

8.0 BUSHFIRE RISK MANAGEMENT PLAN – BUSHFIRE SAFE (AUST) PTY LTD, AUGUST 2012

EXECUTIVE SUMMARY

Bushfiresafe (Aust) P/L has been engaged by Project 28 P/L to undertake a complete Bushfire Risk Assessment for Stage One of the Kings Forest Development. The assessment was conducted in accordance with

- ♦ *Item 6.3 of the NSW Department of Planning Director General's Environmental Assessment Requirements dated 10 September 2010, which states:*

"In order to ensure the protection of property and assets, a detailed bushfire assessment and management plan prepared by a suitably qualified person must be submitted. The assessment must, at a minimum, demonstrate consistency with the requirements of Planning for Bushfire Protection 2006. All asset protection zones must be clearly specified on the Plan of Development and all affected lots are to be encumbered with a Section 88B instrument under the NSW Conveyancing Act 1919."

Note: Correspondence received from NSW Rural Fire Service indicates that the lots affected by Asset Protection Zones are not required to be encumbered with a Section 88B instrument under the NSW Conveyancing Act 1919; a meeting between the developers representative and DOPI officers on the 19 July 2012 supported the NSW Rural Fire Service position, therefore, implementation of Section 88B instruments for lots affected by Asset Protection Zones are not required.

- ♦ *Part 3A of the Environmental Planning & Assessment Act (1979), and*
- ♦ *Section 100B of the Rural Fires Act (1997).*

PROPERTY DESCRIPTION

The Kings Forest site is located immediately west of Tweed Coast Road, between Casuarina Town Centre and Kingscliff on the north coast of NSW and covers an area of 880Ha comprising the following land uses (Table 1). The property has previously been sand mined; utilised for turf production, dairying, small cropping, livestock grazing, sugar-cane production; and for pine plantations. Current activities include livestock grazing and harvesting of the mature pine forests growing on the subject land. It is the intention of the proponents to continue with the livestock grazing activity until urban development commences.

The Kings Forest Stage 1 Project Application No. MP 08_0194 was lodged in November 2011. The Application and Environmental Assessment Report was advertised from December 2011 to January 2012 following which 302 public submissions and 10 agency submissions were received.

As a result of the submissions, amendments to the project have been made. The amended project contains the following key elements (NB: these elements will be revised and updated as the amended project is finalised).

- ♦ *Subdivision to create new lots for future development;*
 - *Bulk earthworks across the site;*
 - *Road works comprising:*

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- construction of the entrance road into the site and associated intersection works on Tweed Coast Road;
- alignment and construction of the proposed Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western precincts; and
- alignment and part construction of two proposed roads through SEPP 14 areas to access the southern precincts;
- Development of 2,036 m² of floor space for rural retail development and access arrangements within Precinct 1;
- Construction of subdivision and infrastructure works along the Kings Forest Parkway and within Precincts 1 and 5;
- The Plan of Development for Precinct 5.

This Bushfire Risk Assessment was conducted through an on-site inspection undertaken on 25th May, 2012 using the methodology set out in Planning for Bushfire Protection manual (RFS, 2006). The on-site assessment included traversing the subject property and all lands within 140 metres from the proposed subdivision.

PRECINCT 1 - COMMERCIAL DEVELOPMENT

A rural retail development is proposed for the parcel of land on the east side of Tweed Coast Road (Lot 7, DP 875447). The proposal involves 1 building, public and staff car parking areas, separate car and truck entries and a designated truck manoeuvring area incorporating a drive-through pickup facility (Plan 2).

The public car park is located at the rear of the building towards the bushfire hazard.

Asset Protection Zones (APZ)

The dominant bushfire prone vegetation was assessed as being the Subtropical Floodplain Forest to the south and east of the development. This vegetation is separated from the development by a 50m ecological buffer. Using this information, this bushfire risk assessment concluded that the following asset protection zone should be established, after reference to Table A2.5 Minimum Specifications for Asset Protection Zones (m) for Residential and Rural Residential Subdivision Purposes (for Class 1 and 2 buildings) in FDI 80 Fire Areas, of the Planning for Bushfire Protection manual (RFS, 2006);

Aspect	Vegetation	APZ (m)	IPA (m)	OPA (m)	Compliance with PBP
South	Forest	21	21	0	Yes, achieved by the carpark area
East	Forest	21	21	0	Yes, achieved by the carpark area

Bush Fire Attack Categories

An assessment of the bushfire attack categories applicable to the proposed development in Precinct 1 was carried out using the methodology detailed in Planning for Bushfire Protection (Addendum Appendix 3 2010). This bushfire risk management assessment concluded that commercial Building A will be in the **BAL - 29** Bushfire Attack Category according to Table A 3.4 Determination of Category of Bush Fire Attack FDI 80 (FRS, 2006) with the following site attributes:

- Forest as the Bushfire prone vegetation to the east and south
- This vegetation occurs on a flat slope
- A minimum separation of 21m is achievable from this vegetation

PRECINCT 5 - RESIDENTIAL DEVELOPMENT

Residential development is proposed for the parcel of land located to the south of Kings Forest Parkway and east of the future Town Centre Precinct (Part Lot 1, DP 781633 and Part Lot 40, DP 7482). The area is presently cleared of all over-storey vegetation and managed as grazing land. Precinct 5 is bordered by Kings Forest Parkway, vegetated buffer and Cudgen Nature Reserve to the east, a vegetated buffer to a creek line along the southern boundary; open forest to the northeast; proposed Precinct 3 to the north; and the proposed Town centre (Precinct 4) to the west. The vegetated buffer along the creek line to the south is zoned 7(l) Environmental Protection 'Wetlands and Littoral Rainforest'; the developable land is zone 2(c) Urban Expansion.

Asset Protection Zones (APZ)

Based on the assessment of the vegetation communities and slopes present on and adjacent to Precinct 5, and in accordance with Appendix 2 Table A2.5, Planning for Bushfire Protection (RFS 2006), this bushfire risk assessment recommends that Asset Protection Zones (APZ), Inner Protection Area (IPA) and Outer Protection Area (OPA) should be established as listed below.

Aspect	Vegetation	APZ (m)	IPA (m)	OPA (m)	Compliance with PBP
East	Tall Heath/Forest	21	21	0	Yes, achieved by the proposed perimeter road & grassed swale area
North, West	Grassland	10	10	0	Yes, achieved by the proposed Kings Forest Parkway
South/East	Forest	27	27	0	Yes, included within the 20m outer buffer to zone and adjoining allotments
South	Forest	21	21	0	Yes, included within the 20m outer buffer to zone and adjoining allotments
South/West	Forest	21	21	0	Yes, achieved by the proposed perimeter road & grassed swale area

The prescribed Asset Protection Zones are provided by the following features of the concept Plan for Precinct 5 as illustrated in Plan 3.

To the east, a perimeter road a grassed swale drainage corridor provides a managed buffer along the eastern perimeter that exceeds that required for the APZ. The perimeter road is located within the development footprint while the grassed swale area shall be located within the 20m outer margin of the ecological buffer from Cudgen Nature Reserve. Additionally, a drainage detention basin to be constructed in the northeast corner of the development will contribute to the required APZ. The APZ has been measured from the property boundary and consists of the entire perimeter road and a small portion of the outer ecological buffer zone.

Along the south eastern limit of Precinct 5, a 50m ecological buffer is required from the zone 7(l) Environmental Protection 'habitat' lands. The 20m outer margin of this buffer will include a grassed swale area which will be utilised for part of the required APZ with the remaining 7 metres contained within the residential lots.

For the south western limit, a 50m ecological buffer is required from the zone 7(l) Environmental Protection 'habitat' and zone 7(a) 'Wetlands and Littoral Rainforest' lands. A perimeter road, and a grassed swale drainage corridor provides a managed buffer that exceeds that required for the APZ. The perimeter road is located within the development footprint while the grassed swale shall be located within the 20m outer margin of the ecological buffer. The APZ has been measured from the property boundary and consists of the entire perimeter road and a small portion of the outer ecological buffer zone.

To the west and north, the prescribed APZ is provided by the perimeter roads.

Bush Fire Attack Categories

An assessment of the bushfire attack categories applicable to the proposed development in Precinct 5 was carried out using the methodology detailed in Planning for Bushfire Protection (Addendum Appendix 3 2010). This bushfire risk management assessment concluded the following bushfire attack categories are applicable for the proposed development, depending on the separation distance from the assessed bushfire prone vegetation.

Vegetation	Aspect	Separation distance (m)	Bushfire Attack category
Forest	East/South Southwest	21-<31	BAL - 29
		31-<42	BAL - 19
		42-<100	BAL - 12.5
		>100	N/A
Forest	Southeast	27-37	BAL - 29
		37-<50	BAL - 19
		50-<100	BAL - 12.5
		>100	N/A
Grassland	North, West	>100m	Low

Fire Trail

With the exception of the south/eastern and southern elevations of the precinct the subdivision has been designed with a perimeter roads which separates the majority of the proposed allotments from the vegetation which will allow access to the bushland interface without the need for a fire trail; the bushfire assessment concluded fire trails would not be required for the south/eastern and southern elevations of the precinct due to the short distances between the three lots (621-623) are connected by the grassed swale area and relatively short lot boundaries which will allow access to the bushland interface in these areas.

ACCESS

Access to the proposed Precincts will be via Kings Forest Parkway and internal interconnecting roads. All interconnecting roads have been designed less than 200m in length without intersections, the development's roads will be dedicated to Tweed Shire Council and shall comply with the requirements in PBP 2006.

SERVICES

There will be a reticulated water supply to the property. The water supply to this subdivision must use a ring main system with the perimeter road. The fire hydrant spacing, sizing and pressure of this reticulated water supply must comply with AS 2419.1 (2005). Fire hydrants are not located on any carriage way and shall be delineated with blue pavement markers. All above ground water and gas service pipes are metal, including and up to any outside taps. Electrical transmission lines will be underground.

CONSTRUCTION STANDARDS

The Bushfire Risk Management assessment undertaken in relation to the proposed subdivision concluded that the construction standard in accordance with AS 3959 (1999) Construction of Buildings in Bushfire Prone Areas (Standards Australia, 2009) will be assessed and nominated when development applications are submitted for the construction of dwellings on the approved allotments.

