and earthworks

5y ARI max velocity (m/s)

- 0.0157
- 0.274
- 0.532
- 0.79
- 1.05
- 1.31
- 1.56
- 1.8
- 2

0 100 200 300 400 m

N

FIG 1. 5y ARI Max velocity, existing conditions.

18/07/2019

southeast
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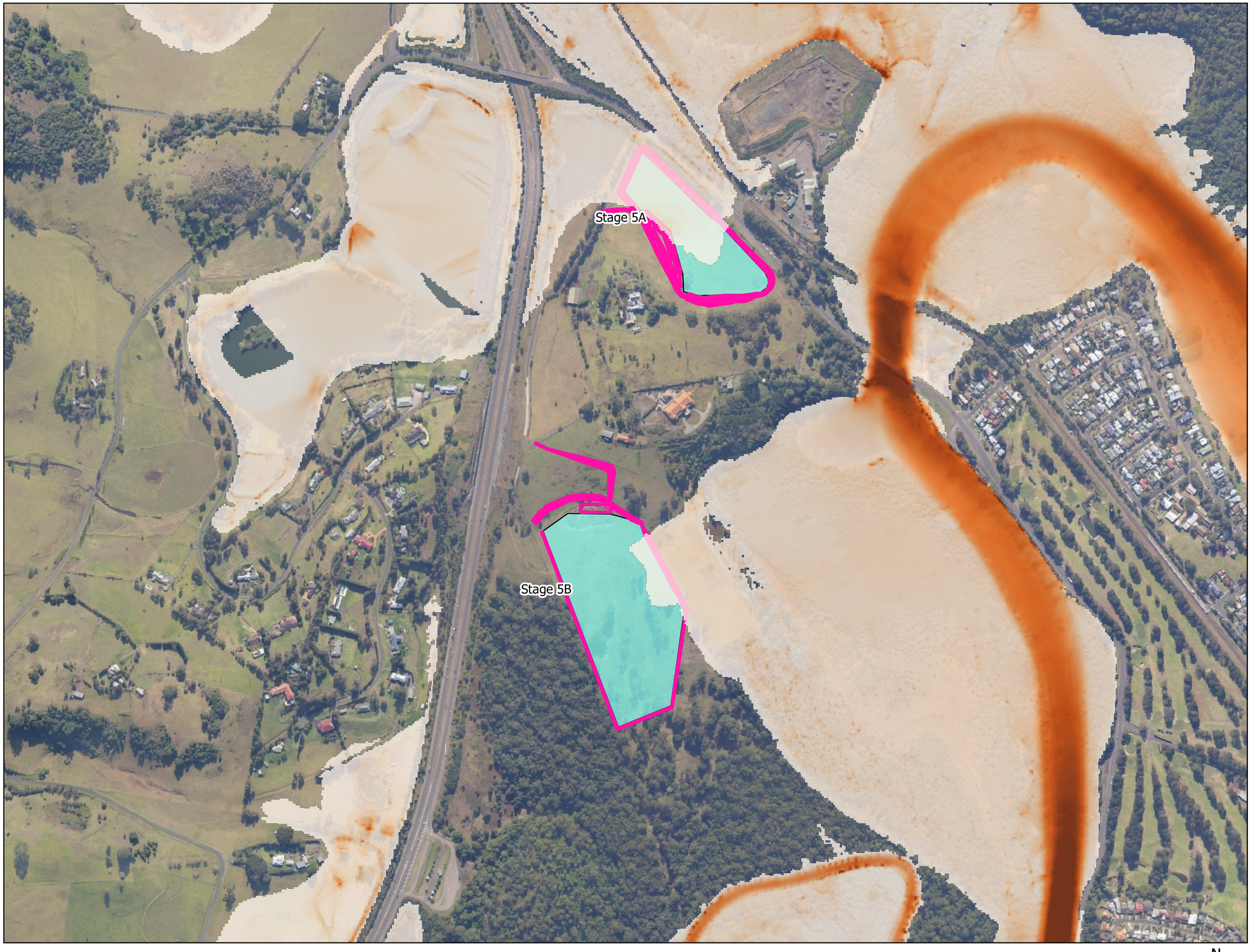

FIG 2. 20y ARI Max velocity, existing conditions.

18/07/2019

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FIG 3. 100y ARI Max velocity, existing conditions.

18/07/2019

southeast
engineering+environmental

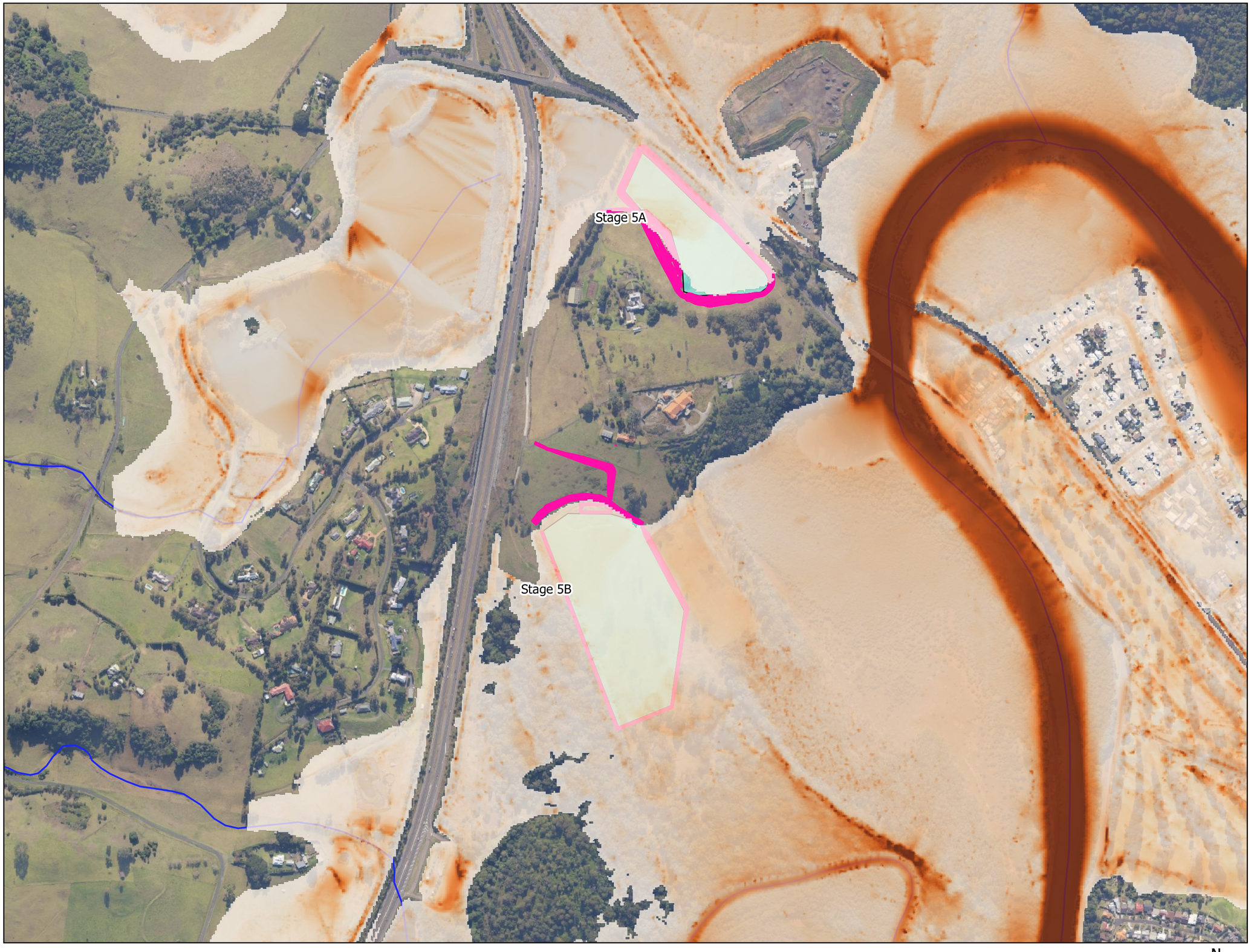

FIG 4. PMF Max velocity, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood dpeth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 5. 5y ARI Flood depth, existing conditions.

18/07/2019

southeast
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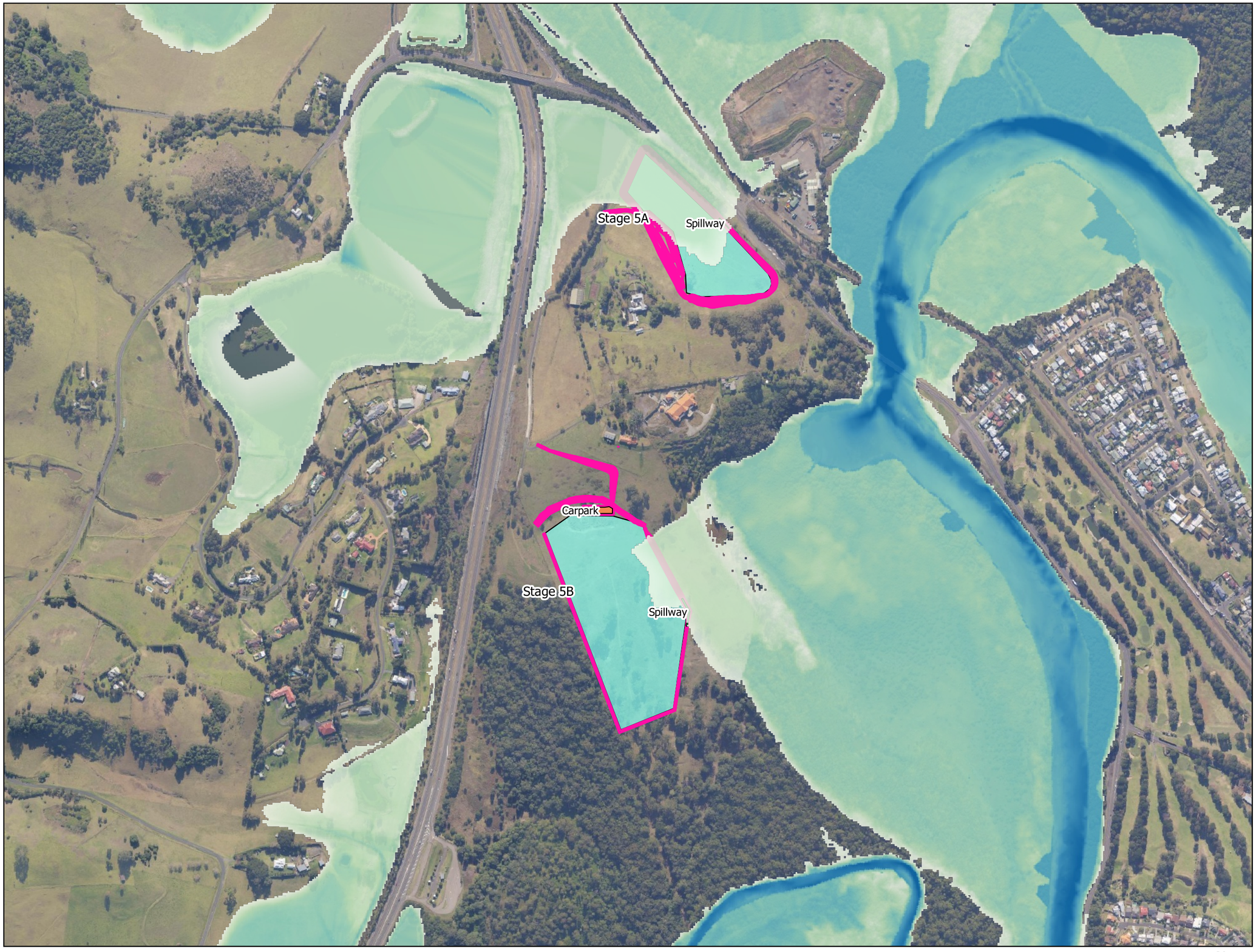


Legend

Dredge pond bunds and earthworks

Flood dpeth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 6. 20y ARI Flood depth, existing conditions.

18/07/2019

southeast
engineering+environmental

FIG 7. 100y ARI Flood depth, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood dpeth (m)

0.144
1.41
2.68
3.95
5.22

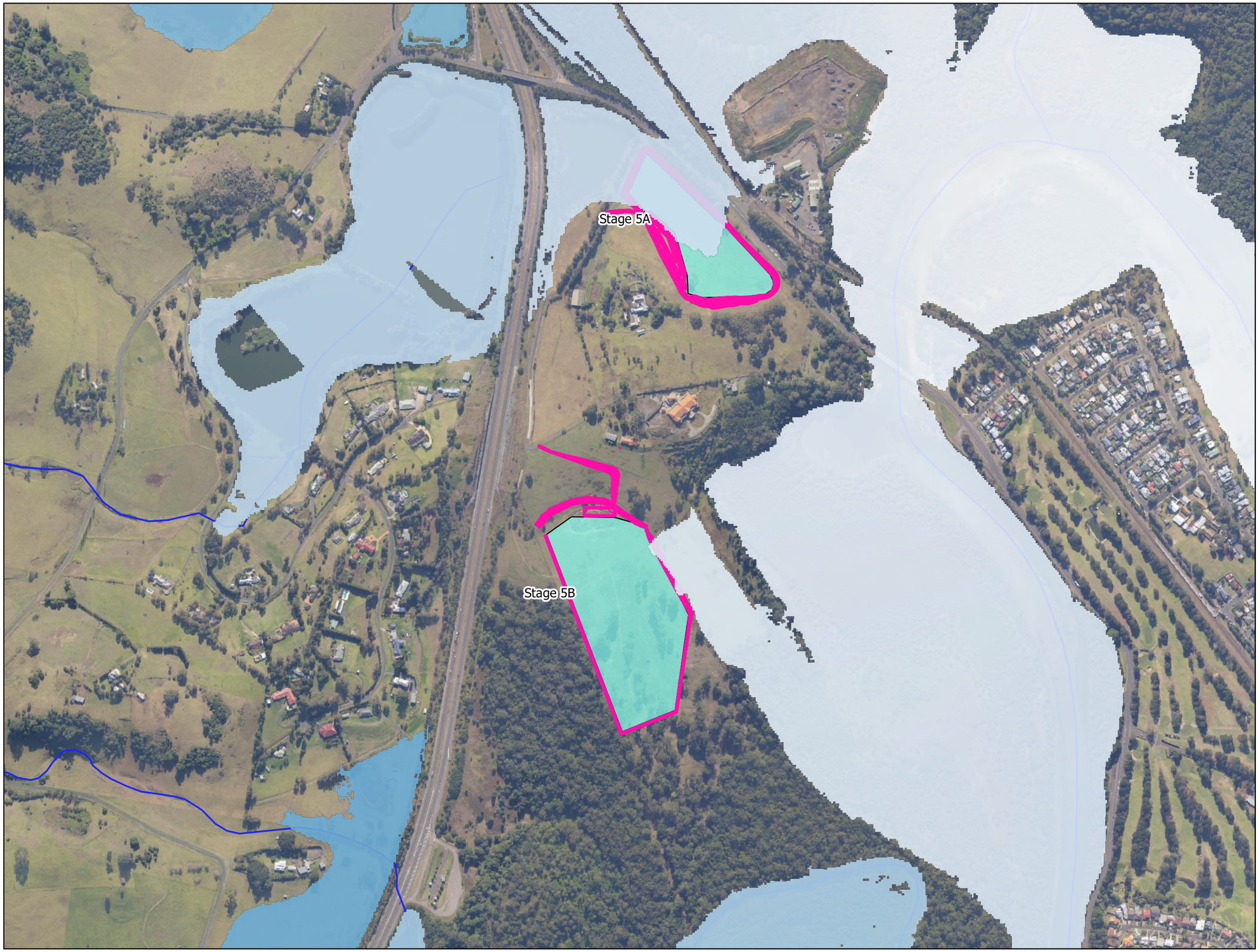
0 100 200 300 400 m

N

FIG 8. PMF Flood depth, existing conditions.

18/07/2019

southeast
engineering+environmental



Legend

Dredge pond bunds and earthworks

5y ARI Flood level (m AHD)

2
2.39
2.78
3.17
3.56
3.95
4.34
4.7
5

0 100 200 300 400 m

N

FIG 9. 5y ARI Flood height, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

20y ARI Flood level (m AHD)

2
2.39
2.78
3.17
3.56
3.95
4.34
4.7
5

0 100 200 300 400 m

N

FIG 10. 20y ARI Flood height, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

0 100 200 300 400 m

N

FIG 11. 100y ARI Flood height, existing conditions.

18/06/2019

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FIG 12. PMF Flood height, existing conditions.

18/07/2019

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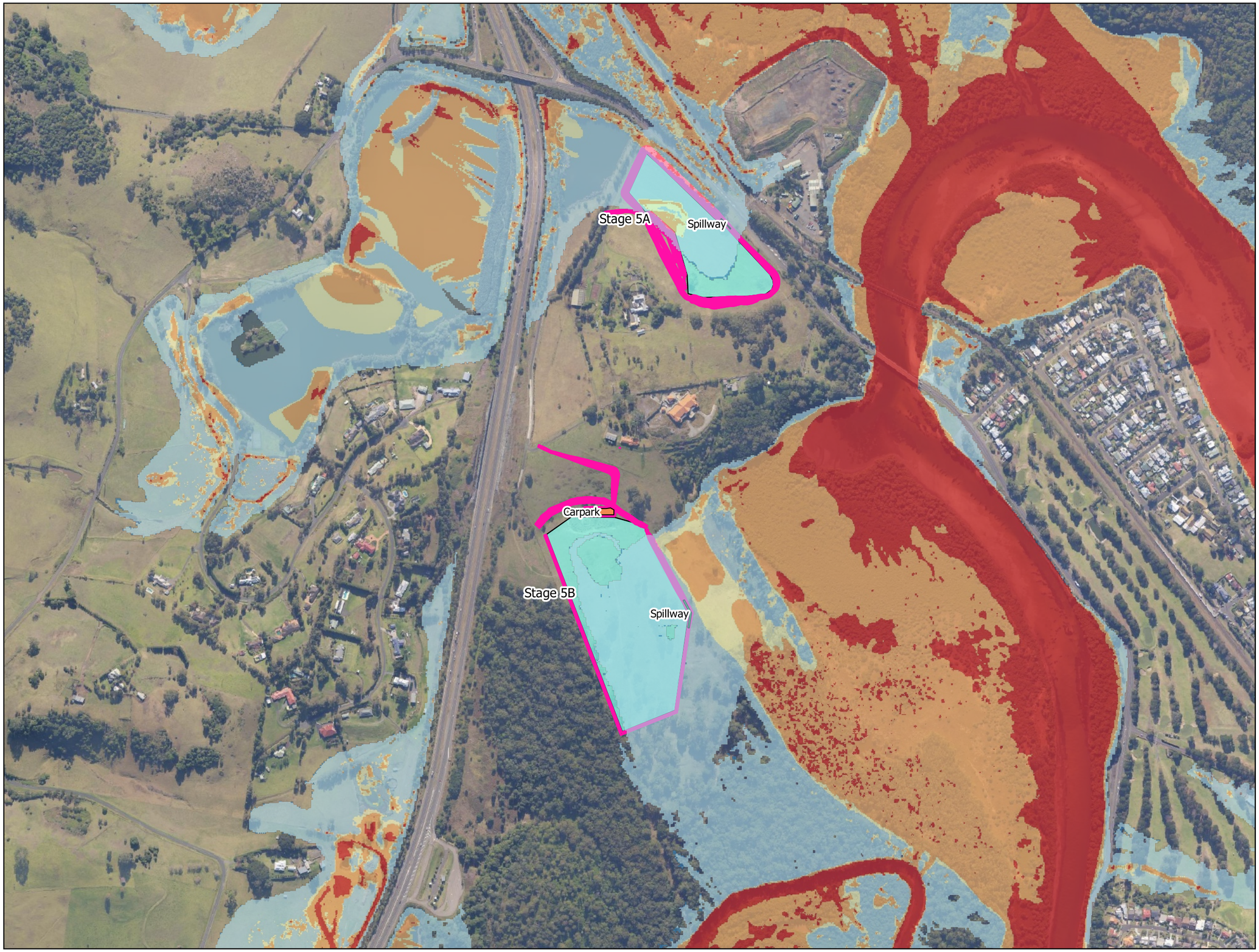
engineering+environmental



Legend

Dredge pond bunds and earthworks

100y VD

- <= 0
- 0 - 0.3
- 0.3 - 0.4
- 0.4 - 1
- > 1

0 100 200 300 400 m

N

FIG 13. 100y ARI VD, existing conditions.

