



Appendix B4


Soil and Water Management Sub-plan

Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats)


August 2021

Document control


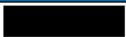
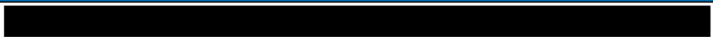


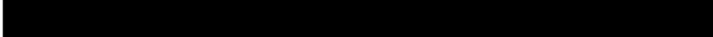






















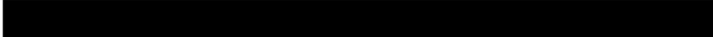
Approval and authorisation

Title	Soil and Water Management Sub-plan Albion Park Rail Bypass (Stage 2 – Princes Highway between Yallah and Oak Flats)
Accepted on behalf of Transport for NSW by	Peter Chudleigh
Signed	
Dated	14 September 2021

Endorsement

Endorsed by the Environmental Representative	Toby Hobbs
Signed	
Dated	27 August 2021

Document status

Revision	Date	Description	Approval
			
			
			
			
			
			
	 		
	 		
			

Revision	Date	Description	Approval

Distribution of controlled copies

This SWMP as part of the CEMP is available to all personnel and sub-contractors via the Project document control management system. An electronic copy can be found on the Project website.

The document is uncontrolled when printed. One controlled hard copy of the SWMP as part of the CEMP and supporting documentation will be maintained by the Quality Manager at the Project office and on the project website.

Copy number	Issued to	Version

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Glossary/ Abbreviations

Abbreviation	Standard text
ANZECC	Australian and New Zealand Environment Conservation Council
ASM	Acid sulfate material
ASS	Acid sulfate soil
CEMP	Construction Environmental Management Plan
Coastal Management SEPP	<i>State Environmental Planning Policy (Coastal Management) 2018</i>
CLMP	Contaminated Land Management Sub-plan
CoA	Conditions of approval (state or federal). State CoA are the NSW Minister for Planning's conditions of approval. Federal CoA are the federal Conditions of Approval under the EPBC Act.
DPIE	NSW Department of Planning and Environment (now known as Department of Planning, Industry and Environment)
DPI	NSW Department of Primary Industries
DPIE	Department of Planning, Industry and Environment (DPIE) - All references to DPIE should be interpreted as DPIE (formerly known as DPIE).
EIS	Environmental Impact Statement
ESCP	Erosion and Sediment Control Plan
EEC	Endangered Ecological Community
EO	Environment Officer
EM	Environment Manager
EPA	NSW Environment Protection Authority
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EWMS	Environmental Work Method Statements
NSW Minister, the	NSW Minister for Planning
Non-compliance	Failure to comply with the requirements of the Project approval or any applicable licence, permit or legal requirements
Non-conformance	Failure to conform to the requirements of Project system documentation including this CEMP or supporting documentation
NTU	Nephelometric Turbidity Unit
OEH	Office of Environment and Heritage - All references to OEH should be interpreted as Department of Planning, Industry and Environment, (DPIE) formerly known as OEH.
PESCP	Progressive erosion and sediment control plan
PIRMP	Pollution Incident Response Management Plan
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
Project, the	Albion Park Rail bypass
REMM	Revised Environmental Management Measures
Roads and Maritime	Roads and Maritime Services – All references to Roads and Maritime should be interpreted as Transport for NSW (formerly Roads and Maritime Services)
RUSLE	Revised Universal Soil Loss Equation
Secretary	Secretary of the NSW Department of Planning and Environment
SMZ	Selected Material Zone

Abbreviation	Standard text
SPIR	Submissions and Preferred Infrastructure Report- A report developed to respond to submissions raised during the exhibition of the EIS and assess changes from the EIS
SWMP	Soil and Water Management Sub-plan
SWTC	Scope of Works and Technical Criteria (SWTC)
TfNSW	Transport for NSW
TSS	Total suspended solids
UDLCS	Urban Design and Landscape Character Strategy
UZF	Upper Zone Formation

1 Introduction

1.1 Context

This Soil and Water Management Sub-plan (SWMP or Plan) forms part of the Construction Environmental Management Plan (CEMP) for the Albion Park Rail bypass (Stage 2 – Princes Motorway between Yallah and Oak Flats) (the Project).

This SWMP has been prepared to address the requirements of the Minister's Conditions of Approval (CoA), the Albion Park Rail Bypass Environmental Impact Statement (EIS), as amended by the Submissions and Preferred Infrastructure Report (SPIR), including the revised environmental management measures (REMM) listed in the SPIR and all applicable legislation.

This revision accounts for the deletion of specific monitoring locations identified in previous revisions based on consultation with NSW EPA, DPI Fisheries and NRAR. Monitoring locations have been removed where construction has been completed and construction related water quality impacts are no longer likely to be experienced in those catchment areas due to a fully stabilised catchment and the use of completed sections of the project by public motorists. This is reflected in the revised Construction water quality monitoring program.

1.2 Background and project description

Transport for NSW (formerly Roads and Maritime Services) is extending the M1 Princes Motorway between Yallah and Oak Flats to bypass Albion Park Rail. The motorway completes the 'missing link' for a high standard road between Sydney and Bomaderry. The project is known as the Albion Park Rail bypass.

The Albion Park Rail Bypass EIS assessed the impacts of construction and operation of the Project on soils and water, within Chapters 8, 16 and 17.

As part of EIS development, a detailed hydrology, flooding and groundwater assessment were prepared to address the Environmental Assessment Requirements issued by the then Department of Planning. The assessments were included in the EIS as Technical paper 3 - hydrology and flooding, and Technical paper 11 - groundwater assessment.

The construction of the proposal would use standard procedures and guidelines to mitigate the following potential impacts:

- Soil erosion and sediment transport
- Landslip and mass movement of soils
- Disturbance of acid sulfate soils (ASS) and / or acid sulfate rock
- Disturbance of saline soils
- Disturbance of contaminated soils (if present)
- Settlement of soft soils
- Stormwater runoff
- Negative impacts on water quality.

The project catchment would experience a net reduction in pollutant export of all pollutants assessed compared to the existing condition. The water quality treatment strategy designed for the operational phase would therefore result in a net reduction in stormwater pollutant loadings entering Lake Illawarra.

1.3 Environmental management systems overview

The overall environmental management system for the Project is described in Chapter 3 of the CEMP.

The SWMP is part of Fulton Hogan's environmental management framework for the Project, as described in Chapter 4 of the CEMP. Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMS) and Progressive Erosion and Sediment Control Plans (PESCP).

EWMS have been developed and signed off by environment and management representatives prior to associated works and construction personnel will be required to undertake works in accordance with the identified mitigation and management measures.

Used together, the CEMP, strategies, procedures, EWMS and PESCP form management guides that clearly identify required environmental management actions for reference by Fulton Hogan personnel and contractors.

The review and document control processes for this Plan are described in Section 1.6 of the CEMP.

1.4 Consultation for preparation of this SWMP

This SWMP (including the construction water quality monitoring program for surface water and groundwater) has been developed in consultation with the Environment Protection Agency (EPA), Department of Primary Industries (DPI) for Water (DPI Water), DPI Fisheries (DPI Fisheries) and relevant Councils (including Wollongong City Council and Shellharbour City Council). A summary of the key issues raised is provided below and it is noted that there were no outstanding issues.

Key observations raised by the EPA generally related to the project boundary; minimisation of the area of the site that is able to generate suspended material when water runs over it; inspection frequency; measurement of rainfall; and the use of Nephelometric Turbidity Unit (NTU) in place of Total suspended solids (TSS) to provide instantaneous in-field readings. The SWMP was revised in response to these observations and reissued to the EPA. It was acknowledged that Fulton Hogan had consulted with the EPA on the SWMP.

DPI Water recommended that groundwater should only be discharged for dewatering when the pH is between 6.5 and 8.5. Fulton Hogan confirmed that all dewatering/ discharge (including of groundwater) will be addressed in a dewatering Environmental Work Method Statement (EWMS), which will be prepared in early 2019, prior to dewatering activities on site. DPI Water accepted this approach.

DPI Fisheries commented on the monitoring of sediment controls and the dewatering EWMS. Fulton Hogan amended the SWMP inspection/ monitoring text and advised that a dewatering EWMS will be prepared in early 2019, prior to dewatering activities on site. DPI Fisheries advised their comments had been adequately addressed.

Wollongong City Council advised it had no comments.

Shellharbour City Council had one comment related to the responsibility for ongoing maintenance of temporary sediment basins. Fulton Hogan advised that all temporary sediment basins will be decommissioned at the end of the project, so there will be no ongoing maintenance of temporary basins beyond that time. Shellharbour City Council confirmed it had no further comment.

An onsite presentation covering reduced construction footprint and monitoring locations was presented to NSW EPA and TfNSW on 20 April 2021. Evidence of this consultation is found in Appendix G of this sub-plan.

As construction nears completion and the project transitions into operation, the project team will continue to consult with the key agencies around the removal of certain monitoring points that may become redundant. Following agency approval or, in the instance where an agency does not respond to the request but a reasonable attempt at consultation regarding the proposed change has been demonstrated, where no objections have been raised, it is proposed that the Environmental Representative will review, endorse and approve the removal of monitoring points as a minor amendment in accordance with the provision of Condition of Approval A24 (i).

A summary of consultation undertaken during preparation of this Plan, including copies of all correspondence, is provided in Appendix A5 of the CEMP.

2 Purpose and objectives

2.1 Purpose

The purpose of this Plan is to describe how Fulton Hogan proposes to manage and protect water quality during construction of the Project.

2.2 Objectives

The key objective of the SWMP (including the construction water quality monitoring program for surface water and groundwater) is to ensure all CoA, revised environmental management measures (REMM) and licence/permit requirements relevant to soil and water including water quality are described, scheduled and assigned responsibility as outlined in:

- The EIS
- Conditions of Approval granted to the project on 30/1/2018
- The environment protection licence (EPL)
- Roads and Maritime specifications G36, G38 and G40.

2.3 Targets

The following targets have been established for the management of soil and water impacts during the project:

- Ensure full compliance with the relevant legislative requirements, CoA and REMM
- Meet EPL water quality discharge parameters for all planned basin discharges (i.e. those within design capacity)
- Manage downstream water quality impacts attributable to the project (i.e. maintain water waterway health by avoiding the introduction of nutrients, sediment and chemicals outside of that permitted by the EPL and/or ANZECC guidelines)
- Ensure training on best practice soil and water management is provided to all construction personnel through site inductions.

2.4 Environmental performance outcomes

Table 2-1 identifies the construction-related environmental performance outcomes identified in the EIS as amended by the SPIR and how these will be achieved.

Table 2-1 Environmental performance outcomes

EIS reference	Environmental performance outcome	How achieved
Section 16.3.1 p501	Erosion and sediment controls during construction would be implemented in accordance with Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004)	Chapter 6 mitigation measure ID SWMM3
Section 16.5 p510, SW02	The construction surface water quality monitoring program would address the requirements of the project environment protection licence	Appendix B Construction water quality monitoring program
Section 16.3.1 p502	The project would minimise the impact associated with the disturbance of acid sulfate soils.	Chapter 6 mitigation measure ID SWMM87
Section 16.3.2, p505	The construction would maintain flow within watercourses crossed by the project during construction.	Chapter 6 mitigation measure ID SWMM40, SWMM41. FFMP Chapter 6 mitigation measure ID SWMM19.

EIS reference	Environmental performance outcome	How achieved
Section 16.5 SW02, p510	The project would prevent/ minimise pollution of waterways from refuelling of vehicles and other equipment and accidental spills.	Chapter 6 mitigation measure ID SWMM74-SWMM81
Section 17.5 SW02, p528	Construction water quality discharge would comply with the requirements of an environment protection licence for the project	Section 7.4 Chapter 6 mitigation measure ID SWMM60, SWMM61.

3 Environmental requirements

3.1 Relevant legislation and guidelines

3.1.1 Legislation

All legislation relevant to this SWMP is included in Appendix A1 of the CEMP.

3.1.2 Guidelines and standards

The main guidelines, specifications and policy documents relevant to this plan include:

- Acid Sulfate Soil Manual (ASSMAC 1998)
- Acid Sulfate Soil and Rock – Victorian EPA Publication 655.1 – July 2009
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000)
- Department of Environment and Conservation (DEC): Bunding & Spill Management. Insert to the Environment Protection Manual for Authorised Officers - Technical section "Bu" November 1997
- Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) March 2004 (reprinted 2006) (the "Blue Book"). Volume 1 and Volume 2
- Volume 2A Installation of Services (DECCW 2008)
- Volume 2C Unsealed Roads (DECCW 2008)
- Volume 2D Main Roads Construction (DECCW 2008)
- DIPNR Roads and Salinity Guideline, 2003
- DLWC, 1998. Constructed Wetlands Manual.
- Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla, 16 pp
- NSW Fisheries, November 2003. Fishnote – Policy and Guidelines for Fish Friendly Waterway Crossings (Ref: NSWF – 1181)
- Roads and Maritime Dewatering Guideline
- RTA's Code of Practice for Water Management – Road Development and Management (1999)
- Approved Methods for the Sampling and Analysis of Water Pollutants in NSW – March 2004
- Guidelines for the Management of Acid Sulphate materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulphidic Black Ooze (RTA 2005)
- Roads and Maritime Environment Direction Management of Tannins from Vegetation Mulch
- Stockpile Site Management Guideline, Roads and Maritime 2011
- Roads and Maritime Guideline for Construction Water Quality Monitoring
- EPA publication "Approved Methods for the Sampling and Analysis of Water Pollutants in NSW."
- Environmental Best Management Practice Guideline for Concreting Contractors, DEC, 2004.

3.2 Minister's Conditions of Approval

The CoA relevant to this Plan are listed in Table 3-1 below and are from the State approval. There are no relevant federal CoA. A cross reference is also included to indicate where the condition is addressed in this Plan or other Project management documents.

Table 3-1 Conditions of Approval relevant to the SWMP

CoA No.	Condition requirements	Document reference																					
C4	<p>The following CEMP sub-plans must be prepared in consultation with the relevant government agencies identified for each CEMP sub-plan and be consistent with the CEMP referred to in Condition C1.</p> <p>Table 3: CEMP Sub-plan Consultation Requirements</p> <table> <tr> <th></th><th>Required CEMP Sub-plan</th><th>Relevant government agencies to be consulted for each CEMP Sub-plan</th></tr> <tr> <td>a)</td><td>Traffic and transport</td><td>Relevant Council(s)</td></tr> <tr> <td>b)</td><td>Noise and vibration</td><td>EPA</td></tr> <tr> <td>c)</td><td>Fauna and Flora</td><td>OEH and DPI Fisheries</td></tr> <tr> <td>d)</td><td>Soil and water</td><td>EPA and DPI Water and Fisheries</td></tr> <tr> <td>e)</td><td>Heritage</td><td>OEH, Relevant Council(s), Registered Aboriginal Parties</td></tr> <tr> <td>f)</td><td>Flooding and Hydrology</td><td>OEH and Relevant Council(s)</td></tr> </table>		Required CEMP Sub-plan	Relevant government agencies to be consulted for each CEMP Sub-plan	a)	Traffic and transport	Relevant Council(s)	b)	Noise and vibration	EPA	c)	Fauna and Flora	OEH and DPI Fisheries	d)	Soil and water	EPA and DPI Water and Fisheries	e)	Heritage	OEH, Relevant Council(s), Registered Aboriginal Parties	f)	Flooding and Hydrology	OEH and Relevant Council(s)	Section 1.4
	Required CEMP Sub-plan	Relevant government agencies to be consulted for each CEMP Sub-plan																					
a)	Traffic and transport	Relevant Council(s)																					
b)	Noise and vibration	EPA																					
c)	Fauna and Flora	OEH and DPI Fisheries																					
d)	Soil and water	EPA and DPI Water and Fisheries																					
e)	Heritage	OEH, Relevant Council(s), Registered Aboriginal Parties																					
f)	Flooding and Hydrology	OEH and Relevant Council(s)																					
C5	The CEMP sub-plans must state how:																						
(a)	The environmental performance outcomes identified in the EIS as amended by the SPIR as modified by these conditions will be achieved	Section 2.4.																					
(b)	the mitigation measures identified in the EIS as amended by the SPIR as modified by these conditions will be implemented;	Through the implementation of this SWMP (in particular refer to Section 3.3).																					
(c)	the relevant terms of this approval will be complied with (in particular Part E of this approval);	Through the implementation of this SWMP (in particular refer to Part E condition cross references below).																					
(d)	the identification of the relevant environmental specific training and induction processes for construction personnel; and	Section 7.2																					
(e)	issues requiring management during construction, as identified through ongoing environmental risk analysis, will be managed.	Chapter 5 second paragraph Chapter 6																					
C6	The CEMP sub-plans must be developed in consultation with relevant government agencies identified in Table 3 of Condition C4 of this approval. Where an agency(ies) request(s) is not included, the Proponent must provide the Secretary justification as to why. Details of all information requested by an agency to be included in a CEMP sub-plan as a result of consultation, including copies of all correspondence from those agencies, must be provided with the relevant CEMP sub-plan.	Section 1.4																					
C7	Any of the CEMP sub-plans may be submitted to the Secretary for approval along with, or subsequent to, the submission of the CEMP but in any event, no later than one (1) month before commencement of construction.	CEMP (main section) Section 1.4																					
C8	Construction must not commence until the CEMP and all CEMP sub-plans have been approved by the Secretary. The CEMP and CEMP sub-plans, as approved by the Secretary, including any minor amendments approved by the ER must be implemented for the duration of construction. Where the SSI is being staged, construction of that stage is not to commence until the relevant CEMP and sub-plans have been approved by the Secretary, unless otherwise agreed by the Secretary.	CEMP (main section) Section 1.4																					

CoA No.	Condition requirements	Document reference															
C9	<p>The following Construction Monitoring Programs must be prepared in consultation with the relevant government agencies identified for each Construction Monitoring Program to compare actual performance of construction of the SSI against performance predicted performance:</p> <p>Table 4: Construction Monitoring Program Consultation Requirements</p> <table border="1"> <thead> <tr> <th></th><th>Required Construction Monitoring Programs</th><th>Relevant government agencies to be consulted for each Construction Monitoring Program</th></tr> </thead> <tbody> <tr> <td>a)</td><td>Air Quality</td><td>EPA</td></tr> <tr> <td>b)</td><td>Groundwater</td><td>DPI Water</td></tr> <tr> <td>c)</td><td>Surface Water</td><td>EPA and DPI Fisheries</td></tr> <tr> <td>d)</td><td>Noise</td><td>EPA</td></tr> </tbody> </table>		Required Construction Monitoring Programs	Relevant government agencies to be consulted for each Construction Monitoring Program	a)	Air Quality	EPA	b)	Groundwater	DPI Water	c)	Surface Water	EPA and DPI Fisheries	d)	Noise	EPA	<p>Section 1.4</p> <p>In accordance with CoA C16, the groundwater and surface water monitoring program requirements have been incorporated into this SWMP. See below.</p>
	Required Construction Monitoring Programs	Relevant government agencies to be consulted for each Construction Monitoring Program															
a)	Air Quality	EPA															
b)	Groundwater	DPI Water															
c)	Surface Water	EPA and DPI Fisheries															
d)	Noise	EPA															
C10	<p>Each construction monitoring program must provide:</p> <p>(a) details of baseline data available</p> <p>(b) details of baseline data to be obtained and when</p> <p>(c) details of all monitoring of the project to be undertaken;</p> <p>(d) the parameters of the project to be monitored;</p> <p>(e) the frequency of monitoring to be undertaken;</p> <p>(f) the location of monitoring;</p> <p>(g) the reporting of monitoring results;</p> <p>(h) procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory; and</p> <p>(i) any consultation to be undertaken in relation to the monitoring programs.</p>	<p>Appendix B Construction water quality monitoring program – item 1.</p> <p>Appendix B Construction water quality monitoring program - item 1.</p> <p>Appendix B Construction water quality monitoring program - item 2.</p> <p>Appendix B Construction water quality monitoring program – item 3.</p> <p>Appendix B Construction water quality monitoring program – Table B-1.</p> <p>Appendix B Construction water quality monitoring program - item 2 and Figure B-1.</p> <p>Appendix B Construction water quality monitoring program – item 6</p> <p>Section 7.8</p> <p>Appendix B Construction water quality monitoring program – item 5</p> <p>Section 7.5</p> <p>Section 1.4</p>															
C11	<p>The Construction Monitoring Programs must be developed in consultation with relevant government agencies as identified in Condition C9 of this approval and must include, to the written satisfaction of the Secretary, information requested by an agency to be included in a Construction Monitoring Programs during such consultation. Details of all information requested by an agency including copies of all correspondence from those agencies, must be provided with the relevant Construction Monitoring Program.</p>	<p>Section 1.4</p>															

CoA No.	Condition requirements	Document reference
C12	The Construction Monitoring Programs must be endorsed by the ER and then submitted to the Secretary for approval at least one (1) month prior to the commencement of construction or within another timeframe agreed with the Secretary.	As permitted by CoA C16, the groundwater and surface water Construction Monitoring Programs have been incorporated into this SWMP. The Construction Monitoring Programs are therefore, endorsed by the ER by virtue of the endorsement of this SWMP on page 1.
C16	Where a relevant CEMP Sub-plan exists, the relevant Construction Monitoring Program may be incorporated into that CEMP Sub-plan.	The groundwater and surface water Construction Monitoring Programs have been incorporated into this SWMP.
PART E – SOILS		
E56	Erosion and sediment controls must be installed and appropriately maintained to minimise water pollution. When implementing such controls, any relevant guidance in the <i>Managing Urban Stormwater</i> series must be considered.	Chapter 6 mitigation measure ID SWMM3, SWMM7, SWMM20.
PART E – WATER		
E88	Strategies for the management of ASS during works must be implemented.	Chapter 6 mitigation measure ID SWMM87
E89	Where available and practicable, and of appropriate chemical and biological quality, stormwater, recycled water or other water sources shall be used in preference to potable water for the delivery of the SSI, including dust control.	Chapter 6 mitigation measure ID SWMM68
E90	Drainage feature crossings (permanent and temporary watercourse crossings and stream diversions) and drainage swales and depressions must be undertaken in accordance with relevant guidelines and designed by a suitably qualified and experienced person in consultation with DPI Fisheries and the EPA.	Chapter 6 mitigation measure ID SWMM3, SWMM4, SWMM5
E91	The realignment of Frazers Creek must be undertaken in consultation with and meet the reasonable requirements of DPI Fisheries.	Chapter 6 mitigation measure ID SWMM4 FFMP Chapter 6 mitigation measure ID FFMM17 Community Communication Strategy

3.3 Revised environmental management measures

Relevant REMM from the EIS as amended by the SPIR are listed in Table 3-2 below. This includes a cross reference as to where the measure is addressed in this Plan or other Project management documents.

Table 3-2 Revised environmental management measures relevant to this SWMP

ID No.	Revised environmental management measure	Document reference
SW01	<p>Industry standard erosion and sediment controls will be designed and implemented in accordance with the following specifications and guidelines:</p> <ul style="list-style-type: none"> Managing Urban Stormwater: Soils and Construction (Landcom, 2004) Roads and Maritime's Erosion and Sedimentation Management Procedure (PN143) Roads and Maritime's Soil and Water Management Specification (G38) The NSW Office of Water's guidelines for Controlled Activities. Volume 2D Main Road Construction published (DECC, 2008). <p>These controls will be established before the start of construction and maintained in effective working order for the duration of the construction period until the site is restored.</p>	<p>Section 3.1.2</p> <p>Chapter 6 mitigation measure ID SWMM3</p> <p>Chapter 6 mitigation measure ID SWMM2, SWMM6.</p>
SW02	<p>The CEMP will include a construction soil and water quality management plan to manage potential impacts on soils and receiving watercourses, to include, but not be limited to:</p> <ul style="list-style-type: none"> Objectives and targets for soil and water quality management Information on the relevant statutory and other requirements relating to soils and water quality, including any permits or licences required for the project Details of any consultation requirements under the Plan An overview of the existing environment and potential impacts related to the construction works. <p>Measures to manage impacts of the project including in relation to:</p> <ul style="list-style-type: none"> Soils, erosion and sedimentation Stockpile management Spoil and fill management Surface water quality Groundwater levels 	<p>This SWMP</p> <p>Sections 2.2, 2.3</p> <p>Chapter 3</p> <p>Section 7.4</p> <p>Section 1.4</p> <p>Chapters 4, 5</p> <p>Chapters 6</p> <p>Chapter 6 mitigation measure ID SWMM1 - SWMM68.</p> <p>Chapter 6 mitigation measure ID SWMM3, SWMM5, SWMM23, SWMM25, SWMM28, SWMM59, SWMM67.</p> <p>Chapter 6 mitigation measure ID SWMM3, SWMM5, SWMM6, SWMM7.</p> <p>Chapter 6 mitigation measure ID SWMM60 - SWMM68.</p> <p>Section 7.3</p>

ID No.	Revised environmental management measure	Document reference
	<ul style="list-style-type: none"> Discharges from sedimentation basins, ASS treatment areas and groundwater de-watering Acid sulfate soils and contaminated lands Significant weather events (such as heavy rainfall or flooding) Re-fuelling of vehicles and other equipment and accidental spills Unexpected finds such as asbestos or contaminated fill <p>A surface water quality monitoring program that as a minimum addresses the requirements of the project environment protection licence</p> <p>Auditing and reporting requirements</p> <p>Site inductions and training for construction personnel in the implementation of the Plan</p> <p>The strategy will be prepared in accordance with the relevant industry standard guidelines and procedures.</p>	<p>Chapter 6 mitigation measure ID SWMM60, SWMM87.</p> <p>Acid sulfate soils: Chapter 6 mitigation measure ID SWMM87</p> <p>Contaminated lands: Chapter 6 mitigation measure ID SWMM85</p> <p>Chapter 6 mitigation measure ID SWMM66</p> <p>Chapter 6 mitigation measure ID SWMM74-SWMM81</p> <p>Unexpected Contaminated Land and Asbestos Finds Procedure (CoA E60) – to be completed separately to this SWMP</p> <p>Chapter 6 mitigation measure ID SWMM64</p> <p>Sections 7.7, 7.8.</p> <p>Section 7.2</p> <p>Section 3.1</p>
SW03	<p>The size, location and number of temporary sedimentation basins to treat site runoff during construction will be confirmed during detailed design. The design process will consider the site constraints (such as topography and ecology), land take, and proximity to receiving waters and / or sensitive receiving waters. They will be designed in accordance with Managing Urban Stormwater: Soils and Construction (Landcom, 2004).</p>	<p>Chapter 6 mitigation measure ID SWMM1-SWMM3</p>
SW04	<p>An emergency spill response procedure will be prepared to minimise the impact of any accidental spills, and include details on the requirements for managing spills, disposing of any contaminated waste, and reporting of any such incidents.</p>	<p>Incident and Emergency Response Plan (IERP) Appendix B</p> <p>WEMP Table 5-2 for disposal of spill kit materials</p> <p>CEMP (main section) Section 3.6 for incident reporting</p>

ID No.	Revised environmental management measure	Document reference
SW05	<p>Areas of potential environmental concern with respect to contamination are identified in this environmental impact statement. The risks posed by work in these areas will be evaluated and managed through a Phase 2 Assessment including:</p> <ul style="list-style-type: none"> • A review of historical information • Targeted sampling and analysis of samples at the areas of potential environmental concern in accordance with the National Environmental Protection (Assessment of Site Contamination) Measure (2013). <p>In the event the Phase 2 Assessment identifies any areas of contamination that are to be impacted by the project, the CEMP will include a strategy to manage these areas, prepared in accordance with the Guidelines for the Management of Contamination (Roads and Maritime, 2013e).</p>	Contaminated Land Management Sub-plan (CLMP)
GW01	<p>Groundwater monitoring will be undertaken adjacent to groundwater dependent ecosystems in close proximity to the project to identify the potential impacts of dewatering or depressurisation of groundwater as a result of the project. The decision to cease groundwater monitoring in the operational phase, following construction, will be confirmed in consultation with a suitably qualified independent expert.</p>	<p>Appendix B Construction water quality monitoring program</p> <p>Annexure B1 Baseline water quality monitoring program (by RMS)</p>

4 Existing Environment

The soil and water quality environment within the work footprint and its environs is described below. This information is a summary of chapter 16 (soils and surface water quality) and chapter 17 (groundwater) of the EIS.