CONCLUSION

The proposed development will comply with the minimum requirements for:

- 1) Asset Protection Zones detailed in Table A2.5 Minimum Specifications for Asset Protection Zones for Residential and Rural Residential Subdivision Purposes (for class 1 & 2 buildings) in FDI 80 Fire Areas in the Planning for Bushfire Protection manual (RFS, 2006);
- 2) Access in accordance with section 4.1.3-2 (Property Access) in the Planning for Bushfire Protection manual (RFS, 2006); and
- 3) Development of the Commercial Precinct, Education Precinct and Residential Precinct satisfies the aims of PBP 2006 and will therefore comply with the provisions for Fire Safety under the Building Code of Australia.

BUSH FIRE RISK MANAGEMENT PLAN**8.1 Scope of the Plan**

The Bushfire Risk Management Plan (BFRMP) is a strategic document which identifies: the level of bush fire risk for human habitation; strategies which will be implemented to manage the bush fire risk identified; and those persons responsible for implementing and maintaining this Bushfire Risk Management Plan.

8.1.1 Area

This Plan covers the proposed education, residential and commercial development of Stage One of Kings Forest. Kings Forest is situated immediately to the west of Tweed Coast Road, between Casuarina Town Centre and Kingscliff, within Tweed Shire Council Local Government Area.

8.1.2 Period of Operation

Once a Bush Fire Safety Authority has been issued by the NSW Rural Fire Service and approved by the Local Authority, this Plan will have a period of operation of the life of the development or until such time that further development of the allotments is proposed.

8.1.3 Aim and objectives of the Plan

The aim of this Plan is to provide for the mitigation of bush fires for the protection of life and property for the habitants, visitors and emergency personnel in bush fire situations. Secondly, the Plan aims to reduce the threat to ecological and environmental assets. To achieve this aim, the Bushfire Risk Management Plan must address a number of specific objectives.

- i. Identify the area most at risk from bush fire attack;
- ii. Reduce the risk of bush fire damage to life and property;
- iii. Ensure that the developer/owner/occupier understands their bush fire management responsibilities;
- iv. Reduce the impact of bush fire on the development;
- v. Develop sustainable Asset Protection Zones (APZ) surrounding the proposed building

8.1.4 Bushfire Risk Management Strategies

This Plan contains a number of strategies, which are directed at addressing the risk to the commercial, retail, school and residential developments from bushfire emergencies. This is achieved through addressing and managing fuel loads, separation distances from the assessed dominant bushfire vegetation, and recommending appropriate bushfire building standards.

8.1.5 Implementation

Implementation of the strategies in this Plan is the responsibility of the developer and shall be undertaken as part of the development infrastructure. The ongoing maintenance of the strategies in this Plan shall be the responsibility of the owner/occupiers of each proposed residential allotments to the limit of their property boundaries

8.2 Legislative Bushfire Hazard Management Responsibilities

8.2.1 Tweed Shire Council

The Tweed Shire Council has responsibility, under Section 66 of the Rural Fires Act, to issue a notice in writing requiring an owner / occupier of any land within the LGA to carry out bushfire hazard reduction works on that land. Section 100E of the Rural Fires Act requires the council to issue bushfire hazard reduction certificates for hazard reduction to be undertaken on private lands.

8.2.2 New South Wales Rural Fire Service

The NSW Rural Fire Service (RFS) has the responsibility for undertaking fire suppression activities, hazard management activities and other functions relative to emergency management, within its areas of operation. Section 73 of the Rural Fires Act (1997) enables the Commissioner to carry out bush fire hazard reduction works on any land as required by a bush fire risk management plan if the work has not been carried out satisfactorily. Incurred costs can be recovered as a debt owed to the Crown.

8.2.3 NSW Fire Brigade

The NSW Fire Brigade has the responsibility for undertaking fire suppression activities, and other functions relative to emergency management, within its area of operation. Through mutual aid agreements, the NSW Fire Brigade can provide assistance to the NSW Rural Fire Service, particularly for structural fire operations within the NSW Rural Fire Brigade Districts. Furthermore, Hazmat operations within New South Wales are the responsibility of the NSW Fire Brigade.

8.2.4 Far North Coast Bush Fire Management Committee

The Far North Coast Bushfire Management Committee has the responsibility for planning for co-ordinated fire fighting activities / hazard management activities on a local government level. It is not an operational organisation, a fire fighting organisation or a funding source for fire management activities. The Bush Fire Management Committee is supported by the following provisions of the Rural Fires Act (1997).

Section 50 of the Act requires the Bush Fire Co-ordinating Committee to constitute a Bush Fire Management Committee for the whole of the area of any local Council area for which a rural fire district is constituted.

Section 51(1A) requires a Bush Fire Management Committee to report to the Bush Fire Coordinating Committee on the implementation of the requirements of the Bushfire Risk Management Plan.

Section 52 requires each Bush Fire Management Committee to prepare a draft bush fire management plan for their local areas which includes a plan of operations and a bush fire risk management plan.

Section 54 of the Act specifies that a draft bush fire risk management plan is to 'set out schemes for the reduction of bush fire hazards in the rural fire district or other part of the State'. A draft bush fire risk management plan may also restrict or prohibit the use of fire or other fire hazard reduction activities in all or specified circumstances or places to which the plan applies.

8.2.5 Private Land Owners / Occupiers

The Rural Fires Act, 1997 provides several legislative opportunities to require land owners and occupiers to manage hazardous fuels. These are listed below:

Section 63(2) states that 'it is the duty of the owner or occupier of land to take the notified steps (if any) and any other practicable steps to prevent the occurrence of fires on, and to minimise the danger of the spread of fires on or from that land'. In this section; 'notified steps' means any steps that:

- (a) a bushfire risk management plan (or the Co-ordinating Committee) advises a person to take;
- (b) are included in a bush fire risk management plan that applies to that land.

Section 87 allows the removal of hazards in the bush fire danger period by the provision of a permit system. The permits are valid for 21 days, excluding total fire ban (TOBAN) days. Section 10 permits are not required to adhere to Part V provisions of the Environmental Planning & Assessment Act (1979) (EP&A Act) in any assessment of impact, except for public authorities. An owner/occupier of private land must obtain from the NSW Rural Fire Service, a bushfire hazard reduction certificate before undertaking hazard reduction works on that land (see Section 100E of the Rural Fires Act (1997)).

8.2.6 NSW Rural Fire District BFRMP

The Tweed Shire Council's Bushfire Management Options are to:

- (a) **Reduce the hazard** - encourages the development of asset protection zones along the settlement area - bushland interface.
- (b) **Reduce vulnerability** - maintain development and building controls and standards appropriate to the level of hazard.

8.3 Introduction

Development application on bushfire prone land must be accompanied by a Bush Fire Safety Authority (BFSA) provided by the Rural Fire Service. Application for a BFSA should follow the requirements of Clause 46, Rural Fires Act, listed as Appendix 4 of the Planning for Bushfire Protection 2006 guidelines (RFS, 2006). In particular, this shall include:

- a) A statement that the site is bush fire prone land, where applicable;
- b) The location, extent and vegetation formation of any bushland on or within 100m of the site;
- c) The slope and aspect of the site and of any bush fire prone land within 100m of the site, which may determine the likely path of any bush fire;
- d) Any features on or adjoining the site that may mitigate the impact of a high intensity bush fire on the proposed development;
- e) A statement of the likely environmental impact of any proposed bush fire protection measures; and
- f) Whether any building complies with AS 3959/1999 in relation to the construction level for bush fire protection.

The Kings Forest Community Concept Plan (06-0318) was approved by the Minister of Planning on 19 August 2010 under SEPP (Major Projects), 2005. This concept plan caters for residential community (including subdivision), educational facility, a town centre, commercial zones; a golf course and club house; a neighbourhood centre and a regional community facility.

For Stage 1 of the Kings Forest development (08-0194), to which this Bushfire Risk Management Plan relates, the Director General's environmental assessment requirements state at Item 6.3:

"In order to ensure the protection of property and assets, a detailed bushfire assessment and management plan prepared by a suitably qualified person must be submitted. The assessment must, at a minimum, demonstrate consistency with the requirements of Planning for Bushfire Protection 2006. All asset protection zones must be clearly specified on the Plan of Development and all affected lots are to be encumbered with a Section 88B instrument under the NSW Conveyancing Act 1919."

Note: Correspondence received from NSW Rural Fire Service indicates that the lots affected by Asset Protection Zones are not required to be encumbered with a Section 88B instrument under the NSW Conveyancing Act 1919; a meeting between the developers representative and DOPI officers on the 19 July 2012 supported the NSW Rural Fire Service position, therefore, implementation of Section 88B instruments for lots affected by Asset Protection Zones are not required.

Whilst Part 3A development applications are assessed differently, there is still the need, through the Director General's environmental assessment requirements listed above, to fully consider the bushfire risk to the proposed development. This is best achieved through reference to the methodology outlined in Appendix 4 of the Planning for Bushfire Protection 2006 guideline (RFS, 2006); this assessment involved the following activities:

- i. Verifying of terrain attributes in relation to the assessed bushfire vegetation.
- ii. Identification of the appropriate bushfire protection for any identified environmental assets.
- iii. Determination of the location of adequate water supplies for fire fighting purposes.
- iv. Identifying the capacity of public roads to handle increased volumes of traffic in a bushfire situation.
- v. Identification of adequacies for implementation of fire trails which link to Public roads in the vicinity.
- vi. Identification of adequacy of arrangements for access and egress from the development for the purposes of an emergency response.
- vii. Identification of construction standards to be used for building elements in the development.
- viii. Identification of adequacy of bushfire maintenance plans and fire emergency procedures for the development.
- ix. Identification of additional bushfire protection measures.

8.3.1 Description of property

The Kings Forest site is located immediately west of Tweed Coast Road, between Casuarina Town Centre and Kingscliff on the north coast of NSW and covers an area of 880Ha. The property has previously been sand mined; utilised for turf production, dairying, small cropping, livestock grazing, sugar-cane production; and for pine plantations. Current activities include livestock grazing and harvesting of the mature pine forests growing on the subject land. It is the intention of the proponents to continue with the livestock grazing activity until urban development commences.