18/06/2019

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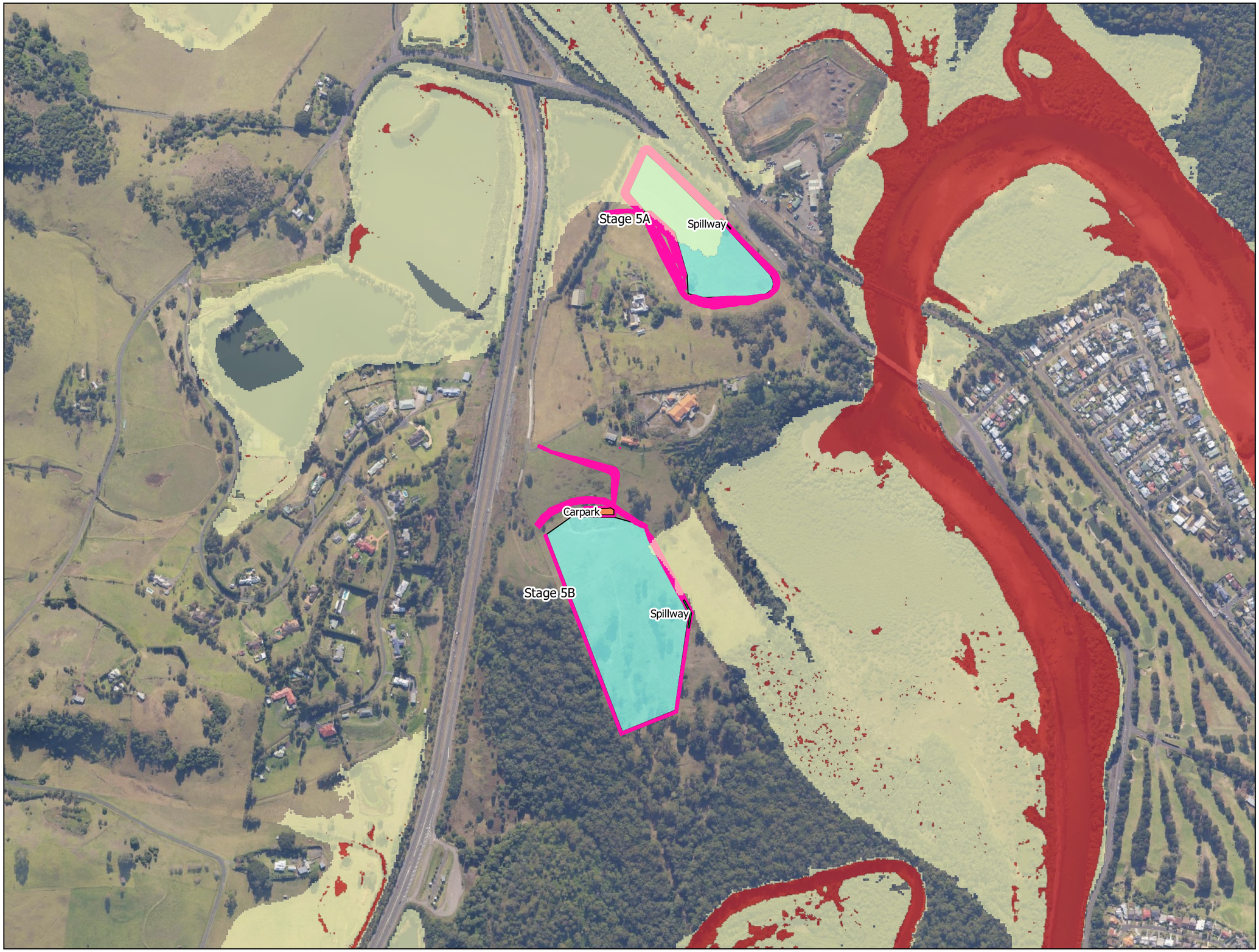
engineering+environmental



Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 14. 5y ARI flood hazard, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 15. 20y ARI flood hazard, existing conditions.

18/07/2019

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

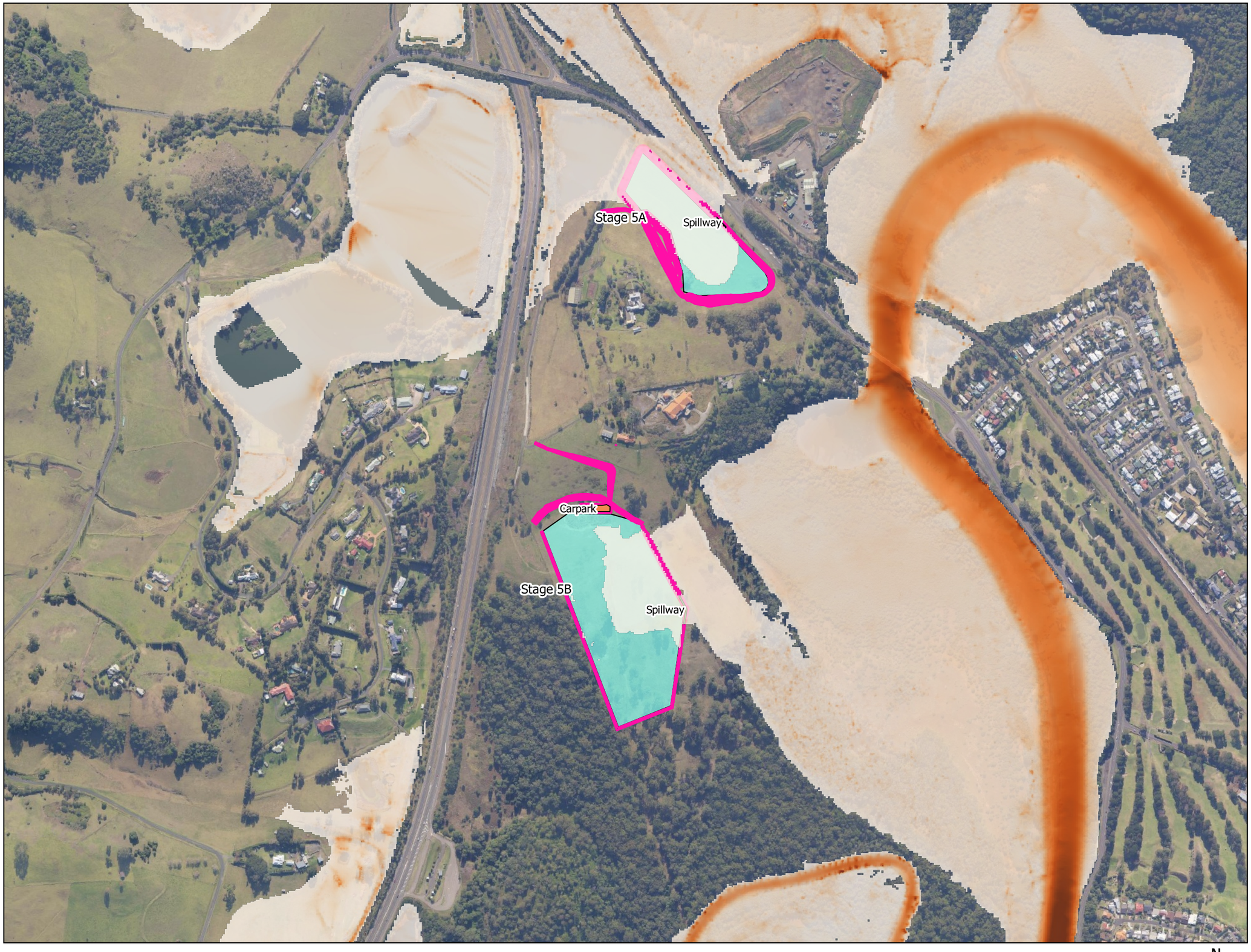
0 100 200 300 400 m

N

FIG 16. 100y ARI flood hazard, existing conditions.

18/07/2019

southeast
engineering+environmental



Legend

Dredge pond bunds and earthworks

5y ARI max velocity (m/s)

- 0.0157
- 0.274
- 0.532
- 0.79
- 1.05
- 1.31
- 1.56
- 1.8
- 2

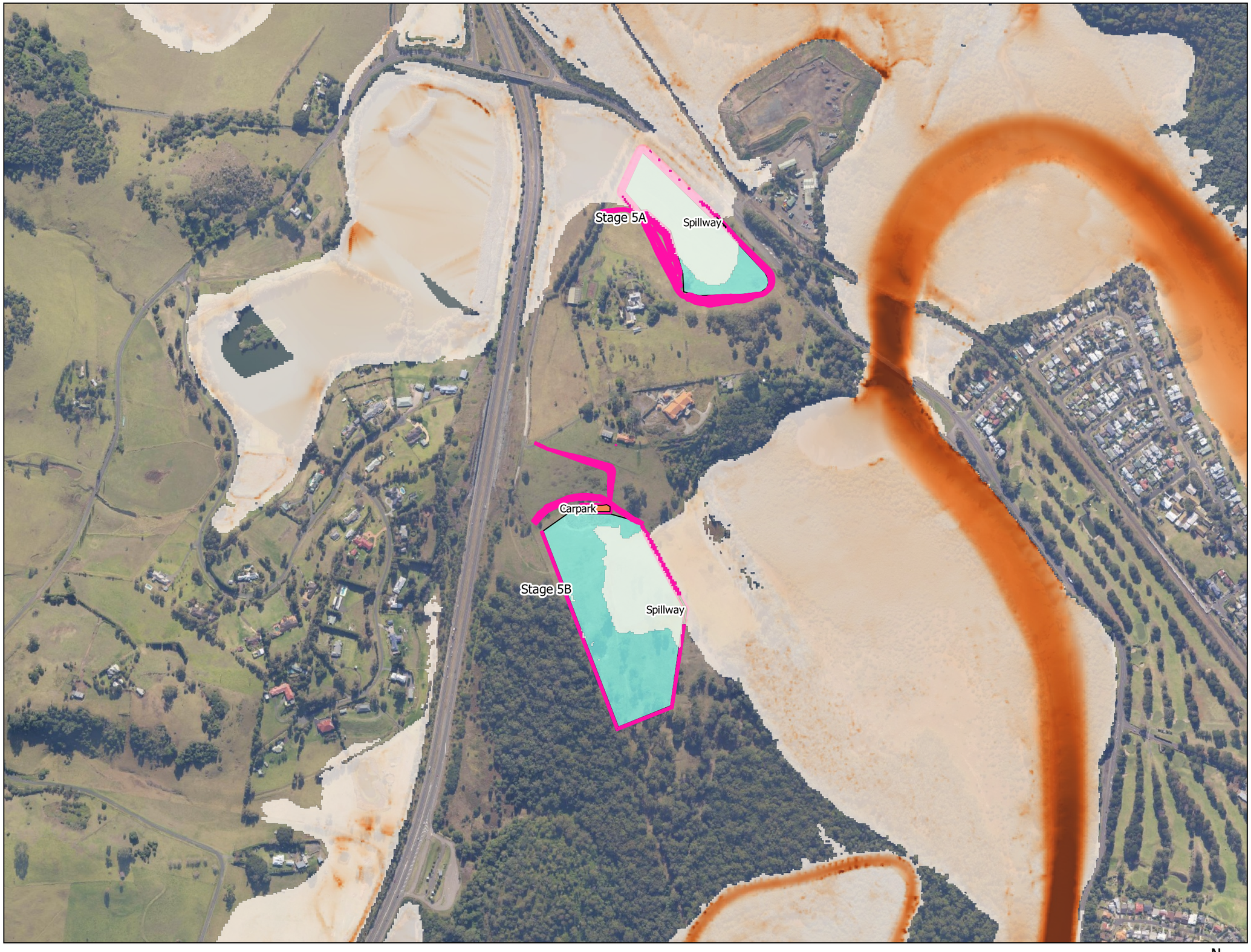
0 100 200 300 400 m

N

FIG 17. 5y ARI Max velocity, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions for basins above spillway for model stability.

southeast
engineering+environmental



Legend

Dredge pond bunds and earthworks

Max velocity (m/s)

- 0.0157
- 0.274
- 0.532
- 0.79
- 1.05
- 1.31
- 1.56
- 1.8
- 2

0 100 200 300 400 m

N

FIG 18. 20y ARI Max velocity, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions for basins above spillway for model stability.

southeast
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FIG 19. 100y ARI Max velocity, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

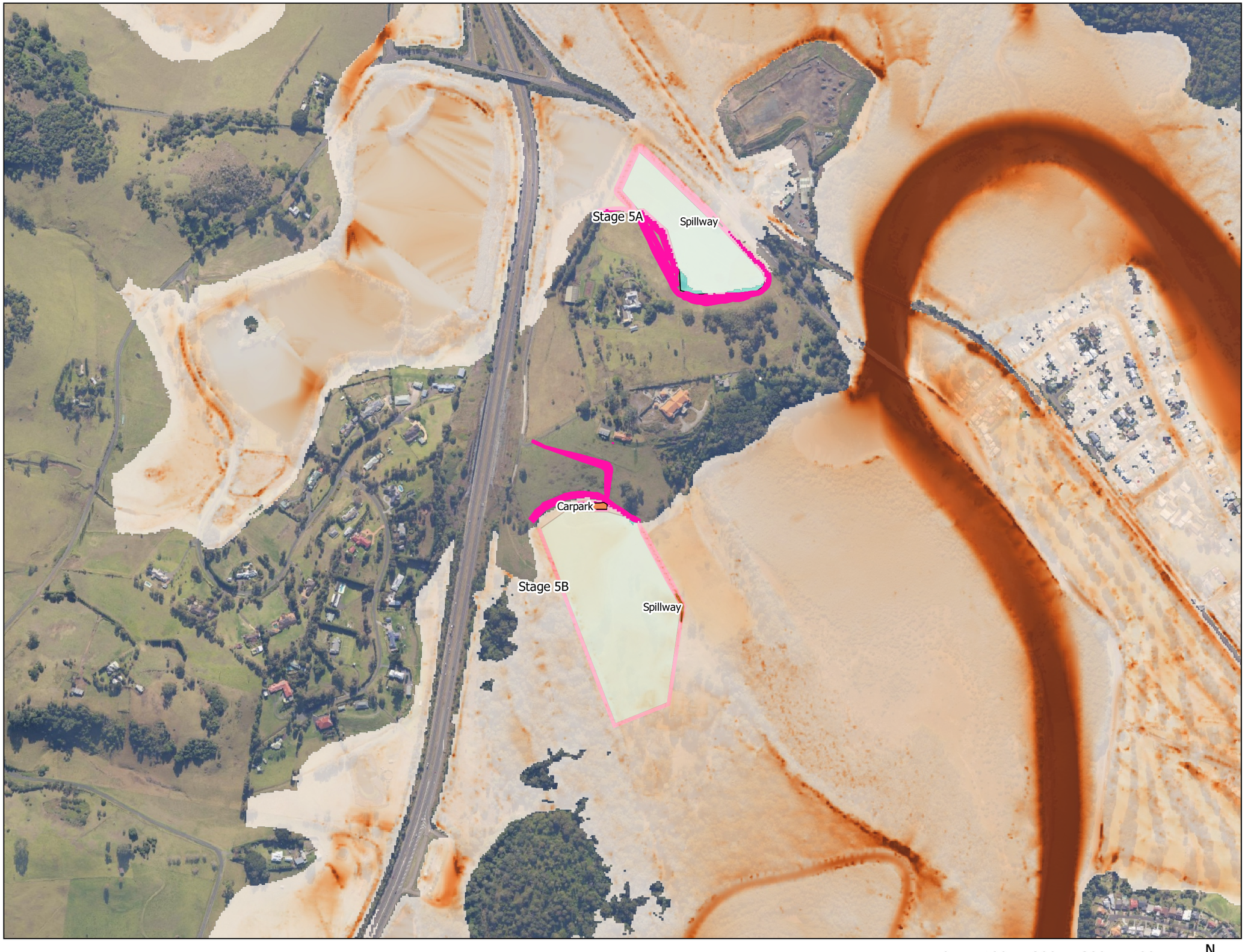

FIG 20. PMF Max velocity, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood depth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 21. 5y ARI Flood depth, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood depth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 22. 20y ARI Flood depth, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood depth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 23. 100y ARI Flood depth, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood depth (m)

0.144
1.41
2.68
3.95
5.22

0 100 200 300 400 m

N

FIG 24. PMF Flood depth, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
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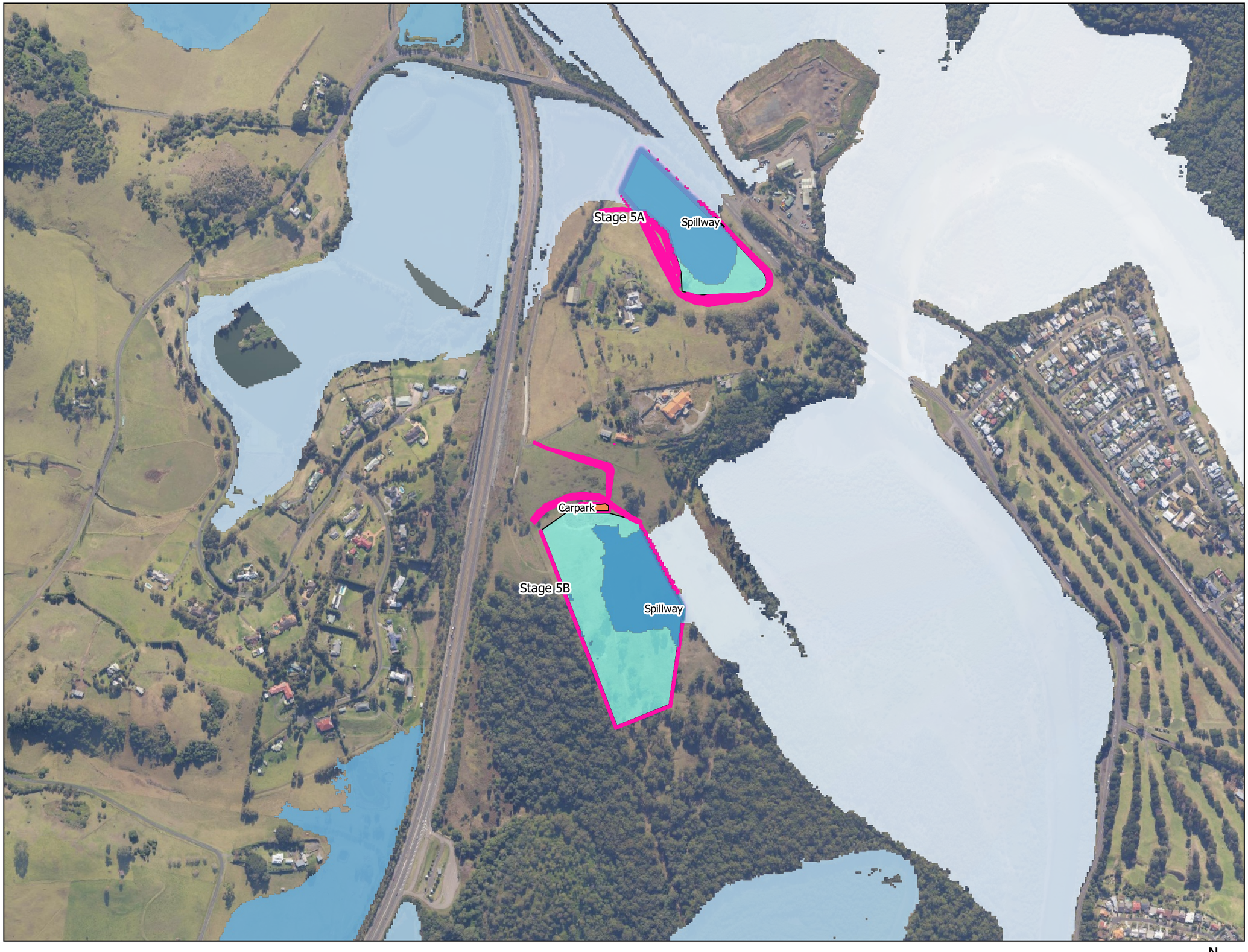

Legend

Dredge pond bunds and earthworks

Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

0 100 200 300 400 m

N

FIG 25. 5y ARI Flood height, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

0 100 200 300 400 m

N

FIG 26. 20y ARI Flood height, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

0 100 200 300 400 m

N

FIG 27. 100y ARI Flood height, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

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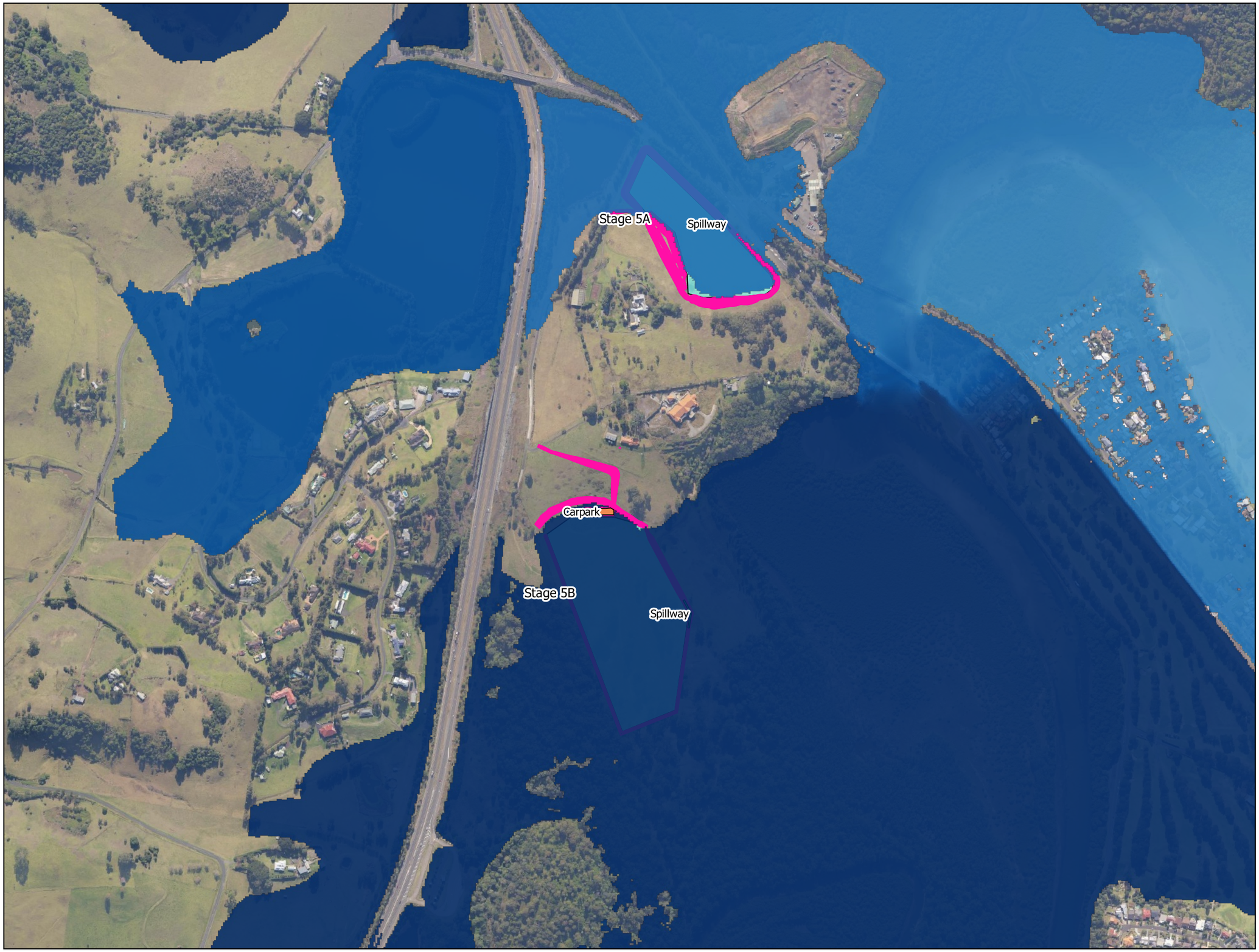


