

PROJECT
**OVERALL WATER
MANAGEMENT PLAN KINGS
FOREST STAGE 1 PROJECT
APPLICATION KINGS FOREST
NEW SOUTH WALES**

PREPARED FOR
PROJECT 28 PTY LTD

DATE
JUNE 2011

DOCUMENT CONTROL

DOCUMENT 10468 OWMP RMH3F.docx

TITLE Overall Water Management Plan, Kings Forest Stage 1 Project Application, Kings Forest, New South Wales

PROJECT MANAGER N. Sutherland

AUTHOR(S) M. Hancock

CLIENT Project 28 Pty Ltd

CLIENT CONTACT Reg van Rij

CLIENT REFERENCE –

SYNOPSIS This report constitutes an Overall Water Management Plan (OWMP) for the Kings Forest Stage 1 Project Application. The OWMP integrates the discreet management provisions outlined in numerous separate reports relating to stormwater, groundwater and integrated water cycle management. This report addresses, in part, the Environmental Assessment Requirements specified by the Director General of the NSW Department of Planning (DGRs) in relation to the proposed Kings Forest development, Kings Forest, New South Wales.

REVISION HISTORY

REVISION #	DATE	EDITION BY	APPROVED BY
1	2/11	M. Hancock	N. Zurig / L. Varcoe
2	4/11	M. Hancock	N. Zurig / L. Varcoe
3	6/11	M. Hancock	N. Zurig / L. Varcoe

DISTRIBUTION

	REVISION NUMBER									
Distribution	1	2	3	4	5	6	7	8	9	10
Project 28 Pty Ltd	3	1	1							
JBA Planning	-	1	1							
G&S file	1	1	1							

BRISBANE

CAIRNS

KAWANA

ROBINA

5/232 Robina Town Centre Dr,
PO Box 4115
Robina Q4230

Phone 07 5578 9944

Fax 07 5578 9945

robina@access.gs

Gilbert and Sutherland Pty Ltd
ABN 56 077 310 840

www.access.gs

SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to prepare an Overall Water Management Plan (OWMP) in support of the Kings Forest Stage 1 Project Application at Kings Forest, New South Wales.

This Overall Water Management Plan (OWMP) addresses, in part, the amended Director General's Requirements (DGRs) and Approved Concept Plan Conditions. Preparation of the OWMP involved a review of the Preferred Project Report for the Concept Plan and existing and revised environmental reports.

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 water management at the site, incorporating stormwater, groundwater and integrated water cycle management. The OWMP integrates the provisions of the following management plans in accordance with the proposed construction sequencing:

- Overall Water Management Plan (G&S, February 2011).
- Erosion and Sediment Control Management Plan (G&S, February 2011).
- Acid Sulfate Soil Management Plan, (G&S, February 2011).
- Integrated Water Cycle Management Plan (G&S, February 2011).
- Stormwater Management Plan (G&S, February 2011).
- Groundwater Assessment and Management Plan (G&S, February 2011).
- Review of Environmental Management Plan (ePar 2009).
- Threatened Species Management Plan (James Warren & Associates 2011, 'JWA').
- Vegetation Management Plan (JWA 2011).

CONTENTS

1	Introduction	7
1.1	Background	8
1.2	Scope of report.....	8
2	Proposed development	9
2.1	Stage 1 Project Application	9
3	Overall Water Management Plan	10
3.1	Aims and objectives	10
3.2	Scope of this document.....	10
3.3	Implementation.....	11
3.4	OWMP structure.....	11
3.5	General commitments	12
3.6	Definitions.....	12
3.7	Contact details.....	13
4	Baseline data collection phase.....	14
4.1	Intent	14
4.2	Background water quality monitoring	14
5	Management of potential impacts – bulk earthworks phase	16
5.1	Intent	16
5.2	Threatened species - Wallum Froglet	16
5.3	Threatened species - Olongburra frog	18
5.4	Acid sulfate soil leachate monitoring	20
5.5	Groundwater monitoring.....	22
5.6	Groundwater seepage monitoring	25
5.7	Surface water quality	28
5.8	Freshwater ecology	32
5.9	Waterways & wetlands management	34
6	Management of potential impacts – landform stabilisation phase	38
6.1	Intent	38
6.2	Aquatic flora & weed management and maintenance	38
6.3	Threatened species - Wallum froglet.....	40
6.4	Threatened species - Olongburra frog	42
6.5	Maintenance of water treatment measures	44

6.6	Stormwater management	47
6.7	Surface water monitoring	50
6.8	Site stabilisation	52
6.9	Groundwater monitoring	53
7	Management of potential impacts – Civil construction	56
7.1	Intent	56
7.2	Aquatic flora & weed management and maintenance	56
7.3	Threatened species - Wallum froglet.....	59
7.4	Threatened species - Olongburra frog	61
7.5	Groundwater monitoring	63
7.6	Groundwater seepage monitoring	66
7.7	Surface water quality	69
7.8	Golf course water conservation	73
7.9	Water management (golf course irrigation)	75
7.10	Golf course nutrient management.....	78
8	Management of potential impacts – On maintenance phase ...	82
8.1	Intent	82
8.2	Implementation	82
8.3	Aquatic flora & weed management and maintenance	83
8.4	Threatened species - Wallum froglet.....	86
8.5	Threatened species - Olongburra frog	88
8.6	Surface water quality	90
8.7	Groundwater monitoring	94
8.8	Maintenance of treatment measures	97
8.9	Golf course water conservation	99
8.10	Water management (golf course irrigation).....	101
8.11	Golf course nutrient management.....	104
9	Management of potential impacts – operational phase.....	108
9.1	Intent	108
9.2	Aquatic flora & weed management and maintenance	108
9.3	Groundwater monitoring	111
9.4	Maintenance of water treatment measures	114
9.5	Surface water monitoring	116
9.6	Golf course water conservation	118
9.7	Water management (golf course irrigation)	120
9.8	Golf course nutrient management	123

10	Monitoring summary for golf course operations.....	127
11	Administration of the OWMP	130
11.1	Amendment of the OWMP	130
11.2	Incident management	130
12	Attachment 1 – Drawings.....	131
13	Attachment 2 – Reference drawings.....	132

LIST OF FIGURES

DRAWING NO.	DESCRIPTION
Attachment 1 - drawings	
10468.6.1	Stage 1 Project Application Master Plan
10468.6.2	Stage 1 in relation to sensitive environmental receptors
Attachment 2 – reference drawings	
12301-05-040-A	Cut and fill plan

GLOSSARY

TERM	MEANING
ASSMAC	Acid Sulfate Soils Management Advisory Committee Manual 1998
DECCW	NSW Department of Environment, Climate Change and Water
DGR	Director General requirement
EPA	Environmental Protection Agency
mAHD	Metres Australian Height Datum
NATA	National association of testing authorities
pH	The degree of acidity or alkalinity measured on a scale of 1 to 14, with 7 as neutral. From 1 to 7 is acidic; from 7 to 14 is alkaline.
SBMP	Site based management plan
SEPP	State environmental planning policy

1 Introduction

1.1 Background

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to provide an Overall Water Management Plan (OWMP) in support of the Kings Forest Stage 1 Project Application.

The concept plan for the proposed Kings Forest Development was approved by the New South Wales Minister for Planning on 22 December 2010 and the Director General of the Department of Planning issued a series of Environmental Assessment Requirements (DGRs) for the site on 23 December 2010.

1.2 Scope of report

This OWMP for the Kings Forest Stage 1 Project Application reviewed and was prepared in accordance with:

- The latest Master Plan, dated December 2010.
- Minister for Planning Concept Approval conditions, dated 22 December 2010.
- The Amended Director General's Environmental Assessment Requirements (DGRs) for Project Application No. 08_0194, dated 23 December 2010.

The OWMP acts as a tool for the integration and implementation of the management strategies relating to stormwater, groundwater and

integrated water cycle management that are proposed in the following reports:

- Overall Water Management Plan (G&S, February 2011).
- Erosion and Sediment Control Management Plan (G&S, February 2011).
- Acid Sulfate Soil Management Plan, (G&S, February 2011).
- Integrated Water Cycle Management Plan (G&S, February 2011).
- Stormwater Management Plan (G&S, February 2011).
- Groundwater Assessment and Management Plan (G&S, February 2011).
- Review of Environmental Management Plan (ePar 2009).
- Threatened Species Management Plan (James Warren & Associates 2011, 'JWA').
- Vegetation Management Plan (JWA 2011).

The OWMP addresses the following December 2010 DGR:

7.7 Provide an overall water management plan, integrating any discrete water, stormwater, groundwater and Acid Sulfate Soil management plans.

This OWMP incorporates the management provisions in the aforementioned reports (see Section 3).

