PROJECT

OVERALL WATER MANAGEMENT PLAN STAGE 1 KINGS FOREST NEW SOUTH WALES

PREPARED FOR

PROJECT 28 PTY LTD

DATE

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GILBERT SUTHERLAND

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CLIENT Project 28 Pty Ltd
CLIENT CONTACT M. Geale
CLIENT REFERENCE –

SYNOPSIS This report constitutes the Overall Water Management Plan (OWMP) for Stage 1 of the Kings Forest Development. The OWMP integrates the discreet management provisions outlined in numerous separate reports relating to stormwater, groundwater and integrated water cycle management that must be implemented during the various stages of site development. This report constitutes an update of the OWMP contained in the Darryl Anderson Consulting Pty Ltd 'Preferred Project Report' dated October 2012 to ensure consistency with the latest version of each foundation report.

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G&S file	1	1	1	1	1					

SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to update the Kings Forest Stage 1 Overall Water Management Plan (OWMP), originally contained in the 2012 Darryl Anderson Consulting Pty Ltd Preferred Project Report, to ensure its consistency with the latest version of each of its foundation reports.

In accordance with the Kings Forest Stage 1 Project Application No. MP 08_0194, the project contains the following key elements:

Kings Forest Residential Subdivision Stage 1 Bulk Earthworks, Roadworks and Subdivision of Precinct 5, including:

- *Subdivision of the site into 10 development lots in four stages;*
- *Bulk earthworks across the site;*
- *Roadworks comprising:*
  - *construction of the entrance road and associated intersection works with Tweed Coast Road;*
  - *construction of the Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western site precincts; and*
  - *construction of two roads providing access to the southern site precincts;*
- *Plan of Development for Precinct 5;*
- *Development of 998 sqm of floorspace for a service station and food and drink premises and access arrangements to Precinct 1;*
- *Construction of subdivision and infrastructure works along Kings Forest Parkway and within Precincts 1 and 5;*
- *Subdivision of Precinct 5 into 376 residential lots comprising:*
  - *one townhouse lot (7,860 sqm)*
  - *37 terrace house lots (minimum lot size 150 sqm)*
  - *25 duplexes (minimum lot size 450 sqm)*
  - *192 zero lot dwellings (minimum lot size 240 sqm)*
  - *121 traditional detached dwellings (minimum lot size 400 sqm)*

Drawing 12066_001 depicts the areas of the site that form the Phase 1 works. These areas are subject to imminent development. The SOMP is relevant to Stage 1 of the Kings Forest Development of which the Phase 1 scope is a subset.

The OWMP identifies and describes strategies for the management of water-related environmental issues and site constraints and their likely impacts during the pre-bulk earthworks, bulk earthworks, landform stabilisation, civil construction, on-maintenance and operational phases of the project. The OWMP addresses water management at the site, incorporating stormwater, groundwater and integrated water cycle management. The OWMP integrates the provisions of the following foundation management plans:

- Erosion and Sediment Control Management Plan (G&S, July 2012 and the Kings Forest Development, Precinct 5, Sediment and Erosion Management Plan (Mortons Urban Solutions, 2020).
- Acid Sulfate Soil Management Plan, (G&S, September 2020).
- Integrated Water Cycle Management Plan (G&S, October 2020).
- Stormwater Management Plan (G&S, October 2020).
- Groundwater Assessment and Management Plan (G&S, 2012) and any subsequent updates.
- Baseline Water Quality Criteria Report, Kings Forest Stage 1, New South Wales, (G&S, May 2020)
- Review of Environmental Management Plan (ePar 2009).
- Threatened Species Management Plans (JWA 2020a-c,).
- Vegetation Management Plans (JWA, 2020d-f).
- Wallum Sedge Frog Management Plan (JWA 2020g).

The implementation table included in the front of this management plan details the actions, responsibilities and performance criteria upon which monitoring and auditing will be implemented.

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1 Introduction

1.1 Background

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to update the Kings Forest Stage 1 Overall Water Management Plan (OWMP) originally contained in the Darryl Anderson Consulting Pty Ltd Preferred Project Report (2012) to ensure its consistency with the latest version of each of its foundation reports.

1.2 Scope of report

The OWMP identifies and describes strategies for the management of water-related environmental issues and site constraints and their likely impacts during the pre-bulk earthworks, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases of the project. The OWMP addresses the site's water management, incorporating stormwater, groundwater and integrated water cycle management. The OWMP integrates the provisions of the following foundation management plans:

- Erosion and Sediment Control Management Plan (G&S, July 2012 and the Kings Forest Development, Precinct 5, Sediment and Erosion Management Plan (Mortons Urban Solutions, 2020).
- Acid Sulfate Soil Management Plan, (G&S, September 2020).
- Integrated Water Cycle Management Plan (G&S, October 2020).
- Stormwater Management Plan (G&S, October 2020).
- Groundwater Assessment and Management Plan (G&S, 2012) and subsequent updates.
- Baseline Water Quality Criteria Report, Kings Forest Stage 1, New South Wales, (G&S, May 2020)
- Review of Environmental Management Plan (ePar 2009).
- Threatened Species Management Plans (JWA 2020a-c,).
- Vegetation and Weed Management Plans (JWA, 2020d-f).
- Wallum Sedge Frog Management Plan (JWA 2020g).

The implementation table included in the front of this management plan details the actions, responsibilities and performance criteria upon which monitoring and auditing may be implemented.

2 Proposed development

2.1 Stage 1 Project Application

In accordance with the Kings Forest Stage 1 Project Application No. MP 08_0194 the project contains the following key elements:

Kings Forest Residential Subdivision Stage 1 Bulk Earthworks, Roadworks and Subdivision of Precinct 5, including:

- *Subdivision of the site into ten development lots in 4 stages; Bulk earthworks across the site;*
- *Roadworks comprising:*
  - *construction of the entrance road and associated intersection works with Tweed Coast Road;*
  - *construction of the Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western site precincts; and*
  - *construction of two roads providing access to the southern site precincts;*
- *Plan of Development for Precinct 5;*
- *Development of 998 sqm of floorspace for a service station and food and drink premises and access arrangements to Precinct 1;*
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  - *25 duplexes (minimum lot size 450sqm)*
  - *192 zero lot dwellings (minimum lot size 240sqm)*
  - *121 traditional detached dwellings (minimum lot size 400sqm)*

The identified potential impacts associated with bulk earthworks are readily anticipated and manageable. Bulk earthworks will be controlled by the management plans listed in Section 5. The relevant provisions of those management plans pertaining to surface water, groundwater, stormwater, integrated water cycle management and water-related environmental issues are included in this report.

3 Overall Water Management Plan

3.1 Aims and objectives

This Overall Water Management Plan (OWMP) provides a framework to ensure that any water-related impacts of the on-site activities are managed, treated, monitored, reported and, if necessary, mitigated.

The OWMP aims to achieve the following:

- Provide evidence of practical and achievable plans for the management of site activities.
- To ensure that legislative and environmental requirements are complied with by producing an integrated planning framework for comprehensive monitoring and control of operational impacts. Specific commitments on strategies and design standards to be employed are also given.
- A framework for regulatory authorities and the proponent to confirm compliance with policies and conditions.
- Evidence to the community that the operation is being managed in an environmentally acceptable manner.

The objectives of this OWMP with respect to water-related issues associated with the Kings Forest Stage 1 Project Application are to ensure:

- All reasonable and practical measures are taken to prevent and/or minimise the likelihood of environmental harm being caused.
- On-site activities occur without adverse environmental impact or causing nuisance to nearby sensitive receptors.

3.2 Scope of this document

This document constitutes an OWMP for the activities involved with the development works to be undertaken for the Stage 1 Project Application for the Kings Forest development area. As such, it is the intent of the document to address the water-related environmental issues that may arise onsite with regard to the proposed activities involved in completing the bulk earthworks and civil works, on-maintenance and operations of the site.

Whilst the OWMP addresses the identified water-related environmental issues, it is not within the scope of this document to detail the full extent of each issue, but rather to link and integrate all water-related management issues. The OWMP was prepared and should be read in accordance with the following reports:

- Erosion and Sediment Control Management Plan (G&S, July 2012 and the Kings Forest Development, Precinct 5, Sediment and Erosion Management Plan (Mortons Urban Solutions, 2020).
- Acid Sulfate Soil Management Plan, (G&S, September 2020).
- Integrated Water Cycle Management Plan (G&S, October 2020).
- Stormwater Management Plan (G&S, October 2020).
- Groundwater Assessment and Management Plan (G&S, 2012) and any subsequent updates.
- Baseline Water Quality Criteria Report, Kings Forest Stage 1, New South Wales, (G&S, May 2020)
- Review of Environmental Management Plan (ePar 2009).
- Threatened Species Management Plans (JWA 2020a-c,).
- Vegetation and Weed Management Plans (JWA, 2020d-f).
- Wallum Sedge Frog Management Plan (JWA 2020g).

3.3 Implementation

The OWMP requires the Proponent to mitigate the potential environmental impacts associated with the construction of the development works during the baseline data collection phase, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases.

3.4 OWMP structure

This OWMP acknowledges the environmental impacts associated with the construction and operation of the proposed development and details strategies to mitigate them. Each control strategy is based upon proven environmental management methods and is presented as a commitment.

The OWMP is based on a series of tables for the baseline data collection phase, bulk earthworks, landform stabilisation phase, civil construction, on-maintenance and operational phases of the development. The person responsible for the implementation of the measures detailed is written on the table itself. The tables then detail the issue, the performance criteria, the implementation strategy, monitoring, auditing, reporting, failure identification and the corrective action. The detachable pages within each section detail the provisions of the OWMP. The format is presented below for reference purposes.

#.# Title

Applies to	The relevant construction stages to which the issue detailed on this page applies.
Person responsible	This is the person(s) who has accepted the responsibility of implementing the OWMP provisions detailed on this page.

Issue	The issue with which the table deals.
Operational policy	The operational policy or management objective that applies to the element.
Performance criteria	Performance criteria (outcomes) for each element of the operation.
Implementation strategy	The strategies or tasks (to nominated operational design standards) that will be implemented to achieve the performance criteria.
Monitoring	The monitoring requirements which will measure actual performance (i.e. specified limits to pre-selected indicators of change).
Auditing	The auditing requirements, which will verify implementation of, agreed construction and operation phase environmental management strategies and compliance with agreed performance criteria.

Reporting	Content, timing and responsibility for reporting and auditing of monitoring results.
Identification of incident or failure	The circumstances under which the agreed performance criteria are unlikely to be met and environmental harm is likely to result.
Corrective action	The action to be implemented in case a performance requirement is not reached and the company(s) responsible for action.

Commitment #

What the management has committed the company to.

An objective of the tabular format is to allow for change and allow the OWMP to be a working document. If items need altering, changes may be made to the individual tables after appropriate consultation with the statutory authorities.

3.5 General commitments

Commitment 1

The development shall proceed in accordance with the construction staging detailed in any approved engineering drawings. The Proponents undertake to comply with the water-related environmental implementation strategy as contained within the approved final OWMP at all times throughout the baseline data collection phase, bulk earthworks, site stabilisation phase, civil construction, on-maintenance and operational phases.

Commitment 2

The Proponents undertake to fulfil all commitments made in the approved OWMP and to carry out their activities on the project site in accordance with relevant current statutory requirements and approved amendments.

3.6 Definitions

In this OWMP these terms have the following meanings;

- OWMP means the approved Overall Water Management Plan and includes any amendments that may be approved from time to time.
- Development means the development of the site in accordance with the Kings Forest Stage 1 Project Application.
- TSC means Tweed Shire Council.
- ASSMAC means the Acid Sulfate Soils Management Advisory Committee.
- Proponent means the person undertaking the construction of the proposed Kings Forest Stage 1 and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the OWMP.
- DPIE means the Department of Planning, Industry and Environment.

3.7 Contact details

The following persons are responsible for the implementation of the management measures described in the individual tables of the OWMP.

Contractor's Site Manager

The name and address of the Contractor and its representative will be notified to TSC by the Consulting Engineer prior to the commencement of each contract/stage of the project.

Consulting Engineer

Unless advised otherwise the Consulting Engineer is:

Company: TBA

Address:

Contact Details:

Phone:

Facsimile:

4 Baseline data collection phase

4.1 Summary

This part of the OWMP details the requirements for baseline data collection to establish site specific water quality criteria for the Kings Forest development.

The baseline data collection program was completed from May to October 2019 with full details provided in the Gilbert & Sutherland Baseline Water Quality Criteria Report, Kings Forest Stage 1, New South Wales, May 2020.

Baseline water quality monitoring was conducted at selected groundwater bores and surface water locations across the development site. The following parameters were monitored over an eight round monitoring program:

- pH (field measurement);
- electrical conductivity (EC) (field measurement);
- turbidity (field measurement);*
- dissolved oxygen (DO) (field measurement);*
- temperature (field measurement);
- redox potential (mV);
- suspended solids (SS) (mg L^{-1});*
- total nitrogen (TN), soluble nitrogen, nitrogen oxide (NO_x), total kjeldahl nitrogen (TKN), nitrite (NO_2) & nitrate (NO_3) (mg L^{-1});
- total phosphorus (TP) & soluble phosphorous (mg L^{-1});
- oil and grease (visual inspection);*
- calcium (Ca);
- magnesium (Mg);
- sodium (Na);
- potassium bicarbonate (K/HCO_3);
- bicarbonate (HCO_3);
- carbonate (CO_3);
- total & dissolved iron (Fe);
- total & dissolved aluminium (Al);
- dissolved manganese (Mn);
- chloride (Cl);
- sulfate (SO_4);
- ammonium (NH_4);
- colour;
- total acidity (titratable);
- total alkalinity;
- arsenic (As);
- cadmium (Cd);
- copper (Cu);
- lead (Pb);
- nickel (Ni);
- zinc (Zn);
- chlorophyll-a;*
- faecal coliforms;
- total algal cell count; and*
- blue green algae.*

*Surface water only

Following completion of the monitoring program the data was analysed and site specific water quality criteria were established in accordance with the recommendations of the ANZECC Guidelines. The water quality criteria as established in that report are provided in Table 4.1.1 and Table 4.1.2 below.

Table 4.1.1 Surface water quality criteria

Parameter	*Saline (SW1, SW2, SW6, and SW9)*	*Brackish (SW5)*	*Fresh (SW3, SW4, SW7, SW8 and SW10)*
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L
Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Table 4.1.2 Groundwater quality criteria

Parameter	*Precinct 1*	*Precinct 5*
pH	3.5-4.33	3.59-4.47
Electrical Conductivity	<339.4 µs/cm	<131 µs/cm
Total Nitrogen	<3 mg/L	<1.3 mg/L
Total Phosphorus	<0.34 mg/L	<0.05 mg/L
Iron (total)	<1.02 mg/L	<0.45 mg/L
Aluminium (total)	<1.89 mg/L	<0.52 mg/L

5 Management of potential impacts – bulk earthworks phase

5.1 Intent

This part of the OWMP specifies those matters which must be complied with by the Proponent during the bulk earthworks phase, being the period during which cut and fill works are being undertaken. The obligations in this section of the OWMP must be complied with by the Proponent until each precinct is at final grade and stabilised.

5.2 Complaints procedure

The following Complaints Procedure as contained in Condition 75 of the Project Approval (MP08_0194) shall be followed at the site.

At the commencement of construction the Proponent shall ensure that the following are available for community complaints during construction:

- A 24 hour telephone number on which complaints about construction activities at the site may be registered.
- A postal address to which written complaints may be sent.
- An email address to which electronic complaints may be transmitted.
- Name, address, contractor licence number and telephone number of the principal contractor, including a telephone number at which the person may be contacted outside working hours.
- Name, address and telephone number of the Project Manager and PCA
- The telephone number, the postal address, email address, the name of the site/project manager and the approved hours of work, shall be displayed on a sign near the entrance to the site, in a position that is clearly visible to the public.