Legend

Dredge pond bunds and earthworks

Flood level (m AHD)

- 2
- 2.39
- 2.78
- 3.17
- 3.56
- 3.95
- 4.34
- 4.7
- 5

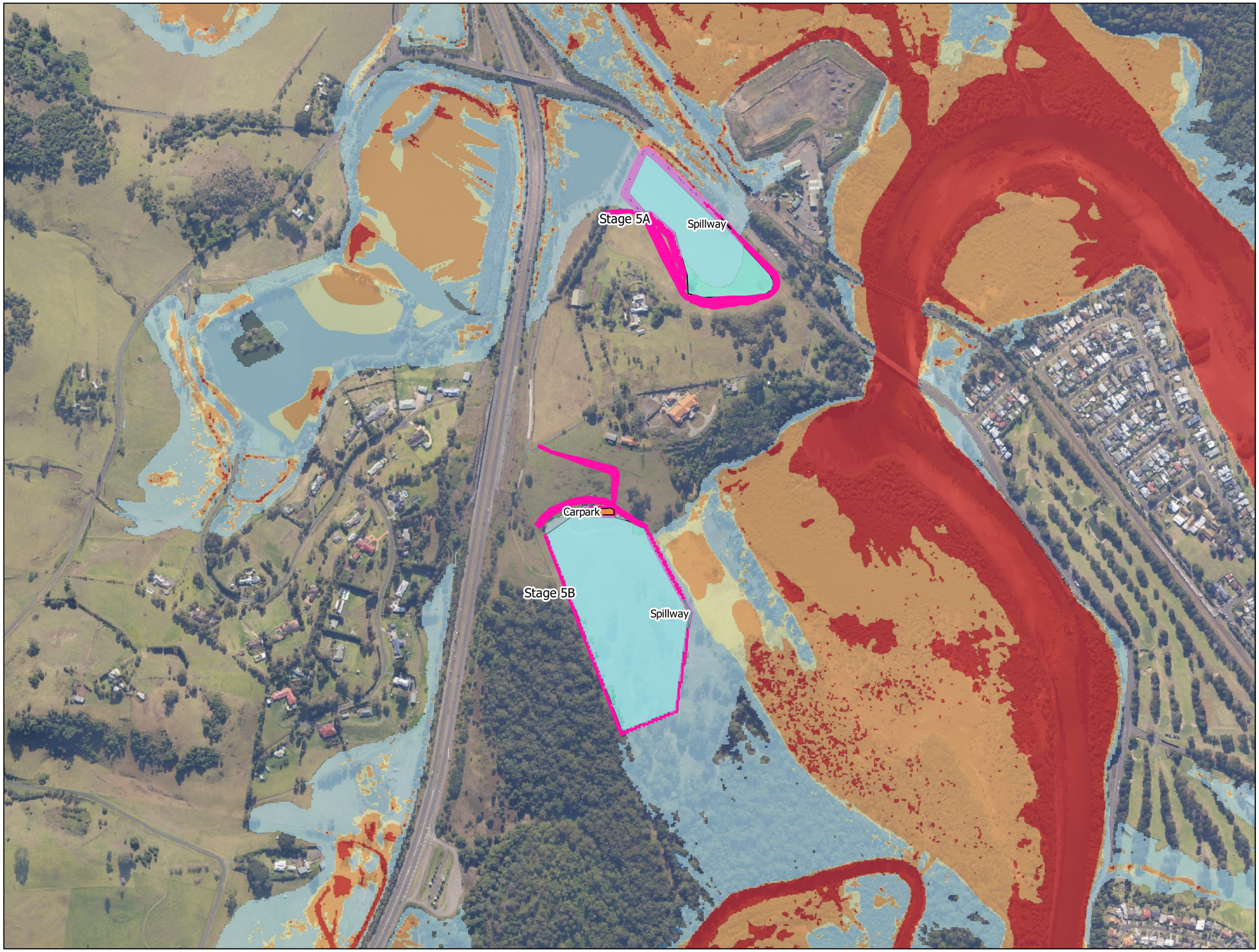
0 100 200 300 400 m

N

FIG 28. PMF Flood height, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental



Legend

Dredge pond bunds and earthworks

100y VD

- <= 0
- 0 - 0.3
- 0.3 - 0.4
- 0.4 - 1
- > 1

0 100 200 300 400 m

N

FIG 29. 100y ARI VD, existing conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 30. 5y ARI flood hazard, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 31. 20y ARI flood hazard, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 32. 100y ARI flood hazard, proposed conditions.

18/07/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

southeast
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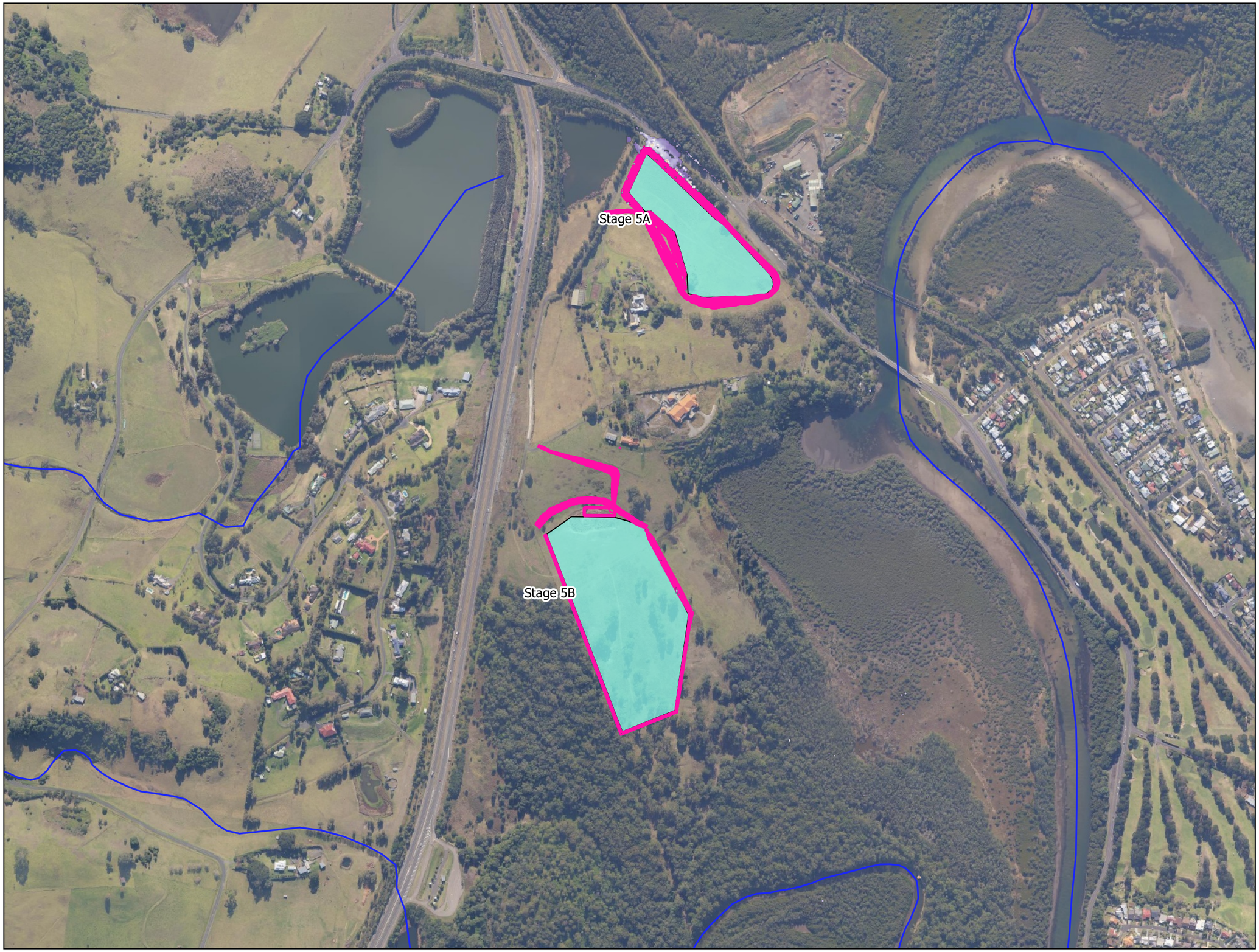

Legend

Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

0 100 200 300 400 m

N

FIG 33. 5y ARI Max velocity difference

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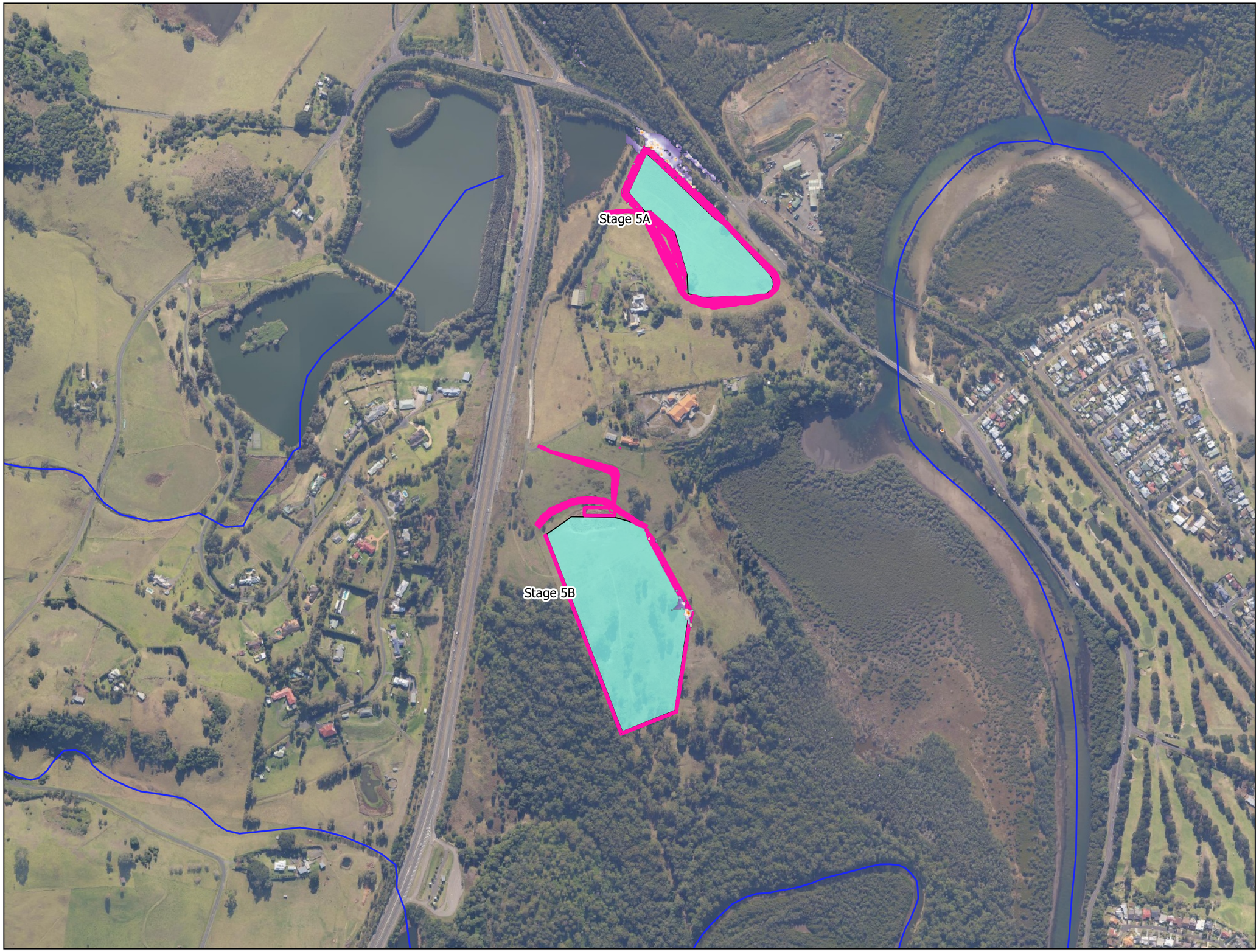

Legend

Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

0 100 200 300 400 m

N

FIG 34. 20y ARI Max velocity difference

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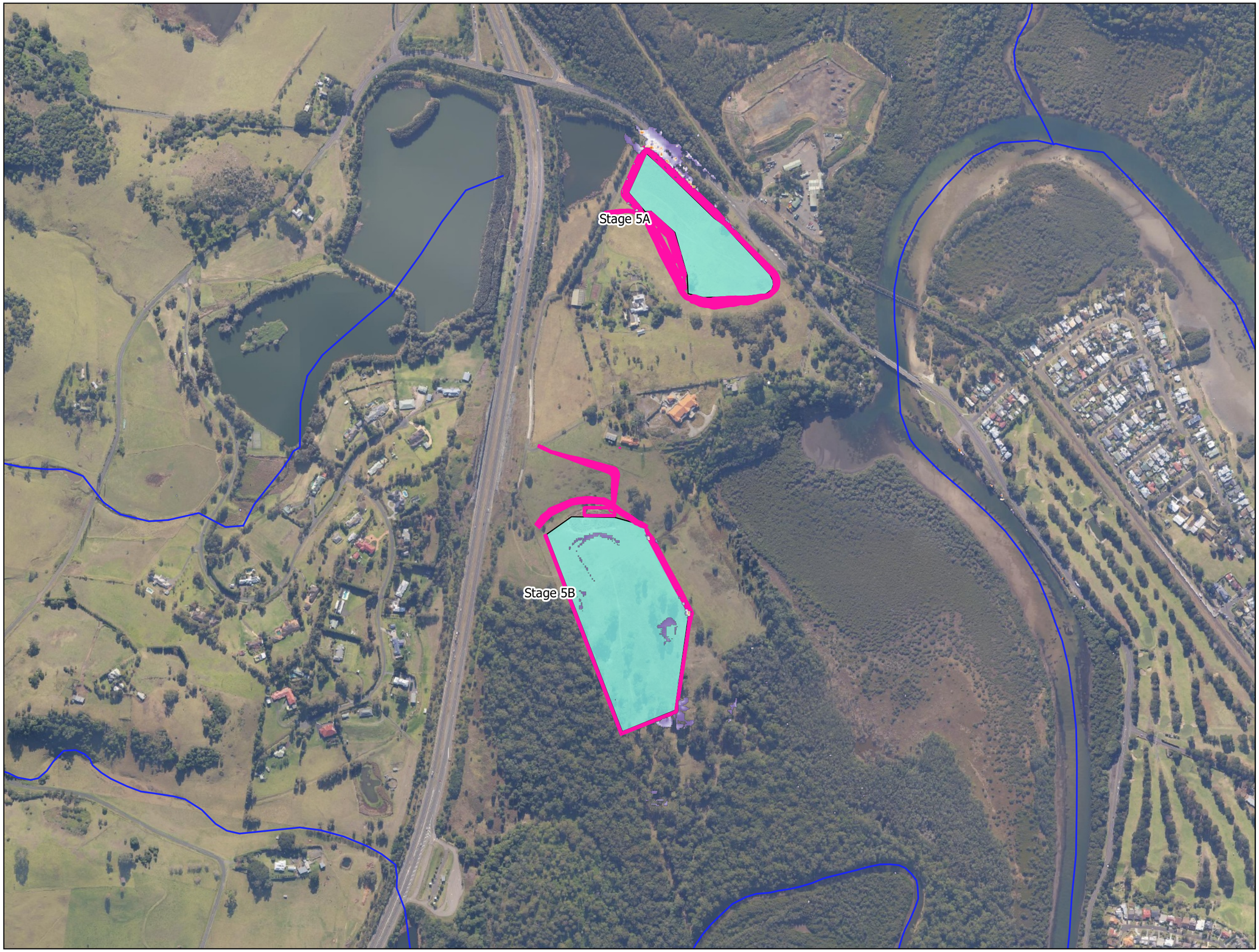

Legend

Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

0 100 200 300 400 m

N

FIG 35. 100y ARI Max velocity difference

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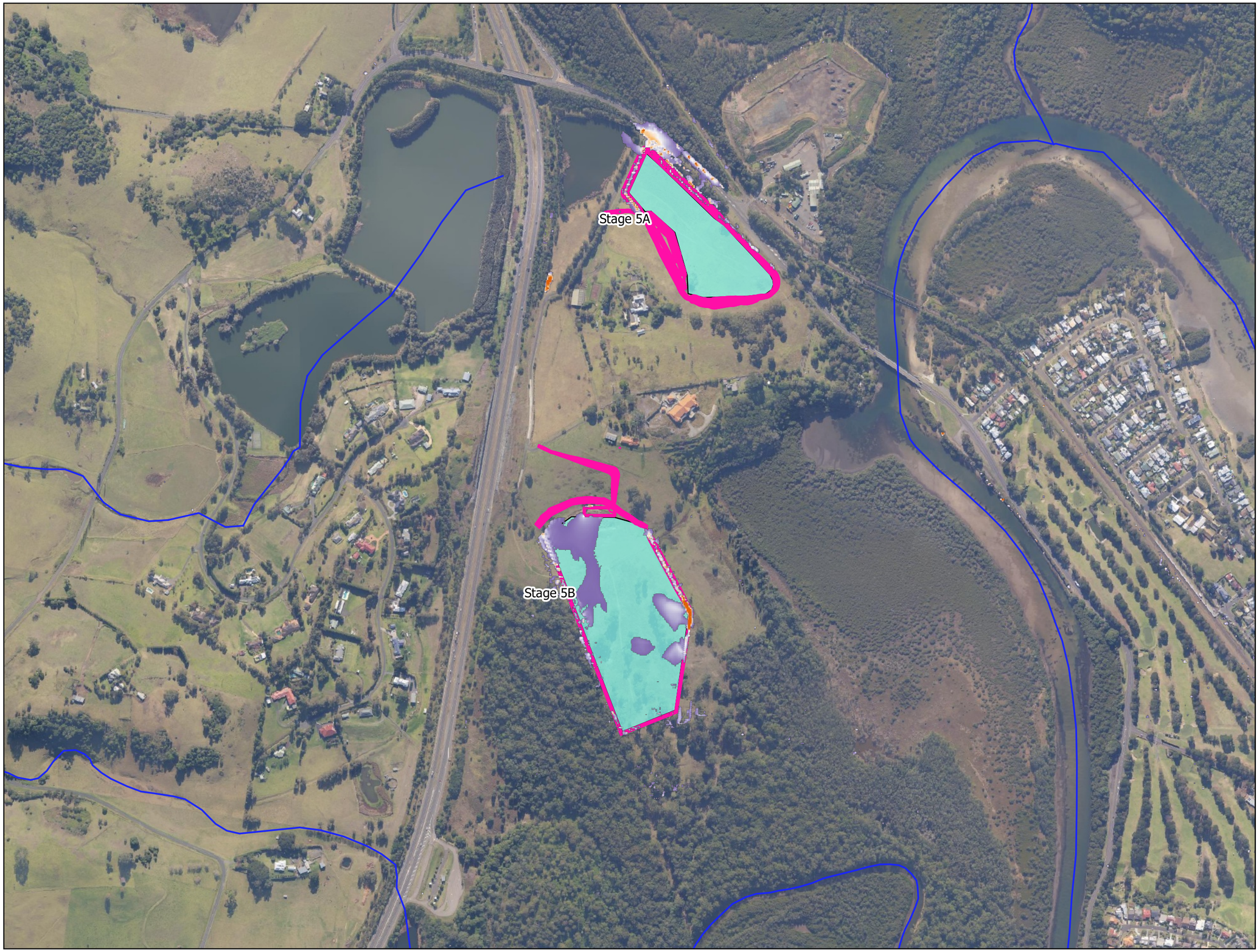

Legend

Dredge pond bunds and earthworks

Max velocity difference (m/s)