2 Proposed development

2.1 Stage 1 Project Application

The approved Kings Forest Concept Plan proposes the creation of a residential community inclusive of associated educational, social, commercial, sporting and recreational amenities. The development is to be completed in stages.

The Kings Forest Stage 1 Project Application seeks approval for a rural retail development in Precinct 1, residential development in Precinct 5 and bulk earthworks within the balance of the site. A Precinct Plan prepared by MPS Architects is provided in Attachment 2.

The proposed development would include:

- Subdivision to create new lots/land parcels for future development.
- Construction of the entrance road to the site and associated works for the intersection with Tweed Coast Road, as well as a new connecting road to the Tweed Shire Council's former waste tip.
- Subdivision and associated infrastructure works for the first stage of urban development (Precinct 5).
- Bulk earthworks and planting for the future golf course.
- A rural retail development (commercial site) on the developable land east of Tweed Coast Road.
- Bulk earthworks as required in all precincts.

The revised Master Plan by MPS Architects is included in the reference drawings for this report (Attachment 2). The Stage 1 Project Application Master Plan is shown on Drawing No. 10468.6.1 (Attachment 1). The proximity of the Stage 1 Project Application Master Plan to sensitive environmental receptors is shown on Drawing No. 10468.6.2 (Attachment 1).

Given that the present application is for Stage 1 of the Master Plan, detailed road and allotment layouts have not been completed for the whole of the project. However preliminary bulk earthworks design, site grading and drainage design have been prepared.

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 1.2. 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:

- Kings Forest Stage 1 Project Application and associated documentation.
- Site Based Management Plan (Gilbert & Sutherland, February 2011, 'G&S').
- Erosion and Sediment Control Management Plan (G&S, February 2011).
- Acid Sulfate Soils Assessment and Management Plan (G&S, February 2011).
- Integrated Water Cycle Management Plan (G&S, February 2011).
- Stormwater Management Plan (G&S, February 2011).
- Groundwater Assessment and Management Plan (G&S, February 2011).
- Review of Environmental Management Plan (ePar 2009).
- Vegetation Management Plan (James Warren & Associates 2011, 'JWA').
- Threatened Species Management Plan (JWA 2011).

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 operations 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.
- DECCW means the Department of Environment, Climate Change and Water.

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 Intent

This part of the OWMP specifies those matters which must be complied with by the Proponent during the baseline data collection phase, being the period prior to bulk earthworks when baseline monitoring is being undertaken.

4.2 Background water quality monitoring

Applies to	Baseline data collection phase
Person responsible	Nominated Environmental Consultant

Issue	Establishing appropriate discharge criteria for the construction phase. To determine the existing water quality conditions at the site (levels and quality) and examine any seasonal variations that may result from increased precipitation. This would serve as 'baseline' data and allow comparison with level and quality results recovered during the bulk earthworks and civil construction phase of works at the site.
Operational policy	To determine existing water quality parameters for the proposed Kings Forest Stage 1 area, prior to construction.
Performance criteria	The performance criteria shall be set by background monitoring of pre-construction water quality conditions. The following parameters shall be monitored for a minimum of eight (8) rounds of monitoring: • 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. Laboratory analysis for total acidity (titratable) should also be undertaken on a monthly basis by a NATA accredited laboratory to determine the total potential acidity hazard that may be associated with groundwater at the site.
Implementation strategy	Surface water quality and groundwater level and quality monitoring on a monthly basis from established monitoring locations prior to commencement of bulk earthworks. Following the completion of background monitoring, a water quality report, including results and interpretation would be prepared and submitted to TSC for review.
Monitoring	Background monitoring shall be conducted by a qualified Environmental Scientist for the parameters listed above to allow the interpretation of data for statistical analysis and groundwater modelling purposes.
Auditing	The consultant will audit the results and submit a background groundwater quality report to TSC prior to the commencement of construction works.
Reporting	A background report to TSC including raw data, a results summary and a discussion comparing results with ANZECC guidelines.
Identification of incident or failure	Failure to collect adequate rounds of data prior to commencement of bulk earthworks.
Corrective action	• Cease works until data is available. • Increase frequency of monitoring until sufficient data is available.

Commitment

The Proponent will undertake background water quality monitoring to ascertain existing conditions at the site prior to bulk earthworks commencing.

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 Threatened species - Wallum Froglet

Applies to:	Species: Wallum Froglet (<i>Crinia signifera</i>) Bulk earthworks phase - disturbed mixed grassland and regenerating heathland
Person responsible:	Contractor's site manager, all personnel, ecologist.

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 <i>Threatened Species Management Plan</i> (JWA 2011)
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. - Reevaluation 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.
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.

Commitment

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

5.3 Threatened species - Olongburra frog

Applies to:	Species: Olongburra Frog (<i>Litoria olongburensis</i>) Bulk earthworks phase
Person responsible:	Contractor site manager, all personnel, ecologist.

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 Olongburra Frog habitat in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011).
Performance criteria	• Minimise impacts on Olongburra Frog habitat. • Colonisation of constructed wetlands by Olongburra 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 Olongburra 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 Olongburra 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.

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 Olongburra Frogs.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability.

Commitment

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

5.4 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 <i>Acid Sulfate Soils Management Plan</i> (Gilbert & Sutherland February 2011).		
Performance criteria	All waters ponded within the bunded treatment pads or associated with acid sulfate soil stockpiles and discharged from the site or to on-site drains or watercourses will comply with the following criteria.		
	Surface Water Quality Parameter	Release Criteria	Criteria Type
	pH*	As developed from background monitoring	Range
	Electrical conductivity	<1.5dS m ⁻¹	Maximum
	Suspended solids	<50mg L ⁻¹	Maximum
	Turbidity	As developed from background monitoring	Maximum
	Dissolved oxygen	60-105% saturation	Minimum
	Dissolved Iron	<0.3mg L ⁻¹	Maximum
	Aluminium	As developed from background monitoring	Maximum
	Litter and gross pollutants	No man made material >5mm in any dimension	--
	Oil and grease	No visible film, no detectable odour	--
	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
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 in estuarine soils below 5m AHD shall be tested within the excavation and treated if necessary prior to discharge in accordance with Table 6.13 'Groundwater seepage monitoring.'		

Monitoring	Low pH waters (i.e. pH<6.5) that need to be amended to be consistent with receiving environment waters of pH >6.5 may be ameliorated in-situ by the use of hydrated lime or crushed ag-lime to achieve a pH>6.5 and <9.0 prior to release. In using hydrated lime, all care shall be undertaken to ensure pH is not above 9.0. Low pH waters consistent with receiving environment waters of pH 4.2-6.7 and that contain dissolved iron above 0.3mg L⁻¹ will require treatment to reduce dissolved iron to acceptable levels prior to discharge. A supply of hydrated lime shall be kept on site at all times for treatment of acidic waters (if encountered). Storage requirements for hydrated lime shall be in accordance with the manufacturer's MSDSs.
	The contractor or site manager shall inspect site works weekly and following rainfall events for any evidence of ponded acidic 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 registered laboratory where appropriate. Daily rainfall to be recorded by the civil contractor.
	Environmental consultant to audit water quality results to ensure all discharges comply with the performance criteria.
	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.
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 such time as the water quality is adjusted to within the range specified by the outcome of background monitoring or other criteria stated above. Correction of water quality will be undertaken in consultation with the environmental consultant.

Commitment

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.

5.5 Groundwater monitoring

Applies to:	Bulk earthworks 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 <i>Groundwater Assessment and Management Plan</i> (Gilbert & Sutherland February 2011).
Performance criteria	Water quality objectives for the bulk earthworks phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken 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; • oil and grease (visual inspection); • calcium; • magnesium; • potassium; • sodium; • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
Implementation	Monitoring of groundwater levels should be undertaken fortnightly during

strategy	the construction 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 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.
Reporting	Quarterly reports are to be submitted to TSC within one (1) month of the collection of water quality data.
	The quarterly reports to TSC shall include raw data, a results summary and a discussion comparing results with baseline values and ANZECC guidelines.
	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 at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring).
	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 fortnightly 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 all possible 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.

