North Byron Parklands

Technical Paper

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Intergrated Water Cycle Assessment

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Integrated Water Cycle Assessment and Management North Byron Parklands Tweed Valley Way and Jones Road, Yelgun New South Wales

Prepared for

North Byron Parklands
A project of:
Billinudgel Property Pty Ltd
(Billinudgel Property Trust)

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Title:	**Integrated Water Cycle Assessment and Management Plan, North Byron Parklands, Tweed Valley Way and Jones Road, Yelgun NSW**
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Client Reference:	North Byron Parklands
Synopsis:	This report describes the outcomes of field assessment and modelling to identify efficient and sustainable water management practices for the North Byron Parklands site. Site data was used to identify water sources to supply the demand from the proposed use of the site as a cultural events and arts facility and to determine the most appropriate methods for the management of wastewater generated.

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Revision History

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Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10
North Byron Parklands	1	1	1							
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Balanced Systems	1	1	1							
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Summary

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by North Byron Parklands on behalf of the Billinudgel Property Trust to undertake site assessments and provide advice on the provision of potable water and management of wastewater for a proposed cultural, arts and events facility known as North Byron Parklands, at Tweed Valley Way, Yelgun NSW. In addition, advice has been provided on integrated water cycle management, including stormwater management, water sensitive urban design and the prevention of surface and groundwater quality impacts.

This report is prepared in respect of a concurrent Concept Plan and Project Application Environmental Assessment report (EA) for the North Byron Parklands (Parklands) project. The project is to establish a world class sustainable cultural events site within an enhanced ecological setting.

Reticulated water supply and municipal sewerage is not available to the site, however, based on data collected during site investigations, laboratory analysis and modelling, and provided the recommended infrastructure is provided, there is sufficient water supply to service the demands from the maximum proposed utilisation of the site. This demand could be met from the harvestable use rights of the property in accordance with the provisions of the NSW Farm Dams Policy.

A wastewater treatment process that has been demonstrated to accommodate the high level of wastewater flow variation associated with event usage has been identified and is the proposed treatment process for the site. MEDLI modelling shows that the proposed storage volumes are adequate and that the treated effluent from the STP can be sustainably used for the irrigation of plantation timbers and pasture species. The modelling shows that irrigation based on soil water deficit is sufficient to consume all of the effluent generated from site usage and that there would be no surface runoff of effluent, or hydrological or quality impacts to surface water or groundwater.

Soil data has been used to assess the likelihood of erosion and sedimentation impacts during the construction and operation of the site. Based on the very low proportion of the site that will be disturbed and with the implementation of standard erosion and sedimentation control practises, SOILOSS modelling shows that the potential impacts can readily be managed.

Integrated water cycle management and stormwater management concepts are discussed and recommended management strategies incorporating elements of Water Sensitive Urban Design are included in the attached Water Management Plan.

Provided that the site is managed in accordance with the Water Management Plan, we are confident that the proposed use of the site will be sustainable and that impacts to groundwater and the on site and adjacent environmental reserves will be avoided.

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List of Drawings

Glossary

Australian Height Datum (AHD)	National reference for the relative height measurement in Australia.
Average Recurrence Interval (ARI)	The average or expected length of time between exceedances of a given variable, such as rainfall.
Bund	An embankment constructed around an area to prevent the inflow or outflow of liquids. Also called Bunding.
Catchment	The area above a given point which contributes to the runoff.
Clay	Very fine-grained sediment or soil (often defined as having a particle size less than 0.002 mm, or 2 microns, in diameter).
Ephemeral	A stream that flows briefly only in direct response to precipitation in the immediate locality and the channel of which at all times above the watertable.
Erosion	The process by which material (such as rock or soil) is worn away or removed (as by wind or water).
Groundwater	The water contained in interconnected pores located below the watertable in an unconfined aquifer or located in a confined aquifer.
Harvestable rights	Harvestable rights are the rights afforded to rural landholders to collect up to 10% of the average regional rainwater runoff from their property in one or more farm dams. The harvestable right can be used for any purpose, including commercial irrigation.
Intermittent	A stream in which the flow is seasonal, usually in response to rainfall in the immediate area (see ephemeral).
Loam	Medium-textured soil composed of approximately 10% to 25% clay, 25% to 50% silt and less than 50% sand.
pH	The degree of acidity or alkalinity measured on a scale of 1 to 14 with 7 as neutral. From 0 to 7 is acidic; from 7 to 14 is alkaline.
Sand	Sediment composed of particles within the size range 63 microns to 2 millimetres.
Scouring	The action of removing sediment from stream banks, particle by particle. This is a more destructive process than collapse when viewed over time due to incremental effects.
Sediment	Unconsolidated, fine-grained material (typically derived from the weathering of rocks), that is transported by water and settles on the floor of seas, rivers streams and other bodies of water.
Silt	A sediment with particles finer than sand and coarser than clay (i.e. 2 to 63 microns).
Sewage	Liquid and solid waste matter from domestic or industrial establishments that is carried away in sewers or drains
Sewerage	Removal of waste materials by means of a sewer system.
Subcatchment	A smaller area within a catchment drained by one or more tributaries of the main water body.
Suspended Solids (SS)	The concentration of filterable particles in water (retained on a 0.45mm filter) and reported by volume (mg/L).
Total Nitrogen (TN)	Total nitrogen is the sum of the nitrogen present in all nitrogen-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Total Phosphorus (TP)	Total phosphorus is the sum of the phosphorus present in all phosphorus-containing components in the water column. The nutrients, nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
Turbidity	A measure of the cloudiness of water which is determined by the amount of light scattered by suspended particles.
Wastewater	See sewage.

1) Introduction

Gilbert & Sutherland Pty Ltd (G&S) was commissioned by North Byron Parklands on behalf of the Billinudgel Property Trust to undertake site assessments and provide advice on the provision of potable water and management of wastewater for a proposed cultural, arts and events facility known as North Byron Parklands, at Tweed Valley Way, Yelgun NSW.

This report is prepared in respect of a concurrent Concept Plan and Project Application Environmental Assessment report (EA) for the North Byron Parklands (Parklands) project.

1.1 Proposal

The project is to establish a world-class sustainable cultural events site within an enhanced ecological setting.

Cultural events involving music, arts, food, leisure and technology are proposed. Ancillary infrastructure will ultimately include:

- Camping areas and facilities
- An internal road network
- An administration & cultural centre
- A conference centre and associated accommodation
- A water treatment plant, dams, tanks and water reticulation
- A sewage treatment plant and sewerage infrastructure

1.2 The site

The areas and real property descriptions of the various allotments that make up the application area are detailed in Table 1.2.1 below.

Table 1.2.1 – Project application lots and areas

Lot/DP	Area (ha.)
Lot 403 and Part Lots 402,404 DP 755687	104.71
Lot 1 DP 1145020	2.47
Part Lot 46 DP 755687	8.43
Part Lot 10 DP 875112	4.29
Part Lot 2 DP848618	8.9
Part Lot 30 DP880376	9.89
Part Lot 102 DP1001878	15.17
Part Lot 12 DP848618	2.05
Total of Application Area	**155.91**

The various properties that make up the site are broader than the application area and cumulatively comprise a total area of 256 hectares. The site is situated in the northeast corner of Byron Shire, NSW. The site is located in close proximity to the Yelgun Interchange which forms part of the recently upgraded Pacific Highway.

1.3 Director General's Requirements

The Director General of the Department of Planning determined that the proposal was for a Major Project pursuant to Part 3A of the *Environmental Planning and Assessment Act 1979* and issued Environmental Assessment Requirements (DGRs) on August 25, 2009. The DGRs that are addressed in this report include the following:

> *4.1 Address existing capacity and requirements of the development for sewerage and water…. Identify and describe staging, if any, of (sewerage and water) infrastructure works.*
>
> *4.2 Provide details on how and where water supply will be derived from to service the site.*
>
> *7.1 Address and outline measures for Integrated Water Cycle Management (including stormwater) based on Water Sensitive Urban Design principles which addresses impacts on the surrounding environment, drainage and water quality controls for the catchment, and erosion and sedimentation controls at construction and operational stages.*
>
> *7.2 Assess the impacts of the proposal on surface and groundwater hydrology and quality during both construction and occupation of the site. Provide details on any monitoring and/or mitigation plans to ensure surface water and groundwater are not detrimentally impacted upon*
>
> *7.3 Consider the nature and profile of the groundwater regime under the site, including any hydrologic impacts which would affect its depth or water quality, result in increased*

> *groundwater discharge, impact on the stability of potential acid sulfate soils in the vicinity, or affect groundwater dependent native vegetation.*
>
> *7.4 If applicable, DECCW's NSW Farm Dams Policy must be addressed.*
>
> *15.1 Provide details of wastewater and water treatment facilities, including capacity, types of systems, and management of odours.*

1.4 Scope of work

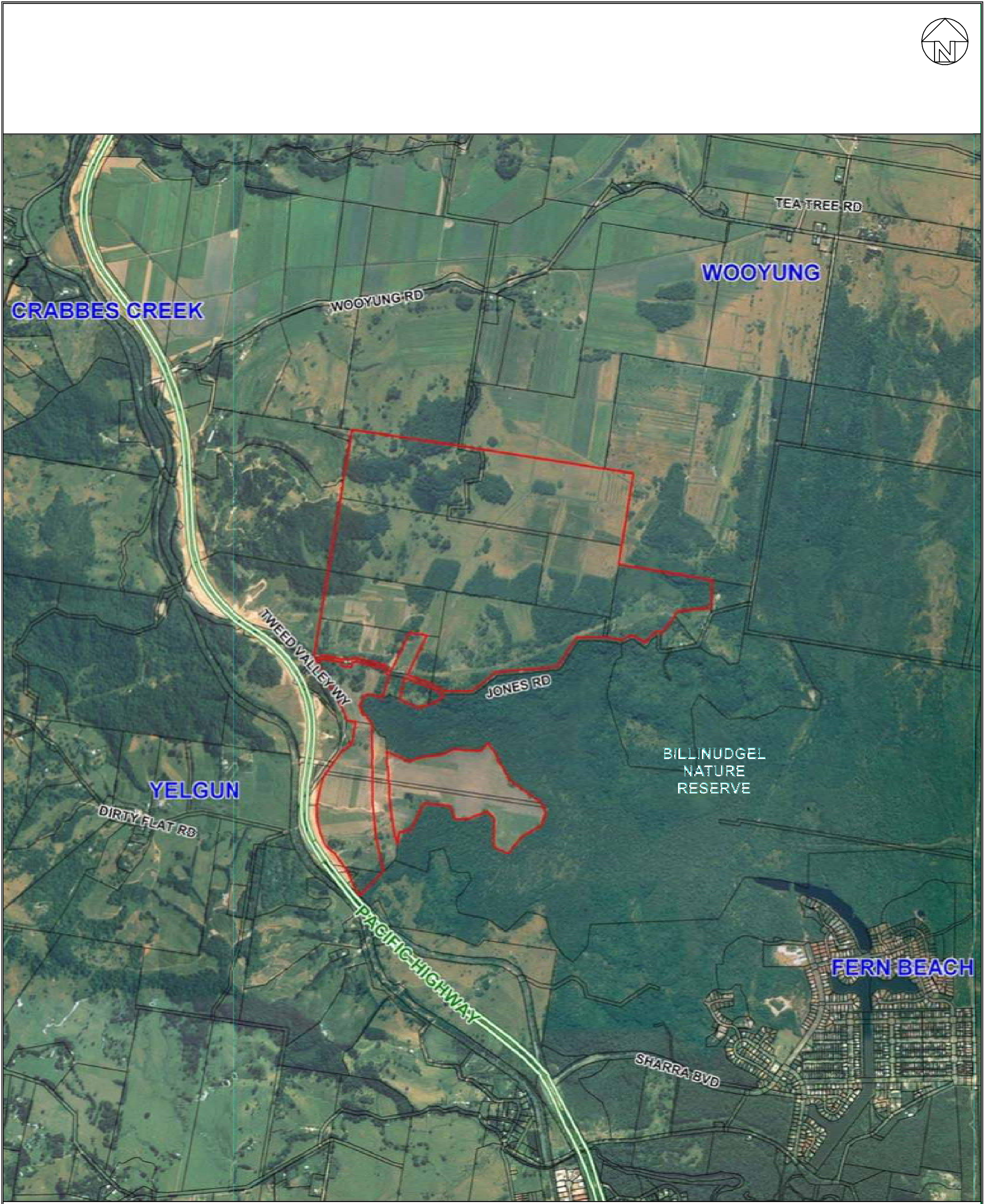
This Integrated Water Cycle Assessment and Management report addresses the issues of water and wastewater usage, storage, reuse and disposal.

Stormwater collection and management is integrated into the overarching strategies for water use, reuse and disposal on site. This approach ensures all proposed solutions and management strategies are compatible and minimises potential water cycle management conflicts arising from the development.

This report is divided into sections dealing with:

- the proposal
- the physical characteristics of the site
- a description of previous and recent soil, surface water and groundwater investigations.
- a Site and Soils Evaluation for on-site wastewater management including effluent irrigation
- an assessment of site soils for erodability and suitability for effluent irrigation and stormwater management
- management of the potential stormwater impacts during the construction and operational phases. These latter management sections form the Water Cycle Management Plan that is included as Attachment 1.

This report, prepared by qualified Gilbert & Sutherland staff, is based on a site soil survey (carried out by suitably qualified Environmental Scientists) and RUSTIC, SOILOSS and MEDLI modelling.



LEGEND
🟥 Site Boundary

Base Image: Balance Systems

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PROJECT
NORTH BYRON PARKLANDS
WATER SUPPLY AND WASTERWATER
MANAGEMENT INFRASTRUCTURE
SITE LOCATION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN K.T.	DRAWING No.
		DATE 11/05/10	CHECKED	GJ0926.1.1

BASE IMAGE: Bill Mills (2009); CADASTRE: Ardill Payne (2009)

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PROJECT

NORTH BYRON PARKLANDS
WATER SUPPLY AND WASTERWATER
MANAGEMENT INFRASTRUCTURE
PROJECT SITE

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN BMW	DRAWING No.
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2) Background

2.1 General

The overall objective of the development of the site is to create a sustainable world-class events site within an ecologically enhanced site.

Specific objectives relating to the event space, the natural environment and the local social and economic environments are articulated in the planning report and these complement and contribute to the overall objective of the site.

The cultural, arts and events facility will require a range of infrastructure to facilitate the achievement of the above objectives. The infrastructure requirements that are central to this report include the provision of stormwater management devices, a potable water treatment plant, dams, tanks and water reticulation and a sewage treatment plant and sewerage infrastructure which will service the permanent infrastructure including the cultural centre, conference centre and associated accommodation and the needs of event participants during cultural events.

It is proposed that permanent water supply and wastewater management infrastructure would not be implemented immediately, with preliminary events to be serviced with temporary facilities. Permanent infrastructure would be introduced after this time.

2.2 Event capacity

The water demand and wastewater loading rates have been calculated on the basis of the theoretical maximum usage of the site as summarised in Table 2.2.1.

It is not expected that this level of site usage would occur in the first five years of its operation and indeed site usage of this scale or intensity may never occur.

For the purpose of calculating potable water demand and wastewater loading rates, it has been assumed that the maximum number of event days would be held for major, moderate and small events.

Table 2.2.1 – Event sizes and maximum event days

Event Size	Number of Patrons	Maximum Event Days per annum
100% capacity	50,000	12
70% capacity	35,000	
40% capacity	20,000	
30% capacity	15,000	
Moderate	3,000 – 10,000	4
Small	300 – 3,000	4
Minor	<300	No limit

2.3 Event frequency

The frequency of events will be determined by the need to accommodate existing events, such as Splendour in the Grass, and the need to balance the demand for new events with the manifold objectives and values of the site.

As the site approaches its potential it is envisaged that a number of major events would be held each year, up to a maximum of twelve (12) 30% - 100% capacity event days per year.

Further detail on the size, timing and frequency of events are provided in the Town Planning report.

2.4 Staging

2.4.1 Stage 1

It is proposed that permanent water supply and wastewater management infrastructure would not be implemented immediately, with preliminary events to be catered for almost exclusively by imported amenities. All potable water would be imported to the site and stored in a series of temporary water tanks as required to suit the specific layout of the event. All wastewater would be exported from the site by licensed operators for treatment and disposal.

It is proposed that a small gatehouse would be built prior to the first event and toilets to service this facility would be included in the design. Similarly, the cultural centre, which would include capacity for event administration staff would be constructed prior to the implementation of the reticulated water supply and sewerage systems on the site. Standard household sewage treatment plants would be sufficient to service both the gatehouse and the cultural centre and such systems would be designed on the basis of the detailed design of the structures and implemented at the time of construction.

2.4.2 Stage 2

When the site usage reaches a critical mass permanent infrastructure for water supply and wastewater collection and management would be implemented. This would include the construction of dams, tanks, water reticulation network and a potable water treatment plant for water supply. A sewage treatment plant, reticulated sewer, pump station, effluent holding dam, effluent polishing wetlands and irrigation areas would be established for the management of wastewater. These works lend themselves to progressive or staged implementation, which may occur to accommodate commercial requirements. Progressive implementation would progressively increase the site's self-sufficiency and proportionately decrease its dependence on transport, imported water and external wastewater treatment facilities.

3) Methodology

3.1 Water demand and wastewater loading rates

3.1.1 Cultural events

Water demand and wastewater loading rates for the proposed cultural event site were calculated on the basis of real data provided from an established large scale music festival, similar in nature to the events proposed for this site, on a number of occasions each year.

The critical factors for water demand and wastewater load include the maximum demand for a single event, the timing of events and the total annual demand and loading. For the purpose of calculating potable water demand and wastewater loading rates, it has been assumed that the maximum number of event days for major, moderate and small events would occur. Minor events have not been factored into the calculations, however logically, providing the infrastructure was able to accommodate the major events, it would be adequate to accommodate a number of minor events also.

3.1.2 Administration/Cultural Centre, Conference Centre and Accommodation

The Administration/Cultural Centre, Conference Centre and associated accommodation represent more traditional site uses, where Australian Standards and State and Local statutory requirements are more readily applied.

The water demand and wastewater loading rates for the conference facilities and accommodation and the administration/ cultural centre were calculated on the basis of the Queensland Planning Guidelines for Water Supply and Sewerage[1], which in the absence of an equivalent guideline for New South Wales, represents a reliable basis for the planning of commercial scale developments.

3.2 Site & soil evaluation

Site and soil evaluations were undertaken during a series of field visits during March 2010. Site evaluation was undertaken using the method of AS/NZS 1547:2000 *On-site Domestic Wastewater-management* by qualified Environmental Scientists and technicians. Soils were examined from all areas of the site, with an emphasis on those areas with the potential to be irrigated with treated effluent Soil sampling and profile description was undertaken according to the Australian Soil and Land Survey Field Handbook[2] and soils were classified according to the Australian Soil Classification.[3]

3.2.1 Soil survey

The soil survey was undertaken using a 90mm dia. head solid flight auger with samples recovered from surface and subsurface soil horizons for modified Emerson analysis. A total of 24 boreholes were constructed across the site to a maximum depth of 3 metres. The soil borelogs are presented in Appendix 1 with the borehole locations shown on Drawing No. GJ0926.1.3. Samples were retained from each of the boreholes for laboratory analysis and Emerson class testing.

3.2.2 Dispersivity

Soil dispersivity was assessed using modified Emerson Class testing (Emerson & Seedsman undated). This test gives an indication of the dispersion and slaking tendency of soils and provides an indication of the soils' erosion potential.

3.2.3 Permeability

Soil permeability was assessed in three locations considered to be representative of the various site soils, using the Constant Head Method in accordance with the Australian Standard (AS/NZS 1547-2000). This method measures the infiltration of water into the soil from a water-tight graduated water reservoir, with a PVC delivery tube. Upon addition of water, the rate of water loss is recorded until a semi-steady state of water loss is reached. A

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[1] Department of Natural Resources & Mines. March 2005. Planning Guidelines for Water Supply and Sewerage. Chapter 5 - Demand/Flow and Projections – Table A.

[2] McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. 1990. *Australian Soil and Land Survey Field Handbook*. Second Edition. Inkata Press, Melbourne.

[3] Isbell, R.F. 1996. *Australian Soil Classification*. CSIRO Publishing.

representative hydraulic conductivity for the given soils can then be calculated.

3.2.4 Erosion risk

An assessment of the erosion risk over the portion of the site likely to be disturbed by the development was undertaken to define whether erosion risk (and management) represents a significant issue.

The National Landcare Program model SOILOSS was used to predict the rate of soil loss due to erosion from the site during the construction phase. SOILOSS uses the principles of the Revised Universal Soil Loss Equation (RUSLE) to predict average annual soil losses due to sheet and rill erosion. SOILOSS also provides recommendations to reduce soil loss including adjustments to land and cover management practices and facilitates the testing of such alterations and changes. In the RUSLE, soil erodibility is represented by the (K) factor and is defined as the annual average soil loss per unit of rainfall erosivity (Houghton and Charman, 1986, Loch and Rosewell, 1992). Results of this modelling are provided in Section 2.2.9.

3.3 Groundwater and surface water monitoring

Data from previous investigations into the groundwater was reviewed as part of this assessment.

To supplement the existing information five groundwater monitoring wells were installed to a maximum depth of 3m below ground surface level using a truck mounted solid flight auger. The monitoring wells were installed for the purpose of monitoring groundwater levels and obtaining groundwater samples to facilitate the establishment of baseline groundwater characteristics.

Surface water was sampled from the existing large dam in the northern portion of the site.

Qualified Gilbert & Sutherland staff collected the water samples and conducted field analysis for pH, conductivity, dissolved oxygen, turbidity and temperature. Water samples were also collected in laboratory supplied containers which were stored in a chilled esky prior to delivery to the NATA accredited laboratory for analysis.

Surface water samples were analysed for a suite of parameters to assess its suitability for drinking water. Groundwater was assessed for a range of analytes including nutrients, major cations and anions and a suite of metals to facilitate the assessment of likely impacts from possible acid sulfate soil disturbance and the irrigation of treated effluent.

3.4 Modelling

3.4.1 Water supply assessment

RUSTIC modelling was undertaken to assess the capacity of existing and proposed farm dams to supply water to meet the demand of the proposed site uses.

RUSTIC is a Runoff, Storage and Irrigation software model developed by the Qld Department of Natural Resources and Water to assist in the design of farm dams and water harvesting equipment, the preparation of irrigation management plans, the selection of cropping strategies, and the assessment of existing systems. It is based on the USDA runoff model.

In this project, RUSTIC was used to:

- determine the availability of water in the existing storage throughout the year to meet nominated demands whilst maintaining an environmental reserve
- determine the capacity of additional water storage(s) to meet the nominated demand
- determine appropriate locations for additional storage(s) based on catchment size, runoff and water availability throughout the year to meet the nominated demands.