0

0.125

0.25

0.375

0.5

0 100 200 300 400 m

N

FIG 36. PMF Max velocity difference

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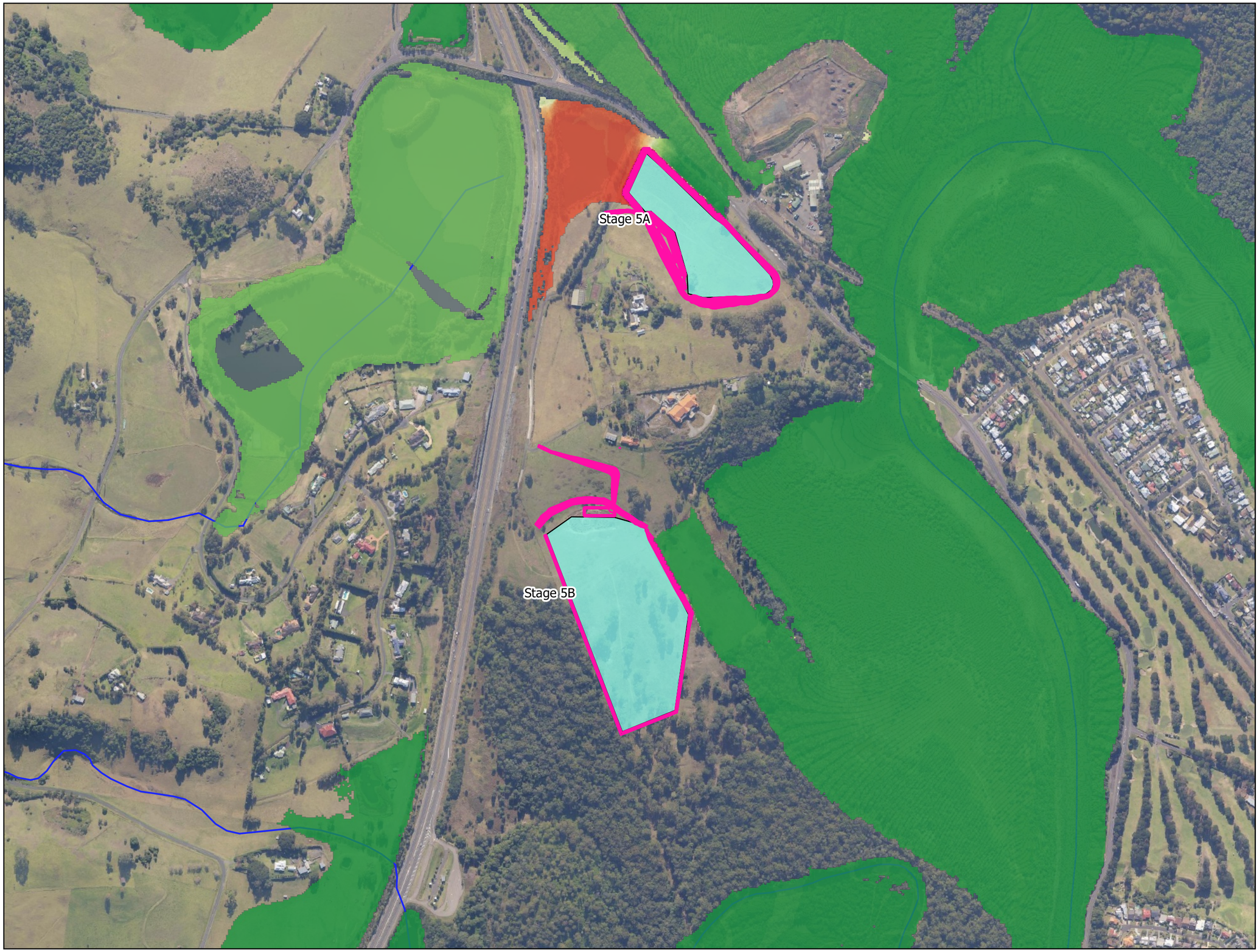

Legend

Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

0 100 200 300 400 m

N

FIG 37. 5y ARI Flood height difference

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engineering+environmental

Legend

Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

0 100 200 300 400 m

N

FIG 38. 20y ARI Flood height difference

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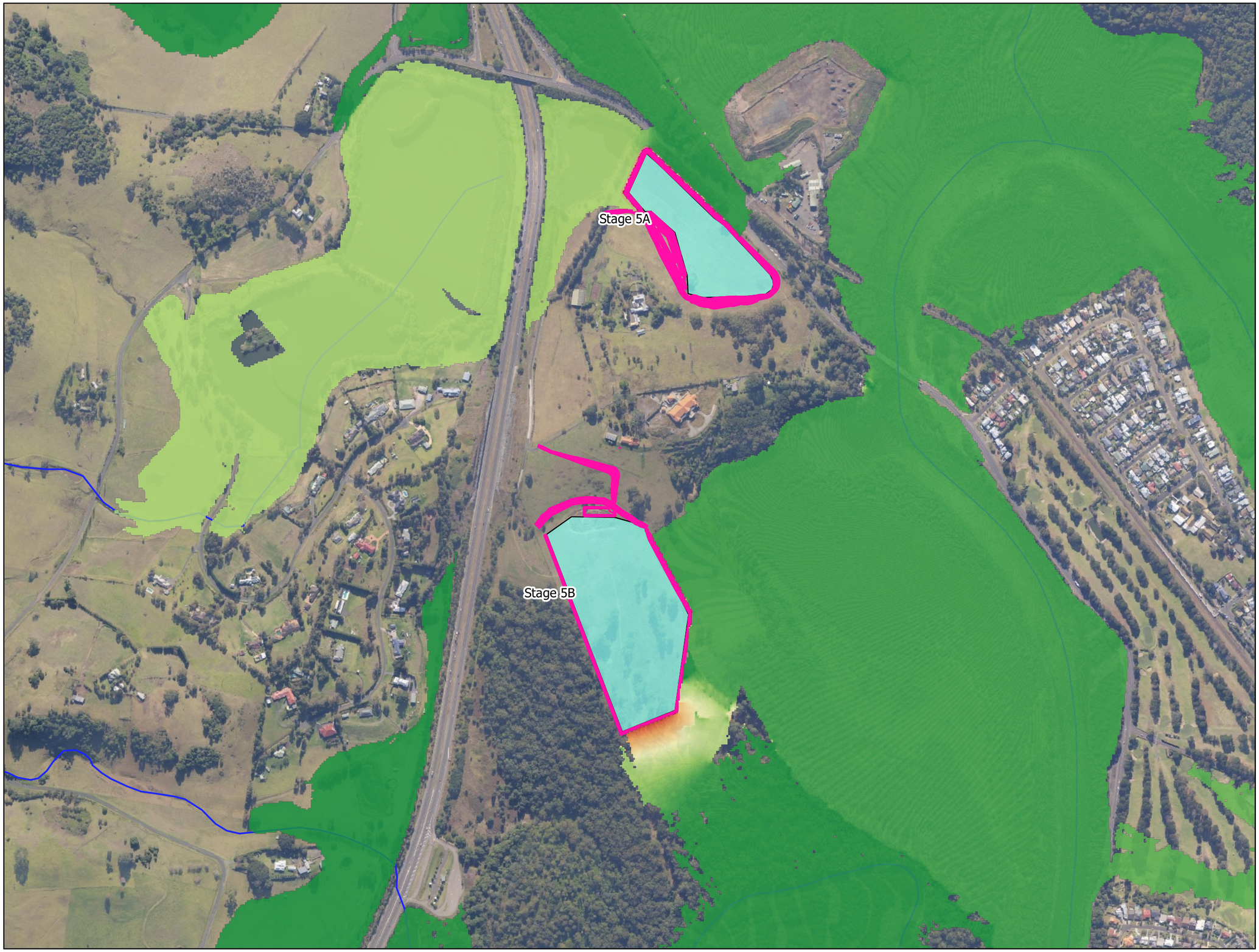

Legend

Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

0 100 200 300 400 m

N

FIG 39. 100y ARI Flood height difference

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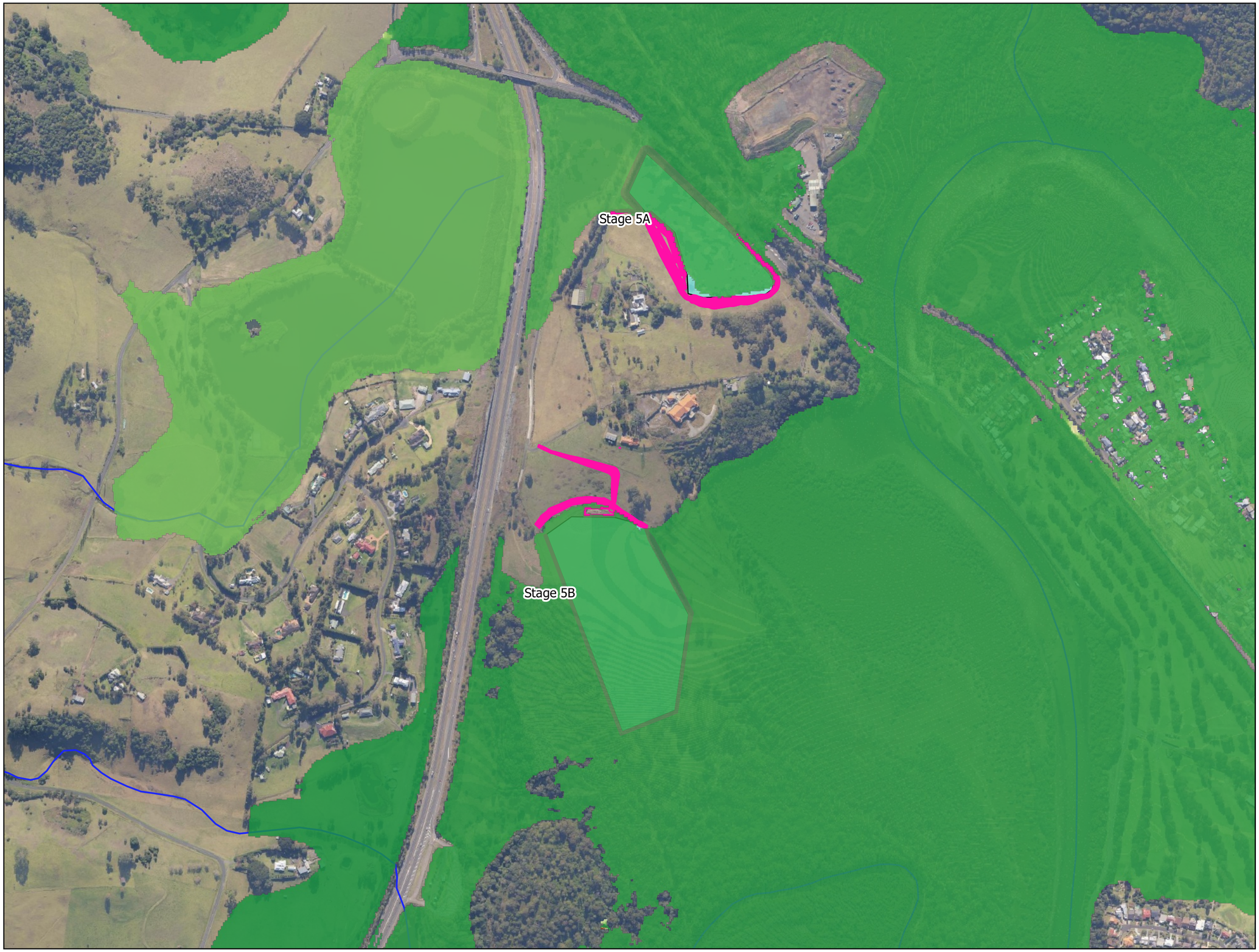

Legend

Dredge pond bunds and earthworks

Flood height difference (m)

0

0.0125

0.025

0.0375

0.05

0 100 200 300 400 m

N

FIG 40. PMF Flood height difference

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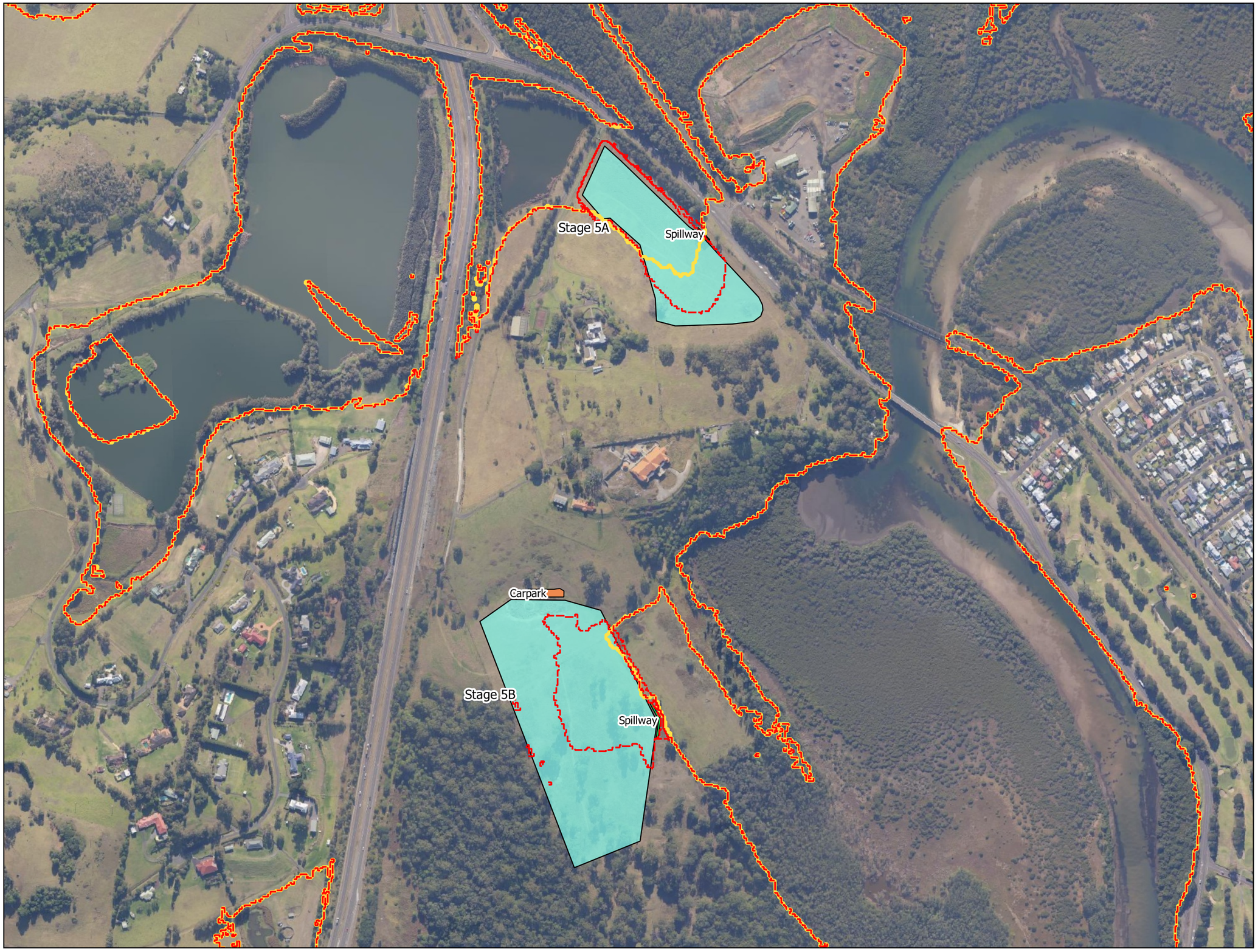

FIG 41. 5y ARI Flood extents pre and post.

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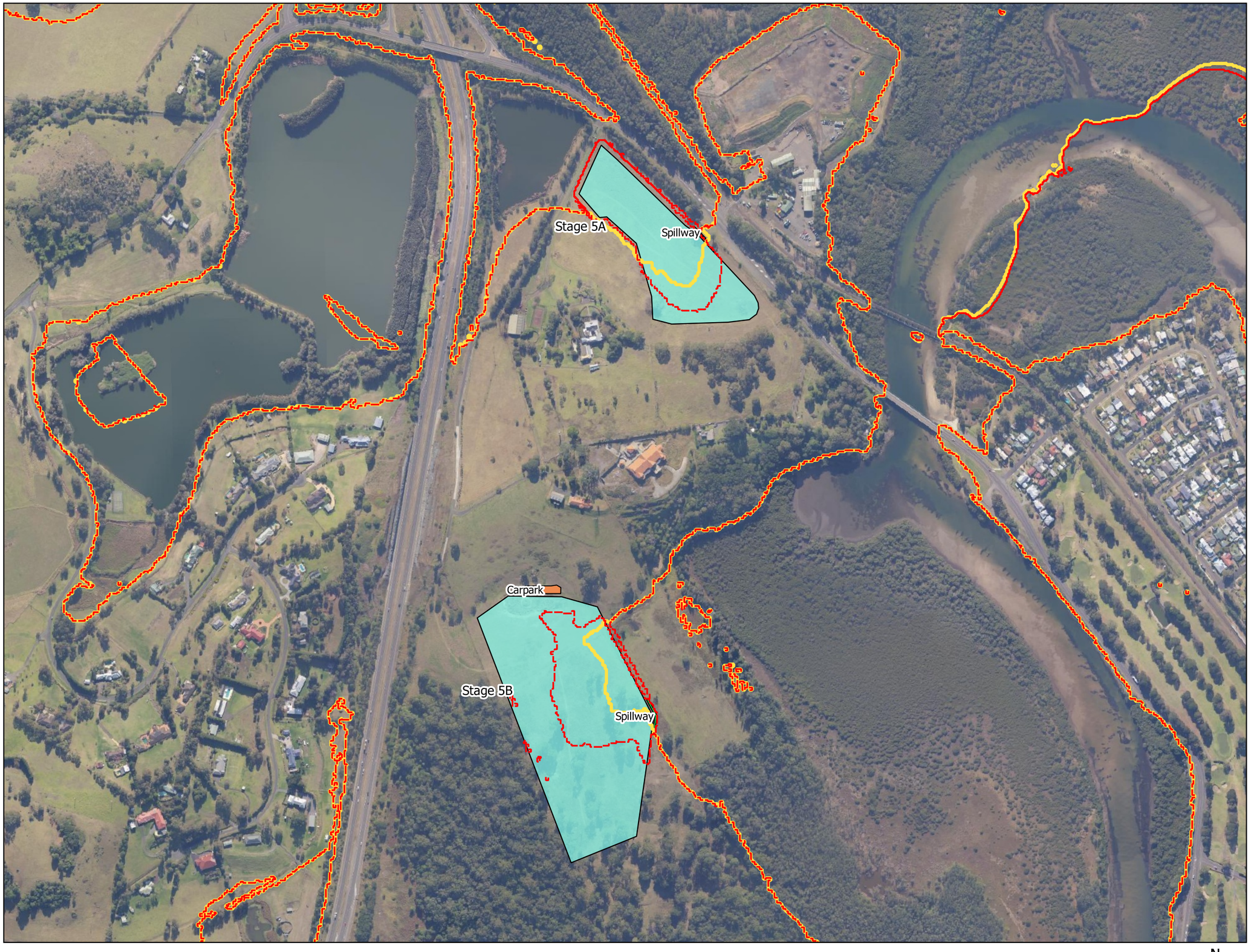

Legend

Existing_flood_extents

Proposed flood_extents

0 100 200 300 400 m

N

FIG 42. 20y ARI Flood extents pre and post.

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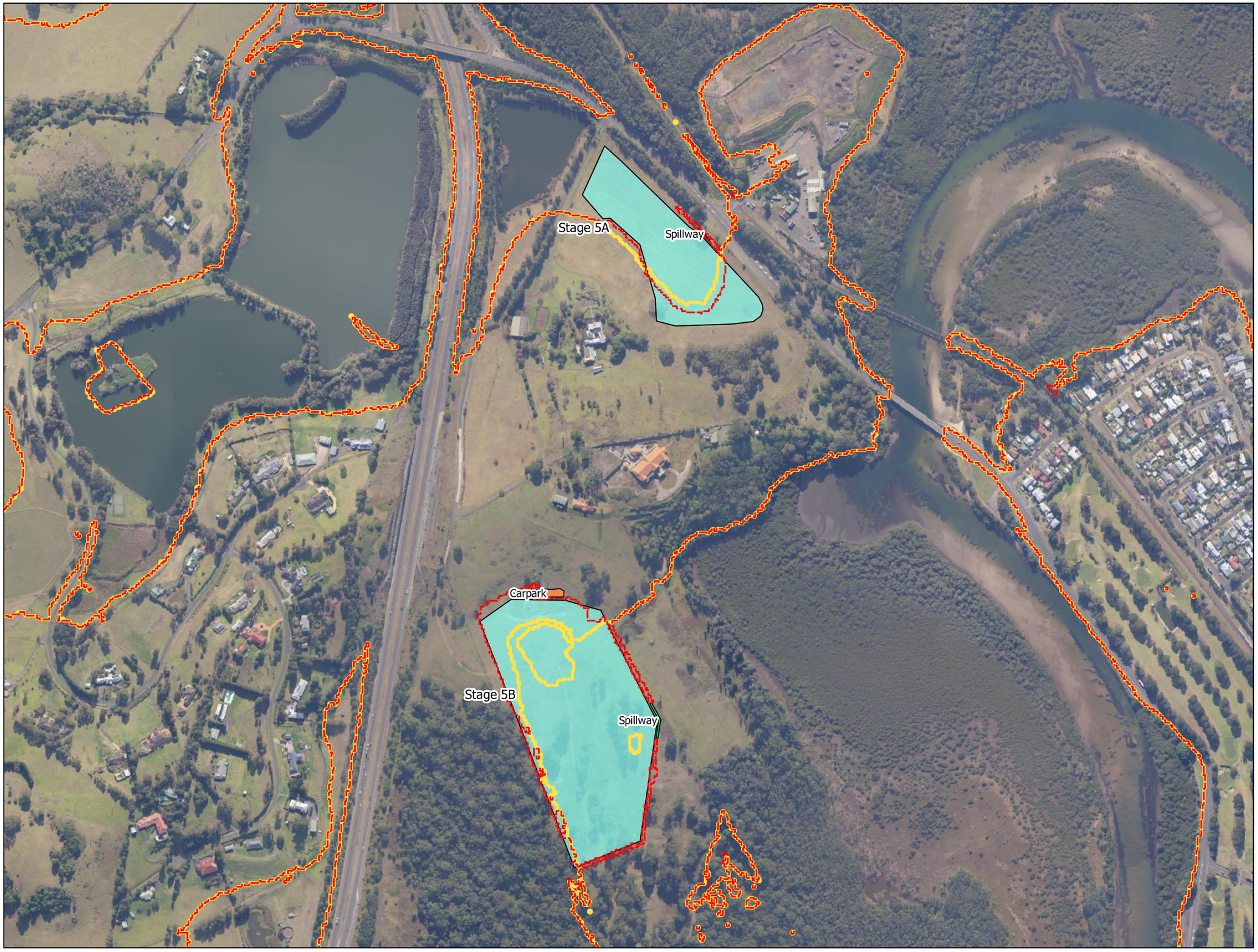

Legend

Existing_flood_extents

Proposed flood_extents

0 100 200 300 400 m

N

FIG 43. 100y ARI Flood extents pre and post.