The Proponent shall record details of all complaints received through the means listed above in an up-to-date Complaints Register.

The Proponent shall provide an initial response to any complaints made in relation to the project during construction within 48 hours of the complaint being made. The response and any subsequent action taken shall be recorded in the Complaints Register.

5.3 Incident reporting

Within 24 hours of detecting any incidents during construction that causes (or may cause) significant harm to the environment, the Proponent shall notify the Council and other relevant agencies of the incident and identify the following:

- Describe the date, time, and nature of the incident.
- Identify the cause (or likely case) of the incident.
- Describe what action has been taken to date.
- Describe any proposed measures to address the incident.

5.4 Threatened species – Wallum Froglet

The information in this table was supplied by JWA (2020a-c) *Threatened Species Management Plans*.

Applies to:	Species: Wallum Froglet (*Crinia signifera*) Bulk earthworks phase - disturbed mixed grassland and regenerating heathland
Person responsible:	Contractor's Site Manager; Ecological Consultant; all personnel

Issue	Protection of habitat. Provision of habitat from construction of artificial wetland areas – constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats. Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum Froglet habitat in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c)
Performance criteria	• Minimise impacts on Wallum Froglet habitat. • Colonisation of constructed wetlands by Wallum Froglet. • Maintenance of water quality (pH, nutrient levels) within constructed and naturally occurring habitat. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum Froglet). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Design of constructed wetlands (liaison with relevant personnel). • Construction of wetlands. • Landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum Froglet activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a weekly basis; and • frog monitoring on a monthly basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard monitoring pro-formas to be filled in accordingly including results of any water quality testing. Results of monitoring to be collated and presented as report to Council, and other relevant authorities. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.

Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum Froglet.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 3

The contractor will commit to monitoring Wallum Froglet populations to ensure that constructed wetlands are appropriately constructed and maintained.

5.5 Threatened species – Wallum sedge frog

The information in this table was supplied by JWA (2020g) *Wallum Sedge Frog Management Plan*.

Applies to:	Species: Wallum sedge frog (*Litoria olongburensis*) Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Ecological Consultant; all personnel

Issue	Protection and restoration of habitat - disturbed mixed grassland and regenerating heathland. Protection and restoration of previously 2 constructed dams which currently occur in precincts 12 and 13, one of which requires repair. Provision of habitat from construction of artificial wetland areas – constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats. Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum sedge frog habitat in accordance with the *Wallum Sedge Frog Management Plan* (JWA, 2020g).
Performance criteria	• Minimise impacts on Wallum sedge Frog habitat. • Colonisation of constructed wetlands by Wallum sedge frog. • Maintenance of water quality (pH, nutrient levels). • Maintenance of aquatic vegetation and dense reedland. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum sedge frog). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Design of constructed wetlands (liaison with relevant personnel). • Construction of habitat areas. • Landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum sedge frog activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a weekly basis; and • frog monitoring on a monthly basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any testing. Results of monitoring to be collated and presented as report to, Council and other relevant statutory authorities.

	Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum sedge frogs.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 4

The contractor will commit to monitoring Wallum sedge frog populations to ensure that constructed wetlands are appropriately constructed and maintained.

5.6 Acid sulfate soil leachate monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Water quality monitoring.
Operational policy	Waters ponded within the bunded treatment pads or associated with acid sulfate soil stockpiles will be managed in accordance with the site's *Acid Sulfate Soils Management Plan* (G&S, September 2020) and any subsequent revisions of that plan. Ponded water that is to be discharged from the site or to on-site drains or watercourses will meet the relevant site specific water quality criteria prior to release.
Performance criteria	The following site-specific water quality criteria would be adopted for all waters ponded within the bunded treatment pads or associated with acid sulfate soil stockpiles that is to be discharged from the site or to on-site drains or watercourses.

Surface water quality criteria			
Parameter	Saline (SW1, SW2, SW6, and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 and SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L
Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Implementation strategy	Surface water monitoring will be undertaken prior to discharge of waters ponding in ASS treated areas. Existing surface water conditions shall be maintained outside the construction area. Runoff will be directed around the bunded PASS treatment areas to minimise the potential for leaching and the possibility of the bund breaching prior to the testing and treatment of the contained water. All ponded surface and/or groundwater within excavations shall be tested within the excavation and treated if necessary prior to discharge in accordance with Section 5.8 'Groundwater seepage monitoring.' A supply of hydrated lime shall be kept on site at all times for treatment of acidic waters (if encountered) to achieve baseline levels. Storage requirements for hydrated lime shall be in accordance with the manufacturer's SDSs.
Monitoring	The contractor or site manager shall inspect site works weekly and following rainfall events for any evidence of ponded waters. Pre-discharge monitoring will be undertaken as outlined above to ensure compliance with the release criteria and results will be documented. All monitoring will be undertaken using equipment regularly calibrated, with samples sent to a NATA-accredited laboratory where appropriate. Daily rainfall to be recorded by the civil contractor.
Auditing	Environmental consultant to audit water quality results to ensure all discharges comply with the performance criteria.
Reporting	Result sheets to be compiled for monitoring results relating to water quality of ponded water. These results to be kept onsite for inspection by local and state government officers upon request. These results to be included in monthly reports to the supervising engineer until completion of works. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Discharge of waters ponded within PASS treatment areas that are outside the specified limits for the site.
Corrective action	If ponded water is detected outside the criteria range, all such waters will be contained until the water quality is adjusted to within the required range. Correction of water quality will be undertaken in consultation with the environmental consultant. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 5

The contractor will ensure water that is trapped within bunded areas established for the treatment of PASS is monitored and treated to ensure that acidic water is not discharged from the site.

5.7 Groundwater monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish stable groundwater conditions and verify by monitoring that development management is appropriate. Groundwater monitoring is to be undertaken in accordance with this OWMP.
Performance criteria	Groundwater quality monitoring will be conducted monthly at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Results shall be compared with the water quality criteria (indicator parameters only) detailed below;

Groundwater quality criteria

Parameter	*Precinct 1*	*Precinct 5*
pH	3.5-4.33	3.59-4.47
Electrical Conductivity	<339.4 µs/cm	<131 µs/cm
Total Nitrogen	<3 mg/L	<1.3 mg/L
Total Phosphorus	<0.34 mg/L	<0.05 mg/L
Iron (total)	<1.02 mg/L	<0.45 mg/L
Aluminium (total)	<1.89 mg/L	<0.52 mg/L

Groundwater levels will be monitored fortnightly throughout bulk earthworks.

Implementation strategy	Groundwater monitoring will be conducted during bulk earthworks at the locations identified on Drawing 12017_001. The progression of earthworks will necessitate the gradual removal of bores within the footprint of development. Bores will be retained for as long as possible. Monitoring of groundwater levels should be undertaken fortnightly during the bulk earthworks phase to determine any effect excavation and dewatering activities may have on groundwater levels. Groundwater samples are to be collected monthly and analysed for the parameters specified in 'Performance Criteria' above.
Monitoring	Carry out fortnightly groundwater level monitoring and monthly groundwater quality monitoring at locations to be specified. Sample recovery and in situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA-accredited laboratory.

Auditing	The environmental consultant is to audit water quality to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site. The data from the water level measurement shall be collated quarterly and evaluated against the background monitoring data. It will also be used to verify the predictive model for groundwater behaviour when required.
Reporting	Monthly reports are to be submitted to TSC. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important1. • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained. • Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	The values of water quality indicators and groundwater levels will vary naturally and not all of this variation is ecologically important.[2] The site-specific criteria are based on the 80th percentile of the baseline data set and thus the probability of a single observation exceeding the 80th percentile is 20%. The probability of a Type 1 error (or the risk of triggering a false alarm) is 20%. The recording of a single result that exceeds the criteria will be used to trigger additional investigations including an increase to fortnightly monitoring of the parameter(s) in question. Results will be used to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.

[1] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

[2] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

<table>
<tr>
<td>Corrective action</td>
<td>
If a trend of declining groundwater quality is detected, the likely source(s) of contamination will be identified.

Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented:
• Locate the source of the contamination/level variation and take appropriate actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.
• All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted.
The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.
<table>
<tr><th rowspan="2">Water Quality Parameter</th><th colspan="2">Release Criteria</th></tr>
<tr><th>Precinct 1</th><th>Precinct 5</th></tr>
<tr><td>pH</td><td>3.5-4.33</td><td>3.59-4.47</td></tr>
<tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>No visible film, no detectable odour</td></tr>
</table>
Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.
</td>
</tr>
</table>

Commitment 6

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

5.8 Groundwater seepage monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater seepage monitoring. Management of groundwater seepage quality entering excavation areas.
Operational policy	To minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage and provide for monitoring and treatment of these waters prior to disposal.
Performance criteria	Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering.

Discharge to recharge trenches/zones

All waters discharged from the excavation areas to recharge trenches or recharge zones during the construction phase should comply with the following criteria:

Water Quality Parameter	Release Criteria	
	Precinct 1	Precinct 5
pH	3.5-4.33	3.59-4.47
Oil and grease	No visible film, no detectable odour	No visible film, no detectable odour

Discharge to surface water bodies

Where the discharge of dewatered groundwater to on-site drains and waterways is intended, water quality will satisfy the relevant surface water quality criteria:

Surface water quality criteria			
Parameter	Saline (SW1, SW2, SW6 and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 and SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L

	Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
	Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour
	*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).			

Implementation strategy

The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least).

Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering.

Dewatered groundwater will undergo appropriate treatment to ensure compliance with the pH criteria prior to release into recharge trenches or surface water bodies.

Where disposal to surface water bodies (drains, waterways etc) is intended additional monitoring (for the surface water quality parameters outlined above) will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25 mm in any 24 hour period) for the duration of the associated dewatering activities.

The following principles will be followed for all dewatering and recharge activities:

- Discharge of dewatered groundwater will occur within the site boundary.
- Discharge of dewatered groundwater will occur within close proximity to the extraction location as far as is operationally achievable
- Sediment basins, and the excavations for swales and/or bioretention basins may act as recharge locations if practical and proximal to the dewatering location.

Records of the measured pH, time of monitoring, calibration records and treatment measures employed are to be kept on site for inspection by the environmental consultant and TSC if requested.

Outside the construction area of each stage existing surface water conditions shall be maintained in accordance with Table 7.7 of this management plan ‘Surface water quality’.

If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with the *Acid Sulfate Soil Management Plan* (G&S, September 2020 and any subsequent revisions of that plan.

The addition of hydrated lime or crushed ag-lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with *Acid Sulfate Soil Management Plan* (G&S, May 2020) and any subsequent revisions of that plan.

Where recharge trenches are required, the base and sides of the trench should also be blanket limed at a predetermined rate prior to the disposal of dewatered

	groundwater in accordance with *Acid Sulfate Soil Management Plan* (G&S, May 2020) and any subsequent revisions of that plan. Before undertaking any earthworks in drains or watercourses, the drain or watercourse will be bunded and contained in a staged manner, with water tested and treated prior to discharge. Particular attention will be given to watercourses containing high levels of organic matter that may also have the potential to form monosulfidic black oozes (MBOs). Existing MBOs will be managed, with organic material within the drain kept to a minimum and dissolved oxygen concentrations within water-bodies monitored and increased if necessary (in accordance with the recommendations outlined in Tulau (2007). Titratable Actual Acidity contents and water pH levels of water-bodies will also be monitored and adjusted as necessary.
Monitoring	Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal via dewatering. Where disposal to surface water bodies (drains, waterways etc) is intended additional monitoring (for the surface water quality parameters outlined above) will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25mm in any 24 hour period) for the duration of the associated dewatering activities. Samples will be sent to a NATA-accredited laboratory for analysis when required.
Auditing	A review of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken. Site management to audit water quality results weekly to verify that discharges comply with the performance criteria.
Reporting	All monitoring results and treatment procedures are to be accurately recorded and maintained onsite for inspection by TSC upon request. Within 24 hours of detecting any incident during construction that causes (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies in accordance with the protocol in Section 5.3.
Identification of incident or failure	Failure to undertake monitoring at the required frequencies. Discharge of ground waters to recharge trenches or surface water bodies that do not satisfy the nominated pH range for this site. A decline in water quality downstream of the dewatering or discharge activities.
Corrective action	Increase monitoring frequency to required levels. Take necessary steps to address the problem and apply remedial measures to prevent the generation of excessive acid seepage waters (i.e. blanket liming of excavated faces and recharge trenches) in consultation with the Environmental Consultant. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 7

The contractor will minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage and monitor and treat these waters prior to disposal.

5.9 Surface water quality monitoring

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Surface water quality monitoring.
Operational policy	To maintain the water quality conditions of the receiving environment during the bulk earthworks phase of the development.
Performance criteria	Surface water monitoring will be conducted monthly and following the first monthly rainfall event (defined as >25mm in 24 hours) at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Results shall be compared with the surface water quality criteria (indicator parameters only) detailed below;

Surface water quality criteria

Parameter	Saline (SW1, SW2, SW6 and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 and SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L
Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Results of monitoring should also be compared to the Tweed Catchment Water Quality Objectives[3] (in accordance with the Project Approval Condition 21[5]) as below;

Parameter	Unit	Objective
pH	pH units	Freshwater 6.5 - 8.5 Estuary 7 - 8.5
Dissolved oxygen	mg/L	80 - 100% saturation
Turbidity	NTU	0.5 - 10 NTU
Total phosphorous	mg/L	0.03 mg/L
Total nitrogen	mg/L	0.3mg/L
Chlorophyll a	ug/L	<4
Note: These objectives are included for comparison only and do not constitute compliance criteria for the site. In many instances, baseline site water quality does not meet these objectives.		

Implementation strategy

Construction of temporary sediment detention basins, clean-water diversion channels, swales and vegetated filter strips will be constructed prior to the commencement of earthworks in accordance with the approved Erosion and Sediment Control Plan (ESCP).

Stormwater control will be achieved by directing as much runoff from disturbed areas as practicable to the sediment detention basins.

Clean water diversion channels will be used to divert clean water from construction areas.

Monitoring of the sediment detention basins prior to controlled release shall occur in accordance with the approved ESCP. Monitoring shall be undertaken for pH, turbidity and suspended solids to ensure compliance with background conditions (as relevant to the discharge location).

Water may be discharged from the site that exhibits a suspended solids concentration greater than 50mg L^{-1}, providing the concentration in the discharge is 10% less than the concentration exhibited in the receiving water.

Where water quality fails to meet the established criteria, corrective measures will be undertaken (e.g. if sediment problems are identified, settling in the sediment detention ponds shall be aided by dosing with flocculation agents) to achieve compliance with the water quality release criteria. Treated water is to be re-tested prior to release to establish the effectiveness of treatment measures.

Landscaping activities and revegetation will occur progressively as soon as possible after areas reach final grade.

Only appropriate herbicides and fertilisers are to be used in accordance with TSC specifications.

Monitoring

Surface water monitoring will be conducted monthly and following the first monthly rainfall event (defined as >25mm in 24 hours) at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1.