3.4.2 MEDLI

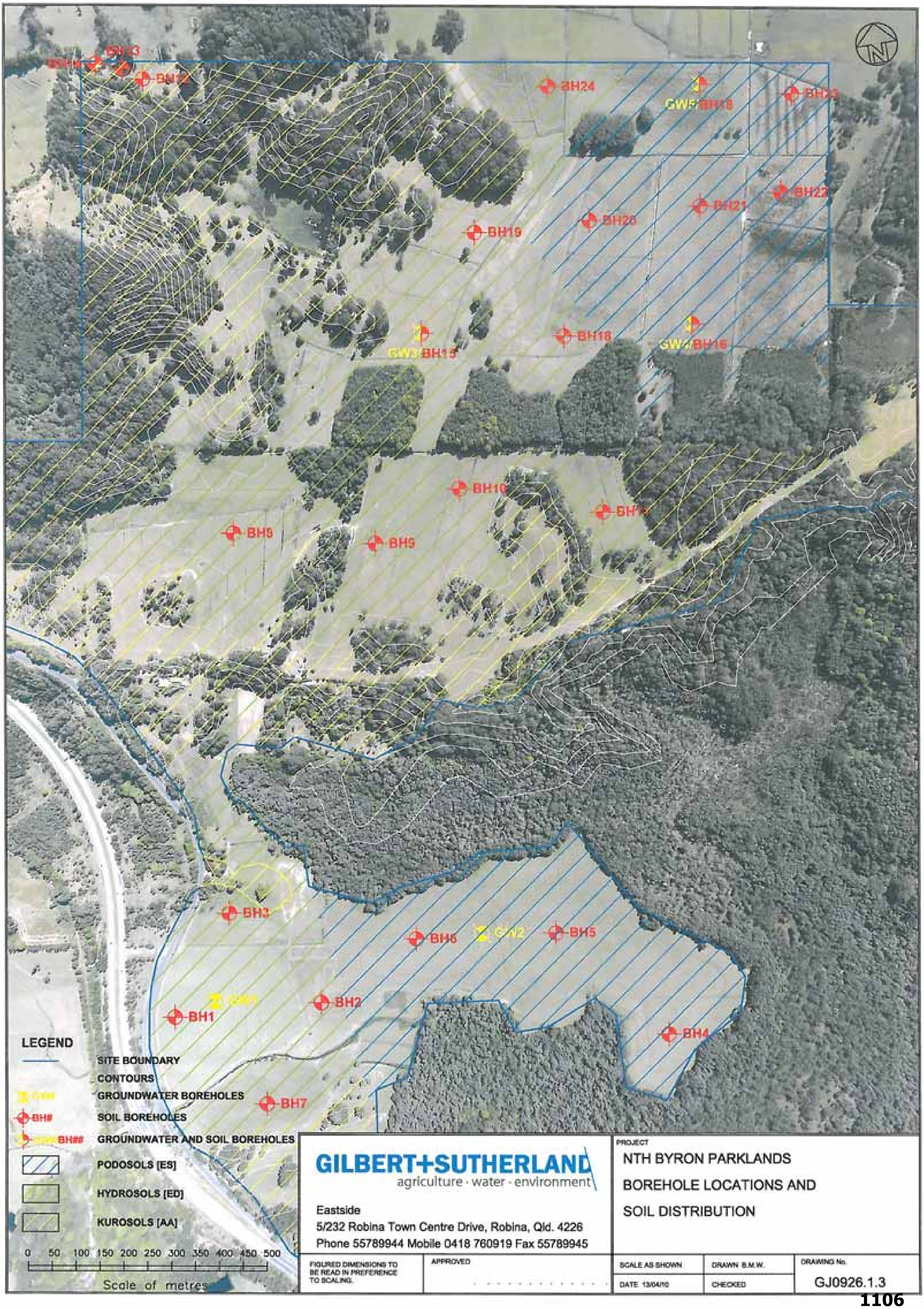
To assess the sustainability of irrigating treated effluent resulting from site activities, to support agricultural production within dedicated irrigation areas water and nutrient balance modelling has been conducted. Land application of treated effluent would be to a combination of woodlot and pasture irrigation areas.

To calculate the size of the irrigation areas required modelling was carried out using the CRC for Waste Research/QDPI Model for Effluent Disposal by Land Irrigation (MEDLI) software.

MEDLI is a complex, daily time-step, hydrological simulation model used to assess the hydraulic performance of the effluent treatment tank and irrigation area. This program also simulates the hydrological and nutrient balance of the treatment tank and effluent irrigation systems over extended periods.

Site specific information based on soil survey and analytical results as well as detailed daily climate files (for a 107 year period) provide the base information for the modelling. The model considers the hydraulic and nutrient impacts associated with the following:

- effluent applied
- precipitation
- evapotranspiration
- percolation
- surface runoff.



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PROJECT
NTH BYRON PARKLANDS
BOREHOLE LOCATIONS AND
SOIL DISTRIBUTION

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

SCALE AS SHOWN

DRAWN B.M.W.

DRAWING No.
GJ0926.1.3

DATE 13/04/10

CHECKED

4) Site & soil evaluation

4.1 Site description

4.1.1 Location

The site is approximately 256ha in area and is located on Tweed Valley Way at Yelgun on the NSW North Coast. The site is accessible from Tweed Valley Way, Jones Road and Wooyung Road.

The site is bounded to the north and south by rural properties, to the west by rural properties and Tweed Valley Way and to the east by rural property and environmental reserves.

4.1.2 Vegetation

Clearing of native vegetation was originally undertaken to facilitate the cultivation of sugarcane and grazing of cattle. Approximately 67% of the site is now pasture land used for grazing. Dense vegetation remains across the remainder of the site with 33 % identified within Council mapping as High Conservation Vegetation.

4.1.3 Geology

A review of the Geological Survey of New South Wales and Queensland 1:250 000 Geological Series sheet no. SH56-3 'Tweed Heads' indicates the low lying portions of the site are underlain by Quaternary alluvial deposits of sands, silts and clays overlying Pleistocene sand deposits which were former beach fronts. The ridge accommodating Jones Road and the more elevated portions in the west of the site are formed on greywacke, slate, phyllite and quartzite of the ancient Silurian Neranleigh-Fernvale group.

4.1.4 Topography

A large proportion of the site is comprised of low lying, low relief alluvial plains. The land surface in these areas ranges from approximately RL2m Australian Height Datum (AHD) in the east, rising gently to the west up to approximately RL3.5m AHD.

Low hills (to RL 60m AHD) are situated on the Neranleigh Fernvale metasediments, which border the site in the northwest and traverse the site from west to east in a ridge in the vicinity of Jones Road.

The site slopes range from level (0%) on the low lying land to steep (40%)[4] on the low hill areas, however the average slopes on the hills are more moderately inclined.

4.1.5 Soils background data

Morand (1996)[5] has identified and mapped the soil landscapes from Ballina to Tweed Heads and identified four soil landscapes on the site. These included:

The Billinudgel erosional soil landscape was identified on the ridges formed over the Neranleigh Fernvale metamorphics. The soils in this landscape are generalized as moderately deep, well to moderately well drained red and yellow podzolic soils and yellow earths.

The Kingscliff soil landscape (b variant) was identified in the alluvial flats to the north of Jones Road. This is an Aeolian derived soil landscape and is characterized by extremely low level, low relief Pleistocene sand sheets overlying peat or alluvium. The soils are generally deep well drained Podzols and are constrained by waterlogging and high water table.

The Crabbes Creek alluvial soil landscape was identified in the western end of the southern portion of the site (south of Jones Road). This landscape is typified by level to gently undulating alluvial terraces within the valley flats between ridges on the Neranleigh Fernvale metamorphics. Soils are typically well drained alluvial clays and clay loams. Waterlogging and high water table are common.

In the eastern portion of the southern alluvial flats the Pottsville soil landscape was identified. Like the Kingscliff landscape, this is an Aeolian derived soil landscape and is characterized by poorly drained depressions between Pleistocene sand sheets and dunes. The soils are generally poorly drained Podzols, Humic Podzols and Humic Gleys and are constrained by waterlogging and permanently high water table.

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[4] McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. 1990. *Australian Soil and Land Survey Field Handbook*. Second Edition. Inkata Press, Melbourne.

[5] Morand, D.T. 1996. *Soil Landscapes of the Murwillumbah – Tweed Heads 1:100,000 Sheet*. NSW Department of Land and Water Conservation, Sydney.

4.1.6 Soils classification and distribution

Gilbert & Sutherland conducted a Soil Survey at the site in March 2010 which involved the drilling of investigative boreholes and collection of samples from24 locations. A total of three main soil orders (or types) were identified on the site. These were Podosols, Hydrosols and Kurosols. The borehole locations and soils map for the site are shown on Drawing No. GJ0926.1.3.

A brief description of the characteristics of each soil order is given below (Isbell,1996) and described in the borelogs, which are attached as Appendix 1.

Podosols
These are soils which possess either a Bs horizon (visible dominance of iron compounds), Bh horizon (organic-aluminium compounds) or Bhs horizon (organic-aluminium and iron compounds).

Hydrosols
These are soils that are saturated in the major part of the solum for at least 2-3 months in most years.

Kurosols
These are soils that have a strong texture contrast between A horizons and strongly acid B horizons. *"Many of these soils have some unusual subsoil chemical features (high magnesium, sodium and aluminium)."*

Comment - Kurosols are highly erodable "in high rainfall so best left under forest cover" (rural resource book)

In general the soils on the site can be grouped into three main areas. The low-lying areas on the north and southeastern areas of the site, those at the base of the hill slopes through the middle of the site, and the soils associated with the higher hill slopes in the northwest and ridgeline in the middle of the site.

Soils located on the low-lying land to the east of the site were generally classified as **Podosols** comprising an organic A1 horizon and a Bs horizon with visible iron compounds, overlying sand.

Soils located in the low lying areas at the base of the hill slopes in the north are generally saturated for at least 2-3 months of the year and classified as **Hydrosols**. Mottles and gleying indicating anoxic conditions were evident.

Kurosols occurred mainly on the hill slopes of the north-western area of the site and middle ridgeline. These soils have a B2 horizon which is strongly acid and reflect the overall geology of the hills with Kurosols associated with the acidic metasediments of the Neranleigh Fernvale group.

4.1.7 Dispersivity

Dispersion describes the tendency for the clay fraction of a soil to go into colloidal suspension where unlimited swelling and disintegration of some of the clay particles forms a colloidal cloud around the sample (Emerson & Seedsman, undated). This attribute provides an indication of the soils' ability to accept effluent in the long term with a dispersive soil being more susceptible to a decline in structure and consequent waterlogging.

The results of modified Emerson Class testing of the samples collected from the site are detailed in Table 4.1.7.1.

Table 4.1.7.1 Emerson Class testing results

Sample ID	Depth (m)		Emerson Number
	From	To	
BH02	0.00	0.15	2M
BH02	0.26	0.60	2M
BH03	0.00	0.15	2M
BH03	0.20	0.80	4/7M
BH04	0.00	0.20	4/7M
BH04	0.40	1.00	3M
BH05	0.15	0.50	2M
BH06	0.00	0.40	2M
BH06	0.60	1.00	2M
BH07	0.00	0.40	4/7M
BH07	0.40	0.70	2M
BH08	0.00	0.35	2M
BH08	0.50	1.00	1M
BH09	0.10	0.35	4/7M
BH09	0.35	1.00	2M
BH10	0.15	0.28	4/7M
BH10	0.38	1.00	2M
BH11	0.00	0.50	2M
BH11	0.70	1.00	4/7M
BH12	1.00	0.35	4/7M
BH12	0.35	0.60	2M
BH13	0.00	0.45	3M
BH13	0.45	1.00	4/7M
BH14	0.00	0.30	4/7M
BH14	0.55	0.90	2M
BH15	0.00	0.25	4/7M
BH15	0.45	1.00	2M

	Depth (m)		
BH16	0.00	0.25	2M
BH16	0.60	1.30	2M
BH17	0.00	0.40	2M
BH17	0.50	1.00	2M
BH18	0.00	0.40	2M
BH18	0.50	1.00	2M
BH19	0.00	0.20	2M
BH19	0.35	1.00	2M
BH20	0.00	0.15	2M
BH20	0.15	0.25	2M
BH21	0.05	0.25	2M
BH21	0.25	0.50	2M
BH22	0.04	0.28	2M
BH22	0.28	0.75	2M
BH23	0.00	0.20	2M
BH23	0.20	0.50	2M
BH24	0.00	0.20	2M
BH24	0.35	0.60	2M

An Emerson number of 1M indicates a strongly dispersive soil. Materials of Class 1M to 3M will generally require some treatment during establishment of the disposal areas including deep ripping and addition of gypsum.

An Emerson number of 8M is considered to be inherently non-dispersive, whilst an Emerson number of 4/7M indicates a soil with slight or no dispersion tendencies.

The majority of the topsoil and subsoil samples tested exhibited Class 2M characteristics. This indicates that soil amendment will be necessary for the proposed irrigation areas as the subsoils below 0.3m near surface level may be disturbed. It is also recommended that gypsum be added to improve soil structure.

4.1.8 Permeability

To ascertain which soil types have the most favourable permeability characteristics for the application of treated effluent, permeability testing using a Cromer Constant Head Permeameter was undertaken. The Constant Head Method was used to ascertain the hydraulic conductivity of near surface, unsaturated soils.

The permeameter consisted of a water-tight 120mm diameter, 6L capacity, clear acrylic graduated water reservoir, with a PVC delivery tube. Upon addition of water, the rate of water loss was recorded until a semi-steady state of water loss was reached.

A representative hydraulic conductivity for the given soils was then calculated.

Permeability testing using the constant head permeameter was undertaken at three (3) borehole locations (BH2, BH14 & BH15). The boreholes were constructed to a minimum depth of 0.9m using a 90mmØ auger.

The borehole locations are shown on Drawing GJ0926.1.3. No groundwater was intercepted during the construction of these boreholes. The results of soil permeability testing are presented in Table 4.1.8.1 and the data is presented in Appendix 2.

Table 4.1.8.1 Permeability results

Testhole	Permeability (m/day)
BH 2	0.032
BH 14	0.6
BH 15	0.36

The results for the representative borehole tests indicate a moderate range of soil permeability with infiltration measured at between 0.032 and 0.6m/day for the soils within the area of investigation.

This result corresponds with the indicative permeability reported in AS/NZS1547:2000 for Category 5 moderately structured light clays similar to the geology encountered during borehole constructions. Based on these measured field permeability and the suggested indicative permeability a design loading rate of 12mm/day was adopted for calculating the size of the evapotranspiration area.

Given the conditions encountered on-site and within the boreholes constructed during the wastewater investigation, the most efficient wastewater disposal method for the proposed allotments would be those systems that adopt surface or shallow subsurface irrigation.

4.1.9 Soil loss modelling

For the site soils, a conservative K factor of 0.04 was adopted using Table 2 of the SOILOSS Technical Handbook (NSW Soil Conservation Service, 1993). This assumes a soil organic matter content of 2%. The K factors for the different soil texture classes identified on-site are as given in Table 4.1.9.1.

Table 4.1.9.1 SOILOSS K Factor based on texture

Soil Texture	Suggested K Factor
Silty clay	0.025
Light to medium clay	0.018
Medium clay	0.015
Heavy clay	0.012

Slope gradients of 2.5%, 5% and 10% were used to represent the slopes likely to be disturbed during construction of the development with slope lengths of approximately 100m prior to construction phase. Similarly, gradients of the same slopes were used with slope lengths of 30m representing sediment and erosion control devices in place during the construction phase. An R value of 7000 was also used in the estimates. A surface cover condition of 'no mulching or seeding' was used to represent the disturbed (construction phase) case and a cover condition of 'well established grasses was used to represent the operational phase.

In terms of the relevance of the 30m slope lengths, these were selected on the basis of the minimum practicable spacing of controls (for example, catch drains or diversion channels) employed to control runoff from exposed surfaces.

The estimated potential soil losses for the particular slope classes and slope lengths are presented in tables 4.1.9.2 and 4.1.9.3 below. The SOILOSS outputs are presented in Appendix 3.

Table 4.1.9.2 Estimated soil loss t/ha during construction phase assuming 'no mulching or seeding'

Slope (%)	Length (m)	Calculated potential soil loss from erosion (t/ha/yr)
2.5	30	91
	100	128
5	30	180
	100	292
10	30	383
	100	715

The qualitative categories of erosion hazard used are low, moderate, high, very high and extreme (Houghton and Charman, 1986). The SOILOSS model (Rosewell, 1993) was originally used to derive soil loss quantities for these qualitative categories mentioned above and these are presented in Table 4.1.9.4 (Rosewell, (1993), NSW Department of Housing, (1998).

Table 4.1.9.3 Estimated soil loss t/ha prior during operational phase assuming 'well established grass' cover.

Slope (%)	Length (m)	Calculated potential soil loss from erosion (t/ha/yr)
2.5	30	0.91
	100	1.3
5	30	1.8
	100	2.9
10	30	3.8
	100	7.1

Table 4.1.9.4 SOILOSS Qualitative categories

Soil Loss Class	Calculated soil loss (t/ha/yr)	Erosion Hazard
1	<250	Very Low
2	251 – 300	Low
3	301 – 375	Low to Moderate
4	376 – 500	Moderate
5	501 – 750	High
6	751 – 1500	Very High
7	1501 – 3750	Extreme

Therefore, based on the results of the soil survey, the modelling of the critical construction phase slopes and erosion hazard categories presented, the overall soil erosion hazard can be classed as 'Very Low' on the basis of the aforementioned base case and construction phase scenarios depicted by SOILOSS modelling.

4.1.10 Erosion risk

Based on the results of the SOILOSS modelling, soil erodibility will potentially be ten times greater during the construction phase (reduced ground cover) than the operational phase (established ground cover). Based on these findings, contractors will need to take care during construction works to limit and manage the exposure of soils.

Based on the results of the soil survey, the modelling of the critical construction phase slopes and erosion hazard categories presented, the overall soil erosion hazard can be classed as 'Very Low' considering the soil type disturbed and assuming appropriate measures are employed. Prior to commencement of construction of any works, erosion and sediment controls should be installed in accordance with an approved and task specific Erosion and Sedimentation Control Plan.

Soil analytical results are presented in Appendix 4.

5) Hydrology

5.1 Surface waters

Previous investigations indicate that surface waters of the southern (carparking) site flow into the adjoining wetland and then infiltrate into the soil and percolate to the groundwater.

A network of surface agricultural drains dissect the level low lying areas of the site draining into Yelgun and Billinudgel creeks.

The pH of the surface waters (in the southern site) as reported by the NSW Sugar Milling Cooperative in November 1996 ranged from 3.9 – 5.1. This is consistent with other wetland area surface waters rich in organic acids.

Surface water was sampled from the existing large dam in the northern portion of the site (SW1) in March 2010. Insitu and laboratory testing results are listed in Table 5.1.1.

As the scope of works included an assessment of potential water sources for potable supply, we have compared the quality of the dam water to the Australian Drinking Water Guidelines (ADWG). Most parameters comply with the ADWG with the exception of thermotolerant and faecal coliforms and iron and turbidity for aesthetic qualities.

If the dam water was to be used for potable supply, it would need to be treated to remove all traces of faecal contamination and to reduce turbidity and iron concentrations to minimise any aesthetic or 'taste' impacts.

Laboratory certificates are attached as Appendix 5.

5.2 Groundwater

Data from previous investigations into the groundwater was reviewed as part of this assessment. During investigations undertaken in 2000 (Appendix 5) the watertable across the cleared areas of the southern (carparking) site was encountered at 1.70 to 2.40m AHD, which was comparable with the levels in the nature reserve (1.89 to 2.20m AHD). Groundwater was encountered at 0.35 to 0.9m below surface level (NSL) on the majority of the southern site.

The surface drains in the eastern portion of the site may be classified as 'water-table' windows for much of the year as the surface and groundwaters effectively merge near to the soil surface. This near surface groundwater is likely to be a continuous feature given the sandy, highly transmissive nature of the sub-soils.

Further groundwater levels and groundwater samples were obtained in March 2010, and the results of monitoring and analysis are listed in Table 5.2.1 and compared to the *ANZECC Guidelines for Water Quality for lowland streams and freshwater ecosystems*[6], being representative of the nearest environmental receptors for groundwater discharging from the site. Although these guidelines apply to surface water they are recommended as a reference point for establishing trigger values by the *Guidelines for Groundwater Protection in Australia*[7].

Groundwater levels vary from 0.33m below NSL on the eastern portion of the southern site and 0.60m below NSL on the low-lying areas of the north east of the site which means there is minimal separation between potential surface contamination and groundwater. In terms of potential irrigation of treated effluent to this area, a high quality of effluent would be required as there is limited separation and therefore limited opportunity for nutrient assimilation and pathogen reduction within the soil profile prior to contact with groundwater.

Groundwater quality results in table 5.2.1 indicate that nutrients (N, P), zinc, aluminium and pH exceed the guideline

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[6] Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 – The Guidelines.* National Water Quality Management Strategy, Canberra.

[7] Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand.1995. *Guidelines for Groundwater Protection in Australia.* National Water Quality Management Strategy, Canberra.

levels, which suggests that the groundwater is already impacted, possibly by the agricultural use of the site, or that these guidelines are not appropriate for this site. It is typically reasonable to assume a 'no worsening' approach to the assessment of impacts and providing the irrigation of treated effluent does not result in an increase in the concentration of the identified contaminants, it could be argued that effluent irrigation is no worse than the existing land-use. If there is no existing groundwater related impact to the environmental receptors adjacent to the site, it is reasonable to assume that this would continue unless there was a decline in the groundwater quality. In order to ensure 'no worsening' of groundwater quality, these parameters would form part of a regular monitoring program with pre-development values used as baseline data to establish site-specific water quality 'targets'.

As the area is predominantly flat, there will be little hydraulic gradient and therefore little lateral movement of groundwater. Groundwater modelling has not been undertaken as the proposal does not include significant disturbance within the groundwater zone.

Laboratory certificates for groundwater are attached as Appendix 5.

Table 5.1.1 Surface Water Quality

Parameter	ADWG limits	Dam	SW1
Sample date:		2007	31/03/2010
Turbidity (ntu)	aesthetic 5	3	**30**
pH	6.5-8	6.35	6.6
Dissolved oxygen	>85%		4.02
Total dissolved salts (mg/L)	-	84	-
Conductivity (EC) (dS/m)	-	0.12	96
Total dissolved solids	500		60
Bicarbonate (mg/L CaCo3 equiv)	-	16	7
Chloride (mg/L)	250	25	20
Total suspended solids (mg/L)	-	5	18
Total Phosphorus (mg/L P)	-	0.03	0.05
Orthophosphate (mg/L P)	-	<0.005	<0.05
Total nitrogen (mg/L N0	-	0.7	0.76
Ammonia (mg/L N)	0.5	<0.005	0.05
Nitrate (mg/L N)	50	0.008	0.05
Nitrite (mg/L N)	-	<0.005	<0.05
Calcium (mg/L)	-	1.8	1.5
Magnesium (mg/L)	-	2.3	2
Sodium (mg/L)	180	17.8	15
Sulphate (mg/L S04^{2-})	500	1	1.5
Potassium (mg/L)	-	1.6	<5.0
Aluminium (mg/L)	aesthetic 0.2	0.038	0.02
Copper (mg/L0	2	0.001	<0.01
Iron (mg/L)	aesthetic 0.3	**1.611**	**1.13**
Manganese (mg/L)	0.5	0.405	0.07
Zinc (mg/L)	aesthetic 3	0.001	<0.01
Arsenic (mg/L)	0.007	0.001	<0.005
Cadmium (mg/L)	0.002	<0.001	<0.001
Lead (mg/L)	0.01	<0.001	<0.01
Biochemical oxygen demand (mg/L 0$_2$)	-	2.4	-
Total Kjeldahl Nitrogen (mg/L N)	-	0.69	-
Sodium Absorption ratio	-		-
Water Hardness (mg/L CaCO3 equiv)	200	14	-
Chloride/suphate ratio	-	24.5	-
Total coliforms (cfu/100ml)	Nil	**2080**	**2,224-**
Faecal coliforms (cfu/100ml)	Nil	**280**	-
Organochlorine Pesticides (mg/L)		<0.0003	-
Organophosphorus Pesticides (mg/L)		<0.001	-
Polychlorinated Biphenyls (PCBs) (mg/L)		<0.003	-

Note: Where the result of analysis for a parameter exceeds the relevant ADWG limit, it is highlighted in bold text .