4.1 Topography and soil characteristics

4.1.1 Topography

Topography within the project area generally consists of undulating hills in the north and south, separated by lower lying coastal floodplain (EIS, p488).

The northern-most part of the project area (near Penrose) is on a broad spur made up of the consolidated rock materials of the Berry Formation (siltstone, shales and sandstones). This spur separates the lower lying Quaternary era alluvial and swamp deposits at Koonawarra to the north, and Duck Creek to the south. Relief in the northern portion of the project area averages 3.5 per cent between Penrose in the north, and Duck Creek in the south. Mount Brown, a regionally significant topographical feature (100 metres Australian height datum (AHD)) is situated one kilometre north-east of the project area at Penrose (EIS, p488).

The topography of the project area gently rises in a northerly direction from about nine metres AHD at its crossing of the Duck Creek floodplain near Yallah to about 30 metres AHD in the vicinity of Haywards Bay. The project area then traverses the Macquarie Rivulet and Frazers Creek floodplains at a relatively consistent elevation of less than six metres AHD through to Tongarra Road. From Tongarra Road through to the southern extent of the project area at Oak Flats, the project area is characterised by gently undulating hills of the Berry Formation. This portion of the project area has a local relief of 20 metres and slopes in the order of five per cent (EIS, p488).

4.1.2 Geology

Published geological information contained within the Wollongong-Port Hacking 1:250 000 Geological Series Sheet (Stroud et al, 1985) indicates the project area traverses two principal geological landscapes – the Permian era Berry Formation and Quaternary era alluvial and swamp deposits. The former geological landscape is present in the northern and southern parts of the project area (principally north of Duck Creek and south of Tongarra Road). Quaternary era alluvium and swamp deposits are largely situated within the central part of the project area, mirroring the floodplains of the present day Duck Creek, Macquarie Rivulet and Frazers Creek (EIS, p488). The geological units present within the project area are shown in Figure 4-1.

The Berry Formation is locally comprised of red brown and grey volcanic sandstones north of Duck Creek and mid grey to grey siltstone and fine sandstone to the south of Duck Creek (Troedson and Hashimoto, 2013). Quaternary era alluvium associated with the Duck Creek floodplain is locally described as Holocene floodplain deposits, comprised of silts, fluvial sand and clay (Troedson and Hashimoto, 2013). Further south, near Macquarie Rivulet and Frazers Creek, the Quaternary era alluvial deposits form a complex of related units, including floodplain deposits (silt, fluvial sand, clay), levee deposits (fluvial sand, silt and clay) and alluvial paleo channel filling units (organic mud, peat, clay, silt, fluvial sand) (EIS, p488).

The Albion Park Rail Bypass Factual Geotechnical Report, Stages 1, 2 and 3 (Golder Associates, 2015) describes the geological conditions that were encountered in the course of the preliminary geotechnical investigation. In the northern portion of the project area, the cut face adjacent to the northbound lanes of the Princes Highway is comprised of sandstone of the Berry Formation. Moving south, at the level of the Princes Highway, the bedrock occurs at shallow depths and comprises siltstones of the Berry Formation with a thin veneer of silty residual soils. This ground profile is reasonably consistent in the project area between the Princes Highway and the South Coast Rail Line, across the old golf course and through the cut down towards the Macquarie Rivulet. The depth to bedrock is relatively shallow and outcropping siltstone can be seen in the small cutting on the eastern side of the rail line (EIS, p489).

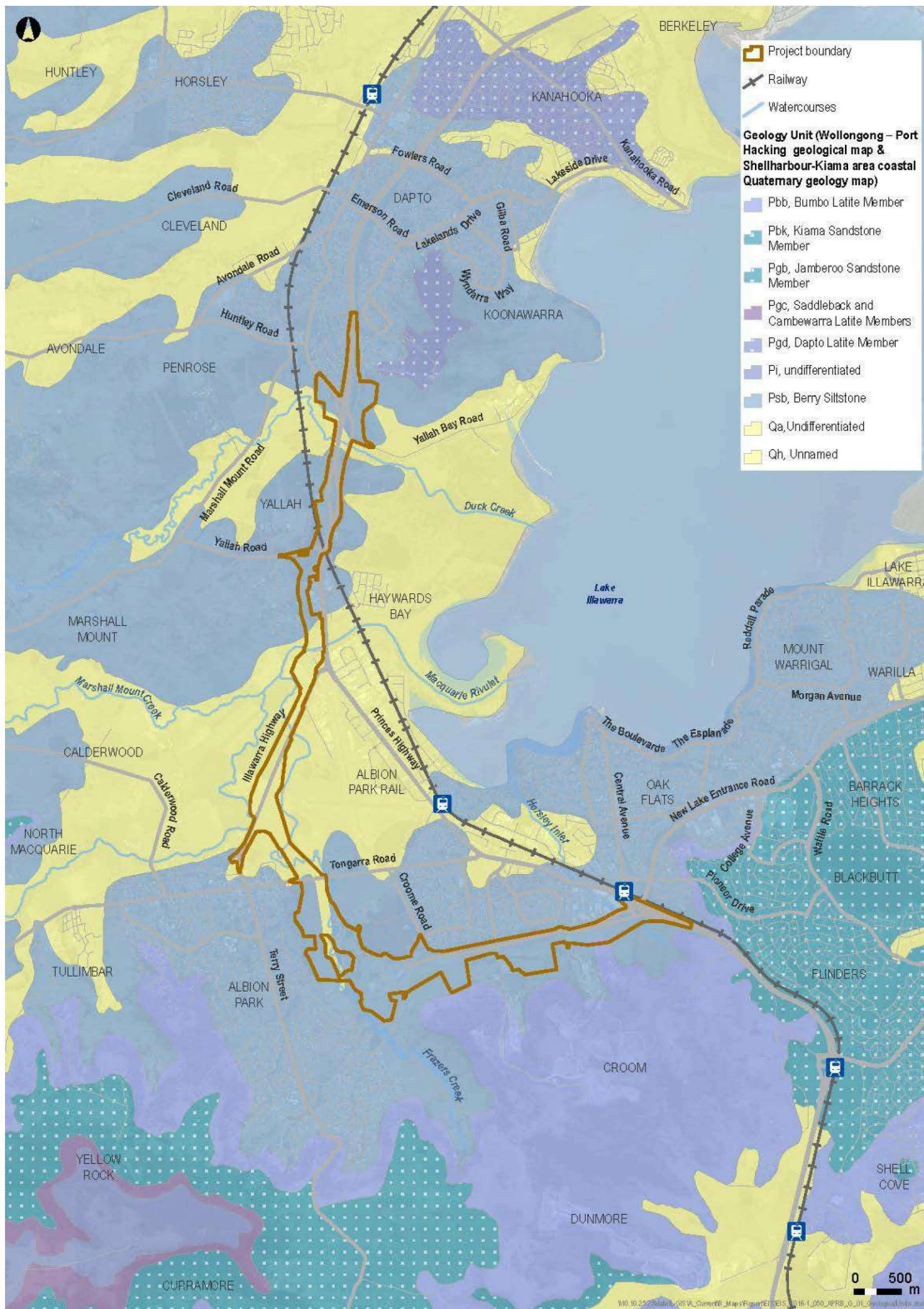


Figure 4-1 Geological units (EIS, p491)¹

¹ It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

In the area south of the Yallah cut, the bedrock level drops off steeply on the northern bank of the Macquarie Rivulet and then rises rapidly on the southern bank, indicating the extent of the remnant channel of the river. Here the deep alluvial soils are potentially compressible (EIS, p489).

The central part of the project area comprises a relatively flat and poorly drained floodplain fed by the Macquarie Rivulet and Frazers Creek. On the southern bank of the Macquarie Rivulet, there is a thin cover of alluvial soil overlying shallow siltstone bedrock. The depth to bedrock rapidly drops off southwards. Further south the surficial soils comprise interbedded varieties of Holocene Age and Pleistocene Age soils. Through the floodplain the depth to bedrock varies between nine metres and 20.5 metres. The covering soils contain zones of soft clays that appear to be coincident with the Pleistocene Age soils (EIS, p488).

As the project route heads south beyond Tongarra Road, the soft alluvial soils are not present, giving way generally to more granular alluvial deposits on approach to the Croom Regional Sporting Complex. Beneath the existing cricket pitch at the Croom Regional Sporting Complex, the depth to bedrock reduces rapidly from around 11 metres to 1.1 metres with a thin veneer of silty clayey residual soils and alluvial soils. While the bedrock mainly comprises siltstone and sandstone, an area of basalt was observed close to the cricket pitch (EIS, p489).

In the region of the existing East West Link, the siltstone bedrock is exposed in the cut faces. Shallow bedrock is typically present for the majority of the East West Link. The higher ground to the south is mainly underlain by latites with some meta-siltstone lenses, with rock head being encountered between one metre and 2.5 metres below existing ground level (EIS, p488).

4.1.3 Soil landscapes

Four soil landscapes, as defined by Hazelton (1992) occur within project area: the Albion Park, Fairy Meadow, Shellharbour and Bombo soil landscapes. The Albion Park and Fairy Meadow soil landscapes are the most common, while the Shellharbour and Bombo soil landscapes are present in a smaller extent to the far north and south of the project area respectively (EIS, p490).

The Albion Park soil landscape is an erosional landscape typified by short steep upper slopes and gentle foot slopes. This soil landscape follows the Berry Geological Formation, and is primarily located in the northern and south-eastern parts of the project area (EIS, p490).

The Fairy Meadow soil landscape is a swamp landscape. It occurs in the project area as a series of broad alluvial plains bisected by Duck Creek, Macquarie Rivulet and Frazers Creek. This soil landscape occurs in the central portion of the study area on unconsolidated Quaternary era deposits. ASS and soft soils within the project area occur principally within the Fairy Meadow soil landscape (EIS, p490).

The erosional Bombo soil landscape follows the distribution of the Bombo Latite. In the project area it takes the form of rolling low hills with benched slopes (EIS, p490).

The erosional Shellharbour soil landscape is characterised by rolling low hills with long side- slopes and broad drainage plains on Budgong Sandstone (EIS, p490).

The geotechnical investigation for the environmental impact statement (Golder Associates, 2015) found a thin veneer of residual soil cover in the north of the project area, over shallow siltstone bedrock. In the central part of the project area, south of Macquarie Rivulet, bedrock was reported at depths of between nine and 20 metres below ground level, overlain by soft clays consistent with the Fairy Meadow soil landscape. Shallow soils were encountered south of the Fairy Meadow soil landscape near the Croom Regional Sporting Complex. Soil landscapes within the project area are shown in Figure 4-2 (EIS, p490).



Figure 4-2 Soil Landscapes (EIS, p492)²

² It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

4.1.4 Acid sulfate soils

The NSW Coastal Acid Sulfate Soils Risk Mapping Series (Department of Land and Water Conservation, 1995) groups land with ASS risk in one of five classes on the basis of the potential impacts that may result from different types of work. In the context of soil disturbance, Class 1 represents the highest risk and Class 5 the lowest risk. The project area includes soils mapped under all five risk classes, as follows (EIS, p493):

- North of Macquarie Rivulet is mapped as Class 5. Soil disturbance would occur in this part of the project area, associated with cuttings to a maximum of eight metres below ground level
- The area around Macquarie Rivulet, Frazers Creek and the associated floodplains is mapped as a complex of Classes 1, 2, 3 and 5. Soil disturbance in this area would be limited to piling for the installation of bridge supports and shallow topsoil stripping from beneath embankments
- The area from the Macquarie Rivulet – Frazers Creek confluence south to Tongarra Road is mapped as Class 4. Shallow soils in this area would be removed in preparation of the construction of elevated soil embankments
- The area between Tongarra Road and the south-eastern extent of the project area at Oak Flats is mapped as Class 5. Elevated embankments are proposed in this area and relatively limited soil would be removed.

As part of the geotechnical investigation for the project, 20 soil samples were collected from boreholes mostly in the central portion of the project area. Laboratory analysis indicated 14 of the 20 samples were found to meet the criteria for the potential to generate acid from exposed soils. The samples that exceeded the trigger levels were collected from boreholes at a range of depths and were located principally on the Macquarie Rivulet and Frazers Creek floodplains, and from the banks of Macquarie Rivulet south to Tongarra Road. A sample from a borehole adjacent to the TransGrid Central Region Dapto Office near the Princes Highway was reported at a concentration that exceeded the trigger level (EIS, p493).

Borehole logs from the project's geotechnical investigation (Golder Associates, 2015) show that pyrite (an indicator for acid sulfate rock) was widely observed within the rock materials in the project area at depths ranging from six through to 20 metres below ground. Analysis of a sample collected from a borehole near Yallah Road indicated acid sulfate rock potential. It is considered likely that there are other areas of acid sulfate rock in the project area, and these would be identified via additional geotechnical investigation during detailed design (EIS, p493).

4.1.5 Soft soils

Soft soils are consistently distributed through the central portion of the site associated with the Fairy Meadow soil landscape, a Quaternary era landscape typified by alluvial and swamp deposits. The thickness of soft soils in the project area ranges from a few metres up to 10 metres across the central domain (Golder Associates, 2015).

4.1.6 Salinity

The Fairy Meadow soil landscape, which occurs within the central part of the project area, is reported to exhibit salinity (Hazelton, 1992). Furthermore, a soil salinity investigation carried out for the nearby West Dapto future growth area (MG Planning, 2006) identified saline soils to the immediate north of the project area, in the suburb of Horsley and near Avondale Road in Penrose. Higher levels of soil salinity are expected in the area due to the estuarine nature of adjacent watercourses.

4.1.7 Contaminated land

According to Chapter 16 of the EIS, there are not any known sites of contamination within the project area that have been regulated under the *Contaminated Land Management Act 1997* (NSW) (EIS, p494).

Based on the background review, and site inspection, a number of potentially contaminating land uses have been identified within the project area. The subject sites are designated as areas of

potential environmental concern for the purposes of this assessment. These areas of potential environmental concern are (Figure 4-3):

- The area adjacent to and within the South Coast Rail Line where it crosses the project. This area includes all of the rail corridor
- Commercial buildings on Yallah Road
- Commercial buildings adjacent to the intersection of the Illawarra and Princes Highways
- Dairy located west of the proposed motorway alignment, near the Illawarra Highway
- A heavy vehicle parking area south of the Durgadin Drive/ East West Link intersection, associated with a quarry.

In addition to the specific areas of potential environmental concern, the local topography and existing infrastructure in the project area (including the Princes Highway and Illawarra Highway) suggests roads and roadside levee banks have commonly been built using fill. Fill has been used in parts of the Croom Regional Sporting Complex to level the playing fields (EIS, p494).

Where the origin of imported fill cannot be reliably identified, the material has the potential to include contaminants. Filled parts of the site are therefore considered to represent areas of potential environmental concern until such time as the composition or source of the fill materials can be determined as suitable for the proposed land use (EIS, p494).

Potential contaminants of concern are commonly grouped according to industry type. The potential contaminants of concern with potential to occur in the project area (and their industry type) include (EIS, p494):

- Hydrocarbons, arsenic, phenolics (creosote), heavy metals, nitrates and ammonia (railway yards)
- Hydrocarbons, metals, solvents (scrap yards)
- Fertilizer, insecticides, fungicides, herbicides (agricultural and horticultural activities)
- Hydrocarbons, metals, solvents, acids/alkalis, refrigerants, antifreeze (engine works).

Filling materials that have been used in the project area have the potential to include some or all of these potential contaminants of concern, along with asbestos (EIS, p494).

The preliminary contamination assessment has identified some areas of potential environmental concern which require further assessment. Consistent with the Guideline for the Management of Contamination (Roads and Maritime, 2013e) and the *National Environment Protection (Assessment of Site Contamination) Measure 1999*, as amended 2013, this further assessment would include intrusive investigations, sampling and laboratory analysis. The design of the intrusive investigations would be in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999* and the *Contaminated Sites: Sampling Design Guidelines* (Environment Protection Authority, 1995). The further assessment would be documented in a detailed site investigation prepared in accordance with the NSW Environment Protection Authority Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites (Office of Environment and Heritage, 2011b) (EIS, p494).

Should the detailed site investigation confirm the presence of contaminants in excess of the relevant guideline values, and conclude that remediation or management measures are required to make the site suitable for the proposed use, a remedial action plan would be developed. The plan would document the approach to remediation and detail the requirements to validate that the site was suitable for the proposed use (EIS, p494).

Subsequent to the EIS, the Hyder Cardno Joint Venture (HCJV) (employed by Roads and Maritime) identified seven locations which were further investigated within the Albion Park Rail bypass footprint. Environmental Site Assessments (ESAs) for those locations presented advice on the subsurface conditions of the sites relative to their intended land use as a road corridor and provided soil management options when required. Refer to the Contaminated Land Management Sub-plan (CLMP) for additional details as required.

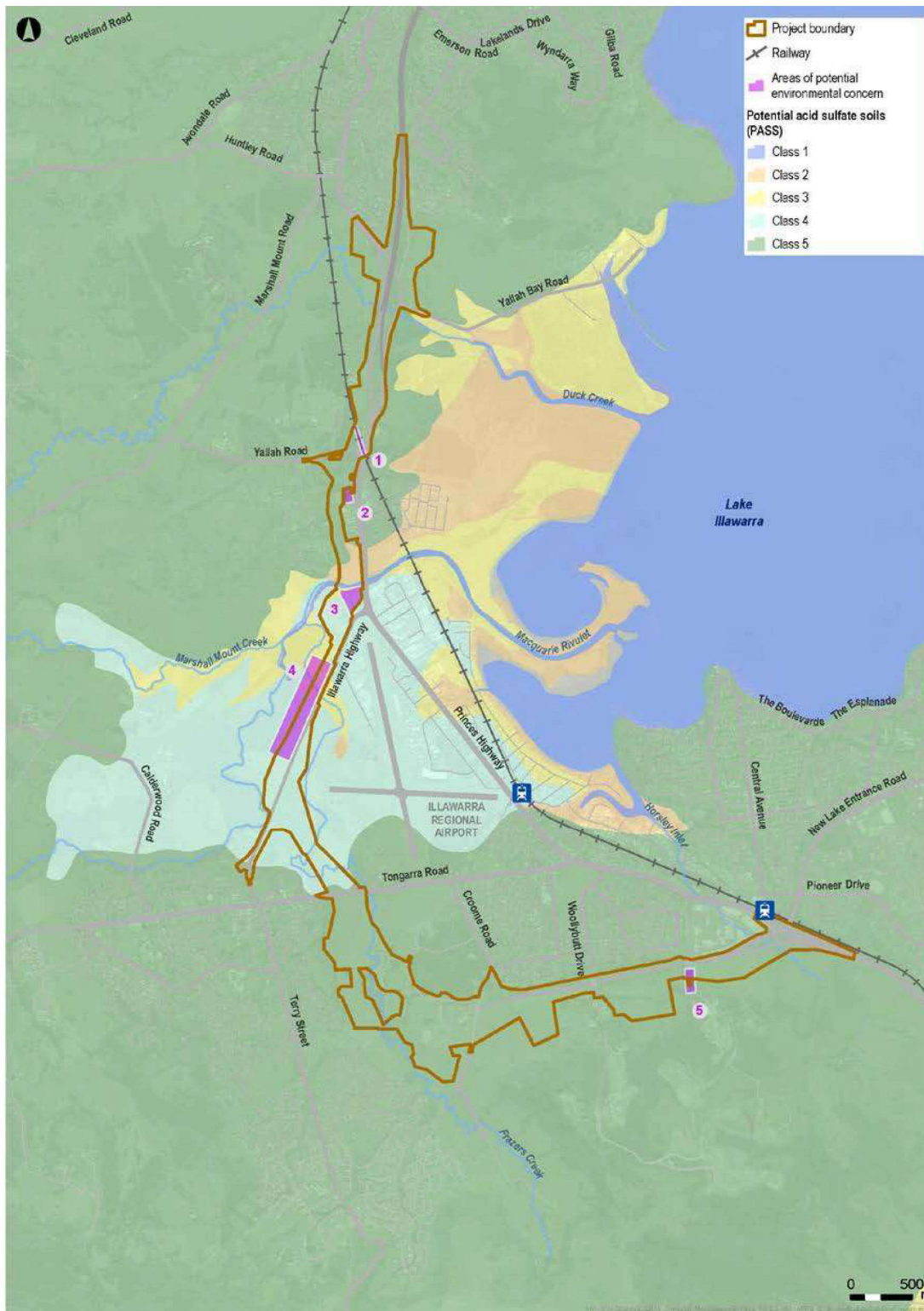


Figure 4-3 Areas of potential environment concern and potential ASS (EIS, p496)³

³ It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

4.2 Surface water

4.2.1 Receiving waters and sensitive receiving environments

The project area drains to three main watercourses, all of which are tributaries of Lake Illawarra:

- Duck Creek
- Macquarie Rivulet, which is fed by Marshall Mount Creek and Frazers Creek
- Horsley Creek.

These watercourses are characterised by largely rural landscapes which are predominantly cleared for rural purposes such as grazing. As these watercourses reach Lake Illawarra they flow through townships located adjacent to the shoreline, where they are influenced by directed stormwater from urban areas. Some commercial and industrial facilities are also located in the catchment for these watercourses. Large scale land development in West Dapto and Calderwood in the upstream of the catchments also has the potential to result in impacts to these watercourses both from existing works (e.g. via erosion and sedimentation related to construction works) and into the future (e.g. due to changes to stormwater quality from these new urban areas) (EIS, p497).

These watercourses, and Lake Illawarra, comprise the receiving waters for the project, and have the potential to be impacted by the project during its construction and/or operation.

These receiving waters comprise a range of sensitive riparian and aquatic ecosystems that support a diverse range of flora and fauna. They may have high conservation value, be highly valued by the community, support human uses (such as fishing or aquaculture), or be susceptible to water pollution. These sensitive ecosystems are referred to as sensitive receiving environments (EIS, p497).

Sensitive receiving environments for the project area are mapped in Figure 4-4. Those that have potential to be indirectly impacted by the project via water quality impacts are located within and downstream of the project area and include (EIS, p497):

- The aquatic and riparian ecosystems of Duck Creek, Macquarie Rivulet and Horsley Creek. The Macquarie Rivulet and Horsley Creek also comprise of key fish habitat
- Freshwater wetlands and saltmarsh threatened ecological communities
- State Environmental Planning Policy (Coastal Management) 2018 (Coastal Management SEPP). The Coastal Management SEPP commenced on 3 April 2018. It aims to promote an integrated and coordinated approach to land use planning in the coastal zone in a manner consistent with the objects of the *Coastal Management Act 2016*. The Coastal Management SEPP consolidates and consequently repeals SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and SEPP 71 (Coastal Protection)
- Groundwater dependent ecosystems
- Lake Illawarra, which is a Nationally Important Wetland (NSW081), a key fish habitat, and a popular place for recreational fishing and swimming.
- Seagrass beds located in Lake Illawarra.

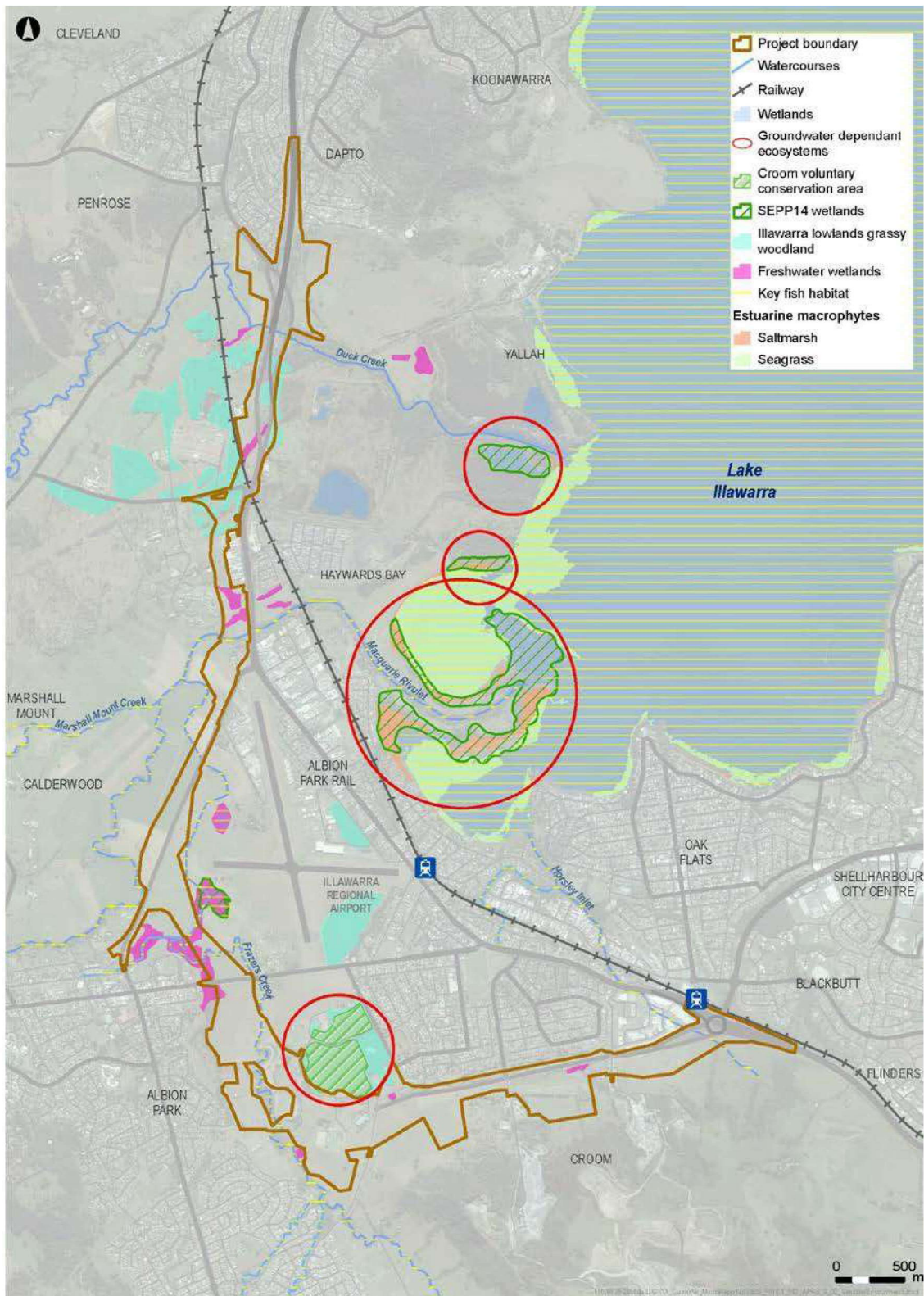


Figure 4-4 Sensitive receiving environments (EIS, p498)⁴

⁴ It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

4.2.2 Surface water quality

The most recently published State of the Environment Report by Shellharbour City Council is for 2010–2011 (Shellharbour City Council, 2011). It presents water quality data for the lower reaches of both Horsley Creek and the Macquarie Rivulet, which is summarised in Table 4-1. Values shown in red text represent exceedances of the trigger levels for aquatic ecosystem health guidelines, with the exception of the dissolved oxygen concentration for lower Horsley Creek, which is below the desirable range for estuaries. The Australian and New Zealand Environment and Conservation Council (2000) Guideline values for fresh and marine water quality are (EIS, p499):

- Chlorophyll a: Four micrograms per litre
- Total nitrogen: 0.3 milligrams per litre
- Total phosphorus: 0.03 milligrams per litre
- Dissolved oxygen 80-110 per cent.