Water Quality Parameter	Release Criteria	Criteria Type
pH	As developed from background monitoring	Range
Oil and grease	No visible film, no detectable odour	-

Commitment

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

5.6 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. To provide for monitoring and treatment of these waters prior to disposal. Groundwater monitoring is to be undertaken in accordance with the site's <i>Groundwater Assessment and Management Plan</i> (Gilbert & Sutherland February 2011).																																				
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. All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Oil and grease</td><td>No visible film or detectable odour</td><td>--</td></tr></table> Where the discharge of dewatered groundwater to on-site or nearby drains and waterways is intended, water quality will satisfy the following performance criteria prior to release at the controlled discharge locations: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH*</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS cm⁻¹</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total and dissolved Iron</td><td><0.3mg L⁻¹</td><td>Maximum</td></tr><tr><td>Total and dissolved Aluminium</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Litter and gross</td><td>No man made material</td><td>-</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH*	As developed from background monitoring	Range	Electrical conductivity	<1.5mS cm ⁻¹	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum	Total and dissolved Aluminium	As developed from background monitoring	Maximum	Litter and gross	No man made material	-
Water Quality Parameter	Release Criteria	Criteria Type																																			
pH	As developed from background monitoring	Range																																			
Oil and grease	No visible film or detectable odour	--																																			
Water Quality Parameter	Release Criteria	Criteria Type																																			
pH*	As developed from background monitoring	Range																																			
Electrical conductivity	<1.5mS cm ⁻¹	Maximum																																			
Suspended solids	<50mg L ⁻¹	Maximum																																			
Turbidity	As developed from background monitoring	Maximum																																			
Dissolved oxygen	60-105% saturation	Minimum																																			
Total and dissolved Iron	<0.3mg L ⁻¹	Maximum																																			
Total and dissolved Aluminium	As developed from background monitoring	Maximum																																			
Litter and gross	No man made material	-																																			

	pollutants	>5mm in any dimension	
	Oil and grease	No visible film, no detectable odour	-
	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
Implementation strategy	The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least). Dewatered groundwater will undergo appropriate treatment to ensure compliance with the above criteria prior to release into recharge trenches. Where disposal to surface water bodies is intended monitoring 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). 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 6.14 '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 an acid sulfate management plan provisions. The addition of liquid 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 Table 'Acid sulfate soil leachate monitoring' of the Site Based Management Plan (Gilbert & Sutherland, April 2011). 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 Table 'Acid sulfate soil assessment and treatment' of the Site Based Management Plan (Gilbert & Sutherland, April 2011). 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		

Monitoring	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.
	Carry out daily pH monitoring of seepage waters entering excavations during the construction phase prior to disposal into recharge trenches.
	Where disposal to surface water bodies is intended, all waters leaving the site at the controlled discharge points will be monitored for pH, electrical conductivity, suspended solids, dissolved oxygen, oil and grease monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once the waterbody(ies) have been brought online and are operational.
	Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. Samples will be forwarded to a NATA registered laboratory for analysis when required.
Auditing	A visual inspection of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken.
	Management to audit water quality results monthly to verify that discharges comply with the performance criteria.
Reporting	Recording of monitoring results and treatment procedures is required. Results are to be available onsite at all times.
Identification of incident or failure	Discharge of ground waters to recharge trenches that do not satisfy the nominated pH range for this site.
Corrective action	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).

Commitment

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

5.7 Surface water quality

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

Issue	Surface water controls.																														
Operational policy	To establish background water quality conditions and maintain these conditions wherever practicable during the construction phase.																														
Performance criteria	All water discharged from the controlled discharge points will comply with the following criteria: <table><thead><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr></thead><tbody><tr><td>pH*</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS/cm</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total and dissolved Iron</td><td><0.3mg L⁻¹</td><td>Maximum</td></tr><tr><td>Filtered Aluminium</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td><td>--</td></tr><tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>--</td></tr></tbody></table> *Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).	Water Quality Parameter	Release Criteria	Criteria Type	pH*	As developed from background monitoring	Range	Electrical conductivity	<1.5mS/cm	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum	Filtered Aluminium	As developed from background monitoring	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	--	Oil and grease	No visible film, no detectable odour	--
Water Quality Parameter	Release Criteria	Criteria Type																													
pH*	As developed from background monitoring	Range																													
Electrical conductivity	<1.5mS/cm	Maximum																													
Suspended solids	<50mg L ⁻¹	Maximum																													
Turbidity	As developed from background monitoring	Maximum																													
Dissolved oxygen	60-105% saturation	Minimum																													
Total and dissolved Iron	<0.3mg L ⁻¹	Maximum																													
Filtered Aluminium	As developed from background monitoring	Maximum																													
Litter and gross pollutants	No man made material >5mm in any dimension	--																													
Oil and grease	No visible film, no detectable odour	--																													
Implementation strategy	Construction of internal bio-retention and filter basins used as temporary sediment detention basins, other temporary sediment detention basins, clean-water diversion channels, swales and vegetated filter strips will be constructed prior to the commencement of earthworks. 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																														

Monitoring	construction areas. Monitoring of the sediment detention basins for compliance with background conditions will take place prior to any discharge of stormwater (controlled or uncontrolled) from the site. Samples are to be collected monthly and during rainfall events (defined as >25mm in any 24 hour period) at the upstream and downstream sampling locations and water quality control pond discharge point and analysed for the above parameters. 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 as soon as possible during/after the construction phase of development. Only appropriate herbicides and fertilisers are to be used in accordance with TSC specifications. Silt fences will be placed along the downstream extents of all construction. Clean-up of GPT's on a quarterly basis or after significant rainfall events.
	Monitoring for pH, electrical conductivity, suspended solids, turbidity, dissolved oxygen, litter and gross pollutants and oil and grease will be conducted monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once any waterbody(ies) specified by the erosion and sediment control plan have made operational. Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. If iron floc, sediments or iron staining are observed at the discharge points, samples should also be taken for laboratory analysis and discharge halted until water has been treated to adequate levels. Iron indicator strips will be used if practicable. 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 daily by the site manager during periods of rainfall.
	Environmental consultant to audit water quality results to ensure all discharges comply with the performance criteria.
	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. These

	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 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.
Identification of incident or failure	The results of the water quality monitoring indicating concentrations exceeding the release limits specified in the 'performance criteria' for a single water quality parameter.
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. Low pH waters (i.e. pH<6.5) that need to be amended to be consistent with receiving environment waters of pH >6.5 may be ameliorated in-situ by the use of hydrated lime or crushed ag-lime to achieve a pH>6.5 and <9.0 prior to release. In using hydrated lime, all care shall be undertaken to ensure pH is not above 9.0. Low pH waters consistent with receiving environment waters of pH 4.2-6.7 and that contain dissolved iron above 0.3mg L⁻¹ will require treatment to reduce dissolved iron to acceptable levels prior to discharge. Electrical conductivity If electrical conductivity exceeds 1.5 dS m⁻¹, 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 30mg L⁻¹ 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 Table 'Erosion controls' and Table 'Sediment control' of the Site Based Management Plan (Gilbert & Sutherland, April 2011).

Dissolved oxygen

In the event that dissolved oxygen levels drop below 6.5mg L^{-1} , the waters will not be released until visual inspections for algae has 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.

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 DECCW.

Commitment

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

5.8 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	Water to comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5dS m⁻¹</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total algae numbers</td><td><50,000cells mL⁻¹</td><td>Maximum</td></tr><tr><td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td><td>--</td></tr><tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>--</td></tr></table> *Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Electrical conductivity	<1.5dS m ⁻¹	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total algae numbers	<50,000cells mL ⁻¹	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	--	Oil and grease	No visible film, no detectable odour	--
Water Quality Parameter	Release Criteria	Criteria Type																							
pH	As developed from background monitoring	Range																							
Electrical conductivity	<1.5dS m ⁻¹	Maximum																							
Suspended solids	<50mg L ⁻¹	Maximum																							
Dissolved oxygen	60-105% saturation	Minimum																							
Total algae numbers	<50,000cells mL ⁻¹	Maximum																							
Litter and gross pollutants	No man made material >5mm in any dimension	--																							
Oil and grease	No visible film, no detectable odour	--																							
Implementation strategy	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.																								
	No decline in macroinvertebrate species richness.																								
	Water levels maintained throughout construction phase. Sediment and erosion control measures to protect water from sedimentation and turbidity in accordance with Table 6.7 ‘Erosion controls’, Table 6.8 ‘Sediment control’ and Table 6.14 ‘Surface water quality’. 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.
Identification of incident or failure	Observation of element(s) outside nominated criteria. Degradation of water quality at the monitoring points to below the 'Performance Criteria' levels. Decreased ecosystem health as indicated by macroinvertebrate sampling.
Corrective action	Identification and source control. Review of construction and/or management methods.