Table 5.2.1 – Groundwater quality

Analyte	Units	ANZECC WQG (Freshwater and lowland rivers)	Site 1 Carpark	Site 2 Main Event	GW1	GW2	GW3	GW4	GW5
Sample date			1997	1997	31/03/10	31/03/10	31/03/10	31/03/10	31/03/10
Depth to GW	m				0.33	0.41	2	0.6	0.61
Electrical conduct (insitu)	µS/cm	125 - 2200			1460	997	n/a	791	775
Electrical conductivity	µScm-1		0.89	0.14	2,361	769	--	575	--
Turbidity	NTU		58	21	400+	400+	400+	400+	400+
pH - insitu	pH units	6.5 – 8.0	6.89	**5.2**	**4.59**	**4.75**	**6.31**	**5.65**	**5.42**
pH - laboratory	pH units	6.5 – 8.0	--	--	**2.5**	**4.3**	**--**	**5.7**	--
Dissolved Oxygen	ppm	-	--	--	5.65	3.61	4.18	2.92	3.04
TDS by calculation	mg/L	-			1,460	480	--	360	--
Bicarbonate HC03	mg/L	-	246	6	NP	NP	--	29	--
Chloride C2O	mg/L	-	135	25.9	750	110	--	65	--
Suspended Solids	mg/L	-	48	41	4,023	24,772	--	10,797	--
Total Phosphorus	mg/L	0.05 (50µg)	0.02	**0.07**	**0.3**	**0.2**	--	**0.2**	--
Ortho Phosphate-P	mg/L	0.02 (20µg)	0.02	0.01	**0.12**	<0.05	--	<0.05	--
Total nitrogen	mg/L	0.5 (500µg)	0.08	**0.55**	**2.03**	**1.62**	--	**1.52**	--
Ammonia	mg/L	0.02 (20µg)	**0.028**	**0.1**	**0.33**	**0.34**	--	**0.11**	--
Nitrate-N	mg/L	NOx 0.04 (40µg)	<0.005	**0.085**	**0.18**	**0.13**	--	<0.05	--
Nitrite-N	mg/L		0.02	<0.005	<0.05	<0.05	--	0.06	--
Calcium	mg/L	-	54.3	2.1	8.8	30	--	15	--
Magnesium	mg/L	-	10.7	2.8	15	22	--	20	--
Sodium	mg/L	-	138.9	19.2	224	100	--	80	--
Sulphur as Sulphate	mg/L		44.2	17.6	244	309	--	176	--
Potassium	mg/L	-	1.8	2	<5.0	<5.0	--	5	--
Aluminium (soluble)	mg/L	pH>6.5: 0.055 (55µg) pH<6.5: ID*	**0.111**	**1.512**	**0.99**	**0.6**	--	**1.47**	--
Copper (soluble)	mg/L	0.0014 (1.4µg)	0.001	**0.195**	0.01	<0.01	--	0.01	--
Iron (soluble)	mg/L	ID*	9.78	0.873	2.12	9.75	--	14	--
Manganese (soluble)	mg/L	1.9 (1900µg)	0.444	0.041	0.61	0.97	--	0.5	--

Analyte	**Units**	**ANZECC WQG (Freshwater and lowland rivers)**	**Site 1 Carpark**	**Site 2 Main Event**	**GW1**	**GW2**	**GW3**	**GW4**	**GW5**
Zinc	mg/L	0.008 (8.0µg)	0.004	**0.307**	**0.2**	**0.51**	--	**0.37**	--
Arsenic	mg/L	0.024 (24µg)	0.002	0.001	0.006	<0.005	--	<0.005	--
Cadmium	mg/L	0.0002 (0.2µg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--
Lead	mg/L	0.0034 (3.4µg)	0.003	**0.024**	<0.01	<0.01	--	**0.01**	--
Biochemical oxygen demand	mg/L 02	-	4	0.8	--	--	--	--	--
Total Kjeldahl Nitrogen	mg/L N	-	0.06	0.47	--	--	--	--	--
Water Hardness (CaCO3 equiv)	mg/L	-	179	17	--	--	--	--	--
Chloride/suphate ratio		-	3.1	1.5	--	--	--	--	--
Total coliforms	cfu/100ml	-	<10	2280	2,178--	--	--	20	--
Faecal coliforms	cfu/100ml	-	<10	1480	--	--	--	--	--
Organochlorine Pesticides	mg/L	ID*	<0.0003	<0.0003	--	--	--	--	--
Organophosphorus Pesticides	mg/L	ID*	<0.001	<0.001	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)	mg/L	ID*	<0.003	<0.003	--	--	--	--	--

*ID – insufficient data to establish guidelines

6) Water supply

6.1 Water demand

6.1.1 Cultural event site

Water demand for the cultural events use of the site has been calculated based on real data obtained from previous large-scale cultural events, involving both a music festival and camping activities. In addition, the water demand estimations have been based on estimates of wastewater generation as there is more reliable data on the wastewater generation rates for previous events.

Generally, for more traditional commercial and residential development, more water is used than wastewater generated. However, based on data from previous events, there is more wastewater generated than water used. This is considered to be a reflection of the volume of pre-packaged beverages that are imported and sold during events and also due to the lack of more traditional water consuming activities including garden irrigation, cleaning and laundry and the lower proportion of the population that is showering and the frequency of showering.

Table 6.1.1.1 Indicative Daily Water demand for maximum representative events with permanent infrastructure

Event	Water Demand (L/day)
Minor event (300 patrons & 300 camping)	8,646
Small event (3000 patrons and 3000 camping)	86,460
Moderate event (10,000 patrons and 10,000 camping)	288,200
100% capacity (50,000 patrons and 25,000 camping)	940,500
Permanent infrastructure	**Water Demand (L/day)**
Conference facilities (300 person conference centre with accommodation for 150 persons assuming 100% occupancy)	45,000
Administration/cultural centre (with 2 full time staff, 12 part time staff)	1,650

Table 6.1.2.2 Indicative Annual Water demand for maximum representative events with permanent infrastructure

Event	No. of event days per annum	Water Demand (L/annum)
Minor event (300 patrons & 300 camping)	4	34,584
Small event (3000 patrons and 3000 camping)	4	345,840
Moderate event (10,000 patrons and 10,000 camping)	4	1,152,800
100% capacity (50,000 patrons and 25,000 camping)	12	11,286,000
Total annual event water demand	24	12,819,224
Permanent infrastructure	**Days per annum**	**Water Demand (L/annum)**
Conference facilities (300 person conference centre with accommodation for 150 persons assuming 100% occupancy)	200	9,000,000
Administration/cultural centre (with 2 full time & 12 part time staff)	312 (6 days/ week)	514,800
Sub-total permanent infrastructure		9,514,800
Total for all site uses		22,334,024

However, to ensure a conservative estimate of water demand is established, it was assumed that the water demand is equivalent to the wastewater generated. A detailed breakdown of the water demand and the wastewater generated is provided in Appendix 6. A summary of the peak daily and annual demand for a range of event sizes is provided in tables 6.1.1.1 and 6.1.1.2 respectively. The demand reflects the proposed maximum occupancy for each category of event.

6.1.2 Administration/cultural centre and conference facilities

The administration/cultural centre will be used continuously by a small number of permanent and temporary staff which will increase during events when it will accommodate additional event administration staff.

The proposed conference centre would be used throughout the year for conferences and accommodation of conference delegates and, once developed, would represent a more continuous demand for water than the events. It is unlikely that conferences will overlap with events, however the accommodation may be used. It should be noted that the conference centre is not a part of the project application, but forms a component of the concept application. Water demand for the conference centre has been included in the calculations for planning and assessment purposes.

For the purpose of ensuring that sufficient water supply is available it has been assumed that the maximum utilisation of the site would occur and therefore that 22.33 ML of water would be available on an annual basis. We reiterate that the assumed maximum usage of the site will not occur in the first few years of the site's operation and indeed may never occur.

6.1.3 Fire fighting

The Rural Firefighting Service does not require fire-fighting water to be of potable quality and this has therefore not been included in our demand calculations. The fire-fighting strategy, including a discussion of appropriate water sources for fire-fighting is detailed in the Bushfire Management Report prepared by Barry Eadie and Associates.

6.2 Water Sources

6.2.1 Groundwater

The site has two groundwater production wells which are licensed to provide water for stock and domestic supply. The groundwater bore in Lot 102 on 1001878 is licensed for farming, irrigation and stock and has a maximum annual allocation of 40ML. It is understood that the groundwater well on Lot 10 on RP875112 is licensed for stock and domestic use.

The allocations associated with these licenses will continue to be used for stock and domestic purposes in support of ongoing primary production on the site.

6.2.2 Farm dams

Numerous farm dams are located around the site and are currently used primarily for the watering of stock. The NSW Farm Dams policy gives rural landholders in NSW the right to harvest surface water runoff in farm dams within predetermined limits without obtaining a licence. This is known as a harvestable use right.

Harvestable rights allow landholders to collect up to 10% of the average regional rainwater runoff on their property in a farm dam(s) providing the dam is built on a hillside or minor stream.[8] The harvestable right can be used for any purpose, including commercial irrigation. One or more dams can be used to secure a property's harvestable right. Regulations apply to the size and location of the construction of a harvestable rights dam(s).

The total capacity of all dams on a property allowed under the harvestable right is called the Maximum Harvestable Right Dam Capacity (MHRDC). To determine the size of a farm dam(s) allowable as harvestable rights dams, the property's MHRDC must be determined. The NSW Department of Water and Energy (DWE) provide an online calculator[9] to help landholders determine the MHRDC allowed, or the property's harvestable right capacity.

The MHRDC is based on 10% of the average regional rainfall runoff of the property and is based on local rainfall and evaporation data. To account for the differences in the reliability of rainfall, runoff and evaporation rates across NSW, the calculator contains a

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[8] NSW Department of Water and Energy, May 2008 factsheet: *What are rural landholders' basic rights to water?* www.dnr.nsw.gov.au/water/pdf/rural_landholder_basic_rights-f.pdf

[9] www.farmdamscaclulator.dnr.nsw.gov.au

MHRDC multiplier that varies according to property location. The calculator calculates the MHRDC by multiplying the property size (Ha) by the location multiplier, to produce a maximum harvestable right dam capacity (in Megalitres; ML).

Based on the size of the North Byron Parklands site, being 256 Ha, and a location multiplier of 0.165, the MHRDC calculator produces a Maximum Harvestable Right Dam Capacity of 42.2 ML.

The existing storage was surveyed by G&S staff to calculate its approximate surface area and capacity. It was estimated that volume of the existing storage is 15.9 ML in its current condition. This is the most significant storage on the property and assuming that less than 1ML is stored in the numerous small dams on the site, further storages with a cumulative maximum volume of 25ML would be permissible, under the harvestable water rights provisions of the Farm Dams Policy.

Flora and fauna assessments for the site have identified that the existing dam has ecological and habitat value, and during surveys in August 2007 was identified to provide habitat for the Comb-crested Jacana which is listed as vulnerable on the schedules of the NSW *Threatened Species Conservation Act* 1995. As a consequence, any extraction of water from the existing dam would be limited to ensure that the ecological values were preserved. This would be achieved by setting an 'environmental reserve', whereby water would not be extracted from the dam once it fell below a level of 10ML.

6.2.3 Rainwater tanks

Rainwater tanks represent an opportunity to harvest rainfall more efficiently than the farm dams, as there is no loss due to infiltration. However, as the total roof area on the site will represent a very small percentage of the total site area, the total contribution to water demand from rainwater tanks will be relatively small.

It is intended that runoff from the roof areas of the proposed permanent structures including the conference centre and the administration/cultural centre would be collected in rainwater storage tanks. The tank water would be used for non-potable uses such as toilet flushing to reduce the demand on treated potable water.

6.2.4 Imported water

Imported water will be used to cater for the initial events on the site, prior to the construction of the necessary water storage, treatment and reticulation infrastructure.

However, potable water may also be imported to the site to service further events or the ongoing demands of the conference and administration/cultural centres even after the water supply infrastructure is in place. This could occur in the event of a water shortage, such as during drought periods or where insufficient rainfall has occurred between events.

6.3 Water supply concept

6.3.1 Water supply using temporary facilities

As discussed previously, all potable water requirements for the initial events will be imported to the site. This water will be used for all sanitary facilities (showers and toilets), drinking and food preparation.

Indicative daily water demand for different sized events serviced by temporary facilities are detailed in Table 6.3.1.1 below. Water demand calculations for a broader range of events are presented in Appendix 6.

It is notable that the water demand is slightly lower for events serviced by temporary facilities than events serviced by permanent infrastructure. This is primarily attributed to the use of portable toilets which are highly water efficient.

Table 6.3.1.1 Indicative Daily Water demand for maximum representative events with temporary infrastructure

Event	Water Demand (L/day)
Minor event (300 patrons & 300 camping)	7,953
Small event (3000 patrons & 3000 camping)	79,530
Moderate event (10,000 patrons and 10,000 camping)	265,100
100% capacity (50,000 patrons and 25,000 camping)	841,500

In conjunction with data provided from previous large events, it has been assumed that water efficient fixtures and management procedures shall be implemented and these practices will need to be implemented to limit the water demand. The required water saving measures will include as a minimum:

- Portable toilets with microflush (<500ml/flush)
- Waterless urinals
- Spring loaded timers on faucets
- Time limited showering
- Water efficient shower heads (<9L/min).
- Patron education

The provision of temporary facilities will involve the establishment of a series of potable water supply tanks, pumps and a reticulation network which will be designed to suit the specific requirements of each event.

Conceptually it is proposed that a large temporary potable water supply tank(s) (minimum 200,000L) would be provided as a central reservoir and this would be filled from tankers over a number of days prior to the event and topped up during the event. Depending on the event layout, water would be pumped from the central reservoir to a series of smaller (5-10,000L) tanks which would be distributed around the site in key locations, to service amenities, food stalls and provide drinking water. It is unlikely that all parts of the various event layouts would be able to be serviced by a temporary reticulation network. For areas where the temporary reticulation is unavailable, water would be supplied to the smaller tanks by potable water tankers which would draw water from the central reservoir.

Water use data shall be collected for each event to assist with the planning of subsequent events and the detailed design of the permanent water supply infrastructure.

6.3.2 Water supply using permanent facilities

The long term, permanent water supply concept for the site is that all potable water will be sourced from the harvestable use rights attached to the property. Additional infrastructure will be required to collect sufficient surface runoff, treat the water to a potable quality and to store and deliver potable water to the site.

As discussed above there is an existing storage with an approximate volume of 15.9ML and the site’s maximum harvestable rights dam capacity is a total of 42.2ML.

The total water demand for the site, assuming maximum utilisation of the site is 22.3ML per annum, which is well within the use rights of the property. To enable the collection of the required volume of water, and to ensure adequate performance of the supply network at least one additional dam is necessary. The performance of the existing and proposed dam is assessed in the following section.

As discussed above, the existing dam has some ecological significance and the visual amenity is an important aspect of the proposed conference facilities on the adjacent ridge. These values need to be preserved and therefore an environmental reserve (maximum drawdown) will be imposed on the dam, reducing the raw water yield.

A second dam with a minimum capacity of 7.5ML will be constructed to capture additional surface water runoff and where capacity allows to store water in excess of the environmental reserve from the existing dam. Detailed design and construction of the dam would be undertaken in accordance with the DECCW’s *NSW Farm Dams Policy*.

Water shall be pumped in between the dams and from the existing dam to a potable water treatment plant with a treatment capacity of 1ML/day.

Water from the treatment plant shall be pumped to an elevated potable water tank fitted with a chemical dosing pump and an aerator to ensure residual chlorine levels comply with the ADWG’s prior to delivery.

Delivery to the site shall be via gravity feed into a reticulated water supply network, with a series of permanent connection points throughout the site, which will cater to both permanent and mobile facilities and/or amenities.

The major features of the water supply network are illustrated in Drawing GJ0926.1.4. The reticulation network is subject to detailed design.

6.4 Water balance

RUSTIC modelling was used to assess the availability of water in the existing storage and its ability to meet site demands whilst maintaining the desired environmental reserve. On this basis, RUSTIC was used to determine how much additional water storage would be required to meet the nominated event demand.

The existing storage was surveyed by G&S staff to calculate its approximate surface area and capacity (15.9 ML). Its catchment size (15.45 Ha) was then determined from aerial maps. These details, along with 50 years of rainfall and evaporation data[10] and monthly pan evaporation figures for Ballina[11], were all entered into RUSTIC. A nominal seepage factor of 5 mm per month was also incorporated into the modelling. The runoff characteristics of the catchment were also determined during site visits and comparison with similar soil types. (This information is entered into the model as the K2 value.)

Nominated demands for events to be held at the site were then determined (based on the calculations discussed in Section 6.1) to enable RUSTIC to allocate water demand during events versus rainfall and runoff captured in the existing storage. Five events were modelled for a 12 month period – occurring in January, March, June, July and October. This reflects the maximum number of major event days for a calendar year, with the number of patrons for each event based on data supplied by the proponent. Water usage requirements reflecting the number of patrons and campers for these events were calculated and are summarised in Table 6.4.1.

Table 6.4.1 Estimated water usage

Month	Patrons & Campers[12]	Event Days	Total water use for event (ML)
January	30,000 20,000	3 days 4 nights	2.1
March	9,000 7,000	3 days 4 nights	0.75
June	3,000	2 days (no camping)	0.053
July	50,000 25,000	3 days 4 nights	3.1
October	44,000 20,000	3 days 4 nights	2.6

As discussed in Section 6.2.2 an environmental reserve (ie a limit on the drawdown from the dam) is necessary to protect the ecological values of the existing dam. Based on discussions with the project ecologist, RUSTIC was run with a reserve of 9ML and 10ML for the existing storage, which represents a significant proportion of the available volume. RUSTIC will not deliver water to a nominated demand if the volume of water in the storage at the time of the demand is below the environmental reserve.

RUSTIC was run on the existing storage to determine if it could reliably supply the nominated event demand. Due to the size of the environmental reserve (two-thirds of the volume of the storage), reliability for the existing storage to deliver the nominated event demands is limited to 70.4% for the storage with a 9ML environmental reserve, and 65.2% when a 10ML environmental reserve is specified.

To cover the shortfall in delivery of event demand, additional storage is required. Several options were modelled based on the site layout and catchment options, including the provision of a tank or tanks to store overflow from the existing storage. This option was discounted as runoff and overflow data from the existing storage model indicates there is insufficient flow, particularly in the second half of the year, to fill the tank enough to meet nominated demands.
After discussions with the proponent, a second storage emerged as the preferred option. A preferred site was selected and its catchment area calculated (6.9 Ha). A new storage dam with 7.5ML capacity could be constructed with no disturbance to existing vegetation.

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[10] Based on a SILO data drill for the locality.

[11] RUSTIC Front End Manual for Ballina, being the closest data source to the Parklands site.

[12] It is assumed that 50% of campers arrive the night prior to the event.

The water supply concept described in Section 6.3 is that the new (7.5ML) storage and the existing storage would be linked, with the ability to pump water from one dam to the other, depending on which dam has storage capacity and to maximise the water harvested for beneficial use. In addition, a minimum 3ML potable water storage tank would be used to store treated water, ready for supply to the site. This effectively increases the combined storage volume by a further 3ML. As such, for the purpose of modelling, the catchments can be considered as a single catchment and the combined storage volume and environmental reserve can be considered as components of a single storage. RUSTIC was therefore re-run with a combined catchment area of 22.35Ha (15.45Ha + 6.9Ha) and a combined storage volume of 26.4ML (15.9+7.5+3ML) and an environmental reserve of 10ML. The above described event demand was again used to assess the reliability of water supply from the combined storage capacity of the dams and tank. In addition, a daily demand to meet the needs of the cultural/ administration centre and the future needs of the conference facilities was added as a daily demand of 26,000L.

Modelling for the combined storages demonstrates that water would be available to meet 86.5% of the combined daily and event demand over the 50 year span of the model.

A further model run, based on the above inputs, but with an increased volume in the new storage of 10.5ML was performed to assess the improvement in reliability (10.5ML is considered the maximum feasible size for a dam in this location, without needing to clear vegetation). This increase in the storage capacity of the second storage increased the reliability of the supply chain to 90.5%.

Therefore, RUSTIC modelling indicates that the combination of the existing storage and a new 7.5ML storage on the preferred site (see map) will deliver the nominated event demand outlined in Table 1 and the daily demand with 86.5% reliability. The new storage would be depleted preferentially as the model results indicate that the existing storage will fall below the environmental reserve due to evaporation in periods of low rainfall.

The daily demand for future site use including the administration/cultural centre and conference facilities will be provided by a combination of potable water from the farm dams and rainwater tanks collecting roof water from each of the facilities. Tank balance modelling would be performed following the detailed design of these facilities, when roof areas are known. An assessment of the capacity of the dams to supply any deficit would be performed at this time, in support of a construction certificate application.

The output from the RUSTIC modelling is provided in Appendix 7.

6.5 Water treatment plant

A potable water treatment plant would be constructed generally in the location shown in Drawing no. GJ0926.1.4. It is important to note that the site is located upslope from the proposed sewage treatment plant and the associated effluent storage pond and polishing wetlands.

The water treatment plant would draw raw water from the existing and proposed farm dams and treat it to a potable standard, as defined by the Australian Drinking Water Guidelines (ADWG's).

The proposed water treatment capacity of the plant is 1ML per day.

The proposed water treatment process has been designed by Midell Water Pty Ltd[13] to reduce colours and odours, provide water of an acceptable taste, and eliminate pathogens.

The water treatment process is illustrated in the attached Figure 1 and includes the following components:

1. Addition of Flocculation Chemicals and hydrogen peroxide: These chemicals reduce colours, odours, suspended solids and begin disinfection.
2. Flocculation Tanks: Provides the required reaction contact time for the flocculation chemical.
3. Clarifier: Reduces colours and suspended solids from the water.

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[13] Midell Water Pty Ltd. 2010.