Within the zone 2(c) Urban Expansion areas, most of the vegetation has been cleared and managed as grassland for livestock grazing. Substantial areas of native vegetation occur within the low-lying flood-prone areas and along the small creeks and gullies that intersect the property; these areas being protected under the zone 7(a) and 7(l) Environmental Protection classifications.

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The subject land is bordered to the north and west of rural grazing land and/or tropical fruit orchards. The disused refuse facility immediately to the north of the subject site has been remediated to playing fields by Tweed Shire Council. Cudgen Nature Reserve, including Cudgen Lake (State Environmental Planning Policy No. 14 Coastal Wetlands), occurs to the south and east of the property.

8.3.2 Proposal

The Kings Forest Stage 1 Project Application No. MP 08_0194 was lodged in November 2011. The Application and Environmental Assessment Report was advertised from December 2011 to January 2012 following which 302 public submissions and 10 agency submissions were received.

As a result of the submissions, amendments to the project have been made. The amended project contains the following key elements (NB: these elements will be revised and updated as the amended project is finalised).

- ♦ Subdivision to create new lots for future development;
 - Bulk earthworks across the site;
 - Road works comprising:
 - construction of the entrance road into the site and associated intersection works on Tweed Coast Road;
 - alignment and construction of the proposed Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western precincts; and
 - alignment and part construction of two proposed roads through SEPP 14 areas to access the southern precincts;
- ♦ Development of 2,036 m² of floor space for rural retail development and access arrangements within Precinct 1;
- ♦ Construction of subdivision and infrastructure works along the Kings Forest Parkway and within Precincts 1 and 5;
- ♦ The Plan of Development for Precinct 5.

The land subject to this proposal is the north east portion of the Property and comprises the following precincts as illustrated on the concept plan (Plan 1).

Precinct 1 - Commercial development situated to the east of Tweed Coast Rd
Precinct 5 - Residential development

Each precinct is assessed according to the methodology outlined in Appendix 4, Planning for Bushfire Protection 2006 and presented in the following sections.

8.3.3 Ecological buffers

As part of SEPP (Major Development) 2005 Amendment No. 10, gazetted in November, 2006 (Government Gazette No. 135, p. 9515) 50m wide ecological buffers are required from any lands designated as zone 7(a) or zone 7(l) Environmental Protection. Development within any ecological buffer must meet the objectives outlined in clause 7(2) and 7(3) of Part 6 Kings Forest Site, Schedule 3 State Significant Sites of SEPP (Major Development) 2005 as listed below:

- a) To protect wetlands or areas of particular habitat significance;

- b) To restrict development so that, as far as practicable, it does not occur within ecological buffers;
- c) To help ensure that development is designed, sited and managed so as to minimise its impact on the ecological and hydrological functions of the ecological buffers; and
- d) To encourage the restoration and maintenance of the native vegetation and ecological processes of the land within and adjacent to wetlands or areas of particular habitat significance.

Vegetation management to achieve the standard for an Asset Protection Zone requested by the Rural Fire Service (RFS, 2006) shall utilise the perimeter road and the grassed swale area within the 20m wide outer zone to any ecological buffer adjacent to any proposed development. This will satisfy the objectives of an ecological buffer in protecting the environmentally sensitive areas.

8.4 Precinct 1 Commercial development

A commercial development is proposed for the parcel of land on the east side of Tweed Coast Road (Lot 7, DP 875447). The proposal involves 1 building, public and staff car parking areas, separate car and truck entries and a designated truck manoeuvring area incorporating a drive-through pickup facility (Plan 2). The public car park is located rear of the building towards the bushfire hazard. This Precinct adjoins State Environmental Planning Policy (SEPP) 14 'Coastal Wetlands' to the south and east that is protected as Zone 7(a) Environmental Protection "Wetland and Littoral Rainforest". There is a 50m ecological buffer to be established along the southern and eastern margins of the developable area of this Precinct between the 7(a) zone and any development. This is a requirement of the SEPP (Major Projects) Amendment No. 10 as illustrated in Attachment 2.

8.4.1 Vegetation classification

The vegetation for this precinct and adjacent properties up to 140m (where practicable) from the proposed development were assessed during a site visit on 25th of May, 2012. The vegetation communities present were identified and classified into formations as described in Keith (2004). Appendix A2.3 of Planning for Bushfire Protection (PBP) manual (RFS, 2006) outlines the methodology for determining the predominant bushfire prone vegetation to the distance of at least 140 metres in all directions from the future development on the site. Vegetation is classified using Table A2.1 of Planning for Bushfire Protection 2006, which classifies vegetation types into the following groups:

- | | |
|--|----------------------------|
| (a) Forests [wet & dry sclerophyll forests] | (g) Freshwater Wetlands; |
| (b) Woodlands | (h) Saline Wetlands |
| (c) Plantations – being pine plantations not native plantations; | (i) Alpine Complex; |
| (d) Forested Wetlands; | (j) Semi – arid Woodlands; |
| (e) Tall Heath lands; | (k) Arid Woodlands; and |
| (f) Short Heath lands | (l) Rainforests |

8.4.2 Vegetation communities present on Precinct 1

Community 1 Managed Grassland: The northern portion of the land is cleared of all over-storey vegetation and maintained as grassland.

Community 2 Forest: A narrow (c. 20m wide) area of Subtropical Lowland Forest is present to the south and east towards Cudgen Creek (boundary to Precinct) merging into Littoral Rainforest near Cudgen Creek. This vegetation is within the 7(a) Environmental Protection (Wetland and Littoral Rainforest) LEP zone. Subtropical Floodplain Forest and Littoral Rainforest are endangered ecological communities and protected under the NSW Threatened Species Conservation Act (1995). The Concept Plan provides for a 50m ecological buffer from this vegetation, consisting of a 30m vegetated inner zone as a barrier to weed invasion and a 20m outer zone.

8.4.3 Vegetation within 140m from Precinct 1

Existing exotic pine plantations (*Pinus elliottii*) in the process of being harvested are present immediately to the north and northeast of the subject land. Cleared grazing / lifestyle residences are present beyond the Pine Plantations. Cudgen Creek and riparian vegetation (Subtropical Floodplain Forest and Littoral Rainforest) is present to the east and southeast. Cudgen Nature Reserve, comprising a Banksia-dominated Tall Heath community occurs to the south; whilst to the west is the Tweed Coast Road reserve and developed residences.

8.4.4 Assessed Dominant Bushfire Vegetation in relation to the Precinct

The Subtropical Floodplain Forest / Littoral Rainforest area is assessed as Category 1 Bushfire prone vegetation, according to the Tweed Shire Bush Fire Prone Lands (TSBPL) map (Tweed Shire Council, 2004) with the remainder of the subject land within the 100m buffer to this vegetation.

The onsite bushfire hazard assessment identified the Subtropical Floodplain Forest and Littoral Rainforest to the south and east of the subject land as the dominant bushfire prone vegetation in relation to the development of Precinct 1.

8.4.5 Landform Assessment

Inspection of published topographic maps and an on-site assessment using a clinometer verified the following land forms were present over this Precinct. The land comprises alluvial flats that are generally flat towards the banks of Cudgen Creek.

8.4.6 Assessed Dominant Slope in relation to identified Bushfire Prone Vegetation

Appendix 2 of Planning for Bushfire Protection (RFS, 2006) recommends that slopes should be assessed, over a distance of at least 100m from a development site and that the dominant gradient of the land should be determined on the basis of which will most significantly influence the fire behaviour at the site. The terrain is flat for the vegetation to the east and south; flat towards Tweed Coast Road and the residential development to the west; and upslope to the north.

8.4.7 Environmental Considerations

The Subtropical Floodplain Forest and Littoral Rainforest areas are protected as endangered ecological communities. No removal of this vegetation is permitted under the Tweed LEP or proposed in the Concept Plan for the development. A 50m ecological buffer is proposed to separate any development from this vegetation.

8.4.8 Asset Protection Zones

Based on the assessment of the vegetation communities and slopes present on and adjacent to Precinct 1, and in accordance with Appendix 2 Table A2.5, Planning for Bushfire Protection (RFS 2006), this bushfire risk assessment recommends that Asset

Protection Zones (APZ), Inner Protection Area (IPA) and Outer Protection Area (OPA) should be established as listed in Table 2.

There is no requirement to establish an Asset Protection Zone for bushfire protection for this development for the north and west aspects since there will be no bushfire prone vegetation within 100m in the Precinct boundary in these directions once the Pine Plantations have been removed. A 21m Asset Protection Zone is recommended for bushfire protection to the east and south; comprising a 21m Inner Protection Area. This APZ is obtained by utilising the proposed car park area. All available land to the east of the proposed Building shall be incorporated in the APZ; this area is proposed to be developed as delivery vehicle unloading and manoeuvring areas and meets the requirements for an APZ. The required APZ are illustrated on Plan 2.

Table 2 Asset Protection Zones for Precinct 1

Aspect	Vegetation	APZ (m)	IPA (m)	OPA (m)	Compliance with PBP
South	Forest	21	21	0	Yes, achieved by the carpark area
East	Forest	21	21	0	Yes, achieved by the carpark area

8.4.9 Assessed Bushfire Attack Category

An assessment of the bushfire attack categories applicable to the proposed development in Precinct 1 was carried out using the methodology detailed in Planning for Bushfire Protection (Addendum Appendix 3 (2010)). This bushfire risk management assessment concluded that the commercial Building will be in a BAL - 29 Bushfire Attack Category according to Table A 3.4 Determination of Category of Bush Fire Attack FDI 80 (RFS, 2006) with the following site attributes:

- ♦ Forest as the Bushfire prone vegetation to the east and south
- ♦ This vegetation occurs on a flat slope
- ♦ A minimum separation of 21m is achievable from this vegetation

8.4.10 Services (Electricity Supply, Water, Gas)

Where possible electrical transmission lines should be underground; where overhead electrical transmission lines are installed, lines should be installed with short pole spacing, unless crossing gullies, gorges or riparian areas. No part of a tree should be closer to a power line than the distance set by the appropriate authority. Regular inspection of lines is required to ensure they are not fouled by branches.