Commitment

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

5.9 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	Maintain surface water quality objectives identified for bulk earthworks: <table border="1"> <thead> <tr> <th>Water Quality Parameter</th><th>Water Quality Objective</th></tr> </thead> <tbody> <tr> <td>pH</td><td>As developed from background monitoring</td></tr> <tr> <td>Electrical conductivity</td><td><1.5 dS m⁻¹</td></tr> <tr> <td>Suspended solids</td><td><50 mg L⁻¹</td></tr> <tr> <td>Dissolved oxygen</td><td>60-105% saturation</td></tr> <tr> <td>Total algae numbers</td><td><50,000cells/mL</td></tr> <tr> <td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td></tr> <tr> <td>Oil and grease</td><td>No visible film, no detectable odour</td></tr> </tbody> </table> *Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>). 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%.	Water Quality Parameter	Water Quality Objective	pH	As developed from background monitoring	Electrical conductivity	<1.5 dS m ⁻¹	Suspended solids	<50 mg L ⁻¹	Dissolved oxygen	60-105% saturation	Total algae numbers	<50,000cells/mL	Litter and gross pollutants	No man made material >5mm in any dimension	Oil and grease	No visible film, no detectable odour
Water Quality Parameter	Water Quality Objective																
pH	As developed from background monitoring																
Electrical conductivity	<1.5 dS m ⁻¹																
Suspended solids	<50 mg L ⁻¹																
Dissolved oxygen	60-105% saturation																
Total algae numbers	<50,000cells/mL																
Litter and gross pollutants	No man made material >5mm in any dimension																
Oil and grease	No visible film, no detectable odour																
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 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 prior to commencement of work in each stage in accordance with Table 'Erosion controls' and Table 'Sediment control' in the Site Based Management Plan (Gilbert & Sutherland, April 2011). 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 sulphate oxidation effects prior to refilling with water at the end of the construction phase. To protect constructed wetlands and receiving environments, discharge of water not complying with nominated parameters must be avoided. 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. A site inspection and monitoring program shall include:

	• weekly site inspections; • inspections immediately following rainfall events that cause runoff; and • inspections immediately before site closure. Surface water quality Surface water monitoring will be conducted at appropriate locations external and internal to the construction area as each wetland and waterway is constructed. 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 NATA accredited 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 to ensure compliance with the performance criteria. Additional visual inspections to be carried out monthly and after rainfall events 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.
Identification of incident or failure	• Degradation of surface water quality at the monitoring points to below background level. • 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.
--	---

Commitment

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.
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 Regular monitoring, particularly in Spring and Summer, is required to

	reduce the potential for algal blooms. Proposed management methods 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 during the landform stabilisation phase. 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; 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. Macrophyte density to be maintained at prescribed levels to achieve hydraulic conductance and pollutant removal.

Commitment

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

Applies to:	Species: Wallum Froglet (<i>Crinia signifera</i>) Landform stabilisation phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Contractor's site manager, all personnel, ecologist.

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 <i>Threatened Species Management Plan</i> (JWA 2011).
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.

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.

Commitment

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

6.4 Threatened species - Olongburra frog

Applies to:	Species: Olongburra Frog (<i>Litoria olongburensis</i>) Landform stabilisation phase – disturbed mixed grassland and regenerating heathland.
Person responsible:	Contractor site manager, all personnel, ecologist.

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 Olongburra Frog habitat in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011).
Performance criteria	• Minimise impacts on Olongburra Frog habitat. • Colonisation of constructed wetlands by Olongburra 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 Olongburra 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. • Reevaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Olongburra 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.
Identification of	• Physical failure of constructed wetlands (e.g. breach).

incident or failure	• Inappropriate pH levels. • Records of high nutrient input. • Absence or decline of Olongburra Frogs.
Corrective action	Apply remedial measures to correct issues of water quality and habitat suitability.

Commitment

The contractor will commit to monitoring Olongburra 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 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 be 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	Non compliance with the criteria will be identified by: • Blockage of stormwater system.

Corrective action	• 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.
	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.

Commitment

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

6.6 Stormwater management

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

Issue	Stormwater quality management.																		
Operational policy	To ensure water discharged from the completed Stage 1 area during the landform stabilisation phase meets specified water quality objectives.																		
Performance criteria	Water discharged from the completed Stage 1 area during the landform stabilisation phase shall meet the designated criteria. The quality of discharge from the site should achieve the following water quality targets. <table border="1"> <thead> <tr> <th>Water Quality Parameter</th><th>Water Quality Objective</th></tr> </thead> <tbody> <tr> <td>pH</td><td>As developed from background monitoring</td></tr> <tr> <td>Dissolved oxygen</td><td>>60-105% saturation</td></tr> <tr> <td>Electrical conductivity</td><td><1.5dS m⁻¹</td></tr> <tr> <td>Suspended solids</td><td><50mg L⁻¹</td></tr> <tr> <td>Turbidity</td><td>As developed from background monitoring</td></tr> <tr> <td>Total algae numbers</td><td><50,000cells mL⁻¹</td></tr> <tr> <td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td></tr> <tr> <td>Oil and grease</td><td>No visible film, no detectable odour</td></tr> </tbody> </table> *Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).	Water Quality Parameter	Water Quality Objective	pH	As developed from background monitoring	Dissolved oxygen	>60-105% saturation	Electrical conductivity	<1.5dS m ⁻¹	Suspended solids	<50mg L ⁻¹	Turbidity	As developed from background monitoring	Total algae numbers	<50,000cells mL ⁻¹	Litter and gross pollutants	No man made material >5mm in any dimension	Oil and grease	No visible film, no detectable odour
Water Quality Parameter	Water Quality Objective																		
pH	As developed from background monitoring																		
Dissolved oxygen	>60-105% saturation																		
Electrical conductivity	<1.5dS m ⁻¹																		
Suspended solids	<50mg L ⁻¹																		
Turbidity	As developed from background monitoring																		
Total algae numbers	<50,000cells mL ⁻¹																		
Litter and gross pollutants	No man made material >5mm in any dimension																		
Oil and grease	No visible film, no detectable odour																		
Implementation strategy	Local site catchment stormwater quality control is achieved through treatment trains consisting of: • At source bio retention system. • Gross Pollutant Trap (GPT). • Vegetated swales.																		
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. Sample recovery and in-situ analysis will be performed by staff on site on a quarterly basis and will be forwarded to a NATA accredited laboratory.
Auditing	Reviews are to be carried out on a monthly basis during establishment to assess the implementation strategy. A checklist is to be completed which assesses the strategies listed above.
Reporting	A Water Quality Report for all water quality monitoring results and assessments shall be submitted to TSC annually.
Identification of incident or failure	Non compliance with agreed performance criteria will be identified by: • Visual inspections identifying build up of sediment & litter, excessive erosion and vegetation damage. • Poorly maintained, damaged or failed control devices. • Deteriorated water quality identified by the environmental consultant as being attributable to the construction activities.
Corrective action	If build up of sediment and litter occurs, remove material, identify cause, inspect all treatment techniques, revise design or review different alternatives and install if necessary. If erosion occurs, fill, vegetate and/or install velocity dissipation in accordance with <i>'Managing Urban Stormwater: Soils and Construction'</i> March 2004 by Landcom, Australia. If vegetation fails, new vegetation should be planted and established. Vegetation may require supplementary watering and replanting. If water quality objectives are not met, inspect all treatment techniques, revise designs or review different alternatives and install if necessary. If silt fences fail, replace and monitor more frequently. If release of silt and other material off the site occurs, clean up, inspect all treatment techniques, revise designs and review different alternatives and install; otherwise reduce the rate of excavation. 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: Suspended solids and turbidity If total suspended solids exceed the site specific target 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 sediment and silt control provisions.

Dissolved oxygen

In the event that dissolved oxygen levels drop below the site specific target, the waters will not be released until visual inspections for algae has been carried out. If algae is 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.

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.

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 (Hazardous and dangerous goods handling and storage). 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 DECCW.

Commitment

The Proponent will ensure the quality of the discharge from the site meets the water quality objectives to ensure no detrimental impacts on the downstream environment, including the waterway and wetland system.

6.7 Surface water 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 specified water quality objectives (WQOs). • 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 achieve the long term WQOs. The WQOs will reflect background monitoring results for: • pH; • dissolved oxygen; • total phosphorous; • total nitrogen; • turbidity; • suspended solids; • chlorophyll 'a'; • faecal coliforms; • total algae numbers; • litter and gross pollutants; and • oil and grease. 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	Routine surface water quality monitoring to be undertaken.
Monitoring	Frequency: Routine quarterly monitoring for one year following the completion of bulk earthworks, including quarterly rainfall event (>25mm/24hrs) monitoring campaigns for the year. Parameters: temperature, dissolved oxygen, pH, conductivity, salinity, turbidity, suspended solids, total nitrogen, total phosphorous, faecal coliforms, chlorophyll 'a' and algae identification and count. Vertical Profiling: Routine quarterly monitoring of temperature, dissolved oxygen, pH, conductivity, salinity and turbidity at 0.5m depths of all off-stream deep water bodies. Every three months, water quality monitoring of each defined off-site

	discharge point will be carried out. Sample recovery and in-situ analysis will be performed by a NATA accredited sampler and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	Reviews are to be carried out on an annual basis during establishment to assess the implementation strategy. A checklist is to be completed which assesses the strategies listed above.
Reporting	A Water Quality Report for all water quality monitoring results and assessments shall be submitted to TSC annually. 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.
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.