4. Sand Filter: Removes suspended solids and associated contaminants of concern.
5. Granulated Activated Carbon: Removes iron taste, algal toxins, tannins and other colours.
6. Chlorine Disinfection: This removes pathogens of concern and provides disinfection residual.

Water would be pumped from the treatment plant to an elevated potable water tank approximately in the location shown in Drawing GJ0926.1.4.

A chemical dosing pump and an aerator would be provided at the reservoir to ensure residual chlorine levels comply with the ADWG's prior to delivery.

6.6 Potable water monitoring requirements

Monitoring of potable water shall be undertaken on-site in accordance with the NSW Public Health Act 2001 (Part 2B – Safety of Drinking Water), and the Australian Drinking Water Guidelines 2004[14].

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[14] National Health and Medical Research Council and the Natural Resource Management Ministerial Council. 2004. Australian Drinking Water Guidelines

North Byron Parklands
Potable Treatment Plant

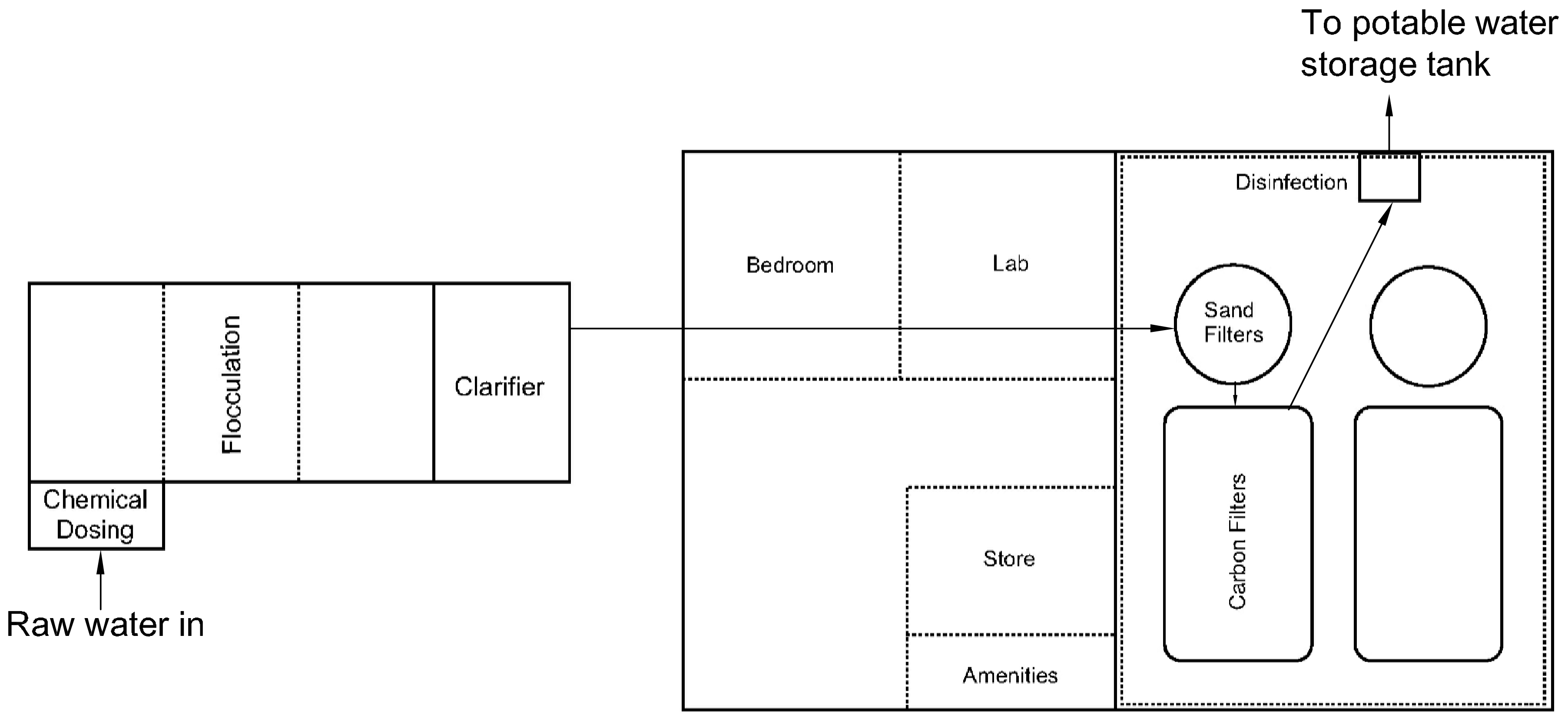
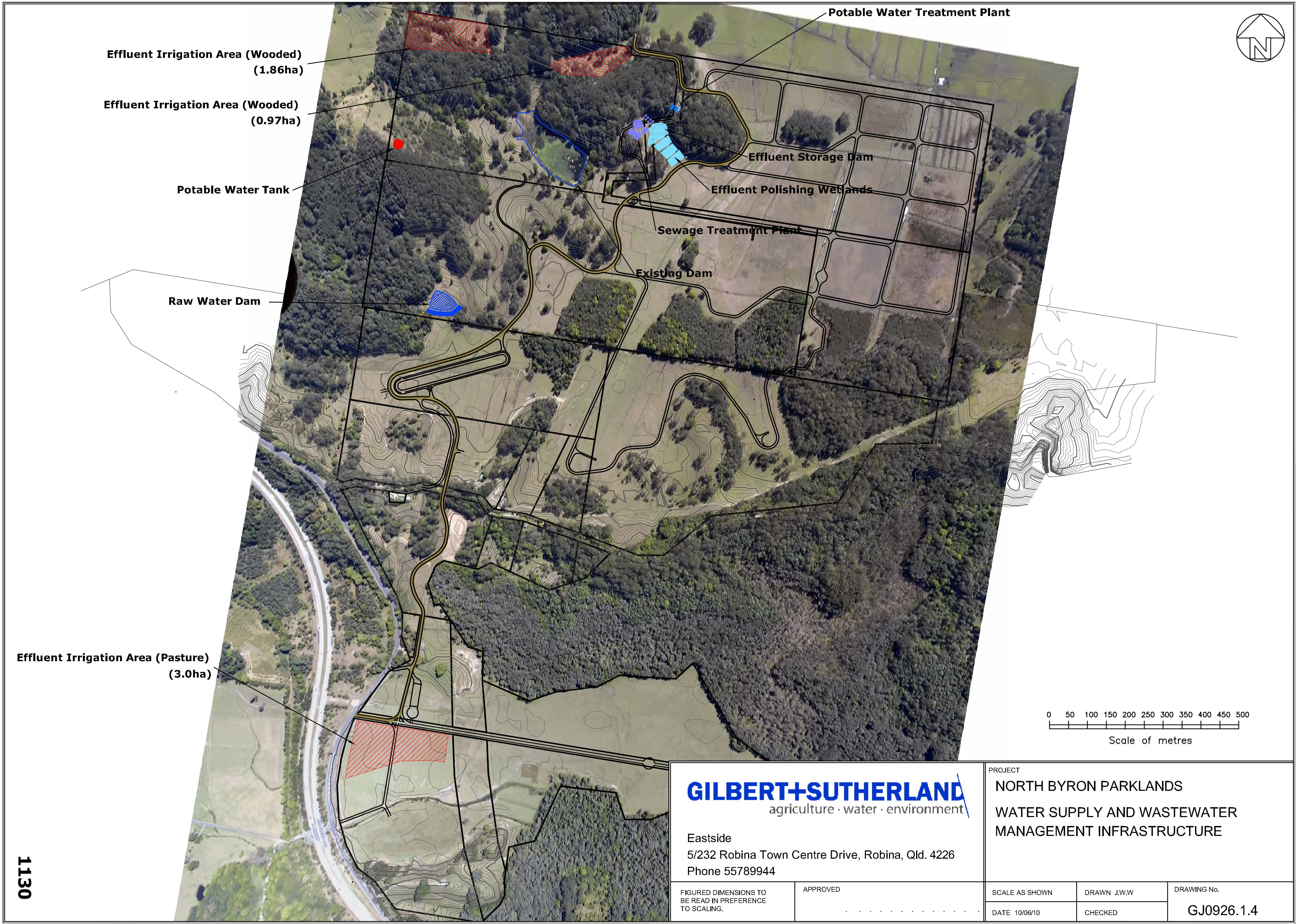


FIGURE 1



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PROJECT
NORTH BYRON PARKLANDS
WATER SUPPLY AND WASTEWATER
MANAGEMENT INFRASTRUCTURE

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.	APPROVED	SCALE AS SHOWN	DRAWN J.W.W	DRAWING No.
		DATE 10/06/10	CHECKED	GJ0926.1.4

7) Wastewater treatment system and application area

7.1 Wastewater loading

7.1.1 Cultural event site

Similar to water demand, wastewater loading from the cultural events use of the site has been calculated based on real data obtained from previous large-scale cultural events, involving both a music festival and camping activities.

The per patron wastewater loading rates will likely increase with the transition from temporary toilet facilities, which are highly water efficient, to more permanent toilets and fixtures, which are less efficient. The estimates of peak wastewater loading have been based on the assumption that permanent fixtures are in use. The provision of showers is a major contributor to wastewater loading and wastewater loading rates can be controlled by various water saving measures particularly if they are associated with the showers. This could include pay-per-use showers, water efficient shower heads and the addition of timers to limit the length of showering. For the purpose of the estimates, it was assumed that pay-per-use showers were available and that there was a 60% uptake of showers amongst campers. A detailed breakdown of the wastewater loadings is provided in Appendix 6. A summary of the peak daily and annual loadings for a range of event sizes is provided in Tables 7.1.1.1 and 7.1.1.2 respectively.

Table 7.1.1.1 Indicative Daily Wastewater demand for maximum representative events and permanent infrastructure

Event	Wastewater Loading (L/day)
Minor event (300 patrons & 300 camping)	8,646
Small event (3000 patrons and 3000 camping)	86,460
Moderate event (10,000 patrons and 10,000 camping)	288,200
100% capacity (50,000 patrons and 25,000 camping)	940,500
Permanent infrastructure	**Wastewater Loading (L/day)**
Conference facilities (300 person conference centre with accommodation for 150 persons assuming 100% occupancy)	17,000
Administration/cultural centre (with 2 full time &12 part time staff)	1,140

Table 7.1.1.2 Indicative Annual Wastewater loading for maximum representative events and permanent infrastructure

Event	Number of event days per annum	Wastewater Loading (L/annum)
Minor event (300 patrons & 300 camping)	4	34,584
Small event (3000 patrons and 3000 camping)	4	345,840
Moderate event (10,000 patrons and 10,000 camping)	4	1,152,800
100% capacity (50,000 patrons and 25,000 camping)	12	11,286,000
Total annual event water demand	24	12,819,224
Permanent infrastructure	**Days per annum**	**Wastewater Loading (L/annum)**
Conference facilities (300 person conference centre with accommodation for 150 persons assuming 100% occupancy)	200	5,400,000
Administration/cultural centre (with 2 full time & 12 part time staff)	312 (6 days/ week)	355,680
Sub-total permanent infrastructure		5,755,680
Total for all site uses		18,574,904

7.1.2 Administration/cultural centre and conference facilities

The administration/cultural centre will be used continuously by a small number of permanent and temporary staff which will increase during events when the number of event administration staff will increase.

The proposed conference centre would be used throughout the year for conferences and accommodation of conference delegates and would represent a more continuous wastewater stream than the event usage of the site. It is again noted that the conference centre is a component of the concept application only and will be subject to a future project application. Wastewater flows from the conference centre have been incorporated to this assessment for planning purposes.

Note that these events and therefore wastewater loading rates are indicative only and represent the peak loading for the various events described. The loadings are based on the maximum number of patrons for each event category and assume that all patrons will camp except in the major event where the maximum capacity of 25,000 campers will be reached.

For the purpose of ensuring that sufficient capacity is provided for the wastewater loading from the proposed use of the site it has been assumed that the maximum utilisation of the site would occur and therefore that 18.57 ML of wastewater would be generated on an annual basis.

7.2 Wastewater management

7.2.1 Temporary facilities

It is proposed that a number of events will be held on the site before the permanent sewerage and sewage treatment infrastructure are constructed.

Indicative daily wastewater flows for different sized events serviced by temporary facilities are detailed in Table 7.2.1.1.

Wastewater loading calculations for a broader range of events are presented in Appendix 6.

As for water supply, wastewater loading rates are slightly lower for events serviced by temporary facilities than events serviced by permanent infrastructure due primarily to the use of highly water efficient portable toilets.

In conjunction with data provided from previous large events, it has been assumed that water efficient fixtures and management procedures shall be implemented and these practices will need to be implemented to limit the wastewater loading. The required water saving measures will include as a minimum:

- Portable toilets with microflush (<500ml/flush)
- Waterless urinals
- Spring loaded timers on faucets
- Time limited showering
- Water efficient shower heads (<9L/min)
- Patron education.

For these events, it is proposed that temporary sanitary and bathroom facilities will be provided. For the comfort of patrons, the number of fixtures to be provided will exceed the requirements of the Building Code of Australia 2010 and the Local Government Regulation 2005. The minimum number of fixtures required to meet the requirements of the Building Code and the Local Government Regulation are detailed in Appendix 6.

The number of fixtures to be provided will be determined on a case-by-case basis, to suit each specific event, in consultation with appropriately experienced and qualified consultants and service providers.

The layout of amenities, temporary sewerage and wastewater collection and

Table 7.2.1.1 Indicative daily wastewater loading for maximum representative events with temporary infrastructure

Event	Water Demand (L/day)
Minor event (300 patrons & 300 camping)	7,953
Small event (3000 patrons & 3000 camping)	79,530
Moderate event (10,000 patrons and 10,000 camping)	265,100
100% capacity (50,000 patrons and 25,000 camping)	841,500

holding tanks shall be designed to suit individual event layouts. Conceptually, it is proposed that a large, temporary wastewater holding tank or tanks (cumulatively holding at least 100,000L) would be located within the resource centre. A series of smaller tanks (5,000 – 10,000L) would be located in the vicinity of amenities to collect wastewater and improve the efficiency of waste collection. Waste would be pumped from these smaller tanks by licensed wastewater contractors and transferred to the large tank(s) in the resource centre. To minimise truck movements from the site, wastewater would be transported from the site using the largest available tanker trucks (>20,000L) rather than the standard pump trucks which have a typical volume of 10-11,000L.

Water use and wastewater volume data shall be collected for each event to assist with the planning of subsequent events and the detailed design of the permanent wastewater treatment infrastructure.

7.2.2 Permanent wastewater management infrastructure

It is considered that on-site treatment of wastewater is a more sustainable solution to wastewater management in the long term. It is therefore proposed that a sewage treatment plant and ancillary sewerage infrastructure would be constructed to treat the wastewater generated from the various site uses.

Conceptually this will include reticulated sewerage operating via a combination of gravity and pumping, a sewage treatment plant, a pump station, effluent holding dams, effluent polishing wetlands and dedicated effluent irrigation areas. The conceptual layout of the sewerage and water supply infrastructure is illustrated on Drawing GJ0926.1.7.

7.2.3 Proposed sewage treatment plant

The proposed sewage treatment plant would be located approximately as illustrated on Drawing GJ0926.1.4. The detailed design of the STP would be subject to Construction Certificate approval. This location confines the STP to a small valley which can easily be screened and access can more readily be controlled. Based on preliminary survey the components of the STP could be accommodated in this area without the need for any clearing of vegetation.

This treatment process is based on the process used at the Woodford Folk Festival (WFF) site ‘Woodfordia’ and has been designed by Midell Water Pty Ltd, who designed the STP for the WFF. The STP has been purpose designed to be able to treat the very high peak loads experienced during event periods and also accommodate the much smaller but more continuous loadings associated with the permanent site uses including the administration/cultural centre and the conference facilities when constructed.

Whilst the daily wastewater flows generated during events at 100% site capacity would approach 1ML/day, it is commercially and economically more effective to construct and operate an STP with a daily treatment capacity of 700kL and provide balance storage for any wastewater generated in excess of this capacity. Therefore, the STP would operate for a number of days following the conclusion of a 100% capacity event.

The proposed treatment process is illustrated in the attached Figure 2 and operates as follows:

1. Screening unit to remove solids. The screening unit is effective at removing solids during peak flows and facilitates the removal of biosolids.
2. Flocculation Chamber. This allows for the chemical flocculation of solids from the wastewater resulting in a clearer effluent with reduced contaminants of concern. The solids can be transferred back to the screening unit, stored and removed as biosolids. It requires a chemical dosing system.
3. Clarification Chamber. This step once again removes solids from the effluent. The solids can be transferred back to the screening unit. The screening unit, flocculation chamber and clarification chamber are accommodated in a sealed shed. Ventilation to the shed will be fitted with activated carbon odour control vents.
4. Aeration/Holding Tank. The aeration tank will add micro-bubbles of air to the effluent and ensure that it is kept in

an aerobic state. The air will reduce odour-forming compounds, reduce contaminants of concern such as pathogens, biochemical oxygen demand and chemical oxygen demand, etc. The other aim of this tank is to store the peak loads of effluent production and even out the effluent flow of the treatment chain to the desired 700 kL per day or 10 L per sec (20 hours operation per day). This tank is sealed which will limit potential impacts from odour. Again, odour control vents fitted with activated carbon filters will be used where ventilation is required.

5. Pumpwell + Hydrogen Peroxide dosing. This pump well pumps the water through 6 Zetos filters. The hydrogen peroxide enhances biological decomposition of organic compounds, reduces odour, clarifies, and disinfects.
6. Zetos Filters: Zetos filters use zeolite, granulated activated carbon and garnet to filter contaminants of concern. The Zetos filters treat nutrients such as nitrogen, while also reducing contaminants such as pharmaceuticals (including antibiotics), personal care products (shampoo, conditioner, and soaps), pathogens, odour and colours.
7. Pump Well + Flocculation Chemical. This pumpwell collects the effluent from Zetos filters and pumps it through the sand filters. If suspended solid concentrations are above optimum a chemical dosing pump can add a flocculent chemical to assist the sand filters in removing particulate matter.
8. Sand Filters: Sand filters remove suspended solids and remove associated contaminants of concern such as nutrients and metals.
9. Granulated Activated Carbon Filters: Granulated Activated Carbon reduce colours, odours, organic compounds, pharmaceuticals and personal care products.
10. Ultraviolet disinfection: This form of disinfection kills and prevents the reproduction of bacteria, viruses and protozoa.
11. Hydrogen Peroxide dosing: This provides a disinfection residual without the environmental hazards associated with chlorine disinfection of recycled water.
12. Waste Stabilisation Dam + Aeration: This is the main storage for the recycled water. Aeration is provided to maintain the quality of the recycled water. The size of the dam is currently being modelled; however preliminary results indicate it ranges between 5 and 8 ML.
13. Constructed Wetlands: A 30 by 90m (2700msq) broken into three alternately dosed cells to achieve even distribution is recommended. These cells could be formed to follow the contour of the hill/vegetation and therefore blend into the features of the site that exist.
14. Recycled Water Distribution Pump Tank: This tank would hold recycled water prior to it being pumped to the nominated irrigation areas.

7.2.4 Effluent quality

The water quality of the treated effluent will meet the following performance criteria at the point of discharge into the effluent storage dam.

These effluent characteristics have been incorporated into the MEDLI model. The expected quality of the treated effluent is shown in Table 7.2.4.1.

Table 7.2.4.1 Effluent quality performance criteria

Parameter	Concentration
pH	6 – 8.5
BOD	<10mg/l
Suspended solids	<5mg/l
Total nitrogen	<20mg/l
Total phosphorus	<5mg/l
Faecal coliforms	<1cfu/100ml

7.2.5 Administration centre and gatehouse

The administration centre and gatehouse are to be constructed prior to the construction of the Sewage Treatment Plant. As the loading rates for these two buildings are low, and similar to the loading from a standard dwelling, it is proposed that the wastewater from these buildings will each be treated using a residential standard Household Sewage Treatment Plant.

The accompanying report within Technical Paper F2 provides the details for the on-site wastewater management systems for these two buildings.

7.2.6 Irrigation of effluent

Treated effluent from the main STP, after passing through the polishing wetlands will be used to irrigate a timber plantation and pasture in the areas shown on Drawing GJ0926.1.4. The pasture will be managed as a ‘cut and cart’ operation, with biomass and nutrients harvested and removed from the site in the form of hay.

To maximise evapotranspiration and nutrient uptake and minimise the deep percolation of nutrients from the designated irrigation areas, irrigation would occur to make up any soil water deficit in the proposed woodlot and pasture production areas.

In order to estimate an appropriate land application area for the expected loadings, a water balance was undertaken using rainfall and evaporation data for Yelgun, based on a SILO data drill. The sizing of the area has been calculated based on iterative model runs described in Section 7.3.

7.3 Hydraulic and nutrient impact assessment

7.3.1 Water balance modelling

For this assessment, the potential to utilise effluent generated from the proposed development for the purpose of irrigation has been tested using water balance modelling and the results of the field soil investigation. Land application of treated effluent would be to a combination of woodlot and pasture irrigation areas.

To calculate the size of the areas required, modelling was carried out using the CRC for Waste Research/QDPI Model for Effluent Disposal by Land Irrigation (MEDLI) software, which included the following considerations:

- effluent applied
- precipitation
- evapotranspiration
- percolation
- surface runoff.

MEDLI is a complex, daily time-step, hydrological simulation model used to assess the hydraulic performance of the effluent treatment tank and irrigation area. This program also simulates the hydrological and nutrient balance of the treatment plant, effluent dams and irrigation systems over extended periods.

A SILO data drill was conducted to obtain historic daily evaporation and rainfall data for the site for a 108 year period which was used in the simulations.

The volume of sewage flow used in the modelling reflected the volume that would be generated at the proposed maximum usage of the site. Whilst effluent would be generated at peak rates during event periods, and at much lesser rates during non-event periods the model does not have the capacity to reflect this. As such, an average daily flow of 50,900L was calculated, based on the annual maximum of 18,574,904L. This was considered a reasonable assumption as the STP, holding dam and wetlands have far greater holding capacity (approximately 9.5ML) than the volume of wastewater generated from the maximum proposed event (approximately 4ML). Provided there was reasonable rest time between large events, there would not be a risk of overflow from the effluent holding dam, or wetlands.

Soils within the critical absorption zone (i.e. subsoil) were sampled from boreholes constructed in the proposed wood lot and pasture production areas. The soils were classified as hydrosol, in the pasture area and kurosol on the ridge where the wood lot is proposed.

These soils were typified by moderately to well structured silty clay loams and silty medium to heavy clays. These soils were classed as Category 6 soils in accordance with Table 4.2A1 of AS/NZS 1547:2000.

The in-situ permeability was determined to range from 0.03m/day in the vicinity of the pasture irrigation area to 0.6m/day on the ridge in the vicinity of the woodlot irrigation area. The measured range of permeability is consistent with Category 6 soils as described in AS/NZS1547:2000 in the pasture area and exceeds it in the woodlot area.

The model was run with the following inputs.

- 108 years of climate data, for Yelgun from a SILO data drill.