[3] https://www.environment.nsw.gov.au/ieo/Tweed/report-02.htm

	Surface water and groundwater quality monitoring are to be conducted simultaneously to allow temporal comparisons between the systems. Sample recovery and in situ analysis will be performed by trained staff and, when required, samples will be forwarded to a NATA-accredited laboratory. Sediment and erosion control measures will be inspected regularly in accordance with the approved ESCP.
Auditing	Environmental consultant to audit water quality results to ensure all discharges from sediment basins comply with the performance criteria as relevant at the discharge location. Environmental consultant to audit monthly and rainfall event water quality results against the site specific water quality criteria.
Reporting	Result sheets to be compiled for monitoring results relating to water quality of water bodies. These results to be kept onsite for inspection by local and state government officers. Monthly reports to be submitted to TSC until completion of works. Reports will be submitted to TSC within 30 working days upon receipt of the laboratory results. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important[4]. • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained. • Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	The values of water quality indicators will vary naturally and not all of this variation is ecologically important.[5] The site-specific criteria are based on the 80th percentile of the baseline data set and thus the probability of a single observation exceeding the 80th percentile

[4] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.
[5] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

	is 20%. The probability of a Type 1 error (or the risk of triggering a false alarm) is 20%. The recording of a single result that exceeds the criteria will be used to trigger additional investigations including an increase to fortnightly monitoring of the parameter(s) in question. Results will be used to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.
Corrective action	All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted. Specific strategies to be implemented in consultation with the Environmental Consultant but may include: **pH** In the event that the pH of waters falls outside of the critical limits, such waters will be contained and the pH adjusted to within the target range prior to release. **Electrical conductivity** If electrical conductivity exceeds the relevant background criteria, the waters will be contained onsite until adequate EC levels are reached. Further monitoring of upstream waters will be conducted to assess the impact of the development on the absolute change to water quality. Rainfall data will also be assessed at such times to determine the impact that rainfall has had on the water quality of the site and discharging waters. **Suspended solids and turbidity** If total suspended solids exceed the relevant background criteria the waters will be contained onsite for a period sufficient to allow suspended solids to settle out prior to release, or treated with a flocculent. After gypsum has been applied, the stored waters will be retested immediately prior to discharge. Erosion control devices will be immediately inspected and cleaned if necessary. Additional devices will be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas will be reviewed with respect to the approved ESCP. **Dissolved oxygen** In the event that dissolved oxygen levels drop below the relevant background criteria, the waters will not be released until visual inspections for algae have been carried out. If algae are present, further laboratory tests will be carried out to determine the type of algae in the waters. A general investigation will be carried out of the flow conditions of the affected waters, to assess the flow rates and volume of water passing through the monitoring locations and suitability for release. **Litter and gross pollutants** In the event that litter and gross pollutants with a dimension greater than 5mm are observed, this material will be clean up and appropriately disposed of as soon as practicable. The contractor shall inform staff of the appropriate waste disposal procedures and reiterate the importance and sensitivity of the surrounding ecosystems.

	Oil and grease In the event that oil and grease are visible and/or an odour is detected within a waterbody, management strategies will be implemented. Specifically, the waters shall be contained and the oil and grease isolated through the use of booms, containments bunds or other appropriate measures. Remediation works shall be implemented in consultation with the environmental consultant and DPIE. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 8

Surface water quality will be maintained during the bulk earthworks phase in accordance with the site specific water quality criteria.

5.10 Freshwater ecology

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Freshwater ecology.
Operational policy	To maintain and/or enhance the value of freshwater ecosystems within and downstream of the site.
Performance criteria	Surface water quality shall be maintained or enhanced and regularly assessed against the site specific water quality criteria detailed in Table 4.1.1. Water may be discharged from the site that exhibits a suspended solids concentration greater than 50mg L^{-1}, providing the concentration in the discharge is 10% less than the concentration exhibited in the receiving water. In addition to the above WQOs no release from the off-stream waterway and wetland system shall occur if blue green algae levels exceed 5,000 cells/mL. No decline in macroinvertebrate species richness.
Implementation strategy	Water levels maintained throughout construction phase. Sediment and erosion control measures to protect water from sedimentation and turbidity in accordance with the approved ESCP. Only locally endemic macrophyte species planted suited to site conditions. Monitoring strategies to be implemented incorporating water quality, weed removal and macroinvertebrate sampling.
Monitoring	Refer to Table 'Waterways & wetlands management' of the OWMP for monitoring strategy. Monitoring of macroinvertebrates in freshwater wetlands as a biological indicator of ecosystem health. Standard sampling and interpretation methods to be followed, such as the Stream Pollution Index.
Auditing	Appropriately qualified environmental consultant to undertake monthly assessment of specified criteria.
Reporting	Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers upon request. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.

Identification of incident or failure	Observation of element(s) outside nominated criteria. Decreased ecosystem health as indicated by macroinvertebrate sampling.
Corrective action	Identification and source control. Review of construction and/or management methods. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 9

The contractor will ensure the integrity of the freshwater ecosystems is maintained for the duration of the construction works.

5.11 Waterways & wetlands management

Applies to:	Bulk earthworks phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Wetlands & waterways management.
Operational policy	To establish and maintain the health of wetlands and waterways during the bulk earthworks phase. To ensure strong plant growth and satisfactory water quality.
Performance criteria	Surface water quality shall be maintained or enhanced and regularly assessed against the site specific water quality criteria detailed in Table 4.1.1. In addition to the above WQOs no release from the off-stream waterway and wetland system shall occur if blue green algae levels exceed 5,000cells/mL. Water may be discharged from the site that exhibits a suspended solids concentration greater than 50mg L^{-1}, providing the concentration in the discharge is 10% less than the concentration exhibited in the receiving water. Plant establishment success rate >80%.
Implementation strategy	The operational work shall be developed in stages to minimise the potential for soil erosion and water pollution. The site can then be progressively developed and rehabilitated. All waters from the active construction areas shall be treated (if required) prior to being discharged into completed areas. The constructed wetlands will come progressively online as staged construction is completed. All runoff from disturbed areas is to be collected by means of surface drains and diverted to internal water bodies. **Protection of waterways and wetlands from sediment** All sediment and erosion control devices shall be installed and maintained in accordance with the approved ESCP. These devices include (but are not limited to): • Diversion of upslope runoff around cleared and/or disturbed areas in a way that minimises erosion, minimises the upslope catchment and diverts waters to a legal point of discharge. • Sediment control fences or other measures at the downslope perimeter of cleared and/or disturbed areas. • Maintenance of all erosion control measures at operational capacity until land is effectively rehabilitated. • Material accumulated behind sediment barriers shall be cleaned out as soon as practicable to minimise the potential for the transfer of sediment off the construction site. Sediment shall be removed to a secure stockpile location.

	Maintenance of water quality Sediment is to be removed from each internal waterbody/sediment basin once 70% of the total available sediment storage component has been reached and weirs are to be regularly maintained and cleaned. Sediment basins/internal waterbodies shall be dosed with flocculating agents when required to ensure that water quality meets required limits. Bypass flows from sediment traps shall be directed to stable areas. The operational water bodies and associated wetland shall be de-silted, replanted as necessary and assessed for any acid sulfate oxidation effects prior to refilling with water at the end of the construction phase. To protect constructed wetlands and receiving environments, discharge of water from active earthworks areas must comply with the specified release criteria in accordance with the '*Surface water quality monitoring'* table. **Maintenance of plant health in shallow vegetated wetlands** Wetlands planted with locally endemic species suited to site conditions. These species ensure minimisation of water usage. As wetlands are planted, water levels will be maintained via pumping of water that satisfies water quality objectives from sediment basins following rainfall events and stormwater flows. Particular attention should be given to weed management during the early stages of wetland vegetation development.
Monitoring	**Sediment and erosion controls** Regular site inspections shall be undertaken to monitor the effectiveness of sediment and erosion controls In accordance with the approved ESCP. **Surface water quality** Surface water monitoring will be conducted in accordance with the '*Surface water quality monitoring'* table and at appropriate locations external and internal to the construction area as each wetland and waterway is constructed. At the additional locations, monitoring will be conducted monthly and during rainfall events for: pH, EC, suspended solids, dissolved oxygen, oil and grease. Sample recovery and in situ analysis will be performed by a qualified Environmental Scientist sampler and, when required, samples will be forwarded to a-NATA-accredited laboratory. Visual inspection of wetland plant health, algae presence, weeds, pests including mosquitoes and cane toads.
Auditing	Environmental consultant to audit water quality and plant health results monthly against the performance criteria. Additional visual inspections to be carried out in accordance with the approved ESCP to verify that control measures are in place and properly maintained.

Reporting	Results sheet and site inspection records to be compiled for monitoring results of water quality of water bodies and erosion and sediment control measures. To be kept onsite for inspection by local and state government officers. Recording of wetland health, establishment, weeds and pests. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Degradation of surface water quality at the monitoring points. • Excessive build-up of sediment. • Loss of wetland plants. • Algal blooms. • Emergence of pest species.
Corrective action	Apply remedial measures to improve sediment and erosion control. Incorporate additional measures including, but not limited to, silt fences and flocculation of the water quality control ponds. If pH is outside the criteria range, then waters will be contained and the pH adjusted to within the range prior to release. If total suspended solids exceed the water quality criteria then water will be contained onsite for a period sufficient to allow suspended solids to settle out prior to release or treated with a flocculent. To increase dissolved oxygen, re-circulation and or aeration should be undertaken. Replanting of wetland species if losses exceed 20%. Review and choose alternative species if necessary. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 10

The Contractor will ensure construction works are managed in a manner that will protect and enhance the integrity of the waterway and wetland system.

6 Management of potential impacts – landform stabilisation phase

6.1 Intent

This part of the OWMP specifies those matters which must be complied with by the Proponent during the landform stabilisation phase, being the period following completion of bulk earthworks when each precinct is at final grade and stabilised, but prior to the commencement of civil construction.

6.2 Aquatic flora & weed management and maintenance

Applies to:	Landform stabilisation phase
Person responsible:	Proponent; Environmental Consultant

Issue	Aquatic flora and weed management and maintenance in constructed wetlands and waterbodies.
Operational policy	To maintain healthy aquatic plant life and control weeds to promote the ecosystem health of constructed wetlands and waterbodies.
Performance criteria	Macrophyte establishment success rate >70%. The suppression of aquatic weeds and algae. Maintenance of hydraulic performance between waterbodies.
Implementation strategy	**Weed strategy** An expectation of avoidance or total removal of aquatic weeds within the waterway and wetland system is not realistic as weeds are present within the catchment and neighbouring sites. Management of macrophytes via removal of vegetation within flow paths to maintain hydraulic conductance. Particular attention should be given to weed management to prevent obstruction of hydraulic conductance. When removing weeds, care must be taken not to damage the growth of native aquatic plants or interrupt natural ecosystem function by adhering to the following methods: • Avoid overspray through use of correct equipment and not spraying in windy conditions. • Bag and removal of weeds offsite. • Manage access to wetlands to avoid damage via trampling. • Should mechanical harvesting of weed growth be required, access to waterbodies will be selected to achieve minimal impact and access points will be rehabilitated at the end of the harvesting period.

	Algae strategy Quarterly monitoring of algal cell counts is required to monitor the potential for algal blooms. Proposed management methods specifically for algal blooms include: • Ability to isolate separate on-stream system pools to contain algal blooms. • Emergency aeration and/or mixing. • Safety signage during algal outbreaks. See Table 'Maintenance of water treatment measures' of the OWMP for further details. **Off-stream waterway and wetland system:** • Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks.
Monitoring	Routine quarterly monitoring for pH, EC, DO, turbidity, TN, TP, SS, Fe, Al, Chlorophyll-a and algal cell count during the landform stabilisation phase. To continue for two years following the completion of construction onsite. Routine quarterly visual inspection of treatment trains for vegetation establishment, damage, weed invasion and clogging.
Auditing	Reviews are to be carried out on a quarterly basis to assess the appropriateness of the implementation strategy. A checklist is to be completed which assesses the effectiveness of strategies detailed above.
Reporting	An Aquatic Flora Report shall be submitted to TSC annually. Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers. **Incident reporting** Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Non-compliance with agreed performance criteria will be identified by: • Vegetative losses >20%; • Weed growth that impacts upon ecosystem function and/or hydraulic conductance; and • Algal blooms exceeding 50,000 cells/ml.
Corrective action	If vegetation fails, new vegetation should be planted and established. Vegetation may require supplementary replanting. If algal blooms occur the following corrective actions should be investigated in consultation with the Environmental Consultant:

	• Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks. Macrophyte density to be maintained at prescribed levels to achieve hydraulic conductance and pollutant removal. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 11

The Proponent will ensure the health of the wetland and waterbody ecosystems is maintained during the landform stabilisation phase through active weed and algae monitoring and management.

6.3 Threatened species – Wallum froglet

The information in this table was supplied by JWA (2020a-c) *Threatened Species Management Plans*.

Applies to:	Species: Wallum Froglet (*Crinia signifera*) Landform stabilisation phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Contractor's site manager; Ecological Consultant; all personnel

Issue	Protection of habitat. Provision of habitat from construction of artificial wetland areas – constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats. Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum Froglet habitat in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c).
Performance criteria	• Minimise impacts on Wallum Froglet habitat. • Colonisation of constructed wetlands by Wallum Froglet. • Maintenance of water quality (pH, nutrient levels) within constructed and naturally occurring habitat. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum Froglet). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Design of constructed wetlands (liaison with relevant personnel). • Construction of wetlands. • Landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum Froglet activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a weekly basis; and • frog monitoring on a monthly basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any water quality testing. Results of monitoring to be collated and presented as report to Council, and other relevant authorities. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall

	notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum Froglet.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 12

The contractor will commit to monitoring Wallum Froglet populations to ensure that constructed wetlands are appropriately constructed and maintained.

6.4 Threatened species – Wallum sedge frog

The information in this table was supplied by JWA (2020g) *Wallum Sedge Frog Management Plan*.

Applies to:	Species: Wallum sedge frog (*Litoria olongburensis*) Landform stabilisation phase – disturbed mixed grassland and regenerating heathland.
Person responsible:	Contractor's Site Manager; Ecological Consultant; all personnel

Issue	Protection and restoration of habitat (2 constructed dams which currently occur in precincts 12 and 13, one of which requires repair). Provision of habitat from construction of artificial wetland areas – constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats. Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum sedge frog habitat in accordance with the *Wallum Sedge Frog Management Plan* (JWA, 2020g).
Performance criteria	• Minimise impacts on Wallum sedge frog habitat. • Colonisation of constructed wetlands by Wallum sedge frog. • Maintenance of water quality (pH, nutrient levels). • Maintenance of aquatic vegetation and dense reedland. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum sedge frog). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Design of constructed wetlands (liaison with relevant personnel). • Construction of habitat areas. • Landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum sedge frog activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a weekly basis; and • frog monitoring on a monthly basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any testing. Results of monitoring to be collated and presented as report to, Council and other relevant statutory authorities.

	Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum sedge frogs.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 13

The contractor will commit to monitoring Wallum sedge frog populations to ensure that constructed wetlands are appropriately constructed and maintained.

6.5 Maintenance of water treatment measures

Applies to:	Landform stabilisation phase
Person responsible:	Proponent

Issue	Maintenance of permanent stormwater quality treatment devices.
Operational policy	To ensure that the stormwater quality treatment devices are maintained at an appropriate operational standard.
Performance criteria	No significant change in the physical characteristics of treatment devices. No significant change in the physicochemical and/or biological characteristics of the treatment devices.
Implementation strategy	Routine visual inspections and monitoring and maintenance.

Monitoring	Routine monthly visual inspection of treatment trains and vegetated open space for:
	• Litter.
	• Erosion.
	• Excessive sediment deposition.
	• Clogging (bio-retention).
	• Vegetation damage (e.g. die off, weed growth).
	• Damaged or failed treatment devices.
	• Change in physical characteristics:
	  • water level; and
	  • area, depth or bed profile of any bio-retention basin. waterway and wetland system.

Auditing	Audit inspections are to be carried out on a quarterly basis to verify that the stormwater quality control structures are properly maintained by the contractor.
Reporting	A checklist is to be completed which assesses the strategies listed above and includes the following: • A record of inspection details and; • A record of details of all maintenance activities (including volume of silt removed from each GPT or other control structure). Results to made available to TSC at all times. A summary of the inspection checklist findings shall be included in the annual water quality monitoring report. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.