Commitment

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.

6.8 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 (a period of 20 days is to be provided). All temporary erosion and sediment control works are to be removed once works are complete and revegetation is successfully established in formerly disturbed areas.
Monitoring	Routine weekly inspections undertaken by the contractor's site manager until the stage is stabilised.
Auditing	A checklist is to be completed which assesses the strategies listed above.
Reporting	Completed checklists to be kept onsite for inspection by TSC upon request.
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 including the incorporation of additional measures, including but not limited to hay bales, silt fences and flocculation of water quality control ponds.

Commitment

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

6.9 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 <i>Groundwater Assessment and Management Plan</i> (Gilbert & Sutherland February 2011).
Performance criteria	Water quality objectives for the construction phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken 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 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. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.

Implementation strategy	Monitoring of groundwater levels should be undertaken quarterly during the landform stabilisation phase.
	Groundwater samples are to be collected quarterly and analysed for the parameters specified above.
Monitoring	Carry out quarterly groundwater level and 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 annually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
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 baseline values and ANZECC guidelines. 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 at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring).
	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 fortnightly 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 all possible 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.		
	Water Quality Parameter	Release Criteria	Criteria Type
	pH	As per background monitoring	Range
	Oil and grease	No visible film, no detectable odour	-

Commitment

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 Regular monitoring, particularly in Spring and Summer, is required to reduce the potential for algal blooms. Proposed management methods

Monitoring	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.
	Routine monthly monitoring for two years following the completion of construction onsite. Routine monthly visual inspection of treatment trains for vegetation establishment, damage, weed invasion and clogging.
	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.
	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.
	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.
	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.

Commitment

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

Applies to:	Species: Wallum Froglet (<i>Crinia signifera</i>) 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 <i>Threatened Species Management Plan</i> (JWA 2011).
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. • Reevaluation 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.

Corrective action	• Records of high nutrient input. • Absence or decline of Wallum Froglet.
	Apply remedial measures to correct issues of water quality as determined by monitoring.

Commitment

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

7.4 Threatened species - Olongburra frog

Applies to:	Species: Olongburra Frog (<i>Litoria olongburensis</i>) 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 Olongburra Frog habitat in accordance with the <i>Threatened Species Management Plan</i> (JWA 2011).
Performance criteria	- Minimise impacts on Olongburra Frog habitat. - Colonisation of constructed wetlands by Olongburra 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 Olongburra 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 Olongburra 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.
Identification of incident or failure	- Physical failure of constructed wetlands (e.g. breach). - Inappropriate pH levels.

Corrective action	• Records of high nutrient input. • Absence or decline of Olongburra Frogs.
	Apply remedial measures to correct issues of water quality as determined by monitoring outcomes.

Commitment

The land user will commit to monitoring Olongburra 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 <i>Groundwater Assessment and Management Plan</i> (Gilbert & Sutherland February 2011).
Performance criteria	Water quality objectives for the construction phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken 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. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.

Implementation strategy	Monitoring of groundwater levels should be undertaken monthly during the civil construction phase. Groundwater samples are to be collected monthly and analysed for the parameters specified above.
Monitoring	Carry out monthly groundwater level and 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 annually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
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 baseline values and ANZECC guidelines. • 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 at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). • 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 fortnightly 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 all possible 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.

Water Quality Parameter	Release Criteria	Criteria Type
pH	As developed from background monitoring	Range
Oil and grease	No visible film, no detectable odour	-

Commitment

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. To provide for monitoring and treatment of these waters prior to disposal. Groundwater monitoring is to be undertaken in accordance with the site's <i>Groundwater Assessment and Management Plan</i> (Gilbert & Sutherland February 2011).																											
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. All waters discharged from the excavation areas to the recharge trenches during the construction phase should comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Oil and grease</td><td>No visible film or detectable odour</td><td>--</td></tr></table> Where the discharge of dewatered groundwater to on-site or nearby drains and waterways is intended, water quality will satisfy the following performance criteria prior to release at the controlled discharge locations: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS/cm</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Electrical conductivity	<1.5mS/cm	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum
Water Quality Parameter	Release Criteria	Criteria Type																										
pH	As developed from background monitoring	Range																										
Oil and grease	No visible film or detectable odour	--																										
Water Quality Parameter	Release Criteria	Criteria Type																										
pH	As developed from background monitoring	Range																										
Electrical conductivity	<1.5mS/cm	Maximum																										
Suspended solids	<50mg L ⁻¹	Maximum																										
Turbidity	As developed from background monitoring	Maximum																										
Dissolved oxygen	60-105% saturation	Minimum																										

	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum
	Total and dissolved Aluminium	As developed from background monitoring	Maximum
	Litter and gross pollutants	No man made material >5mm in any dimension	--
	Oil and grease	No visible film, no detectable odour	-
	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
Implementation strategy	The release criteria for aluminium and total and dissolved iron concentrations will be consistent with the receiving water quality.		
	The site contractor shall be equipped with reliable pH monitoring equipment that will be calibrated on a weekly basis (at least). Dewatered groundwater will undergo appropriate treatment to ensure compliance with the above criteria prior to release into recharge trenches. Where disposal to surface water bodies is intended monitoring 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). 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 8.14 '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 an acid sulfate management plan provisions. The addition of liquid 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 Table 'Acid sulfate soil leachate monitoring' of the Site Based Management Plan (Gilbert & Sutherland, April 2011). 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 Table 'Acid sulfate soil assessment and treatment' of the Site Based Management Plan (Gilbert & Sutherland, April 2011). 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 into recharge trenches. Where disposal to surface water bodies is intended, all waters leaving the site at the controlled discharge points will be monitored for pH, electrical conductivity, suspended solids, dissolved oxygen, oil and grease monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once the waterbody(ies) have been brought online and are operational. Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. Samples will be forwarded to a NATA registered laboratory for analysis when required.
Auditing	A visual inspection of the contractor's monitoring and treatment records shall be undertaken to verify sufficient monitoring and treatment is being undertaken. Management to audit water quality results monthly to verify that discharges comply with the performance criteria.
Reporting	Recording of monitoring results and treatment procedures is required. Results are to be available onsite at all times.
Identification of incident or failure	Discharge of ground waters to recharge trenches that do not satisfy the nominated pH range for this site.
Corrective action	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).

Commitment

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

7.7 Surface water quality

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

Issue	Surface water controls.		
Operational policy	To establish background water quality conditions and maintain these conditions wherever practicable during the construction phase.		
Performance criteria	All water discharged from the controlled discharge points will comply with the following criteria:		
	Water Quality Parameter	Release Criteria	Criteria Type
	pH	As developed from background monitoring	Range
	Electrical conductivity	<1.5mS/cm	Maximum
	Suspended solids	<50mg L ⁻¹	Maximum
	Turbidity	As developed from background monitoring	Maximum
	Dissolved oxygen	60-105% saturation	Minimum
	Total algae numbers	<50,000cells/mL	Maximum
	Total and dissolved Iron	<0.3mg L ⁻¹	Maximum
	Total and dissolved Aluminium	As developed from background monitoring	Maximum
	Litter and gross pollutants	No man made material >5mm in any dimension	--
	Oil and grease	No visible film, no detectable odour	--
	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
Implementation strategy	Completion of internal bio-retention and filter basins, waterbodies, swales and vegetated filter strips as specified at detailed design and approved by TSC. Monitoring of the sediment detention basins for compliance with background conditions will take place prior to any discharge of stormwater		

Monitoring	(controlled or uncontrolled) from the site. Samples are to be collected monthly and during rainfall events (defined as >25mm in any 24 hour period) at the upstream and downstream sampling locations and water quality control pond discharge point and analysed for the above parameters. 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 as soon as possible during/after the construction phase of development. Only appropriate herbicides and fertilisers are to be used in accordance with TSC specifications. Silt fences will be placed along the downstream extents of all construction. Clean-up of GPT's on a quarterly basis or after significant rainfall events.
	Monitoring for pH, electrical conductivity, suspended solids, turbidity, dissolved oxygen, litter and gross pollutants and oil and grease will be conducted monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once any waterbody(ies) specified by the erosion and sediment control plan have made operational. Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. If iron floc, sediments or iron staining are observed at the discharge points, samples should also be taken for laboratory analysis and discharge halted until water has been treated to adequate levels. Iron indicator strips will be used if practicable. 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 daily by the site manager during periods of rainfall.
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 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. These 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 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.
Identification of incident or failure	The results of the water quality monitoring indicating concentrations exceeding the release limits specified in the “performance criteria” for a single water quality parameter.
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. Low pH waters (i.e. pH<6.5) that need to be amended to be consistent with receiving environment waters of pH >6.5 may be ameliorated in-situ by the use of hydrated lime or crushed ag-lime to achieve a pH>6.5 and <9.0 prior to release. In using hydrated lime, all care shall be undertaken to ensure pH is not above 9.0. Low pH waters consistent with receiving environment waters of pH 4.2-6.7 and that contain dissolved iron above 0.3mg L⁻¹ will require treatment to reduce dissolved iron to acceptable levels prior to discharge. Electrical conductivity If electrical conductivity exceeds 1.5 dS m⁻¹, 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 30mg L^{-1} 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 Table 'Erosion controls' and Table 'Sediment control' of the Site Based Management Plan (Gilbert & Sutherland, April 2011).