- Wastewater generated at an average rate of 50,900L/day.
- Irrigation of 70% of the available effluent to 2.8Ha of plantation timber.
- Irrigation of 30% of the available effluent to 3Ha of ryegrass pasture.
- Medium permeability brown earth soils, which most closely reflect the field measured permeability, texture and phosphorus adsorption characteristics of the site soils.
- Effluent quality reflecting the performance criteria stated in Table 7.2.4.1 above.
- Irrigation at a soil water deficit of 1mm, to 2mm beyond the drained upper limit.

7.3.2 Hydraulic loadings

The MEDLI modelling for the woodlot area shows that 569mm would be irrigated per year, adding to the average rainfall of 1853mm year. Approximately 37% (mm/year) of the combined rainfall and irrigation would be lost in plant transpiration and soil evaporation, with a total of 625mm/year lost to deep drainage and 569mm/year lost as runoff. The model indicates that surface runoff is comprised completely of rainfall, with no surface runoff of effluent as would be expected when irrigation is triggered based on a soil water deficit.

The modelling for the pasture area shows that 277mm would be irrigated per year, adding to the average rainfall of 1853mm year. Approximately 36% (mm/year) of this would be lost in plant transpiration and soil evaporation, with a total of 767mm/year lost to deep drainage and 589mm/year lost as runoff. Again, the model indicates surface runoff is comprised completely of rainfall.

The increase in deep drainage, ie groundwater recharge, compared to the base case (with a cover of tropical pasture) is 149mm/year in the woodlot and 291mm/year in the pasture area. The nutrient balance below considers the significance of this increase in terms of groundwater quality.

The geotechnical impact of this increase in deep percolation is not within the scope of this report and it is recommended that a geotechnical advice be considered prior to the establishment of the woodlot.

7.3.3 Nutrient balance

The irrigation areas would be cropped and managed to maximise nutrient uptake and minimise the deep percolation of nutrients through the soil profile.

The modelling for the woodlot area shows that the combined plant uptake of nitrogen and volatilisation (78.3kg/ha/year) would be in excess of the 76.9kg/ha/year added in irrigation. This would result in an average NO_3^--N concentration in deep drainage of 0.7mg/L, which exceeds the ANZECC (2000) Water Quality Guidelines[15] threshold (0.5mg/L) for the maintenance of aquatic ecosystems (rivers and streams), however represents better water quality than the existing groundwater with concentrations ranging from 1.52 – 2.03mg/L identified during recent monitoring.

Phosphorus added to the woodlot via irrigation would almost entirely be removed by plant uptake and soil adsorption with a PO_4-P concentration below the root zone of 0.5mg/L. Whilst this concentration exceeds the ANZECC Water Quality Guidelines threshold for rivers and streams it is only marginally higher than the existing groundwater quality which contains Phosphorus concentrations of up to 0.4mg/L. It should also be noted that the woodlot would be situated on elevated ground and there would be considerable opportunity for phosphorus assimilation by vegetation or sorption to the soils before it reported to the groundwater underlaying the alluvial flat.

The modelling for the pasture area shows that the plant uptake of nitrogen (24.4kg/ha/year) would be in excess of the 18.8kg/ha/year added in irrigation. This would result in an average NO_3^--N concentration in deep drainage of 0.0mg/L, which is below the ANZECC Guidelines[16]

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[15] Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 – The Guidelines.* National Water Quality Management Strategy, Canberra.

[16] Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 – The Guidelines.* National Water Quality Management Strategy, Canberra.

threshold (0.04mg/L) for the maintenance of aquatic ecosystems (lowland rivers and streams) and is vastly better than the existing water quality reported above.

Phosphorus added to the pasture area via irrigation would almost entirely be removed by plant uptake and soil adsorption with a PO_4-P concentration below the root zone of 0.1mg/L. This concentration exceeds the ANZECC Water Quality Guidelines threshold for lowland rivers and streams and represents better water quality than the existing groundwater. The MEDLI modelling results are presented in Appendix 8.

7.4 Buffer distances

7.4.1 STP

The sewage treatment plant, located as shown on Drawing GJ0926.1.4 would be a minimum of 190 metres from the nearest property boundary and more than 400m from the nearest residence, which meets the provisions of the Byron Shire Council Development Control Plan. The plant is approximately 140m from the nearest proposed site activities. Whilst this is less than the 400m recommended in the DCP, the design of the STP is such that odour is not significant compared to a traditional STP and it is unlikely that odour will be detected by site users.

7.4.2 Irrigation Areas

Irrigation areas would be maintained a minimum of 5m from property boundaries, where drip irrigation is used and a minimum of 20m where spray irrigation is used

For public health reasons, the irrigation areas will have signage in accordance with the *Environmental Guidelines for the Use of Effluent by Irrigation*[17] .

7.5 Maintenance requirements and validation testing

To ensure that effluent of the modelled quality is delivered consistently to the irrigation areas at the specified quality, a monitoring and maintenance program would form part of the operational procedure for the site.

A maintenance contract would be entered into for the commissioning, validation, operation, ongoing monitoring, servicing and maintenance of the sewage treatment plant.

In addition to maintenance of the STP, the irrigation areas will require harvesting at crop maturity to ensure that nutrients are removed from the system and to promote continued growth, nutrient assimilation and water uptake.

3.2.1 Validation testing

Validation testing of the waste treatment system influent and effluent shall be undertaken in-situ in accordance with the NSW Guidelines for Management of Private Recycled Water Schemes. Sampling shall be undertaken over a 12 week period and shall demonstrate compliance with the Guideline values listed in Table 7.2.4.1.

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[17] NSW Department of Environment and Conservation. 2004. *Environmental Guidelines for the Use of Effluent by Irrigation.* DEC, Sydney.

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PROJECT
NORTH BYRON PARKLANDS

CONCEPTUAL WATER SUPPLY & SEWER DRAINAGE LAYOUT

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

SCALE AS SHOWN

DATE 28.06.2010

DRAWN N.W.D

CHECKED

DRAWING No.
GJ0926.1.7

North Byron Parklands
Wastewater Treatment Plant

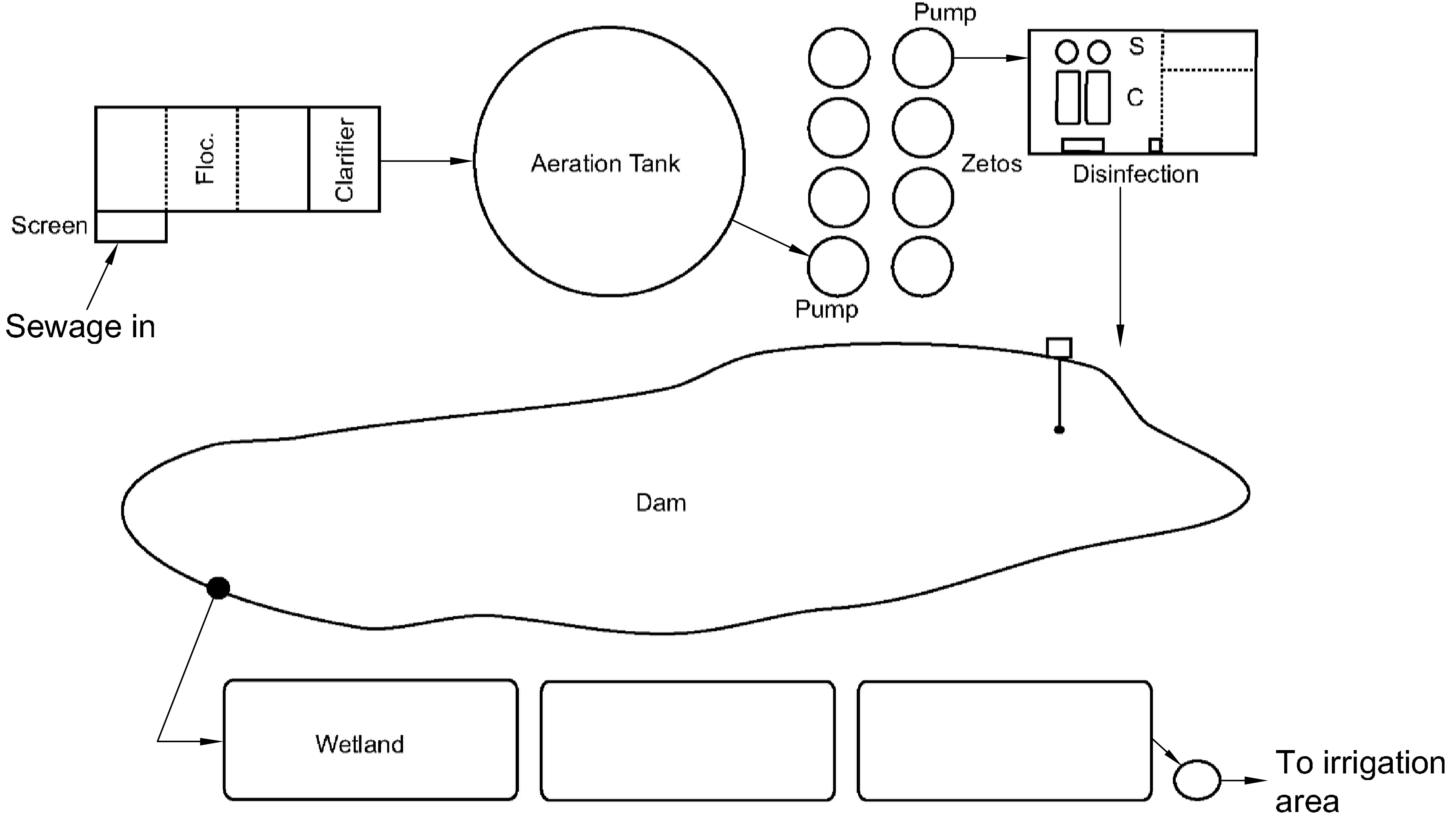

FIGURE 2

8) Integrated water cycle management

8.1 IWCM Concept

Integrated Water Cycle Management (IWCM) describes a way of managing water in which all components of the water system (water supply, wastewater, stormwater and groundwater) are integrated to optimise the use of the resource. Sound IWCM means the community's water needs are met, whilst minimising environmental impacts and maximising the efficient use of this finite resource.

IWCM can involve the integration of a large number of concepts for re-use, reduction and recycling. These options may include (but are not limited to):

- demand management – use of water efficient appliances
- rainwater (roof runoff) collection and re-use
- stormwater collection and reuse
- aquifer storage and recovery
- effluent recycling (sewer mining)
- WSUD measures for water quality improvement.

The optimum IWCM solution for any development will typically involve a combination of these options, based on existing infrastructure, local climate and site-based constraints. Economic and social factors may also contribute to the selection of appropriate IWCM options.

8.2 IWCM at North Byron Parklands

An assessment of potential IWCM options for the North Byron Parklands Site was undertaken to identify individual components that may be appropriate to the site. The elements to be used as part of the IWCM strategy for the North Byron Parklands development are described herein, with further detail provided in the Water Management Plan (WMP) which is attached as Appendix 9.

All permanent buildings are to have rainwater tanks installed. Collected rainwater is to be utilised as potable supply, and for other various uses such as toilet flushing. To reduce demand on the water supply and maximise efficiency, WELS Scheme rated water-efficient devices (including taps, showerheads, toilets, dishwashers and washing machines) will be installed.

Where possible, overflow from rainwater tanks will be directed to existing onsite storage devices (eg. Dams). Captured water can then be suitability treated and used as a water source. Overflow from rainwater tanks that is unable to be captured in onsite storage devices will be diffusely discharged over a vegetated filter/buffer.

Stormwater quality treatment will be provided for rainfall runoff from hardstand areas by means of vegetated swales and vegetated filters and buffer strips. Suitable grading would be used to ensure diffuse discharge into the vegetated filters and buffer strips Any engineered stormwater quality devices would be designed and arranged to minimise the disturbance of acid sulfate soils and the operational phase groundwater drawdown. Where possible stormwater devices will be designed so as to maximise recharge to groundwater.

MUSIC modelling has been used to demonstrate the proposed development will have no adverse impacts on the quality of waters discharging from the site. A discussion of the proposed stormwater quality treatment options has been provided in the Water Management Plan attached as Appendix 9.

9) Stormwater quality assessment

9.1 MUSIC modelling

The CRC for Catchment Hydrology Model for Urban Stormwater Improvement Conceptualisation (MUSIC) Version 3.01 computer model was used to assess the likely impacts of the proposed development on water quality.

MUSIC is a water resources package with components for generating surface and subsurface runoff, non-point source pollutant export and pollutant transporting and routing. It is specifically designed for the analysis of the effects of planned land use changes and for the evaluation of best management practice stormwater quality improvement devices.

The input data requirements for the MUSIC model are described below.

9.1.1 Model input data

This model requires the input of rainfall and evapotranspiration data. The rainfall data must be in the form of 6 minute time-step pluviometer records.

The Coolangatta Bowls Club data set was selected as the nearest, most appropriate station for this study in terms of proximity and relief with data available in a suitable form (6 minute timestep).

Table 9.1.1.1 Rainfall Statistics

Year	Total Rainfall (mm)	Percentile Ranking
1971	1374.7	20
1972	2301.5	80
1973	2099	70
1974	2988.6	100
1975	1757	50
1976	2358.8	90
1977	1443.8	30
1978	2053.4	60
1979	1324.1	10
1980	1465.9	40
1981	1072.2	0
Average	1840	-

An assessment of the data was conducted to determine a representative period. From this we extracted a continuous 6 minute time-step dataset from 01/10/1972 to 01/06/1981.

An analysis of the 6 minute time-step MUSIC dataset yielded an average annual rainfall of 1840mm and the annual totals as shown in Table 9.1.1.1.

An analysis of a daily time-step rainfall data set for the site (interpolated using the Qld DNR drill data service) spanning the period from 1889 to 2009 provided the following annual rainfall data:

Driest Year	731
10th percentile year	1325
Average year	1881
Median year	1846
90th percentile year	2496
Wettest year	3223

Average monthly potential areal evapotranspiration values were obtained from GCCC MUSIC Modelling guidelines (2006)[18]. These values are presented in Table 9.1.2.2.

Table 9.1.1.2 Evapotranspiration data

Month	Evapotranspiration (mm)
Jan	190
Feb	152
Mar	150
Apr	105
May	75
Jun	60
Jul	65
Aug	80
Sep	107
Oct	150
Nov	175
Dec	190

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[18] In the absence of equivalent guidelines for Byron, Tweed or Ballina Shires.

9.1.2 Runoff parameters

Relevant parameters for the land uses, sourced from Gold Coast City Council's 'MUSIC Modelling Guidelines' (2006)[17], are presented in Table 9.1.2.1.

Table 9.1.2.1 – Parameters for rural and urban land uses

Parameter	Rural residential Land use	Urban Land use
Field capacity (mm)	80	200
Infiltration coefficient	200	50
Infiltration exponent	1	1
Rainfall threshold (mm)	1	1
Soil capacity (mm)	120	400
Initial storage (%)	25	10
Daily recharge rate (%)	25	25
Daily drainage rate (%)	5	5
Initial depth (mm)	50	50

9.1.3 Water quality parameters

The water quality parameters modelled were: Suspended Sediment (SS); Total Nitrogen (TN); and, Total Phosphorus (TP).

The sediment and nutrient export characteristics were adopted from the GCCC 2006 MUSIC modelling guidelines as shown in Table 9.1.3.1.

It should be noted that the rainfall to runoff model and the pollutant export expressions have not been calibrated for local catchments, meaning the modelling results cannot be expected to produce accurate assessments of the amount of pollutants likely to be exported from the proposed development. However, the results do provide useful assessments which enable comparisons of the effectiveness of various stormwater management strategies. It has been assumed that the impervious percentage of roads is to be 40%, the impervious percentage for building roofs is to be 100% impervious.

The percentage impervious modelled is summarised in Table 9.1.2.2 below.

Table 9.1.2.2 – Percent impervious inputs for rural and urban land uses

Catchment	Percentage Impervious (%)
Rural residential road	40
Urban roof	100
Rural balance	0

9.1.4 Modelling undertaken

The MUSIC model was used to form a basic model for the stormwater treatment system representing the anticipated environment subsequent to the change in land use (Developed Case, i.e. after completion of internal roads and permanent buildings).

The following scenarios were modelled:

- Base case
- Developed case for proposed permanent structures WITHOUT treatment measures.
- Developed case for proposed permanent structures WITH treatment measures.
- Developed case for the entire site WITHOUT treatment measures.
- Developed case for the entire site WITH treatment measures.

Details of the stormwater treatment methods recommended and the results of the MUSIC modelling are provided in Section 9.

9.1.5 Catchment description

This assessment is based on the conceptual plan and provides conceptual details of the

Table 9.1.3.1 Pollutant Export Parameters (Log_{10}mg/L)

Land use	Parameter	Suspended Solids		Total Nitrogen		Total Phosphorus	
		Base Flow	Storm Flow	Base Flow	Storm Flow	Base Flow	Base Flow
Rural-residential	Mean	0.53	2.26	-0.52	0.32	-1.54	-0.56
	Std Deviation	0.24	0.51	0.39	0.30	0.38	0.28
Urban	Mean	1.00	2.18	0.20	0.26	-0.97	-0.47
	Std Deviation	0.34	0.39	0.20	0.23	0.31	0.31

treatment measures likely to be adopted and their performance in mitigating the impacts of stormwater runoff from the completed development.

For modelling of the Base Case it is considered that rural residential land with a percent impervious of zero is an acceptable representation.

The developed areas for the land uses modelled have been estimated using Drawing No. GJ0926.1.4.

The areas of the various land uses included in the model and their estimated impervious fraction used to represent the site when fully developed, are shown in Table 9.1.5.1.

Table 9.1.5.1 Catchment characteristics and estimated post developed impervious fractions

Catchment	Area (ha)	Fraction mpervious
Rural residential road	9.3	0.4
Urban roof	0.5	1.00
Rural residential balance	126.4	0.00

Generally the 'urban' land use has been used to represent the roof of buildings. The rural-residential land use has been used to represent the balance of the catchments and roads.

9.2 Water Quality Objectives

The Water Quality Objectives (WQO's) for site runoff have been identified according to the Byron Shire Development Control Plan 2002 (Amendment No. 5: Effective 25 November 2004).

'Part N - Stormwater Management – Stormwater Quality Control' of the Development Control Plan identifies targets for mean annual pollutant load reductions. These targets are given in Table 9.2.1.

Table 9.2.1 Mean annual pollutant load reductions

Indicator	Treatment target (reduction)
Suspended Solids (SS)	80%
Total Nitrogen (TN)	45%
Total Phosphorus (TP)	45%

For this assessment the average annual pollutant load reductions are applicable to those increases due to permanent development and thus a comparison of water quality impacts due to the proposed development will be undertaken separately to that of the entire site. An overall comparison of the entire site for the developed treated case with the base case will be made to assess impacts on the quality of waters discharging from the site.

10) Stormwater quality assessment results

Details of the MUSIC modelling software, the input parameters and the catchments have been provided in Section 9.

10.1.1 Base Case

The results described below in Table 10.1.1.1 indicate the average annual runoff volume and quantities of suspended sediment, nitrogen and phosphorus predicted to be exported from the site with its current level of development, during the 7 year model simulation.

Table 10.1.1.1 Base Case average annual pollutant loads

Runoff (ML/year)	Suspended Sediment (kg/year)	Total Nitrogen (kg/year)	Total Phosphorus (kg/year)
1,130	300,000	2,400	306

10.1.2 Developed Untreated Case

Table 10.1.2.1 presents the average annual runoff volumes and quantities of suspended sediment, nitrogen and phosphorus predicted to be exported from the site in its developed untreated state during the 7 year model simulation.

Table 10.1.2.1 Developed Untreated Case average annual pollutant loads

Runoff (ML/year)	Suspended Sediment (kg/year)	Total Nitrogen (kg/year)	Total Phosphorus (kg/year)
Entire Development Site			
1,180	319,000	2,270	323
Proposed Permanent Development (roads and buildings)			
124	31,800	306	36.2

The pollutant loadings above, when compared to the loadings in Table 10.1.1.1, demonstrate the increase in runoff and pollutants that is predicted to occur if the development was completed without any stormwater management or treatment measures. To meet the requirements of the Byron Shire Development Control Plan (2002) the mean annual pollutant load reductions for the proposed permanent development given in Table 10.1.2.2 must be achieved.

Table 10.1.2.2 Average annual pollutant load reductions (% reduction).

Suspended Sediment	Total Nitrogen	Total Phosphorus
80	45	45

10.1.3 Developed Treated Case

The same areas as above were modelled under the same rainfall conditions in a developed state with the following treatment measures included.

It is proposed that runoff from the site will be treated using a combination of rainwater tanks, grassed swales and buffer strips/vegetated filters. All permanent buildings within the development would be required to install rainwater tanks. The treatment train for each catchment is outlined below;

- Rainfall runoff from hardstand areas is proposed to be treated by means of buffer strips.
- Where possible, overflow from rainwater tanks will be directed to existing onsite storage devices (eg. Dams), if this is not achievable overflow from the rainwater tanks would be discharged directly to a buffer strip.
- Runoff from the roads would be directed to grassed swales prior to discharge through vegetated filters/buffer strips.

The selected treatment devices are discussed below.

Rainwater tanks

Rainwater tanks will be used to store rainfall captured from the roofs that would otherwise have been conveyed to a point of discharge. The collection and storage of rainwater would form a component of the site's integrated water cycle management.

It is expected that the tank water would be used for flushing toilets and all outdoor uses and that the tanks would be connected to the reticulated drinking water supply system for top-up purposes. Please note that a first flush diversion device or filtration unit should be installed.

The benefit of rainwater tanks has not been included in the MUSIC model.

Swales
Discharge from roads will be directed into grassed swales as shown on Drawing No. GJ0926.1.5.

A swale is a vegetated drain that runs longitudinally to treat stormwater. The vegetation in the swale and the volumetric capacity of the swale allow it to retard flows and treat the water as it passes down its length. Vegetation in the swale will include appropriate sedges, rushes and grasses. The removal efficiency of a swale is dependent on the size and configuration of the swale. Pollutant removal is modelled by MUSIC using empirical equations derived from analysis of data published in technical literature (MUSIC manual). The dimensions of the swales modelled are shown in Table 10.1.3.2.

Table 10.1.3.2. – Modelled swale details

Treatment of proposed road	
Length (m)	1000
Bed Slope (%)	0.5
Average base width (m)	0.6
Average top width (m)	3
Average depth (m)	0.5
Vegetation Height (m)	0.25
Seepage loss (mm/hr)	1.62

Vegetated filters/buffer
Discharge from the grassed swales, overflow from tanks and hardstand runoff would be directed to vegetated filters as shown on Drawing No. GJ0926.1.5.

The vegetated filters would be ideally located to utilise existing site vegetation for treatment of shallow overland flow. The flow entering the vegetated filter should be evenly distributed as sheet flow across its upstream end.

Direct discharges from the filters or adjacent impervious areas should be pre-treated with flow spreaders as required. Flow spreaders function to uniformly spread flows across the filter strip.

Operating characteristics of the vegetated filters treating runoff from the roads are set out in Table 10.1.3.3 whilst the buffer strip characteristics for treatment of roof areas are described in Table 10.1.3.4.