The State of the Catchment 2010 Riverine Ecosystems report for the Southern Rivers Region (NSW Government, 2010a) states that the Macquarie Rivulet had numerous exceedances of the guidelines for concentrations of total nitrogen and total phosphorous during the reporting period, and that turbidity levels were high. This is generally consistent with the results presented in the State of the Environment Report (Shellharbour City Council, 2011).

This data indicates that both the Macquarie Rivulet and Horsley Creek are subject to an existing level of impact from the road network and other activities in the catchment. It is noted that the existing road network has limited provision for treating stormwater runoff from the road surface. This is likely contributing to some of the observed water quality issues, along with other land uses in the catchment, including the railway, urban development, agriculture and sporting fields (EIS, p499).

Table 4-1 Existing water quality - Horsley Creek and Macquarie Rivulet (EIS, p500)

Watercourse	Chlorophyll-a (µg/L)		Total Nitrogen (mg/L)		Total phosphorous (mg/L)		Dissolved oxygen (%)	
	2009-2010	2010-2011	2009-2010	2010-2011	2009-2010	2010-2011	2009-2010	2010-2011
Lower Horsley Creek	5.4	6.6	0.41	0.7	0.07	0.31	Not available	70.6
Lower Macquarie Rivulet	1.05	1.3	0.74	0.5	0.11	0.08	Not available	85.8

There was no publicly available water quality data for Duck Creek to enable a similar assessment of existing water quality. The environmental impact statement assumes that the water quality would be subject to a similar level of impact as the Macquarie Rivulet and Horsley Creek.

4.3 Groundwater

This chapter is summarised from Chapter 17 of the EIS.

4.3.1 Groundwater characteristics

The project area is located within the Sydney Basin South Groundwater Source, which is bounded by the Illawarra Range to the north, the Turpentine Range to the south and east, and the geological boundary of the Goulburn Fractured Rock to the west. The groundwater source has a total area of just over 3000 square kilometres. Bores accessing the groundwater source are mainly limited to the northern half of its extent, with National Parks covering much of the southern part (NSW Office of Water, 2011a). The relatively high rainfall and considerable topographical relief suggest that the groundwater contours can be expected to follow the topography. Groundwater discharge is therefore most likely to occur in the low lying coastal area. The study area and project location are mapped in Figure 4-5, which also shows the distribution of bores (EIS, p517).

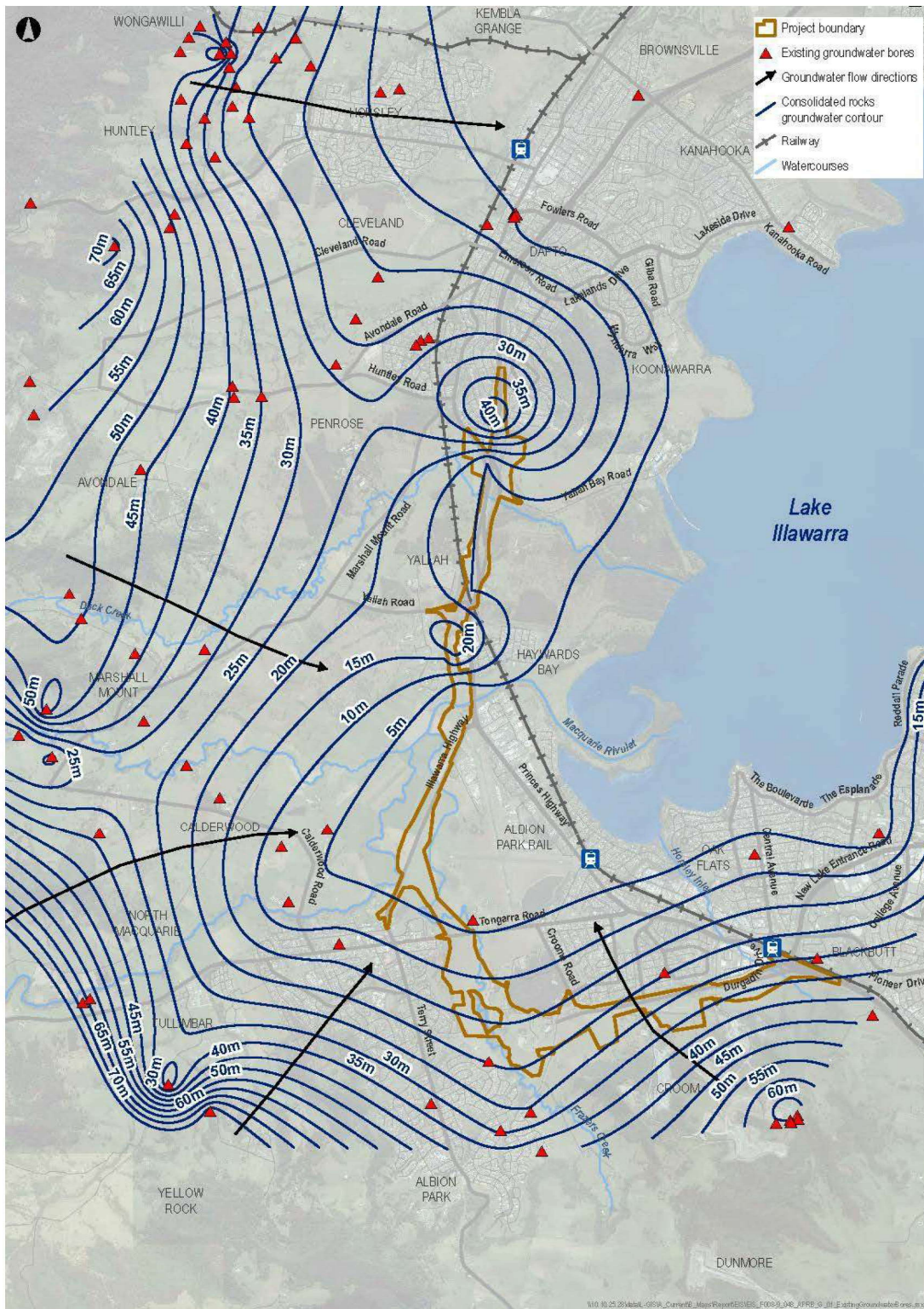


Figure 4-5 Groundwater assessment study area showing existing groundwater bores (EIS, p518)⁵

⁵ It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

4.3.2 Groundwater use

The EIS (p519) identified that there are 104 bores located in the groundwater study area, of which a total of 66 are used for water supply. None of the bores used for water supply are located within the project boundary; and most are located further to the west and north-west of the project area.

The licences for water supply bores indicate that they are typically used for watering stock, domestic use and monitoring groundwater. A total of 36 bores used for monitoring are located on five properties, appear to be associated with industrial activity on the subject sites (EIS, p519).

Of the 66 licenced producing bores, 28 are targeting the consolidated rock formation and only two bores are targeting alluvium formations. This reflects the bore yield and groundwater characteristics described in Section 17.2.1 of the EIS, namely that better groundwater resources are found in the fractured rock units of the consolidated formation.

A total of nine bores are used for recreational, industrial and irrigation purposes. Those bores are licenced and have a defined water allocation. Groundwater allocations range from one to 19 megalitres per year (or equivalent share units). The larger groundwater allocation is for recreation purpose with 19 megalitres per year (or equivalent share units) of groundwater allocation.

It is noted that this information is based on a review of the groundwater licences, and does not necessarily reflect the current and ongoing use of the bores (EIS, p519).

4.3.3 Groundwater quality

Based on the fact that the data collation and review in relation to contaminated soils did not identify any known sites of contamination (refer Section 16.2.1 of the EIS), it is considered that there is a low likelihood of encountering contaminated groundwater (EIS, p519).

4.3.4 Groundwater dependent ecosystems

Within the Greater Metropolitan Region for the Sydney Basin South groundwater source, the Macquarie Rivulet estuary wetland is the only defined groundwater dependent ecosystem of high significance near the project (EIS, p520). It is located 1.3 kilometres east of the project and adjacent to Lake Illawarra. The groundwater levels would be close to the surface near Lake Illawarra, and would contribute to the groundwater dependent of the Coastal Management SEPP in this location (EIS, p520).

Other freshwater wetlands (such as the Freshwater Wetlands endangered ecological community) may be only partly sustained by groundwater, relying primarily on surface water flows. A Coastal Management SEPP on Frazers Creek, located directly east of the project, supports low-level vegetation and freshwater fauna, and is potentially partially supported by groundwater. Based on a review of the information presented in Technical Paper 4- Biodiversity Assessment Report, it is not considered to be a high-value groundwater dependent ecosystem (EIS, p520).

It is expected that only deep rooted freshwater wetland communities are expected to be reliant on groundwater. This would include the Illawarra Lowland Grassy Woodland endangered ecological community, which is thought to be partially reliant on groundwater. One Illawarra Lowland Grassy Woodland community located close to the project in Croom Reserve is identified as having a high priority for conservation due to its status as an endangered ecological community that forms part of the Voluntary Conservation Area (see Chapter 9 of the EIS). This community is therefore considered to be a groundwater dependent ecosystem.

The groundwater dependent ecosystems are mapped in Figure 4-6.

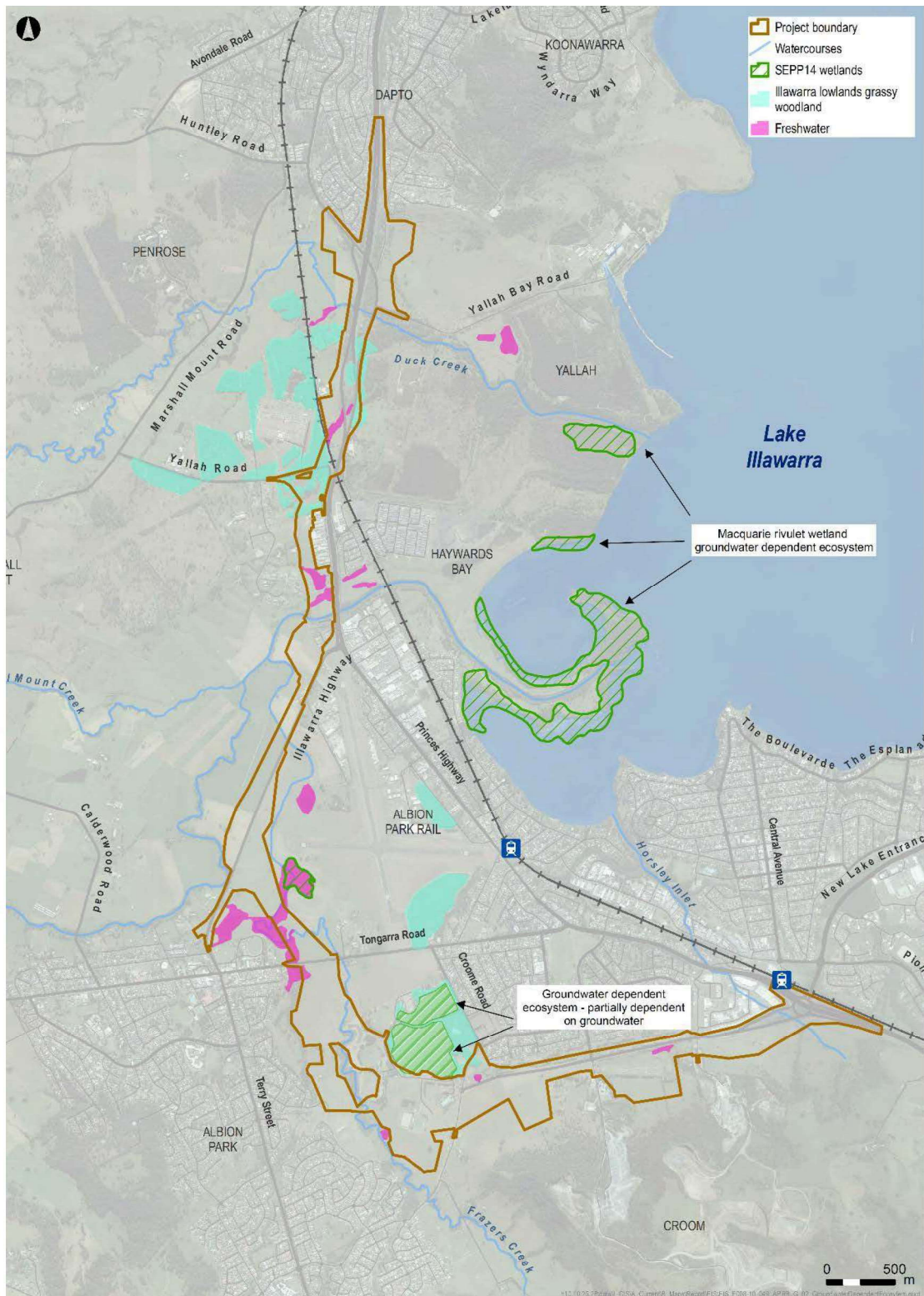


Figure 4-6 Groundwater dependent ecosystems and wetlands (EIS, p521)⁶

⁶ It is noted that the project boundary in the SPIR (not the EIS) is the approved project boundary for the overall approved State Significant Infrastructure (SSI 6878). However, the Project forms Stage 2 of SSI 6878 only. Stage 2 comprises the extension of the Princes Motorway between Yallah and Oak Flats and all associated works including bridges, interchanges and local road changes or upgrades (excluding Stage 3 – Yallah Interchange; and any work as part of Stage 1 - Croom Regional Sporting Complex reconfiguration). For additional details refer to the Albion Park Rail bypass Staging Report (Roads and Maritime, March 2018).

4.4 Rainfall

The rainfall records from Albion Park have been selected to reflect the potential rainfall conditions across the project site due to its proximity to the overall site, and extent of available data (from 1888 to present). A summary of the rainfall records from the Bureau of Meteorology is provided in

Table 4-2 Summary of rainfall records

Summary of rainfall record from 1892 to present													
	Summer / Autumn						Winter / Spring						
	Dec	Jan	Feb	Mar	Apr	Ma	Jun	July	Aug	Sep	Oct	Nov	Year
Mean rainfall (mm)	78.6	103.3	125.3	132.0	100.2	91.5	107.4	69.0	67.2	59.6	76.4	84.3	1095.8
Mean rain days	7.3	8.0	8.2	8.6	7.0	6.9	7.0	5.7	5.8	6.3	6.9	7.7	85.3

Source: [Bureau of Meteorology Website, Accessed 27 April 2020](#)

4.5 Rainfall erosivity factor

The rainfall erosivity factor is a measure of the ability of rainfall to cause erosion (referred as “R” in the revised universal soil loss equation (RUSLE)). The rainfall erosivity factor is used to determine the soil loss in tonnes per hectare over one year, and is used in calculations when sizing construction sediment basins. The rainfall erosivity factor forms part of the soil loss calculations made during development of the erosion and sediment control plan contained in Appendix A.

5 Environmental aspects and impacts

The key construction activities and the associated potential sources of soil and water impacts are identified through a risk management approach. The consequence and likelihood of each activity's impact on the environment has been assessed to prioritise its significance. The results of this risk assessment are included in Appendix A2 of the CEMP.

Ongoing environmental risk analysis during construction will be undertaken through regular monitoring, inspections and auditing as described in Chapter 7.

5.1 Construction activities

Key aspects of the project that could result in adverse impacts to soils, sediments and water (Chapters 16.3.1 and 16.3.2 in the EIS) are presented in Table 5-1.

Table 5-1 Potential construction activities and associated environmental issues

Environmental Issue	Construction activity
Soil erosion and sediment transport	<ul style="list-style-type: none"> • The excavation and transport of soils • The construction of subgrade, embankments and culverts • The temporary stockpiling of material.
Landslip	<ul style="list-style-type: none"> • Cuttings to achieve required road grades • Construction of embankment • Localised excavations, typically for drainage structures.
ASS and acid sulfate rock	<ul style="list-style-type: none"> • Dewatering activities designed to lower the groundwater table • Drainage work to temporarily and permanently manage surface water flows • Excavation of ASS/ acid sulfate rock and stockpiling of untreated materials, particularly deep soil strata and those situated below the groundwater table • Piling activities, particularly the installation of solid piles that displace ASS • Reuse of ASS and acid sulfate rock within permanent embankments and for landscape rehabilitation • Excavation of sediments around creek crossings • Exposure of in-situ soils and rock to the atmosphere in trenches, excavations and cuttings.
Settlement of soft soils	<ul style="list-style-type: none"> • Excavation and replacement of unsuitable soft materials • Construction of raised embankments • Soil consolidation • Ground improvement measures such as wick drainage.
Salinity and acidity	<ul style="list-style-type: none"> • Vegetation clearing • Earthworks.
Water quality	<ul style="list-style-type: none"> • Stockpiling of vegetation • Vegetation clearing and the exposure of soils • Earthworks or dewatering • Disturbance of contaminated materials • Use of vehicles, plant and machinery on site • Work activities • Construction of adjusted Frazers Creek • Activities at ancillary sites • Generation of waste and spoil • Installation of working platforms in waterways (Macquarie Rivulet, Frazers Creek, Duck Creek).

5.2 Impacts

The potential for impacts on soil and water will depend on a number of factors. Primarily impacts will be dependent on the nature, extent and magnitude of construction activities and their interaction with the natural environment. Potential impacts on soil and water as a result of the project are presented in Table 5-2.

Table 5-2 Potential impacts on soil and water

Environmental Issue	Action/Impact
Soil erosion and sediment transport	<ul style="list-style-type: none"> Increased risk of soil erosion Transportation of soils and sediments via stormwater runoff and wind to nearby waterways and sensitive receiving environments Adverse impacts on the health of ecosystems by smothering benthic habitats Increasing turbidity in the water column Decreasing light penetration Introducing sediment bound nutrients, trace materials and other toxicants.
Landslip	<ul style="list-style-type: none"> Rise to risk of landslips and mass material movement
ASS and acid sulfate rock	<ul style="list-style-type: none"> Exposure of ASS that were previously submerged below the groundwater table Soil and groundwater acidification in ASS landscapes Modification of groundwater levels in ASS landscapes pose a risk of disturbing ASS by exposing them to oxygen, which can increase the potential for sulfide oxidation and consequent acid generation.
Contaminated land	<ul style="list-style-type: none"> Lateral migration of contaminants into the environment via stormwater runoff and vertical infiltration of contaminants into previously unaffected soils and groundwater Increased risks of exposure for human receptors (workers, and members of the public) via the pathways of skin contact, ingestion and inhalation of volatile or airborne contaminants due to increased proximity to the contaminated materials.
Settlement of soft soils	<ul style="list-style-type: none"> Soft soils underneath engineered embankments are expected to settle during the construction phase of the project with a typical consolidation time of three to six months following the application of treatments such as wick drainage A total settlement of about 1350 millimetres is expected for soft soils Reduction of water content within shallow soils Minor changes to shallow groundwater levels Localised reductions in soil permeability and moisture levels.
Salinity and acidity	<ul style="list-style-type: none"> Deeper saline soils being brought to the surface Risk to vegetation growth Risk of erosion Salt export to surface water bodies.
Water quality	<ul style="list-style-type: none"> Tannin leachates from stockpiled vegetation, which could enter watercourses, resulting in increased acidity, reduced water clarity and light penetration, and increased biological oxygen demand Soil erosion by the action of wind or stormwater, and transport into waterways, leading to increased turbidity, sedimentation, and potentially the introduction of nutrients and any other pollutants associated with the sediments. There is an increased risk where vegetation clearing and / or earthworks are proposed adjacent to or within a watercourse (such as for bridge works or culverts). These activities could result in bank instability Exposure of potential or actual ASS in some parts of the project area could result in the mobilisation of acidic runoff into watercourses. This would result in increased acidity of surface water and / or groundwater. This work could cause the mobilisation of heavy metals into the environment The mobilisation of contaminants into surface water and / or groundwater, negatively impacting aquatic ecosystems Potential for an accidental spill or leak of fuel, oil, greases or other chemicals, which could pollute surface water and / or groundwater Potential for stagnation of waters, which could lead to water quality issues such as stratification, changes in nutrient cycling and decreased oxygen concentrations. Where flow modification leads to exposure of potential or actual ASS, this could lead to acid generation, with resultant negative impacts on surface water and groundwater

Environmental Issue	Action/Impact
	<ul style="list-style-type: none"> Adjusting Frazers Creek north of the existing Croom Regional Sporting Complex could result in soil erosion and sediment transport into waterways, leading to increased turbidity, sedimentation, and potentially the introduction of nutrients and any other pollutants associated with the sediments Activities at ancillary sites could adversely impact surface water and groundwater.
Impacts on sensitive receiving environments	<ul style="list-style-type: none"> Short-term, localised losses of terrestrial and aquatic species Short-term to medium-term declines in aquatic and riparian habitat condition Short-term localised impacts on the suitability of waterways for recreation Minor effects on the quality of water for usage by humans and / or livestock.

Some impacts on soil and water attributable to the project are anticipated. Relevant aspects and the potential for related impacts have been considered in a risk assessment at Appendix A2 of the CEMP. Chapter 6 provides a suite of mitigation measures that will be implemented to avoid or minimise those impacts.

6 Environmental mitigation measures

Specific mitigation measures to address impacts on soil and water are outlined in Table 6-1.

Table 6-1 Soil and water mitigation measures

ID	Mitigation measure	Responsibility
SWMM1	Engage a soil conservationist selected from the Roads and Maritime' Registered Category of 'Soil Conservation Consultancy Services', to review erosion and sediment control plans where required.	Environmental Manager
SWMM2	Install erosion and sediment controls in all construction areas where soil disturbance is going to occur, prior to soil disturbance occurring.	Environmental Manager Project Engineers Foreman
SWMM3	Design, install and maintain all erosion and sediment controls in accordance with the Erosion and sediment control plan (ESCP) included in Appendix A of this plan. The ESCP has been prepared in accordance with the Blue Book (Landcom, 2004 and DECC, 2008) and includes relevant standard drawings and details from these texts.	Environmental Manager Project Engineers Foreman
SWMM4	Consult with the required, plus optional additional agencies as relevant. For example, ensure permanent and temporary watercourse crossings and stream diversions, drainage swales and depressions are undertaken in consultation with DPI Fisheries and the EPA. Ensure Frazers Creek adjustment is designed and constructed in consultation with DPI Fisheries and DPI Water.	Environmental Manager
SWMM5	In addition to the overarching primary ESCP (refer to Appendix A) prepare Progressive Erosion and Sediment Control Plans (PESCPs) prior to commencing each stage or parcel of work where there is a risk of erosion and sediment loss.	Environmental Manager Project Engineers
SWMM6	Implement appropriate erosion and sediment control measures for each particular section of works in accordance with the PESCP, prior to the commencement of any clearing, stripping or earthworks.	Project Engineers Foreman
SWMM7	Install certain structures and controls (i.e. sediment basins, pipes and culverts) early (i.e. prior to clearing and stripping) to promote successful erosion and sediment control during construction (principally, during clearing, stripping and earthworks).	Project Engineers Foreman
SWMM8	Update PESCPs as required and as the works progress and the site changes.	Environmental Manager
SWMM9	Establish clearing limits and work boundaries that are well defined using barrier tape (or equivalent) prior to any construction, clearing or stripping works commencing. Exclusion zones and fencing or other means to demarcate vegetation to be retained in close proximity to the works need to be in accordance with the Roads and Maritime Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects (RTA, 2011)	Environmental Manager Project Engineers Foreman
SWMM10	Minimise the extent of clearing and retain as much groundcover as possible.	Project Engineers Foreman
SWMM11	Clearly mark all vegetation that is to be retained. Exclusion zones and fencing or other means to demarcate vegetation to be retained in close proximity to the works need to be in accordance with the Roads and Maritime Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA Projects (RTA, 2011).	Environmental Manager Project Engineers Foreman
SWMM12	Clear land progressively and clear the areas associated with the current section/stage of works only.	Project Engineers Foreman
SWMM13	Initially clear and grub leaving the soil surface in a reasonably rough condition with some surface vegetative cover.	Project Engineers Foreman
SWMM14	Maximise the separation of 'clean' (offsite) run-on water from 'dirty' (onsite) (e.g. turbid) construction area runoff as much as possible.	Environmental Manager Project Engineers

ID	Mitigation measure	Responsibility
		Foreman
SWMM15	Construct drainage structures early in the project including: <ul style="list-style-type: none"> • Sediment basins and traps • Catch drains, and • Culverts/ pipes and associated inlet and outlet protection (eg. dissipaters). 	Project Engineers Foreman
SWMM16	Maximise the diversion of turbid construction runoff into sediment basins.	Project Engineers Foreman
SWMM17	Control runoff during the construction of embankments (e.g. fill shaping and the construction of temporary dykes and batter drains).	Project Engineers Foreman
SWMM18	Divert clean water runoff into pits and the stormwater drainage system as soon as practical to reduce surface flow lengths.	Project Engineers Foreman
SWMM19	Divert offsite run-on water around the works site as much as possible. Use permanent cut-off drains to achieve this as much as possible.	Project Engineers Foreman
SWMM20	Maintain slope lengths at appropriate lengths (refer to the standard drawings in the Primary ESCP) to reduce water velocity and minimise erosion. Use catch drains to collect and divert runoff from the slopes.	Project Engineers Foreman
SWMM21	Use geotextile linings or other surface protection methods to provide temporary surface protection in areas where appropriate (e.g. batter drains, culvert construction).	Project Engineers Foreman
SWMM22	Use check dams within diversion drains where required to reduce water velocity and minimise erosion within the drains.	Project Engineers Foreman
SWMM23	Locate stockpiles in accordance with the <i>Stockpile Management Protocol</i> included in Appendix E of this SWMP.	Project Engineers Foreman
SWMM24	Progressively stabilise exposed ground surfaces using temporary methods such as soil binders, cover crop species or other appropriate practices.	Project Engineers Foreman
SWMM25	Stabilise stockpiles and batters progressively using temporary methods such as geotextile fabric, stabilised mulch, soil binders (e.g. Gluon polymer emulsion) or cover crop species. Use Rye Corn during the months of April to August or Japanese Millet during the months of September to March as required by R178.	Project Engineers Foreman
SWMM26	Immediately commence stabilisation of waterways, including their beds and banks, after the completion of any works within these areas. All stabilised areas to mimic a naturalised creek system and the disturbed areas to be planted with native species in accordance with the Landscape Design Drawings.	Project Engineers Foreman
SWMM27	Control dust using methods such as water trucks, temporary stabilisation methods, soil binders, compaction, progressive revegetation techniques or other appropriate practices.	Project Engineers Foreman
SWMM28	Use temporary ground covers such as soil stabilisers (e.g. Gluon polymer emulsion), hydroseed or hydromulch as much as possible to stabilise batters, stockpiles and large surface areas.	Project Engineers Foreman
SWMM29	Construct sediment control measures as close to the potential source of sediment as possible.	Environmental Manager Project Engineers Foreman
SWMM30	Ensure sediment basin management of turbid water immediately after rain as required with one or a combination of: <ul style="list-style-type: none"> • Flocculation with gypsum (or approved alternative flocculate), and 	Environmental Manager Project Engineers