Dissolved oxygen

In the event that dissolved oxygen levels drop below 6.5mg L^{-1} , the waters will not be released until visual inspections for algae has 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.

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 DECCW.

Commitment

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 (SEPP14 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	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.

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 the Tweed shire council and NSW Department of Planning.
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

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 (SEPP14 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	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.

Monitoring	• 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 eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	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 SEPP 14 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 Tweed shire council and other appropriate authorities.
	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

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 (SEPP14 wetland and Ecological protection zones).
Performance criteria	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. <i>Critical criteria set at:</i> • Critical limits set as per background monitoring. <i>Parameters:</i> • 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 (eg, 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 (eg, 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,

Monitoring	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 operations 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.
	Groundwater <i>Monthly</i> • 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, NH₄, NO₃ P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. Surface water <i>Monthly</i> • Central irrigation supply. • Surface habitat water bodies. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃ P – Total, Ortho; Calcium; Magnesium; Sodium; Potassium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour. <i>Monthly</i> • Central irrigation supply. Parameters: • Irrigation water quality, N & P.

	Soils 6 monthly • Soil fertility sampling as per standard practice for turf (agricultural) management.
	Biomass <i>Quarterly</i> • 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).
	<i>Biannually</i> • SEPP 14 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 the Tweed Shire Council and NSW Department of Planning.
	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

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 SEPP14 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 6 months 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 Regular monitoring, particularly in Spring and Summer, is required to reduce the potential for algal blooms. Proposed management methods 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.

Monitoring	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.
	Routine monthly monitoring. 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.
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: <i>500 cells/ml</i> • Increase turnover mixing until numbers are brought back to lower levels. • Fertiliser activity to be limited. • Maintain regular monitoring. <i>2,000 cells/ml</i> 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

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

Applies to:	Species: Wallum Froglet (<i>Crinia signifera</i>) On-maintenance phase - disturbed mixed grassland and regenerating heathland.
Person responsible:	Site manager, ecologist

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. Reevaluation 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.

Corrective action	• Records of high nutrient input. • Absence or decline of Wallum Froglet.
	Apply remedial measures to correct issues of water quality as determined by monitoring.

Commitment

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

8.5 Threatened species - Olongburra frog

Applies to:	Species: Olongburra Frog (<i>Litoria olongburensis</i>) On-maintenance phase
Person responsible:	Site manager, ecologist

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 Olongburra Frog habitat.
Performance criteria	Minimise impacts on Olongburra Frog habitat. Colonisation of constructed wetlands by Olongburra 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 Olongburra 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. Reevaluation of monitoring and actions annually.
Monitoring	Regular inspections to: • monitor water quality; and • monitor Olongburra 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, Council and any other relevant statutory authorities.
Identification of incident or failure	• Physical failure of constructed wetlands (e.g. breach). • Inappropriate pH levels.

Corrective action	• Records of high nutrient input. • Absence or decline of Olongburra Frogs.
	Apply remedial measures to correct issues of water quality as determined by monitoring outcomes.

Commitment

The land user will commit to monitoring Olongburra Frog populations to ensure that wetlands are appropriately maintained.

8.6 Surface water quality

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

Issue	Surface water controls.																																				
Operational policy	To maintain background water quality conditions wherever practicable during the on-maintenance phase.																																				
Performance criteria	All water discharged from the controlled discharge points will comply with the following criteria: <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As developed from background monitoring</td><td>Range</td></tr><tr><td>Electrical conductivity</td><td><1.5mS/cm</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td><50mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>60-105% saturation</td><td>Minimum</td></tr><tr><td>Total N</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Total P</td><td>As developed from background monitoring</td><td>Maximum</td></tr><tr><td>Total algae numbers</td><td><50,000cells mL⁻¹</td><td>Maximum</td></tr><tr><td>Litter and gross pollutants</td><td>No man made material >5mm in any dimension</td><td>--</td></tr><tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>--</td></tr><tr><td colspan="3">*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As developed from background monitoring	Range	Electrical conductivity	<1.5mS/cm	Maximum	Suspended solids	<50mg L ⁻¹	Maximum	Turbidity	As developed from background monitoring	Maximum	Dissolved oxygen	60-105% saturation	Minimum	Total N	As developed from background monitoring	Maximum	Total P	As developed from background monitoring	Maximum	Total algae numbers	<50,000cells mL ⁻¹	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	--	Oil and grease	No visible film, no detectable odour	--	*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).		
Water Quality Parameter	Release Criteria	Criteria Type																																			
pH	As developed from background monitoring	Range																																			
Electrical conductivity	<1.5mS/cm	Maximum																																			
Suspended solids	<50mg L ⁻¹	Maximum																																			
Turbidity	As developed from background monitoring	Maximum																																			
Dissolved oxygen	60-105% saturation	Minimum																																			
Total N	As developed from background monitoring	Maximum																																			
Total P	As developed from background monitoring	Maximum																																			
Total algae numbers	<50,000cells mL ⁻¹	Maximum																																			
Litter and gross pollutants	No man made material >5mm in any dimension	--																																			
Oil and grease	No visible film, no detectable odour	--																																			
*Note that pH will be consistent with receiving water quality. If receiving waters are estuarine, pH should be 6.5 – 8.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the Threatened Species Management Plan (JWA 2011) for habitat requirements for Wallum Froglet (<i>Crinia signifera</i>) and Olongburra Frog (<i>Litoria olongburensis</i>).																																					
Implementation strategy	Maintenance of internal bio-retention and filter basins, waterbodies, swales and vegetated filter strips as specified at detailed design and approved by TSC. Samples are to be collected monthly and during rainfall events (defined as																																				

Monitoring	>25mm in any 24 hour period) at the upstream and downstream sampling locations and water quality control pond discharge point and analysed for the above parameters. Where water quality fails to meet the established criteria, corrective measures will be undertaken 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. 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 for pH, electrical conductivity, suspended solids, turbidity, dissolved oxygen, total N, total P, litter and gross pollutants and oil and grease will be conducted monthly and during rainfall events. Analysis for total algae numbers will also be conducted monthly and during rainfall events once any waterbody(ies) specified by the erosion and sediment control plan have made operational. Monitoring for aluminium and total and dissolved iron will occur on a monthly basis at water holding locations prior to discharge off site. If iron floc, sediments or iron staining are observed at the discharge points, samples should also be taken for laboratory analysis and discharge halted until water has been treated to adequate levels. Iron indicator strips will be used if practicable. 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 daily by the site manager during periods of rainfall.
	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 water bodies. These results to be kept onsite for inspection by local and state government officers. Biannual report to 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 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

Identification of incident or failure	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.
	The results of the water quality monitoring indicating concentrations exceeding the release limits specified in the “performance criteria” for a single water quality parameter.
	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. Low pH waters (i.e. pH<6.5) that need to be amended to be consistent with receiving environment waters of pH >6.5 may be ameliorated in-situ by the use of hydrated lime or crushed ag-lime to achieve a pH>6.5 and <9.0 prior to release. In using hydrated lime, all care shall be undertaken to ensure pH is not above 9.0. Low pH waters consistent with receiving environment waters of pH 4.2-6.7 and that contain dissolved iron above 0.3mg L⁻¹ will require treatment to reduce dissolved iron to acceptable levels prior to discharge. Electrical conductivity If electrical conductivity exceeds 1.5 dS m⁻¹, 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 30mg L⁻¹ 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 Table “Erosion controls” and Table ‘Sediment control’ of the Site

Based Management Plan (Gilbert & Sutherland, April 2011).

Dissolved oxygen

In the event that dissolved oxygen levels drop below 6.5mg L^{-1} , the waters will not be released until visual inspections for algae has 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.

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 DECCW.