Reticulated water is available to the development and will be supplied to each allotment through the town mains system in accordance with local water authority, council development control plans (DCPs) or any other policies and procedures.

- a) External fire hydrants will be installed and located in accordance with Australian Standard 2419-1, the hydrants shall be installed so as a clear unobstructed path to each designated building envelope, and
- b) The fire hydrants shall be installed at a maximum distance of 80m from the furthest extremity of the building/s, and
- c) The location of fire hydrants shall be delineated by blue pavement markers in the centre of the road, and

- d) All delivery water lines shall be installed underground to a minimum depth of three hundred millimetres (300mm), with all points above ground using metal pipes or raisers with a minimum internal diameter of nineteen millimetres (19mm).

8.4.11 Public Road Capacity to Handle Increased Volumes of Traffic in a Bushfire Emergency

The public road (Tweed Coast Road) in the vicinity of the subject property is adequate to handle increased volumes of traffic in a bushfire emergency. This road;

- has a bitumen surface;
- is two-way, allowing traffic to pass in opposite directions; and
- has the capacity to carry fully loaded fire fighting vehicles

Access to the proposed Precinct will be via constructed driveways from Tweed Coast Road. This will involve separate car and truck entries. There is also provision for vehicles to gain access to the rear storage areas via a driveway along the northern margin and where required, to enter the drive-through pickup area and return to Tweed Coast Road via the public car park.

Fire Trails are not required since the bushfire hazard can be accessed from the proposed access roads and car park areas. The Delivery / Pickup vehicle entry along the northern boundary and the public car park serve as a perimeter road providing adequate access to the bushland interface.

8.5 Precinct 5 Residential development

Residential development is proposed for the parcel of land located to the south of the proposed Kings Forest Parkway and east of the future Town Centre Precinct (Part Lot 1, DP 781633 and Part Lot 40, DP 7482). The area is presently cleared of all over-storey vegetation and managed as grazing land. Precinct 5 is surrounded by the Cudgen Nature Reserve to the east, a vegetated buffer to a creek line along the southern; open forest to the northeast; and proposed Precinct 3 to the north. The vegetated buffer along the creek line to the south is zoned 7(a) Environmental Protection 'Littoral Rainforest and Wetland', whereas the developable land is zone 2(c) Urban Expansion.

The residential development will comprise a range of dwelling types (mews, plexes, zero-lot, conventional, terrace homes, SOHO and medium density dwellings), generally serviced by a perimeter road, interconnecting roads and cul-de-sacs. A central open space / park is proposed with a drainage detention basin located in the northeast portion of the development.

8.5.1 Vegetation classification

The vegetation for this precinct and adjacent properties up to 140m (where practicable) from the proposed development were assessed during a site visit on 25th of May, 2012. The vegetation communities present were identified and classified into formations as described in Keith (2004).

Community 1 Managed Grassland: All of the developable area of Precinct 5 has been cleared of all over-storey vegetation and maintained as grassland.

8.5.2 Vegetation within 140m from Precinct 5

Community 2 Tall Heath: Cudgen Nature Reserve to the east of the subject land comprises a Tall Heath community dominated by Coast Banksia (*Banksia serrata*), with Tea trees (*Leptospermum* sp.), Rough-barked Apple (*Angophora subvelutina* x *robur*) and Slash Pine (*Pinus elliotii*) escapes with occasional Scribbly Gum (*Eucalyptus signata*) as emergent trees (Figure 10). Due to the occurrence of emergent Scribbly Gum this vegetation shall be classed as forest vegetation to adequately address the requirements for asset protection zones.



Figure 1: Tall Heath vegetation within Cudgen Nature Reserve (Photograph, S. Cotter).

Community 3 Open Forest: To the south of Kings Forest Parkway, on land designated an zone 7(l) Environmental Protection 'habitat' is an open forest (Figure 13) dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*), Scribbly Gum (*Eucalyptus signata*), Swamp Turpentine (*Lophostemon sauveolens*) Rough-barked Apple (*Angophora subvelutina* x *robur*) and Slash Pine (*Pinus elliotii*) escapes with a heathy understorey of Black She-Oak (*Allocasurina littoralis*), Coast Banksia (*Banksia serrata*) and Tea trees (*Leptospermum* sp.).



Figure 2: Tall Open Forest to the south of Kings Forest parkway Photograph, S. Cotter).

Community 4 Subtropical Floodplain Forest: Regenerating Floodplain Forest forms the vegetated buffer with the creek line along the southern boundary of this Precinct. This vegetation is protected as part of the zone 7(l) Environmental Protection 'habitat'.

8.5.3 Assessed Dominant Bushfire Vegetation in Relation to the Proposed Precinct,

The eastern and southern margins of this Precinct are assessed as within the 100m buffer to Category 1 Bushfire prone vegetation, according to the Tweed Shire Bush Fire Prone Lands (TSBPL) map (Tweed Shire Council, 2011) with the remaining land not classified as being bushfire prone land. The Subtropical Floodplain Forest and Littoral Rainforest along a tributary to Cudgen Creek to the south and the Tall Heath (Cudgen Nature Reserve) to the east were assessed as the bushfire prone vegetation most influencing development within this Precinct.



Figure 3: Subtropical Floodplain Forest vegetation – zone 7(l) along the southern margin of the Precinct (photograph, S. Cotter).

8.5.4 Landform assessment

Inspection of published topographic maps and an on-site assessment using an inclinometer verified that the land is generally flat to slight upslope and is surrounded by level ground for greater than 100m to the north, west and east. To the south/east the ground surface slopes downwards at between 0 and 5° towards the tributary to Cudgen Creek.

8.5.5 Environmental considerations

The Subtropical floodplain Forest and Littoral Rainforest areas are protected as endangered ecological communities. No removal of the vegetation is permitted under the Tweed LEP or proposed in the Concept Plan for the development. This vegetation represents Primary Koala Habitat and hence the majority of the Koala-preferred tree species shall be retained for the development (Figure 13).

Cudgen Nature Reserve adjoins the eastern, southern and south/eastern aspects of the precinct with fire protection of the reserve being the responsibility of NPWS and managed through the implementation of their Fire Management Strategy which is reviewed and updated on a regular basis. A meeting held on the 18 June 2012 with Damian Hoffmeyer, Manager of Bushfire Planning, Northern District NPWS, Murwillumbah and Wayne Hadaway (Bushfiresafe (Aust) Pty Ltd, Mr Hoffmeyer advised that he will be recommending inclusion in the existing Cudgen Nature Reserve and land to be dedicated adjacent to Depot Road adjoining the north eastern part of Precinct 5 a “Strategic Fire Advantage Zone” (ie. fuel reduced area) which will be included in the Cudgen Nature Reserve Management Plan.

The Cudgen Nature Reserve is identified as a Core Koala habitat, the protection of koalas from the impact of bushfires is the responsibility of the NPWS; however, as part of the development of precinct 5 a koala fence is proposed within the 20 metre outer buffer area to prevent koalas entering the residential area, also a Koala Plan of Management (KPoM) has been prepared for the development which identifies strategies for the protection of Koalas from bushfires within the development area. At the meeting held on the 18 June 2012 with Damian Hoffmeyer, Manager of Bushfire Planning, Northern District NPWS, Murwillumbah, Mr Hoffmeyer advised that the Koala fence shall be located within the outer ecological buffer separated from the inner ecological buffer zone so all ongoing maintenance of the fence falls outside the responsibility of the NPWS.



Figure 4: Koala-preferred Swamp Mahogany trees within a small gully, marked with flagging tape (arrow) to be retained (Photograph, S. Cotter).

8.5.6 Asset Protection Zones

Based on the assessment of the vegetation communities and slopes present on and adjacent to Precinct 5, and in accordance with Appendix 2 Table A2.5, Planning for Bushfire Protection (RFS 2006), this bushfire risk assessment recommends that Asset Protection Zones (APZ), Inner Protection Area (IPA) and Outer Protection Area (OPA) should be established as listed in Table 8.

Table 8: Asset Protection Zones for Precinct 5

Aspect	Vegetation	APZ (m)	IPA (m)	OPA (m)	Compliance with PBP
East	Tall Heath/Forest	21	21	0	Yes, achieved by the proposed perimeter road & grassed swale area
North, West	Grassland	10	10	0	Yes, achieved by the proposed Kings Forest Parkway
South/East	Forest	27	27	0	Yes, included within the 20m outer buffer to zone and adjoining allotments
South	Forest	21	21	0	Yes, included within the 20m outer buffer to zone and adjoining allotments
South/West	Forest	21	21	0	Yes, achieved by the proposed perimeter road & grassed swale area

The prescribed Asset Protection Zones are provided by the following features of the concept Plan for Precinct 5 as illustrated in Plan 3.

To the east, a perimeter road a grassed swale drainage corridor provides a managed buffer along the eastern perimeter that exceeds that required for the APZ. The perimeter road is located within the development footprint while the grassed swale area shall be located within the 20m outer margin of the ecological buffer from Cudgen Nature Reserve. Additionally, a drainage detention basin to be constructed in the northeast corner of the development will contribute to the required APZ. The APZ has been measured from the property boundary and consists of the entire perimeter road and a small portion of the outer ecological buffer zone.

Along the south eastern limit of Precinct 5, a 50m ecological buffer is required from the zone 7(l) Environmental Protection 'habitat' lands. The 20m outer margin of this buffer will include a grassed swale area which will be utilised for part of the required APZ with the remaining 7 metres contained within the residential lots.

For the south western limit, a 50m ecological buffer is required from the zone 7(l) Environmental Protection 'habitat' and zone 7(a) 'Wetlands and Littoral Rainforest' lands. A perimeter road and a grassed swale drainage corridor provides a managed buffer that exceeds that required for the APZ. The perimeter road is located within the development footprint while the grassed swale shall be located within the 20m outer margin of the ecological buffer. The APZ has been measured from the property boundary and consists of the entire perimeter road and a small portion of the outer ecological buffer zone.

To the west and north, the prescribed APZ is provided by perimeter roads (Kings Forest Parkway and un-named future roads).