Identification of incident or failure	Identification of incident or failure may be identified by: • Blockage of stormwater system. • Build-up of sediment & litter or re-entrainment of trapped sediments. • Excessive erosion. • Vegetation damage. • Poorly maintained, damaged or failed control devices. • A change in the physical characteristics. • A change in the physicochemical and/or biological characteristics. • Impeded drainage of bio-retention and filter basins. • Deterioration of water quality downstream of the control structure/s.
Corrective action	**Bio-retention and filter basin maintenance** Regular harvesting to ensure vegetation is maintained at acceptable levels. Removal of a portion of vegetation to maintain nutrient and biomass balance Removed vegetation to be composed and reused on landscaping in other parts of development site Soil renovation (as required) to maintain permeability Removal of litter. **Gross pollutant traps** Removal of trap material in accordance with manufacturer's specifications. **Vegetated rough** Regular mowing and maintenance of rough filter characteristic by mulching organic matter back into rough soil profile. Ensure vegetation is maintained at acceptable levels (minimum 85% foliage protective cover). Removal of litter within the swale. **Waterway and wetland system** As per weed management program **Sediment/sludge removal** Sludge and sediments are expected to settle in the inlet zones of the wetlands and other water bodies. In the operational state this is expected to be minor and de-silting will only be required on an infrequent basis (maybe every 50 years). Prior to works the recommended best practice method of sediment/sludge removal of the time will be used. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 14

The Proponent will ensure management measures are implemented (if required) to ensure the stormwater quality treatment devices are maintained at operational standard.

6.6 Surface water quality monitoring

Applies to:	Landform stabilisation phase
Person responsible:	Proponent; Environmental Consultant

Issue	Surface water monitoring.
Operational policy	To ensure that any waters discharged from the site meet the water quality criteria in Table 4.1.1 and that the water quality in the waterway and wetland system remains at an acceptable level.
Performance criteria	The quality of discharge from the site should comply with water quality criteria in Table 4.1.1. In addition to the above WQOs no release from the off-stream waterway and wetland system shall occur if blue green algae levels exceed 5,000 cells/mL.
Implementation strategy	Quarterly surface water quality monitoring to be undertaken.
Monitoring	**Frequency**: Routine quarterly monthly and rainfall event (>25mm/24hrs) monitoring for one year following the completion of bulk earthworks. **Parameters**: Those listed in Table 4.1.1. **Vertical Profiling**: Routine quarterly monitoring of temperature, dissolved oxygen, pH, EC and turbidity at 0.5m depths of all off-stream deep water bodies. **Location:** Quarterly monitoring at the surface water locations shown on Drawing 12017_001. Additional locations to be specified oat each defined off-site discharge point in consultation with the Environmental Consultant. Sample recovery and in situ analysis will be performed by a qualified Environmental Scientist and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	Auditing to be conducted on a quarterly basis.
Reporting	The contractor to notify the DPIE immediately of breaches with potential to cause harm to the environment. A Water Quality Report for all water quality monitoring results and assessments shall be submitted to TSC quarterly. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the release criteria. • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria.

	• Recommendations that are relevant to ensuring a high level of water quality is maintained. Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Surface water quality parameter monitoring identifying exceedance of WQOs.
Corrective action	If exceedance of WQOs continues to occur, inspect all treatment techniques, revise designs or review different alternatives and install if necessary. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 15

The Proponent will ensure routine monitoring is carried out to ensure water quality is in accordance with the water quality objectives during the land stabilisation phase.

6.7 Site stabilisation

Applies to:	Landform stabilisation phase
Person responsible:	Contractor's Site Manager

Issue	Landform stabilisation at the completion of the bulk earthworks phase Stage 1 works.
Operational policy	Landscaping, stabilisation and revegetation of completed areas to aid the treatment of surface water and minimise sediment transport.
Performance criteria	No sediment transport from completed areas.
Implementation strategy	• Progressive stabilisation and revegetation of completed areas. • The landscaping and rehabilitation program shall be programmed to ensure that minimal time delay occurs between final land shaping and permanent rehabilitation in accordance with the approved ESCP. • All temporary erosion and sediment control works are to be removed once works are complete and revegetation is successfully established in formerly disturbed areas in accordance with the approved ESCP.
Monitoring	Routine weekly inspections and following rainfall events (>25 mm in 24 hours) undertaken by the Contractor's site manager until the stage is stabilised.
Auditing	Auditing to be conducted on a quarterly basis.
Reporting	Completed checklists of site inspections to be kept onsite for inspection by TSC upon request. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Failure of vegetated areas • Signs of erosion onsite. • Damaged or failed erosion control devices. • Decline in water quality as identified by environmental consultant.
Corrective action	• Test topsoil if revegetation works have been unsuccessful to determine the possible problem. • Review procedures in consultation with landscape architect and/or horticulturalist. Apply remedial measures to improve sediment and erosion control (e.g. the incorporation of additional measures, including but not limited to hay bales, silt fences and flocculation of water quality control ponds). Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 16

The Proponent will ensure each stage or precinct is stabilised once final grade is achieved.

6.8 Groundwater monitoring

Applies to:	Landform stabilisation phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish the stable groundwater conditions and verify by monitoring that development management is appropriate. Groundwater monitoring is to be undertaken in accordance with the site's *Groundwater Assessment and Management Plan* (G&S July 2012) and any subsequent revisions of that plan.
Performance criteria	Groundwater quality performance criteria as specified in Table 4.1.2. No variation in groundwater levels beyond normal seasonal fluctuations.
Implementation strategy	Quarterly groundwater monitoring during the Landform stabilisation phase will be undertaken for the parameters in Section 4.1 and compared with the site specific water quality criteria in Table 4.1.2. Groundwater levels will be monitored quarterly throughout the landform stabilisation phase.
Monitoring	Carry out quarterly groundwater level and quality monitoring at locations shown on Drawing 12017_001. Sample recovery and in situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	Auditing to be conducted on a quarterly basis.
Reporting	Annual reports are to be submitted to TSC. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important.[6] • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained.

[6] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

<table>
<tr><td></td><td>• Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided.
Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.</td></tr>
<tr><td>Identification of incident or failure</td><td>Degradation of groundwater quality.
Variations in groundwater levels beyond typical seasonal fluctuations.</td></tr>
<tr><td>Corrective action</td><td>If the test results for any parameter fails to meet the performance criteria further investigations will be conducted including more frequent monitoring of the subject parameter(s).
The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified.
Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented:
• Locate the source of the contamination/level variation and take appropriate actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.
• All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted.
The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.
<table>
<tr><th rowspan="2">Water Quality Parameter</th><th colspan="2">Release Criteria</th></tr>
<tr><th>Precinct 1</th><th>Precinct 5</th></tr>
<tr><td>pH</td><td>3.5-4.33</td><td>3.59-4.47</td></tr>
<tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>No visible film, no detectable odour</td></tr>
</table>
Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.</td></tr>
</table>

Commitment 17

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

7 Management of potential impacts – civil construction

7.1 Intent

This part of the OWMP specifies those matters which must be complied with by the Proponent during the civil construction phase, being the period after the landform stabilisation phase but before the on-maintenance phase commences in each stage.

7.2 Aquatic flora & weed management and maintenance

Applies to:	Civil construction phase
Person responsible:	Proponent; Environmental Consultant

Issue	Aquatic flora and weed management and maintenance.
Operational policy	To maintain healthy aquatic plant life and control weeds to promote the ecosystem health of wetlands and waterbodies.
Performance criteria	Macrophyte establishment success rate >70%. The suppression of aquatic weeds and algae. Maintenance of hydraulic performance between waterbodies.
Implementation strategy	**Weed strategy** An expectation of avoidance or total removal of aquatic weeds within the waterway and wetland system is not realistic as weeds are present within the catchment and neighbouring sites. Management of macrophytes via removal of vegetation within flow paths to maintain hydraulic conductance. Particular attention should be given to weed management to prevent obstruction of hydraulic conductance. When removing weeds, care must be taken not to damage the growth of native aquatic plants or interrupt natural ecosystem function by adhering to the following methods: • Avoid overspray through use of correct equipment and not spraying in windy conditions. • Bag and removal of weeds offsite. • Manage access to wetlands to avoid damage via trampling. • Should mechanical harvesting of weed growth be required, access to waterbodies will be selected to achieve minimal impact and access points will be rehabilitated at the end of the harvesting period. **Algae strategy** Quarterly monitoring of algal cell counts is required to monitor the potential for algal blooms. Proposed management methods specifically for algal blooms include:

	• Ability to isolate separate on-stream system pools to contain algal blooms. • Emergency aeration and/or mixing. • Safety signage during algal outbreaks. See Table 'Maintenance of water treatment measures' of the OWMP for further details. **Off-stream waterway and wetland system** • Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks.
Monitoring	Routine quarterly monitoring for pH, EC, DO, turbidity, TN, TP, SS, Fe, Al, Chlorophyll-a and algal cell count during the construction phase and for two years following the completion of construction onsite. Routine monthly visual inspection of treatment trains for vegetation establishment, damage, weed invasion and clogging.
Auditing	Reviews are to be carried out on a quarterly basis to assess the appropriateness of the implementation strategy. A checklist is to be completed which assesses the effectiveness of strategies detailed above.
Reporting	An Aquatic Flora Report shall be submitted to TSC annually. Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Non-compliance with agreed performance criteria will be identified by: • Vegetative losses >20%. • Weed growth that impacts upon ecosystem function and/or hydraulic conductance. • Algal blooms exceeding 500 cells/ml.
Corrective action	If vegetation fails, new vegetation should be planted and established. Vegetation may require supplementary replanting. Macrophyte density to be maintained at prescribed levels to achieve hydraulic conductance and pollutant removal. If blue green algae numbers exceed 500 cells/ml: • Increase turnover mixing until numbers are brought back to lower levels. • Fertiliser activity to be limited. • Maintain regular monitoring.

	If blue green algae numbers exceed 2,000 cells/ml:
	• Increase mixing:
	  • Increase turnover through additional pumping of the recirculation system.
	  • Vertical mixing through emergency compressed air or mechanical mixing devices.
	• Fertiliser activity and sprinkling to be limited where possible in the vicinity of the test sites of concern.
	• Harvest and land dispose of any dead fish.
	• Monitoring frequency to be increased at affected sites to once a month.
	
	If blue green algae numbers exceed 15,000 cells/ml:
	• All fertiliser activity and sprinkling to be stopped in the vicinity of the sites of concern.
	• Warning signs to be posted around the sites of concern.
	• All site personnel to be notified.
	• Monitoring frequency to increase at affected sites to once a week.
	• Contingency measures are to be considered including:
	• Increased mixing.
	• Harvesting and land disposal of algae and dead fish.
	• Allowing bloom to run its course.
	
	Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 18

The land user will ensure the health of the wetland and water body ecosystems is maintained - through active weed and algae monitoring and management.

7.3 Threatened species – Wallum froglet

The information in this table was supplied by JWA (2020a-c) *Threatened Species Management Plans*.

Applies to:	Species: Wallum Froglet (*Crinia signifera*) Civil construction phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Proponent; Ecological Consultant

Issue	Protection of habitat. Provision of habitat from construction of artificial wetland areas (Constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats). Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum Froglet habitat in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c).
Performance criteria	• Minimise impacts on Wallum Froglet habitat. • Colonisation of constructed wetlands by Wallum Froglet. • Maintenance of water quality (pH, nutrient levels) within constructed and naturally occurring habitat. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum Froglet). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Maintenance of natural constructed wetlands (liaison with relevant personnel) and landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum Froglet activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a Quarterly basis; and • frog monitoring on an annual basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any water quality testing. Results of monitoring to be collated and presented as report to client, Council and any other relevant statutory authorities. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall

	notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum Froglet.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 19

The land user will commit to monitoring Wallum Froglet populations to ensure that habitats are maintained.

7.4 Threatened species – Wallum sedge frog

The information in this table was supplied by JWA (2020g) *Wallum Sedge Frog Management Plan*.

Applies to:	Species: Wallum sedge frog (*Litoria olongburensis*) Civil construction phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Proponent; Ecological Consultant

Issue	Protection and restoration of habitat (2 constructed dams which currently occur, one of which requires repair). Provision of habitat from construction of artificial wetland areas (Constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats). Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum sedge frog habitat in accordance with the *Wallum Sedge Frog Management Plan* (JWA, 2020g).
Performance criteria	• Minimise impacts on Wallum sedge frog habitat. • Colonisation of constructed wetlands by Wallum sedge frog. • Maintenance of water quality (pH, nutrient levels). • Maintenance of aquatic vegetation and dense reedland. • Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum sedge frog). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	• Maintenance of natural and constructed wetlands (liaison with relevant personnel) as well as landscaping /revegetation works. • Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum sedge frog activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a quarterly basis; and • frog monitoring on an annually basis with an emphasis on monitoring in breeding season (spring & summer).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any testing. Results of monitoring to be collated and presented as report to client, ecologist, Council and any other relevant statutory authorities.

	Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum sedge frogs.
Corrective action	Apply remedial measures to correct issues of water quality as determined by monitoring outcomes. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 20

The land user will commit to monitoring Wallum sedge frog populations to ensure that wetlands are appropriately maintained.

7.5 Groundwater monitoring

Applies to:	Civil construction phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish the stable groundwater conditions and verify by monitoring that development management is appropriate. Groundwater monitoring is to be undertaken in accordance with the site's *Groundwater Assessment and Management Plan* (G&S July 2012) and any subsequent revisions of that plan.
Performance criteria	Groundwater quality performance criteria as specified in Table 4.1.2. No variation in groundwater levels beyond normal seasonal fluctuations.
Implementation strategy	Monthly groundwater monitoring during the Civil Construction phase will be undertaken for the parameters in Table 4.1.2 and compared with the site specific water quality criteria therein. Groundwater levels will be monitored monthly throughout the civil construction phase.
Monitoring	Carry out monthly groundwater level and quality monitoring at relevant locations shown on Drawing 12017_001. Sample recovery and in situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	Auditing to be conducted on a quarterly basis.
Reporting	Annual reports are to be submitted to TSC. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important[7]. • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained.

[7] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

<table>
<tr><td></td><td>
Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided.
Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.

Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
</td></tr>
<tr><td>Identification of incident or failure</td><td>Degradation of groundwater quality.

Variations in groundwater levels beyond typical seasonal fluctuations.</td></tr>
<tr><td>Corrective action</td><td>
If the test results for any parameter fails to meet the performance criteria further investigations will be conducted including more frequent monitoring of the subject parameter(s).

The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified.

Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented:

Locate the source of the contamination/level variation and take appropriate action to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence.
All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted.

The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.
<table>
<tr><th rowspan="2">Water Quality Parameter</th><th colspan="2">Release Criteria</th></tr>
<tr><th>Precinct 1</th><th>Precinct 5</th></tr>
<tr><td>pH</td><td>3.5-4.33</td><td>3.59-4.47</td></tr>
<tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>No visible film, no detectable odour</td></tr>
</table>
Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.
</td></tr>
</table>

Commitment 21

The contractor will seek to establish stable groundwater conditions and verify by monitoring that development management is appropriate.

7.6 Groundwater seepage monitoring

Applies to:	Civil construction phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue

Groundwater seepage monitoring.

Management of groundwater seepage quality entering excavation areas.

Operational policy

To minimise and manage the generation of acidic waters entering the onsite excavation areas through seepage and provide for monitoring and treatment of these waters prior to disposal.

Groundwater monitoring is to be undertaken in accordance with the site's *Groundwater Assessment and Management Plan* (G&S July 2012) and any subsequent revisions of that plan.

Performance criteria

Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering.

Discharge to recharge trenches

All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria:

Water Quality Parameter	Release Criteria	
	Precinct 1	Precinct 5
pH	3.5-4.33	3.59-4.47
Oil and grease	No visible film, no detectable odour	No visible film, no detectable odour

Discharge to surface water bodies

Where the discharge of dewatered groundwater to on-site drains and waterways is intended, water quality will satisfy the relevant surface water quality criteria:

Surface water quality criteria

Parameter	Saline (SW1, SW2, SW6, and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 & SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L

Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Implementation strategy

The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least).

Daily pH monitoring of any seepage within the excavation areas is to be undertaken prior to the disposal of these waters via dewatering.