Commitment

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

8.7 Groundwater monitoring

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

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 (Gilbert & Sutherland February 2011).
Performance criteria	Water quality objectives for the on-maintenance phase of works would be devised using DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken 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; • oil and grease (visual inspection); • calcium; • magnesium; • potassium; • sodium; • dissolved manganese; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.

Implementation strategy	Monitoring of groundwater levels should be undertaken monthly during the on-maintenance phase.
	Groundwater samples are to be collected monthly and analysed for the parameters specified above.
Monitoring	Carry out monthly groundwater level and 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 biannually to ensure that no deleterious effects are resulting from any excavation, filling and dewatering operations at the site.
Reporting	Biannual 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 baseline values and DECCW guidelines. 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 at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring).
	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 fortnightly 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 all possible 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.

Commitment

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 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 be 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	Non compliance with the criteria will be identified by: • Blockage of stormwater system.

Corrective action	• 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.
	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

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 (SEPP14 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	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	Monthly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported biannually to the Tweed shire council and NSW Department of Planning.
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

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 (SEPP14 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	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.

Monitoring	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 eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	Monthly <i>Height monitoring:</i> • 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 SEPP 14 wetland). <i>Parameters:</i> • 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 the Tweed shire council and NSW Department of Planning.
	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

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 (SEPP14 wetland and Ecological protection zones).
Performance criteria	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: • Critical limit 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

Implementation strategy	• colour. 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 (eg, 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 (eg, 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
-------------------------	--

Monitoring	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 operations that incorporate nutrients into turf (eg, 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.
	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, NH₄, NO₃, 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, NH₄, NO₃, 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 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: - SEPP 14 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 the Tweed Shire Council and NSW Department of Planning.
	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

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 SEPP14 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 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 golf course management

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 Regular monitoring, particularly in Spring and Summer, is required to reduce the potential for algal blooms. Proposed management methods

Monitoring	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.
	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.
	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.
	Maintenance and compilation of assessment sheets to be appropriately stored onsite for inspection by local and state government officers.
	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.
	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: <i>500 cells/ml</i> • Increase turnover mixing until numbers are brought back to lower levels. • Fertiliser activity to be limited. • Maintain regular monitoring. <i>2,000 cells/ml</i> • 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

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 (Gilbert & Sutherland February 2011).
Performance criteria	Water quality objectives for the operational phase of works would be devised from DECCW guidelines for groundwater monitoring. These proposed objectives would be submitted to TSC for review and approval prior to implementation. Groundwater monitoring will be undertaken for the following parameters: • pH (field measurement); • EC (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 (mg L^{-1}); • oil and grease (visual inspection); • calcium; • magnesium; • total and dissolved iron; • dissolved manganese; • filtered aluminium; • bicarbonate; • carbonate; • chloride; • sulfate; and • colour. Laboratory analysis for total acidity (titratable) and total alkalinity should also be undertaken.
Implementation	Monitoring of groundwater levels should be undertaken quarterly during

strategy	the operational phase. Groundwater samples are to be collected quarterly and analysed for the parameters specified above.
Monitoring	Carry out quarterly groundwater level and 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 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 baseline values and DECCW groundwater guidelines. 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 at the monitoring points to below the "Performance Criteria" levels (to be derived following baseline monitoring). 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 all possible 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.

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

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 golf course management

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	The quality of discharge from the site should achieve the long term WQOs. The WQOs will reflect background monitoring for: - pH; - dissolved oxygen; - total and soluble phosphorous; - total and dissolved iron; - total nitrogen and nitrate, nitrite and ammonium; - turbidity; - suspended solids; - chlorophyll 'a'; - faecal coliforms; - total algae numbers; - litter and gross pollutants; and - oil and grease.
Implementation strategy	Routine surface water quality monitoring to be undertaken.
Monitoring	Frequency: Routine quarterly monitoring for two years following the completion of the on-maintenance period, with biannual rainfall event (>25mm/24hrs) monitoring campaigns. Parameters: temperature, dissolved oxygen, pH, conductivity, salinity, turbidity, suspended solids, total nitrogen, total phosphorous, faecal coliforms, chlorophyll 'a' and algae identification and count. 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 NATA accredited sampler and, when required, samples will be forwarded to a NATA accredited laboratory.
Auditing	Reviews are to be carried out on a 6 monthly basis to assess the implementation strategy. A checklist is to be completed which assesses

	the strategies listed above.
Reporting	Annual Water quality report to be held by Tweed Shire Council.
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.

Commitment

The golf course management 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 (SEPP14 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	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	Monthly monitoring of groundwater height.
Auditing	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an annual basis.
Reporting	Results of monitoring will be reported biannually to the Tweed shire council and NSW Department of Planning.
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

The golf course management 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 (SEPP14 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	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.

Monitoring	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 eg Drought tolerant plants in elevated areas, waterlog tolerant plants in depressions.
	Biannually <i>Height monitoring:</i> • 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 SEPP 14 wetland). <i>Parameters:</i> • 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 the Tweed shire council and NSW Department of Planning.
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

The golf course management 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 (SEPP14 wetland and Ecological protection zones).
Performance criteria	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 ground water 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

Implementation strategy	• colour..
	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 operations that incorporate nutrients into turf (eg, 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.

Monitoring	• 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 operations that incorporate nutrients into turf (eg, 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.
	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); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, P – Total, Ortho; 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); Dissolved oxygen (field measure); Temperature (field measure); N – Total, NH₄, NO₃, 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 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). SEPP 14 wetlands Annually - SEPP 14 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 the Tweed Shire Council and NSW Department of Planning.
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

The golf course management will ensure the water table and surface water areas associated with the golf course does not input excess nutrients into the surrounding SEPP14 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 Site Based Management Plan (Gilbert & Sutherland, February 2011) Appendix 11.

Monitoring schedule summary for operation phase of golf course management.

Parameters for monitoring						
Item	Daily	Weekly	Monthly	Quarterly	6 monthly	Annually
Groundwater				Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure) N – Total, NH ₄ , NO ₃ ; P – Total, Ortho; Calcium; Magnesium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour.		
Bio-retention surface waters			Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen		pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature	

			(field measure); Temperature (field measure)		(field measure) N – Total, NH ₄ , NO ₃ ; P – Total, Ortho; Calcium; Magnesium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour.		
Irrigation dam surface water			Height (AHD); pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure)	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; Bicarbonate; Carbonate; Chloride; Sulfate. SAR and residual alkali	pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure) N – Total, NH ₄ , NO ₃ ; P – Total, Ortho; Calcium; Magnesium; Total and dissolved iron; Dissolved manganese; Filtered aluminium; Bicarbonate; Carbonate; Chloride; Sulfate; and Colour.		
Biomass							
SEPP14 wetland						Reference transect for floristic structure and	

							function	
Bio-retention and filter basins, waterways and other water bodies						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 such as water level; area, depth or bed profile of any bio-retention basin, waterway and wetland system		

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**
NORTH

LEGEND

- TOWN CENTRE / NEIGHBOURHOOD CENTRE
- RESIDENTIAL
- COMMUNITY FACILITIES / EDUCATION
- EMPLOYMENT LAND
- STRUCTURED OPEN SPACE (ACTIVE)
(Passive open space to council standards, location subject to urban design).
- ENVIRONMENTAL PROTECTION AREA
TO BE DEDICATED TO COUNCIL OR NPWS.
- 50m ECOLOGICAL BUFFER
(Includes APZs & Roads where approved)
- * STATE SCHOOL SITE
- PROPOSED ZONE SUBSTATION
(Subject to County Energy final approval)
- PRIVATE OPEN SPACE
- GOLF COURSE AREA
(Encompassing ecological buffers where indicated)
- PRIVATE OPEN SPACE INCLUDING LAKE

Precinct Number

SOURCES

Base plan: MPS Architects - Concept Plan
June 2011 (MPS 2142 DA-01b)