8.5.7 Assessed Bushfire Attack Category

An assessment of the bushfire attack categories applicable to the proposed development in Precinct 5 was carried out using the methodology detailed in Planning for Bushfire Protection (Addendum Appendix 3 (2010)). This bushfire risk management assessment concluded the following bushfire attack categories are applicable for the proposed development, depending on the separation distance from the assessed bushfire prone vegetation. (Table 9).

Table 9: Bushfire Attack categories applicable to Precinct 5

Vegetation	Aspect	Separation distance (m)	Bushfire Attack category
Forest	East/South Southwest	21-<31	BAL - 29
		31-<42	BAL - 19
		42-<100	BAL - 12.5
		>100	N/A
Forest	Southeast	27-37	BAL - 29
		37-<50	BAL - 19
		50-<100	BAL - 12.5
		>100	N/A
Grassland	North, West	>100m	Low

8.5.8 Services (Electricity Supply, Water, Gas)

Where possible electrical transmission lines should be underground; where overhead electrical transmission lines are installed, lines should be installed with short pole spacing, unless crossing gullies, gorges or riparian areas. No part of a tree should be closer to a power line than the distance set by the appropriate authority. Regular inspection of lines is required to ensure they are not fouled by branches.

Reticulated water is available to the development and will be supplied to each allotment through the town mains system in accordance with local water authority, council development control plans (DCPs) or any other policies and procedures.

- External fire hydrants will be installed and located in accordance with Australian Standard 2419-1, the hydrants shall be installed so as a clear unobstructed path to each designated building envelope, and
- The fire hydrants shall be installed at a maximum distance of 80m from the furthest extremity of the building/s, and
- The location of fire hydrants shall be delineated by blue pavement markers in the centre of the road, and
- All delivery water lines shall be installed underground to a minimum depth of three hundred millimetres (300mm), with all points above ground using metal pipes or raisers with a minimum internal diameter of nineteen millimetres (19mm).

Note: Once completed a copy of the hydrant location plan shall be supplied to the NPWS for addition into their Cudgen Nature Reserve Fire Management Strategy.

8.5.9 Public Road Capacity to Handle Increased Volumes of Traffic in a Bushfire Emergency

The public roads (Tweed Coast Road, Kings Forest Parkway) in the vicinity of the subject property are adequate to handle increased volumes of traffic in a bushfire emergency. These roads;

- ♦ have a bitumen surface;
- ♦ are two-way, allowing traffic to pass in opposite directions; and
- ♦ have the capacity to carry fully loaded fire fighting vehicles

Access to the proposed Precinct will be via a dual carriageway from the un-named road along the western boundary of this Precinct with linkage to Kings Forest Parkway. All internal roads for the Precinct are either interconnecting or form a perimeter road ensuring unimpeded traffic flows within the Precinct. All roads are less than 200m in length and shall be dedicated to Tweed Shire Council as part of the proposed development.

8.5.10 Fire Trail

With the exception of the south/eastern and southern elevations of the precinct the subdivision has been designed with a perimeter roads which separates the majority of the proposed allotments from the vegetation which will allow access to the bushland interface without the need for a fire trail; the bushfire assessment concluded fire trails would not be required for the south/eastern and southern elevations of the precinct due to the short distances between the three lots (621-623) are connected by the grassed swale area and relatively short lot boundaries which will allow access to the bushland interface in these areas.

8.6 Access Requirements

Consideration should be given to the following requirements for access to the proposed development as outlined in the Planning for Bushfire Protection manual (RFS, 2006).

- a) Access roads should have a minimum trafficable width of 4 metres with a metre on each side, maintained as a bushfire fuel free area;
- b) Roads should be through roads. Dead end roads are not recommended, but if unavoidable, dead ends should not be more than 200m in length, incorporate a minimum 12m radius turning circle, and should be clearly sign posted as dead end;
- c) The capacity of road surfaces and bridges should be sufficient to carry fully loaded fire-fighting vehicles (approximately 27 tonnes or 9 tonnes per axle);
- d) Curves should have a minimum inner radius of 6m and be minimal in number to allow for rapid access and escape;
- e) The minimum distance between inner and outer curves should be 6m;
- f) Maximum grades should not exceed 15° and preferably not more than 10° or gradient specified by road design standards, whichever is the lesser gradient;
- g) There must be a minimum vertical clearance to a height of 4 metres above the road at all times;
- h) Roads should not traverse a wetland or other land potentially subject to periodic inundation (other than flood or storm surge);
- i) Roads should be clearly sign-posted (with easily distinguished names) and buildings should be clearly numbered. Bridges should clearly indicate load rating;

8.7 Bushfire Construction Standards

The bushfire risk management assessment undertaken in relation to the proposed subdivision concluded that the construction standard in accordance with AS 3959 Construction of Buildings in Bushfire Prone Areas (Standards Australia, 2009) will be assessed and nominated when development applications are submitted for the construction of dwellings on the approved allotments.

8.8 Landscaping and property maintenance – Bushfire provisions

According to the PBP manual, the principles of landscaping for bush fire protection are to: prevent flame impingement on the dwelling; provide a defendable space for property protection; reduce fire spread; deflect and filter embers; provide shelter from radiant heat; and reduce wind speed. Careful consideration of the species selection, their location relative to their flammability, and on-going maintenance to readily remove flammable fuels (leaf litter, twigs and debris) is critical to providing for bushfire protection (RFS, 2006).

8.9 Extent of compliance and/or deviation from specifications

The proposed development will comply with the minimum requirements for:

- 1) Asset Protection Zones detailed in Table A2.5 (Minimum Specifications for Asset Protection Zones (APZ) for Residential and Rural Residential Subdivision Purposes (for class 1 & 2 buildings) in FDI 80 Fire Areas); and
- 2) Access in accordance with section 4.1.3-2 (Property Access) in the manual for Planning for Bushfire Protection (RFS, 2006).
- 3) Development of the Commercial Precinct and Residential Precinct satisfies the aims of PBP 2006 and will therefore comply with the provisions for Fire Safety under the Building Code of Australia.

Glossary

APZ	Asset Protection Zone
BFRMP	Bushfire Risk Management Plan
EEC	Endangered Ecological Community
EP&A	Environmental Planning and Assessment Act
IPA	Inner Protection Area
KPoM	Koala Plan of Management
LEP	Local Environment Plan
LGA	Local Government Area
OPA	Outer Protection Area
PBP	Planning for Bushfire Protection manual
RFS	Rural Fire Service of New South Wales
SEPP	State Environmental Planning Policy
TOBAN	Total Fire Ban
TSBPL	Tweed Shire Bush Fire Prone Lands map
TSC Act	Threatened Species Conservation Act (1995)
TSCA Act	Threatened Species Conservation Amendment Act (2002)

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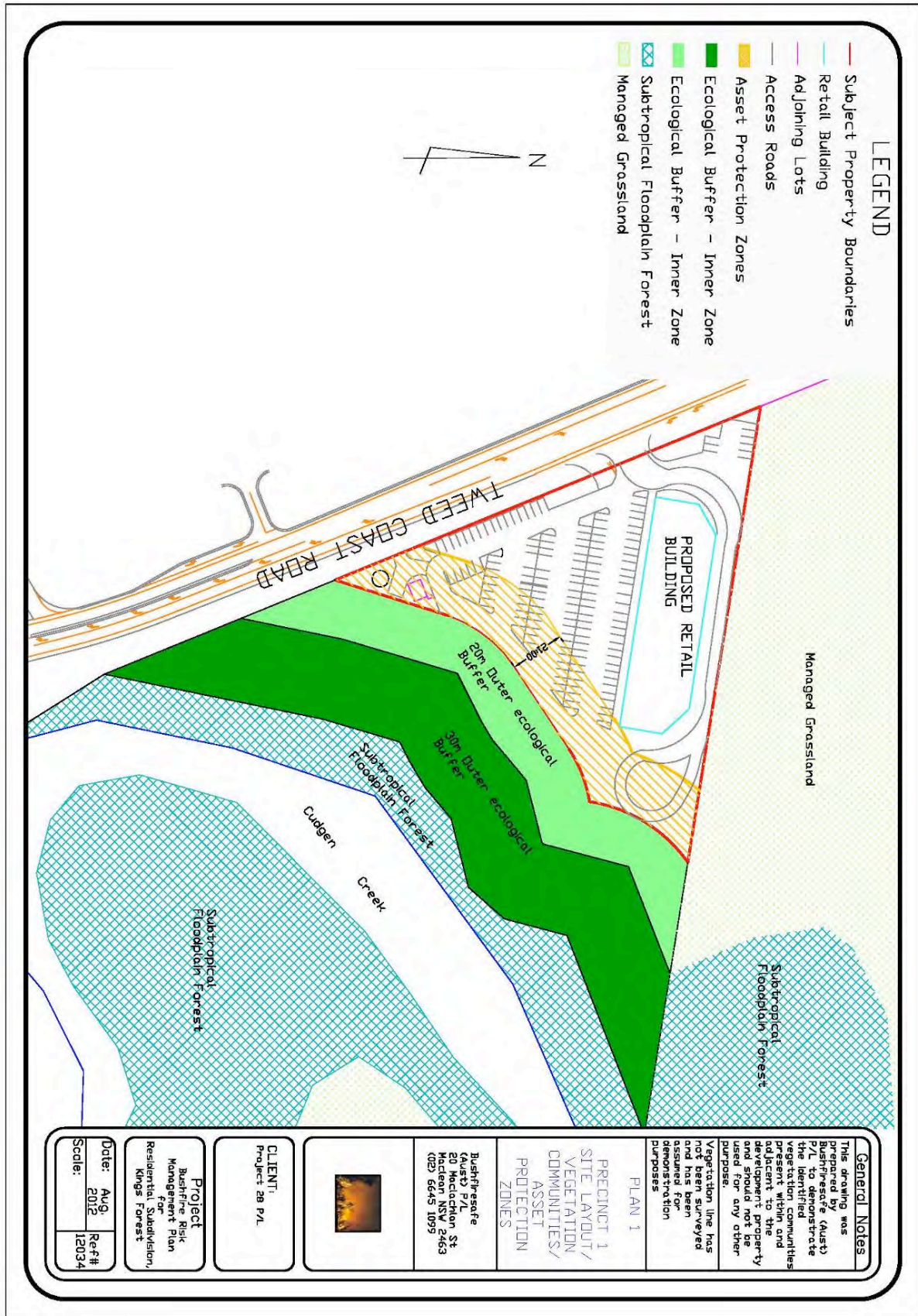
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APPENDIX 1 FIGURES