Table 10.1.3.3. – Modelled vegetated filter (modelled in MUSIC using swale treatment node)

Receiving runoff from swale	
Length (m)	10
Bed Slope (%)	0.1
Average base width (m)	1000
Average top width (m)	1000
Average depth (m)	0.01
Vegetation Height (m)	0.25
Seepage loss (mm/hr)	1.62

It should be noted that the vegetated filter receiving runoff from the swale was modelled within MUSIC utilising the swale treatment node. This is a result of a limitation within MUSIC which prevents the vegetated filter (buffer) node from following another treatment node. Also the vegetated filter node does not provide credit for the treatment of all runoff (both impervious and pervious areas). As such, it is considered that the swale node provides a more realistic representation of the treatment in this case, where runoff from both pervious and impervious areas will have the benefit of treatment by the vegetated filter.

Table 10.1.3.4. – Modelled buffer strip

Treatment of runoff from building roofs	
Percentage of upstream area buffered (%)	100
Buffer area (% of upstream impervious area)	10
Seepage loss (mm/hr)	1.62

The mean annual loads have been investigated to assess the efficacy of the treatment devices.

The Development Control Plan (2002) specifies the required percentage reductions in annual pollutant loads, as given in Table 10.1.2.2. It is considered that these pollutant load reductions are required to be obtained for the proposed permanent development of the site.

With the implementation of treatment devices the mean annual loads were reduced and results are shown in Table 10.1.3.5.

Table 10.1.3.5 – Developed treated case average annual pollutant loads

Runoff (ML/year)	TSS (kg/year)	TN (kg/year)	TP (kg/year)
Entire Development Site			
1130	290000	2080	299
Proposed Permanent Development			
76.1	3030	120	11.5

The model results (summarised in Table 10.1.3.6) show substantial decreases in annual loads from permanent when compared to the developed case without treatment and satisfy the specified guidelines.

Table 10.1.3.6 – Developed treated case estimated pollutant load reductions

	TSS	TN	TP
Load Reduction	90.5%	60.8%	68.4%
Target	90%	45%	45%

The mean annual pollutant loads have been summarised in Table 10.1.3.7 with the pollutant loads modelled for Base Case. The results indicate that by implementing the proposed treatment devices, the proposed development will have no adverse impacts on the quality of water discharging from the site (i.e. no increase in annual pollutant loads exported from the site).

Table 10.1.3.7 – Developed treated case vs Base Case of the entire development site

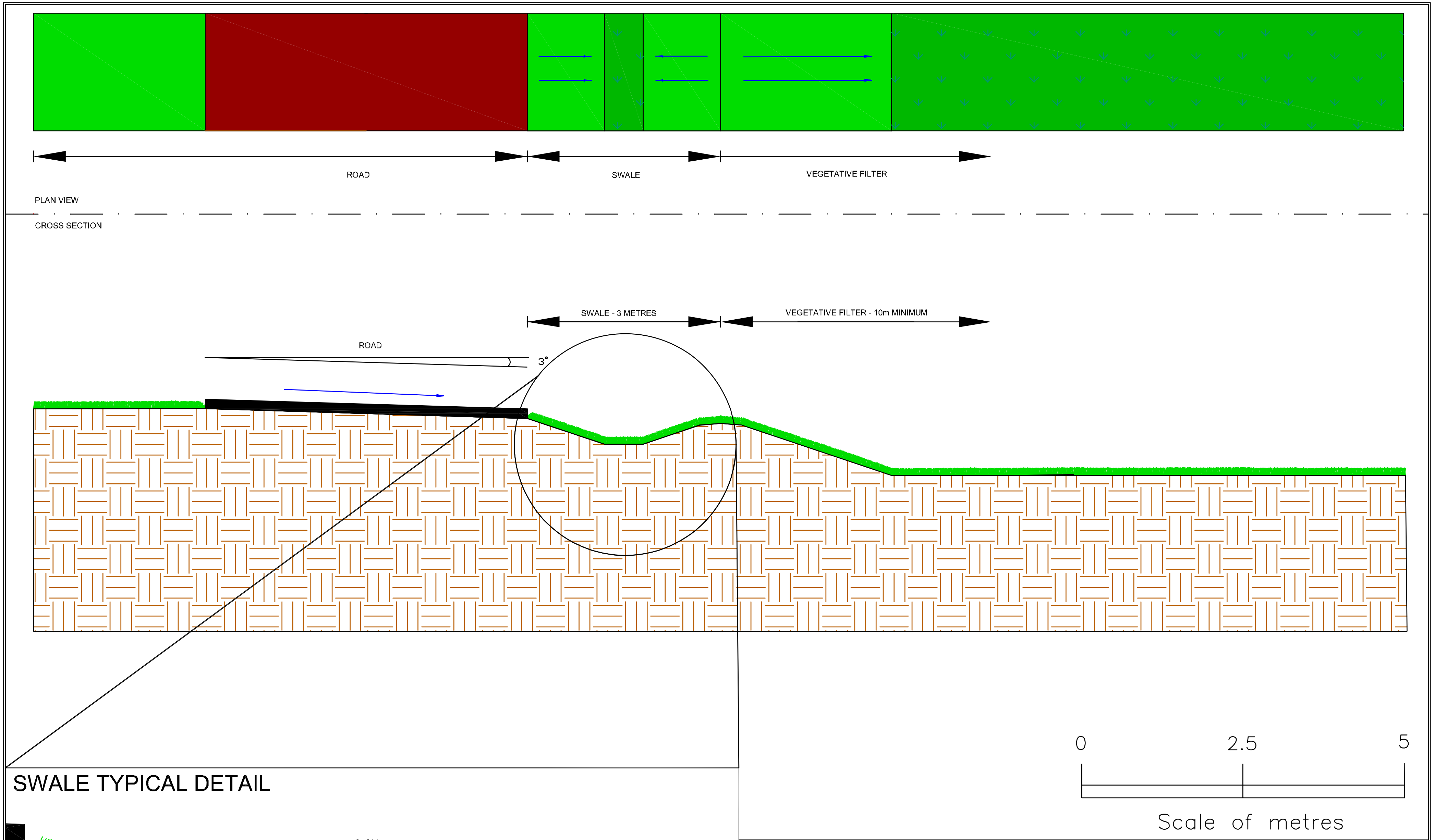
	TSS (kg/year)	TN (kg/year)	TP (kg/year)
Base Case	300000	2400	306
Developed Treated Case	290000	2080	299

10.2 Stormwater Assessment Conclusions

This assessment indicates that provided the recommended water quality management measures are properly installed and maintained, runoff from the proposed development will achieve acceptable water quality.

MUSIC modelling has been used to demonstrate the proposed development will have no adverse impacts on the quality of waters discharging from the site. It has also demonstrated that the requirements of the Development Control Plan (2002) for Byron Shire can be met.

Careful management will be required to ensure that the projected quality improvements are achieved and maintained, particularly during the construction phases. These details are considered in the water management plan, which is included as Appendix 9.



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PROJECT
NORTH BYRON PARKLANDS

CONCEPTUAL STORMWATER MANAGEMENT

TYPICAL ROAD DETAIL

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

SCALE AS SHOWN
DATE 10/06/10
DRAWN J.W.W
CHECKED
DRAWING No.
GJ0926.1.5

11) Conclusions

This report is prepared in respect of a concurrent Concept Plan and Project Application Environmental Assessment report (EA) for the North Byron Parklands (Parklands) project.

The Director General of the Department of Planning issued Environmental Assessment Requirements (DGRs) on August 25, 2009.

Gilbert & Sutherland was engaged to provide input to the Environment Assessment report and have addressed DGRs relating to Integrated Water Cycle Management including stormwater management and water sensitive urban design, as well as issues of water supply, wastewater management and surface water and groundwater hydrology and quality.

DGRs that are addressed in this report are described in italics below followed by our summary response and conclusions.

4.1 Address existing capacity and requirements of the development for sewerage and water…. Identify and describe staging, if any, of (sewerage and water) infrastructure works.

Reticulated water supply and municipal sewerage is not available to the site nor within a reasonable distance of the site. On-site water supply and wastewater treatment would ultimately be provided, however it is proposed that initial events on the site would be wholly serviced with imported potable water and by exporting wastewater to licensed treatment facilities.

4.2 Provide details on how and where water supply will be derived from to service the site.

Based on data collected during site investigations, laboratory analysis and RUSTIC modelling there is sufficient surface water supply to service the demands from the maximum proposed utilisation of the site.

This demand could be met from the harvestable use rights of the property and would involve the use of water from the existing farm dam and the construction of a new farm dam of at least 7.5ML capacity. A potable water treatment plant and potable water storage tank would also be necessary.

Rainwater tanks would be added to permanent structures including the conference centre and administration/ cultural centre as part of the stormwater management process and to supplement the water supply.

7.1 Address and outline measures for Integrated Water Cycle Management (including stormwater) based on Water Sensitive Urban Design principles which addresses impacts on the surrounding environment, drainage and water quality controls for the catchment, and erosion and sedimentation controls at construction and operational stages.

An assessment of potential IWCM options for the Parklands site was undertaken to identify individual components that may be appropriate to the site. Stormwater management concepts are discussed and recommended management strategies incorporating elements of Water Sensitive Urban Design are included in the attached Water Management Plan.

MUSIC modelling has been used to assess the efficacy of the recommended stormwater treatment train and demonstrates the proposed development will have no adverse impacts on the quality of waters discharging from the site.

Soil data has been used to assess the likelihood of erosion and sedimentation impacts during the construction and operation of the site. Based on the very low proportion of the site that will be disturbed and with the implementation of standard erosion and sedimentation control practises, SOILOSS modelling shows that the potential impacts can readily be managed.

7.2 Assess the impacts of the proposal on surface and groundwater hydrology and quality during both construction and occupation of the site. Provide details on any monitoring and/or mitigation plans to ensure surface water and groundwater are not detrimentally impacted upon.

Irrigation of effluent would be undertaken on a soil moisture deficit basis, minimising infiltration of effluent and recharge to groundwater. MEDLI modelling shows that irrigation based on soil water deficit is sufficient to consume all of the effluent generated from site usage and that there would be no surface runoff of effluent, or surface water or groundwater impacts.

The Water Management Plan appended to this report contains monitoring requirements for groundwater and surface water to ensure that any site related impacts are identified and appropriately managed.

7.3 Consider the nature and profile of the groundwater regime under the site, including any hydrologic impacts which would affect its depth or water quality, result in increased groundwater discharge, impact on the stability of potential acid sulfate soils in the vicinity, or affect groundwater dependent native vegetation.

Groundwater investigations undertaken for this and previous assessments demonstrate that the groundwater quality is already impacted, potentially from the ongoing agricultural use of the site. MEDLI modelling shows that there would be no surface runoff of effluent, or surface water or groundwater quality impacts. Effluent irrigation would be based on soil moisture deficit meaning that there would be minimal recharge to groundwater and consequent discharge from the site. As the water quality of effluent percolating below the root zone is generally better than the existing groundwater quality, and that large buffers would be provided and because rehabilitated, it is unlikely that groundwater dependent vegetation would be affected.

7.4 If applicable, DECCW's NSW Farm Dams Policy must be addressed.

The existing farm dam on the site contains less than the site's Maximum Harvestable Use Rights capacity and therefore does not require approval from the NSW Office of Water. However, some maintenance is necessary to bring the dam structure into compliance with the requirements of the policy. The proposed new dam would also be within the site's Maximum Harvestable Use Rights capacity and again would not need to be licensed. Construction of the dam would be undertaken in accordance with the Farm Dams Policy.

15.1 Provide details of wastewater and water treatment facilities, including capacity, types of systems, and management of odours.

A wastewater treatment process that has been demonstrated at a similar event site to accommodate the high level of wastewater flow variation associated with event usage has been identified and is the proposed treatment process for the site. The treatment process would produce the equivalent of Class A effluent quality and is demonstrated to perform with no odour impacts. The STP would have a design capacity of 700kL per day, and would have large balancing tanks and effluent storage dams to accommodate the wastewater flow from a 100% capacity event.

Effluent would be irrigated to 2.8Ha of woodlot timber and 3Ha of pasture. The timber would be grown as a commercial plantation and pasture would be grown for hay production, effectively exporting nutrients from the site.

In conclusion, provided that the site is managed in accordance with the attached Water Management Plan, we are confident that the proposed use of the site will be sustainable and that impacts to groundwater, surface water and the on site and adjacent environmental reserves will be avoided.

12) Appendix 1 – Borelogs

Borehole: BH1

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.29.103

Longitude 153.30.807

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		░	SILTY CLAY LOAM, 7.5YR 3/3 , Moderate, coarse crumb peds, organic matter, roots, traces of fine sand		7.5YR 3/3		
		▨	MEDIUM HEAVY CLAY, 10YR 3/3, 5YR 4/6, Strong, medium subangular, 5% mottles		10YR 3/3, 5YR 4/6		
.5		▨	HEAVY CLAY, 7.5YR 2.5/2 , Massive		7.5YR 2.5/2		.5
		▨	HEAVY CLAY, 7.5YR 3/2, 5YR 5/8, Massive, orange mottles		7.5YR 3/2, 5YR 5/8		
		■	SILTY CLAY, 5YR 5/1 , Massive, traces of fine sand		5YR 5/1		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH2

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.564

Longitude 153.30.991

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▒	SILTY CLAY LOAM, 7.5YR 3/3 , Moderate pedality, coarse crumb structure, mod plasticity, moist, organic matter (roots)		7.5YR 3/3	2M	
.5		▨	MEDIUM HEAVY CLAY, 7.5YR 3/2 , Medium blocky peds, 10% orange mottles at 450-600 depth, charcoal at 450-800		7.5YR 3/2	2M	.5
		■	SILTY CLAY, 5YR 5/2 , Massive, minor fines, moderate plasticity, moist, 15% orange mottles, pH 5.0		5YR 5/2		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH3

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.992

Longitude 153.30.905

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling		Soil Description				Depth NSL(m)
	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	
		░	SILTY CLAY LOAM, 7.5YR 4/1 , Moderate pedality, polyhedral, Organic matter (roots), pH 5.5		7.5YR 4/1	2M	
		▨	HEAVY CLAY, 10YR 2/1 , Massive, moist, pH 5.5		10YR 2/1	4/7M	
.5							.5
		▨	HEAVY CLAY, 10YR 2/1, 10YR 3/3, Massive, moist, 5% mottles		10YR 2/1, 10YR 3/3	4/7M	
		■	SILTY CLAY, 7.5YR 4/2 , Massive, moist, mod plasticity, pH 5.0		7.5YR 4/2		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH4

GILBERT+SUTHERLAND
agriculture - water - environment

Project: GJ0926
Client: Splendour Pty Ltd
Latitude 28.29.183
Longitude 153.31.421
RL(m): _____

Depth (m): 1
Logged by: RJ
Drilled by: Gilbert & Sutherland
Start date: ☐
Completion date: ☐

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	SILTY CLAY LOAM, 5YR 2.5/1 , Moderate pedality, 50% medium blocky peds, Organic matter (roots), moist,		5YR 2.5/1	4/7M	
		▨	SANDY CLAY LOAM, 2.5YR 3/1 , Weak pedality, fine crumb structure, Wet		2.5YR 3/1		
.5		▨	SANDY CLAY LOAM, 2.5YR 5/1 , Massive, saturated		2.5YR 5/1	3M	.5
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH5

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.29.053

Longitude 153.31.2.87

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			SILTY CLAY LOAM, 7.5YR 3/2 , Moderate pedality, 50% crumb, 50% medium blocky peds, organic matter		7.5YR 3/2		
			CLAYEY SAND, 2.5YR 4/1 , Fine crumb structure, gradual change to:		2.5YR 4/1	2M	
.5							.5
			CLAYEY SAND, 2.5YR 5/1 , Fine to v.fine structure, Fine sand saturated, C is gradual change to fine sands,		2.5YR 5/1		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH6

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.29.031

Longitude 153.31.135

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	MEDIUM CLAY, 2.5YR 3/1 , Moderate, polyhedral (4), Organic matter (roots), moist		2.5YR 3/1	2M	
.5		▨	MEDIUM HEAVY CLAY, 5YR 4/1 , Moderate, polyhedral, 3% orange mottles, charcoal 300-450mm, gradual change to		5YR 4/1		.5
		▨	SANDY CLAY, 5YR 5/1 , Moderate, polyhedral		5YR 5/1	2M	
		░	SAND, 5YR 5/1 , Massive, fine wet sand		5YR 5/1		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH7

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.29.208

Longitude 153.30.863

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	LIGHT CLAY, 7.5YR 3/3 , Moderate, subangular, Moist, Organic matter		7.5YR 3/3		
		▨	LIGHT CLAY, 7.5YR 3/3, 5YR 5/8, Moderate, subangular, Moist, Organic matter, pH 6.5		7.5YR 3/3, 5YR 5/8	4/7M	
.5		▨	MEDIUM CLAY, 10YR 3/4 , Massive, Moist, pH 6		10YR 3/4	2M	.5
		■	SILTY CLAY, Greyish yellow brown, 10YR 6/6, Massive, Light clay with silt, 50% mottles		10YR 4/2, 10YR 6/6		
		■	SILTY CLAY, Greyish yellow brown , Massive, 50% mottles, charcoal & silt fines		10YR 4/2		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH8

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.564

Longitude 153.30.991

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	LIGHT CLAY, 10YR 4/3 , Moderate pedality, moist		10YR 4/3	2M	
		▨	LIGHT MEDIUM CLAY, 10YR 4/3, 2.5Y 5/6, Massive, 7% orange mottles		10YR 4/3, 2.5Y 5/6	2M	
		▨	LIGHT MEDIUM CLAY, 10YR 5/4, 2.5Y 5/6, Massive, 30% orange mottles		10YR 5/4, 2.5Y 5/6		
.5							.5
		▨	LIGHT MEDIUM CLAY, 2.5Y 5/6, 2.5Y 5/2, Massive, Moderate plasticity, 40% mottles		2.5Y 5/6, 2.5Y 5/2	1M	
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH9

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.636

Longitude 153.31.145

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▩	CLAY LOAM, 7.5YR 2.5/1 , Weak pedality, medium crumb peds, Organic matter (roots), moist, pH 5		7.5YR 2.5/1		
		▩	CLAY LOAM, 7.5YR 2.5/2 , Weak pedality, medium crumb structure, Moist, abrupt boundary to next layer		7.5YR 2.5/2	4/7M	
.5		▨	HEAVY CLAY, 7.5YR 4/2 , Massive, Charcoal present at 550mm, water seeping into hole at 800mm, pH 4.5		7.5YR 4/2	2M	.5
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH10

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.5511

Longitude 153.31.25

RL(m): _____

GILBERT+SUTHERLAND

agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling Depth (RL) m	Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▦	LOAM, 10YR 2/1 , Weak pedality, medium crumb structure, Organic matter, pH 4.5		10YR 2/1		
		▦	LOAM, 10YR 2/1, 10YR 4/6, Weak pedality, coarse blocky peds, 20% mottles, pH 4.5		10YR 2/1, 10YR 4/6	4/7M	
		▩	CLAY LOAM, Brownish black , Moist, horizon to next layer		10YR2/2		
.5		▨	HEAVY CLAY, 10YR 3/2 , Massive, wet, water in hole at 900, pH 5.0		10YR 3/2	2M	.5
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH11

GILBERT+SUTHERLAND
agriculture - water - environment

Project: GJ0926
Client: Splendour Pty Ltd
Latitude 28.28.645
Longitude 158.31.442
RL(m): _____

Depth (m): 1
Logged by: RJ
Drilled by: Gilbert & Sutherland
Start date:
Completion date:

Depth NSL(m)	Drilling		Soil Description				Depth NSL(m)
	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	
			LOAM, 7.5YR 3/2 , weak pedality, medium subangular peds, organic matter (roots), pH 5.0, gradual boundary to:		7.5YR 3/2	2M	
			LOAM, 7.5 3/1, 7.5YR 7/8, weak pedality, medium subangular peds, 20% charcoal, 10% mottles		7.5 3/1, 7.5YR 7/8	2M	
.5			LIGHT CLAY, 10YR 2/2 , Massive		10YR 2/2		.5
			CLAYEY SILT, 7.5YR 4/2 , Weak pedality, fine crumb structure, 10% orange mottles, pH 5.5		7.5YR 4/2	4/7M	
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH12

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.077

Longitude 153.30.996

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		░	SILTY CLAY LOAM, 2.5YR 2.5/2 , Moderate pedality, polyhedral peds, moist		2.5YR 2.5/2		
		░	SILTY CLAY LOAM, 2.5YR 2.5/2, 10R 4/8, Moderate pedality, polyhedral peds, moist, 3% red mottles		2.5YR 2.5/2, 10R 4/8	4/7M	
.5		▨	LIGHT CLAY, 10YR 5/2, 10R 4/8, Massive (moist), moist, 5% red mottles, charcoal present		10YR 5/2, 10R 4/8	2M	.5
		▧	MEDIUM CLAY, 10YR 6/4, 2.5YR 3/6, Massive (moist), Gravel present, mottles		10YR 6/4, 2.5YR 3/6		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH13

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.056

Longitude 153.30.967

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	LIGHT CLAY, 7.5YR 3/4 , Weak fine crumb, Dry, organic matter (roots)		7.5YR 3/4	3M	
		▨	LIGHT CLAY, 7.5YR 3/4 , Weak fine crumb, Dry, 15% medium/coarse angular gravel		7.5YR 3/4	3M	
.5		▨	MEDIUM CLAY, 7.5YR 3/4 , Moderate, medium subangular, dry, silt fines		7.5YR 3/4	4/7M	.5
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH14

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.0

Longitude 153.30.928

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 0.9

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		░	SILTY CLAY LOAM, 7.5YR 2/5 , Medium polyhedral peds, minor coarse angular gravels, 5% orange mottles, organic matter (roots), biota, silt crumbs 2 - 4mm, gradual change to		7.5YR 2/5	4/7M	
.5		▨	LIGHT MEDIUM CLAY, 10YR 5/4 , Massive (moist), 15% orange mottles, charcoal, cobbles, gradual change to		10YR 5/4		.5
		▨	MEDIUM CLAY, 10YR 5/6 , Massive (moist), orange mottles, cobbles, weathered rock		10YR 5/6	2M	
			, End of bore				
1.0							1.0
1.5							1.5
2.0							2.0

Borehole: BH15

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.352

Longitude 153.31.276

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 2.2

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			LOAM, 7.5YR 2.5/3 , Moderate structure, crumb peds, Organic matter (roots), moist, pH 5		7.5YR 2.5/3	4/7M	
			LOAM, 7.5YR 2.5/3, 10YR 7/8, 8/2, Moderate structure, crumb peds, Mottles, moist, pH 5		7.5YR 2.5/3, 10YR 7/8, 8/2	4/7M	
			CLAY LOAM, 7.5YR 2.5/3, 10YR 7/8, 8/2, Moderate structure, crumb & subangular peds, Charcoal, 50% mottles , moist, pH 5		7.5YR 2.5/3, 10YR 7/8, 8/2		
.5			MEDIUM HEAVY CLAY, 7.5YR 3/1 , Massive, 10% charcoal fines, pH 5		7.5YR 3/1	2M	.5
			HEAVY CLAY, 10YR 4/3, 10YR 4/6, Massive, 30% mottles 10YR 4/6 + charcoal, pH 5		10YR 4/3, 10YR 4/6		
1.0 1.5			HEAVY CLAY, Gley 2.4/5PB, 10YR 6/8, Massive, 10% mottles (dry iron oxide fines), wet, pH 4		Gley 2.4/5PB, 10YR 6/8		1.0 1.5
2.0			MEDIUM HEAVY CLAY, Gley 2 6/5PB , Massive, Sand fines, wet		Gley 2 6/5PB		2.0
			, End of bore				