ID	Mitigation measure	Responsibility
	<ul style="list-style-type: none"> Pump-out for construction purposes or dust control. 	Foreman
SWMM31	Do not release water from sediment basins prior to achieving acceptable water-quality standards (refer to mitigation measure ID SWMM60 for water quality criteria).	Environmental Manager Project Engineers Foreman
SWMM32	Control the tracking of mud and soil material onto local roads using shakers, rubble pads or washdown areas.	Foreman
SWMM33	Provide sediment fencing or equivalent downslope of disturbed areas that can't be directed into a designated sediment basin, trap or bund unless completely impractical (e.g. works within watercourses). Implement alternative controls (i.e. silt curtains and enhanced erosion controls) in these locations.	Environmental Manager Project Engineers Foreman
SWMM34	Use mulch bunds, earth bunds or straw bales as alternatives to sediment fencing where appropriate. However, do not use mulch in concentrated flow areas or where it has the potential to result in tannin leachate into waterways. Refer to Appendix F <i>Roads and Maritime Environmental Direction: Management of Tannins from Vegetation Mulch</i> .	Environmental Manager Project Engineers Foreman
SWMM35	Treat water accumulating within any excavation, trap or low point on site that cannot be re-used in construction or dust suppression, as per the requirements for sediment basins before discharge from site. Refer to mitigation measure ID SWMM60 for water quality criteria.	Environmental Manager Project Engineers Foreman
SWMM36	Install sediment controls around stormwater inlet pits where appropriate and where they won't cause or exacerbate flooding. Consider traffic management and safety if installing such devices on live traffic roads.	Environmental Manager Project Engineers Foreman
SWMM37	Remove sediment controls only after works are complete and 70 per cent stabilisation of disturbed surfaces is achieved.	Environmental Manager Project Engineers Foreman
SWMM38	Test sediment basins and, if required, treat, prior to discharge within 5 days of a rainfall event that causes runoff (refer to mitigation measure ID SWMM60 for water quality criteria). Alternatively, pump sediment basins out for construction or dust control purposes to ensure the required capacities remain available for future rainfall.	Environmental Manager Project Engineers Foreman
SWMM39	Carry out dust suppression whenever necessary to minimise sediments becoming air borne due to wind erosion.	Foreman
SWMM40	Design, construct and maintain temporary waterway crossings in accordance with the requirements of the Blue Book and in consultation with Fulton Hogan's Soil Conservationist where necessary.	Environmental Manager
SWMM41	Undertake all works in and around waterways in accordance with a Works in/around Waterways EWMS. This EWMS will undergo agency review and comment.	Environmental Manager Project Engineers Foreman
SWMM42	Complete any vegetation clearing and removal of topsoil near the waterways in accordance with a Clearing and Grubbing EWMS.	Environmental Manager Project Engineers Foreman
SWMM43	Minimise removal of native riparian vegetation, where practical	Environmental Manager Foreman

ID	Mitigation measure	Responsibility
SWMM44	Undertake permanent replanting/revegetation with local native species in accordance with the Landscape Design Drawings, as soon as practicable. The Vegetation Management Plan will be included in the Landscape Design Drawings.	Project Engineers Foreman
SWMM45	Design all sediment basins in accordance with the requirements of Roads and Maritime Specifications G36 and G38 and in accordance with the Blue Book (Landcom, 2004 and DECC, 2008).	Environmental Manager Project Engineers Foreman
SWMM46	Provide suitable access into sediment basin locations to allow for safe removal of sediment and maintenance operations.	Environmental Manager Project Engineers Foreman
SWMM47	Inspect all sedimentation basins at least weekly and following any rainfall event causing runoff.	Environmental Manager Project Engineers Foreman
SWMM48	Immediately schedule de-silting and water treatment if sediment accumulates to a level above 30 per cent of the sediment storage zone marker.	Environmental Manager Project Engineers Foreman
SWMM49	Apply flocculant to settle sediments within 24 hours of the conclusion of the last rainfall event causing runoff.	Environmental Manager Project Engineers Foreman
SWMM50	Include the following items on sediment basins: <ul style="list-style-type: none"> • A spillway constructed and stabilised to the 100-year ARI event • A marker peg (or equivalent) showing the boundary between the Sediment (Storage) and Water (Settling) zones of the basin • A sediment basin ID • Lined inlets to minimise scour, and • Measures to minimise the safety risk for site workers. 	Environmental Manager Project Engineers Foreman
SWMM51	Adequately compact and stabilise sediment basin walls with appropriate protective ground cover. Provide freeboard of at least 600mm from the spillway invert to the top of any earth wall.	Environmental Manager Project Engineers Foreman
SWMM52	Source water for compaction and dust suppression preferentially from sediment basins.	Environmental Manager Project Engineers Foreman
SWMM53	Treat water in sediment basins and discharge within 5 day of a rainfall event that causes runoff. Refer to mitigation measure ID SWMM60 for water quality criteria.	Environmental Manager Project Engineers Foreman
SWMM54	Undertake all dewatering on site in accordance with the Blue Book and Roads and Maritime guideline titled Environmental Management of Construction Site Dewatering. Prepare and implement a Dewatering EWMS to ensure that the waters being discharged meet the water quality criteria specified under mitigation measure ID SWMM60.	Environmental Manager Project Engineers Foreman

ID	Mitigation measure	Responsibility
SWMM55	Issue a Dewatering Permit prior to any dewatering on site.	Environmental Manager Project Engineers Foreman
SWMM56	Where using cover crop species to progressively revegetate disturbed areas, use Rye Corn during the months of April to August or Japanese Millet during the months of September to March.	Project Engineers Foreman
SWMM57	Commence stabilisation of waterways, including their beds and banks, immediately after the completion of any works within these areas.	Project Engineers Foreman
SWMM58	Control dust through progressive revegetation techniques and by watering unsealed areas.	Project Engineers Foreman
SWMM59	Use temporary ground covers such as soil stabilisers (e.g. Gluon polymer emulsion), hydroseed or hydromulch as much as possible to stabilise batters, stockpiles and large surface areas.	Project Engineers Foreman
SWMM60	<p>Do not release water from any discharge points (e.g. from sediment basins) until the following water quality criteria are met (unless an EPL specifies otherwise):</p> <ul style="list-style-type: none"> • pH 6.5-8.5 • Total suspended solids (TSS) \leq 50mg/L • No visible oil and grease <p>Promptly distribute the results of water quality monitoring to relevant project staff for action and further investigate any exceedances. Where a discharge occurs solely as a result of rainfall exceeding the five day 85th percentile rainfall depth value of 41.9mm, the abovementioned pH and TSS criteria do not apply.</p> <p>Multiple High Efficiency Sediment (HES) Basins will be trialled across the project in consultation with the EPA and TfNSW. HES basins treat sediment laden runoff and reduce the volume of sediment leaving a site, thus protecting downstream environments from excessive sedimentation and water quality degradation during the rainfall.</p>	Environmental Manager
SWMM61	<p>A relationship has been developed between NTU and TSS for water quality in sediment basins. This relationship has determined that 31 NTU is the equivalent of 50 mg/L TSS. A method to enable the ongoing verification of the relationship between NTU and TSS has been developed and is being implemented. 10% of discharge samples are sent for laboratory analysis to maintain quality assurance.</p> <p>A copy of the statistical correlation assessment methodology and results has been provided to the EPA. The updated EPL has been provided to TfNSW (formerly Roads and Maritime) for approval of NTU in place of TSS.</p>	Environmental Manager
SWMM62	If water is to be re-used for dust suppression or construction purposes, the above criteria do not apply providing water does not leave the site (either directly or indirectly via runoff).	Environmental Manager
SWMM63	<p>Provide and maintain access to the sediment basins to permit:</p> <ul style="list-style-type: none"> • Clear identification of each sediment basin and discharge point • Easy collection of samples • Collection of representative samples of water discharged from the sediment basin(s), and • Access to the sampling point(s) at all times by an authorised officer of the EPA. 	Environmental Manager
SWMM64	Complete water quality monitoring in accordance with the <i>Construction Water Quality Monitoring Program</i> contained at Appendix B.	Environmental Manager

ID	Mitigation measure	Responsibility
SWMM65	Record and retain the results of any monitoring: <ul style="list-style-type: none"> In a legible form, or in a form that can readily be reduced to a legible form For at least four years after the monitoring or recording event to which they relate took place, and So that they can be produced in a legible form to any authorised officer of the EPA who asks to see them. 	Environmental Manager
SWMM66	Check weather forecasts daily and implement the <i>Heavy Rainfall Event Procedure</i> (included in Appendix D of this plan) where required.	Environmental Manager
SWMM67	Manage vegetation stockpiles to minimise the impact of tannins leaching into the surrounding environment in accordance with <i>Roads and Maritime Environmental Direction: Management of Tannins from Vegetation Mulch</i> included in Appendix F of this SWMP.	Environmental Manager Project Engineers Foreman
SWMM68	Where available and practicable, and of appropriate chemical and biological quality, use stormwater, recycled water or other water sources where feasible and reasonable, in preference to potable water for construction activities, including concrete mixing and dust control.	Environmental Manager Project Engineers Foreman
SWMM69	Wash concrete mixers, pumps, concrete tools and other equipment at specially designated washout areas that are constructed in a manner that will prevent storm water surface run-off from being contaminated.	Environmental Manager Foreman
SWMM70	Locate washout areas within an area that is not subject to natural surface storm water run-off and away from drainage lines. Post signs to advise workers of their locations.	Environmental Manager Foreman
SWMM71	Construct the washout areas with an impermeable type material capable of retaining any contaminated water and concrete residue.	Environmental Manager Foreman
SWMM72	Monitor the washout areas to ensure that they are not getting over full and that the washing activity is not contaminating the surrounding area.	Environmental Manager Foreman
SWMM73	As part of the project induction program, advise all personnel performing concreting or saw cutting activities of the concrete washout areas and their obligations to: <ul style="list-style-type: none"> Clean their plant, tools and equipment within the designated area Maintain the area in a clean condition, and Ensure that contaminated water associated with their activities is appropriately controlled and prevented from reaching natural storm water surface drainage areas. 	Environmental Manager
SWMM74	Properly maintain and regularly check spray sealing and asphalt paving plant, equipment and associated tools to minimise the risk of spills.	Foreman
SWMM75	Promptly contain and collect any spills of fuel or bitumen materials using spill kits. Maintain spill kits and fire extinguishers at all times in the spray trucks, tankers and associated plant.	Foreman
SWMM76	Promptly report all spills to the Environmental Manager.	Environmental Manager Foreman
SWMM77	Allocate designated equipment washdown and cleaning areas for major asphalt works with appropriate environmental controls in place (e.g. bunds) to prevent washout water from reaching the receiving environment.	Foreman

ID	Mitigation measure	Responsibility
SWMM78	Do not locate storage areas within 50 metres of any aquatic habitat, natural surface drainage areas, storm drainage systems, poorly drained or flood prone areas, or any area with a slope steeper than 10 per cent.	Project Engineers Foreman
SWMM79	Keep liquid chemicals and fuels in bunded storage areas or sheds that have the capacity to contain spills from leaky containers or from an incident involving a decanting activity. Ensure the bunded capacity is at least 120 per cent of the total capacity of all containers stored inside the bunded area or shed.	Foreman
SWMM80	Designated bunded plant refuelling areas, plant service/maintenance areas and concrete/plant wash down areas will be placed at least five metres from native vegetation and at least 50 metres from the following: -a natural surface drainage area, and -a built drainage structure such as a storm water pipe or box culvert.	Foreman
SWMM81	During site induction, advise all personnel of the following: -The location of bunded storage areas, liquid absorbent materials and other spill containment materials and kits. -Storage of large quantities of fuel for construction plant is not permitted. Licensed fuel trucks carrying emergency fuel spill kits must be used to service plant and equipment. -All drums and decanted containers must be labelled and stored within bunded areas whenever they are not in use. Whenever practical, all unattended drums/containers must be returned to the bunded storage area.	Environmental Manager
SWMM82	Provisional mitigation measure: Locate temporary batching plants (in the unlikely event they are required) in accordance with the Ancillary Facilities Management Plan required under CoA A17.	Environmental Manager
SWMM83	Provisional mitigation measure: Establish and operate concrete batching plants (in the unlikely event they are required) in accordance with a site specific environment work method statement (EWMS) for Concrete batching.	Environmental Manager Project Engineers Foreman
SWMM84	Portable toilet block systems will be regularly serviced. All effluent facilities will be positioned with consideration of vicinity of water courses, sensitive flora/fauna habitats and residents.	Environmental Manager Project Engineers Foreman
SWMM85	In the event that unexpected contamination is identified implement the Unexpected Contaminated Land and Asbestos Finds Procedure (under CoA E60).	Environmental Manager
SWMM86	Undertake all remediation works in consultation with the EPA and in accordance with the CLMP.	Environmental Manager
SWMM87	Should the presence of ASS or potential ASS (PASS) be confirmed, follow the Acid Sulfate Soil Management Procedure included in Appendix C of this SWMP. An EWMS will be developed and implemented for ASS and rock treatment and potential or actual acid sulfate soil areas.	Environmental Manager Project Engineers Foreman

7 Compliance management

7.1 Roles and responsibilities

The Fulton Hogan Project Team's organisational structure and overall roles and responsibilities are outlined in Section 3.2 of the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Chapter 6 of this Plan. The responsibilities of the Soil Conservationist are detailed below.

7.1.1 Soil Conservationist

The environmental responsibilities of the Soil Conservationist are to:

- Prepare the primary ESCP for the project
- Review progressive erosion and sediment control plans as required
- Provide advice on erosion and sediment control measures as required.
- Conduct regular inspections as required.

7.2 Training

All employees, sub-contractors and utility staff working on site will undergo site induction training relating to soil and water management issues, including:

- Existence and requirements of this SWMP
- Existence of sensitive area plans
- Existence of erosion and sediment control plans (primary and progressive)
- Relevant legislation
- Roles and responsibilities for soil and water management
- The location of ASS or PASS
- Water quality management and protection measures
- Procedure to be implemented in the event of an unexpected discovery of contaminated land.

Targeted training in the form of toolbox talks or specific training will also be provided to personnel with a key role in soil and water management. Examples of training topics include:

- ERSED control installation methodology
- Sediment basin construction
- Sediment basin operation
- Sediment basin maintenance
- Working near or in drainage lines and creeks
- Emergency response measures in high rainfall events
- Preparedness for high rainfall events
- Lessons learnt from incidents and other event e.g. high rainfall/flooding
- Mulch and tannin management
- Spill response
- Stockpile location criteria
- Identification of potentially contaminated spoil and fill material
- Trigger levels.

Further details regarding staff induction and training are outlined in Section 3.4 of the CEMP.

7.3 Monitoring and inspections

Regular monitoring and inspections will be undertaken during construction. Monitoring and inspections will include, but not be limited to:

- Up and downstream of the project alignment water quality monitoring at nominated locations
- Groundwater monitoring, both level and quality at nominated locations
- Monitoring of groundwater dependent endangered ecological communities to evaluate health and vitality
- Construction sediment basin water quality prior to discharge
- All erosion and sediment control measures on the project must be inspected and works undertaken to repair and/or maintain these controls:
 - weekly during standard construction hours outlined in CoA E36 and the EPL
 - daily during periods of rainfall, and
 - within 24 hours of cessation of a rainfall event causing runoff to occur on or from the project.
- Inspections to monitor and maintain erosion and sediment controls when rain or showers are forecasted to be 'heavy' or 'violent' in accordance with the Heavy Rainfall Event Procedure (included in Appendix D of this plan). The procedure outlines how to monitor rainfall forecasts and prepare site to minimise impacts as much as practicable.

The type, timing, frequency and trigger levels are detailed in the Construction Water Quality Monitoring Program attached at Appendix B. It is the responsibility of the Environmental Manager to ensure that the construction water quality monitoring program is implemented.

Additional requirements and responsibilities in relation to inspections and monitoring are documented in Section 3.7.1 and Section 3.7.2 of the CEMP.

7.4 Licences and permits

EPL 21139 has been issued by NSW EPA for the project. The EPL prescribes water quality parameters to be measured and associated discharge criteria. The EPL also details the monitoring and analytical requirements by reference to authority publications such as the Approved Methods for Sampling and Analysis of Water Pollutants in NSW, 2004 (EPA, 2004). All construction work will be undertaken in accordance with the EPL for the duration of the project.

Any other relevant licenses or permits will be obtained during construction as required.

7.5 Non-conformances

Non-conformances will be dealt with and documented in accordance with Section 3.8 of the CEMP. Also refer to Appendix B for the procedures to identify and implement additional mitigation measures where results of monitoring have exceeded the EPL criteria and/or trigger levels.

7.6 Weather monitoring

Rainfall at the premises will be measured and recorded in millimetres per 24-hour period at the same time each day.

Automatic rainfall intensity/ weather devices have been installed at two locations in the northern and southern sections on the project.

7.7 Auditing

Audits (both internal and external) will be undertaken to assess the effectiveness of environmental controls, compliance with this sub-plan, CoA and other relevant approvals, licenses and guidelines.

Audit requirements are detailed in Section 3.7.3 of the CEMP.

7.8 Reporting

Reporting requirements and responsibilities (including for the Construction Monitoring Report) are documented in Section 3.7.5 of the CEMP. Also refer to Table B-1 of the construction water quality monitoring program at Appendix B.

8 Review and improvement

8.1 Continuous improvement

Continuous improvement of this SWMP will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance
- Determine the cause or causes of non-conformances and deficiencies
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies
- Verify the effectiveness of the corrective and preventative actions
- Document any changes in procedures resulting from process improvement
- Make comparisons with objectives and targets.

8.2 SWMP update and amendment

The processes described in Section 3.7 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

Any revisions outside of the amendments detailed in Section 1.4 to this SWMP will be in accordance with the process outlined in Section 1.6 of the CEMP and as required, be provided to Roads and Maritime, ER and other relevant stakeholders for review and comment and forwarded to the Secretary of NSW Department of Planning and Environment (DPIE) for approval.

A copy of the updated SWMP and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure (refer to Section 1.5 of the CEMP).

Appendix A Primary Erosion and Sediment Control Plans and Standard Blue Book Drawings

Appendix B Construction water quality monitoring program

Construction water quality monitoring program

1. Background

WSP was engaged by Transport for NSW (formerly Roads and Maritime Services) to prepare a baseline water quality monitoring program for the project. Transport for NSW (formerly Roads and Maritime Services) commenced baseline monitoring of surface water quality and groundwater quality in November 2017 at various sites along the project alignment. Transport for NSW (formerly Roads and Maritime Services) will continue to monitor background conditions until commencement of construction. Baseline monitoring data reports (including results) are provided by WSP to Transport for NSW (formerly Roads and Maritime Services) on a monthly basis separate to this SWMP. The reports are available upon request. Upon completion of baseline monitoring, surface water and groundwater results recorded will be incorporated in a baseline monitoring program summary report. This report will include a discussion of observed baseline trends in water quality and groundwater levels (WSP, 2018 p20). Once the baseline monitoring program summary report has been completed, statistical assessment of the data will be undertaken to confirm the trigger levels presented in Table B-1.

It is noted that the baseline monitoring program provides information about general ecosystem health, rather than impacts from road construction activities.

The baseline water quality monitoring program (WSP, 2018) is contained in Annexure B1 and has been considered in the development of this construction water quality monitoring program.

2. Construction monitoring locations

During the construction phase of the project, surface water and groundwater quality will be monitored at the same locations as for the baseline monitoring program with the exception of SW1 as it is not influenced by Stage 2 works. Surface water quality will be monitored at six locations (i.e. SW3-SW4, SW5A, SW6 to SW9) and groundwater quality will be monitored at four locations (i.e. GW1 to GW4). It is noted that WSP (2018, p3-5) gave consideration to the location of groundwater dependent ecosystems when siting the groundwater monitoring wells.

Removal of surface water monitoring locations SW2, SW2DS, GW5 and BH318 has occurred with consultation with NSW EPA on 20 April 2021, DPI Fisheries and NRAR on 21 April 2021 with no objections raised. Due to the completed state of the project in these catchments these monitoring locations will only provide information relevant to Motorway operational conditions and no longer represent construction related impacts. As a result, there will now be a total of eight construction surface water quality and four groundwater monitoring locations for the project.

All construction water quality monitoring locations are shown in Figure B-1 and on the Sensitive Area Plans contained in Appendix A6 of the CEMP.

The precise location (easting and northing) of each water sampling location will be determined once the project team mobilises to site and agrees the location with the various landowners (where relevant). The location of the ground water monitoring points will be chosen to ensure they are clear of permanent and temporary works areas and confirmed on site with survey to ensure they are not destroyed during the project. This is a requirement of Transport for NSW (formerly Roads and Maritime Services) Scope of Works and Technical Criteria (SWTC) Appendix 14 Clause 14.4.2. They will also be assessed with the construction team to ensure they will remain accessible throughout the project.

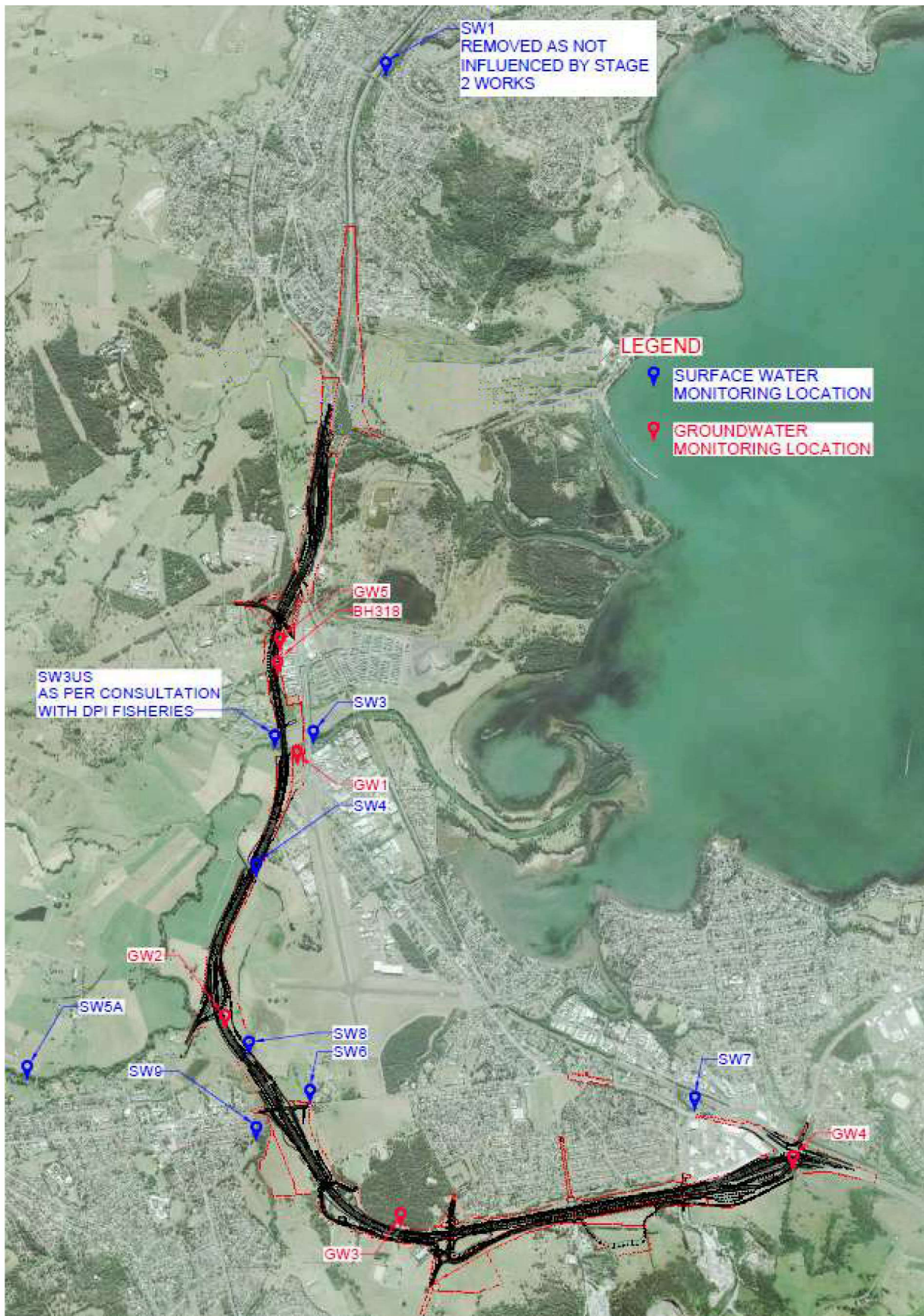


Figure B-1 Construction monitoring network (WSP, 2018) as amended to include two additional surface water monitoring locations (i.e. SW2DS and SW3US)

3. Construction monitoring parameters

The purpose of water quality monitoring during the construction phase is to determine impacts resulting from construction of the project only (i.e. road construction) and not other unrelated sources, such as agricultural operations. The potential impacts from road construction activities will most likely result from erosion and sediment control loss and spills. Nutrients from construction activities are not anticipated. The construction surface water and groundwater parameters are listed below.

In accordance with G38 Clause 2.3, a NATA accredited laboratory will be used for all testing of water quality.

Surface water

Surface water monitoring focuses on the parameters associated with road construction and include:

- Total suspended solids
- pH
- Oil and grease.

Groundwater

Groundwater monitoring focuses on the parameters associated with road construction and include:

- pH
- electrical conductivity
- temperature
- no visible oil and grease
- dissolved metals for GW2 only, which is located in a PASS risk area

Groundwater levels will also be measured at each groundwater monitoring location identified in Figure B-1.

4. Construction monitoring trigger levels

Following consultation with DPI Water, trigger levels have been included in the construction water quality monitoring program. Refer to Table B-1 below. The trigger levels identify when construction impacts are approaching the EPL criteria where relevant.

Monitoring results will be checked against the trigger levels (refer to Table B-1) and EPL criteria (refer to mitigation measure ID SWMM60) to identify any exceedances.

Refer to point 5 below for the procedures to be implemented when a monitoring result is outside of the water quality trigger level and/or EPL criteria.

5. Procedures to identify and implement additional mitigation measures where results of monitoring are unsatisfactory

Implementation of the standard mitigation measures listed in Table 6-1 will ensure surface water and groundwater impacts are minimised during construction. In the event that complaints about surface water and/or groundwater are received or an exceedance of the EPL criteria (refer to mitigation measure ID SWMM60) or trigger levels (refer to Table B-1) has been identified through monitoring, site inspections or audits, Fulton Hogan will implement the following procedure:

- The Environmental Manager will investigate the issue to determine possible causes of the non-conformance (in accordance with Section 7.5) and to develop appropriate mitigation measures on a case-by-case basis.
- Surface water and/or groundwater complaints will be managed in accordance with complaints management process described in Sections 2.3 and 2.4 of the Community Communication Strategy. Where investigation confirmed clear and unambiguous impact resulting from the

construction of the project, the Environmental Manager, in consultation with the project team, will identify additional mitigation measures which may include, but not necessarily be limited to:

- Modification of the construction methods used
- Conduct unscheduled monitoring to further verify exceedance trend, where relevant

It is the responsibility of the Environmental Manager to ensure that the identified contingency measures are implemented.

6. Construction water quality monitoring program

Table B-1 summarises the construction water quality monitoring program for the Project. Information regarding non-conformances and reporting requirements are documented in Section 7.5 and 7.8 respectively of this SWMP.