Dewatered groundwater will undergo appropriate treatment to ensure compliance with the pH criteria prior to release into recharge trenches or surface water bodies.

Where disposal to surface water bodies (drains, waterways etc) is intended additional monitoring (for the surface water quality parameters outlined above) will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25 mm in any 24 hour period) for the duration of the associated dewatering activities.

Records of the measured pH, time of monitoring, calibration records and treatment measures employed are to be kept on site for inspection by the environmental consultant and TSC.

The total acid risk of seepage waters shall be determined from the total acidity (titratable) results measured during the background monitoring program. These results will be considered during the preparation of a treatment program for any dewatered acidic groundwater.

Outside the construction area of each stage existing surface water conditions shall be maintained in accordance with Table 7.7 ‘Surface water quality’.

If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with the *Acid Sulfate Soil Management Plan* (G&S, July 2012) and any subsequent revisions of that plan.

The addition of hydrated lime or crushed ag-lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with the *Acid Sulfate Soil Management Plan* (G&S, May 2020) and any subsequent revisions of that plan.

Before undertaking any earthworks in drains or watercourses, the drain or watercourse will be bunded and contained in a staged manner, with water tested and treated prior to discharge. Particular attention will be given to watercourses containing high levels of organic matter that may also have the potential to form monosulfidic black oozes (MBOs). Existing MBOs will be managed, with organic material within the drain kept to a minimum and dissolved oxygen concentrations within water-bodies monitored and increased if

	necessary (in accordance with the recommendations outlined in Tulau (2007). Titratable Actual Acidity contents and water pH levels of water-bodies will also be monitored and adjusted as necessary.
Monitoring	Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal via dewatering. Where disposal to surface water bodies (drains, waterways etc) is intended additional monitoring (for the surface water quality parameters outlined above) will be undertaken at the controlled discharge points by the environmental consultant monthly and during rainfall events (defined as >25 mm in any 24 hour period) for the duration of the associated dewatering activities. Samples will be forwarded to a NATA-accredited laboratory for analysis when required.
Auditing	A review of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken. Site management to audit water quality results weekly during dewatering activities to verify that discharges comply with the performance criteria.
Reporting	All monitoring results and treatment procedures are to be accurately recorded and maintained onsite for inspection by TSC upon request. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Failure to undertake monitoring at the required frequencies. Discharge of ground waters to recharge trenches or surface water bodies that do not satisfy the nominated pH range for this site. A decline in water quality downstream of the dewatering or discharge activities.
Corrective action	Increase monitoring frequency to required levels. Take necessary steps to address the problem and apply remedial measures to prevent the generation of excessive acid seepage waters (i.e. blanket liming of excavated faces and recharge trenches) in consultation with the Environmental Consultant. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 22

The contractor will minimise and manage groundwater seepage and treat these waters prior to disposal if required.

7.7 Surface water quality monitoring

Applies to:	Civil construction phase
Person responsible:	Contractor's Site Manager; Environmental Consultant

Issue	Surface water quality monitoring.
Operational policy	To maintain the water quality conditions of the receiving waters during the construction phase.
Performance criteria	Surface water monitoring will be conducted monthly and following the first monthly rainfall event (defined as >25 mm in 24 hours) at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Results shall be compared with the surface water quality criteria (indicator parameters only) detailed below;

Surface water quality criteria

Parameter	Saline (SW1, SW2, SW6, and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 and SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L
Litter and gross pollutants	No man made material <5mm in any dimension	No man made material <5mm in any dimension	No man made material <5mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Implementation strategy	Completion of internal bio-retention and filter basins, waterbodies, swales and vegetated filter strips as specified at detailed design. Monitoring of the sediment detention basins prior to controlled release shall occur in accordance with the approved ESCP. Monitoring shall be undertaken for pH, turbidity and suspended solids to ensure compliance with background conditions (as relevant to the discharge location). Water may be discharged from the site that exhibits a suspended solids concentration greater than 50mg L^{-1}, providing the concentration in the discharge is 10% less than the concentration exhibited in the receiving water. Where water quality fails to meet the established criteria, corrective measures will be undertaken (e.g. if sediment problems are identified, settling in the sediment detention ponds shall be aided by dosing with flocculation agents) to achieve compliance with the water quality release criteria. Treated water is to be re-tested prior to release to establish the effectiveness of treatment measures. Landscaping activities and revegetation will occur progressively as soon as possible after areas reach final grade. Only appropriate herbicides and fertilisers are to be used in accordance with TSC specifications. Clean-up of GPT's on a quarterly basis or after significant rainfall events.
Monitoring	Surface water monitoring will be conducted monthly and following the first monthly rainfall event (defined as >25mm in 24 hours) at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Surface water and groundwater quality monitoring are to be conducted simultaneously to allow temporal comparisons between the systems. Sample recovery and in situ analysis will be performed by trained onsite staff and, when required, samples will be forwarded to a NATA-accredited laboratory. Sediment and erosion control measures will be inspected regularly in accordance with the approved ESCP.
Auditing	Environmental consultant to audit water quality results to ensure all discharges from sediment basins comply with the performance criteria as relevant at the discharge location. Environmental consultant to audit monthly and rainfall event water quality results against the site specific water quality criteria.
Reporting	Monthly reports to be submitted to TSC until completion of works. Reports will be submitted to TSC within 30 working days upon receipt of laboratory results. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria.

	• When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important.[8] • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained. • Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	The values of water quality indicators will vary naturally and not all of this variation is ecologically important.[9]. The site-specific criteria are based on the 80th percentile of the baseline data set and thus the probability of a single observation exceeding the 80th percentile is 20%. The probability of a Type 1 error (or the risk of triggering a false alarm) is 20%. The recording of a single result that exceeds the criteria will be used to trigger additional investigations including an increase to fortnightly monitoring of the parameter(s) in question. Results will be used to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.
Corrective action	All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted. Specific strategies to be implemented are as follows: **pH** In the event that the pH of waters falls outside of the critical limits, such waters will be contained and the pH adjusted to within the target range prior to release. Monitoring of the pH level shall be carried out immediately prior to release. **Electrical conductivity** If electrical conductivity exceeds the relevant background criteria, the waters will be contained onsite until adequate EC levels are reached. Further monitoring of upstream waters will be conducted to assess the impact of the development on the absolute change to water quality. Rainfall data will also be assessed at such times to determine the impact that rainfall has had on the water quality of the site and discharging waters.

[8] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.
[9] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

	Suspended solids and turbidity If total suspended solids exceed the relevant background criteria the waters will be contained onsite for a period sufficient to allow suspended solids to settle out prior to release, or treated with a flocculent. After gypsum has been applied, the stored waters will be retested immediately prior to discharge. Erosion control devices will be immediately inspected and cleaned if necessary. Additional devices will be installed if a need is detected to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas will be reviewed with regard to the approved ESCP. **Dissolved oxygen** In the event that dissolved oxygen levels drop below the relevant background criteria, the waters will not be released until visual inspections for algae have been carried out. If algae are present, further laboratory tests will be carried out to determine the type of algae in the waters. A general investigation will be carried out of the flow conditions of the affected waters, to assess the flow rates and volume of water passing through the monitoring locations and suitability for release. **Litter and gross pollutants** In the event that litter and gross pollutants with a dimension greater than 5mm are observed, this material will be clean up and appropriately disposed of as soon as practicable. The contractor shall inform staff of the appropriate waste disposal procedures and reiterate the importance and sensitivity of the surrounding ecosystems. **Oil and grease** In the event that oil and grease are visible and/or an odour is detected within a waterbody, management strategies will be implemented. Specifically, the waters shall be contained and the oil and grease isolated through the use of booms, containments bunds or other appropriate measures. Remediation works shall be implemented in consultation with the environmental consultant and DPIE. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 23

The Contractor will maintain background water quality conditions as much as practicable during the civil construction phase of the development.

7.8 Golf course water conservation

Applies to:	Civil construction phase of golf course, precincts 12 and 13
Person responsible:	Proponent; Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (Coastal Management SEPP wetland (previously SEPP 14) and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Water flows are to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Harvesting** • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. **Volume** • Maintain constant volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to groundwater. **Storage** • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. **Treatment** • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. **Distribution** • 30% annual average recharge to ecosystem.

	• 70 % to landscape in golf course. **Maintenance of treatment basins** • Basins maintained to ensure nutrient stripping and water infiltration.
Monitoring	Fortnightly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on a monthly basis.
Reporting	Results of monitoring will be reported quarterly to TSC and NSW DPIE. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 24

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

7.9 Water management (golf course irrigation)

Applies to:	Civil construction of golf course, precincts 12 and 13
Person responsible:	Proponent; Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Irrigation is to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Source of water** • Extraction at central point of development which is distant from ground water dependant ecosystems. **Distribution** • Pipe mains and lateral distribution. • Spray irrigation for distribution efficiency. • Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). • Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). **Irrigation scheduling** • Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). • Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). • Soil water deficit based trigger for irrigation. • Effective soil depth for schedule 0-200mm. • Refill point to be set at 70% plant available soil moisture depletion. • Irrigation applied to 98% of field capacity.

	Water allocation model • Sustainable yield applied to irrigation set at 70 % recharge potential. • Recycling. • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. **Soil management** • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. **Plant selection and management** • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location e.g. Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
Monitoring	**Fortnightly** Height monitoring: • Surface water – dams, basins, adjacent ecosystem water bodies. • Ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent Coastal Management SEPP wetland). Parameters: • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). **Daily** • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a quarterly basis.
Reporting	Results of monitoring will be reported quarterly to the TSC and other appropriate authorities. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.

Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – Irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – Implement alternate water supply. Groundwater higher than critical level – Determine source of excess water. High rainfall events – do nothing if incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 25

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

7.10 Golf course nutrient management

Applies to:	Civil construction of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Water quality is to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. Critical criteria set as per background monitoring for the following Parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total nitrogen and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; and • oil and grease (visual inspection); • calcium; • magnesium; • potassium; • sodium; • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour.

Implementation strategy	**Tees** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site's Fertiliser Management Plan. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. **Greens** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for green maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. **Fairways** • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. In addition,

	a mass balance method will be used to identify fertiliser rates – inputs of water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off. **Rough** • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough. **Swales and detention basins** • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
Monitoring	**Groundwater** *Monthly* • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1 m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH_4, NO_3; P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. **Surface water** *Monthly* • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH_4, NO_3 P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. *Monthly* • Central irrigation supply. Parameters: • Irrigation water quality, N & P.

	Soils 6 monthly • Soil fertility sampling as per standard practice for turf (agricultural) management. **Biomass** *Quarterly* • Fairway reference sites set at four locations within golf course. • The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). *Biannually* • Coastal Management SEPP wetland (previously SEPP 14) and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported annually to TSC and NSW DPIE. Within 24 hours of detecting any incidents during construction that cause (or may cause) significant harm to the environment, the Proponent shall notify TSC and other relevant agencies of the incident in accordance with the protocol in Section 5.3.
Identification of incident or failure	• Groundwater analyses in excess of critical limits for two consecutive sample events. • Critical limit set considering background monitoring.
Corrective action	Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor. Upon receipt of a complaint follow the Complaints Procedure provided in Section 5.2.

Commitment 26

The land user will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding Coastal Management SEPP wetlands and ecological protection zones.

8 Management of potential impacts – on maintenance phase

8.1 Intent

This part of the OWMP specifies those matters which must be complied with by the Proponent during the 12 month on maintenance period, being the period after civil construction but before TSC assumes responsibility for the subdivision works. The Proponents' obligations in this Section of the OWMP conclude at the end of the maintenance period for each stage.

8.2 Implementation

At the completion of the construction of the development's civil works, the GPT's (if any have been installed) should be cleaned out to become part of the permanent stormwater quality control treatment train.

8.3 Aquatic flora & weed management and maintenance

Applies to:	On-maintenance phase
Person responsible:	Site Manager; Environmental Consultant

Issue	Aquatic flora and weed management and maintenance.
Operational policy	To maintain healthy aquatic plant life and control weeds to promote the ecosystem health of wetlands and waterbodies.
Performance criteria	Macrophyte establishment success rate >70%. The suppression of aquatic weeds and algae. Maintenance of hydraulic performance between waterbodies.
Implementation strategy	**Weed strategy** An expectation of avoidance or total removal of aquatic weeds within the waterway and wetland system is not realistic as weeds are present within the catchment and neighbouring sites. Management of macrophytes via removal of vegetation within flow paths to maintain hydraulic conductance. Particular attention should be given to weed management to prevent obstruction of hydraulic conductance. When removing weeds, care must be taken not to damage the growth of native aquatic plants or interrupt natural ecosystem function by adhering to the following methods: • Avoid overspray through use of correct equipment and not spraying in windy conditions. • Bag and removal of weeds offsite. • Manage access to wetlands to avoid damage via trampling. • Should mechanical harvesting of weed growth be required, access to waterbodies will be selected to achieve minimal impact and access points will be rehabilitated at the end of the harvesting period. **Algae strategy** Quarterly monitoring of algal cell counts is required to monitor the potential for algal blooms. Proposed management methods specifically for algal blooms include: • Ability to isolate separate on-stream system pools to contain algal blooms. • Emergency aeration and/or mixing. • Safety signage during algal outbreaks. • See Table 'Maintenance of water treatment measures' of the OWMP for further details.

	Off-stream waterway and wetland system • Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks.
Monitoring	Routine quarterly monitoring for pH, EC, DO, turbidity, TN, TP, SS, Fe, Al, Chlorophyll-a and algal cell count. Routine quarterly visual inspection of treatment trains for vegetation establishment, damage, weed invasion and clogging.
Auditing	Reviews are to be carried out on a quarterly basis to assess the appropriateness of the implementation strategy. A checklist is to be completed which assesses the effectiveness of strategies detailed above.
Reporting	An Aquatic Flora Report shall be submitted to TSC annually. Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers.
Identification of incident or failure	Non-compliance with agreed performance criteria will be identified by: • Vegetative losses >20%. • Weed growth that impacts upon ecosystem function and/or hydraulic conductance. • Algal blooms exceeding 500 cells/ml.
Corrective action	If vegetation fails, new vegetation should be planted and established. Vegetation may require supplementary replanting. Macrophyte density to be maintained at prescribed levels to achieve hydraulic conductance and pollutant removal. If algal blooms occur the following corrective actions should be investigated in consultation with the Environmental Consultant; • Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks. The following specific actions may be undertaken in consultation with the Environmental Consultant; *500 cells/ml* • Increase turnover mixing until numbers are brought back to lower levels. • Fertiliser activity to be limited. • Maintain regular monitoring.

	2,000 cells/ml Increase mixing: • Increase turnover through additional pumping of the recirculation system. • Vertical mixing through emergency compressed air or mechanical mixing devices. • Fertiliser activity and sprinkling to be limited where possible in the vicinity of the test sites of concern. • Harvest and land dispose of any dead fish. • Monitoring frequency to be increased at affected sites to once a month. *15,000 cells/ml* All fertiliser activity and sprinkling to be stopped in the vicinity of the sites of concern. Warning signs to be posted around the sites of concern. All site personnel to be notified. Monitoring frequency to increase at affected sites to once a week. Contingency measures are to be considered including: • Increased mixing. • Harvesting and land disposal of algae and dead fish. • Allowing bloom to run its course.

Commitment 27

The land user will ensure the health of the wetland and water body ecosystems is maintained - through active weed and algae monitoring and management.

8.4 Threatened species - Wallum froglet

The information in this table was supplied by JWA (2020a-c) *Threatened Species Management Plans*.