Borehole: BH16

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.406

Longitude 153.31.606

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 2

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

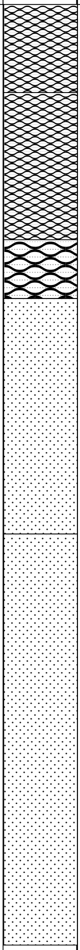
	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			SANDY LOAM, 10YR 2/1 , Weak structure, medium crumb peds, organic matter (roots), moist		10YR 2/1	2M	
			SANDY LOAM, 10YR 2/1, 10YR 4/4, Weak structure, medium subangular peds, Charcoal fines, mulch layer @ 20mm		10YR 2/1, 10YR 4/4	2M	
			CLAY LOAM, 10YR 3/2 , Moderate structure, medium subangular peds, moist		10YR 3/2		
.5			SANDY CLAY , Massive				.5
1.0			SAND, Greyish yellow brown , Massive, wet		10YR 4/2	2M	1.0
1.5			HEAVY CLAY, Gley 1 6/N , Marine clay, massive, wet, sand fines, high plasticity		Gley 1 6/N		1.5
			SAND, 7.5YR 7/1 , Massive, wet		7.5YR 7/1		
2.0			, End of bore				2.0

Borehole: BH17

GILBERT+SUTHERLAND
agriculture - water - environment

Project: GJ0926
Client: Splendour Pty Ltd
Latitude 28.28.133
Longitude 153.31.678
RL(m): _____

Depth (m): 1.6
Logged by: RJ
Drilled by: Gilbert & Sutherland
Start date: ☐
Completion date: ☐



Depth NSL(m)	Drilling Depth (RL) m	Drilling Graphic log	Soil Description Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			CLAY LOAM, 2.5YR 2.5/1 , Moderate structure, coarse crumb peds, organic matter, moist		2.5YR 2.5/1	2M	
			CLAY LOAM, 5YR 2.5/1 , Moderate structure, coarse crumb peds, mulch pieces and sand fines		5YR 2.5/1	2M	
			SANDY CLAY LOAM, 7.5YR 3/1 , Moderate structure, medium polyhedral peds		7.5YR 3/1		
.5			SAND, 7.5YR 5/2 , Massive, moist		7.5YR 5/2	2M	.5
1.0 1.5			SAND, 7.5YR 5/2 , Massive, wet		7.5YR 5/2		1.0 1.5
2.0			, End of bore				2.0

Borehole: BH18

GILBERT+SUTHERLAND
agriculture - water - environment

Project: GJ0926
Client: Splendour Pty Ltd
Latitude 28.28.398
Longitude 153.31.427
RL(m): _____

Depth (m): 1
Logged by: RJ
Drilled by: Gilbert & Sutherland
Start date: ☐
Completion date: ☐

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		░	SILTY CLAY LOAM, 7.5YR 2.5/1 , Moderate structure, medium crumb & polyhedral peds		7.5YR 2.5/1	2M	
		░	SILTY CLAY LOAM, 7.5YR 2.5/1 , Moderate structure, coarse polyhedral peds, pH 5		7.5YR 2.5/1	2M	
		▨	MEDIUM CLAY, 5YR 4/1 , Massive, wet		5YR 4/1		
.5		▨	MEDIUM CLAY, 5YR 4/1, 5YR 5/8, Massive, wet, sand fines, 10% mottles at .80, pH 5		5YR 4/1, 5YR 5/8	2M	.5
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH19

GILBERT+SUTHERLAND
agriculture - water - environment

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.28.260

Longitude 153.31.352

RL(m): _____

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▩	LOAM, 7.5YR 3/1 , Moderate structure, coarse crumb peds, organic matter (roots)		7.5YR 3/1	2M	
		▩	LOAM, 10YR 6/6, 10YR 6/6, Moderate, coarse crumb, 40% mottles (silt fines), pH 5		10YR 6/6, 10YR 6/6	2M	
		▩	LOAM, 10YR 6/6 , Moderate, coarse crumb, organics (bark mulch)		10YR 6/6		
.5		▨					.5
		▨	MEDIUM CLAY, 10YR 6/2 , Massive, 10% orange mottles, 5% charcoal traces, pH 4.5		10YR 6/2	2M	
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH20

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.26.41

Longitude 153.30.19

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▨	LOAM, 7.5YR 2.5/1 , Moderate structure, fine/med crumb, organic matter (roots), moist		7.5YR 2.5/1	2M	
		▨	CLAY LOAM, 7.5YR 2.5/1 , Moderate structure, subangular blocky, sand fines, organic matter		7.5YR 2.5/1	2M	
		▨	SANDY CLAY LOAM, 5YR 4/1 , Massive, wet		5YR 4/1		
.5							.5
		▨	SAND, 5YR 5/2 , Massive, wet		5YR 5/2		
1.0			, End of bore				1.0
1.5							1.5
2.0							2.0

Borehole: BH21

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.26.46

Longitude 153.30.19

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1

Logged by: RJ

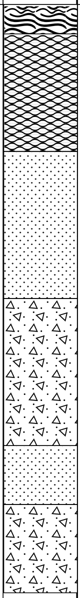
Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Drilling

Soil Description



Depth NSL(m)	Depth (RL) m	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		SILTY LOAM, 10YR 2/2 , Medium crumb/polyhedral, organic matter (roots)		10YR 2/2		
		CLAY LOAM, 2.5Y 2.5/1 , Moderate structure, medium subangular peds, moist		2.5Y 2.5/1	2M	
		SAND, 10YR 5/2 , Massive, moist		10YR 5/2	2M	
.5						.5
		CLAYEY SAND, 7.5YR 2.5/3 , Massive, wet		7.5YR 2.5/3		
		SAND, 10YR 5/2 , Massive, wet		10YR 5/2		
		CLAYEY SAND, 7.5YR , Coherent sand, wet		7.5YR		
1.0		, End of bore				1.0
1.5						1.5
2.0						2.0

Borehole: BH22

Project: GJ0926

Client: Splendour Pty Ltd

Latitude 28.29.50

Longitude 153.32.1

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

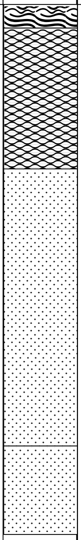
Depth (m): 0.9

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling		Soil Description				Depth NSL(m)
	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	
			SILTY LOAM, 10YR 2/2 , Moderate struct, coarse crumb/med polyhedral peds, organics & biota		10YR 2/2		
			CLAY LOAM, 10YR 2/2 , Moderate, medium polyhedral peds, tree bark mulch (orange) & charcoal		10YR 2/2	2M	
.5			SAND, 7.5YR 6/2 , Massive structure, moist		7.5YR 6/2	2M	.5
			SAND, 7.5YR 4/2 , Massive structure, wet		7.5YR 4/2		
			, End of bore				
1.0							1.0
1.5							1.5
2.0							2.0

Borehole: **BH23**

Project: GJ0926

Client: Splendour Pty Ltd

Latitude ____________

Longitude ____________

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

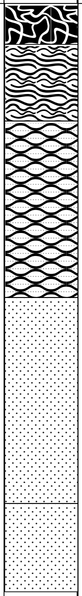
Depth (m): 1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐



Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			LOAM, 5YR 2.5/1 , Mod/strong structure, medium crumb peds, organics & biota		5YR 2.5/1	2M	
			SILTY LOAM, 5YR 2.5/1 , Coarse crumb peds, Red bark mulch, clear boundary to:		5YR 2.5/1	2M	
			SANDY CLAY LOAM, 5YR 2.5/1 , Subangular peds, sand fines		5YR 2.5/1	2M	
.5			SAND, 5YR 6/1 , Massive, moist, 5% charcoal, clay pieces		5YR 6/1		.5
			SAND, 5YR 4/2 , Massive, wet		5YR 4/2		
1.0							1.0
1.5							1.5
2.0							2.0

Borehole: BH24

Project: GJ0926

Client: Splendour Pty Ltd

Latitude ____________

Longitude ____________

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

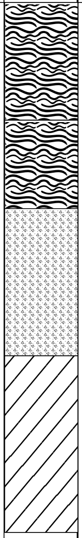
Depth (m): 0.9

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date:

Completion date:

	Drilling		Soil Description				
Depth NSL(m)	Depth (RL) m	Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
			SILTY LOAM, 10YR 2/1 , Moderate structure, fine crumb peds, organics, pH 5.5		10YR 2/1	2M	
			SILTY LOAM, 10YR 3/2 , Medium subangular peds		10YR 3/2		
.5			SILTY CLAY LOAM, 2.5Y 3/1 , Massive,wet/moist, mulch 2%, sand fines, pH 5		2.5Y 3/1	2M	.5
			MEDIUM CLAY, 5YR 2.5/1 , Massive, wet		5YR 2.5/1		
			, End of bore				
1.0							1.0
1.5							1.5
2.0							2.0

Borehole: **BH25**

Project: GJ0926

Client: Splendour Pty Ltd

Latitude ____________

Longitude ____________

RL(m): _____

GILBERT+SUTHERLAND
agriculture - water - environment

Depth (m): 1.1

Logged by: RJ

Drilled by: Gilbert & Sutherland

Start date: ☐

Completion date: ☐

Depth NSL(m)	Drilling: Depth (RL) m	Drilling: Graphic log	Soil Description (as per McDonald et.al1990)	Aust. Soil Class.	Colour	Emerson Class	Depth NSL(m)
		▒	SILTY CLAY LOAM, 10YR 6/4 , Weak medium crumb		10YR 6/4		
.5		▨	LIGHT CLAY, 7.5YR 6/6 , Moderate, polyhedral 4		7.5YR 6/6		.5
		▨	LIGHT CLAY, 2.5Y 7/6 , Massive, 20% orange mottles		2.5Y 7/6 10YR 6/4 7.5YR 6/6 2.5 7/6		
1.0			, End of bore SILTY CLAY LOAM, 10YR 6/4 , Weak structure, crumb peds, dry LIGHT CLAY, 7.5YR 6/6 , Medium structure, med polyhedral peds, dry LIGHT CLAY, 2.5 7/6 , Massive structure, 20-25% orange mottles, dry				1.0
1.5							1.5
2.0							2.0

13) Appendix 2 – Soil permeability results

Permeability Results

Constant head permeameter

Project	North Byron Park-Splendour in the Grass	**Location**	Southern Site area (GW1/PBH1)
Site description	North Byron Parklands		
Tested by	NJG, ND	**Date**	31-Mar-10

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.7	
Depth (m) of water in hole	0.5	
Hole diameter (mm)	90	
Depth (m) to imperm. layer		

	Test 1	Test 2
Source of test water	tap	
Est. salinity (mg/L) of test water		
Est. SAR of test water		

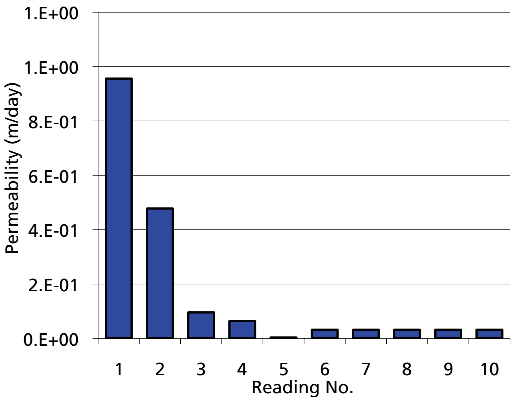
TEST 1

Depth interval (m) tested 0.2 to 0.7

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.3	1	3.0E-01	9.6E-01
2	0.15	1	1.5E-01	4.8E-01
3	0.03	1	3.0E-02	9.6E-02
4	0.02	1	2.0E-02	6.4E-02
5	0.001	1	1.0E-03	3.2E-03
6	0.01	1	1.0E-02	3.2E-02
7	0.01	1	1.0E-02	3.2E-02
8	0.01	1	1.0E-02	3.2E-02
9	0.01	1	1.0E-02	3.2E-02
10	0.01	1	1.0E-02	3.2E-02



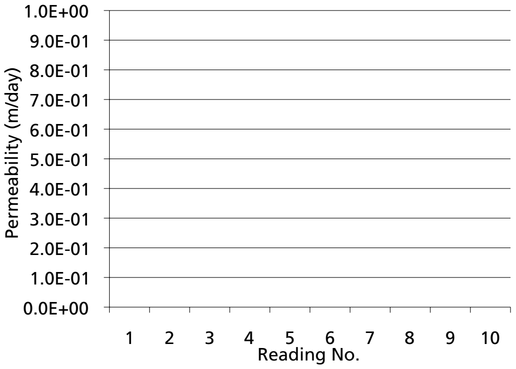
TEST 2

Depth interval (m) tested to

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



Note: Permeability $K = 4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^2+0.25]^{0.5}+(r/H)\}/2piH^2$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use K = 3Qln[H/r]/piH(2H+3S).

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project Splendour in the Grass

Location Northern basin next to GW3 (PBH3)

Site description North Byron Parklands

Tested by NJG, ND

Date 31.3.10

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.8	
Depth (m) of water in hole	0.6	
Hole diameter (mm)	90	
Depth (m) to imperm. layer		

	Test 1	Test 2
Source of test water		
Est. salinity (mg/L) of test water		
Est. SAR of test water		

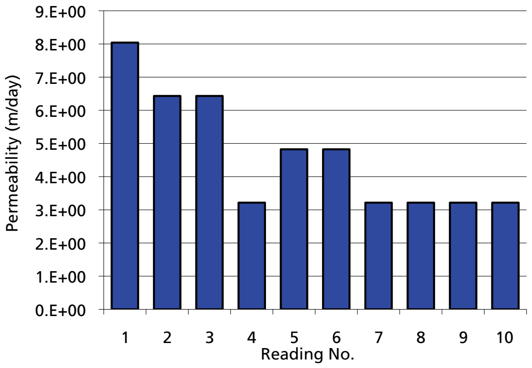
TEST 1

Depth interval (m) tested 0.2 to 0.8

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.8	0.5	1.6E+00	3.9E+00
2	0.2	0.5	4.0E-01	9.7E-01
3	0.05	0.5	1.0E-01	2.4E-01
4	0.15	1	1.5E-01	3.6E-01
5	0.1	1	1.0E-01	2.4E-01
6	0.2	1	2.0E-01	4.9E-01
7	0.1	1	1.0E-01	2.4E-01
8	0.15	1	1.5E-01	3.6E-01
9	0.15	1	1.5E-01	3.6E-01
10	0.1	1	1.0E-01	2.4E-01



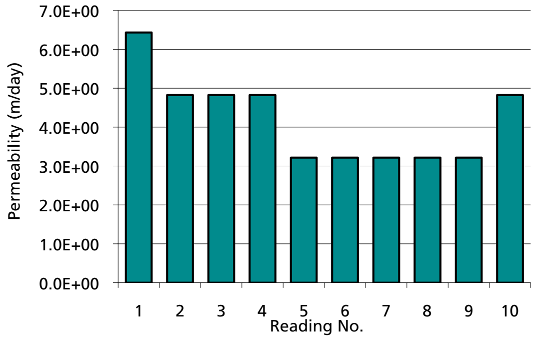
TEST 2

Depth interval (m) tested to

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



Note: Permeability K = $4.4Q\{\sinh^{-1}(H/2r)-[(r/H)^{2}+0.25]^{0.5}+(r/H)\}/2piH^{2}$ where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use K = 3Qln[H/r]/piH(2H+3S).

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

Permeability Results

Constant head permeameter

Project Splendour in the Grass

Location Northern Rige (BH14/PBH2)

Site description North Byron Parklands

Tested by NJG, ND

Date 31-Mar-10

Test hole geometry

	Test 1	Test 2
Hole depth (m)	0.6	
Depth (m) of water in hole	0.4	
Hole diameter (mm)	90	
Depth (m) to imperm. layer		

	Test 1	Test 2
Source of test water		
Est. salinity (mg/L) of test water		
Est. SAR of test water		

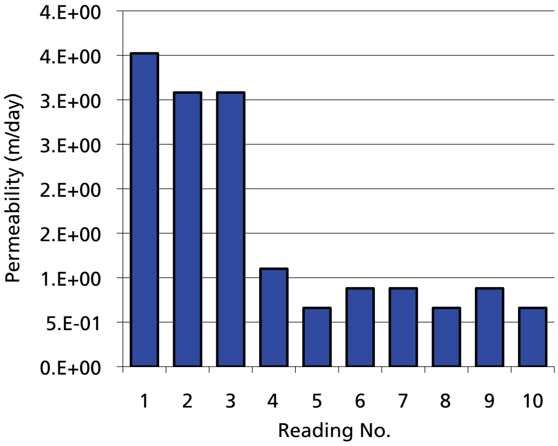
TEST 1

Depth interval (m) tested 0.2 to 0.6

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1	0.4	0.5	8.0E-01	3.5E+00
2	0.35	0.5	7.0E-01	3.1E+00
3	0.35	0.5	7.0E-01	3.1E+00
4	0.25	1	2.5E-01	1.1E+00
5	0.15	1	1.5E-01	6.6E-01
6	0.2	1	2.0E-01	8.8E-01
7	0.2	1	2.0E-01	8.8E-01
8	0.15	1	1.5E-01	6.6E-01
9	0.2	1	2.0E-01	8.8E-01
10	0.15	1	1.5E-01	6.6E-01



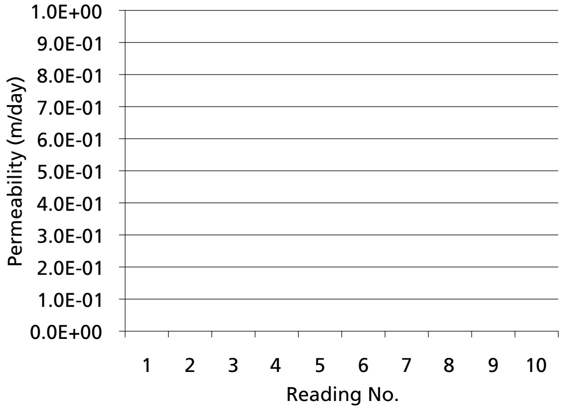
TEST 2

Depth interval (m) tested to

Test duration (mins)

Soil type tested

Reading No.	Water infiltrated (L)	Time to infiltrate (min)	Infiltrat. rate (L/min)	Perme-ability (m/day)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				



Note: Permeability K = 4.4Q{sinh^{-1}(H/2r)-[(r/H)^2+0.25]$^{0.5}$+(r/H)}/2piH^2 where Q = infiltration rate, H = depth of water in test hole, r = hole radius and pi = 3.1416. H should be in the range 5r to 10r. See Australian/New Zealand Standard 1547: 2000 *On-site domestic-wastewater management.* Appendix 4.1F.

If an impermeable layer is at depth S no more than 2H below the base of the test hole, use K = 3Qln[H/r]/piH(2H+3S).

See Talsma, T. and Hallam, P. (1980): Hydraulic Conductivity Measurement of Forest Catchments. *Australian Journal of Soil Research* 30, pp 139-148.

14) Appendix 3 – SOILOSS output

```
***********************************************************************
*************************** SOILOSS USER ******************************
***********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

=======================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010        Time : 14:06               Report Number :  1
-----------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1        R = 7000
Soil Erodibility  : User supplied                        K = 0.040
Topography        :Slope:  2.5%  Slope Length:  30 m   LxS = 0.327
Support Practice  : No cultivation (P = 1)               P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)                C = 1.0000

                    Long-term average annual soil loss: A =  91  t/ha
-----------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
-----------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


***********************************************************************
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**********************************************************************
*************************** SOILOSS USER *****************************
**********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

======================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010        Time : 14:09              Report Number :  2
----------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1       R = 7000
Soil Erodibility  : User supplied                       K = 0.040
Topography        :Slope:  2.5%  Slope Length: 100 m   LxS = 0.458
Support Practice  : No cultivation (P = 1)              P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)               C = 1.0000

                    Long-term average annual soil loss: A = 128  t/ha
----------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
----------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


**********************************************************************
```

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**********************************************************************
*************************** SOILOSS USER *****************************
**********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

======================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010        Time : 14:10              Report Number :  3
----------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1       R = 7000
Soil Erodibility  : User supplied                       K = 0.040
Topography        :Slope:  5.0%  Slope Length:  30 m   LxS = 0.643
Support Practice  : No cultivation (P = 1)              P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)               C = 1.0000

                    Long-term average annual soil loss: A = 180  t/ha
----------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
----------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


**********************************************************************
```

```
**********************************************************************
*************************** SOILOSS USER *****************************
**********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

======================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010        Time : 14:11              Report Number :  4
----------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1       R = 7000
Soil Erodibility  : User supplied                       K = 0.040
Topography        :Slope:  5.0%  Slope Length: 100 m   LxS = 1.042
Support Practice  : No cultivation (P = 1)              P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)               C = 1.0000

                    Long-term average annual soil loss: A = 292  t/ha
----------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
----------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


**********************************************************************
```

```
*********************************************************************
************************** SOILOSS USER *****************************
*********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

=====================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010        Time : 14:11           Report Number :  5
---------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1       R = 7000
Soil Erodibility  : User supplied                       K = 0.040
Topography        :Slope: 10.0%  Slope Length:  30 m   LxS = 1.368
Support Practice  : No cultivation (P = 1)              P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)               C = 1.0000

                    Long-term average annual soil loss: A = 383  t/ha
---------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
---------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


*********************************************************************
```

```
**********************************************************************
*************************** SOILOSS USER *****************************
**********************************************************************
                       SOIL LOSS ESTIMATION

The computer program, SOILOSS, uses the procedures of the Universal
Soil Loss Equation (USLE) to predict the average annual soil loss due
to sheet and rill erosion. It is based on extensive research in the
United States and by the Soil Conservation Service in New South Wales.

The following report was prepared by SOILOSS:

======================================================================
Estimation prepared for : GJ0826
Date : 12-05-2010       Time : 14:11              Report Number :  6
----------------------------------------------------------------------
                    A = R x K x L x S x P x C

Rainfall Erosivity:             Rainfall Zone:  1       R = 7000
Soil Erodibility  : User supplied                       K = 0.040
Topography        :Slope: 10.0%  Slope Length: 100 m   LxS = 2.552
Support Practice  : No cultivation (P = 1)              P = 1.000
Management        :
              Rotation :
          Cultivations :
          Stubble Mgmt :Urban land (bare)               C = 1.0000

                    Long-term average annual soil loss: A = 715  t/ha
----------------------------------------------------------------------
Soil Loss Targets :

There is very little information to indicate target levels of soil
loss for Australian soils. The following are suggested as a guide:

          Very deep and fertile soils                 <10 t/ha.a
               Moderately deep and fertile soils      <5  t/ha.a
                    Shallow or infertile soils        <1  t/ha.a
----------------------------------------------------------------------
Management Options :

To reduce soil loss:
*  Provide some cover.