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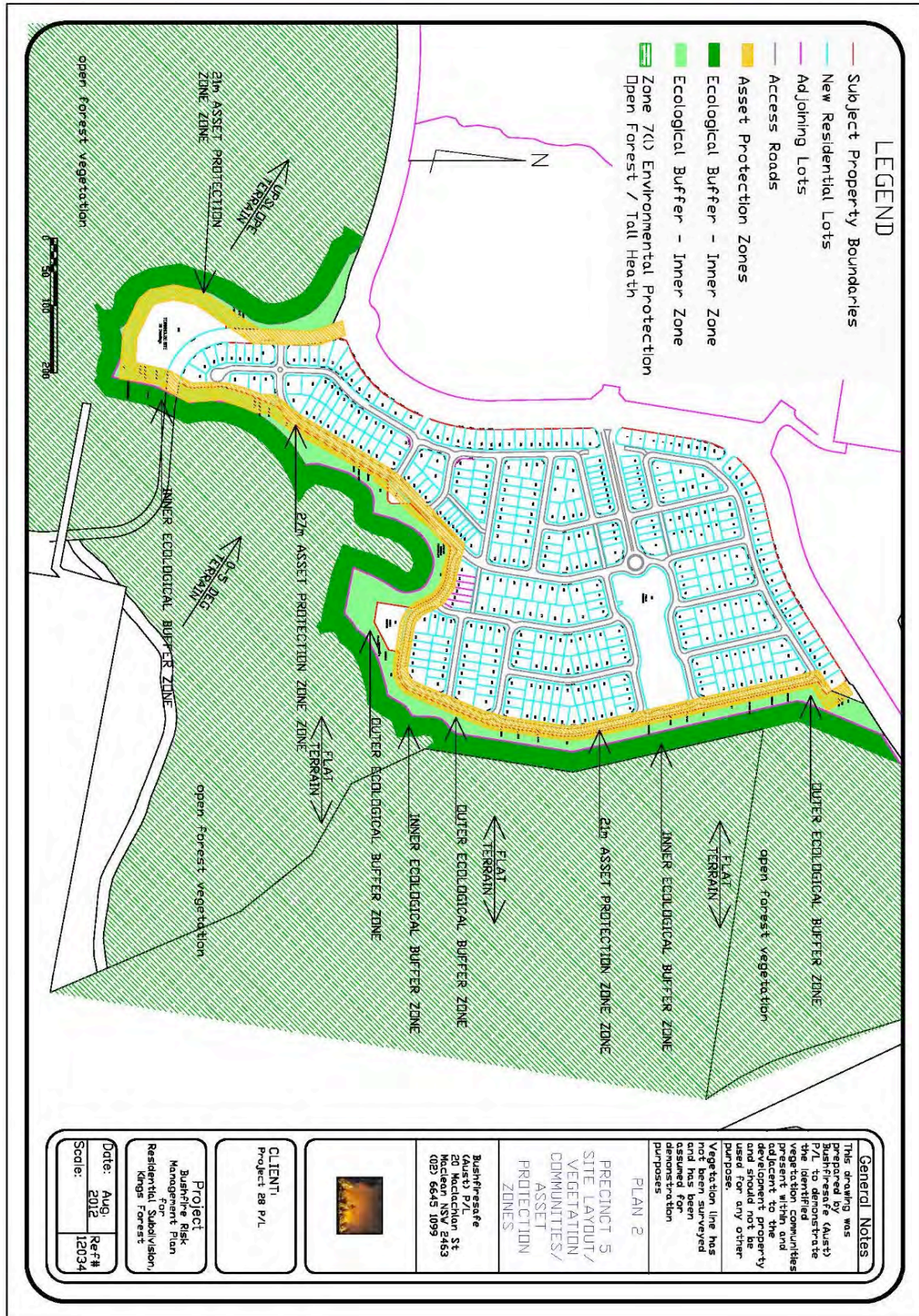
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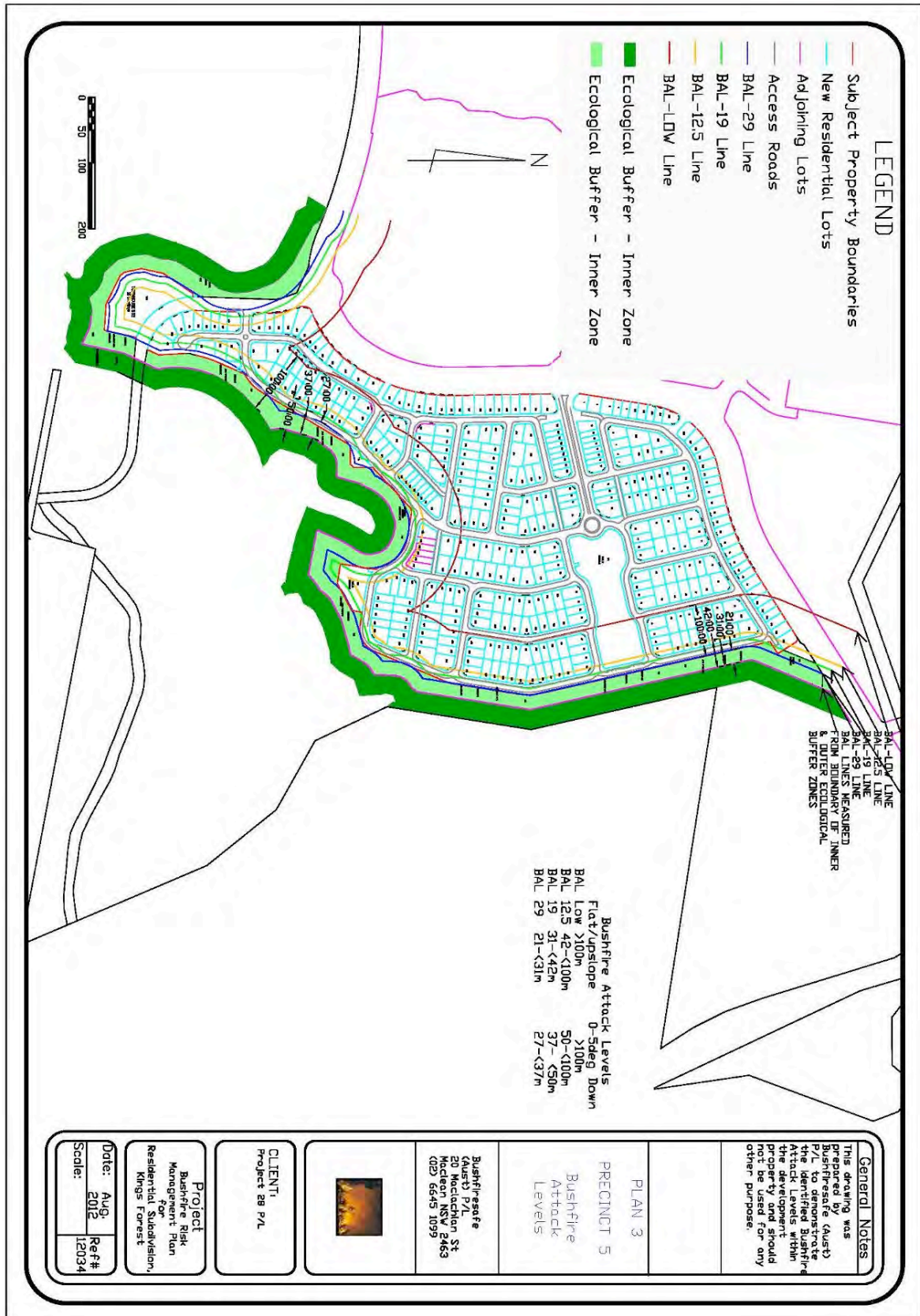
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9.0 GROUNDWATER MANAGEMENT PLAN – GILBERT & SUTHERLAND

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AUTHOR(S) C. Anderson

CLIENT Project 28 Pty Ltd

CLIENT CONTACT Reg van Rij

CLIENT REFERENCE –

SYNOPSIS This report constitutes a Groundwater Management Plan (GMP) for the entirety of the Kings Forest Stage 1 Project Application, including the golf course within precincts 12 and 13. This report should be read in conjunction with the Groundwater Assessment. The GMP establishes responsibilities and procedures for the management of groundwater during the pre-bulk earthworks, bulk earthworks, landform stabilisation phase, civil construction, on maintenance and operational life of the project. The implementation of the GMP provisions will help to ensure work is conducted in an environmentally responsible manner.

REVISION HISTORY

REVISION #	DATE	EDITION BY	APPROVED BY	FILE NAME
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2	7/12	C. Anderson	P. Mathew /L. Varcoe	10927 GMP RCMA1F

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G&S file	1	1								

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SUMMARY

Project 28 Pty Ltd commissioned Gilbert & Sutherland Pty Ltd (G&S) to prepare a Groundwater Management Plan (GMP) in support of the Kings Forest Stage 1 Project Application at Kings Forest, Cudgen, New South Wales.

The Kings Forest Stage 1 Project Application No. MP 08_0194 was lodged in November 2011. The Application and Environmental Assessment Report was advertised from December 2011 to January 2012 following which 302 public submissions and 10 agency submissions were received.

As a result of the submissions, amendments to the project have been made. The amended project contains the following key elements (NB: these elements will be revised and updated as the amended project is finalised):

- Subdivision to create new lots for future development;
 - Bulk earthworks across the site;
 - Road works comprising:
 - construction of the entrance road into the site and associated intersection works on Tweed Coast Road;
 - alignment and construction of the proposed Kings Forest Parkway from Tweed Coast Road via Precincts 4 and 5 through to the western precincts; and
 - alignment and part construction of two proposed roads through SEPP 14 areas to access the southern precincts;
- Development of 2,036 m² of floor space for rural supplies development and access arrangements within Precinct 1;
- Construction of subdivision and infrastructure works along the Kings Forest Parkway and within Precincts 1 and 5;
- The Plan of Development for Precinct 5.