Applies to:	Species: Wallum Froglet (*Crinia signifera*) On-maintenance phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Site Manager; Ecological Consultant

Issue	Protection of habitat. Provision of habitat from construction of artificial wetland areas (Constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats). Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum Froglet habitat.
Performance criteria	Minimise impacts on Wallum Froglet habitat. Colonisation of constructed wetlands by Wallum Froglet. Maintenance of water quality (pH, nutrient levels) within constructed and naturally occurring habitat. Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum Froglet). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	Maintenance of natural constructed wetlands (liaison with relevant personnel) and landscaping /revegetation works. Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum Froglet activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a Quarterly basis; and • frog monitoring on an annual basis with an emphasis on monitoring in breeding season (June – August).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any water quality testing. Results of monitoring to be collated and presented as report to client, Council and any other relevant statutory authorities.

Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum Froglet.
Corrective action	Apply remedial measures to correct issues of water quality as determined by monitoring.

Commitment 28

The land user will commit to monitoring Wallum Froglet populations to ensure that habitats are maintained.

8.5 Threatened species – Wallum sedge frog

The information in this table was supplied by JWA (2020g) *Wallum Sedge Frog Management Plan*.

Applies to:	Species: Wallum sedge frog (*Litoria olongburensis*) On-maintenance phase
Person responsible:	Site Manager; Ecological Consultant

Issue	Protection and restoration of habitat (2 constructed dams which currently occur in precincts 12 and 13, one of which requires repair). Provision of habitat from construction of artificial wetland areas (Constructed habitat areas providing suitable acidic conditions (pH 4.2 – 6.7), aquatic vegetation and a variety of microhabitats). Maintenance of constructed habitat areas to limit changes in hydrology, nutrient loading etc.
Operational policy	Protection of Wallum sedge frog habitat.
Performance criteria	Minimise impacts on Wallum sedge frog habitat. Colonisation of constructed wetlands by Wallum sedge frog. Maintenance of water quality (pH, nutrient levels). Maintenance of aquatic vegetation and dense reedland. Minimise any open water areas on the site as this will create optimum conditions for Cane Toads (predator of Wallum sedge frog). All ponds should be planted with a dense edge of reeds/sedges, and drainage swales should be well vegetated with reeds/sedges.
Implementation strategy	Maintenance of natural and constructed wetlands (liaison with relevant personnel) as well as landscaping /revegetation works. Re-evaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Wallum sedge frog activity.
Auditing	Regular monitoring inspections to be completed at stated intervals: • water quality monitoring on a quarterly basis; and • frog monitoring on an annual basis with an emphasis on monitoring in breeding season (spring & summer).
Reporting	Standard pro-formas for monitoring to be filled in accordingly including results of any testing. Results of monitoring to be collated and presented as report to client, Council and any other relevant statutory authorities.

Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Wallum sedge frogs.
Corrective action	Apply remedial measures to correct issues of water quality as determined by monitoring outcomes.

Commitment 29

The land user will commit to monitoring Wallum sedge frog populations to ensure that wetlands are appropriately maintained.

8.6 Surface water quality monitoring

Applies to:	On-maintenance phase
Person responsible:	Site Manager; Environmental Consultant

Issue	Surface water quality monitoring.
Operational policy	To maintain the water quality conditions of the receiving waters during the on-maintenance phase of the development.
Performance criteria	Surface water monitoring will be conducted quarterly and following the first quarterly rainfall event (defined as >25 mm in 24 hours) at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Results shall be compared with the surface water quality criteria (indicator parameters only) detailed below.

Surface water quality criteria			
Parameter	Saline (SW1, SW2, SW6, and SW9)	Brackish (SW5)	Fresh (SW3, SW4, SW7, SW8 and SW10)
pH	5.66-6.3	5.34-6.14	5.23-6.66
Electrical Conductivity	<38700 µs/cm	<4008.6 µs/cm	<230.4 µs/cm
Dissolved Oxygen	>7.10 mg/L	>4.87 mg/L	>2.91 mg/L
Turbidity	<3.1 mg/L	<23.76 mg/L	<32.54 mg/L
Total Nitrogen	<0.5 mg/L	<1 mg/L	<1.46 mg/L
Total Phosphorus	<0.03 mg/L	<0.04 mg/L	<0.14 mg/L
Iron (total)	<0.41 mg/L	<4.40 mg/L	<6.57 mg/L
Aluminium (total)	<0.22 mg/L	<0.36 mg/L	<0.68 mg/L
Chlorophyll-a	<6 µg/L	<6 µg/L	<6 µg/L
Litter and gross pollutants	No man made material <5 mm in any dimension	No man made material <5 mm in any dimension	No man made material <5 mm in any dimension
Oil and/or grease	No visible film, no detectable odour	No visible film, no detectable odour	No visible film, no detectable odour

*Note: pH must be consistent with receiving water quality. Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. If receiving waters are estuarine, pH can range from 5.5 -7.5; if receiving waters are fresh, pH can range from 4.2 – 6.7 in accordance with the *Threatened Species Management Plans* (JWA, 2020a-c) for habitat requirements for Wallum Froglet (*Crinia signifera*) and the *Wallum Sedge Frog Management Plan* (JWA 2020g) for habitat requirements for the Wallum sedge Frog (*Litoria olongburensis*).

Implementation strategy	Landscaping activities and revegetation will occur progressively and be maintained throughout the on-maintenance phase. Only appropriate herbicides and fertilisers are to be used in accordance with TSC specifications.
Monitoring	**Frequency**: Routine quarterly monthly and rainfall event (>25mm/24hrs) monitoring for one year following the completion of bulk earthworks. **Parameters**: Those listed in Table 4.1.1. **Vertical Profiling**: Routine quarterly monitoring of temperature, dissolved oxygen, pH, EC and turbidity at 0.5m depths of all off-stream deep water bodies. **Location:** Quarterly monitoring at the surface water locations shown on Drawing 12017_001. Additional locations to be specified oat each defined off-site discharge point in consultation with the Environmental Consultant. Sample recovery and in situ analysis will be performed by a qualified Environmental Scientist and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	Environmental consultant to audit quarterly and rainfall event water quality results against the site specific water quality criteria.
Reporting	The contractor to notify the DPIE immediately of breaches with potential to cause harm to the environment. A Water Quality Report for all water quality monitoring results and assessments shall be submitted to TSC quarterly. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important[10]. • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained. • Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided.

[10] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

Identification of incident or failure	The values of water quality indicators will vary naturally and not all of this variation is ecologically important[11]. The site-specific criteria are based on the 80th percentile of the baseline data set and thus the probability of a single observation exceeding the 80th percentile is 20%. The probability of a Type 1 error (or the risk of triggering a false alarm) is 20%. The recording of a single result that exceeds the criteria will be used to trigger additional investigations including an increase to fortnightly monitoring of the parameter(s) in question. Results will be used to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.
Corrective action	To be determined in consultation with the environmental consultant.

Commitment 30

The manager will maintain background water quality conditions as much as practicable during the on-maintenance phase of the development.

[11] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

8.7 Groundwater monitoring

Applies to:	On-maintenance phase
Person responsible:	Site Manager; Environmental Consultant

Issue	Groundwater monitoring.
Operational policy	To establish stable groundwater conditions and verify by monitoring that development management is appropriate. Groundwater monitoring is to be undertaken in accordance with the site's Groundwater Assessment and Management Plan (G&S July 2012) and any subsequent revisions of that plan.
Performance criteria	Groundwater quality and levels to be monitored monthly at the locations shown on Drawing No. 12017_001 for the parameters listed in Section 4.1. Results shall be compared with the water quality criteria (indicator parameters only) detailed below;

Groundwater quality criteria

Parameter	*Precinct 1*	*Precinct 5*
pH	3.5-4.33	3.59-4.47
Electrical Conductivity	<339.4 µs/cm	<131 µs/cm
Total Nitrogen	<3 mg/L	<1.3 mg/L
Total Phosphorus	<0.34 mg/L	<0.05 mg/L
Iron (total)	<1.02 mg/L	<0.45 mg/L
Aluminium (total)	<1.89 mg/L	<0.52 mg/L

	No variation in groundwater levels beyond normal seasonal fluctuations.
Implementation strategy	Groundwater monitoring will be conducted during the on-maintenance phase at the locations identified on Drawing 12017_001 (unless removed due to the progression of site development). Groundwater samples are to be collected quarterly and analysed for the parameters specified in 'Performance Criteria' above.
Monitoring	Carry out quarterly groundwater level and quality monitoring at locations shown on Drawing 12017_001 (unless removed due to the progression of site development). Sample recovery and in situ analysis will be performed by qualified staff and, when required, samples will be forwarded to a NATA-accredited laboratory.

Auditing	The environmental consultant is to audit water quality quarterly to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site. The data from the water level measurement shall be collated quarterly and evaluated against the background monitoring data. It will also be used to verify the predictive model for groundwater behaviour when required.
Reporting	Quarterly reports are to be submitted to TSC. The water quality reports will be prepared by a suitably qualified and experienced Environmental Consultant. These reports will detail: • The results for each of the environmental indicators monitored. • An assessment of the monitoring results against the criteria. • Consideration must be given to the preferred water quality conditions of WSF communities when interpreting pH results against the site-specific water quality criteria. • When interpreting compliance with the adopted water quality criteria, it is essential to acknowledge that the values of water quality indicators vary naturally and that not all of this variation is ecologically important.[12] • An evaluation, if applicable, of the environmental conditions if monitoring results fall outside the limits of the release criteria. • Recommendations that are relevant to ensuring a high level of water quality is maintained. • Each report will include previous water quality results in tabular format for comparative purposes and trend graphs will be provided. Laboratory certificates will be provided.
Identification of incident or failure	The values of water quality indicators and groundwater levels will vary naturally and not all of this variation is ecologically important.[13] The site-specific criteria are based on the 80th percentile of the baseline data set and thus the probability of a single observation exceeding the 80th percentile is 20%. The probability of a Type 1 error (or the risk of triggering a false alarm) is 20%. The recording of a single result that exceeds the criteria will be used to trigger additional investigations including an increase to fortnightly monitoring of the parameter(s) in question. Results will be used to ascertain whether an adverse trend may be emerging and if so, allow early detection of the cause of the trend. The findings of such site investigations should be used to determine whether a non-compliance has occurred.
Corrective action	If a trend of declining groundwater quality is detected, the likely source(s) of contamination will be identified.

[12] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.
[13] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, 2000, Section 3.1, Page 21.

	Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take appropriate actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence. • All development activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted. The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below.

Commitment 31

The manager will seek to maintain stable groundwater conditions and verify by monitoring that development management is appropriate.

8.8 Maintenance of treatment measures

Applies to:	On-maintenance phase
Person responsible:	Proponent; Site Manager

Issue	Maintenance of permanent stormwater quality treatment devices.
Operational policy	To ensure that the stormwater quality treatment devices are maintained at an appropriate operational standard.
Performance criteria	No significant change in the physical characteristics of treatment devices. No significant change in the physicochemical and/or biological characteristics of the treatment devices.
Implementation strategy	Routine visual inspections and monitoring and maintenance.
Monitoring	Routine monthly visual inspection of treatment trains and vegetated open space for: • litter; • erosion; • excessive sediment deposition; • clogging (bio-retention); • vegetation damage (e.g. die off, weed growth); and • damaged or failed treatment devices. Change in physical characteristics: • water level; and • area, depth or bed profile of any bio-retention basin, waterway and wetland system.
Auditing	Audit inspections are to be carried out on a quarterly basis to verify that the stormwater quality control structures are properly maintained by the contractor.
Reporting	A checklist is to be completed which assesses the strategies listed above and includes the following: • A record of inspection details and; • A record of details of all maintenance activities (including volume of silt removed from each GPT or other control structure). Results to made available to TSC at all times. A summary of the inspection checklist findings shall be included in the annual water quality monitoring report.
Identification of incident or failure	Identification of incident or failure may be identified by: • Blockage of stormwater system. • Build-up of sediment & litter or re-entrainment of trapped sediments.

	• Excessive erosion. • Vegetation damage. • Poorly maintained, damaged or failed control devices. • A change in the physical characteristics. • A change in the physicochemical and/or biological characteristics. • Impeded drainage of bio-retention and filter basins. • Deterioration of water quality downstream of the control structure/s.
Corrective action	**Bio-retention and filter basin maintenance** • Regular harvesting to ensure vegetation is maintained at acceptable levels. • Removal of a portion of vegetation to maintain nutrient and biomass balance. • Removed vegetation to be composed and reused on landscaping in other parts of development site. • Soil renovation (as required) to maintain permeability. • Removal of litter. **Gross pollutant traps** • Removal of trap material in accordance with manufacturer's specifications. **Vegetated rough** • Regular mowing and maintenance of rough filter characteristic by mulching organic matter back into rough soil profile • ensure vegetation is maintained at acceptable levels (minimum 85% foliage protective cover). • Removal of litter within the swale. Waterway and wetland system will be as per weed management program.

Commitment 32

The manager will ensure management measures are implemented (if required) to ensure the stormwater quality treatment devices are maintained at operational standard.

8.9 Golf course water conservation

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Water flows are to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Harvesting** • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. **Volume** • Maintain constant volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to ground water. **Storage** • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. **Treatment** • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. **Distribution** • 30% annual average recharge to ecosystem. • 70 % to landscape in golf course.

	Maintenance of treatment basins • Basins maintained to ensure nutrient stripping and water infiltration. An Environmental Management System (EMS) for the golf course should be developed and implemented to ensure staff and contractors are familiar with the above strategies.
Monitoring	Quarterly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an biannual basis.
Reporting	Results of monitoring will be reported biannually to TSC and NSW DPIE.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment 33

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

8.10 Water management (golf course irrigation)

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Groundwater levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in groundwater height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Irrigation to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Source of water** • Extraction at central point of development which is distant from ground water dependant ecosystems. **Distribution** • Pipe mains and lateral distribution. • Spray irrigation for distribution efficiency. • Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). • Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). **Irrigation scheduling** • Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). • Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). • Soil water deficit based trigger for irrigation. • Effective soil depth for schedule 0-200 mm. • Refill point to be set at 70% plant available soil moisture depletion. • Irrigation applied to 98% of field capacity.

	Water allocation model • Sustainable yield applied to irrigation set at 70 % recharge potential. **Recycling** • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. **Soil management** • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. **Plant selection and management** • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location e.g. Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
Monitoring	**Monthly** *Height monitoring:* • Surface water – dams, basins, adjacent ecosystem water bodies. • Ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent Coastal Management SEPP wetland). *Parameters:* • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). **Daily** • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a biannual basis.
Reporting	Results of monitoring will be reported biannually to TSC and DPIE.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course.

	Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing if incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment 34

The land user will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

8.11 Golf course nutrient management

Applies to:	On-maintenance Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Water quality is to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. Critical criteria set as per background monitoring. Parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total nitrogen and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; • oil and grease (visual inspection); • calcium; • magnesium; • potassium; • sodium; • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour.

Implementation strategy	**Tees** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site's Fertiliser Management Plan. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. **Greens** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for green maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. **Fairways** • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. In addition,

	a mass balance method will be used to identify fertiliser rates – inputs of water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off. **Rough** • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough. **Swales and detention basins** • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
Monitoring	**Groundwater** Monthly: • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1 m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total; NH_4; NO_3; P – Total; Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. **Surface water** Monthly: • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH_4, NO_3, P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Quarterly: • Central irrigation supply. • Parameters: irrigation water quality, N & P. **Soils** Biannually:

	• Soil fertility sampling as per standard practice for turf (agricultural) management. **Biomass** Quarterly: • Fairway reference sites set at four locations within golf course. • The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). Biannually: • Coastal Management SEPP wetland and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a biannual basis.
Reporting	Results of monitoring will be reported biannually to TSC and NSW DPIE.
Identification of incident or failure	• Groundwater analyses in excess of critical limits for two consecutive sample events. • Critical limit set considering background monitoring.
Corrective action	Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor.

Commitment 35

The land user will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding Coastal Management SEPP wetlands and ecological protection zones.

9 Management of potential impacts – operational phase

9.1 Intent

This part of the OWMP specifies those matters which should be complied with by the golf course management during the operational phase, being the period after which each stage has been accepted off-maintenance by Council. The Proponent's obligations end following cessation of the on-maintenance period.