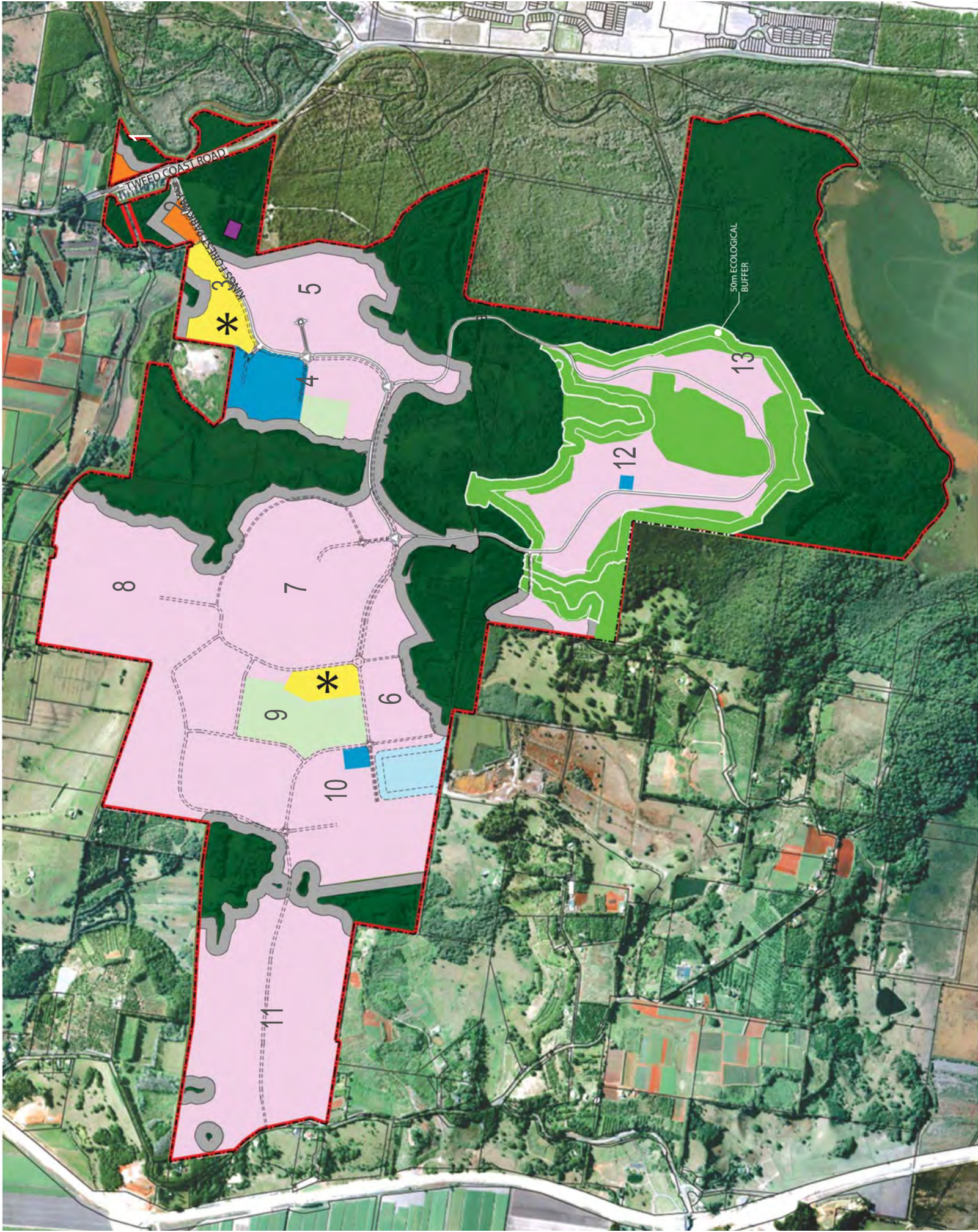
CAIRNS
KAWANA

ROBINA
5 / 232 Robina Town Centre Dr.
PO Box 4115
Robina Q4230
Phone 07 5578 9944
Fax 07 5578 9945
robina@access.gs

BRISBANE
Gilbert and Sultherland Pty Ltd
ABN 56 077 310 840

www.access.gs

AGRICULTURE WATER ENVIRONMENT



PROJECT
**KINGS FOREST STAGE 1
PROJECT APPLICATION**

CLIENT
PROJECT 28 PTY LTD

DRAWING
**DEVELOPMENT AREA AND
MASTER PLAN**

DATE	DRAWN	PROJECT NO
24/06/2011	AJS	10468
SCALE	CHECKED	DRAWING NO
1:20 000	ER	10468.6.1



SCALE
1:20 000



ORIENTATION
NORTH

LEGEND

SEPP 14 Wetland Areas -
Approximate Location



7(a) Environmental
Protection Littoral Rainforest



7(i) Environmental
Protection, Habitat

SOURCES

Base plan: MPS Architects December 2010
(MPS 2142 MP-01)

SEPP 14 Data: MPS Architects April 2011
(MPS 2142 DA-03a)

CAIRNS
KAWANA

ROBINA

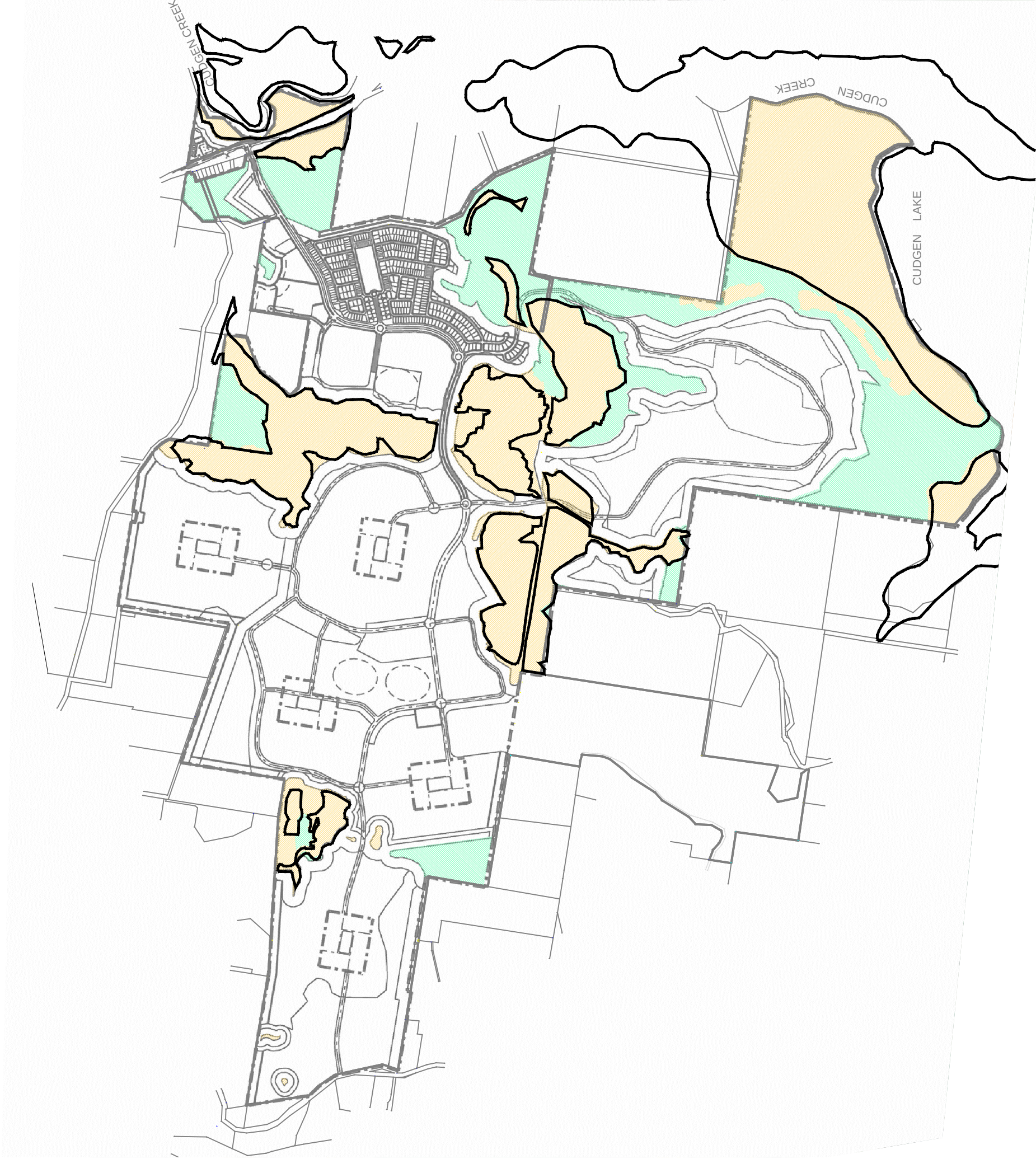
5 / 232 Robina Town Centre Dr.
PO Box 4115
Robina Q4230
Phone 07 5578 9944
Fax 07 5578 9945
robina@access.gs

BRISBANE

Gilbert and Sultherland Pty Ltd
ABN 56 077 310 840

www.access.gs

AGRICULTURE WATER ENVIRONMENT



PROJECT

KINGS FOREST STAGE 1
PROJECT APPLICATION

CLIENT

PROJECT 28 PTY LTD

DRAWING

SENSITIVE ENVIRONMENTAL
RECEPTORS

DATE
24/06/2011

DRAWN
AJS

PROJECT NO
10468

SCALE
1:20 000

CHECKED
ER

DRAWING NO
10468.6.2

A1.3

13 Attachment 2 – Reference drawings