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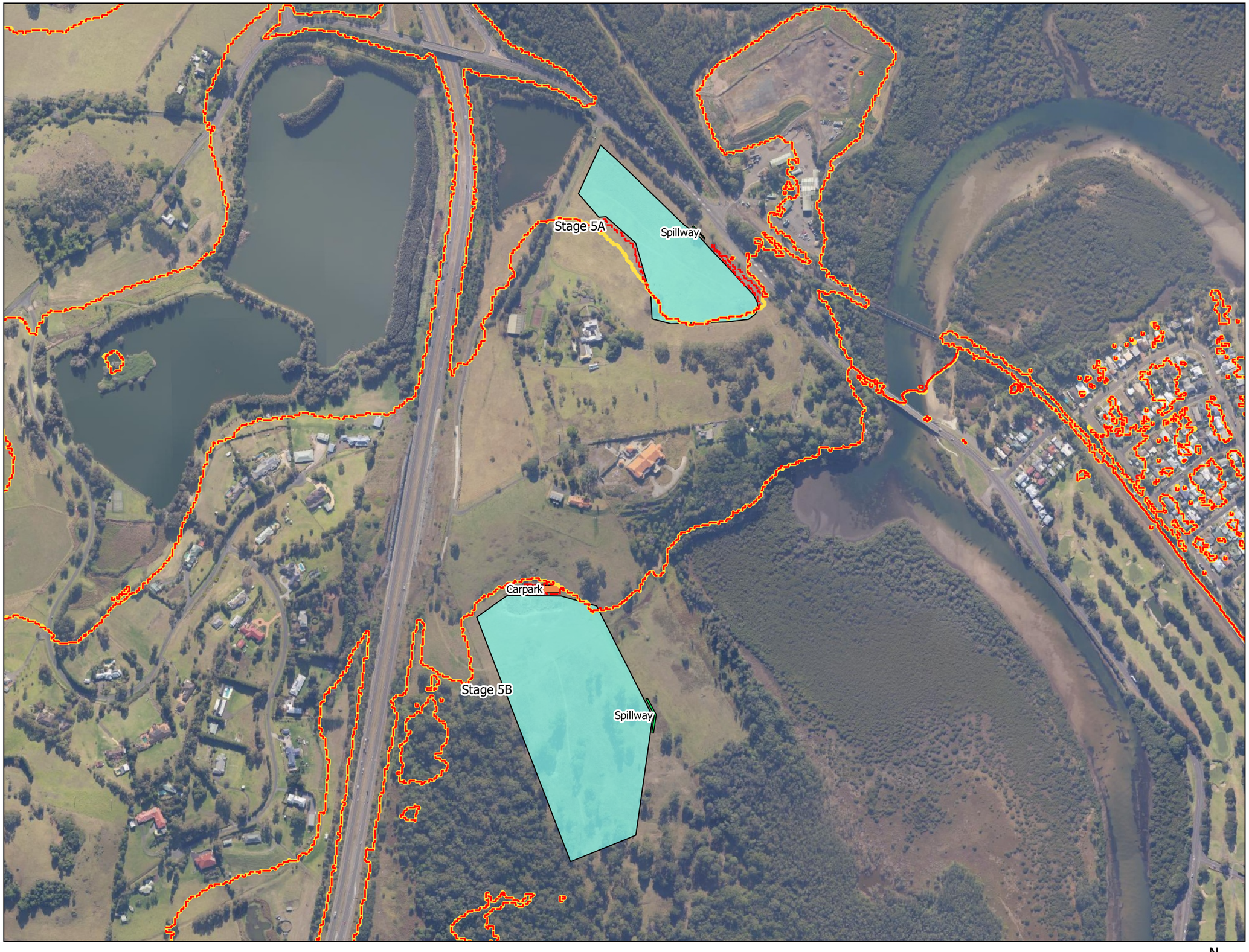

Legend

Existing_flood_extents

Proposed flood_extents

0 100 200 300 400 m

N

FIG 44. PMF Flood extents pre and post.

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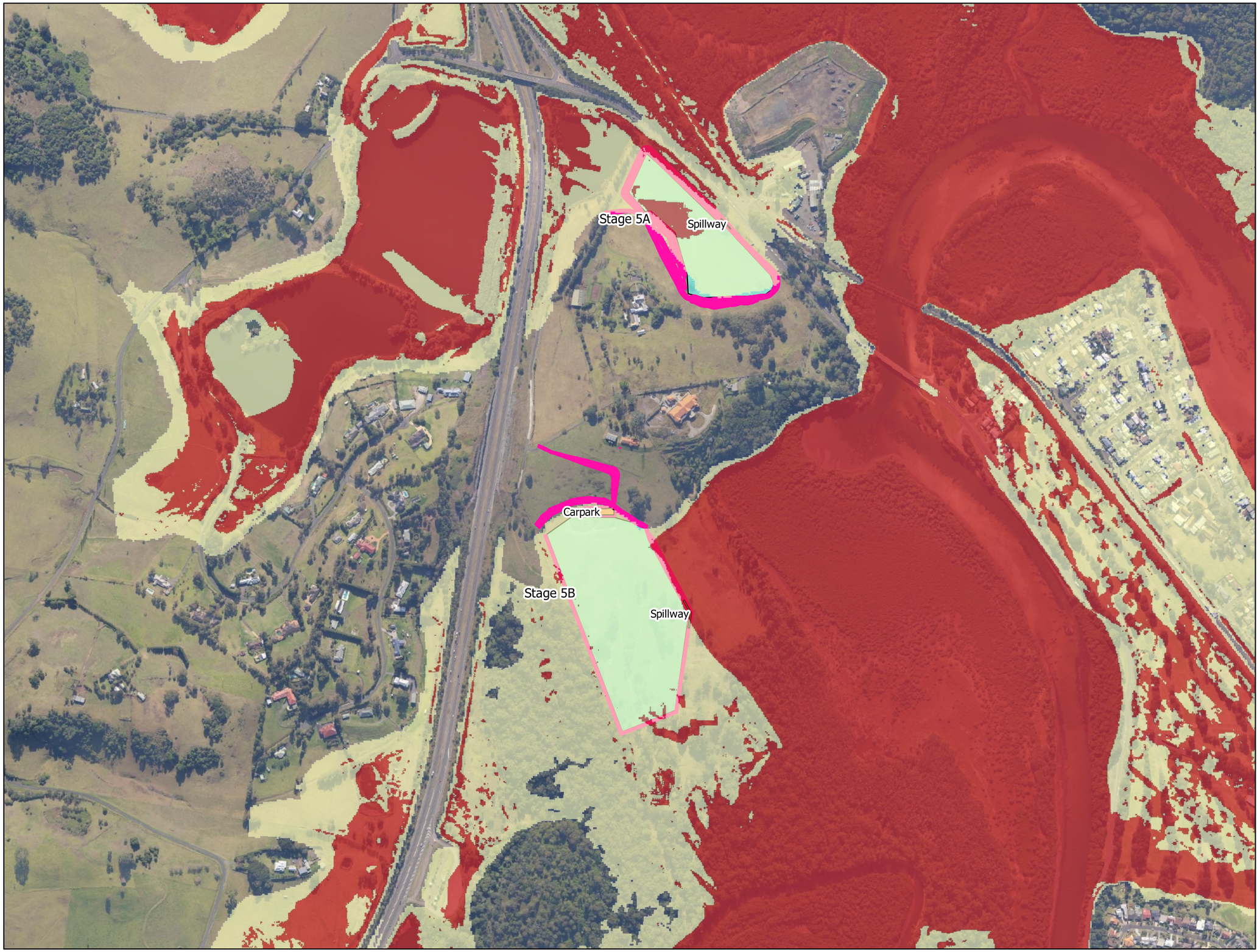
southeast

engineering+environmental



Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 45. PMF flood hazard, existing conditions.

17/09/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

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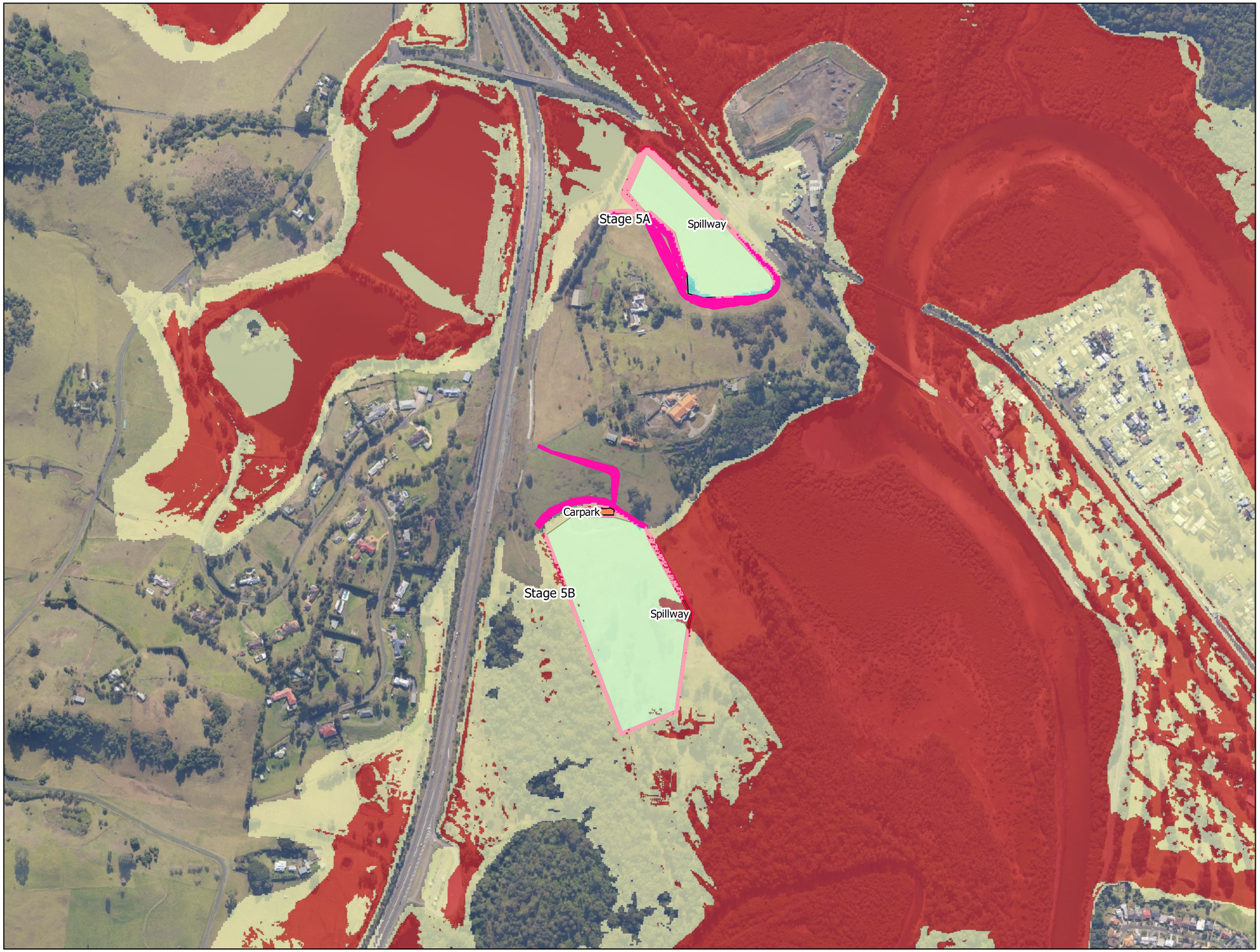

Legend

Dredge pond bunds and earthworks

Flood Hazard (VD<0.55=Low)

Low

High

0 100 200 300 400 m

N

FIG 46. PMF flood hazard, proposed conditions.

17/09/2019 Note: Flows within basin a function of model start conditions with basin water level above spillway for model stability.

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Appendix E

Water quality data

E.1 Average annual surface water quality

DSS Average Annual Surface Water Quality Results

		Field Parameters						Lab Results										
	Analyte	Temp (˚C)	Conductivity (µS-cm)	pH	DO (% Sat)	ORP (mV)	Turbidity (NTU)	pH	Turbidity (NTU)	O&G (mg-L)	TDS (mg-L)	TSS (mg-L)	Conductivity (µS-cm)	Sulfate (mg-L)	Chloride (mg-L)	Iron (mg-L)	Potassium (mg-L)	Magnesium (mg-L)
	Limit/WQO	-	1,500	6.5–8.5	-	-	5–20	6.5–8.5	5–20	-	-	50	1,500	250	300	6	50	50
DW10	FY06 Average	-	376	7.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW10	FY07 Average	17.70	428	7.36	-	-	-	-	-	-	-	8	881	-	-	-	-	-
DW10	FY08 Average	21.90	425	8.11	-	-	-	-	292.7	-	-	57	389	-	-	-	-	-
DW10	FY09 Average	16.60	627	7.06	-	-	-	-	20.8	-	-	24	766	-	-	-	-	-
DW10	FY10 Average	18.70	580	6.44	43	302	42.0	6.20	44.7	-	-	64	561	-	-	-	-	-
DW10	FY11 Average	16.30	272	6.07	55	326	44.8	6.40	21.3	-	-	43	332	-	-	-	-	-
DW10	FY12 Average	16.70	316	6.74	52	330	23.5	6.50	9.6	-	-	8	298	-	-	-	-	-
DW10	FY13 Average	17.80	422	6.46	54	143	52.4	6.70	20.5	-	-	15	409	-	-	-	-	-
DW10	FY14 Average	18.10	350	7.15	55	192	28.8	6.80	15.0	-	-	24	318	-	-	-	-	-
DW10	FY15 Average	16.30	274	7.27	45	251	16.8	7.00	15.3	-	-	16	330	-	-	-	-	-
DW10	FY16 Average	17.00	420	7.26	56	251	14.8	6.80	12.5	-	-	11	381	-	-	-	-	-
DW10	FY17 Average	13.90	459	7.86	76	281	22.5	7.50	18.1	-	-	14	486	128.00	58.00	0.14	8.70	9.65
DW10	FY18 Average	20.80	682	8.00	81	332	44.3	7.80	20.6	-	-	22	638	64.14	89.71	0.30	4.86	13.71
DW10	FY19 Average	20.90	663	6.68	38	322	28.0	6.40	38.2	-	-	89	686	18.14	107.86	8.71	7.00	19.29
DW10	FY20 Average	16.55	627	7.17	60	410	51.8	6.61	38.6	-	295	51	488	17.26	83.10	3.48	2.63	11.98
DW11	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW11	FY07 Average	20.10	445	7.58	-	-	-	-	7.0	-	-	32	837	-	-	-	-	-
DW11	FY08 Average	19.80	477	8.10	-	-	-	-	43.9	-	-	30	258	-	-	-	-	-
DW11	FY09 Average	13.30	12	7.25	-	-	-	-	-	-	-	1	1,030	-	-	-	-	-
DW11	FY10 Average	24.20	929	7.09	84	315	36.3	7.30	36.0	-	-	9	888	-	-	-	-	-
DW11	FY11 Average	16.50	647	6.74	85	347	79.0	7.50	34.7	-	-	15	682	-	-	-	-	-
DW11	FY12 Average	20.10	607	6.95	93	382	25.4	7.20	28.5	-	-	12	564	-	-	-	-	-
DW11	FY13 Average	18.70	614	6.83	92	105	39.3	7.40	32.4	-	-	13	594	-	-	-	-	-
DW11	FY14 Average	18.30	703	7.10	77	271	77.7	7.60	71.6	-	-	20	605	-	-	-	-	-
DW11	FY15 Average	16.20	602	7.30	72	349	36.5	7.60	26.3	-	-	14	646	-	-	-	-	-
DW11	FY16 Average	16.00	698	7.39	97	294	38.0	7.80	11.4	-	-	16	619	-	-	-	-	-
DW11	FY17 Average	19.00	890	8.06	119	210	31.8	7.80	76.0	-	-	47	623	-	-	-	-	-
DW11	FY18 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW11	FY19 Average	20.50	898	7.24	74	369	17.8	7.30	11.3	-	-	69	1,055	-	-	-	-	-
DW11	FY20 Average	20.13	811	6.94	84	426	27.5	7.37	14.4	-	1,025	19	801	-	-	-	-	-
DW12	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW12	FY07 Average	19.50	493	7.57	-	-	-	-	7.5	-	-	9	832	-	-	-	-	-
DW12	FY08 Average	22.00	716	7.87	-	-	-	-	6.3	-	-	24	-	-	-	-	-	-
DW12	FY09 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW12	FY10 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW12	FY11 Average	14.80	248	5.74	70	443	10.7	6.20	9.0	-	-	2	259	-	-	-	-	-
DW12	FY12 Average	-	-	-	-	-	-	6.20	14.4	-	-	2	220	-	-	-	-	-
DW12	FY13 Average	18.30	238	6.63	77	135	38.4	6.40	8.7	-	-	4	249	-	-	-	-	-
DW12	FY14 Average	18.70	318	7.25	45	331	32.0	6.60	14.4	-	-	23	213	-	-	-	-	-
DW12	FY15 Average	16.30	199	6.89	59	329	17.4	6.70	13.3	-	-	5	217	-	-	-	-	-
DW12	FY16 Average	15.00	186	8.30	80	295	9.8	6.60	6.9	-	-	1	336	-	-	-	-	-
DW12	FY17 Average	-	-	-	-	-	-	6.90	478.8	-	-	162	242	-	-	-	-	-
DW12	FY18 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW12	FY19 Average	25.50	372	5.89	75	504	34.9	5.90	33.2	-	-	7	356	-	-	-	-	-
DW12	FY20 Average	-	-	-	-	-	-	6.30	18.7	-	-	16	314	-	-	-	-	-
DW13	FY06 Average	-	608	7.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW13	FY07 Average	18.00	549	7.54	-	-	-	-	-	-	-	13	862	-	-	-	-	-
DW13	FY08 Average	23.00	379	7.61	-	-	-	-	29.0	-	-	33	704	-	-	-	-	-
DW13	FY09 Average	-	698	7.24	-	-	-	-	7.5	-	-	18	781	-	-	-	-	-
DW13	FY10 Average	21.00	654	6.96	33	217	10.0	6.80	14.1	-	-	17	847	-	-	-	-	-
DW13	FY11 Average	17.00	466	6.51	62	375	116.7	6.70	17.9	-	-	13	551	-	-	-	-	-
DW13	FY12 Average	15.50	512	6.63	43	337	15.4	6.80	16.4	-	-	10	493	-	-	-	-	-
DW13	FY13 Average	17.00	677	6.35	36	158	58.9	6.90	24.0	-	-	17	614	-	-	-	-	-
DW13	FY14 Average	17.00	638	7.20	26	190	22.6	7.20	18.7	-	-	76	529	-	-	-	-	-
DW13	FY15 Average	17.00	610	7.49	33	221	19.4	7.40	15.5	-	-	8	620	-	-	-	-	-
DW13	FY16 Average	16.00	422	7.49	47	199	21.9	7.60	16.2	-	-	75	417	-	-	-	-	-
DW13	FY17 Average	13.00	451	8.11	31	270	-	7.30	7.8	-	-	7	490	16.00	68.00	0.07	2.40	-
DW13	FY18 Average	16.50	668	7.42	51	362	134.3	7.40	29.6	-	-	36	663	41.00	56.00	0.21	4.50	11.00
DW13	FY19 Average	19.00	752	7.21	59	424	34.3	7.10	38.7	-	-	26	806	20.75	88.38	1.09	2.63	15.50
DW13	FY20 Average	14.58	916	7.22	53	398	51.3	7.00	37.4	-	460	14	706	47.00	128.00	0.59	4.40	8.60
DW14	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW14	FY07 Average	-	512	7.23	-	-	-	-	28.0	-	-	61	-	373.70	193.80	0.07	7.03	16.53
DW14	FY08 Average	20.00	1,809	7.41	-	-	-	-	570.0	-	-	307	2,310	822.50	293.30	0.13	8.40	19.82
DW14	FY09 Average	20.00	1,809	7.41	-	-	-	-	42.0	-	-	50	2,608	546.40	451.40	0.15	15.25	43.96
DW14	FY10 Average	20.80	2,978	7.73	89	269	46.5	7.80	33.0	-	-	28	2,833	494.70	544.10	0.10	22.37	56.17
DW14	FY11 Average	21.40	2,607	7.10	70	329	67.7	7.60	28.0	-	-	22	1,912	303.00	369.50	0.33	15.08	36.78
DW14	FY12 Average	18.90	808	7.40	86	332	45.8	7.70	30.9	-	-	11	966	127.30	140.20	0.49	8.83	17.04
DW14	FY13 Average	19.70	1,130	7.50	79	140	35.9	8.10	28.7	-	-	18	1,071	120.80	192.10	0.32	11.40	21.72
DW14	FY14 Average	19.40	868	7.50	74	216	40.9	8.10	36.3	-	-	20	843	103.00	154.70	0.50	10.43	15.29
DW14	FY15 Average	19.50	884	7.70	72	242	99.3	8.10	43.5	-	-	30	874	91.20	125.90	0.25	8.20	24.85
DW14	FY16 Average	19.50	884	7.70	72	242	99.3	8.10	46.8	-	-	30	534	68.83	58.92	0.26	6.51	13.98
DW14	FY17 Average	18.30	584	7.80	79	228	62.0	8.10	44.6	-	-	27	535	69.40	59.30	0.20	6.50	12.10
DW14	FY18 Average	18.80	757	8.52	90	337	34.0	8.40	21.2	-	-	16	715	74.10	98.70	0.20	4.10	13.30
DW14	FY19 Average	20.00	1,952	8.30	100	426	10.9	8.20	8.4	-	-	11	1,948	153.58	464.92	0.16	9.42	34.17
DW14	FY20 Average	18.85	1,975	7.92	97	397	14.3	8.19	9.4	-	1,219	8	1,991	169.67	441.17	0.18	10.96	33.42