9.2 Aquatic flora & weed management and maintenance

Applies to:	Operational period of golf course
Person responsible:	Golf Course Manager

Issue	Aquatic flora and weed management and maintenance.
Operational policy	To maintain healthy aquatic plant life and control weeds to promote the ecosystem health of wetlands and waterbodies.
Performance criteria	• Macrophyte establishment success rate >70%. • The suppression of aquatic weeds and algae. • Maintenance of hydraulic performance between waterbodies.
Implementation strategy	Weed monitoring and maintenance is to be conducted in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Weed strategy** An expectation of avoidance or total removal of aquatic weeds within the waterway and wetland system is not realistic as weeds are present within the catchment and neighbouring sites. Management of macrophytes via removal of vegetation within flow paths to maintain hydraulic conductance. Particular attention should be given to weed management to prevent obstruction of hydraulic conductance. When removing weeds, care must be taken not to damage the growth of native aquatic plants or interrupt natural ecosystem function by adhering to the following methods: • Avoid overspray through use of correct equipment and not spraying in windy conditions. • Bag and removal of weeds offsite. • Manage access to wetlands to avoid damage via trampling. • Should mechanical harvesting of weed growth be required, access to waterbodies will be selected to achieve minimal impact and access points will be rehabilitated at the end of the harvesting period.

	Algae strategy Quarterly monitoring, particularly in Spring and Summer, is required to reduce the potential for algal blooms. Proposed management methods could include: • Ability to isolate separate on-stream system pools to contain algal blooms. • Emergency aeration and/or mixing. • Safety signage during algal outbreaks. **Off-stream waterway and wetland system** Proposed management methods include: • Containment of blooms within off-stream waterway and wetland system. • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks.
Monitoring	Routine quarterly monitoring for two years following the completion of the on-maintenance phase of works. Routine quarterly visual inspection of treatment trains for vegetation establishment, damage, weed invasion and clogging.
Auditing	Reviews to be carried out on a quarterly basis to assess the appropriateness of the implementation strategy. A checklist is to be completed which assesses the effectiveness of strategies detailed above.
Reporting	Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers.
Identification of incident or failure	Non-compliance with agreed performance criteria will be identified by: • Vegetative losses >20%. • Weed growth that impacts upon ecosystem function and/or hydraulic conductance. • Algal blooms exceeding 500 cells/ml.
Corrective action	If vegetation fails, new vegetation should be planted and established. Vegetation may require supplementary replanting. Macrophyte density to be maintained at prescribed levels to achieve hydraulic conductance and pollutant removal. If algal blooms occur the following corrective actions should be investigated in consultation with the Environmental Consultant; • Containment of blooms within off-stream waterway and wetland system (no release of water if blue green algae levels exceed 50,000 cells/ml). • Emergency turnover. • Emergency vertical aeration and/or mixing. • Safety signage during algal outbreaks.

	The following specific actions may be undertaken in consultation with the Environmental Consultant: *500 cells/ml* • Increase turnover mixing until numbers are brought back to lower levels. • Fertiliser activity to be limited. • Maintain regular monitoring. *2,000 cells/ml* • Increase mixing. • Increase turnover through additional pumping of the recirculation system. • Vertical mixing through emergency compressed air or mechanical mixing devices. • Fertiliser activity and sprinkling to be limited where possible in the vicinity of the test sites of concern. • Harvest and land dispose of any dead fish. • Monitoring frequency to be increased at affected sites to once a month. *15,000 cells/ml* • All fertiliser activity and sprinkling to be stopped in the vicinity of the sites of concern. • Warning signs to be posted around the sites of concern. • All site personnel to be notified. • Monitoring frequency to be increased at affected sites to once a week. Contingency measures are to be considered including: • Increased mixing. • Harvesting and land disposal of algae and dead fish; and • Allowing bloom to run its course.

Commitment 36

The golf course management will ensure the health of the wetland and waterbody ecosystems is maintained through active weed and algae monitoring and management.

9.3 Groundwater monitoring

Applies to:	Operational phase
Person responsible:	Golf Course Manager

Issue	Groundwater monitoring.
Operational policy	To maintain stable groundwater conditions and verify by monitoring that development management is appropriate. Groundwater monitoring is to be undertaken in accordance with the site's *Groundwater Assessment and Management Plan* (G&S July 2012) and any subsequent amendments.
Performance criteria	Groundwater quality performance criteria as specified in Table 11.4.1.2. No variation in groundwater levels beyond normal seasonal fluctuations. Additional monitoring for hydrocarbon (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); and enterococci.
Implementation strategy	Monitoring of groundwater levels should be undertaken biannually during the operational phase. Groundwater samples are to be collected biannually and analysed for the parameters specified above.
Monitoring	Carry out biannual groundwater level and quality monitoring at locations identified on Drawing 12017_001 (unless removed due to the progression of site development). Sample recovery and in situ analysis will be performed by onsite staff and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	The environmental consultant is to audit water quality biannually to ensure that no deleterious effects are resulting from site activities.
Reporting	Annual reports are to be submitted to TSC. The annual reports to TSC shall include raw data, a results summary and a discussion comparing results with criteria as specified in Table 11.4.1.2. Result sheets to be compiled for monitoring results. All results shall be made available for inspection by local and state government officers when requested.
Identification of incident or failure	Degradation of groundwater quality. Variations in groundwater levels beyond typical seasonal fluctuations.
Corrective action	If the test results for any parameter fails to meet the performance criteria (to be determined based on background monitoring), further investigations will be conducted. This will involve monthly groundwater quality monitoring (or more frequent if deemed necessary by the environmental consultant) of the subject parameter(s).

	The results of the investigation should ascertain if the incident/failure is an anomaly or if a sustained decline in groundwater quality is present. If a trend exists for declining groundwater quality, the likely source(s) of contamination will be identified. Should the investigation indicate that site activities are triggering the incident/failure, the following will be implemented: • Locate the source of the contamination/level variation and take appropriate actions to contain and control the contaminant/level variation. Investigate the cause of the contamination/level variation and take action to prevent a recurrence. • All activities taking place at the time of incident/failure shall be reviewed to verify compliance with the OWMP provisions and, if necessary, construction methods and procedures shall be adjusted.

Commitment 37

The Golf Course Manager will seek to maintain stable groundwater conditions and verify by monitoring that management is appropriate.

9.4 Maintenance of water treatment measures

Applies to:	Operational period of golf course
Person responsible:	Golf Course Manager

Issue	Maintenance of stormwater quality treatment devices.
Operational policy	To ensure that the stormwater quality treatment devices are maintained at an appropriate operational standard.
Performance criteria	No significant change in the physical characteristics of treatment devices. No significant change in the physicochemical and/or biological characteristics of the treatment devices.
Implementation strategy	Routine visual inspections and monitoring and maintenance.
Monitoring	Routine quarterly visual inspection of treatment trains and vegetated open space for: • Litter. • Erosion. • Excessive sediment deposition. • Clogging (bio-retention). • Vegetation damage (e.g. die off, weed growth). • Damaged or failed treatment devices: • Change in physical characteristics. • Water level. • Area, depth or bed profile of any bio-retention basin, waterway and wetland system.
Auditing	Audits are to be carried out on an annual basis to assess the implementation strategy.
Reporting	A checklist is to be completed which assesses the strategies listed above.
Identification of incident or failure	Non-compliance with the criteria will be identified by: • Blockage of stormwater system. • Build-up of sediment & litter or re-entrainment of trapped sediments. • Excessive erosion. • Vegetation damage. • Poorly maintained, damaged or failed control devices. • A change in the physical characteristics. • A change in the physicochemical and/or biological characteristics. • Impeded drainage of bio-retention and filter basins. • Deterioration of water quality downstream of the control structure/s.

Corrective action	Bio-retention and filter basin maintenance • Regular harvesting to ensure vegetation maintained at acceptable levels. • Removal of a portion of vegetation to maintain nutrient and biomass balance. • Removed vegetation to be composed and reused on landscaping in other parts of development site. • Soil renovation (as required) to maintain permeability. • Removal of litter. **Gross pollutant traps** • Removal of trap material in accordance with manufacturer's specifications. **Vegetated rough** • Regular mowing and maintenance of rough filter characteristic by mulching organic matter back into rough soil profile. • ensure vegetation is maintained at acceptable levels (minimum 85% foliage protective cover). • Removal of litter within the swale. **Waterway and wetland system** • As per weed management program **Sediment/sludge removal** • Sludge and sediments are expected to settle in the inlet zones of the wetlands and other water bodies. In the operational state this is expected to be minor and de-silting will only be required on an infrequent basis (maybe every 50 years). Prior to works the recommended best practice method of sediment/sludge removal of the time will be used.

Commitment 38

The Golf Course Manager will ensure management measures are implemented (if required) to ensure the stormwater quality treatment devices are maintained at operational standard.

9.5 Surface water monitoring

Applies to:	Operational period of golf course
Person responsible:	Golf Course Manager

Issue	Surface water monitoring.
Operational policy	Any waters discharged from the site should meet the specified water quality objectives (WQOs). Water quality in the waterway and wetland system should remain at an acceptable level.
Performance criteria	All controlled water discharges from the site will comply with water quality criteria set by pre-construction background monitoring as referred to in Table 11.4.1.1 of this OWMP.
Implementation strategy	Routine surface water quality monitoring to be undertaken.
Monitoring	**Frequency**: Routine biannual monitoring for two years following the completion of the on-maintenance period, with biannual rainfall event (>25mm/24hrs) monitoring campaigns. **Parameters**: Those listed in Table 11.4.2 (Background water quality monitoring) in addition to: hydrocarbon (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); and enterococci. **Vertical Profiling**: Routine biannual monitoring of temperature, dissolved oxygen, pH, conductivity, salinity and turbidity at 0.5m depths of all off-stream deep water bodies. Sample recovery and in situ analysis will be performed by a qualified Environmental Scientist and, when required, samples will be forwarded to a NATA-accredited laboratory.
Auditing	Biannual audits to be undertaken.
Reporting	Annual Water quality report to be provided to TSC.
Identification of incident or failure	Surface water quality parameter monitoring identifying exceedance of WQOs.
Corrective action	If exceedance of WQOs continues to occur, inspect all treatment techniques, revise designs or review different alternatives and install if necessary in consultation with the Environmental Consultant.

Commitment 39

The Golf Course Manager will ensure routine monitoring is carried out to ensure water quality is in accordance with the water quality objectives.

9.6 Golf course water conservation

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Water flows are to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Harvesting** • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. **Volume** • Maintain constant volumes by maintaining course infiltration rate and fairways runoff directed to swales for detention and infiltration to ground water. **Storage** • Subsurface storage. • Central dam of surface run-off collection and ground water window. • Habitat storages within landscape plan. **Treatment** • Bio-detention and filter basins to remove nutrients. • Sediments removed by filtering through rough and percolation through Bio-detention and filter basin floor. **Distribution** • 30% annual average recharge to ecosystem. • 70 % to landscape in golf course.

	Maintenance of treatment basins • Basins maintained to ensure nutrient stripping and water infiltration. An Environmental Management System (EMS) for the golf course should be developed and implemented to ensure staff and contractors are familiar with the above strategies.
Monitoring	Quarterly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an biannual basis.
Reporting	Results of monitoring will be reported biannually to TSC and DPIE.
Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment 40

The Golf Course Manager will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

9.7 Water management (golf course irrigation)

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	All water flows must be controlled and managed to allow the effective use of the onsite water within a total water cycle. Essential to the ecological stability of the golf course and surrounding wetland and ecological protection zone is the maintenance of water quantities to both golf course and ecosystems.
Operational policy	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Ground water levels to be maintained within and adjacent to golf course with critical levels to be in accord with the seasonal variation in ground water height. Monitoring periods to be divided into Summer recharge period and Winter depletion period.
Implementation strategy	Irrigation is to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. **Source of water** • Extraction at central point of development which is distant from ground water dependant ecosystems. **Distribution** • Pipe mains and lateral distribution. • Spray irrigation for distribution efficiency. • Irrigation on tees greens and fairways only (allowing for minor over-spray on adjacent roughs). • Pump stations and associated infrastructure, including sprinkler heads, to be sized and installed in accordance with recommendations in ePar (2009, pp10). **Irrigation scheduling** • Install weather station and computerised control system to ensure efficient irrigation in accordance with recommendations in ePar (2009, pp9). • Irrigation to occur at dawn or dusk (generally characterised by lower relative humidity, air temperature and wind speed). • Soil water deficit based trigger for irrigation. • Effective soil depth for schedule 0-200mm.

	• Refill point to be set at 70% plant available soil moisture depletion. • Irrigation applied to 98% of field capacity. **Water allocation model** • Sustainable yield applied to irrigation set at 70 % recharge potential. • Recycling. • Fairways constructed with gradient towards bio-detention basins. • Capture of irrigation runoff in detention basins for treatment and groundwater recharge. • Tees and greens captured separately and recycled to fairways. **Soil management** • Soil amendment to improve moisture holding (zeolite etc). • Maintenance of soil organic matter for soil structure maintenance. • Minimise compaction by machinery selection and operating procedures. • Control traffic. **Plant selection and management** • Native species and naturalised species endemic to local area. • Species selection dependant on landscape location e.g. Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
Monitoring	**Biannually** *Height monitoring:* • surface water – dams, basins, adjacent ecosystem water bodies; and • ground water transect from detention basins to protection area (e.g. of groundwater monitoring bore transect through golf course and extending into adjacent Coastal Management SEPP wetland). *Parameters:* • Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure). **Daily** • Soil water – Soil water monitoring for refill point - methods to be selected as appropriate to soil and turf management conditions, for instance: tensiometers (150 mm depth), or Penman's estimation etc.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported annually to TSC and NSW DPIE.

Identification of incident or failure	Ground water heights outside of critical limits to water level.
Corrective action	Groundwater lower than the critical level – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 40% to ecosystem 60% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 60% to ecosystem 40% to golf course. Continue to monitor. Ground water still outside limits – irrigation extraction rate of golf course to be modified to redistribute the recharge potential to a new regime of 80% to ecosystem 20% to golf course. Seek alternate sources of water for golf course irrigation and undertake environmental management and plan for the import of water supply to site. Continue to monitor. Ground water still outside limits – implement alternate water supply. Groundwater higher than critical level – determine source of excess water. High rainfall events – do nothing if incident is self-correcting. Golf course groundwater mounding – alter irrigation regime to decrease irrigation input to site.

Commitment 41

The Golf Course Manager will ensure the water table heights in the vicinity of the golf course will be maintained within the critical limits identified in the Overall Water Management Plan.

9.8 Golf course nutrient management

Applies to:	Operational Phase of golf course, precincts 12 and 13
Person responsible:	Golf Course Manager

Issue	The nutrients applied to maintain the vigour of the golf course must not gain access to the surrounding environment. All nutrients must be controlled and managed to allow the effective use of the onsite water and to ensure to the ecological stability of the golf course and surrounding wetland and ecological protection zone.
Operational policy	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones (Coastal Management SEPP wetland and Ecological protection zones).
Performance criteria	Water quality is to be managed in accordance with the DECC document *'Improving the environmental management of NSW Golf Courses'*. Ground and surface water nutrient levels to be maintained within and adjacent to golf course within critical levels in accord with the seasonal variation in ground water. Monitoring periods to be divided into Summer recharge period and Winter depletion period. Critical criteria set at mean groundwater nutrient level considering background monitoring. Parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L^{-1}); • total nitrogen and nitrate, nitrite and ammonium (mg L^{-1}); • total and soluble phosphorus (mg L^{-1}); • total and soluble iron and filtered aluminium; • oil and grease (visual inspection); • calcium; • magnesium; • potassium; • sodium; • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour.