Table B-1 Construction water quality monitoring program

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
SURFACE WATER						
Construction surface water quality at SW4, SW6, SW7, SW8, SW9.	Refer to the surface water monitoring locations identified in Figure B-1	Monthly Report Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids	Monthly	2 consecutive exceedances of the monthly average for TSS determined through assessment of the baseline data contained in the baseline monitoring program summary report
				pH	Monthly	Less than 6.6 and greater than 7.9
				Oil and grease	Monthly visual inspection and as required in response to spills on site. Laboratory testing only if sheen is visually present.	Greater than or equal to 9 mg/L
SW5a	Refer to the surface water monitoring locations identified in Figure B-1	Monthly Report Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
				pH	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
				Oil and Grease	Monthly	N/A. Location is an upstream control site and is not influenced by Stage 2 works.
Upstream and downstream of the bridge works at	Refer to the surface water monitoring locations	Monthly Report Water quality sampling field	Environment Manager	Total suspended solids	Monthly	2 consecutive exceedances of the monthly average for TSS determined

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
Macquarie Rivulet (i.e. SW3US, SW3)	identified in Figure B-1	record Chain of custody form (for environmental samples)/ Laboratory results				through assessment of the baseline data contained in the baseline monitoring program summary report
				pH	Monthly	Less than 6.6 and greater than 7.9 Less than 6.9 and greater than 8.4 (Macquarie Rivulet only - estuarine)
				Oil and grease	Monthly visual inspection and as required in response to spills on site. Laboratory testing only if sheen is visually present.	Greater than or equal to 9 mg/L
Sediment basin discharge water quality	Refer to the discharge points specified in the EPL.	Monthly Report Dewatering record Water quality sampling field record Chain of custody form (for environmental samples)/ Laboratory results	Environment Manager	Total suspended solids (or NTU in accordance with the EPL)	Prior to discharge	48 mg/L TSS (or NTU equivalent in accordance with the EPL)
				pH	Prior to discharge	Less than 6.6 and greater than 8.4
				Oil and grease	Prior to discharge	Visible oil and grease
Monitoring Bureau of Meteorology forecast	All	Email Record to staff	Environment Manager/ Administration	Not applicable	Daily	Not applicable
GROUNDWATER						
Groundwater construction water quality monitoring	Refer to the groundwater monitoring locations identified in Figure B-1.	Quarterly Report Dewatering record Water quality sampling field record Chain of custody form (for environmental samples)/	Environment Manager	pH electrical conductivity temperature no visible oil and grease dissolved metals for GW2 only,	Quarterly	2 consecutive exceedances of the quarterly averages determined through assessment of the baseline data contained in the baseline monitoring

Monitoring details	Area	Record	Responsibility	Monitoring parameters	Frequency	Trigger Level
		Laboratory results		which is located in a PASS risk area		program summary report
Groundwater level	Refer to the groundwater monitoring locations identified in Figure B-1.	Quarterly Report	Environment Manager	Groundwater level	Quarterly	2 consecutive exceedances of the quarterly average level determined through assessment of the baseline data contained in the baseline monitoring program summary report

Annexure B1 Baseline water quality monitoring program (by then, Roads and Maritime)

ROADS AND MARITIME SERVICES

BASELINE MONITORING PROGRAM - ALBION PARK RAIL BYPASS

APRIL 2018



Question today *Imagine tomorrow* Create for the future

Baseline monitoring program - Albion Park Rail bypass

Roads and Maritime Services

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1 INTRODUCTION

1.1 BACKGROUND

The Roads and Maritime Services is planning a 9.8 km extension of the Prices Motorway to a four-lane divided motorway between Yallah and Oak Flats, to bypass the suburb of Albion Park Rail, NSW. Key features of the Albion Park Rail bypass (the project) include the provision of interchanges, multiple bridges to carry the motorway over roads and water courses, and improved pedestrian and cycle connections.

An environmental impact statement was prepared for the project in 2015 and a submissions and preferred infrastructure report was submitted in September 2017. The Department of Planning and Environment provided planning approval for the project in early 2018, with major construction anticipated to commence in early 2019 (Roads and Maritime Services, 2018).

The project area consists of rocky hills and ridges to the north and south, an escarpment to the west and the foreshore of Lake Illawarra to the east. The central section of the project area comprises a low-lying floodplain. Much of the central section of the project area is classified as Class 1 (highest risk) for potential acid sulfate soils (Hyder Cardno Joint Venture, 2015).

1.2 OBJECTIVES

The objectives of the surface water and groundwater monitoring program are to obtain baseline monitoring data, which considers seasonality, prior to the commencement of construction for the project. The baseline data will support the development of surface water and groundwater monitoring programs to be used for impact assessment during project construction and operation.

The primary objectives of this document are to detail the baseline surface water and groundwater monitoring program and water quality sampling protocols that are being adopted.

2 CONSULTATION WITH REGULATORS

A framework baseline monitoring program (WSP, 2017a), which provides the basis of this baseline monitoring program, was prepared and sent to the NSW Environment Protection Authority (EPA) and the Division of Crown Lands & Water (Department of Industry, formerly Department of Primary Industries - Water). This section summaries the consultation.

2.1 NSW ENVIRONMENT PROTECTION AUTHORITY

The framework baseline monitoring program (WSP, 2017a) was sent to the NSW EPA in October 2017. The EPA deemed a meeting was not required. An email was sent by the EPA (Jen Byrne) on 26 October 2017, stating the framework was reviewed, especially in relation to surface water. The EPA stated the framework appears to be comprehensive. The following comments were provided for consideration:

- Continuing to monitor the same sample locations during construction and post-construction.
 - The University of Wollongong School of Environmental Science may have some data to supplement the study.
 - Publishing the monitoring data on the website of the Roads and Maritime Services.
 - Including reference to sampling and analysis methods, such as the approved methods for the sampling and analysis of water pollutants in NSW (EPA, 2004).
 - Providing the NSW EPA with any monitoring data collected.
-

2.2 DEPARTMENT OF INDUSTRY

The framework baseline monitoring program (WSP, 2017a) was sent to the Department of Industry (DI) and a meeting held on 7 December 2017. Richard Green and Janne Grose from DI attended the meeting. The following was recommended:

- The production of a flow net and surveying the new monitoring wells.
- Analysing the groundwater in the vicinity of the main cut, which is near an industrial area, for benzene, toluene, ethylbenzene, xylene and naphthalene (BTEXN), polycyclic aromatic hydrocarbons (PAH), total recoverable hydrocarbons (TRH) and oil and grease. Recommended as a one-off event for now.
- Analysing the groundwater in the vicinity of the Fire and Rescue site at Albion Park and the alluvium for per- and polyfluoroalkyl substances (PFAS) and pesticides. An assessment for further monitoring to be made following receipt of the results.

Refer to Section 12 in relation to the additional monitoring undertaken in response to the above recommendations.

The groundwater component of the framework was deemed adequate, with internal DI discussion regarding the surface water required prior to determining the surface water monitoring programs adequacy.

The DI provided a letter on 6 February 2018, stating the following:

- The groundwater monitoring program is adequate.
- The proposed surface water sampling of 48 to 72 hours following a rainfall event should be reduced.
- The program should detail how data from sampling is to be stored, analysed, interpreted and reported on.

Refer to Section 5 for further information regarding the sampling time following a rainfall event. Refer to Sections 8, 9 and 10 for details regarding the storage, analysis, interpretation and reporting.

3 OVERVIEW OF ENVIRONMENTAL IMPACTS

3.1 SURFACE WATER

The following information on surface water and potential impacts was summarised from Hyder Cardno Joint Venture (2015).

The project area drains to three main watercourses, all of which are tributaries of Lake Illawarra: Duck Creek, Macquarie Rivulet (which is fed by Marshall Mount Creek and Frazers Creek), and Horsley Creek (Figure 3.1). These watercourses and Lake Illawarra, comprise the receiving waters for the project, and have the potential to be impacted by the project during construction and operation.

The sensitive receiving environments are shown in Figure 3.1. Those that may potentially be impacted by the project, via water quality impacts, are located within and downstream of the project area and include:

- the ecosystems of Duck Creek, Macquarie Rivulet and Horsley Creek
- freshwater wetlands and saltmarsh threatened ecological communities
- State Environmental Planning Policy (SEPP) 14 (Coastal Wetlands)
- groundwater dependent ecosystems (GDEs)
- Lake Illawarra.

The construction phase impacts on water quality are associated with the following:

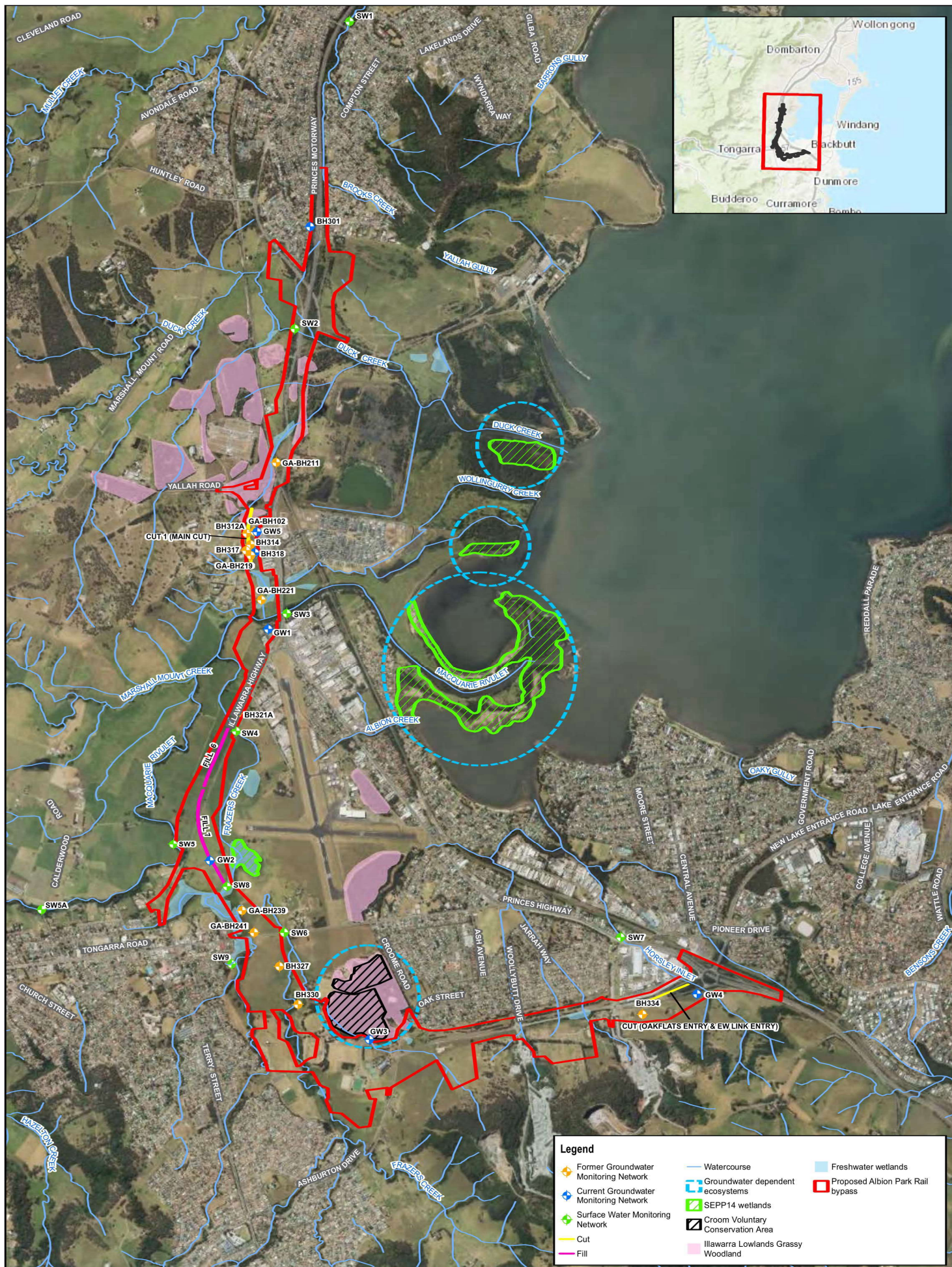
- leaching of tannins from stockpiled vegetation
- sediment from vegetation clearing and exposure of soils
- earthworks and dewatering, exposing potential and actual acid sulfate soils
- disturbance of contaminated materials
- use of vehicles, plant and machinery
- adjusting Frazers Creek north of the existing Croom Regional Sporting Complex
- activities at ancillary sites, such as storage of chemicals and stockpiling
- construction activities generating waste.

The above has the potential to negatively impact receiving waters by increasing turbidity and sedimentation, changes in acidity, changed in dissolved oxygen and introduction of pollutants such as nutrients, metals, oils and grease.

3.2 GROUNDWATER

The following information on the groundwater systems and potential impacts was summarised from Roads and Maritime Services (2015).

The hydrogeology of the project area consists of an unconfined, unconsolidated alluvium aquifer (Quaternary age) and a deeper unconfined to semi-confined consolidated rock aquifer (shale, siltstone, sandstone and volcanics (latites and tuffs)) (Permian age). Broadly, the geology is dominated by consolidated rock to the north and south and alluvium in the centre of the study area.



Map: PS106112_GIS_001_A7

Author: David.Naiken

Date: 1/03/2018

Approved by: P.Van Ravesteyn



Data source: Department of Finances, Services and Innovation (2017). Data derived from RMS, Hyder, Cardno (2017). ESRI

Coordinate system: GDA 1994 MGA Zone 56
Scale ratio correct when printed at A3



Roads and Maritime Services

Albion Park Rail Bypass

Figure 3.1
Monitoring Network

Groundwater flow in the alluvium and the consolidated rocks is predominantly from west to east, and south to north in the southern part of the study area.

As stated in Roads and Maritime Services (2015), the aquifers were interpreted to support the Macquarie Rivulet GDE, possibly in conjunction with surface water interaction, located at the estuary of the Macquarie Rivulet on Illawarra Lake. The Macquarie Rivulet GDE has been identified as high priority in the NSW regulation. A SEPP 14 freshwater wetland located on Frazers Creek is directly east of the alignment. Reliance on groundwater is uncertain. Deep rooted vegetation of the Illawarra Lowlands Grassy Woodland Endangered Ecological Community (EEC) would be partially reliant on groundwater, including Croom Reserve, located close to the alignment (Figure 3.1).

The project activities, which include a number of bridges, cut and fill areas and soil treatments, have a potential to impact the groundwater regime. There will be several cuts, with one deep cut (Cut 1), to the south of Yallah Road and north of Macquarie Rivulet (Figure 3.1). The cut is 440 m long, up to 15.2 m high, predominantly in siltstone and a predicted outflow for this cut of 21 m³/day over the distance of 440 m.

The impact assessment identified some key findings, such as the following:

- The Macquarie Rivulet estuary GDE and SEPP14 wetland on Frazers Creek are not anticipated to be impacted by the project, however there is a level of risk to the wetland and the deep rooted GDEs associated with the Illawarra Lowlands Grassy Woodland EEC at Croom Reserve.
- There is some dewatering required due to road cuts on the northern section of the route, particularly associated with Cut 1. There will be no impact on groundwater users or GDEs.
- Fill and soil treatments may locally alter groundwater flow in the alluvium aquifer, associated with the two largest fill areas of Fill 6 and Fill 7 (Figure 3.1). This is through the use of wick drains which drain pore water and cause compaction of the sediments.
- There is a risk of groundwater contamination from spills and runoff water.

4 MONITORING NETWORK

4.1 SURFACE WATER

The surface water monitoring network, along with the rationale for selection, is provided in Table 4.1. The location of the network is shown in Figure 3.1. Safety was taken into consideration in the design of the monitoring network, with sampling sites carefully selected to ensure they can be accessed safely during dry weather events and following rainfall.

Table 4.1 Surface water monitoring network

SITE IDENTIFIER	LOCATION	RATIONALE
SW1	Brooks Creek, north of the project area, near Emerson Road	Flowing to the north, past the northern-most section of the project.
SW2	Duck Creek, near the intersection of the Princes Highway and Yallah Bay Road.	One of the main watercourses in the project area; a tributary of Lake Illawarra.
SW3	Macquarie Rivulet, east of the Princes Motorway (bridge)	One of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE.
SW4	Frazers Creek, east of Terry Street (Illawarra Highway), Albion Park Rail	Macquarie Rivulet is fed by Frazers Creek. Location is downstream from freshwater wetlands, including a SEPP 14 wetland. The preferred location for SW4 is at the downstream (western) side of the project boundary, however site access has made this unfeasible. Thus, the upstream location was selected.
SW5	Macquarie Rivulet, on the western edge of the project area, by the Illawarra Highway	One of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE. SW5 was to be sampled further upstream as a control site, however property access was not obtained. SW5 was sampled from November 2017 to mid-February 2018. This location was replaced in late February 2018 with SW5A.
SW5A	Macquarie Rivulet, on the western edge of the project area, by the Illawarra Highway	This is a control site (unaffected by the project) and one of the main watercourses in the project area; a tributary of Lake Illawarra. Contributes flow to the Macquarie Rivulet GDE. SW5A replaces SW5, and was sampled from late February 2018.
SW6	Frazers Creek, south of Tongarra Road, Croom	Macquarie Rivulet is fed by Frazers Creek. The location is downstream from Croom Reserve, an Illawarra Lowlands Grassy Woodland EEC and GDE.

SITE IDENTIFIER	LOCATION	RATIONALE
SW7	Horsley Inlet, between Princes Highway and Pioneer Drive, Albion Park Rail. North of the south-eastern edge of the project area.	One of the main watercourses in the project area; a tributary of Lake Illawarra. Flowing to the northwest, through the project area to Lake Illawarra.
SW8	Frazers Creek, just upstream of a SEPP14 (freshwater) wetland, east of Terry Street, Albion Park.	Just upstream of a SEPP14 wetland on Frazers Creek, which feeds Macquarie Rivulet.
SW9	Tributary of Frazers Creek, southeast of O’Gorman Street, Albion Park	Flowing to the north, into the project area. Macquarie Rivulet is fed by Frazers Creek. SW9 may occasionally be affected by backwater from downstream and thus may not always be considered as a control site. The preferred location was further upstream, to ensure this site as a control site, however this is unfeasible as there is no surface flow.

4.2 GROUNDWATER

4.2.1 EXISTING GROUNDWATER MONITORING NETWORK

A groundwater monitoring network was installed by Golder Associates (2017) in late 2014 and early 2015 (Figure 3.1). All existing monitoring wells, except BH301, are likely to be destroyed during construction as they are located on or in close vicinity of the alignment. BH301 is in the northern portion of the project and comprises part of the current monitoring network.

In addition to BH301, monitoring an existing monitoring well near Cut 1 was recommended given the predicted dewatering and drawdown in this area, even though it may be destroyed during construction. This would supplement the data obtained from monitoring well GW5 (Section 4.2.2). Of the existing monitoring wells in the vicinity of the cut (BH312A, BH314, BH317, BH318, GA-BH102 and GA-BH219), BH318 was recommended to comprise part of the current monitoring network given the following:

- it is located further from GW5 than BH312A and GA-BH102, and thus would provide a better spread of data
- it is located on the edge of the cut and thus has a higher potential to survive construction than the monitoring wells located in the centre of the cut (BH314 and GA-BH219)
- it appears to be well constructed (Golder Associates, 2017).

4.2.2 ADDITIONAL GROUNDWATER MONITORING NETWORK

The additional monitoring network, along with the rationale and target formation, is provided in Table 4.2. Along with the rationale listed in the table, main considerations for all sites included locations outside construction activities, so that they can be utilised ongoing during project operations, site access/land ownership, and locations within the project boundary.

The location of the network is shown in Figure 3.1. The five monitoring wells were drilled and developed in November 2017 (WSP, 2018).

Table 4.2 Groundwater monitoring network

SITE IDENTIFIER	LOCATION	RATIONALE	TARGET FORMATION
GW1	West of the Princes Motorway, south of Macquarie Rivulet, Yallah	Obtain baseline groundwater information in the northern portion of the project area. Nearby existing monitoring well, GA-BH211, will be destroyed during construction activities.	Consolidated rock aquifer
GW2	Near the freshwater wetland on Frazers Creek and Fill 7	There is potential impact from compaction of the alluvium at Fill 7, potentially affecting groundwater flow to the SEPP 14 wetland.	Alluvium aquifer
GW3	Croom Reserve	Croom Reserve contains deep rooted vegetation of the Illawarra Lowlands Grassy Woodland EEC which would be partially relying on groundwater. There is a level or risk associated with the project. Nearby existing monitoring well, BH330, will be destroyed during construction activities.	Consolidated rock aquifer
GW4	South of East West Link, Croom	Obtain baseline groundwater information in the southern portion of the project area. Nearby existing monitoring well, BH334, will be destroyed during construction activities.	Consolidated rock aquifer
GW5	Directly east of Cut 1	Cut 1 is the deepest cut with a predicted outflow for this cut of 21 m ³ /day over the length of the cut. The existing monitoring network in the vicinity of the cut is expected to be destroyed during construction. Monitoring the baseline conditions and drawdown due to dewatering during construction are required.	Consolidated rock aquifer

5 MONITORING FREQUENCY

The baseline monitoring frequency is outlined below and summarised in Table 5.1:

- Monthly for surface water – dry events.
- Following 15 mm or more of rainfall within 24 hours for surface water – wet weather events. Sampling is to be undertaken within 24 to 48 hours of the wet weather event. For a long rain event (e.g. 1-2 weeks duration), sampling may occur more than once.
- Quarterly for groundwater.

Table 5.1 Monitoring frequency

SAMPLING	2017		2018									
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Surface water	X	X	X	X	X	X	X	X	X	X	X	X
Groundwater		X			X			X			X	

The monitoring frequency will be reassessed following 12 months of monitoring. Monitoring will also be required during the construction and operational phases.

Note, rainfall will exceed 15 mm in 24 hours approximately 17 times per year. This is based on the rainfall records from January 2000 to December 2017 from the Bureau of Meteorology (BOM) rainfall station at Albion Park (site number 0680241; refer to Section 7.3).

6 ANALYTICAL SUITE AND METHODS

6.1 ANALYTICAL SUITE

A base analytical suite for surface water is analysed monthly (Type A), with a more extensive analytical suite analysed on a quarterly basis (Type B). The surface water samples collected during the wet weather events are analysed for the Type A parameters. The analytical suite for surface water and groundwater is summarised in Table 6.1.

Table 6.1 Analytical suite

	ANALYSIS	SURFACE WATER – DRY AND WET WEATHER EVENTS TYPE A	SURFACE WATER – QUARTERLY DRY WEATHER EVENTS TYPE B	GROUND- WATER
pH	In the field	X	X	X
Electrical conductivity	In the field	X	X	X
Temperature	In the field	X	X	X
Oxidation-reduction potential	In the field	X	X	X
Dissolved oxygen	In the field	X	X	
Turbidity	Laboratory	X	X	
Total suspended solids	Laboratory	X	X	
Total oils and grease ¹	Visual and olfactory inspection	X	X	X
Total nitrogen	Laboratory	X	X	X
Total phosphorus	Laboratory	X	X	X
Total dissolved solids	Laboratory			X
Total recoverable hydrocarbons	Laboratory		X	
Total metals ²	Laboratory		X	
Dissolved metals ²	Laboratory			X ³
Major cations ⁴	Laboratory			X
Major anions ⁵	Laboratory			X

- (1) Oil and grease is to be analysed by the laboratory only if total oils and grease are visually or olfactorily present.
- (2) Total and dissolved metals comprise aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver and zinc.
- (3) Dissolved metal analysis for GW2 only, which is located in a potential acid sulfate soil risk area.
- (4) Major cations comprise calcium, sodium, magnesium and potassium.
- (5) Major anions comprise chloride, sulphate, alkalinity and bicarbonate.

6.2 LABORATORY METHODS

Laboratory analysis is undertaken by Australian Laboratory Services (ALS). ALS has been accredited by an independent accreditation body acceptable to the NSW Environment Protection Authority (EPA), the National Association of Testing Authorities (NATA).

Laboratory methods used by ALS for the project are compared with the NSW EPA (2004) approved methods for the sampling and analysis of water pollutants. The laboratory methods used by ALS and the EPA-approved methods per analyte are listed in Table 6.2.

Table 6.2 Laboratory methods per analyte

ANALYTE	EPA-APPROVED METHOD	ALS METHOD
Alkalinity (total)	APHA 2320	APHA 2320 B
Aluminium	USEPA 6020	USEPA 6020
Arsenic (As III)	USEPA 6020	USEPA 6020
Bicarbonate	APHA 2320	APHA 2320 B
Cadmium	USEPA 6020	USEPA 6020
Chromium	USEPA 6020	USEPA 6020
Copper	USEPA 6020	USEPA 6020
Iron	USEPA 6020	USEPA 6020
Lead	USEPA 6020	USEPA 6020
Manganese	USEPA 6020	USEPA 6020
Mercury	APHA 3112	APHA 3112 - Hg B
Nickel	USEPA 6020	USEPA 6020
Oil and grease	APHA 5520 D	APHA 5520 D
Silver	USEPA 6020	USEPA 6020
Suspended solids	APHA 2540 D	APHA 2540 D
Total dissolved solids	APHA 2540 C	APHA 2540 C
Total nitrogen	APHA 4500 N-C	APHA 4500-Norg
Total phosphorus	APHA 4500 P F	APHA 4500 P F
TRH (C ₆ -C ₄₀)	USEPA 8015B	USEPA 8015A
Turbidity	APHA 2130	APHA 2130 B
Zinc	USEPA 6020	USEPA 6020

The methods used by ALS are generally consistent with the EPA-approved methods. Slight differences may occur when the EPA-approved methods relate to an older version of the American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater, such as the 1998 version. ALS informed WSP that the specification of an APHA number without a letter suggests any of the equivalent lettered methods are permissible (refer to alkalinity (total), bicarbonate, mercury, total nitrogen and turbidity). ALS also stated that the letter following the USEPA 8015 method for TRP (C₆-C₄₀) does not denote the actual method for TRH, and thus the ALS method is consistent with the EPA-approved method.

7 MONITORING METHODOLOGY

7.1 EQUIPMENT

7.1.1 GENERAL EQUIPMENT

The following equipment is used for the majority of sampling tasks and is applicable to groundwater and surface water sampling:

- personal protective equipment and other safety equipment as identified in the health, environment and safety plan for the project
- sampling record sheets (Appendix A)
- chain-of-custody (COC) forms (Appendix B)
- multi-parameter water quality instruments and calibration solutions
- appropriate sample containers with the required preservatives as specified by the laboratory
- storage containers for the samples (such as an esky)
- decontamination equipment including clean buckets, phosphate-free detergent such as Decon 90, liquid chlorine and potable water
- nitrile gloves, syringes and water filters for filtering samples (e.g. dissolved metals)
- mobile phone with camera.

7.1.2 SURFACE WATER EQUIPMENT

Surface water samples are collected using a grab sample technique. Samples are collected directly into laboratory-supplied sample containers that do not contain preservatives with the use of a telescopic sampling pole if there is moderate to high surface flow or steep banks. The sampled water is then decanted into the appropriate bottles. The submerged portion of the telescopic sampling pole is cleaned using phosphate-free detergent and potable water, followed by a solution of 200 mg/L of chlorine, which is left on the pole for one minute. The chlorine is then rinsed off with potable water. The use of chlorine is an additional precaution due to the Epizootic Haematopoietic Necrosis (EHN) virus.

7.1.3 GROUNDWATER EQUIPMENT

7.1.3.1 PURGING AND SAMPLING

A range of methods can be used to purge groundwater and collect groundwater quality samples from the monitoring wells. The most appropriate method for each monitoring well is selected based on the depth of the well, the depth to groundwater, and the permeability of the formation at the screened zone. Higher yielding monitoring wells are purged and sampled using a submersible (high-flow) pump. Lower yielding wells or wells with limited purge volume are sampled using a disposable bailer or a grab sampler.

SUBMERSIBLE (HIGH-FLOW) PUMP

A high-flow pump (12-volt Monsoon pump) is deployed in high yielding wells. Typically a minimum of three well volumes are extracted before a water quality sample is collected, however abstracting this volume is not required when field parameters (particularly pH and EC) have stabilised (refer to Section 7.2.4).

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- decontamination equipment including clean buckets, phosphate-free detergent such as Decon 90, liquid chlorine and potable water
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BAILING

Disposable bailers with a single stop valve are used to collect samples from shallow wells with limited purge volume and/or low yielding wells. Monitoring wells screened in low yielding aquifers with a slow recovery are bailed dry and samples are collected once the monitoring well has sufficiently recovered to obtain a groundwater sample.

GRAB SAMPLER

A no-purge (passive) grab sampler (e.g. HydraSleeve®) may be used for extremely slowly recovering monitoring wells. The grab sampler will be deployed and retrieved in the well in accordance with the manufacturer's instructions. With this method, groundwater samples are collected directly from the screened zone without having to purge the monitoring well prior to sample collection. It is a single-use (disposable) sampler (HydraSleeve, 2016).

7.1.3.2 GROUNDWATER LEVELS

An electronic groundwater level dipper is used to measure the static groundwater level. Solinst Leveloggers will be deployed to continuously monitor groundwater levels in the current monitoring network. Two barometric loggers will also be installed to correct for atmospheric pressure. Data loggers will be:

- Suspended from the surface using stainless steel cable and swages.
- Suspended below the standing groundwater level. Potential groundwater level variations in the monitoring well and individual logger specifications (different loggers have different pressure thresholds) are considered before the depth at which the logger is to be installed is determined, as the logger must remain below the groundwater level.
- Programmed and then lowered into the monitoring well. Data logging intervals are to be set at six-hourly intervals (00:00, 6:00, 12:00 and 18:00).