DSS Average Annual Surface Water Quality Results

	Analyte	Soduim (mg-L)	Total Phosphrus (mg-L)	Ammonia -N (mg-L)	Bicarbonate Alkalinity (mg-L)	Nitrate - N (mg-L)	Nitrite - N (mg-L)	TKN (mg-L)	Total Nitrogen (mg-L)	Dissolved Oxygen (mg-L)	E.Coli (CFU-100mL)	Faecal Coliforms (CFU-100mL)
	Limit/WQO	400	0.005–0.05	20	750	-	-	-	0.1–0.5	6	-	1,000
DW10	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW10	FY17 Average	54.50	-	0.03	-	-	-	158.00	0.19	1.10	-	1.00
DW10	FY18 Average	82.00	8.43	-	128.14	-	-	0.73	0.20	6.00	-	1,716.71
DW10	FY19 Average	82.43	3.37	0.26	85.00	-	-	4.61	1.30	7.70	-	1,801.43
DW10	FY20 Average	30.51	0.28	1.13	77.50	0.28	0.29	1.41	1.65	6.72	680.00	358.00
DW11	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY18 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY19 Average	-	-	-	-	-	-	-	-	-	-	-
DW11	FY20 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY18 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY19 Average	-	-	-	-	-	-	-	-	-	-	-
DW12	FY20 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW13	FY17 Average	37.00	0.21	0.02	-	-	-	-	-	-	-	7.00
DW13	FY18 Average	96.50	0.25	0.01	165.50	-	-	-	-	6.38	-	1,315.00
DW13	FY19 Average	92.00	0.45	0.14	225.00	-	-	-	0.99	5.22	-	96.25
DW13	FY20 Average	181.00	0.14	-	155.00	0.97	0.02	0.05	1.04	7.75	-	-
DW14	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW14	FY07 Average	35.05	0.08	0.10	413.03	-	-	-	-	7.60	-	-
DW14	FY08 Average	100.97	0.14	0.34	124.04	-	-	0.05	-	7.27	-	-
DW14	FY09 Average	241.88	0.06	0.26	183.57	-	-	0.50	-	8.45	-	28.00
DW14	FY10 Average	323.80	0.04	0.19	197.01	-	-	0.50	-	8.59	-	54.00
DW14	FY11 Average	196.12	0.05	0.58	146.22	-	-	0.50	-	-	-	18.00
DW14	FY12 Average	81.10	0.05	0.07	117.90	-	-	0.50	-	-	-	60.00
DW14	FY13 Average	93.54	0.15	0.17	129.16	-	-	0.50	-	-	-	10.00
DW14	FY14 Average	80.25	0.08	0.07	135.46	-	-	0.50	-	-	-	28.00
DW14	FY15 Average	81.67	0.09	0.06	153.73	-	-	0.54	-	-	-	56.00
DW14	FY16 Average	56.33	0.08	0.12	134.25	-	-	0.47	-	-	-	14.67
DW14	FY17 Average	51.20	0.19	0.10	131.00	-	-	0.90	-	-	-	11.00
DW14	FY18 Average	90.50	0.20	0.40	137.20	-	-	0.80	0.60	9.10	-	7.10
DW14	FY19 Average	291.75	0.06	0.14	150.45	-	-	0.58	0.63	8.96	-	9.58
DW14	FY20 Average	141.67	0.05	0.06	118.17	0.35	0.21	0.34	0.60	8.73	15.00	8.00

DSS Average Annual Surface Water Quality Results

	Analyte	Enterococci (CFU-100mL)	Total Algae (cells-ml)	Blue Green Algae (cells-ml)	Chlorophyll-a (mg-m3)
	Limit/WQO	230	15,000	15,000	2–10
DW10	FY06 Average	-	-	-	-
DW10	FY07 Average	-	-	-	-
DW10	FY08 Average	-	-	-	-
DW10	FY09 Average	-	-	-	-
DW10	FY10 Average	-	-	-	-
DW10	FY11 Average	-	-	-	-
DW10	FY12 Average	-	-	-	-
DW10	FY13 Average	-	-	-	-
DW10	FY14 Average	-	-	-	-
DW10	FY15 Average	-	-	-	-
DW10	FY16 Average	-	-	-	-
DW10	FY17 Average	3,800	-	-	1
DW10	FY18 Average	11,556	-	-	464
DW10	FY19 Average	17,880	-	-	7,090
DW10	FY20 Average	185	74,526	2,447	124
DW11	FY06 Average	-	-	-	-
DW11	FY07 Average	-	-	-	-
DW11	FY08 Average	-	-	-	-
DW11	FY09 Average	-	-	-	-
DW11	FY10 Average	-	-	-	-
DW11	FY11 Average	-	-	-	-
DW11	FY12 Average	-	-	-	-
DW11	FY13 Average	-	-	-	-
DW11	FY14 Average	-	-	-	-
DW11	FY15 Average	-	-	-	-
DW11	FY16 Average	-	-	-	-
DW11	FY17 Average	-	-	-	-
DW11	FY18 Average	-	-	-	-
DW11	FY19 Average	-	-	-	-
DW11	FY20 Average	-	-	-	-
DW12	FY06 Average	-	-	-	-
DW12	FY07 Average	-	-	-	-
DW12	FY08 Average	-	-	-	-
DW12	FY09 Average	-	-	-	-
DW12	FY10 Average	-	-	-	-
DW12	FY11 Average	-	-	-	-
DW12	FY12 Average	-	-	-	-
DW12	FY13 Average	-	-	-	-
DW12	FY14 Average	-	-	-	-
DW12	FY15 Average	-	-	-	-
DW12	FY16 Average	-	-	-	-
DW12	FY17 Average	-	-	-	-
DW12	FY18 Average	-	-	-	-
DW12	FY19 Average	-	-	-	-
DW12	FY20 Average	-	-	-	-
DW13	FY06 Average	-	-	-	-
DW13	FY07 Average	-	-	-	-
DW13	FY08 Average	-	-	-	-
DW13	FY09 Average	-	-	-	-
DW13	FY10 Average	-	-	-	-
DW13	FY11 Average	-	-	-	-
DW13	FY12 Average	-	-	-	-
DW13	FY13 Average	-	-	-	-
DW13	FY14 Average	-	-	-	-
DW13	FY15 Average	-	-	-	-
DW13	FY16 Average	-	-	-	-
DW13	FY17 Average	7	-	160	-
DW13	FY18 Average	365	1,600	-	2
DW13	FY19 Average	187	1,142	-	1
DW13	FY20 Average	-	375	-	2
DW14	FY06 Average	-	-	-	-
DW14	FY07 Average	-	-	-	-
DW14	FY08 Average	-	-	-	-
DW14	FY09 Average	-	-	4,186	34
DW14	FY10 Average	-	-	18,195	21
DW14	FY11 Average	407	-	10,756	4
DW14	FY12 Average	17	-	6,099	8
DW14	FY13 Average	10	-	10,648	4
DW14	FY14 Average	64	-	27,512	11
DW14	FY15 Average	7	-	1,343	70
DW14	FY16 Average	7	-	8,578	7
DW14	FY17 Average	4	-	8,663	8
DW14	FY18 Average	8	8,219	-	8
DW14	FY19 Average	7	58,163	-	6
DW14	FY20 Average	9	145,248	128,564	3

DSS Average Annual Surface Water Quality Results

		Field Parameters						Lab Results										
	Analyte	Temp (˚C)	Conductivity (µS-cm)	pH	DO (% Sat)	ORP (mV)	Turbidity (NTU)	pH	Turbidity (NTU)	O&G (mg-L)	TDS (mg-L)	TSS (mg-L)	Conductivity (µS-cm)	Sulfate (mg-L)	Chloride (mg-L)	Iron (mg-L)	Potassium (mg-L)	Magnesium (mg-L)
	Limit/WQO	-	1,500	6.5–8.5	-	-	5–20	6.5–8.5	5–20	-	-	50	1,500	250	300	6	50	50
DW15a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW15a	FY07 Average	-	-	-	-	-	-	-	28.0	-	-	142	1,044	373.70	-	0.07	7.03	16.53
DW15a	FY08 Average	19.80	1,923	7.47	-	-	-	-	103.0	-	-	167	-	504.41	333.17	0.48	6.47	20.94
DW15a	FY09 Average	19.80	1,923	7.47	-	-	-	-	361.3	-	-	114	2,674	556.25	457.12	0.60	15.60	44.50
DW15a	FY10 Average	19.30	3,265	8.18	96	282	340.0	7.70	318.3	-	-	550	2,933	550.17	586.40	0.12	22.85	61.72
DW15a	FY11 Average	24.00	2,494	7.17	73	328	29.6	8.00	15.0	-	-	11	1,825	282.90	355.17	0.16	13.43	30.31
DW15a	FY12 Average	16.90	795	7.20	74	317	58.1	8.10	27.2	-	-	16	1,117	159.80	176.78	0.19	10.52	18.69
DW15a	FY13 Average	20.30	1,192	7.65	83	117	41.0	8.20	37.5	-	-	28	1,160	135.45	207.26	0.28	13.38	20.44
DW15a	FY14 Average	19.60	1,117	7.74	103	223	107.6	8.40	54.6	-	-	47	1,019	129.89	189.51	0.34	16.01	18.73
DW15a	FY15 Average	19.20	952	8.01	79	243	176.9	8.10	102.4	-	-	76	973	122.10	132.50	0.25	9.49	24.70
DW15a	FY16 Average	18.90	716	8.24	89	243	243.7	8.20	203.2	-	-	152	655	84.17	73.58	0.24	10.33	16.50
DW15a	FY17 Average	16.50	867	7.91	89	271	266.5	8.00	187.3	-	-	136	1,347	151.13	282.63	0.03	12.49	25.68
DW15a	FY18 Average	18.80	4,027	8.24	95	354	88.9	7.90	27.3	-	-	31	3,844	292.75	998.08	0.12	20.50	69.00
DW15a	FY19 Average	20.00	6,315	8.19	96	381	33.0	8.10	22.5	-	-	46	6,487	493.33	1,703.00	0.09	29.83	112.00
DW15a	FY20 Average	18.91	6,362	7.86	97	449	36.5	8.06	30.9	-	3,834	38	5,973	403.08	1,753.00	0.81	33.50	92.58
DW16	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW16	FY07 Average	-	-	-	-	-	-	-	5.7	-	-	3	604	49.40	-	0.65	3.21	8.26
DW16	FY08 Average	16.30	781	7.35	-	-	-	-	20.1	-	-	143	703	85.16	89.01	0.21	4.30	15.43
DW16	FY09 Average	16.30	781	7.35	-	-	-	-	42.8	-	-	176	981	133.32	127.15	0.48	6.69	26.34
DW16	FY10 Average	20.00	2,058	6.68	32	261	60.8	6.70	15.4	-	-	39	1,573	208.05	316.71	0.32	9.66	36.23
DW16	FY11 Average	17.30	630	6.67	64	300	373.9	7.20	4.2	-	-	11	661	64.26	77.54	0.16	3.09	17.44
DW16	FY12 Average	10.90	581	7.01	25	301	22.3	7.00	7.5	-	-	17	592	65.49	62.42	0.19	2.78	15.30
DW16	FY13 Average	14.40	575	6.60	41	120	16.9	7.00	10.7	-	-	9	558	72.18	64.03	0.30	5.17	12.72
DW16	FY14 Average	15.20	648	7.95	91	313	236.5	7.40	28.8	-	-	100	714	66.03	120.25	0.15	5.40	15.25
DW16	FY15 Average	15.20	648	7.96	91	313	236.5	7.70	176.6	-	-	368	630	87.67	72.00	0.07	5.23	17.00
DW16	FY16 Average	18.00	557	7.62	56	243	44.2	7.60	30.0	-	-	26	564	45.00	54.14	0.17	11.53	10.81
DW16	FY17 Average	16.10	509	8.40	99	260	52.3	7.90	34.2	-	-	19	680	84.00	159.50	0.13	7.95	16.65
DW16	FY18 Average	18.60	760	8.55	96	331	36.3	8.30	21.9	-	-	18	970	74.08	98.67	0.18	4.08	13.25
DW16	FY19 Average	20.70	2,335	8.03	91	445	12.9	8.10	9.5	-	-	16	2,369	130.50	385.25	0.12	7.75	26.50
DW16	FY20 Average	15.67	2,770	7.89	95	430	14.5	8.01	16.7	-	1,682	11	2,432	-	-	-	-	-
DW17	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW17	FY07 Average	18.10	690	7.57	-	-	-	-	-	-	-	9	1,900	-	-	-	-	-
DW17	FY08 Average	25.40	14,440	7.37	-	-	-	-	8.0	-	-	12	-	-	-	-	-	-
DW17	FY09 Average	17.00	1,450	6.86	-	-	-	-	28.0	-	-	20	1,276	-	-	-	-	-
DW17	FY10 Average	22.10	724	6.80	27	64	297.0	-	205.3	-	-	61	624	-	-	-	-	-
DW17	FY11 Average	14.40	523	6.20	51	360	204.0	6.60	77.4	-	-	77	384	-	-	-	-	-
DW17	FY12 Average	-	-	-	-	-	-	6.50	25.3	-	-	27	254	-	-	-	-	-
DW17	FY13 Average	20.10	5,262	6.80	41	90	59.6	6.90	21.6	-	-	20	4,740	-	-	-	-	-
DW17	FY14 Average	18.90	649	7.26	40	172	707.0	7.10	576.6	-	-	409	501	-	-	-	-	-
DW17	FY15 Average	17.10	679	7.40	51	183	63.6	7.20	44.8	-	-	26	532	-	-	-	-	-
DW17	FY16 Average	19.50	790	7.40	53	203	27.8	7.40	17.1	-	-	25	644	-	-	-	-	-
DW17	FY17 Average	16.60	1,110	6.90	53	297	33.4	7.30	29.4	-	-	34	6,922	-	-	-	-	-
DW17	FY18 Average	19.40	535	7.51	27	345	539.0	7.50	160.0	-	-	89	531	-	-	-	-	-
DW17	FY19 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW18	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW18	FY07 Average	18.90	743	6.72	-	-	-	-	42.5	-	-	25	3,140	-	-	-	-	-
DW18	FY08 Average	20.30	3,636	7.80	-	-	-	-	15.8	-	-	10	665	-	-	-	-	-
DW18	FY09 Average	17.40	746	7.19	-	-	-	-	148.0	-	-	241	856	-	-	-	-	-
DW18	FY10 Average	20.10	1,387	6.92	25	120	46.5	6.60	57.9	-	-	150	1,247	-	-	-	-	-
DW18	FY11 Average	18.20	403	6.40	46	303	52.9	6.70	18.0	-	-	31	424	-	-	-	-	-
DW18	FY12 Average	18.20	458	6.70	43	336	37.1	6.80	14.1	-	-	13	444	-	-	-	-	-
DW18	FY13 Average	19.60	823	6.90	62	90	38.3	6.80	26.4	-	-	28	808	-	-	-	-	-
DW18	FY14 Average	18.60	591	6.90	49	182	53.6	7.10	36.2	-	-	21	548	-	-	-	-	-
DW18	FY15 Average	17.20	708	7.50	53	263	57.4	7.10	21.2	-	-	32	703	-	-	-	-	-
DW18	FY16 Average	18.90	699	7.50	62	240	26.2	7.20	16.1	-	-	19	615	-	-	-	-	-
DW18	FY17 Average	15.30	879	7.30	67	265	40.4	7.40	26.2	-	-	21	4,134	25.50	61.30	0.40	4.60	7.70
DW18	FY18 Average	20.90	10,287	7.60	96	308	50.2	7.40	21.9	-	-	31	8,621	520.50	2,912.80	1.10	64.20	200.80
DW18	FY19 Average	21.50	3,199	7.19	75	452	38.3	7.30	16.2	-	-	18	3,242	971.00	6,218.00	0.50	137.50	456.00
DW18	FY20 Average	16.21	741	7.17	67	449	24.9	7.02	12.4	0	378	36	667	-	-	-	-	-
DW19	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY07 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY08 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY09 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY10 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY11 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY12 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY13 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY14 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY15 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY16 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW19	FY17 Average	16.40	1,344	7.90	80	265	60.0	7.60	31.7	-	-	28	1,377	93.30	279.30	0.10	11.50	22.20
DW19	FY18 Average	18.90	8,584	7.70	96	344	86.0	7.50	22.0	-	-	33	7,803	479.90	2,221.20	0.30	49.30	161.60
DW19	FY19 Average	20.70	5,790	7.97	102	445	8.9	7.90	7.4	-	-	17	6,273	390.70	1,602.50	0.10	27.90	113.80
DW19	FY20 Average	18.88	5,949	7.94	102	403	11.6	8.09	8.3	-	3,291	11	5,252	335.50	1,529.83	9.09	32.33	96.25
DW20a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

DSS Average Annual Surface Water Quality Results

	Analyte	Soduim (mg-L)	Total Phosphrus (mg-L)	Ammonia -N (mg-L)	Bicarbonate Alkalinity (mg-L)	Nitrate - N (mg-L)	Nitrite - N (mg-L)	TKN (mg-L)	Total Nitrogen (mg-L)	Dissolved Oxygen (mg-L)	E.Coli (CFU-100mL)	Faecal Coliforms (CFU-100mL)
	Limit/WQO	400	0.005–0.05	20	750	-	-	-	0.1–0.5	6	-	1,000
DW15a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW15a	FY07 Average	35.05	-	0.06	-	-	-	-	-	7.63	-	-
DW15a	FY08 Average	114.49	0.21	0.28	-	-	-	0.50	-	7.61	-	-
DW15a	FY09 Average	247.88	0.05	0.23	167.21	-	-	0.50	-	8.37	-	-
DW15a	FY10 Average	329.77	0.05	0.13	203.53	-	-	0.50	-	8.53	-	-
DW15a	FY11 Average	176.52	0.05	0.11	-	-	-	0.50	-	-	-	64.50
DW15a	FY12 Average	101.62	0.04	0.08	-	-	-	0.50	-	-	-	30.00
DW15a	FY13 Average	109.15	0.26	0.30	-	-	-	0.50	-	-	-	20.00
DW15a	FY14 Average	120.02	0.07	0.06	-	-	-	0.50	-	-	-	82.50
DW15a	FY15 Average	98.58	0.10	0.03	-	-	-	0.57	-	-	-	117.00
DW15a	FY16 Average	68.42	0.09	0.06	-	-	-	0.53	-	-	-	37.50
DW15a	FY17 Average	137.63	0.07	0.02	-	-	-	1.59	-	-	-	11.40
DW15a	FY18 Average	551.92	0.12	0.12	159.75	-	-	1.06	0.93	9.04	-	492.83
DW15a	FY19 Average	928.92	0.09	0.10	167.50	-	-	0.75	0.81	8.56	-	77.08
DW15a	FY20 Average	418.00	0.09	0.11	130.25	0.95	3.70	1.71	5.07	8.65	-	48.00
DW16	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW16	FY07 Average	14.62	-	0.03	-	-	-	-	-	7.79	-	-
DW16	FY08 Average	54.40	0.14	0.10	-	-	-	0.50	-	7.30	-	-
DW16	FY09 Average	98.43	0.76	0.73	142.33	-	-	-	-	8.28	-	-
DW16	FY10 Average	169.59	0.43	0.41	96.83	-	-	-	-	8.62	-	-
DW16	FY11 Average	68.88	0.21	0.10	-	-	-	0.50	-	-	-	140.00
DW16	FY12 Average	53.75	0.10	0.05	-	-	-	0.67	-	-	-	-
DW16	FY13 Average	45.50	0.08	0.28	-	-	-	0.50	-	-	-	50.00
DW16	FY14 Average	71.00	0.18	0.01	-	-	-	0.50	-	-	-	-
DW16	FY15 Average	53.00	0.10	0.05	-	-	-	0.50	-	-	-	-
DW16	FY16 Average	51.00	0.31	0.02	-	-	-	0.33	-	-	-	60.00
DW16	FY17 Average	85.25	0.14	0.02	-	-	-	1.41	-	-	-	7.00
DW16	FY18 Average	90.50	0.16	0.35	137.20	-	-	0.81	0.63	9.14	-	7.08
DW16	FY19 Average	227.00	0.04	0.10	149.50	-	-	0.50	0.60	8.88	-	2.50
DW16	FY20 Average	-	-	-	-	-	-	-	-	10.40	-	-
DW17	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY18 Average	-	-	-	-	-	-	-	-	-	-	-
DW17	FY19 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW18	FY17 Average	26.30	0.20	0.01	-	-	-	-	75.00	-	-	72.50
DW18	FY18 Average	1,628.30	0.50	0.12	96.80	-	-	2.00	2.10	7.90	-	4,825.00
DW18	FY19 Average	3,773.50	0.10	0.32	99.50	-	-	2.00	2.00	6.20	-	755.00
DW18	FY20 Average	-	-	-	-	-	-	-	-	5.86	-	-
DW19	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW19	FY17 Average	111.00	0.05	0.03	-	-	-	1.50	-	-	-	10.30
DW19	FY18 Average	1,336.40	0.10	0.10	158.10	-	-	1.30	1.10	8.60	-	134.40
DW19	FY19 Average	927.60	0.00	0.16	193.70	-	-	0.70	0.80	8.80	-	8.10
DW19	FY20 Average	464.17	0.05	0.18	130.58	1.19	2.78	1.53	4.11	8.77	-	7.00
DW20a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-