The GMP should be read in conjunction with the Groundwater Assessment. The GMP identifies and describes strategies for the management of 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 proposed development of Stage 1, in accordance with the project application.

This revised report addresses the amendments to the project and the key issues raised in the submissions.

Response to Submissions

Submitter: Tweed Shire Council

Issue: Consistency with the DECC document 'Improving the environmental management of NSW Golf Courses'.

Response: Water conservation, irrigation and nutrient management within the golf course will be conducted in accordance with the DECC document 'Improving the environmental management of NSW Golf Courses'.

Submitter: Tweed Shire Council

Issue: The on maintenance phase does not take into account a full twelve-months of seasonal influences

Response: The on maintenance period has been extended to 12 months.

Kings Forest, Stage 1 - Summary and Implementation Table, Groundwater Management Plan

Action No	ACTION	Location (reference to Map)	Purpose	TIMING and FREQUENCY	RESPONSIBILITY	PERFORMANCE MEASURE	MONITORING and reporting	Further Details
Baseline data collection phase								
GMP 1	Background water quality monitoring	Groundwater monitoring locations to be specified	Establishing appropriate discharge criteria	A minimum of 12 months of background monthly monitoring	Nominated Environmental Consultant	The performance criteria shall be set by background monitoring of pre-construction water quality conditions	Background water quality report submitted to TSC	Water quality parameters are listed in Table 9.2.2
Management of potential impacts – Bulk earthworks phase								
GMP 2	Groundwater monitoring	Locations to be specified	To establish stable groundwater conditions and verify by monitoring that development management is appropriate	- Fortnightly groundwater level monitoring - Monthly groundwater quality monitoring	Contractor's Site Manager; Environmental Consultant	Groundwater monitoring will be undertaken for the parameters listed in Table 9.2.2	- Quarterly reports to TSC - Results to be kept onsite for inspection upon request	Table 9.3.2
GMP 3	Groundwater seepage monitoring	Excavation areas	Management of groundwater seepage quality	- Prior to controlled discharge - Monthly and during rainfall events	Contractor's Site Manager; Environmental Consultant	Compliance with water quality criteria listed in Table 9.3.3	Monitoring results and treatment procedures are to be available onsite at all times	Table 9.3.3
Management of potential impacts – Landform stabilisation phase								
GMP 4	Groundwater monitoring	Locations to be specified	To establish stable groundwater conditions	Quarterly groundwater level and quality monitoring	Contractor's Site Manager; Environmental Consultant	Compliance with water quality criteria listed in Table 9.2.2	- Annual reports to TSC - Results to be kept onsite for inspection upon request	Table 9.4.2

Action No	ACTION	Location (reference to Map)	Purpose	TIMING and FREQUENCY	RESPONSIBILITY	PERFORMANCE MEASURE	MONITORING and reporting	Further Details
Management of potential impacts – Civil construction phase								
GMP 5	Groundwater monitoring	Locations to be specified	To establish stable groundwater conditions	Monthly groundwater level and quality monitoring	Contractor's Site Manager; Environmental Consultant	Compliance with water quality criteria listed in Table 9.2.2	- Annual reports to TSC - Results to be kept onsite for inspection upon request	Table 9.5.2
GMP 6	Groundwater seepage monitoring	Excavation areas	Management of groundwater seepage quality	- Prior to controlled discharge - Monthly and during rainfall events	Contractor's Site Manager; Environmental Consultant	Compliance with water quality criteria listed in Table 9.5.3	Monitoring results and treatment procedures are to be available onsite at all times	Table 9.5.3
GMP 7	Golf course water conservation	Golf course, precincts 12 and 13	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones	Fortnightly monitoring of groundwater height.	Proponent; Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Quarterly reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.5.4
GMP 8	Water management (golf course irrigation)	Golf course, precincts 12 and 13	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones	Daily monitoring of soil moisture Fortnightly monitoring of surface water and groundwater height	Proponent; Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Quarterly reporting to TSC and appropriate authorities	Implementation strategy is provided in Table 9.5.5
GMP 9	Golf course nutrient management	Golf course, precincts 12 and 13	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones	- Monthly surface water and groundwater - Biannual soils - Quarterly and biannual biomass	Golf Course Manager	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	Annual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.5.6

Action No	ACTION	Location (reference to Map)	Purpose	TIMING and FREQUENCY	RESPONSIBILITY	PERFORMANCE MEASURE	MONITORING and reporting	Further Details
Management of potential impacts –On maintenance phase								
GMP 10	Groundwater monitoring	Locations to be specified	To maintain stable groundwater conditions	Monthly groundwater level and quality monitoring	Site Manager; Environmental Consultant	Compliance with water quality criteria listed in Table 9.2.2	• Biannual reports to TSC • Results to be kept onsite for inspection upon request	Table 9.6.2
GMP 11	Golf course water conservation	Golf course, precincts 12 and 13	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones	Monthly monitoring of groundwater height	Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Biannual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.6.3
GMP 12	Water management (golf course irrigation)	Golf course, precincts 12 and 13	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones	• Daily monitoring of soil moisture • Monthly monitoring of surface water and groundwater height	Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Biannual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.6.4
GMP 13	Golf course nutrient management	Golf course, precincts 12 and 13	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones	• Monthly surface water and groundwater • Biannual soils • Quarterly and biannual biomass	Golf Course Manager	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	Biannual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.6.5

Action No	ACTION	Location (reference to Map)	Purpose	TIMING and FREQUENCY	RESPONSIBILITY	PERFORMANCE MEASURE	MONITORING and reporting	Further Details
Management of potential impacts – Operational phase								
GMP 14	Groundwater monitoring	Locations to be specified	To maintain stable groundwater conditions	Quarterly groundwater level and quality monitoring	Golf Course Manager	Compliance with water quality criteria listed in Table 9.2.2	- Annual reports to TSC - Results to be kept onsite for inspection upon request	Table 9.7.2
GMP 15	Golf course water conservation	Golf course, precincts 12 and 13	To manage the rainfall on site to effectively distribute water supply to both the golf course and the surrounding Ecological zones	Monthly monitoring of groundwater height	Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Biannual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.7.3
GMP 16	Water management (golf course irrigation)	Golf course, precincts 12 and 13	To manage the irrigation applied to the golf course to minimise its impact on the surrounding Ecological zones	- Daily monitoring of soil moisture - Biannual monitoring of surface water and groundwater height	Golf Course Manager	Ground water levels to be maintained within and adjacent to golf course in accord with seasonal variation	Annual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.7.4
GMP 17	Golf course nutrient management	Golf course, precincts 12 and 13	To manage the nutrients applied to the golf course to minimise its impact on the surrounding Ecological zones	- Quarterly surface water and groundwater - Annual soils and biomass - Annual floristic structure monitoring within SEPP 14 wetlands	Golf Course Manager	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	Annual reporting to TSC and NSW Department of Planning	Implementation strategy is provided in Table 9.7.5

9.1 Groundwater Management Plan

9.1.1 Aims and objectives

This Groundwater Management Plan (GMP) provides a framework to ensure that any impacts to groundwater from the on-site activities are managed, treated, monitored, reported and, if necessary, mitigated.

The GMP 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 GMP are to ensure the following:

- 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.
- Operation of the golf course within precincts 12 and 13 will provide an effective buffer separating the urban development from SEPP 14 wetlands and environmental protection zones that are adjacent to the site.

9.1.2 Scope of this document

This document constitutes an overarching GMP 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 environmental issues relating to groundwater 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.

Although addressing the issues, it is not within the scope of this document to detail the full extent of each issue, but rather to link and integrate the range of management issues governing each individual aspect. The reports specific to the development of the GMP include:

- Kings Forest Stage 1 Project Application and associated documentation.
- Acid Sulfate Soils Assessment and Management Plan (Gilbert & Sutherland, July 2012).
- Integrated Water Cycle Management Plan (Gilbert & Sutherland, July 2012).
- Groundwater Assessment and Management Plan (Gilbert & Sutherland, July 2012).
- Review of Environmental Management Plan (ePar 2009).

9.1.3 Implementation

The GMP requires the Proponent to mitigate the potential environmental impacts related to groundwater 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.

9.1.4 GMP structure

This GMP acknowledges the environmental impacts to groundwater 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 GMP 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 GMP. 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 GMP 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 GMP to be a working document. If items need altering, changes may be made to the individual tables after appropriate consultation with the statutory authorities.

9.1.5 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 environmental implementation strategy relating to groundwater as contained within the approved final GMP 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 GMP and to carry out their activities on the project site in accordance with relevant current statutory requirements and approved amendments.

Commitment 3

The principal golf course management operating the golf course within precincts 12 and 13 shall comply with the environmental implementation strategy relating to groundwater as contained within the approved GMP during the operational phase.

9.1.6 Definitions

In this GMP these terms have the following meanings;

- GMP means the approved Groundwater 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.
- 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 GMP.

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

9.1.7 Contact details

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

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:

9.2 Baseline data collection phase

9.2.1 Intent

This part of the GMP 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.

9.2.2 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 12 months to capture the range of seasonal variation: • pH (field measurement); • electrical conductivity (EC) (field measurement); • temperature (field measurement); • redox potential (mV) • total nitrogen (TN), soluble nitrogen, nitrogen oxide (NO_x), total kjeldahl nitrogen (TKN), nitrite (NO₂) & nitrate (NO₃) (mg L⁻¹); • total phosphorus (TP) & soluble phosphorous (mg L⁻¹); • oil and grease (visual inspection);* • calcium (Ca); • magnesium (Mg); • sodium (Na); • potassium bicarbonate (K/HCO₃); • bicarbonate (HCO₃); • carbonate (CO₃); • total & dissolved iron (Fe); • total & dissolved aluminium (Al);

	• dissolved manganese (Mn); • chloride (Cl); • sulfate (SO₄); • ammonium (NH₄); • colour; • total acidity (titratable); • total alkalinity; • arsenic (As); • cadmium (Cd); • copper (Cu); • lead (Pb); • nickel (Ni); • zinc (Zn);and • faecal coliforms.
Implementation strategy	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.