7.2 SAMPLING AND MONITORING

Surface water and groundwater monitoring are conducted in general accordance with WSP's standard operating procedure. The procedure outlines the general protocols, procedures and work practices to be applied when collecting surface water and groundwater samples and downloading data loggers.

7.2.1 SURFACE WATER SAMPLING

The surface water sampler is carefully lowered into the surface water body to obtain the samples. The grab sampler is lowered approximately 100-500 mm below the surface of the water body, depending on the depth of water. Disturbing the sediment and surface debris is avoided as much as possible when collecting a sample. Following collection, the surface water sample is decanted into the laboratory supplied sample containers.

The appearance of the surface water body is recorded, such as colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation and algae. Notes are also made of any other relevant observations such as dead, decaying or distressed vegetation, surface rubbish, and surface sheen. Refer to Section 8.4.1.

Should the sampling location be considered unsafe due to changed conditions, such as following a large rainfall event, then a suitable nearby location will be selected, and any change recorded on the sampling record sheets (Section 8.4.1).

7.2.2 GROUNDWATER LEVELS

Groundwater levels are manually measured by an electronic groundwater level dipper and data loggers will be installed at each monitoring well to automatically measure the groundwater level at a predetermined time interval (refer to Section 7.1.3.2).

Manual groundwater levels are recorded prior to purging or sampling. The groundwater level is measured from the top of casing and is measured to the nearest millimetre. The depth of the monitoring well is also recorded. These levels are recorded on the groundwater sampling record sheets (refer to Section 8.4.1).

The data logger can then be retrieved from the monitoring well for download by pulling up the stainless steel wire attached to the data logger. Data loggers will then be downloaded using appropriate software for storage and data processing. The following diagnostics are performed regularly to ensure data loggers are functioning properly:

- visual inspection and cleaning the data logger if necessary
- inspection of swages and connections to ensure the data logger is secured at the surface
- real time data is checked to ensure water levels recorded by the data logger are accurate before redeploying
- recording data logger battery levels.

7.2.3 GROUNDWATER SAMPLING

Following the measurement of static groundwater levels, typically three well volumes are purged prior to sampling. Less than three well volumes can be removed prior to sampling in the following circumstances:

- A well is purged dry and will not yield sufficient water for further continuous purging. As such, the recovery water is then sampled.
- At least one well volume has been removed and field parameters stabilise, principally pH, EC and temperature. Field parameters are considered to have stabilised when three consecutive sets of the selected field parameters are within 10%.
- No-purge sampling equipment is used (e.g. HydraSleeve or similar) for very low yielding monitoring wells, that may not sufficiently recover overnight.

The purged water colour, turbidity, any odours and other observations are assessed and recorded. Characteristics of how these change as pumping progresses over time are also noted on the groundwater sampling record sheet (refer to Section 8.4.1).

7.2.4 COLLECTION OF FIELD PARAMETERS

The field parameters listed in Section 6.1 are measured using a calibrated water quality meter, which is calibrated daily. Field parameters are measured from samples collected with a laboratory supplied plastic sample collection container for surface water samples. Groundwater samples are measured in the pumped water stream as purging progresses or from a sample collected with a disposable bailer (depending on sampling technique). The readings stabilise before being recorded on the surface water or groundwater sampling data record sheets (refer to Section 8.4.1).

7.2.5 COLLECTION OF SAMPLES FOR LABORATORY ANALYSIS

Surface water and groundwater samples are collected using the methods outlined above and decanted into laboratory-supplied containers. The following procedures are used:

- All fields are completed on the label of the sample container using a xylene free marker.
- Sampling personnel wear a new pair of nitrile disposable gloves for each sample location.
- All bottles are filled and capped as quickly as practicable to reduce exposure of the sample to the atmosphere. Care is taken when handling sample container lids to avoid contact with any surfaces that may compromise the integrity of the sample.
- When collecting samples for volatile analysis, all bottles are filled as far as practicable to minimise the headspace within the container and avoid potential loss of volatiles.
- Where filtering of samples is required to remove fine suspended particles, for example for dissolved metals analysis, disposable disc filters (0.45 µm) are used with disposable syringes. Filtering equipment is not reused between sampling locations.

7.3 METEOROLOGY

The rainfall from the BOM rainfall station located closest to the project is monitored on a daily basis, that is, Albion Park (Wollongong Airport) (site number 068241). Following 15 mm or more of rainfall within 24 hours, sampling is undertaken within 24 to 48 hours after the wet weather event.

8 QUALITY MANAGEMENT

8.1 QUALITY CONTROL

One blind replicate (field duplicate) water sample is collected for every 10 samples during each monitoring round and is collected to provide an indication of the precision (repeatability) of the laboratory's analysis and sampling procedures, as well as the heterogeneity of the sampling material. Duplicate samples are labelled 'QA#' with the first QA sample labelled QA1 and the second labelled QA2 etc. in order of collection. When a duplicate sample is taken, a note is made on the sampling record sheet of the parent sample. Duplicate samples are submitted to a NATA accredited laboratory for analysis.

Where appropriate, dedicated sampling equipment is used to eliminate the risk of cross-contamination as much as possible. Examples of such equipment are disposable bailers, HydraSleeves, filters and syringes. For reusable sampling equipment, such as submersible pumps, they are cleaned using phosphate-free detergent and rinsed with potable water between sample locations. The submerged portion of the telescopic sampling pole is cleaned using phosphate-free detergent and chlorine, which is an additional precaution due to the EHN virus. Refer to Section 7 for further information.

8.2 QUALITY ASSURANCE

8.2.1 RECORDS

Surface water and groundwater sampling record sheets are completed for each sampling location, providing a record of relevant information at each location. Sampling record sheets for the project are provided at Appendix A. Some of the information contained in these sheets are listed below:

- well number or sampling identification
- date and time
- sampling method
- samplers name
- specific field parameters and their units
- comments, such as colour, odour and turbidity
- purge volume (for groundwater only)
- quality assurance/quality control details
- general environmental/climatic conditions.

8.2.2 CHAIN OF CUSTODY

A COC form is completed following sampling and sent with the samples to the laboratory. The COC is a record of the sampling undertaken and the analysis required. A COC is shown at Appendix B. Some of the information contained within a COC is listed below:

- sample ID
- sample date and time
- analysis required

- sampler and project manager's names and contact details
- date and time the samples were relinquished by the sampler and received by the laboratory
- project number.

8.2.3 *SAMPLE STORAGE, TRANSIT AND DELIVERY*

The following additional quality measures are undertaken:

- Immediately following sampling, all samples are placed into an esky pre-packed with ice in a bag to prevent leakage or with ice bricks.
- To reduce the potential for breakage, samples are placed upright on the firm base of the esky. Samples are arranged to minimise lateral movement during transport.
- A quality control check is completed of the labels of all samples to be submitted to the laboratory against the sample ID's on the COC.
- The esky containing the samples for transport to the laboratory are sealed.
- All samples (temperature below 6°C) are picked up by a courier or delivered directly to the laboratory as soon as practical with the completed and relinquished COC.

9 ANALYSIS AND INTERPRETATION

Analysis and interpretation of the data collection during this pre-construction period will focus on establishing the baseline conditions. During construction and operation of the project, the baseline results will be used for comparison, to enable any potential impacts to be identified.

The Australian and New Zealand guidelines for fresh and marine water quality (ANZECC/ARMCANZ, 2000) will be used to compare with the baseline water quality results from the surface water and groundwater monitoring. The water quality guidelines for the protection of freshwater aquatic ecosystems are used, with:

- Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems. The lowland river trigger values have been adopted for the majority of surface water (see next point) and groundwater.
- Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems. The estuarine trigger values for SW3 only, Macquarie Rivulet, have been adopted due to the tidal nature of Macquarie Rivulet at this location.
- Freshwater trigger values for toxicants at a 95% level of protection are also adopted for groundwater and surface water.

The guideline values per analyte are listed in Table 9.1. Guideline values trigger values are not available for temperature, redox, TSS, TDS, calcium, sodium, magnesium, potassium, chloride, sulphate, alkalinity or bicarbonate.

Table 9.1 Guideline values

	UNITS	ANZECC/ARMCANZ (2000) GUIDELINES		
		SURFACE WATER (EXCEPT SW3)	SW3 – MACQUARIE RIVULET	GROUNDWATER
pH	pH units	6.5-8.0 ¹	7.0-8.5 ²	6.5-8.0 ¹
EC	µS/cm	125–2200 ¹	N/A	125–2200 ¹
Dissolved oxygen	% saturation	85-110 ¹	80-110 ²	N/A
Turbidity	NTU	6-50 ¹	0.5-10 ²	N/A
Total nitrogen	mg/L	0.35 ¹	0.3 ²	0.35 ¹
Total phosphorus	mg/L	0.025 ¹	0.03 ²	0.025 ¹
Aluminium	mg/L	0.055 ^{3,4}	0.055 ^{3,4}	0.055 ^{3,4}
Arsenic (As III)	mg/L	0.024 ³ (As III)	0.024 ³ (As III)	0.024 ³ (As III)
Cadmium	mg/L	0.0002 ³	0.0002 ³	0.0002 ³
Chromium	mg/L	0.001 ³ (Cr VI)	0.001 ³ (Cr VI)	0.001 ³ (Cr VI)
Copper	mg/L	0.0014 ³	0.0014 ³	0.0014 ³
Iron	mg/L	ID ³	ID ³	ID ³
Lead	mg/L	0.0034 ³	0.0034 ³	0.0034 ³
Manganese	mg/L	1.9 ³	1.9 ³	1.9 ³
Mercury	mg/L	0.0006 ³ (inorganic Hg)	0.0006 ³ (inorganic Hg)	0.0006 ³ (inorganic Hg)

	UNITS	ANZECC/ARMCANZ (2000) GUIDELINES		
		SURFACE WATER (EXCEPT SW3)	SW3 – MACQUARIE RIVULET	GROUNDWATER
Nickel	mg/L	0.011 ³	0.011 ³	0.011 ³
Silver	mg/L	0.00005 ³	0.00005 ³	0.00005 ³
Zinc	mg/L	0.008 ³	0.008 ³	0.008 ³

- (1) Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems (lowland river).
- (2) Default trigger values for physical and chemical stressors for south-eastern Australia for slightly disturbed ecosystems (estuarine).
- (3) Freshwater trigger values for toxicants at a 95% level of protection.
- (4) pH>6.5, otherwise there is no trigger value at pH <6.5.
- ID – Insufficient data to derive a reliable trigger value.

The baseline surface water quality data and groundwater levels will also be assessed in consideration of the weather, particularly rainfall.

10 RECORDING AND REPORTING OF MONITORING RESULTS

10.1 RECORDING RESULTS

The following documents and files are placed on the electronic project folder as soon as possible upon completion of the fieldwork:

- surface water and groundwater sampling record sheets (for templates refer to Appendix A)
 - completed COC (for template refer to Appendix B)
 - logger data files
 - signed health, environment and safety plan for the project.
-

10.2 REPORTING RESULTS

Surface water and groundwater monitoring results are reported monthly in a brief report. The contents of the report include a summary of the monitoring activities undertaken that month, the monitoring results with values outside the guidelines highlighted, rainfall and temperature data for the month, and calculated relative percentage differences for the duplicate and primary samples.

Upon completion of 12 months of baseline monitoring, surface water and groundwater results recorded during the previous 12 months will be incorporated in a baseline monitoring program summary report. This report will include a discussion of observed baseline trends in water quality and groundwater levels and in relation to rainfall. In addition, recommendations for any alterations to the monitoring program will be included.

11 ROLES AND RESPONSIBILITIES

The role of the project manager is to oversee and manage the project and is the primary contact for the Roads and Maritime Services. In general, the project manager is responsible for project scope, schedule, costs, personnel, safety and quality. The project manager is supported by WSP and the project management processes that are based on industry best practice and externally accredited safety and quality systems.

The project manager is also a technical specialist, allowing for review and assessment of the technical and quality aspects of the project on an ongoing basis. The project manager, a Principal Hydrogeologist, typically undertakes the technical review of tasks and reports, and is also supported by other Principal Hydrogeologists and Principal Hydrologists as required.

The project manager familiarises field personnel with the project scope and requirements, including the analytical suite, holding times, sample security procedures and other project requirements. Safety is an integral part of our day-to-day business, with safety protocols in place for all field activities.

Fieldwork staff are nominated by the project manager. The staff are technically qualified, have undertaken the relevant safety training and are first-aid certified. Before staff use any sampling equipment, they are trained and competent in the use of the equipment, and be familiar with the operation and safe work method statements for the tasks to be performed. Prior to a new field staff member undertaking the monitoring, the new personnel will shadow the current personnel, to ensure they are familiar with the specific requirements of the project, including all site locations and access.

Some of the responsibilities of the fieldwork staff are as follows:

- adhere to the health, environment and safety plan for the project
- follow the sampling protocols outlined within this report
- ensure representative samples are collected, appropriately stored, and transported to the laboratory
- monitor the daily rainfall
- record and save the required information, such as the sampling record sheets
- draft the monthly reports

12 ADDITIONAL ONE-OFF GROUNDWATER SAMPLING

12.1 SAMPLE ORIGINAL MONITORING NETWORK

To allow for the commencement of baseline groundwater monitoring prior to installing the new groundwater monitoring network, 13 existing groundwater monitoring wells were sampled in November 2017 for the quarterly analytical suite, as listed in Section 6.1. Manual groundwater levels were measured and where data loggers were installed, these were downloaded.

The results were included in the November 2017 monthly report (WSP, 2017b).

12.2 SAMPLE THE NETWORK NEAR THE INDUSTRIAL AREA AND MAIN CUT

Consultation with Crown Lands and Water on 7 December 2017 (Section 2) resulted in the one-off sampling of the monitoring wells near the industrial area and main cut, that is GW1, BH312A, BH314, BH317, BH318, GA-BH102 and GA-BH219 (Figure 3.1). The groundwater samples were analysed for BTEXN, TRH, PAH, dissolved metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) and oil and grease.

The results were included in the December 2017 quarterly report (WSP, 2017c).

12.3 SAMPLE THE NETWORK IN AGRICULTURAL AREA AND NEAR THE FIRE & RESCUE SITE

Consultation with Crown Lands and Water on 7 December 2017 (Section 2) resulted in the one-off sampling of the monitoring wells to the east of the Fire & Rescue NSW site at Albion Park, that is GW2, GA-BH239, GA-BH241, BH321A and BH327 (Figure 3.1). The groundwater samples were analysed for per- and poly-fluoroalkyl substances (PFAS) (full suite – 28 analytes), organochlorine pesticides and organophosphorus pesticides (OC/OP pesticides).

The results were included in the December 2017 quarterly report (WSP, 2017c).

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APPENDIX A

SAMPLING RECORD SHEETS





Surface Water Sampling Record Sheet

Job. number: PS106112					Sampling date:			Water quality meter ID:		
Client:					Sampling method:			Calibration date:		
Sample ID.	Time	Temp. (°C)	EC (uS/cm)	TDS (mg/L)	Redox (mV)	DO		pH	Bottles collected:	Comments: Including colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation, algae, gauge reading and environmental/climatic conditions.
						% sat	mg/L			
Sampler's name:					Signature:			QA/QC details:		

Version: A	Reviewer: P van Ravesteyn	Date: 27/02/18	Approver: Andrea Madden	Date: 27/02/18
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Surface Water Sampling Record Sheet

Sample ID.	Time	Temp. (°C)	EC (uS/cm)	TDS (mg/L)	Redox (mV)	DO		pH	Bottles collected:	Comments: Including colour, turbidity, water flow, odour, surface crusts, films or floating material, vegetation, algae, gauge reading and environmental/climatic conditions.
						% sat	mg/L			
Sampler's name:					Signature:				QA/QC details:	

Version: A	Reviewer: P van Ravesteyn	Date: 27/02/18	Approver: Andrea Madden	Date: 27/02/18
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Groundwater Sampling Record Sheet

Job Number: PS106112					Well Number:				
Property name/owner:					Purging Date:				
Contact details:					Sampling Date:				
Depth to groundwater from TOC (m):					PVC Stickup (m):				
Well depth from TOC (PVC) (m):					Casing diameter (mm):				
Purging Information									
Purging method: <input type="radio"/> Micropurge <input type="radio"/> Grundfos <input type="radio"/> 12V pump <input type="radio"/> Bailer <input type="radio"/> Flowing <input type="radio"/> Grab sample					Calculated bore volume (m ³) = $\pi r^2 h$ $\pi = 3.14$ $r = 0.5 \times \text{casing diameter (m)}$ $h = \text{well depth} - \text{depth to GW (m)}$				
Logger download: <input type="radio"/> YES <input type="radio"/> NO					1 bore volume (L): 3 bore volumes (L): 1m ³ = 1000L				
Start time:					Purging depth:				
Finish time:									
Field Results While Purging									
Time	Vol (L)	Temp. °C	EC (uS/cm)	TDS (g/L)	DO		pH	Redox (mV)	Colour/odour/turbidity
					%sat	mg/L			
CO ₂ (mg/L) = mL in syringe x 10 =									
Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled.									
Sampling Details									
Sampling method (<i>if different from purging method</i>): <input type="radio"/> Micropurge <input type="radio"/> Grundfos <input type="radio"/> 12V pump <input type="radio"/> Bailer <input type="radio"/> Flowing <input type="radio"/> Grab sample					Bottles collected:				
Sampling time:					QA/QC details				
Other comments and observations (environmental/climatic conditions):									
Sampler's name:					Signature:				



Groundwater Sampling Record Sheet


Field Results While Purging (continued)									
Time	Vol (L)	Temp. °C	EC (uS/cm)	TDS (g/L)	DO		pH	Redox (mV)	Colour/odour/ turbidity
					%sat	ppm			

Other comments:

APPENDIX B

CHAIN OF CUSTODY



		CHAIN OF CUSTODY ALS Laboratory: please tick →		<div>QADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0850 E: adeelaide@alsglobal.com</div> <div>QBRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com</div> <div>QGLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com</div>		<div>QMACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com</div> <div>QIMELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com</div> <div>QMUDGE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mal@alsglobal.com</div>		<div>QNEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com</div> <div>QNOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com</div> <div>QPERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7055 E: samples.perth@alsglobal.com</div>		<div>QSYDNEY 277-299 Woodpark Road Smithfield NSW 2164 Ph: 02 8794 8555 E: samples.sydney@alsglobal.com</div> <div>QTOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com</div> <div>QWOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembia@alsglobal.com</div>					
CLIENT: WSP				TURNAROUND R: <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some)				<input type="checkbox"/> Non Standard or urgent TAT (List due date):				FOR LABORATORY USE ONLY (Circle)			
OFFICE: L27, 680 George St. Sydney 2001				PROJECT: ALS QUOTE NO.:				COC SEQUENCE NUMBER (Circle)				Custody Seal Intact? Yes No N/A			
ORDER NUMBER:				PROJECT MANAGER:				COC: 1 2 3 4 5 6 7				Free ice / frozen ice bricks present upon receipt? Yes No N/A			
PROJECT MANAGER:				CONTACT PH:				OF: 1 2 3 4 5 6 7				Random Sample Temperature on Receipt: °C			
SAMPLER:				SAMPLER MOBILE:				RELINQUISHED BY:				RECEIVED BY:			
COC emailed to ALS?				EDD FORMAT (or default): .csv				DATE/TIME:				DATE/TIME:			
Email Reports to:				DATE/TIME:				DATE/TIME:				DATE/TIME:			
Email Invoice to:				DATE/TIME:				DATE/TIME:				DATE/TIME:			
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:															
ALS USE															
SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)															
ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).															
Additional Information															
LAB ID															
SAMPLE ID															
DATE / TIME															
MATRIX															
TOTAL CONTAINERS															
Sampled by															
Signature															
Remarks															
TOTAL															
<small>Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cit Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Impreserved; AP = Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Pres; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.</small>															

Appendix C Acid Sulfate Soil Management Procedure

Acid Sulfate Soil Management Procedure

1. Purpose

This procedure details the actions to be taken when actual acid sulfate rock (ASR), acid sulfate soils (ASS) or potential acid sulfate Soils (PASS) are encountered during excavation/ construction activities. This procedure is prepared to demonstrate compliance with the following standards and guidelines:

- The Acid Sulfate Soils Manual (1998)
- Acid Sulfate Soils Assessment Guidelines (1998)
- Laboratory Methods Guidelines (2004), and
- EPA Waste Classification Guidelines (2014), Part 4: Acid Sulfate Soils.

2. Scope

This procedure applies to all construction activities undertaken as part of the Project that have the potential to uncover / disturb ASR / ASS / PASS.

3. Induction and training

All site personnel and subcontractors working in areas of high probability ASR / ASS risk will be trained in the relevant parts of this procedure.

4. Procedure

Identification of ASS treatment areas

The design and location of ASR / ASS treatment areas will be marked on PESCPs and any other relevant plans. Potential areas of acid sulfate material are tabulated below. These areas and the type of material will be confirmed via additional geotechnical investigation during the detailed design phase.

Table C-1 Potential areas of acid sulfate material

Area	Approximate Chainage (m)	Construction Activity	ASS probability
Northern and southern banks of the Macquarie Rivulet	18400-18750	Minor excavation and bridge piles	High risk 1-2m
South of Macquarie Rivulet	18750-19500	Minor cuts and excavation for drainage, footings, etc	Low risk above 4m AHD
Norther and southern bank of Frazer Creek	19500-19870	Minor excavation and bridge piles	High risk 2-4m AHD
South of Frazer Creek	19870-21400	Minor excavation for bridge foundations drainage, footings, etc.	Low risk above 4m AHD

Unexpected actual ASR / ASS or PASS encountered during excavation / construction activities

If ASR / ASS / PASS is encountered during excavation/construction activities the Foreman must:

- STOP ALL WORK in the immediate/ affected area and contact the Environmental Officer (EO)
- Recommence works in alternate area where practicable.

The EO is responsible for testing of ASR / ASS / PASS and will undertake testing to determine the acidity (field pH test) and potential for acidity (field 30 per cent peroxide test) of the material encountered.

Any of the following characteristics indicate the presence of ASR / ASS:

- Soil pH of less than four
- A sulphurous smell following soil disturbance
- Pale yellow surface encrustations;
- Excessive iron staining on drain surfaces or stream banks, or iron stained drain water and orange red ochre deposits around water bodies
- Excessive corrosion of concrete and / or steel structures exposed to ground or drainage waters, or rapid corrosion of fresh steel in the soil; and
- Blue-grey, blue-green or grey waterlogged soils which smell of rotten egg gas.

High risk indicators for PASS could include:

- Low position in the landscape
- Soil from beneath the water table
- Heavy textures
- Dark colours; and
- Sulfur odour (rotten egg odour).

Action criteria for management intervention

Table C-2 details the texture based action criteria for management of ASR / ASS disturbance. Where soils containing concentrations at or above the action criteria are disturbed, management of spoil is required.

For the purposes of the Project, both action criteria have been included for reference purposes, ie less than 1,000 tonnes for fine texture soils, and greater than 1,000 tonnes for all soil types. As the project will disturb spoil greater than 1000 tonnes, the action criteria of greater than 1000 tonnes disturbed should be used.

Table C-2 Action criteria based on the ASS analysis for three broad texture categories

Type of material	Clay content	Action criteria 1 to 1000 tonnes disturbed		Action criteria >1000 tonnes disturbed	
		Sulphur trail % S oxidisable e.g. STOS or SPOS	Acid trail mol H+/tonne e.g. TPA or TSA	Sulphur trail % S oxidisable e.g. STOS or SPOS	Acid trail mol H+/tonne e.g. TPA or TSA
Texture range (McDonald et al. (1990))	Approx clay content (%<0.002 mm)				
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 – 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≤40	0.1	62	0.03	18

Source: Ahern *et al.* 1998

Neutralisation of excavated acid sulfate materials (ASM) from earthworks

If field tests are positive or inconclusive, laboratory analysis using the Chromium Suite will be required to determine if the material is in fact ASS and/or the required treatment rates based on the net acidity.

Neutralising agents must be incorporated within all ASR / ASS / PASS. All cut batters shall be coated with fine aglime at the rate of five kg/m and the lime coating should be checked and re-limed as necessary on a daily basis during periods of dewatering during construction excavation. The base of all fill areas where treated material is to be placed shall be treated with a neutralising agent forming a guard layer prior to the placement of any fill soils to neutralise downward seepage of acidic

drainage water. This application may need to be increased depending on stockpile height and actual and potential acidity of the ASM developed through detail assessment.

Aglime rates will be as determined through analytical assessment to establish per cent of sulfur present (S%) to determine an indicative level of treatment as specified in Table C-3. Interpretation of analytical data must be conducted by an appropriately qualified and experienced in dealing with ASS/PASS management.

ASS/PASS must be sufficiently dry before neutralising is commenced so that the lime can be thoroughly mixed through the soil. Where moisture levels in soil are high, the soil must be dried by spreading and leaving open to the atmosphere. Drying can be accelerated by regular aeration by turning with an excavator or backhoe. Drying should be carried out on a guard layer and protected from stormwater ingress.

Mixing of ASS/PASS with neutralising agent shall be carried out by spreading the soil in layers of not more than 300mm to 400mm thick using an agricultural spreader and disc plough, rotary hoe or similar. Care shall be taken to ensure that mixing occurs throughout the depth of the layer prior to placement of new material.

Following the successful treatment of the lot (as determined through the validation testing), the material shall be compacted and the next layer of excavated material to be treated shall be placed over the already treated material. This process shall be continued until the required site elevation is achieved.

Even when neutralised, excavated and processed ASR will not be used for upper pavement layers above Upper Zone Formation (UZF), including Selected Material Zone (SMZ) and verge and other layers with the potential to be exposed.

Table C-3 Treatment levels and aglime required to treat total weight of disturbed ASS (Source: Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2002)

Disturbed ASS (tonnes) (=m ³ ×BD) †	Soil Analysis* – Existing Acidity plus Potential Acidity (converted to equivalent S% units)													
	0.03	0.06	0.1	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	4	5
1	0	0	0	0	0	0.03	0.04	0.05	0.1	0.1	0.1	0.1	0.2	0.2
5	0	0	0	0.05	0.1	0.1	0.2	0.2	0.4	0.5	0.6	0.7	0.9	1.2
10	0	0.03	0.05	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.4	1.9	2.3
50	0.1	0.1	0.2	0.5	0.9	1.4	1.9	2.3	3.5	4.7	5.9	7.0	9.4	12
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4	12	14	19	23
200	0.3	0.6	0.9	1.9	3.7	5.6	7.5	9.4	14	19	23	28	37	47
250	0.4	0.7	1.2	2.3	4.7	7.0	9.4	12	18	23	29	35	47	59
350	0.5	1.0	1.6	3.3	6.6	10	13	16	25	33	41	49	66	82
500	0.7	1.4	2.3	4.7	9.4	14	19	23	35	47	59	70	94	117
600	0.8	1.7	2.8	5.6	11	17	22	28	42	56	70	84	112	140
750	1.1	2.1	3.5	7.0	14	21	28	35	53	70	88	105	140	176
900	1.3	2.5	4.2	8.4	17	25	34	42	63	84	105	126	168	211
1000	1.4	2.8	4.7	9.4	19	28	37	47	70	94	117	140	187	234
2000	2.8	5.6	9.4	19	37	56	75	94	140	187	234	281	374	468
5000	7.0	14	23	47	94	140	187	234	351	468	585	702	936	1170
10000	14	28	47	94	187	281	374	468	702	936	1170	1404	1872	2340

L	Low treatment: (≤0.1 tonnes lime)
M	Medium treatment: (>0.1 to 1 tonne lime)
H	High treatment: (>1 to 5 tonnes lime)
VH	Very High treatment: (>5 to 25 tonnes lime)
NH	Extra High treatment: (>25 tonnes lime)

Notes

1. The tonnes (t) of pure fine aglime, CaCO₃ required to fully treat the total weight/volume of ASS can be read from the table at the intersection of the weight of disturbed soil [row] with the existing plus potential acidity [column]. Where the exact weight or soil analysis figure does not appear in the heading of the row or column, use the next highest value
2. An approximate soil weight (tonnes) can be obtained from the calculated volume by multiplying volume (cubic m) by bulk density (t/m³). (Use 1.7 if B.D. is not known.) Dense fine sandy soils may have a BD up to 1.7, and hence 100 cubic metres of such soil may weigh up to 170 t. In these calculations, it is necessary to convert to dry soil masses, since analyses are reported on a dry weight basis.
3. Potential acidity can be determined by Chromium Reducible Sulfur (S_{CR}), Peroxide Oxidisable Sulfur (S_{POS}) and Total Oxidisable Sulfur (S_{TOS}). For samples with pH less than 5.5, the existing acidity must also be determined by appropriate laboratory analysis eg. Titratable Actual Acidity (TAA). Soils with retained acidity eg. jarosite or other similar insoluble compounds have a less available acidity and will require more detailed analysis. The amount of treatment required may be reduced if the self-neutralising capacity of the soil is appropriately measured.