DSS Average Annual Surface Water Quality Results

	Analyte	Enterococci (CFU-100mL)	Total Algae (cells-ml)	Blue Green Algae (cells-ml)	Chlorophyll-a (mg-m3)
	Limit/WQO	230	15,000	15,000	2–10
DW15a	FY06 Average	-	-	-	-
DW15a	FY07 Average	-	-	-	-
DW15a	FY08 Average	-	-	-	-
DW15a	FY09 Average	76	-	2,306	13
DW15a	FY10 Average	-	-	-	-
DW15a	FY11 Average	1,691	-	2,062	6
DW15a	FY12 Average	47	-	29,379	25
DW15a	FY13 Average	10	-	3,619	11
DW15a	FY14 Average	308	-	7,217	8
DW15a	FY15 Average	25	-	689	282
DW15a	FY16 Average	12	-	3,475	8
DW15a	FY17 Average	7	-	5,910	12
DW15a	FY18 Average	886	11,444	-	18
DW15a	FY19 Average	36	96,195	-	23
DW15a	FY20 Average	24	506,520	649,142	12
DW16	FY06 Average	-	-	-	-
DW16	FY07 Average	-	-	-	-
DW16	FY08 Average	-	-	-	-
DW16	FY09 Average	24	-	86,161	-
DW16	FY10 Average	400	-	38,508	-
DW16	FY11 Average	165	-	493	-
DW16	FY12 Average	-	-	-	-
DW16	FY13 Average	80	-	4,851	6
DW16	FY14 Average	-	-	-	-
DW16	FY15 Average	-	-	-	-
DW16	FY16 Average	15	-	3,037	5
DW16	FY17 Average	-	-	3,671	4
DW16	FY18 Average	8	8,219	-	8
DW16	FY19 Average	6	41,100	-	2
DW16	FY20 Average	-	-	-	-
DW17	FY06 Average	-	-	-	-
DW17	FY07 Average	-	-	-	-
DW17	FY08 Average	-	-	-	-
DW17	FY09 Average	-	-	-	-
DW17	FY10 Average	-	-	-	-
DW17	FY11 Average	-	-	-	-
DW17	FY12 Average	-	-	-	-
DW17	FY13 Average	-	-	-	-
DW17	FY14 Average	-	-	-	-
DW17	FY15 Average	-	-	-	-
DW17	FY16 Average	-	-	-	-
DW17	FY17 Average	-	-	-	-
DW17	FY18 Average	-	-	-	-
DW17	FY19 Average	-	-	-	-
DW18	FY06 Average	-	-	-	-
DW18	FY07 Average	-	-	-	-
DW18	FY08 Average	-	-	-	-
DW18	FY09 Average	-	-	-	-
DW18	FY10 Average	-	-	-	-
DW18	FY11 Average	-	-	-	-
DW18	FY12 Average	-	-	-	-
DW18	FY13 Average	-	-	-	-
DW18	FY14 Average	-	-	-	-
DW18	FY15 Average	-	-	-	-
DW18	FY16 Average	-	-	-	-
DW18	FY17 Average	-	-	515	3
DW18	FY18 Average	749	235,830	-	46
DW18	FY19 Average	19	750	-	10
DW18	FY20 Average	-	-	-	-
DW19	FY06 Average	-	-	-	-
DW19	FY07 Average	-	-	-	-
DW19	FY08 Average	-	-	-	-
DW19	FY09 Average	-	-	-	-
DW19	FY10 Average	-	-	-	-
DW19	FY11 Average	-	-	-	-
DW19	FY12 Average	-	-	-	-
DW19	FY13 Average	-	-	-	-
DW19	FY14 Average	-	-	-	-
DW19	FY15 Average	-	-	-	-
DW19	FY16 Average	-	-	-	-
DW19	FY17 Average	6	-	4,565	4
DW19	FY18 Average	49	45,587	-	16
DW19	FY19 Average	8	186,163	-	7
DW19	FY20 Average	6	729,733	707,910	5
DW20a	FY06 Average	-	-	-	-

DSS Average Annual Surface Water Quality Results

		Field Parameters						Lab Results										
	Analyte	Temp (˚C)	Conductivity (µS-cm)	pH	DO (% Sat)	ORP (mV)	Turbidity (NTU)	pH	Turbidity (NTU)	O&G (mg-L)	TDS (mg-L)	TSS (mg-L)	Conductivity (µS-cm)	Sulfate (mg-L)	Chloride (mg-L)	Iron (mg-L)	Potassium (mg-L)	Magnesium (mg-L)
	Limit/WQO	-	1,500	6.5–8.5	-	-	5–20	6.5–8.5	5–20	-	-	50	1,500	250	300	6	50	50
DW20a	FY07 Average	17.70	426	7.12	-	-	-	-	23.0	-	-	24	-	-	-	-	-	-
DW20a	FY08 Average	23.00	490	7.76	-	-	-	-	8.5	-	-	3	593	-	-	-	-	-
DW20a	FY09 Average	18.10	3,275	6.85	-	-	-	-	24.6	-	-	65	4,778	-	-	-	-	-
DW20a	FY10 Average	20.40	3,523	6.88	44	189	48.0	6.70	21.5	-	-	37	7,268	-	-	-	-	-
DW20a	FY11 Average	17.90	493	6.40	45	337	91.0	6.60	13.4	-	-	10	485	-	-	-	-	-
DW20a	FY12 Average	19.40	590	6.00	36	397	5.5	6.90	15.4	-	-	13	524	-	-	-	-	-
DW20a	FY13 Average	18.50	2,171	6.60	56	106	49.4	6.70	19.5	-	-	21	1,606	-	-	-	-	-
DW20a	FY14 Average	18.90	586	6.80	28	216	104.0	7.30	21.0	-	-	20	534	-	-	-	-	-
DW20a	FY15 Average	17.80	789	7.40	49	292	503.6	7.40	13.6	-	-	13	681	-	-	-	-	-
DW20a	FY16 Average	19.50	586	7.79	46	232	41.7	7.40	25.3	-	-	31	2,062	-	-	-	-	-
DW20b	FY17 Average	18.00	611	8.40	82	272	77.0	7.70	32.2	-	-	26	1,308	-	-	-	-	-
DW20b	FY18 Average	18.60	4,424	8.00	73	351	48.3	7.50	22.2	-	-	17	4,066	-	-	-	-	-
DW20b	FY19 Average	21.10	2,749	8.02	86	451	10.9	8.00	7.2	-	-	13	2,778	-	-	-	-	-
DW20b	FY20 Average	16.41	3,579	7.88	90	407	9.8	7.90	6.5	-	2,283	10	3,441	-	-	-	-	-
DW21a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY07 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY08 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY09 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY10 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY11 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY12 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY13 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY14 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY15 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY16 Average	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY17 Average	15.90	920	8.50	53	235	35.2	7.40	14.6	-	-	20	4,676.00	-	-	-	-	-
DW21a	FY18 Average	17.60	25,046	7.50	79	325	30.5	7.50	10.5	-	-	16	26,582.00	-	-	-	-	-
DW21a	FY19 Average	21.60	11,585	7.52	90	460	12.1	7.60	9.6	-	-	14	9,855.00	-	-	-	-	-
DW21a	FY20 Average	15.33	21,620	7.43	89	436	11.2	7.57	6.8	-	13,559	16	19,238.23	-	-	-	-	-
DW9	FY06 Average	-	648	7.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DW9	FY07 Average	19.40	472	7.48	-	-	-	-	-	-	-	68	582.00	-	-	-	-	-
DW9	FY08 Average	21.50	602	7.36	-	-	-	-	258.3	-	-	17	562.00	-	-	-	-	-
DW9	FY09 Average	17.70	556	7.32	-	-	-	-	187.2	-	-	47	815.00	-	-	-	-	-
DW9	FY10 Average	19.50	732	6.82	-	244	94.8	6.70	47.5	-	-	75	689.00	-	-	-	-	-
DW9	FY11 Average	16.30	431	6.04	-	342	80.0	6.60	25.1	-	-	73	607.00	-	-	-	-	-
DW9	FY12 Average	-	-	-	-	-	-	6.40	56.9	-	-	179	372.00	-	-	-	-	-
DW9	FY13 Average	-	-	-	-	-	-	6.70	42.5	-	-	102	453.00	-	-	-	-	-
DW9	FY14 Average	20.30	275	7.70	-	399	302.3	7.00	100.5	-	-	42	225.00	-	-	-	-	-
DW9	FY15 Average	15.00	460	7.40	-	321	51.3	7.60	22.3	-	-	12	461.00	-	-	-	-	-
DW9	FY16 Average	16.10	445	7.06	-	269	30.3	7.40	38.0	-	-	27	351.00	-	-	-	-	-
DW9	FY17 Average	-	-	-	-	-	-	7.40	18.0	-	-	23	271.00	-	-	-	-	-
DW9	FY18 Average	16.60	337	7.61	87	396	129.0	7.60	79.9	-	-	47	350.00	19.00	39.50	0.21	1.50	5.50
DW9	FY19 Average	18.90	453	7.11	59	413	13.7	7.00	13.3	-	-	15	487.00	10.75	73.92	1.98	1.67	12.75
DW9	FY20 Average	16.05	527	7.46	56	388	16.8	7.02	15.8	-	247	23	429.44	11.59	68.25	2.08	2.36	9.39

Notes: Red denotes WQO value exceeded

DSS Average Annual Surface Water Quality Results

	Analyte	Soduim (mg-L)	Total Phosphrus (mg-L)	Ammonia -N (mg-L)	Bicarbonate Alkalinity (mg-L)	Nitrate - N (mg-L)	Nitrite - N (mg-L)	TKN (mg-L)	Total Nitrogen (mg-L)	Dissolved Oxygen (mg-L)	E.Coli (CFU-100mL)	Faecal Coliforms (CFU-100mL)
	Limit/WQO	400	0.005–0.05	20	750	-	-	-	0.1–0.5	6	-	1,000
DW20a	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW20a	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW20b	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW20b	FY18 Average	-	-	-	-	-	-	-	-	-	-	-
DW20b	FY19 Average	-	-	-	-	-	-	-	-	-	-	-
DW20b	FY20 Average	-	-	-	-	-	-	-	-	9.16	-	-
DW21a	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY18 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY19 Average	-	-	-	-	-	-	-	-	-	-	-
DW21a	FY20 Average	-	-	-	-	-	-	-	-	10.60	-	-
DW9	FY06 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY07 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY08 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY09 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY10 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY11 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY12 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY13 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY14 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY15 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY16 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY17 Average	-	-	-	-	-	-	-	-	-	-	-
DW9	FY18 Average	29.00	0.21	-	57.00	-	-	-	1.60	8.37	-	1,865.00
DW9	FY19 Average	58.92	0.26	0.14	107.25	-	-	0.63	0.77	5.48	-	472.58
DW9	FY20 Average	27.71	0.14	0.17	82.92	0.28	0.25	0.31	0.59	8.08	20.00	12.50

Notes: Red denotes WQO value exceeded

DSS Average Annual Surface Water Quality Results

	Analyte	Enterococci (CFU-100mL)	Total Algae (cells-ml)	Blue Green Algae (cells-ml)	Chlorophyll-a (mg-m3)
	Limit/WQO	230	15,000	15,000	2–10
DW20a	FY07 Average	-	-	-	-
DW20a	FY08 Average	-	-	-	-
DW20a	FY09 Average	-	-	-	-
DW20a	FY10 Average	-	-	-	-
DW20a	FY11 Average	-	-	-	-
DW20a	FY12 Average	-	-	-	-
DW20a	FY13 Average	-	-	-	-
DW20a	FY14 Average	-	-	-	-
DW20a	FY15 Average	-	-	-	-
DW20a	FY16 Average	-	-	-	-
DW20b	FY17 Average	-	-	-	-
DW20b	FY18 Average	-	-	-	-
DW20b	FY19 Average	-	-	-	-
DW20b	FY20 Average	-	-	-	-
DW21a	FY06 Average	-	-	-	-
DW21a	FY07 Average	-	-	-	-
DW21a	FY08 Average	-	-	-	-
DW21a	FY09 Average	-	-	-	-
DW21a	FY10 Average	-	-	-	-
DW21a	FY11 Average	-	-	-	-
DW21a	FY12 Average	-	-	-	-
DW21a	FY13 Average	-	-	-	-
DW21a	FY14 Average	-	-	-	-
DW21a	FY15 Average	-	-	-	-
DW21a	FY16 Average	-	-	-	-
DW21a	FY17 Average	-	-	-	-
DW21a	FY18 Average	-	-	-	-
DW21a	FY19 Average	-	-	-	-
DW21a	FY20 Average	-	-	-	-
DW9	FY06 Average	-	-	-	-
DW9	FY07 Average	-	-	-	-
DW9	FY08 Average	-	-	-	-
DW9	FY09 Average	-	-	-	-
DW9	FY10 Average	-	-	-	-
DW9	FY11 Average	-	-	-	-
DW9	FY12 Average	-	-	-	-
DW9	FY13 Average	-	-	-	-
DW9	FY14 Average	-	-	-	-
DW9	FY15 Average	-	-	-	-
DW9	FY16 Average	-	-	-	-
DW9	FY17 Average	-	-	-	-
DW9	FY18 Average	2,668	-	-	-
DW9	FY19 Average	713	581	-	3
DW9	FY20 Average	13	2,858	2,399	9

Notes: Red denotes WQO value exceeded

E.2 Stage 5 groundwater quality

DSS Groundwater Quality Results

Analyte		pH	ORP (mv)	Fluoride (mg/L)	TDS (mg-L)	Calcium (mg/L)	Conductivity (µS-cm)	Sulfate (mg-L)	Chloride (mg-L)	Iron (mg-L)	Potassium (mg-L)	Magnesium (mg-L)	Soduim(mg-L)	Total Phosphrus (mg-L)	Ammonia -N (mg-L)
Limit/WQO		6.5–8.5	-	-	-	-	1,500	250	300	6	50	50	400	0.005–0.05	20
Sample ID	**Date**														
MW5A1	Oct-18	6.70	-	0	130	24	-	17	24	1.00	5.10	5	11	-	0.10
MW5A1	Nov-18	6.00	-	0	92	10	-	9	26	0.31	9.30	5	10	-	0.10
MW5A1	Jan-19	7.20	-	0	240	68	-	14	28	0.08	5.00	6	8	-	0.10
MW5A1	Aug-19	5.80	-	0	115	17	210	19	29	0.67	3.10	5	13	-	-
MW5A1	Nov-19	5.80	-	0	140	10	187	33	30	0.10	4.90	5	25	-	-
MW5A1	Feb-20	6.70	464.0	1	0	34	261	23	46	0.49	17.73	16	150	0.16	0.01
MW5A1	May-20	5.80	475.0	1	0	20	260	27	42	1.52	8.37	6	5	0.05	0.01
MW5A1	Aug-20	6.80	412.0	1	0	18	935	46	36	0.87	10.00	4	15	0.01	0.01
MW5A2	Oct-18	6.70	-	0	365	48	-	8	70	4.40	1.20	24	63	-	0.70
MW5A2	Feb-20	6.60	469.0	1	0	67	903	47	83	0.80	2.50	26	81	0.01	0.01
MW5A2	May-20	6.60	323.0	1	0	65	965	25	99	2.36	4.51	34	30	0.20	0.01
MW5A2	Aug-20	6.90	351.0	1	0	27	294	62	96	1.90	1.40	20	63	0.25	0.01
MW5A3	Oct-18	6.70	-	0	735	55	-	11	355	5.50	8.80	28	185	-	1.10
MW5A3	Nov-18	6.70	-	0	510	67	-	14	210	2.70	12.00	19	98	-	0.50
MW5A3	Jan-19	6.30	-	0	1,090	94	-	34	560	3.40	15.00	38	235	-	1.40
MW5A3	Aug-19	7.40	-	0	475	49	927	14	180	4.60	4.40	12	100	-	-
MW5A3	Nov-19	7.40	-	0	515	43	786	15	200	3.50	5.40	11	125	-	-
MW5A3	Feb-20	6.80	443.0	1	0	66	1,215	13	265	5.33	12.07	15	162	0.27	0.01
MW5A3	May-20	7.40	383.0	1	0	35	850	9	159	4.11	4.04	11	33	0.18	0.01
MW5A3	Aug-20	6.90	348.0	1	0	19	733	16	126	3.00	5.60	6	88	0.16	0.01
MW5B1	Oct-18	7.70	-	0	205	52	-	8	24	0.44	4.10	7	17	-	0.10
MW5B1	Feb-20	7.70	428.0	1	0	50	417	36	33	0.35	8.55	7	27	0.13	0.01
MW5B1	May-20	7.70	343.0	1	0	42	397	30	36	0.79	5.43	7	7	0.06	0.01
MW5B1	Aug-20	7.60	340.0	1	0	22	387	32	30	0.13	7.70	4	18	0.05	0.01
MW5B2-D	Oct-18	7.60	-	0	355	78	-	11	53	0.18	5.60	14	37	-	0.70
MW5B2-D	Jan-19	7.30	-	0	355	90	-	16	57	0.23	5.70	12	28	-	0.60
MW5B2-D	Feb-20	7.50	432.0	1	0	83	676	20	56	0.61	9.34	16	64	0.12	0.01
MW5B2-D	May-20	8.00	317.0	1	0	64	680	17	66	4.40	2.81	12	11	0.11	0.01
MW5B2-D	Aug-20	7.50	334.0	1	0	30	688	31	57	1.50	6.20	8	36	0.06	0.01
MW5B2-S	Oct-18	7.60	-	0	385	82	-	32	57	0.20	6.30	14	51	-	0.40
MW5B2-S	Jan-19	7.30	-	0	420	100	-	38	51	1.30	6.40	12	36	-	0.40
MW5B2-S	Aug-19	7.40	-	0	440	92	742	39	46	1.20	3.80	14	48	-	-
MW5B2-S	Aug-19	7.40	-	0	440	92	742	39	46	1.20	3.80	14	48	-	-
MW5B2-S	Aug-19	7.40	-	0	440	92	742	39	46	1.20	3.80	14	48	-	-
MW5B2-S	Nov-19	7.10	-	0	385	86	633	31	45	0.16	4.30	12	50	-	-
MW5B2-S	Feb-20	7.40	435.0	1	0	93	724	36	45	0.84	9.09	15	74	0.14	0.01
MW5B2-S	May-20	7.40	319.0	1	0	81	724	35	49	1.18	3.39	13	13	0.05	0.01
MW5B2-S	Aug-20	7.30	342.0	1	0	31	662	51	38	0.72	5.10	8	33	0.05	0.01
MW5B3	Oct-18	7.70	-	0	260	70	-	2	33	0.27	1.60	10	17	-	0.20
MW5B3	Feb-20	7.70	435.0	1	0	84	563	5	45	0.21	5.47	12	43	0.25	0.01
MW5B3	May-20	7.80	304.0	1	0	65	620	3	52	0.89	2.00	12	10	0.10	0.01
MW5B3	Aug-20	7.60	308.0	1	0	29	546	26	38	0.26	2.40	6	19	0.04	0.01
MW5B4	Oct-18	7.60	-	0	315	89	-	2	25	0.08	1.70	10	16	-	0.30
MW5B4	Jan-19	7.30	-	0	360	105	-	18	32	0.04	2.40	9	13	-	0.20
MW5B4	Aug-19	7.60	-	0	390	100	-	11	34	0.09	2.30	11	36	-	-
MW5B4	Feb-20	7.60	434.0	1	0	115	603	14	42	0.32	5.10	8	54	0.41	0.01
MW5B4	May-20	7.40	299.0	1	0	52	592	5	41	0.52	2.49	5	10	0.06	0.01
MW5B4	Aug-20	7.70	307.0	1	0	28	533	35	30	0.16	2.50	5	22	0.06	0.01
MW5B5	Oct-18	7.50	-	0	580	130	-	2	160	0.06	2.60	18	65	-	0.40
MW5B5	Jan-19	7.20	-	0	650	160	-	12	175	0.17	3.30	18	54	-	0.30