Implementation strategy	**Tees** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. Fertiliser rates to be determined in consultation with the recommendations in ePar (2009, pp8) or the site's Fertiliser Management Plan. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g. turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Clippings removed and composted for reuse on landscaping. **Greens** • Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways. • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for green maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. • Application method – split application at low rates, timed with other fairway operations that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off) • Clippings removed and composted for reuse on landscaping. **Fairways** • Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity). • Fertiliser selection – slow release and specialty fertilisers for tee maintenance. • Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management. In addition, a mass balance method will be used to identify fertiliser rates – inputs of

	water nutrients, fertiliser and effluent from tees and greens, output soil store, biomass and percolation. • Application method – split application at low rates, timed with other fairway operation s that incorporate nutrients into turf (e.g., turf renovation and top dressing, fertiliser incorporation irrigation events to prevent contamination of surface run-off). • Irrigation maximum refill set to 98% field capacity to ensure first rainfall infiltrates and not runs off. **Rough** • No fertiliser used. • Rough to act as irrigation, sediment and nutrient buffer. • Biomass mulched back into rough. **Swales and detention basins** • No fertiliser used. • Maintenance removal of biomass to composting and reuse in landscaping.
Monitoring	**Groundwater** Quarterly • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); DO (field measure); Temperature (field measure); N – Total; NH_4; NO_3; P – Total; Ortho-P; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. **Surface water** Quarterly • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); DO (field measure); Temperature (field measure); N – Total, NH_4, NO_3 , P – Total, Ortho-P; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. **Soils** Annually • Soil fertility sampling as per standard practice for turf (agricultural) management.

	Biomass Annually • Fairway reference sites set at four locations within golf course. • The reference sites will have the biomass collected (weighed) and analysed for N & P. (Data to be used in estimating mass balance for monitoring purposes). **Coastal Management SEPP wetlands (Previously SEPP 14)** Annually • Coastal Management SEPP wetland and environmental protection zone to be monitored with two (2) reference transects to outline floristic structure and function.
Auditing	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported annually to TSC and NSW DPIE.
Identification of incident or failure	• Groundwater analyses in excess of critical limits for two consecutive sample events. • Critical limit set at considering background monitoring.
Corrective action	Fertiliser regime re-assessed and fertiliser management plan altered by change of fertiliser form, rate or application technology. Continue to monitor.

Commitment 42

The Golf Course Manager will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding Coastal Management SEPP wetlands and ecological protection zones.

10 Monitoring summary for golf course operations

For ease of reference, a monitoring schedule summary relating to stormwater, groundwater and integrated water cycle management for the future Body Corporate of the golf course is provided in the table below. For a more detailed monitoring schedule, refer to the *Kings Forest Stage 1 Management Plan* (DAC, 2012).

Monitoring schedule summary for operation phase of golf course management

Item	Daily	Monthly	Quarterly	Biannually	Annually
Groundwater		Height (AHD)	Height (AHD); pH; EC; temperature; TN; soluble N; NO_x; TKN; NO_2; NO_3; TP; soluble P; Ca; Mg; Na; K/HCO_3; HCO_3; CO_3; total & dissolved Fe; total & dissolved Al; dissolved manganese Mn; Cl; SO_4; NH_4; colour; total acidity (titratable); total alkalinity; As; Cd; Cu; Pb; Ni; Zn; TPH; BTEX; faecal coliforms; and enterococci.	Groundwater monitoring bore transect through golf course and extending into adjacent Coastal Management SEPP wetland: Height (AHD); pH; EC; DO; temperature.	
Leachate			Multiple group lysimeters set at 1m depth in four (4) locations in golf course fairways: pH; EC; DO; temperature; TN, NH_4, NO_3, TP; Ortho-P; Ca; Mg; Na; K; total and dissolved Fe; dissolved Mn; filtered Al; HCO_3; CO_3; Cl; SO_4; and Colour.		
Soils	Soil water monitoring for refill point				Soil fertility sampling as per standard practice for turf (agricultural) management.

Item	Daily	Monthly	Quarterly	Biannually	Annually
Central irrigation supply, water bodies			pH; EC; DO; temperature; TN; NH_4; NO_3; TP; Ortho-P; Ca; Mg; Na; K; total and dissolved Fe; dissolved Mn; filtered Al; HCO_3; CO_3; Cl; SO_4; and Colour.	Height (AHD); pH; EC; DO; temperature. Vertical profiling of all off-stream deep water bodies: temperature; DO; pH, EC; salinity and turbidity at 0.5m depths.	
Biomass					Four locations within golf course: biomass weighed and analysed for N & P.
Wetland and waterbody ecosystems		Regular monitoring, particularly in Spring and Summer, is required to reduce the potential for algal blooms.	Visual inspection of wetlands and water bodies for vegetation establishment, damage, weed invasion and clogging		Two reference transects within the Coastal Management SEPP wetland to outline floristic structure and function.
Stormwater quality treatment devices			Visual inspection of treatment trains and vegetated open space for: litter; erosion; excessive sediment deposition; clogging (bio-retention); vegetation damage (e.g. die off, weed growth); damaged or failed treatment devices (change in physical characteristics such as water level); and area, depth or bed profile of any bio-retention basin, waterway and wetland system		

Item	Daily	Monthly	Quarterly	Biannually	Annually
Surface water			For two years following the completion of the on-maintenance period: pH; EC; turbidity; DO; temperature; SS; TN; soluble N; NO_x; TKN; NO_2; NO_3; TP; soluble P; oil & grease; Ca; Mg; Na; K/HCO_3; HCO_3; CO_3; total & dissolved Fe; total & dissolved Al; dissolved manganese Mn; Cl; SO_4; NH_4; colour; total acidity (titratable); total alkalinity; As; Cd; Cu; Pb; Ni; Zn; TPH; BTEX; chlorophyll-a; faecal coliforms; enterococci; total algal cell count; and blue green algae.	Rainfall event-based (>25mm in 24 hrs) for two years following the completion of the on-maintenance period: pH; EC; turbidity; DO; temperature; SS; TN; soluble N; NO_x; TKN; NO_2; NO_3; TP; soluble P; oil & grease; Ca; Mg; Na; K/HCO_3; HCO_3; CO_3; total & dissolved Fe; total & dissolved Al; dissolved manganese Mn; Cl; SO_4; NH_4; colour; total acidity (titratable); total alkalinity; As; Cd; Cu; Pb; Ni; Zn; TPH; BTEX; chlorophyll-a; faecal coliforms; enterococci; total algal cell count; and blue green algae. Vertical profiling of all off-stream deep water bodies: temperature; DO; pH, EC; salinity and turbidity at 0.5m depths.	

11 Administration of the OWMP

11.1 Amendment of the OWMP

The Proponent may make an application to TSC to amend the provisions of this OWMP. The application shall:

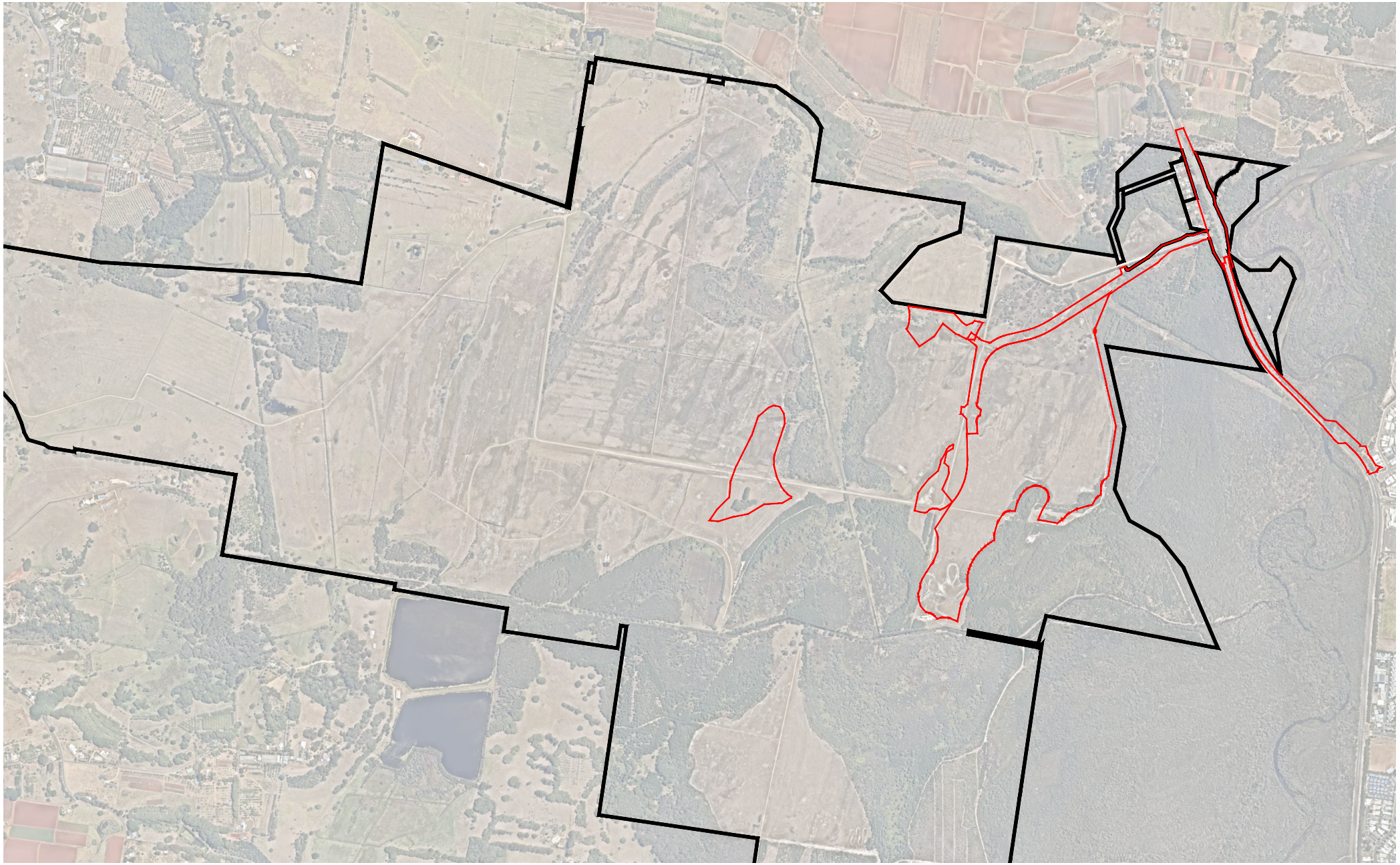
- be in writing; and
- specify the provisions of the OWMP to which the application relates; and
- state how the proposed amendments achieve the objectives of the provisions to which the amendments relate.

TSC shall approve the amendment where TSC is satisfied acting reasonably that the proposed amendments achieve the objective of the provisions to which the amendment relates.

11.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this OWMP have clearly defined responsibilities under the NSW *Protection of the Environment Operations Act* (1997) to report any incidents likely to cause material or serious environmental harm.

12 Attachment 1 – Drawings



ORIENTATION

SCALE 1:12 500

100 200 300 400 500 600
metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs www.access.gs

LEGEND

- Phase 1 Works Boundary
- Site Boundary

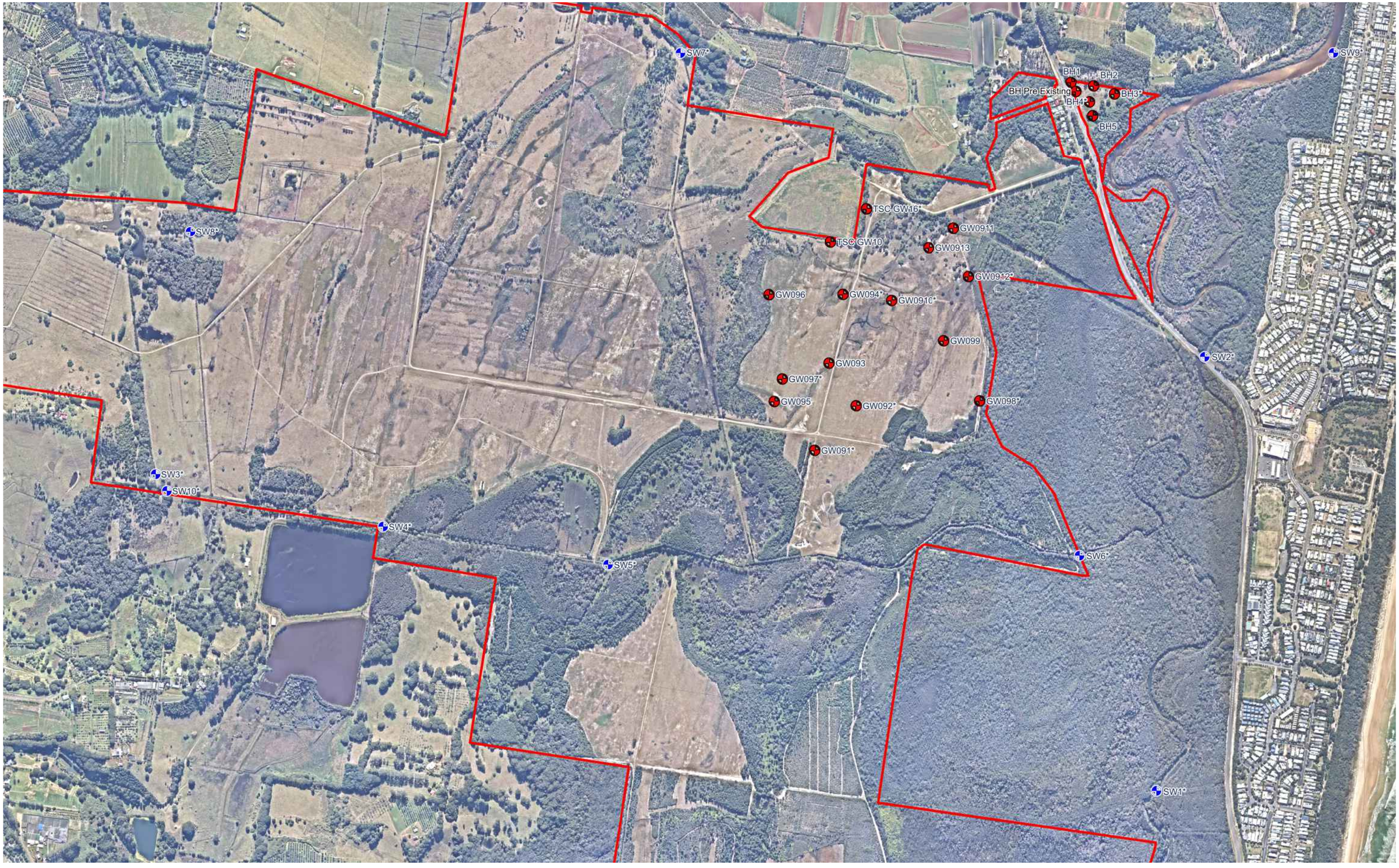
SOURCES

Image: Near Map, Image dated 6 November 2019.

PROJECT	CLIENT	DRAWING
KINGS FOREST - PHASE 1 WORKS	PROJECT 28 PTY LTD	KINGS FOREST PHASE 1 WORKS

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:12,500@A3	28/05/2020	SWP	ELH	12066	100	-

GILBERT SUTHERLAND



ORIENTATION

SCALE

100 200 300 400 500
metres

ROBINA
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LEGEND

- Cadastral boundaries
- Site boundary
- Groundwater monitoring boreholes
- Surface water monitoring locations

SOURCES

Image: Nearmap image dated 15/07/2019.

NOTES

1. Field in-situ monitoring conducted at all locations.
2. Laboratory samples collected at monitoring locations with an asterix*.

PROJECT
KINGS FOREST

CLIENT
PROJECT 28 PTY LTD

DRAWING
BASELINE MONITORING LOCATIONS

SCALE	DATE	DRAWN	CHECKED	PROJECT	DRAWING	REVISION
1:12,500@A3	12/09/2019	AJF	NMS	12017	001	-

GILBERT SUTHERLAND