Neutralising materials

For management or neutralisation of ASS/PASS soils, medium-fine Aglime will be used. Dolomitic Aglime, or magnesium-blend Aglime, will not be used. In general, a finer grind is better. The Aglime purity should preferably be 90 per cent or better, (that is, neutralising value (NV) greater than 90), unless there is a significant savings to be made by use of less pure Aglime. In the latter case, however, the individual lime dosing rates will need to be increased accordingly. The requirement for greater amounts of Aglime of lower purity should be borne in mind when assessing the supplies of this material, as the cost savings from less pure material may be offset by the need for more, and correspondingly higher total transport costs.

ASS/PASS treatment will occur within an ASS treatment area. Material which is transported to treatment cells must be completely treated and removed from the treatment area before new material is introduced. This will ensure that treated material remains segregated and is not mixed with contaminated material. Aglime or other suitable treatment material will be stored at the treatment area in sufficient quantities to enable the treatment of all ASS/PASS material expected to be treated in the upcoming few weeks/months and will be determined by the expected delivery schedule of treatment material. The management of onsite treatment is the responsibility of the Site Foreman, with assistance from the Environmental Officer (EO).

Aglime is non-corrosive, and requires no special handling – it may be necessary to cover the stockpile with a tarpaulin or cover the stockpile with plastic, to minimise dust generation and prevent wetting, since it is then more difficult to spread. Intermittently, until such time as field testing suggests otherwise, a small quantity of Aglime will be stored on site, in the order of 200 kilograms or so. This will enable the regular treatment of soil and cater for any unexpected occurrences of 'hotter' ASS/PASS.

Dolomitic aglime, or magnesium-blend aglime, should not be used as these materials impose environmental risks from overdosing with the potential to damage estuarine ecosystems. A reasonable quantity of calcium hydroxide solution (hydrated lime) shall be kept on site at all times for treatment of acidic waters. The supply shall be stored in a covered and bunded area to prevent accidental release to waters. Neutralising agents must be replenished and or replaced regularly to remain effective against loss by wind or water erosion.

Validation of ameliorated ASR / ASS / PASS

Samples of the treated soil should be taken and laboratory analysed to demonstrate compliance with the performance criteria (ie. verification testing). These performance criteria equate to there being no net acidity in the soil following neutralisation. Soil that has been treated by neutralisation techniques and has not met these criteria must be retreated until the above performance criteria are met.

The objective of ameliorating ASR / ASS / PASS materials is to ensure that there is no chance that net acidity will be produced. Validation testing only occurs when soils have been treated (with a neutralising agent) to prevent any future acidification. If results of the validation testing indicate a failure to comply with the performance criteria, soil may need to be re-treated with an additional application of neutralising agent.

Soils that have been mixed with aglime will be analysed by either the SPOCAS or SCR Suite test methods at a rate of one sample per 250 cubic metre. All validation samples are to be recorded by GPS or survey, clearly marked on a map/sketch or otherwise recorded.

Where large quantities (greater than 1,000 cubic metres) of ameliorated soils are involved and 'net acidity' rates are generally low (18 mol H⁺/t to less than 125 mol H⁺/t or 0.03 to 0.20 per cent sulfur), a reduced rate of sampling may be appropriate subject to approval. A rate of one sample per 1,000 cubic metre may be suitable for example.

The following performance criteria must be attained for soil that has been treated using neutralisation:

- The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil

- Post-neutralisation, the soil pH is to be greater than 5.5
- Excess neutralising agent should remain within the soil until all acid generation reactions are complete and the soil has no further capacity to generate acidity.

If ameliorated ASS is going to be reused on site, due environmental regard for areas of placement should be assessed, documented and approved by the Fulton Hogan Environment Manager (EM). Assessment measures may include:

- Location of proposed placement areas and potential receptors (waterways, sensitive flora and fauna, structures)
- Stability and suitability of materials as select fill (especially clays), and
- Suitability of soil type for plant growth.

In the unlikely event that the treated material is unable to be reused on-site for other purposes, the material will need to be disposed of to an appropriately licensed waste disposal facility. The EM/EO will liaise with a licensed waste facility and coordinate the process.

Large-scale dewatering or drainage

Earthworks and/or pumping that result in localised drainage or lowering of groundwater and the exposure of sulfidic soils to the ingress of oxygen may generate acidity as a function of soil type(s), sulfide contents, area exposed, and length of time the excavation remains 'dry'. The scale of the dewatering or drainage should be defined by the size of the cone of depression rather than the size of the void. Activities of this type are high-risk, and should not be undertaken without technical risk assessment by qualified personnel and the formulation of management measures sufficient to reduce risk to levels acceptable by the administering authorities.

Neutralising acid leachate and drain water using lime

The liming rate for treating acid water should be carefully calculated to avoid the possibility of "overshooting" the optimum pH levels of 6.5 to 8.5. This can occur quite easily if more soluble or caustic neutralising agents such as hydrated lime (pH 12) or magnesium hydroxide (pH 12) are used. It should be noted that when neutralising acid water, no safety factor is used. However, monitoring of pH should be carried out regularly during neutralisation procedures.

Agricultural lime (pH 8.2) is the safest neutralising agent. It equilibrates around a pH of 8.2 that is not generally harmful to plants, stock or humans and most aquatic ecology species. The main shortcoming associated with the use of lime is its insolubility in water.

When using alkaline materials, strict protocols must be established for the use, handling and monitoring of these materials. Prior to any ASR / ASS / PASS management, appropriate personal protective equipment (PPE) is to be worn as per relevant SDS (eg for Lime). This may include:

- Eye goggles and/or face masks
- Hard Hat
- Rubber boots, gloves
- Appropriate clothing (e.g. long sleeved shirts).

Calculating the quantity of lime

The current pH is measured with a recently calibrated pH detector. The desired pH is usually between 6.5 and 8.5 with pH 7 is normally targeted. The volume of water can be calculated by assuming one cubic metre of acid water is equivalent to one kilolitre (1000 litre) and 1,000 cubic metre is equivalent to one megalitre (ML).

As a general guide, Table C-4 shows minimum quantities of pure lime, hydrated lime or sodium bicarbonate needed to treat dams or drains of one ML (1,000 cubic metre) capacity.

Table C-4 Quantity of pure neutralising agent required to raise from existing pH to pH 7 for one megalitre of low salinity acid water

Current water pH	[H+] {mol/L}	H+ in 1 Megalitre {mol}	Lime to neutralise 1 Megalitre {kg pure CaCO ₃ }	Hydr. lime to neutralise 1 Megalitre {kg pure Ca(OH) ₂ }	Pure NaHCO ₃ / 1 Megalitre {kg }
0.5	0.316	316,228	15,824	11,716	26,563
1.0	0.1	100,000	5,004	3705	8390
1.5	0.032	32,000	1,600	1185	2686
2.0	0.01	10,000	500	370	839
2.5	0.0032	3,200	160	118	269
3.0	0.001	1,000	50	37	84
3.5	0.00032	320	16	12	27
4.0	0.0001	100	5	4	8.4
4.5	0.000032	32	1.6	1.18	2.69
5.0	0.00001	10	0.5	0.37	0.84
5.5	0.0000032	3.2	0.16	0.12	0.27
6.0	0.000001	1	0.05	0.037	0.08
6.5	0.00000032	.32	0.016	0.12	0.027

Notes on Table C-3:

- 1 m³ = 1,000 litre = 1 kilolitre = 0.001 megalitre
- Agricultural lime has very low solubility and may take considerable time to even partially react
- Hydrated lime is more soluble than aglime and hence more suited to water treatment. However, as Ca(OH)₂ has a high water pH, incremental addition and thorough mixing is needed to prevent overshooting the desired pH. The water pH should be checked regularly after thorough mixing and time for equilibration before further addition of neutralising product
- Weights of lime or hydrated lime are based on theoretical pure material and hence use of such amounts of commercial product will generally result in under treatment
- To more accurately calculate the amount of commercial product required, the weight of lime from the table should be multiplied by a purity factor (100/ Neutralising Value for aglime) or (148/ Neutralising Value for hydrated lime).
- Calculations are based on low salinity water acidified by hydrogen ion, H⁺ (acid) and do not take into account the considerable buffering capacity or acid producing reactions of some acid salts and soluble species of aluminium and iron. For example, as the pH increases towards 4, the precipitation of soluble ferric ion occurs, liberating more acid:
- $\text{Fe}^{3+} + 3\text{H}_2\text{O} \rightarrow \text{Fe}(\text{OH})_3 + 3\text{H}^+$
- If neutralising substantial quantities of ASS leachate, full laboratory analysis of the water will be necessary to adequately estimate the amount of neutralising material required.

Application of lime to water

To increase the efficiency, lime should be mixed into a slurry before adding. A slurry can be prepared in a concrete truck, cement mixer or large vat with an agitator. Methods of application of the slurry include:

- Spraying the slurry over the water with a dispersion pump
- Pumping the slurry into the water body with air sparging (compressed air delivered through pipes) to improve mixing once added to water
- Pouring the slurry out behind a small motorboat and letting the motor mix it in
- Incorporating the slurry into the dredge line (when pumping dredge material)
- Using mobile water treatment equipment such as the 'Neutra- mill' and 'Aqua Fix' to dispense neutralising reagents to large water bodies.

A change in pH will not be instantaneous. The rate of neutralisation will vary with the solubility, fineness of the lime, the application technique and the acidity (pH) of the water. The finer the lime (preferably microfine with the consistency of white dust) and the more agitated the water, the faster the lime will dissolve and become effective. The pH must be carefully monitored even after the desired pH has been reached. If the water has not reached the desired pH within two weeks, more lime may need to be added. Before additional lime is added, the lack of success should be investigated. Issues to consider may include:

- The quality of the lime being used
- The effectiveness of the application technique
- The existence of additional sources of acid leaching into the water body further acidifying the water, and
- The lime has become lumpy and is sitting on the bottom

Neutralisation may be faster if higher rates are used, but is not recommended as it is expensive and resource wasteful. Moreover, over-dosing may result, though this is unlikely to be a concern with agricultural lime.

Appendix D Heavy rainfall event procedure

Heavy Rainfall Event Procedure

Purpose

To detail the actions to be taken in the event of a 'heavy' or 'violent' rainfall forecast as defined by the Australian Government Bureau of Meteorology. The procedure outlines how to monitor rainfall forecasts and prepare site to minimise impacts as much as practicable.

For management measures and procedures to be implemented prior to a flooding event, including timeframes for securing work sites and moving plant and equipment, refer to the Flooding and Hydrology Management Sub-plan (FHMP).

Table D-1 Definition of rain or showers intensity

Category	Description
Light	Up to 2 mm per hour. Individual drops easily identified, puddles form slowly, small streams may flow in gutters.
Moderate	2.2 mm to 6 mm per hour. Rapidly forming puddles, down pipes flowing freely, some spray visible over hard surfaces.
Heavy	6.2 mm to 50mm mm per hour. Falls in sheets, misty spray over hard surfaces, may cause roaring noise on roof.
Violent	Over 50mm per hour. Gutters and downpipes overflowing, spray to height of several centimetres over hard surfaces, may cause roaring noise on roof.

Source: Australian Government Bureau of Meteorology website <http://www.bom.gov.au/info/wwords>

Induction and training

All Fulton Hogan Superintendents, Foremen and Engineers will be trained in this procedure.

Procedure

1. Monitoring of 'heavy' or 'violent' rain or shower events (through the Australian Government Bureau of Meteorology):
2. On each working day, the Environmental Manager (EM)/ Environment Officer (EO) or delegate will log on to the Australian Government Bureau of Meteorology website <http://www.bom.gov.au/weather/nsw> review the weather forecast for the next three days and notify the Project team of the same by email. When rain or showers are described as 'heavy' or 'violent', the EM/EO or delegate will highlight that:
 - rain or showers are described as 'heavy' or 'violent' (as applicable)
 - the Heavy Rainfall Event Procedure must be followed.
3. The EM/ EO or delegate will keep a record of all weather forecast emails.
4. The daily weather forecast may be discussed at Prestart Meetings as deemed required by the Fulton Hogan Foreman/ Superintendent.
5. When rain or showers are described as 'heavy' or 'violent' the Fulton Hogan Superintendent will notify the Project team of personnel who will monitor and maintain erosion and sediment controls if required.
6. The Foremen will ensure that there is an adequate supply of erosion and sediment control measures on site.
7. Prior to the 'heavy' or 'violent' rainfall or shower event, the Foremen and the EM/ EO or delegate will inspect erosion and sediment control measures, focusing on the critical areas first. These may include stockpile areas, chemical storage areas and sediment basins.
8. Additional temporary erosion and sediment controls will be installed as required.

Appendix E Stockpile Management Protocol

Stockpile Management Protocol

Purpose

This protocol provides a process for the establishment of *temporary* stockpile areas within the approved project boundary and any approved ancillary facility to ensure that environmental impacts associated with stockpiling are minimised during construction.

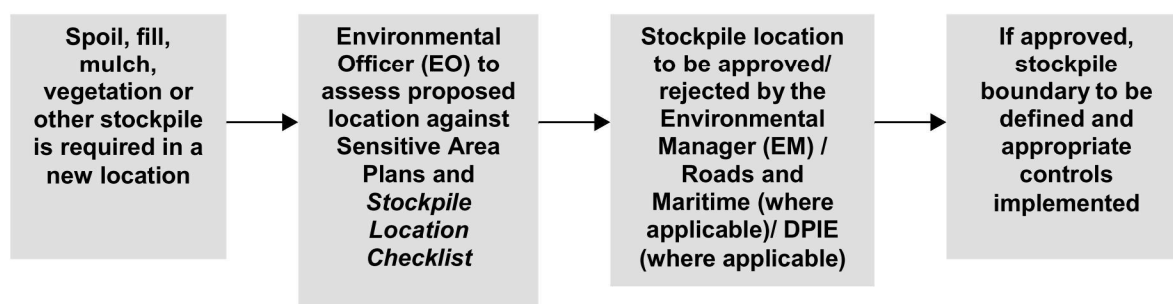
Stockpile sites may typically be required to store material including, but not limited to:

- Excavated materials to be used in fill embankments and other design features
- ASS subject to treatment prior to reuse
- Excavated material unsuitable for reuse in the formation
- Excess concrete, pavement, rock, steel and other material stored for either future use in the Project or prior to removal from site, and
- Topsoil, mulch, excess timber for landscaping and revegetation works.

Scope

This protocol and associated *Stockpile location checklist* describe the environmental criteria/ factors to be considered to ensure stockpiles are located in areas where potential environmental harm is minimised.

To avoid duplication, refer to the relevant Sub-plan e.g. AQMP, WEMP, FFMP, NVMP, HMP and this SWMP for the mitigation measures that will be implemented to avoid/ minimise air quality; waste management; flora and fauna; noise; heritage; and erosion and sediment impacts respectively from stockpiles.



Induction and training

All site personnel and subcontractors will be trained in this procedure.

Procedure

Proposed stockpile information

Prior to requesting the assessment of a stockpile location from the EO, the person requesting the new stockpile location should check approved stockpile locations to ensure current approved stockpile sites cannot be better utilised. Minimise the number of stockpiles sites wherever practicable.

If existing sites cannot be used, the expected quantity of material, expected dimensions required, expected stockpiling timeframes, destination of the stockpiled material, whose land the stockpile will be located on and the type of material to be stockpiled must be detailed. Once this information is known, the EO shall be contacted for an assessment of the proposed stockpile location.

Assessment of stockpile site

The EO shall utilise the **Stockpile Location Checklist** (included in this Protocol, Table E-1) to assess the stockpile location.

Note stockpiles within the approved project boundary are intrinsic to and undifferentiated from the bulk earthworks operations, these stockpiles are assessed in accordance with the section below of this protocol below.

Approval of stockpile site

Stockpiles within the approved project boundary

The EO shall give the completed *Stockpile Location Checklist* (Table E-1) to the EM for review and assessment. Following this review, the EM shall either approve or reject the proposed stockpile location and notify the EO of the decision.

A register of all stockpile sites (Table E-2, included in this Protocol) shall be kept on file by the EO and they shall also ensure that any additional erosion and sediment control measures are included in the relevant progressive erosion and sediment control plan (PESCP).

Preparing stockpile site

If the proposed stockpile site is approved, the boundaries will be agreed between the person proposing the stockpile and the EO (or Roads and Maritime where required). The proposed stockpile site will be marked out and appropriate erosion and sediment controls installed. Stockpile sites will also be signposted to clearly identify and delineate between other stockpiles. The erection of signs will be agreed with the Site Foreman.

Details of stockpile management in regard to erosion and sediment control will be included in the relevant ESCP/ PESCP.

Mulch stockpiles

Locate and manage mulch stockpiles to minimise and manage tannin generation. Refer to Appendix F of this SWMP for **Roads and Maritime Environmental Direction: Management of Tannins from Vegetation Mulch**.

Stockpile location checklist

Proposed Stockpile number:	
Chainage:	
Location sketch is attached? (mandatory)	<input type="checkbox"/> Yes
Stockpile type and dimensions (HxWxD):	

The location of stockpile sites will be determined following review of the following documents and requirements:

- CEMP and Sub-plans including review of relevant mitigation measures
- Sensitive Area Plans
- Stockpile Management Protocol
- Revised environmental management measure REMM SW02
- Roads and Maritime Specification D&C G36, G38 and G40
- Roads and Maritime Stockpile Site Management Guideline.

Where proposed sites do not comply with the criteria below, provide justification and additional mitigation measures to demonstrate how potential impacts will be managed.

Table E-1 Stockpile location criteria

Criteria		Source of requirement	Does the proposed site meet the criteria?	If proposed site does not meet the criteria, provide justification/ additional mitigation measures to demonstrate how potential impacts will be managed
Vegetation	Site should minimise damage to natural vegetation and trees	G40 cl 5.2		
	Site should be located outside of the 'dripline' of trees	G 40 cl 2.4.1(ii)		
	Site should be located outside of the tree protection zone of trees or native vegetation identified for retention. Refer to AS 4970.	G 38 cl 3.2		
	Site should avoid clearing native <i>Ficus</i> and <i>Eucalyptus</i> species	SWTC App 14 cl 14.3		
	Site must not result in any clearing of native vegetation beyond that which is otherwise required for the project.	SWTC App 4 cl 4.21		
	Site should be located so that the removal of threatened species, endangered ecological communities (EECs) or roosting habitat for listed threatened fauna species is not required	SWTC App 4 cl 4.21		

Criteria		Source of requirement	Does the proposed site meet the criteria?	If proposed site does not meet the criteria, provide justification/ additional mitigation measures to demonstrate how potential impacts will be managed
Drainage and water quality	Site should be located away from drainage lines and watercourses	G40 cl 5.2		
	Site should be located at least 50 m from a waterway unless an ESCP/PESCP is prepared and implemented so as not to adversely affect water quality in the waterway ¹	SWTC App 4 cl 4.21		
	Site should be located at least five metres from likely areas of concentrated water flows and at least 10 metres from waterways that are classified as Class 1 and Class 2 from the DPI Fisheries guideline "Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings"	G 38 cl 3.2 SWTC App 4 cl 4.21		
	Site should be located on land with a slope less than 10 per cent.	SWTC App 4 cl 4.21		
Dust and noise	Site should be located away from dust sensitive locations	G36 cl 4.4.2(o)		
	Site should be located away from noise sensitive locations	G36 cl 4.6.1(f)		
Access	Site must be positioned with ready access to the road network or direct access to the construction corridor	SWTC App 4 cl 4.21		
	Site must be positioned so that the stockpiled material is accessible at any time	G40 cl 5.2		
Heritage	Site be located in areas of low heritage conservation significance (including areas identified as low Aboriginal Cultural value) so as to not impact upon heritage sites beyond those already impacted by the Project.	SWTC App 4 cl 4.21		
Flooding and hydrology	Where stockpiles are to be located in the floodplain, site located and sized to ensure temporary impacts are not greater than those specified in the design criteria.	REMM HF02 G 38 cl 3.2		

¹"Waterway" is defined in SWTC Appendix 4 Clause 4.21(a)(ii) as "any Class 1 or Class 2 fish habitat waterways (as described in the Department of Primary Industries Fisheries guidelines); and waters that are used for the purpose of human consumption."

Prepared by Environment Officer: Date:.....
Environmental Manager: Date:.....
Approved / Rejected (please circle) by: Date:

Table E-2 Approved stockpile location register

[illegible]

Appendix F Roads and Maritime environmental direction: management of tannins from vegetation mulch

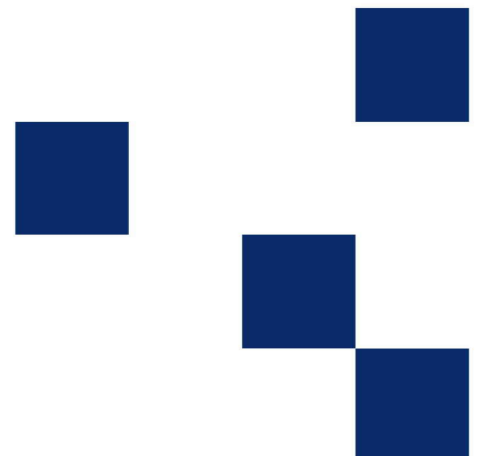


Transport
Roads & Maritime
Services

ENVIRONMENTAL DIRECTION

Management of Tannins from Vegetation Mulch

JANUARY 2012



ABOUT THIS RELEASE

Environmental Direction number	25
Environmental Direction title	Management of Tannins from Vegetation Mulch
Author	Environment Branch (Environmental Policy)

Issue	Date	Revision description
1	December 2011	Final draft
2	January 2012	Final

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1 PURPOSE

The purpose of this environmental direction is to set RMS's minimum management measures to minimise the generation and discharge of tannins from vegetation mulch on Roads and Maritime Services (RMS) construction projects. Additional background information on tannins and the use of mulch on construction sites is included in section 3 of this direction.

2 MANAGEMENT MEASURES

The primary focus must be to minimise tannin generation on construction sites.

2.1 General mulch management measures

These general mulch management measures are to be followed for all RMS construction projects.

2.1.1 Planning and works staging

The first step in planning and works staging is to identify the amount of mulch to be generated. With this information, a strategy can be prepared to manage mulch on site. Staging of chipping, tub grinding and/or mulching activities should be planned to reduce the volume of mulch to be managed at any one time. The volume of excess mulch can then be assessed and plans made to dispose of this off site.

Other general considerations at the planning and works staging phase are as follows:

- Mulch stockpile sites should be established with appropriate controls in place before the main site clearing activities commence. Limited clearing may be required earlier for establishment of stockpile areas and access.
- Stage the mulching of cleared vegetation to ensure that mulch can be progressively moved to elevated, or otherwise suitable, stockpile locations. It is preferred that mulch should be transferred to a stockpile or reused on the day of mulching.
- Plan to efficiently reuse mulch in progressive works to reduce the time that mulch is concentrated in stockpile locations.
- Excess mulch can be managed by community giveaway. This takes considerable time and mulch needs to be suitably located and managed as this occurs. The conditions for community giveaway of mulch are included as Appendix 3.
- Any other form of bulk offsite mulch disposal (eg to Council parkland or a development site) must be assessed to ensure waste management provisions are adhered to for off site disposal.

2.1.2 Stockpile location and management

- Mulch stockpile sites should be established on elevated ground where possible.
- Stockpile sites with a duration of not more than 1 month should be constructed not less than 20 metres from a watercourse, including floodplains.
- Stockpile sites with a duration of more than 1 month should be constructed not less than 50 metres from a watercourse, including floodplains.
- Mulch stockpiles should be designed and constructed to divert upgradient water to prevent it from entering the stockpile site.

2.1.3 Management measures for the use of mulch on site

- Do not use mulch for surface cover or sedimentation controls in any low lying areas of the site that remain consistently wet. Alternative controls such as geofabric (for surface protection) or sediment fence will be required in these areas.
- Do not spread surface mulch in thicker than 100mm layers. Mixing mulch with topsoil is encouraged for batters to prevent loss of topsoil during initial stabilisation. It should be noted that mulch will generally cause nitrogen draw down which may inhibit plant growth, unless mulch has been composted first.
- Care is to be taken to ensure that excessive mulch is not applied for sedimentation controls such as perimeter bunds or catch dams.

2.1.4 Monitoring and response

- Monitor the site for generation of tannins. Tannin impacts can be readily identified visually as dark coloured ponded water. Site staff should be trained to identify and report potential impacts to the site project management or environment staff.
- Review management practices where required to prevent the generation of tannins in identified problem areas.

2.2 Mulch management methods for high risk sites

2.2.1 High risk sites

High risk sites, where additional management measures may be required, include:

- where large quantities of mulch will be generated and stockpiled.
- where high tannin generating vegetation types are to be mulched (see 3.1).
- where the receiving environment is identified as sensitive (eg Marine Park, threatened aquatic species habitat).
- where tannins have been observed to be generated or discharged from an operating site with standard management controls.

2.2.2 Stockpile management measures for high risk sites

- Mulch stockpiles for high tannin generating vegetation types should incorporate an impermeable bund to capture stockpile leachate or tannin impacted water. Impervious bunds must be a minimum of 300 mm high, preferably higher to capture tannin impacted water. All bunded stockpiles that are in place for a period longer than one month must include a lined discharge point for overflow in extreme rainfall events.
- Stockpiles established on sloping sites must be designed to provide temporary stormwater containment equivalent to a 300 mm minimum height bund on a flat site.
- Tannin impacted water should be pumped out of bunded stockpiles within 5 days of the end of a rainfall event to maintain the storage capacity. This water should be used for on site purposes including dust suppression and landscape watering. These activities must be managed to prevent any pooling or runoff of tannin impacted water.
- Bunded stockpiles must be inspected within 24 hours of cessation of any rainfall event greater than 10mm to ensure tannin impacted water does not overflow.

2.3 Site management procedures

Site management procedures must be prepared for all sites where tannins are identified as a potential issue. Site management procedures should be based on the management measures provided in this Environmental Direction.

3 BACKGROUND

3.1 Tannin generation from vegetation mulch

See Plates 1 – 3 in Appendix 1.

Tannins are naturally occurring plant compounds. Tannin generation from vegetation mulch is likely to be highest from low-lying coastal floodplain areas. The species of vegetation (eg *Melaleuca*) will have a major impact on the likelihood of tannin generation.

Tannin generation is generally highest from mulched vegetation that is stockpiled in areas that are subject to inundation. Placement in wet areas will result in accelerated leaching of tannins into water, concentration of tannins in pooled water, and greater impacts on water quality.

3.2 Tannin impacts on water quality

See Plates 4 – 5 in Appendix 1.