Notes: Red denotes WQO value exceeded

DSS Groundwater Quality Results

Analyte		Bicarbonate Alkalinity (mg-L)	Nitrate - N (mg-L)	Nitrite - N (mg-L)	TKN (mg-L)	Total Nitrogen (mg-L)	Dissolved Oxygen (mg-L)	E.Coli (CFU-100mL)	Faecal Coliforms (CFU-100mL)	Enterococci (CFU-100mL)
Limit/WQO		750	-	-	-	0.1–0.5	6	-	1,000	230
Sample ID	**Date**									
MW5A1	Oct-18	70	2.90	-	-	-	-	-	-	-
MW5A1	Nov-18	33	3.60	-	-	-	-	-	-	-
MW5A1	Jan-19	200	0.89	-	-	-	-	-	-	-
MW5A1	Aug-19	26	9.80	-	-	3.10	-	-	-	-
MW5A1	Nov-19	24	11.00	-	-	3.70	-	-	-	-
MW5A1	Feb-20	50	2.05	0.01	0.19	2.25	7.72	1.00	1.00	1
MW5A1	May-20	29	6.36	0.01	0.01	6.37	7.34	1.00	1.00	1
MW5A1	Aug-20	15	8.59	0.01	0.01	8.59	8.11	1.00	1.00	1
MW5A2	Oct-18	295	0.10	-	-	-	-	-	-	-
MW5A2	Feb-20	336	0.91	0.01	0.29	1.20	6.38	1.00	1.00	1
MW5A2	May-20	330	0.31	0.01	0.03	0.35	6.78	1.00	1.00	33
MW5A2	Aug-20	329	0.19	0.01	0.01	0.19	6.56	1.00	1.00	1
MW5A3	Oct-18	165	0.10	-	-	-	-	-	-	-
MW5A3	Nov-18	190	0.10	-	-	-	-	-	-	-
MW5A3	Jan-19	155	0.10	-	-	-	-	-	-	-
MW5A3	Aug-19	180	0.10	-	-	2.10	-	-	-	-
MW5A3	Nov-19	185	0.10	-	-	1.80	-	-	-	-
MW5A3	Feb-20	185	1.15	0.01	0.43	1.59	6.66	1.00	1.00	1
MW5A3	May-20	151	0.28	0.04	0.01	0.32	7.56	10.00	10.00	1
MW5A3	Aug-20	224	0.19	0.01	0.02	0.22	7.34	1.00	1.00	1
MW5B1	Oct-18	180	12.00	-	-	-	-	-	-	-
MW5B1	Feb-20	166	2.68	0.01	0.06	2.74	7.47	2.00	2.00	1
MW5B1	May-20	107	3.18	0.06	0.01	3.24	8.06	1.00	1.00	1
MW5B1	Aug-20	124	5.17	0.02	0.01	5.19	8.20	1.00	1.00	1
MW5B2-D	Oct-18	300	0.10	-	-	-	-	-	-	-
MW5B2-D	Jan-19	305	0.10	-	-	-	-	-	-	-
MW5B2-D	Feb-20	263	0.79	0.01	0.07	0.86	6.29	1.00	1.00	1
MW5B2-D	May-20	242	0.17	0.01	0.01	0.18	8.25	1.00	1.00	1
MW5B2-D	Aug-20	314	0.18	0.01	0.01	0.18	7.22	1.00	1.00	1
MW5B2-S	Oct-18	320	0.10	-	-	-	-	-	-	-
MW5B2-S	Jan-19	330	0.10	-	-	-	-	-	-	-
MW5B2-S	Aug-19	365	0.10	-	-	1.10	-	-	-	-
MW5B2-S	Aug-19	365	0.10	-	-	1.10	-	-	-	-
MW5B2-S	Aug-19	365	0.10	-	-	1.10	-	-	-	-
MW5B2-S	Nov-19	340	0.10	-	-	0.90	-	-	-	-
MW5B2-S	Feb-20	294	0.53	0.01	0.17	0.70	5.96	10.00	10.00	20
MW5B2-S	May-20	288	0.56	0.13	0.01	0.69	6.98	1.00	1.00	1
MW5B2-S	Aug-20	314	0.49	0.01	0.01	0.49	7.15	1.00	1.00	1
MW5B3	Oct-18	250	0.10	-	-	-	-	-	-	-
MW5B3	Feb-20	246	0.66	0.01	0.06	0.72	7.24	1.00	1.00	1
MW5B3	May-20	239	0.14	0.01	0.01	0.15	6.60	1.00	1.00	1
MW5B3	Aug-20	274	0.14	0.01	0.01	0.14	6.84	1.00	1.00	1
MW5B4	Oct-18	325	0.10	-	-	-	-	-	-	-
MW5B4	Jan-19	330	0.10	-	-	-	-	-	-	-
MW5B4	Aug-19	375	1.10	-	-	1.10	-	-	-	-
MW5B4	Feb-20	250	0.40	0.01	0.01	0.40	6.72	1.00	1.00	1
MW5B4	May-20	248	0.25	0.03	0.01	0.28	7.10	1.00	1.00	1
MW5B4	Aug-20	249	0.42	0.01	0.08	0.50	7.11	1.00	1.00	1
MW5B5	Oct-18	380	0.10	-	-	-	-	-	-	-
MW5B5	Jan-19	420	0.10	-	-	-	-	-	-	-

Notes: Red denotes WQO value exceeded

Appendix F

Water quality exceedance protocol

F.1 Water quality exceedance protocol

1. **Confirmation of the exceedance** – If the result appears to be erroneous then the laboratory will be contacted to ensure no error has been made in storing, analysing, or recording the sample or result. Should this investigation conclude the treatment, analysis and result recording for the sample are satisfactory, DSS will proceed to the notification step of the protocol.

1. **Notification of exceedance** – In the case where the nominated criteria contained within Section 6.5 is exceeded, the Environment Co-ordinator will notify the Planning Secretary, EPA and Natural Resources Access Regulator (NRAR) and other relevant agencies, and affected landowners within 7 days of confirmation as to the nature of the exceedance. An exceedance of a compliance criteria value will require the preparation of a corrective action plan.

2. **Corrective action** – The following corrective action will be undertaken:

    a) A sample from the monitoring site from which the exceedance was recorded will be re-sampled where possible and re-assessed to confirm an exceedance of criteria. A compliant result following reassessment will be considered a sufficient response. However, the monitoring point and parameter will be noted for reference in the event a future exceedance is recorded.

    A second noncompliant result will require the following further corrective action:

    b) DSS will prepare a corrective action plan to return the component of the operation to compliance. Preparation of the action plan may require the assistance of a specialist consultant in the relevant field. Details regarding the preparation of the corrective action plan will be included in the relevant Annual Review and EPL Annual Return and to the DPE prior to implementation, if requested.

3. **Reassessment** – Non-compliance with environmental criteria will require re-assessment to demonstrate a return to compliance by re-sampling and re-analysing the exceeded parameter(s) from the offending site following the completion of the action plan. If scheduled monitoring is to occur within 2 weeks of completion of the action list, the re-sampling can be delayed. A third exceedance will require a return to Step 2 of the protocol.

4. **Notification of compliance** – DSS will notify the Director General, EPA and other relevant government agency(ies) and local stakeholder(s) of the return to compliance following the successful completion of Step 5.

5. **Reporting** – The recorded exceedance, corrective actions and reassessment will be reported to the CCC and described in the Annual Review.

Appendix G

ESCP checklist

Environment Inspection Checklist DSS-ENV-FO-01

This checklist must be completed once a month, by an allocated person as decided by the Site Management. Actions arising from the inspection are to be listed in the spaces provided below, uploaded to SIMs and tracked by Site Managers. All completed checklists showing signed-off actions must be kept on file.

Inspector Name:		**Date:**		**Signature:**	

Item	Checklist Item	Status			Comments
		C	NC	N/A	
GENERAL REQUIREMENTS					
1.	Inspect site entrance – *check sediment on road, product build up on rail line, rubbish, drag ou, signage for covering loads and going through wheel wash – action clean up*				
2.	Inspect site boundary – *Fences in good condition etc.*				
3.	Check extraction boundaries are clearly marked out and intact.				
4.	Any complaints received in the last month have been recorded and managed through SIMS. All relevant complaints discussed at toolbox/pre-start meetings.				
5.	Site Emergency Response plan and PIRMP current and displayed.				
6.	All SWMS prepared have addressed relevant environmental management aspects (dust, noise, water, erosion etc).				
7.	Have inductions been updated to include all requirements relating to noise, air, spill management, ecology, heritage, water, taffic and dust environmental aspects				
LAND MANAGEMENT					
8.	No vegetation cleared or ground disturbance with out approval as per GRP-HSEQ-8-03 Land Management.				
9.	Future vegetation clearing planned in next month has approval as per GRP-HSEQ-8-03 Land Management.				
10.	Any spills added to the site Contaminated Land Register				
HERITAGE MANAGEMENT					
11.	Ensure no instances of ground disturbance in Stage 5A and 5B is undertaken without the required archaeological salvage investigations completed				
12.	Are the unexpected finds protocol and discovery of suspected human remains protocol available for available for staff in the case that portocols are required to be initiated				
FLORA AND FAUNA MANAGEMENT					
13.	No major infestations of Weeds and Feral animals.				
14.	No evidence of animal interaction on site, No animals being fed on site. Any wildlife found on site communicated to site supervisor and wildlife hotline contacted for injured wildlife.				
15.	All weed management inspections, maintenance and records (identified weeds, chemicals and volumes used, etc.) filed in Environmental Management Records.				
REHABILITATION MANAGEMENT					
16.	Rehabilitated areas and areas undergoing rehabilitation inspected – *Area clearly marked, no sign of disturbance.*				
17.	Review site operations, identify any areas for rehabilitation potential as per site rehabilitation management plan and plan future work where appropriate.				

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Item	Checklist Item	Status			Comments
		C	NC	N/A	
WASTE MANAGEMENT					
18.	Designated Waste areas/bins available and inspected - *Recyclables (Cans, bottles, paper)* - *Oily waste (Rags, filters, empty containers, oil)* - *General waste / Other*				
19.	Waste Register/ Records maintained and up to date detailing; *Waste Sources Quantities, Disposal Methods, Disposal Routes.*				
20.	No evidence of illegal dumping on site – *report any to HSE.*				
21.	Operational and Workshop area tidy – good general house keeping and no evidence of littering and rubbish.				
22.	Waste storage tanks, in working order and have no leaks				
NOISE & BLAST MANAGEMENT					
23.	Check activities, plant and equipment isn't causing un-usual or excessive noise. (Annual Assessment due in July).				
AIR MANAGEMENT					
24.	Dust controls in place and in working order such as – *Water Carts, Bag Filters, Enclosed Equipment etc. Record any broken, unworking systems or areas that require maintenance*				
25.	No Air Emission from broken down plant and machinery				
26.	Deposited Dust monitoring completed on schedule (monthly)				
27.	All monitoring data recorded, reviewed, and any exceedances investigated.				
28.	Are all dust monitoring stations secured and not obstructed				
TRAFFIC MANAGEMENT					
29.	Have all drivers completed the Drivers Code of Conduct				
30.	Have all VENM drivers completed the VENM/PASS Client Package				
31.	Are all road safety signs correctly displayed on site and visible. Are there any areas identified on site which required to be signposted				
HYDROCARBON / SPILL MANAGEMENT					
32.	Spill response equipment available - *spill kits, MSDS, PPE*				
33.	Bunds used for the storage of hydrocarbons and chemicals able to capture 110% of stored liquid. Not filled with rain water				
34.	Flammable liquids stored in designated area fitted with dry chemical or carbon dioxide extinguisher				
35.	Dangerous Goods are clearly labelled, sealed and returned to bund/cabinet after use. *No fuel containers/paint tins lying around site*.				
36.	Batteries are stored on pallet above ground				
37.	Storage areas are appropriately signed				
38.	Any spills entered into SIMS				

Environment Inspection Checklist DSS-ENV-FO-01

Item	Checklist Item	Status			Comments
		C	NC	N/A	
39.	Above Ground Storage Tanks (ASTs) – *No visible leaks, include in comments condition of valves, pumps, lines, and correct signange.*				
40.	Inspect Fuel bay area – *Check for evidence of spillage or leaks, check spill capture area and clean-up if required.*				
41.	Inspect the oil bay for: • No used rubbish, rags, are bins emptied • Is there sufficient lighting • Clean rags available • Items stored safely and correctly • Are doors and locks in good operation • Are there any slip, trip and/or fall hazards • Warning signs visible and in good condition • Are fire fighting equipment available and in working order				
WATER MANAGEMENT					
42.	Site monthly water quality monitored.				
43.	Any discharges from the site (controlled and/or uncontrolled) have been monitored and water quality recorded, with exceedances referred to the environmental coordinator (Refer to Water Management Plan). Any discharges from Stage 5 ponds are to be reported to management immediately				
44.	**Stormwater Management / Erosion and Sediment Control Inspection (TO BE COMPLETED MONTHLY AND FOLLOWING >50mm/48hrs RAINFALL)**				
45.	Is clean water runoff areas directed away from dirty water catchments?				
46.	Are sand mining, processing and site access facilities confined to the minimum practical area and are nearby waterways being protected?				
47.	Is there any evidence of erosion onsite (gullies,landslips,rill erosion, sheet erosion, subsidence,stream bank instability) associated with project activities?				
48.	Have upstream/downstream flow entry/exit points been inspected for signs of erosion? Has scour protection been installed if required?				
49.	Inspect bike track and take photos of culvert areas. If tracking is visible enter				
50.	Have the banks of the operational dredge ponds and final landform lakes been inspected for signs of erosion? Has mitigation been carried out if required?				
51.	Are there any other areas around the site that require installation of erosion and sediment controls in Stage 2-4? (Check through flow chart, Appendix F, Blue Book Volume 2E: Mines and Quarries). See Enviro Officer for more information if required.				

Item	Checklist Item	Status			Comments
		C	NC	N/A	
52.	Does following temporary erosion and sediment control structures need to be implemented during construction of Stage 5: • clean water diversions to reduce the volume of runoff entering disturbance areas; • mitre drains to divert and disperse concentrated flows where appropriate; • check dams to reduce flow velocities and capture sediment within any diversion drains until fully stabilised; • sediment fencing and sediment traps to reduce suspended sediment in runoff leaving the disturbance areas. Please constult with Environmental site representative and consult with the blue book *Managing Urban Stormwater: Soils and Construction – Volume 2E – mines and quarries (DECC 2008a)* for schematic drawings				
53.	Are natural waterways being maintained offline for as long as possible? (Western Tributary, Northern Tributary, Rocklow Creek)				
54.	Is there evidence of erosion on the site access road or road side drainage networks?				
55.	Do any erosion controls need to be repaired or have sediment removed from them				
56.	Are permanent/final bunds vegetated? Are temporary bunds in need of maintenance? Is the bund around the fines pond maintained to prevent inundation and at 3.7m AHD?				
57.	Has backfilling of the operational ponds ceased either: 12 hours prior to the commencement of overflows and/or when freeboard in 30cm below the overflow level?				
58.	Has backfilling of ponds ceased when they are overflowing?				
59.	Do water quality monitoring results indicate that the erosion and sediment controls are suitable for meeting the water quality objectives/criteria?				
60.	Are there any additional controls that could be implemented to minimise erosion and sedimentation.				
STAGE 5					
61.	Is there any signs of the following (See below figure for bund failure visual examples: • Slumping on the downstream side of the dam wall • Is there any cracking on the dam face • Is there an increase of seepage of water downstream of the dam • Is there any signs of animal borrowing on the dam face Is there any signs of a sudden drop in dam water level				
62.	Ensure dirty water within Stage 5B dredge pond is contained so that it doesn't mix with floodwaters of Minnamurra River				

Environment Inspection Checklist DSS-ENV-FO-01

Item	Checklist Item	Status			Comments
		C	NC	N/A	
63.	Ensure dirty water runoff from extraction area, site office and carpark, and access road is captured				
64.	Check that surface water runoff from upstream catchments is not taking place				
65.	Check that fencing around site boundary is suitable to prevent cattle, horses and other livestock from leaving the site and ensure that surrounding remnant trees and vegetation are not disturbed by site operations				
66.	Check for alligator weed, blackberry and other invasive plant species				
67.	Check that marker pegs remain in place and are clearly identifiable				
68.	Take photographs of markers				

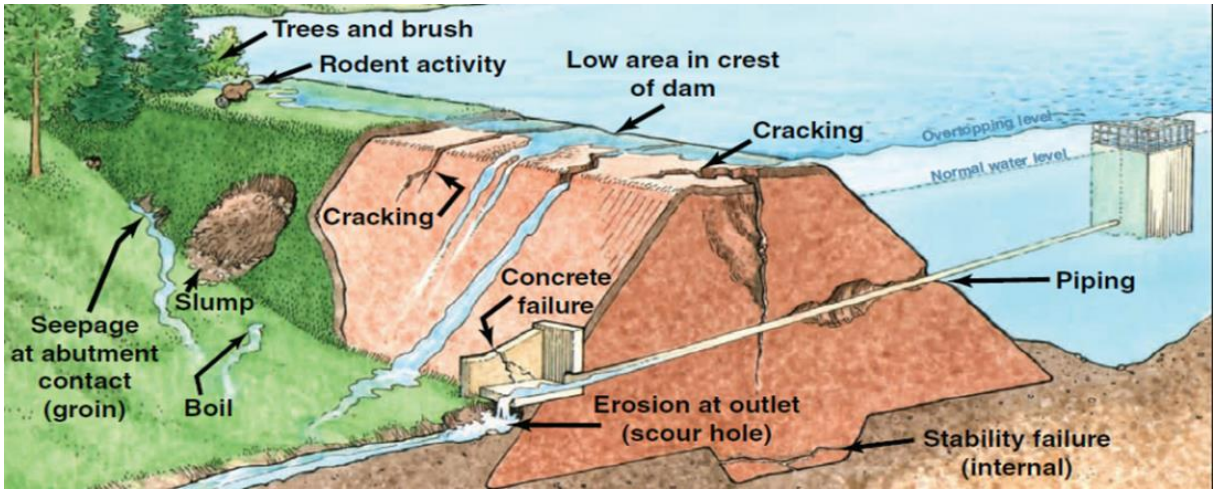

Figure 1: Example of bund failure

Further Resources

[Managing Urban Stormwater: soils and construction. Volume 2E - mines and quarries (nsw.gov.au)]

Environment Inspection Checklist DSS-ENV-FO-01

Detail any items that require attention and/or remedial action. Actions are to be uploaded to SEQuence as incident or hazard type ‘Environmental’. The Site Manager must monitor progress and completion of actions.

Finding/Actions Required					
Item No.	**Comment**	**Action Taken**	**By Who**	**By When**	**SEQuence No.**

Appendix H

Stage 5B PMF flood bund design

Note that the extraction footprint area in the following flood assessment is slightly larger than the actual extraction footprint, as exhibited previously in this plan. The flood assessment was completed prior to the Stage 5 dredge pond footprint being refined to avoid extraction occurring in the C3 environment zone. The height of the flood bund utilised for the following flood assessment is as described in this plan (i.e. designed to the PMF flood level) and therefore the outcomes of the flood assessment are considered valid for the purposes of identifying flood impacts. No extraction or clearing will take place beyond the extraction footprint set out in Figure 4.1 and Figure 4.2 of this plan.

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Sharon Makin
Environment Business Partner NSW/ACT
Mobile: 0401894185
Email: Sharon.Makin@boral.com.au

Dear Sharon,

Re: DSS Stage 5B Flood Mitigation – PMF bund level and design – Flood Assessment

Conditions were issued for the Dunmore Sand and Soil Stage 5 expansion. This letter addresses part of the Stage 5 Flood Mitigation condition 29B outlined below:

> *Condition 29B*
>
> *Prior to undertaking any development in Stag 5B, the Applicant must provide the Planning Secretary with the detailed design of the Stage 5B flood mitigation bunds which demonstrates that the bunds can prevent inundation of the Stage 5B pond and car parking area by floodwaters associated with the probable maximum flood event.*

The original Stage 5B bund design provided protection from interaction with floodwaters and the dredge pond up to the 1% AEP flood event from the Minnamurra River.

The current maximum PMF height over the 5B area is approximately 5.15m AHD.

A bund surrounding the 5B pond area with a level of 5.5m AHD has been incorporated into the existing hydraulic model of the Minnamurra River to assess:

a) What impact the bund may have on floodwaters; and

b) Whether a berm height level of 5.5m AHD provides sufficient protection.

The bund height has been increased to 5.5m AHD, which isolates the Stage 5B dredge pond from the PMF event. The construction of a bund within the existing PMF footprint increases flood levels upstream of the bunded pond area by up to 0.17m immediately adjacent to the western edge of the bund, to 5.32m AHD. Impacts from this flood level increase are confined to the surrounding nature reserve for this extremely rare event.

A bund level of 5.5m AHD has at least 180mm freeboard to the post development PMF event peak flood level, isolating the pond from extremely rare flood events.

Refer to attached figures for detail in Appendix A.

Please contact the undersigned if you have any questions.

Yours sincerely

Lachlan Bain
Environmental Engineer BEng (Env). MEnvMgt.

Appendix A

Legend

Dredge pond bunds and earthworks

Existinf PMF Flood Height (m AHD)

Band 1

<= 5.058

5.058 - 5.116

5.116 - 5.173

5.173 - 5.231

5.231 - 5.289

5.289 - 5.347

5.347 - 5.400

5.400 - 5.444

> 5.444

0 100 200 300 400 m

PMF Flood height, existing conditions.

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Legend

Dredge pond bunds and earthworks

PMF difference 5B bund Band 1 (Gray)

<= 0.0230

0.0230 - 0.0590

0.0590 - 0.0950

0.0950 - 0.1310

> 0.1310

0 100 200 300 400 m

PMF Flood height difference

24/05/2023

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