9.3 Management of potential impacts – bulk earthworks phase

9.3.1 Intent

This part of the GMP 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 GMP must be complied with by the Proponent until each precinct is at final grade and stabilised.

9.3.2 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.
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 parameters listed in Table 9.2.2.
Implementation strategy	Monitoring of groundwater levels should be undertaken fortnightly during 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.

Identification of incident or failure	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.									
	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 GMP provisions and, if necessary, construction methods and procedures shall be adjusted. The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below. <table><tr><th>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, no detectable odour</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, no detectable odour	-
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.

9.3.3 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.																																							
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 criteria set by pre-construction background monitoring. The following interim 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>5.5-7.5</td><td>Range</td></tr><tr><td>Salinity</td><td>12ppt</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td>10mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>10NTU</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>5mg L⁻¹</td><td>Minimum</td></tr><tr><td>Total Iron</td><td>1.7mg L⁻¹</td><td>Maximum</td></tr><tr><td>Total Aluminium</td><td>9mg L⁻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 – 7.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2012) 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	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH	5.5-7.5	Range	Salinity	12ppt	Maximum	Suspended solids	10mg L ⁻¹	Maximum	Turbidity	10NTU	Maximum	Dissolved oxygen	5mg L ⁻¹	Minimum	Total Iron	1.7mg L ⁻¹	Maximum	Total Aluminium	9mg L ⁻¹	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	-	Oil and grease	No visible film, no detectable odour	-
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Litter and gross pollutants	No man made material >5mm in any dimension	-																																						
Oil and grease	No visible film, no detectable odour	-																																						

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 with reference to background monitoring in accordance with Table 11.5.7 'Surface water quality' of the Overall Water Management Plan (G&S, July 2012) – Section 11 of the *Kings Forest Stage 1 Management Plan* (DAC, 2012).

If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with the *Acid Sulfate Soil Management Plan* (G&S, July 2012) – Section 27 of the *Kings Forest Stage 1 Management Plan* (DAC, 2012).

The addition of hydrated lime or crushed ag-lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with the *Acid Sulfate Soil Management Plan* (G&S July 2012) – Section 27 of the *Kings Forest Stage 1 Management Plan* (DAC, 2012).

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 the *Acid Sulfate Soil Management Plan* (G&S July 2012) – Section 27 of the *Kings Forest Stage 1 Management Plan* (DAC, 2012).

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-accredited 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.

9.4 Management of potential impacts – landform stabilisation phase

9.4.1 Intent

This part of the GMP 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.

9.4.2 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.
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 parameters listed in Table 9.2.2.
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 GMP provisions and, if necessary, construction methods and procedures shall be adjusted. The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below. <table><tr><th>Water Quality Parameter</th><th>Release Criteria</th><th>Criteria Type</th></tr><tr><td>pH</td><td>As per background monitoring</td><td>Range</td></tr><tr><td>Oil and grease</td><td>No visible film, no detectable odour</td><td>-</td></tr></table>	Water Quality Parameter	Release Criteria	Criteria Type	pH	As per background monitoring	Range	Oil and grease	No visible film, no detectable odour	-
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.

9.5 Management of potential impacts – Civil construction

9.5.1 Intent

This part of the GMP 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.

9.5.2 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.
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 parameters listed in Table 9.2.2.
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 GMP provisions and, if necessary, construction methods and procedures shall be adjusted. The quality of the dewatered groundwater being discharged to recharge trenches shall be reviewed to confirm compliance with the performance criteria detailed below. <table><tr><th>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, no detectable odour</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, no detectable odour	-
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.

9.5.3 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.																																							
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>5.5 – 5.7</td><td>Range</td></tr><tr><td>Salinity</td><td>12ppt</td><td>Maximum</td></tr><tr><td>Suspended solids</td><td>10mg L⁻¹</td><td>Maximum</td></tr><tr><td>Turbidity</td><td>10NTU</td><td>Maximum</td></tr><tr><td>Dissolved oxygen</td><td>5mg L⁻¹</td><td>Minimum</td></tr><tr><td>Total Iron</td><td>1.7mg L⁻¹</td><td>Maximum</td></tr><tr><td>Total Aluminium</td><td>9mg L⁻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 – 7.5; if receiving waters are acidic, pH should be 4.2 – 6.7 in accordance with the <i>Threatened Species Management Plan</i> (JWA 2012) 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	Oil and grease	No visible film or detectable odour	--	Water Quality Parameter	Release Criteria	Criteria Type	pH	5.5 – 5.7	Range	Salinity	12ppt	Maximum	Suspended solids	10mg L ⁻¹	Maximum	Turbidity	10NTU	Maximum	Dissolved oxygen	5mg L ⁻¹	Minimum	Total Iron	1.7mg L ⁻¹	Maximum	Total Aluminium	9mg L ⁻¹	Maximum	Litter and gross pollutants	No man made material >5mm in any dimension	--	Oil and grease	No visible film, no detectable odour	-
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Total Aluminium	9mg L ⁻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	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 with reference Table 11.7.7 'Surface water quality' of the Overall Water Management Plan (G&S, July 2012) – Section 11 of the <i>Kings Forest Stage 1 Management Plan</i> (DAC, 2012).
	If acidic seepage waters are encountered, the batter slopes of the excavation face should be subject to blanket liming as required at a predetermined rate in accordance with the <i>Acid Sulfate Soil Management Plan</i> (G&S, July 2012) – Section 27 of the <i>Kings Forest Stage 1 Management Plan</i> (DAC, 2012).
	The addition of hydrated lime or crushed ag-lime to acidic seepage waters may also be required. The environmental consultant should be consulted to determine the need for this treatment and the required addition rate in accordance with the <i>Acid Sulfate Soil Management Plan</i> (G&S July 2012) – Section 27 of the <i>Kings Forest Stage 1 Management Plan</i> (DAC, 2012).
	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 the <i>Acid Sulfate Soil Management Plan</i> (G&S July 2012) – Section 27 of the <i>Kings Forest Stage 1 Management Plan</i> (DAC, 2012).
	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

Monitoring	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-accredited 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.

9.5.4 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	Water flows are to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in 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 TSC 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 Groundwater Management Plan.

9.5.5 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	Irrigation is to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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.
	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 TSC 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.
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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 Groundwater Management Plan.

9.5.6 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	Water quality is to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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 limits set as per background monitoring for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L⁻¹); • total 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,

	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.
Monitoring	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 TSC 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.

9.6 Management of potential impacts – On maintenance phase

9.6.1 Intent

This part of the GMP specifies those matters relating to groundwater which must be complied with by the Proponent during the 12 month on-maintenance period, being the period after civil construction but before TSC assumes responsibility for the subdivision works or Golf Course Management assumes responsibility for the golf course. The Proponents' obligations in this Section of the GMP conclude at the end of the maintenance period for each stage.

9.6.2 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.
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 parameters listed in Table 9.2.2 (Background water quality monitoring) in addition to: hydrocarbon (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); and enterococci.
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 GMP 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.

9.6.3 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	Water flows are to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in 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.

Monitoring Auditing Reporting Identification of incident or failure Corrective action	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.
	Monthly monitoring of groundwater height.
	Environmental consultant will audit the groundwater monitoring procedures and outcomes of the monitoring on an annual basis.
	Results of monitoring will be reported biannually to TSC and NSW Department of Planning.
	Ground water heights outside of critical limits to water level.
	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 Groundwater Management Plan.

9.6.4 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	Irrigation to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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.
	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).
Auditing	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.
	Environmental consultant will audit the monitoring procedures and outcomes of the monitoring on a biannual basis.
	Results of monitoring will be reported biannually to TSC and NSW Department of Planning.
	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 Groundwater Management Plan.

9.6.5 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	Water quality is to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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 limits set as per background monitoring for the following parameters: • pH (field measurement); • electrical conductivity (field measurement); • turbidity (field measurement); • dissolved oxygen (field measurement); • temperature (field measurement); • suspended solids (mg L⁻¹); • total 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,

	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.
Monitoring	Groundwater Monthly: • Ground water quality samples (from all height monitoring bores). • Multiple group lysimeters set at 1 m depth in four (4) locations in golf course fairways– leachate samples. • Parameters: pH (field measure); EC (field measure); Dissolved oxygen (field measure); Temperature (field measure); N – Total, 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 TSC 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.

9.7 Management of potential impacts – operational phase

9.7.1 Intent

This part of the GMP specifies those matters which should be complied with by the Golf Course management during the operational phase. It also specifies those matters which need to be addressed by Council following its acceptance off maintenance.

9.7.2 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.
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 parameters listed in Table 9.2.2 (Background water quality monitoring) in addition to: hydrocarbon (TPH); benzene, toluene, ethylbenzene and xylenes (BTEX); and enterococci.
Implementation strategy	Monitoring of groundwater levels should be undertaken quarterly during 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 GMP provisions and, if necessary, construction methods and procedures shall be adjusted.

Commitment

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

9.7.3 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	Water flows are to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. Harvesting • All water directed to bio-retention basins. • Held to recharge groundwater. • Golf course graded towards the basins. Volume • Maintain a no change in 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
	Auditing
	Reporting
	Identification of incident or failure
	Corrective action

Commitment

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

9.7.4 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	Irrigation is to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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 • groundwater 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 TSC 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.
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Commitment

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

9.7.5 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	Water quality is to be managed in accordance with the DECC document <i>'Improving the environmental management of NSW Golf Courses'</i>. 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 for: • 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.

Implementation strategy

Tees

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

Greens

- Impervious membrane under green set at 0.6m below NSL, leachate collected in containment well and reused on fairways.
- Soil conditioning to improve nutrient retention and moisture holding capacity (e.g. Zeolite incorporated top 100mm, development and maintenance of soil organic matter for soil structure and cation exchange capacity).
- Fertiliser selection – slow release and specialty fertilisers for green maintenance.
- Fertiliser rate – minimal for turf stability as determined by soil testing consistent with standard best practice for turf management.
- Application method – split application at low rates, timed with other fairway 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, a mass balance method will be used to identify fertiliser rates – inputs of

Monitoring	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 TSC 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 Manager 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.

9.8 Administration of the GMP

9.8.1 Amendment of the GMP

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

- be in writing; and
- specify the provisions of the GMP 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.

9.8.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this GMP 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.