The main concern with the discharge of water that is high in tannins is that it may increase the biological oxygen demand (BOD) of the receiving environment. Increases in BOD may result in a decrease in available dissolved oxygen. A lack of dissolved oxygen is identified as the main cause of about 80 percent of fish kills in NSW rivers and estuaries.

Tannin impacts may result in dark coloured water discharge from construction sites. This impact can be obvious and may raise the concern of the community and other stakeholders including regulatory authorities. Once discharged to the environment, tannins may reduce visibility and light penetration and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

Tannins cannot be readily treated with standard construction site water quality controls. Once water on site is impacted with tannins it is not possible to treat effectively with currently approved flocculants. Minimisation of tannin generation in the first place is the management strategy that must be applied.

3.3 Use of mulch on construction sites

See Plates 10 – 16 in Appendix 2.

The RMS Biodiversity Guidelines provide guidance on the benefits of reusing various sizes of vegetation for different purposes. Mulch is a readily available and cheap source of material for temporary site stabilisation and sedimentation control. The re-use of mulch reduces the need to transport this material off-site and reduces handling and disposal costs for construction contracts.

Unprotected mulch sedimentation controls should not be placed in concentrated flow lines where mulch may be washed away. Mulch may be protected by wrapping it with geofabric or other materials to provide a stable control. All temporary catch dams constructed from mulch must have a stable outlet to minimise the washing away of mulch in high rainfall events, and the possible failure of the control.

4 ADDITIONAL RESOURCES

- RTA Biodiversity Guidelines- Protecting and Managing Biodiversity on RTA Projects, 2011
- Pacific Highway Mulch Protocol 2011

5 APPENDICES

Appendix 1: Plates showing tannin generation & water quality impacts



Plate 1: Melaleuca vegetation community – mulch from this vegetation type will generally produce high amounts of tannins.



Plate 2: Vegetation mulching activity – mulch should be progressively moved into prepared stockpile areas.



Plate 3: Tannin generation from recently felled and partially mulched vegetation in an area subject to localised inundation. Mulched vegetation should be progressively moved to prepared stockpiles to manage tannin impacted water.



Plate 4: Tannin impact in stormwater at the discharge point from a road construction site. The discharge of impacted water may be obvious to community and other stakeholders.



Plate 5: Tannins in a drainage line generated from very thickly applied mulch on the batter above. Note that the sedimentation fence is not effective in treating the tannins.

Appendix 2: Plates showing the use of mulch for erosion & sedimentation controls



Plate 6: Mulched vegetation stockpiled in a low-lying area subject to inundation. This is not an appropriate stockpile location and may increase the generation of tannins from stockpiled mulch.



Plate 7: Mulch being placed as batter erosion control. Mulch should not be applied in layers more than 100 mm thick for surface stabilisation.



Plate 8: Site showing recent application of a mulch/topsoil mix on batters (40% mulch to 60% topsoil). Mulch mixes are used to provide temporary stabilisation to prevent the loss of topsoil from batters in heavy rainfall events. Mulch use is also shown as a mounded sedimentation control to prevent sediment entering the median drain.



Plate 9: A mulch/topsoil mix used to provide temporary batter stabilisation and to assist cover crop establishment.



Plate 10: Successful establishment of cover crops on batters where mulch has been used with topsoil to assist temporary stabilisation.



Plate 11: Geofabric wrapped mulch bunds used for sedimentation control



Plate 12: Mulch used as a bund for a temporary sedimentation catch dam. Mulch is effective as it can provide both containment and filtering of site water. Mulch should not be used as a control in areas of concentrated flow where it may be washed away. Any mulch containment control should have a defined and lined outlet that allows discharge from the control without washing mulch away. Note that this control does not have a defined discharge outlet which should be installed to prevent failure of the control in heavy rainfall events.

Appendix 3: Minimum requirements for community mulch giveaways

The purpose of community mulch giveaways is to provide mulch for residential landscaping purposes.

The activities of a community mulch giveaway are permissible under the *Protection of the Environment Operations (Waste) Regulation 2005 – General Exemption Under Part 6, Clause 51 and 51A* (the Raw Mulch Exemption 2008). However, the activities remain subject to other relevant environmental regulations within the Act and Regulations. The Raw Mulch Exemption 2008 is subject to the following conditions:

- The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.
- The consumer must land apply the raw mulch within a reasonable period of time.

Further information can be found at: www.environment.nsw.gov.au/resources/waste/ex08mulch.pdf

It is the mulch generators responsibility to ensure that the mulch is reused in an environmentally responsible manner.

A safe work method statement (SWMS) must be prepared that identifies potential OHS risks and all prevention and mitigation measures. The SWMS must apply to both the community and site workers involved in the mulch giveaway.

Each member of the community who participates in the mulch giveaway must read and understand a site specific information sheet. A template information sheet is attached as Appendix 4.

The site occupier must maintain written records for each load of mulch that is taken away and to ensure that each community participant understands the conditions of the community mulch giveaway information sheet. A suggested template to record this information is attached as Appendix 5.

Appendix 4: Community mulch giveaway information sheet

The following community mulch giveaway information sheet must be populated with site specific information.

Community Mulch Giveaway

Information Sheet

Details of Mulch Supply	
Site Occupier	<insert name of contractor / alliance etc>
Project Name	<insert project name>
Location	<insert location of mulch stockpile>
Mulch stockpile access directions	<insert adequate directions for community members to find the stockpile location>

Background
<ul style="list-style-type: none">This information sheet supports the non-commercial giveaway of mulch for local residents.The product is raw vegetation mulch from <insert project location / name>.

Conditions
<ul style="list-style-type: none">Any one individual may only take a maximum of 5 trailer loads from this project.The mulch may only be used for residential landscaping purposes.Mulch must not be placed in or immediately adjacent to waterways.The raw mulch can only be applied to land for the purposes of filtration or as a soil amendment material or used either singularly or in any combination as input material(s) to a composting process.The consumer must apply the raw mulch to land within a reasonable period of time.

Community Safety Requirements
<ul style="list-style-type: none"><add in any safety requirements or mitigation measures from the SWMS that apply to the community><add in any safety requirements or mitigation measures from the SWMS that apply to the community><add in any safety requirements or mitigation measures from the SWMS that apply to the community><add in any safety requirements or mitigation measures from the SWMS that apply to the community>

Appendix 5: Records template for community mulch giveaway

The records in the following suggested template must be kept as a minimum.

Community Mulch Giveaway Record Sheet

[illegible]

Appendix G Monitoring location removal consultation

CHISHOLM, Shannon

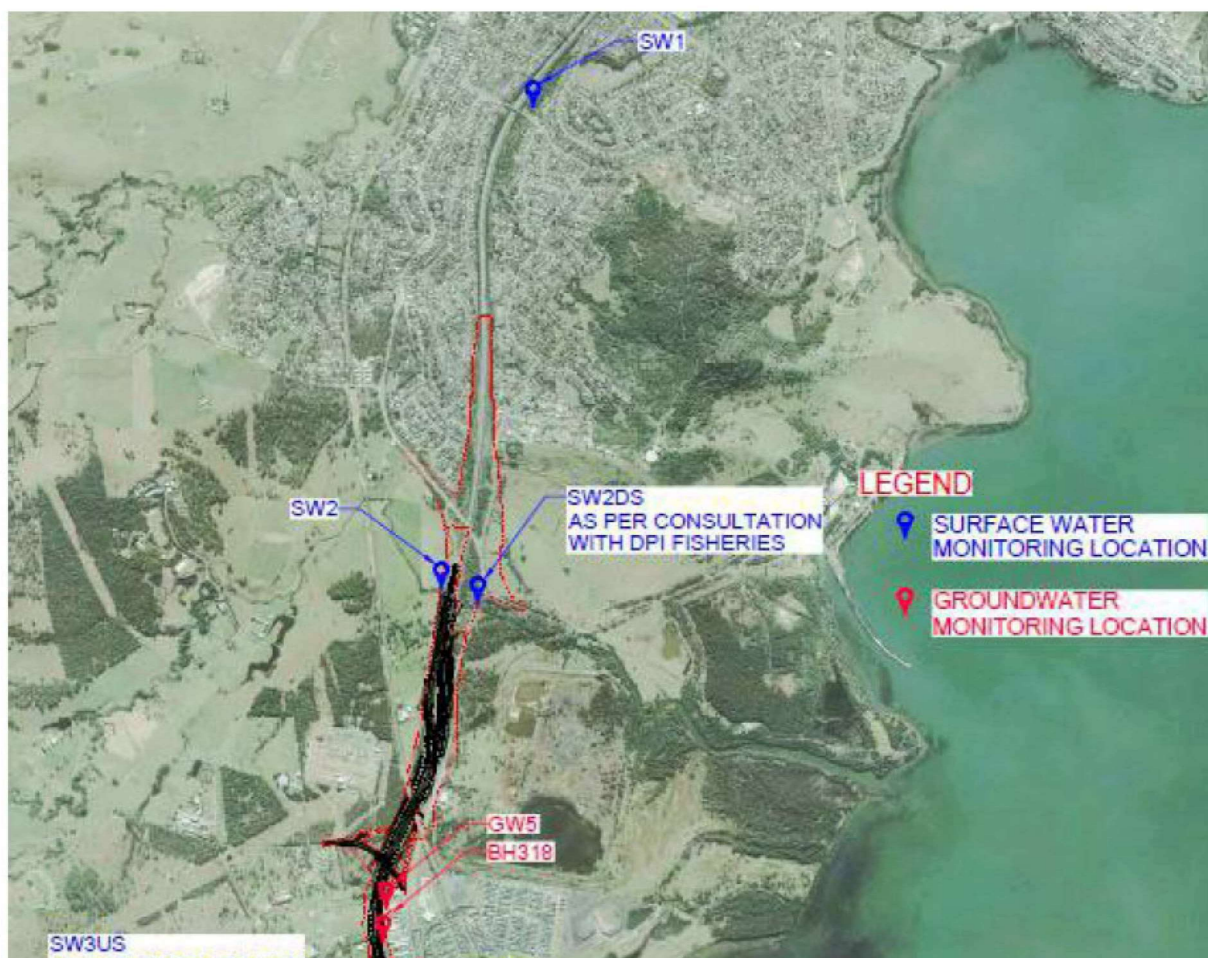
From: CHISHOLM, Shannon
Sent: Wednesday, 21 April 2021 4:07 PM
To: [REDACTED]
Cc: COOPER, Jacob; 'Peter Chudleigh'; 'Toby Hobbs'
Subject: RE: Albion PArk Rail bypass: Documentation supporting proposed changes following the northern traffic switch

Sorry Chris,

I failed to articulate that there is also a downstream location at Duck Creek that we added originally after a request from Jillian and we will also be seeking to remove it (ie all SW2 points).

Also there is an additional groundwater monitoring well , BH318 in the Cut 1 area we are proposing to delete form the monitoring program.

Both points are detailed below.



Thanks,
Shannon

From: CHISHOLM, Shannon
Sent: Wednesday, 21 April 2021 2:25 PM
To: [REDACTED]
Cc: COOPER, Jacob [REDACTED]; Peter Chudleigh [REDACTED]; 'Toby Hobbs' [REDACTED]
Subject: Albion PARK Rail bypass: Documentation supporting proposed changes following the northern traffic switch

Hi Chris,

Thanks for your time again yesterday.

The purpose of this email is to provide you with a copy of yesterday's presentation (attached). This was aimed at providing early notice of our intent to progressively reduce the extent of our licensed premises based on construction completion.

The presentation also sought to document consultation with key Agencies (EPA and TfNSW) whilst opening dialogue regarding proposed amendments to our environmental monitoring program, given that we anticipate there will be no scheduled activities taking place within the switch zone, and consideration around the absence of further construction impacts along with potential safety concerns regarding those monitoring locations.

As you could see during yesterday's site inspection, there is a significant focus on final delivery of our scope of works and activities such as asphaltting and landscaping now dominate our site.

We are constantly assessing our catchments along with environmental aspects and impacts associated with our construction work to minimise the project's footprint so when the Yallah to Albion Park traffic switch is achieved, we anticipate there will be no further construction impacts and are proposing changes to our monitoring programs as detailed in the CEMP sub plans:

- Noise and Vibration Sub-plan (Appendix B3);
- Soil and Water Management Sub-plan (Appendix B4); and
- Air Quality Management Sub-plan (Appendix B6).

In the near future, we plan to provide you with the above revised sub-plans which will likely detail:

- Proposed relocation of Dust Monitoring Gauge DMG 1 from Cut 1, Yallah to Opposite earth works and pavement construction activities adjacent the Oak Flats Interchange;
- Proposed removal of 3 noise monitoring locations that will be dominated by Motorway acoustics;
- Proposed removal of 2 surface and 2 ground water monitoring locations due to absence of construction impacts or elevated risk associated with interacting with public motorists in accessing those locations.

The plans will also include a commitment to ongoing consultation with all Agencies nominated by DPIE regarding future completion of works and additional amendments to the monitoring programs.

I am also liaising with Jeremy Morice from NSW Natural Resource Access Regulator (NRAR) and Jillian Reynolds from NSW DPI (Fisheries) to ensure all DPIE nominated stakeholders (CoA C9) are consulted.

We presently anticipate that we will more formally propose the amendments to EPA, inclusive of revised premises drawings in around 4 weeks time.

Kind Regards

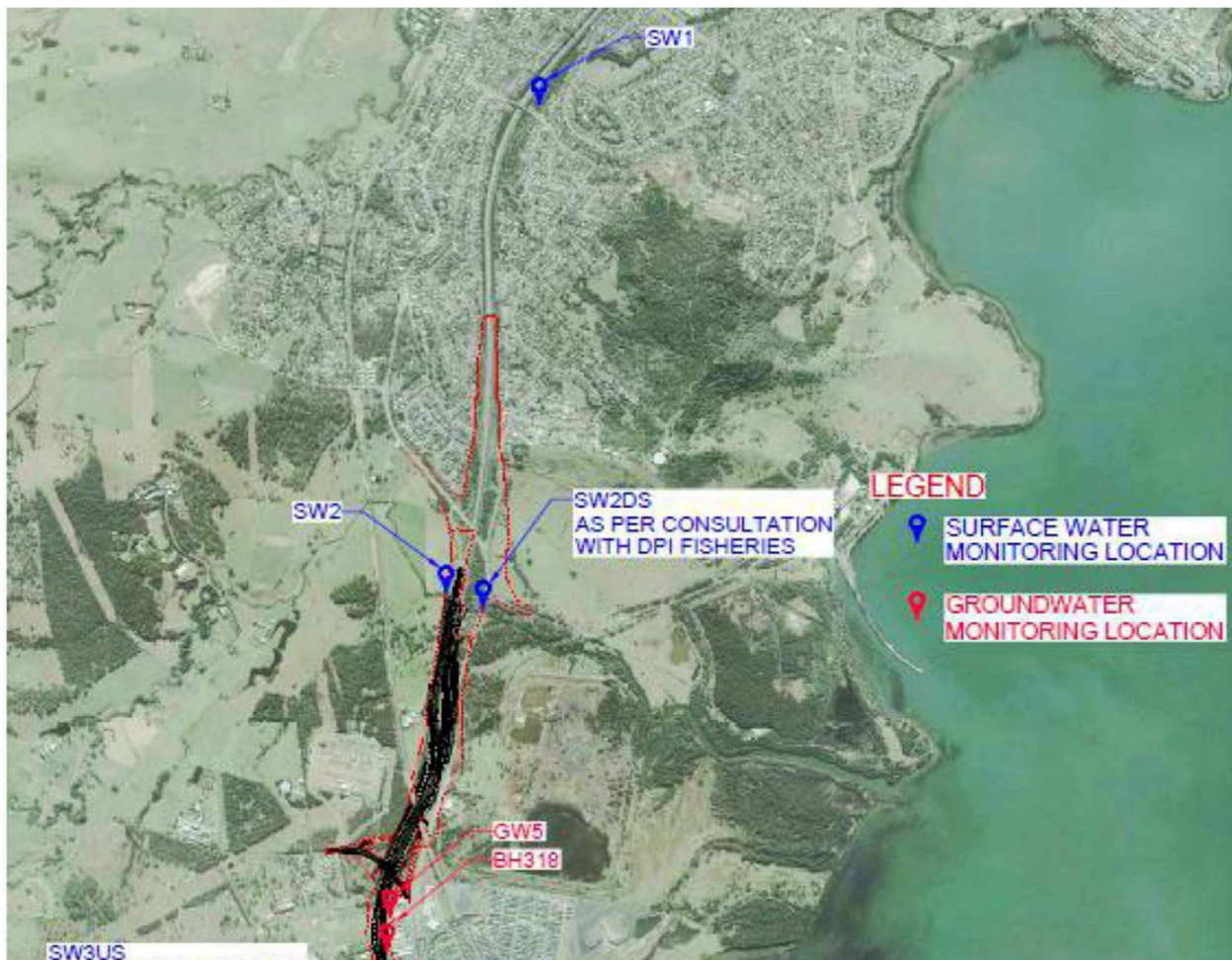
Shannon Chisholm | Environmental & Sustainability Manager – Albion Park Rail bypass | **Fulton Hogan** | 1914 Illawarra Hwy, Albion Park Rail NSW, 2527 | P.O. Box 1014, Albion Park Rail, NSW, 2527, Australia | Mobile +61 400 459769



CHISHOLM, Shannon

From: CHISHOLM, Shannon
Sent: Wednesday, 21 April 2021 3:59 PM
To: Jillian Reynolds [REDACTED]
Cc: COOPER, Jacob
Subject: RE: Albion Park Rail bypass: Documentation supporting proposed changes following the northern traffic switch

Sorry Jillian – My request should also have referenced removal of your previously requested SW2 downstream monitoring location ie All of Duck Creek monitoring



Thanks, Shannon

From: CHISHOLM, Shannon
Sent: Wednesday, 21 April 2021 3:46 PM
To: Jillian Reynolds [REDACTED]
Cc: COOPER, Jacob [REDACTED]
Subject: Albion Park Rail bypass: Documentation supporting proposed changes following the northern traffic switch

Hi Jillian,

I hope this finds you well?

Since we last inspected the site in early February this year, the construction team has progressed very well and over the next 3-4 weeks will open a new section of the M1 from Yallah through to Albion Park as indicated in the attached presentation that Jacob and I provided to TfNSW and EPA yesterday.

The presentation attached seeks to document consultation with key Agencies (EPA, TfNSW, DPI Fisheries and NRAR) whilst opening dialogue regarding proposed amendments to our environmental monitoring program, given that we anticipate there will be no scheduled activities taking place within the upcoming traffic switch zone.

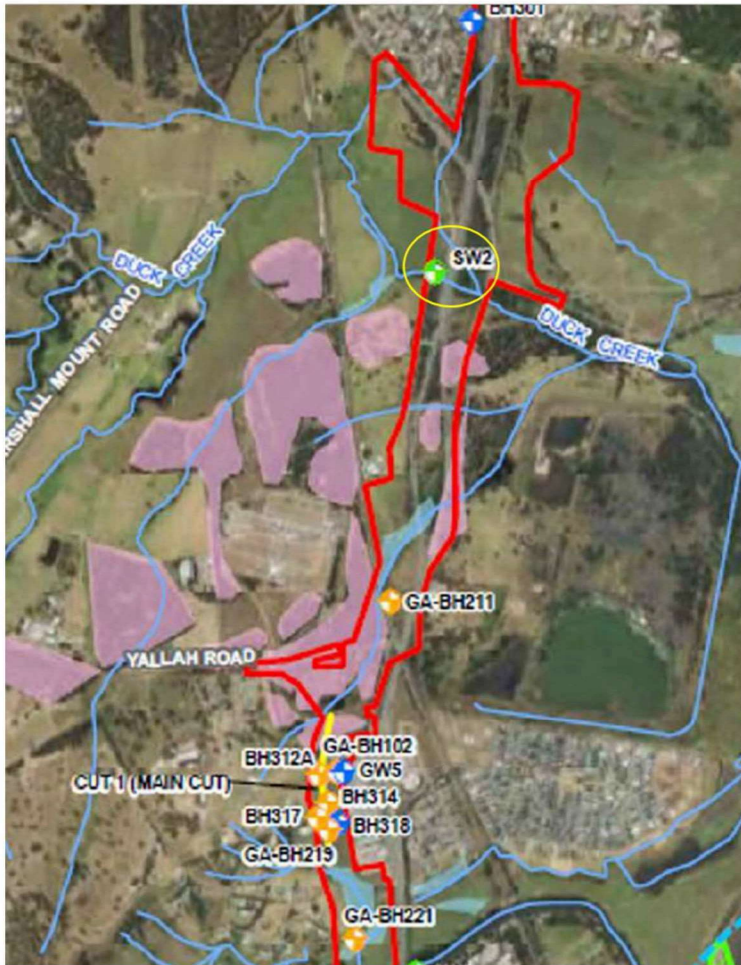
We are constantly assessing our catchments along with environmental aspects and impacts associated with our construction work to minimise the project's footprint so when the Yallah to Albion Park traffic switch is achieved, we anticipate there will be no further construction impacts to Duck Creek (consistent with the trend in monitoring data below) and are proposing changes to our water monitoring program as detailed in the Soil and Water Management (CEMP Sub-plan Appendix B4)

No.	Trigger level	29/06/2020	22/07/2020	17/08/2020	24/09/2020	30/10/2020	19/11/2020	8/12/2020	5/01/2021	22/02/2021
SW1	7.42	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SW2	8.5	No Sample	No Sample	6	No Sample	<5	<5	No Sample	12	<5

We are seeking your concurrence with the removal of monitoring point SW2 so that we can proceed with amending our management plans and subsequently provide those plans back to the Secretary of the DPIE for approval of our amendments.

I note that you previously agreed to the deletion of SW1 as it was not impacted by construction and am hopeful that your familiarity with our site will provide you comfort regarding our proposal to delete monitoring at Duck Creek (SW2) because the catchment will be stable and there will be a significant increase in risk to our staff in terms of accessing the Duck creek monitoring location SW2 due to interaction with public motorists in a high speed environment.

Should you want to have another inspection of the catchment, pls let us know and we can make arrangements for you.



Noting that the imagery in the presentation is at least a month old, you'll see there is a significant focus on final delivery of our scope of works and activities such as asphaltting and landscaping now dominates our site.

Thanks Jillian

Kind Regards

Shannon Chisholm | Environmental & Sustainability Manager – Albion Park Rail bypass | **Fulton Hogan** | [REDACTED]



CHISHOLM, Shannon

From: CHISHOLM, Shannon
Sent: Wednesday, 21 April 2021 4:25 PM
To: 'Jeremy Morice'
Cc: COOPER, Jacob
Subject: Albion Park Rail bypass: Documentation supporting proposed changes following the major traffic switch
Attachments: 210419_Consultation on monitoring program changes & basin transitions_for presentation to EPA_SC..pdf

Hi Jeremy,

I hope this finds you well?

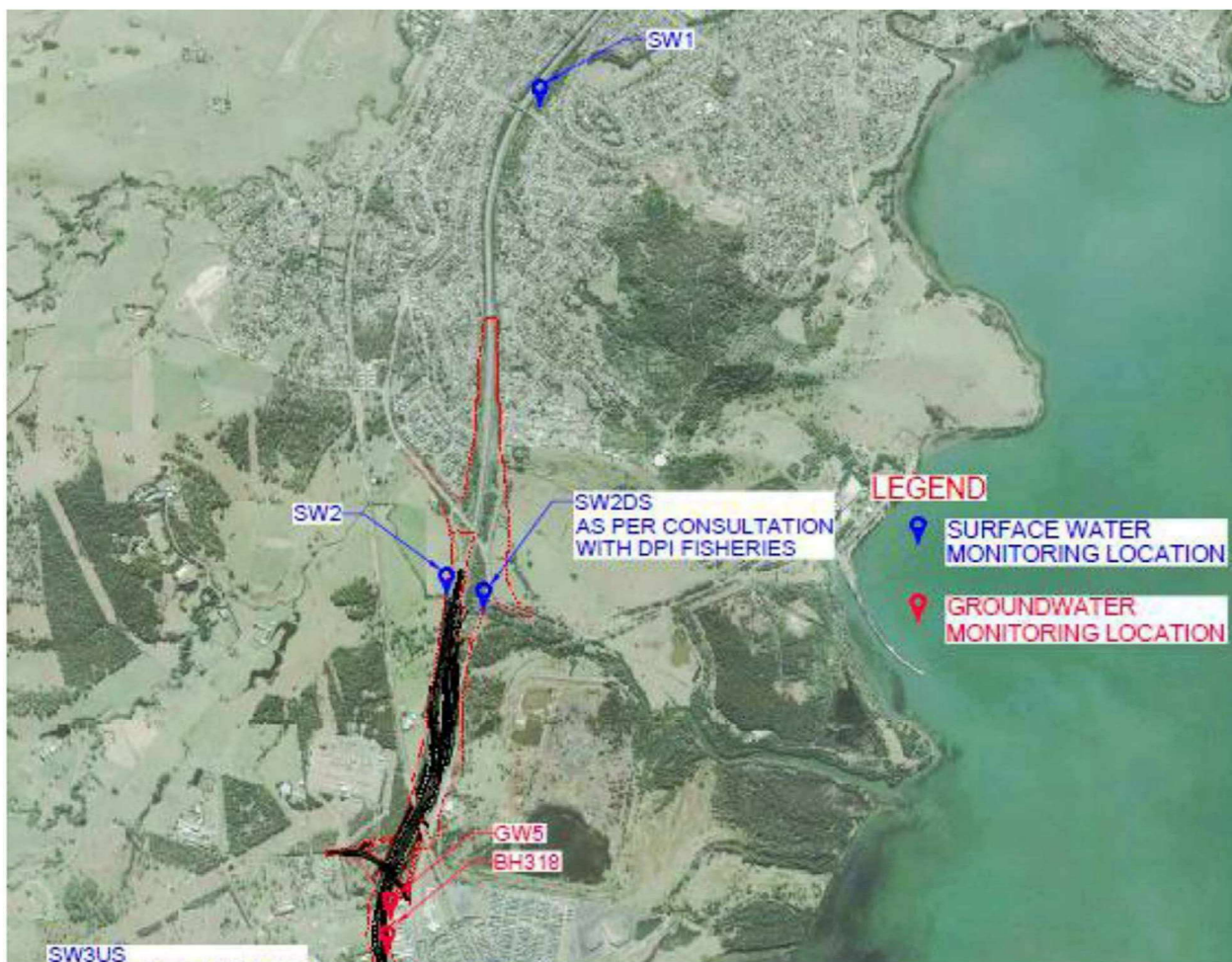
Since we last sent through ground water monitoring data the site in early March this year, the construction team has progressed very well and over the next 3-4 weeks will open a new section of the M1 from Yallah through to Albion Park as indicated in the attached presentation that Jacob and I provided to TfNSW and EPA yesterday.

The presentation attached seeks to document consultation with key Agencies (EPA, TfNSW, DPI Fisheries and NRAR) whilst opening dialogue regarding proposed amendments to our environmental monitoring program, given that we anticipate there will be no scheduled activities taking place within the upcoming traffic switch zone and hence, no further construction related impacts to groundwater. More generally though, accessing the ground monitoring wells will be problematic and increased risk to our staff due to potential interactions with public motorists in a high speed environment.

We are seeking your concurrence with the removal of groundwater monitoring points GW5, BH318 and GW1 over the next 4 weeks and given that excavation has been completed with asphalt pavement now covering the main alignment except for just south of the Cleary Bros quarry near the Oak Flats interchange, we are also proposing to cease ground water monitoring GW2 and GW3 after the next sampling event.

Noting that the imagery in the presentation is at least a month old, you'll see there is a significant focus on final delivery of our scope of works and activities such as asphaltting and landscaping now dominates our site, and reviewing the data from our previous monitoring, we don't feel there is any benefit continuing the monitoring due to lack of construction impacts.

Should you wish to undertake a site inspection of the project, pls let us know and we can make arrangements for you.



Thanks Jeremy

Kind Regards

Shannon Chisholm | Environmental & Sustainability Manager – Albion Park Rail bypass | Fulton Hogan |