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```

15) Appendix 4 – Laboratory certificates for soil analysis

SGS Agritech
214 McDougall Street
Toowoomba QLD 4350
t +61 (0)7 4633 0599
f +61 (0)7 4633 0711
e au.agritech.twb@sgs.com

Report of Analysis

TW10-03320

Client:
GILBERT & SUTHERLAND ROBINA
PO BOX 4115

ROBINA
4230

Page 1/4

Order Number: GJ0870-1

Report Date: 12-May-2010
Received Date: 21-April-2010

Analysis	**U.M.**	**TW10-03320.001** **BH 0-0.2** **Soil**	**TW10-03320.002** **BH1 0.2-1.0** **Soil**	**TW10-03320.003** **BH2 0-0.2** **Soil**	**TW10-03320.004** **BH2 0.2-1.0** **Soil**
Phosphate Phosphorus	mg/kg	<65	<65	<65	<65
Nitrite Nitrogen	mg/kg	<1	<1	<1	<1
Total Kjeldahl Nitrogen	mg/kg	4178	1590	4826	3469
ACIDITY					
pH - CaCl2	pH units	4.67	4.62	4.96	4.78
pH - Water	pH units	5.19	4.99	5.65	5.50
MAJOR ELEMENTS					
Potassium	mg/kg	140	50	185	74
Phosphorus - Colwell extr	mg/kg	6	4	6	4
Nitrate Nitrogen	mg/kg	6	1	5	3
Nitrogen	mg/kg	4184	1591	4831	3472
SECONDARY ELEMENTS					
Calcium	mg/kg	243	49	958	172
Magnesium	mg/kg	120	59	263	92
Aluminium	mg/kg	68	33	-	49
SALINITY					
Electrical Conductivity	dS/m	0.08	0.05	0.08	0.05
Sodium	mg/kg	27	11	34	25
EXCHANGEABLE CATIONS					
Calcium/Magnesium Ratio		1.22	0.50	2.19	1.12
Cation Exchange	meq/100g	3.45	1.28	7.60	2.47
Exchangeable Aluminium	meq/100g	0.76	0.37	Not Applicable	0.55
Exchangeable Aluminium Percent	%	22.0	28.8	Not Applicable	22.2
Exchangeable Calcium	meq/100g	1.21	0.25	4.79	0.86
Exchangeable Calcium Percent	%	35.2	19.2	63.0	34.7
Exchangeable Magnesium	meq/100g	1.00	0.49	2.19	0.77
Exchangeable Magnesium Percent	%	28.9	38.1	28.8	31.1
Exchangeable Potassium	meq/100g	0.36	0.13	0.48	0.19
Exchangeable Potassium Percent	%	10.4	10.0	6.3	7.7
Exchangeable Sodium	meq/100g	0.12	0.05	0.15	0.11
Exchangeable Sodium Percent	%	3.4	3.9	2.0	4.3
OTHER					
Equilibrium P Concentration	µg/mL	-	-	-	-
P Buffer Capacity		-	-	-	-
Phosphorus	%	0.092	0.067	0.097	0.083

Report of Analysis

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TW10-03320

Analysis	**U.M.**	TW10-03320.005 BH3 0-0.2 Soil	TW10-03320.006 BH3 0.2-0.70 Soil	TW10-03320.007 BH4 0.1-0.25 Soil	TW10-03320.008 BH4 0.25-0.65 Soil
Phosphate Phosphorus	mg/kg	<65	<65	<65	<65
Nitrite Nitrogen	mg/kg	<1	<1	<1	<1
Total Kjeldahl Nitrogen	mg/kg	4890	2353	2407	1394
ACIDITY					
pH - CaCl2	pH units	4.89	4.75	4.90	5.02
pH - Water	pH units	5.36	5.63	5.60	5.65
MAJOR ELEMENTS					
Potassium	mg/kg	194	68	113	47
Phosphorus - Colwell extr	mg/kg	11	3	3	3
Nitrate Nitrogen	mg/kg	4	2	2	1
Nitrogen	mg/kg	4894	2355	2409	1396
SECONDARY ELEMENTS					
Calcium	mg/kg	1061	214	478	355
Magnesium	mg/kg	176	93	111	64
Aluminium	mg/kg	22	-	-	-
SALINITY					
Electrical Conductivity	dS/m	0.33	0.05	0.04	0.03
Sodium	mg/kg	47	31	21	24
EXCHANGEABLE CATIONS					
Calcium/Magnesium Ratio		3.62	1.38	2.60	3.30
Cation Exchange	meq/100g	7.72	2.15	3.69	2.54
Exchangeable Aluminium	meq/100g	0.25	Not Applicable	Not Applicable	Not Applicable
Exchangeable Aluminium Percent	%	3.2	Not Applicable	Not Applicable	Not Applicable
Exchangeable Calcium	meq/100g	5.30	1.07	2.39	1.77
Exchangeable Calcium Percent	%	68.7	49.7	64.8	70.0
Exchangeable Magnesium	meq/100g	1.46	0.78	0.92	0.54
Exchangeable Magnesium Percent	%	19.0	36.1	24.9	21.2
Exchangeable Potassium	meq/100g	0.50	0.17	0.29	0.12
Exchangeable Potassium Percent	%	6.5	8.0	7.8	4.7
Exchangeable Sodium	meq/100g	0.21	0.13	0.09	0.10
Exchangeable Sodium Percent	%	2.7	6.2	2.5	4.1
OTHER					
Equilibrium P Concentration	µg/mL	-	-	-	-
P Buffer Capacity		-	-	-	-
Phosphorus	%	0.13	0.076	0.089	0.078

Results are on an 'air dried' basis.
Remaining results to follow

Analysed Between 21/04/2010 - 11/05/2010

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Report of Analysis

TW10-03320

Method of Analysis

Analysis	U.M.	Det.Lim.	Method
Electrical Conductivity	dS/m	0.01	SOL003/SOL001/2
pH - CaCl2	pH units	0.01	SOL003/SOL001/2
pH - Water	pH units	0.01	SOL003/SOL001/2
Calcium	mg/kg	1	SOL044
Calcium/Magnesium Ratio		0.01	SOL044
Cation Exchange	meq/100g	0.01	SOL044
Exchangeable Aluminium	meq/100g	0.01	SOL044
Exchangeable Aluminium Percent	%	0.1	SOL044
Exchangeable Calcium	meq/100g	0.01	SOL044
Exchangeable Calcium Percent	%	0.1	SOL044
Exchangeable Magnesium	meq/100g	0.01	SOL044
Exchangeable Magnesium Percent	%	0.1	SOL044
Exchangeable Potassium	meq/100g	0.01	SOL044
Exchangeable Potassium Percent	%	0.1	SOL044
Exchangeable Sodium	meq/100g	0.01	SOL044
Exchangeable Sodium Percent	%	0.1	SOL044
Magnesium	mg/kg	1	SOL044
Potassium	mg/kg	1	SOL044
Sodium	mg/kg	1	SOL044
Equilibrium P Concentration	µg/mL	20.0	SOL027
P Buffer Capacity		0.50	SOL027
Phosphorus - Colwell extr	mg/kg	1	SOL005/001/4
Phosphate Phosphorus	mg/kg	65	ANL001
Nitrite Nitrogen	mg/kg	1	ANL001
Nitrate Nitrogen	mg/kg	1	SOL030
Nitrogen	mg/kg	10	PRN002
Total Kjeldahl Nitrogen	mg/kg	1	
Phosphorus	%	0.010	MIN001
Aluminium	mg/kg	1	SOL002/1-2

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Report of Analysis

TW10-03320

The analyses presented in the report refer exclusively to the samples analysed.

The presented report can only be reproduced in its entirety.

TDelFabbro

Tabatha Del Fabbro - Section Head

For and on behalf of SGS Australia Pty Ltd

P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.001 **Marking:** BH 0-0.2

Colwell P mg/kg	5.86

$$\text{P Sorbed} = a \times \text{Equilibrium P Conc.}^{b}$$

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
50	0.948	5	0.095	54.91	105.09
100	1.319	10	0.132	104.54	146.78
250	1.396	25	0.140	254.46	155.46
500	2.785	50	0.279	503.07	312.64
750	4.002	75	0.400	751.86	451.17
1000	14.155	100	1.415	991.71	1619.96

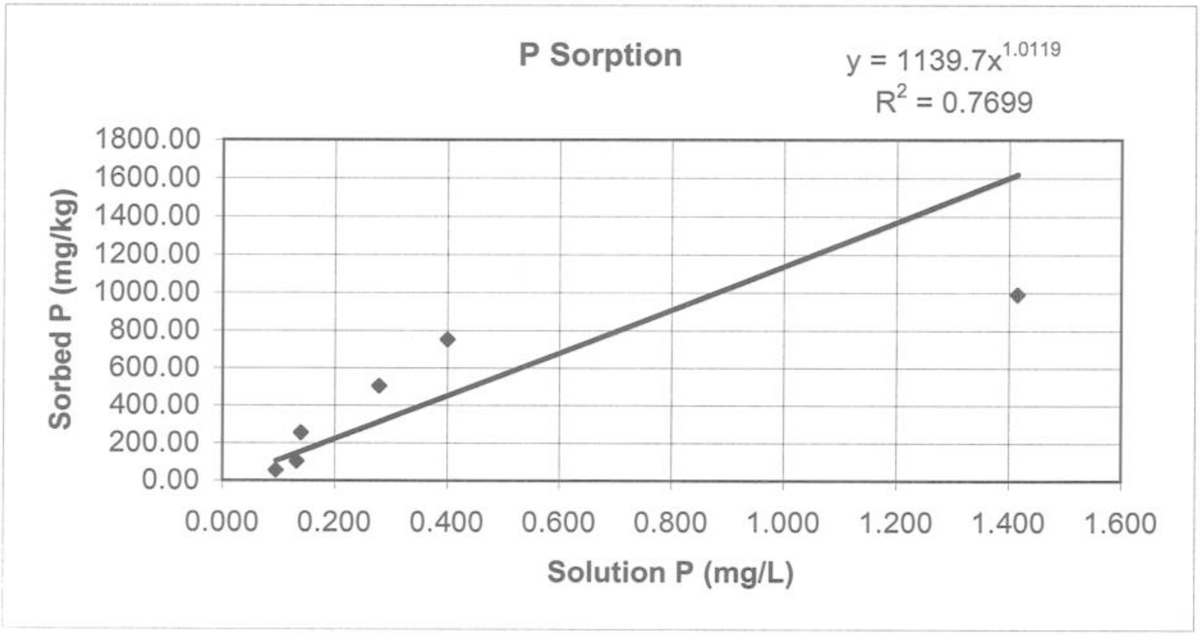
a	1139.740
b	1.012
R^2	0.877

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

565	1140	5809	11715	23623	59707



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.002 **Marking:** BH1 0.2-1.0

Colwell P mg/kg	3.59

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
10	0.267	1	0.027	13.32	38.23
25	0.288	2.5	0.029	28.30	43.76
50	0.350	5	0.035	53.24	62.20
100	0.436	10	0.044	103.15	92.09
250	0.485	25	0.049	253.10	111.78
500	0.528	50	0.053	503.06	130.13
750	1.399	75	0.140	752.19	747.15
1000	2.358	100	0.236	1001.23	1906.71

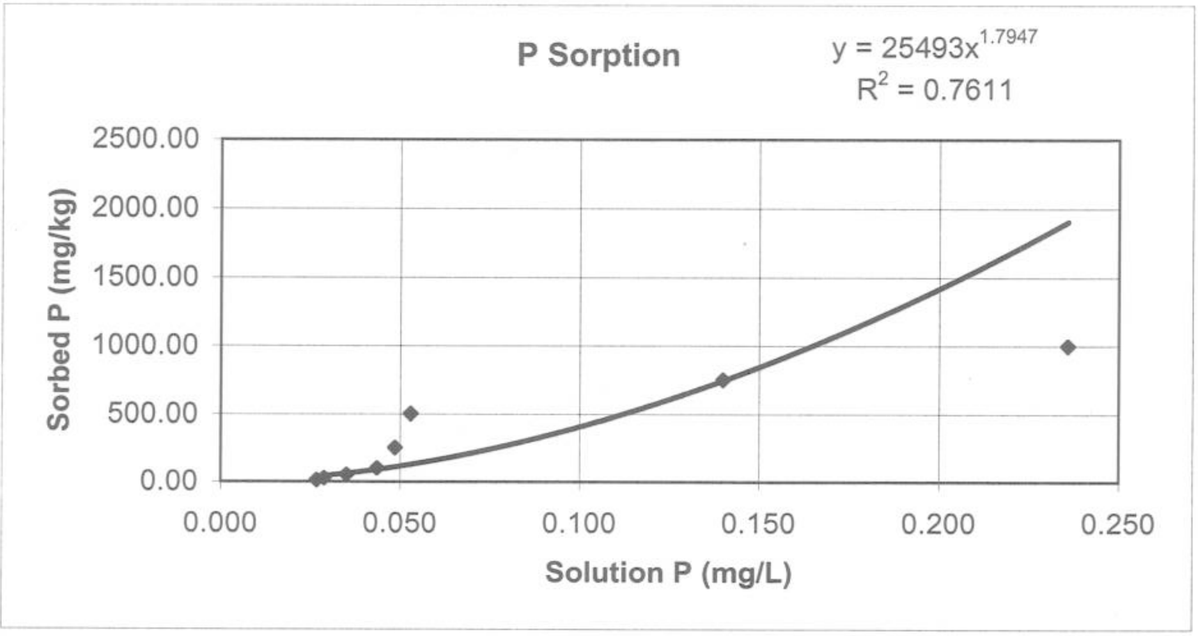
a	25492.824
b	1.795
R^2	0.872

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

7348	25493	457999	1589006	5512978	28547768



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.003 **Marking:** BH2 0-0.2

Colwell P mg/kg	6.14

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
10	2.094	1	0.209	14.05	15.69
25	2.510	2.5	0.251	28.63	21.91
50	4.284	5	0.428	51.86	58.65
250	10.271	25	1.027	245.87	293.62
500	15.173	50	1.517	490.97	602.41
750	15.677	75	1.568	740.46	639.80
1000	17.787	100	1.779	988.35	807.30

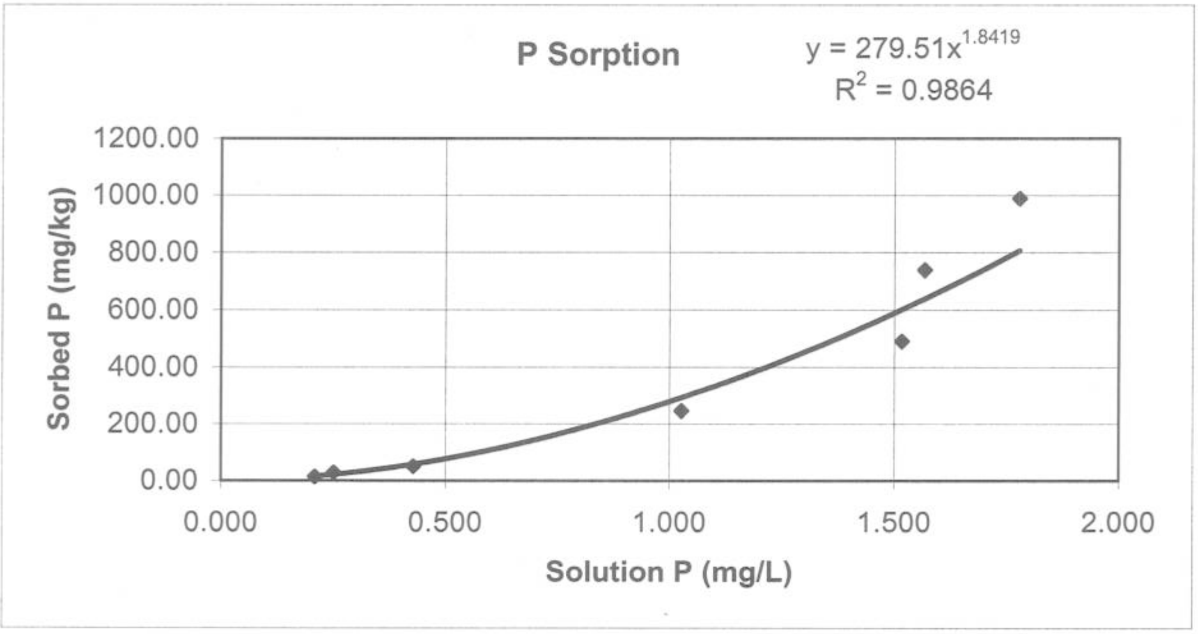
a	279.510
b	1.842
R^2	0.993

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

78	280	5418	19421	69619	376427



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.004 **Marking:** BH2 0.2-1.0

Colwell P mg/kg	3.59

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
100	0.366	10	0.037	103.22	125.75
250	0.805	25	0.081	252.78	221.00
500	1.994	50	0.199	501.60	422.42
750	4.017	75	0.402	749.57	696.88
1000	8.527	100	0.853	995.06	1193.28

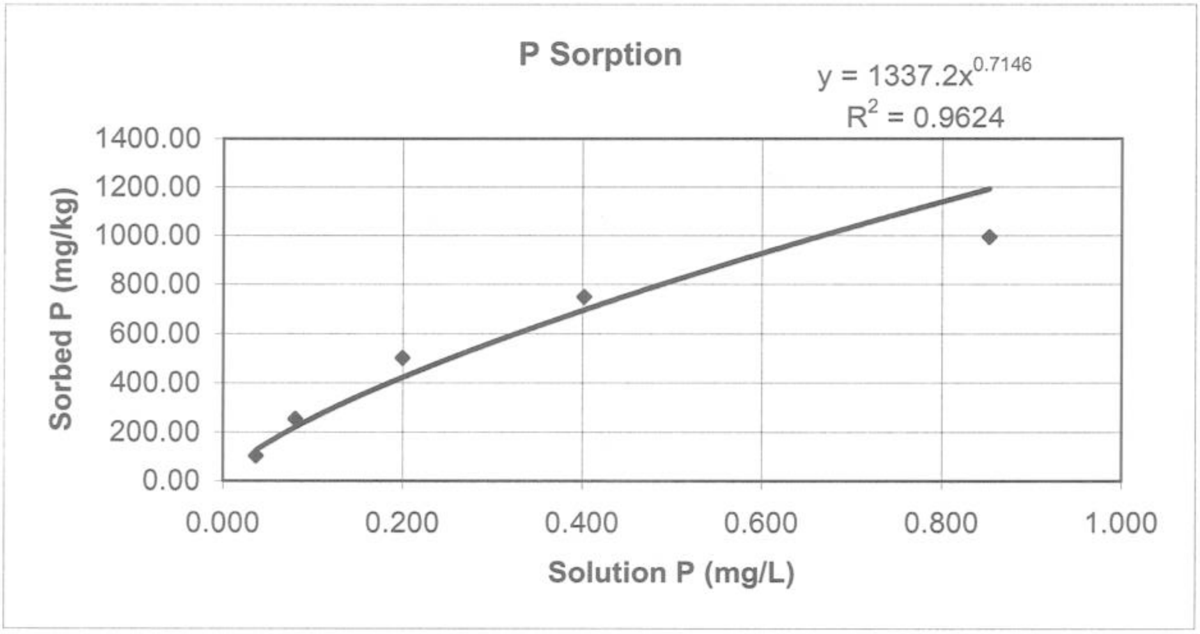
a	1337.174
b	0.715
R^2	0.981

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

815	1337	4224	6931	11374	21893



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.005 **Marking:** BH3 0-0.2

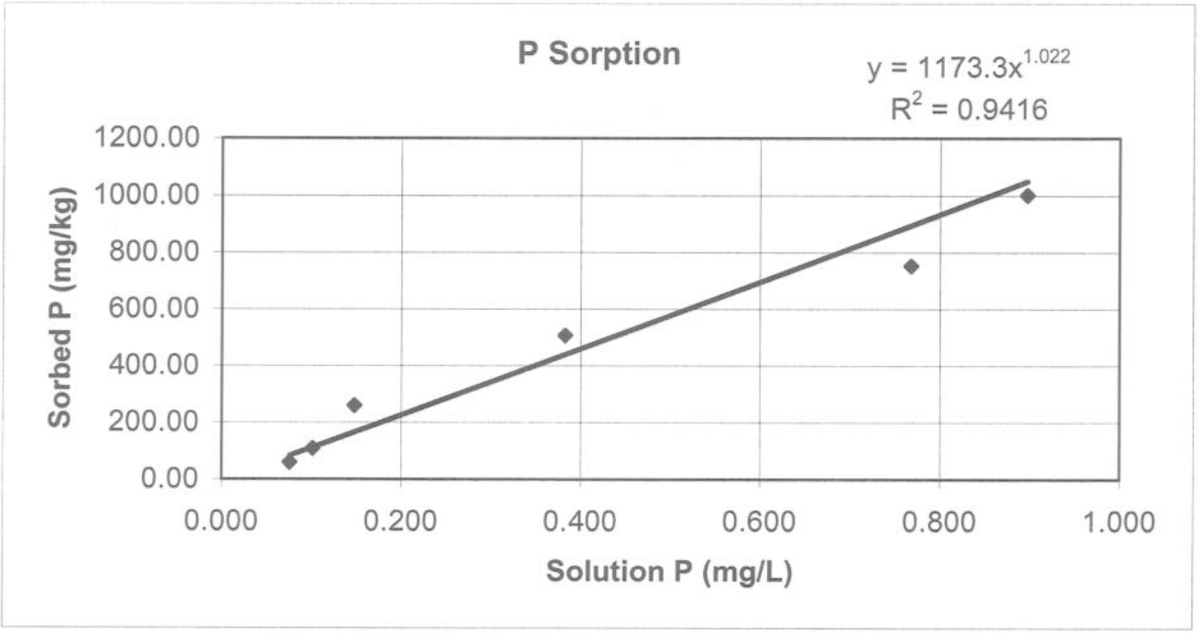
Colwell P mg/kg	10.69

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
50	0.755	5	0.076	59.93	83.73
100	1.014	10	0.101	109.68	113.08
250	1.479	25	0.148	259.21	166.34
500	3.827	50	0.383	506.86	439.58
750	7.680	75	0.768	753.01	895.92
1000	8.972	100	0.897	1001.72	1050.21

a	1173.281
b	1.022
R^2	0.970

Equilibrium P Concentration mg/L					
0.5	1	5	10	20	50
P Sorbed mg/kg Estimated					
578	1173	6078	12342	25062	63928



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.006 **Marking:** BH3 0.2-0.70

Colwell P mg/kg	2.86

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
50	0.266	5	0.027	52.59	65.70
100	0.300	10	0.030	102.56	75.64
250	0.947	25	0.095	251.91	296.97
750	1.971	75	0.197	750.89	710.49
1000	2.568	100	0.257	1000.29	973.32

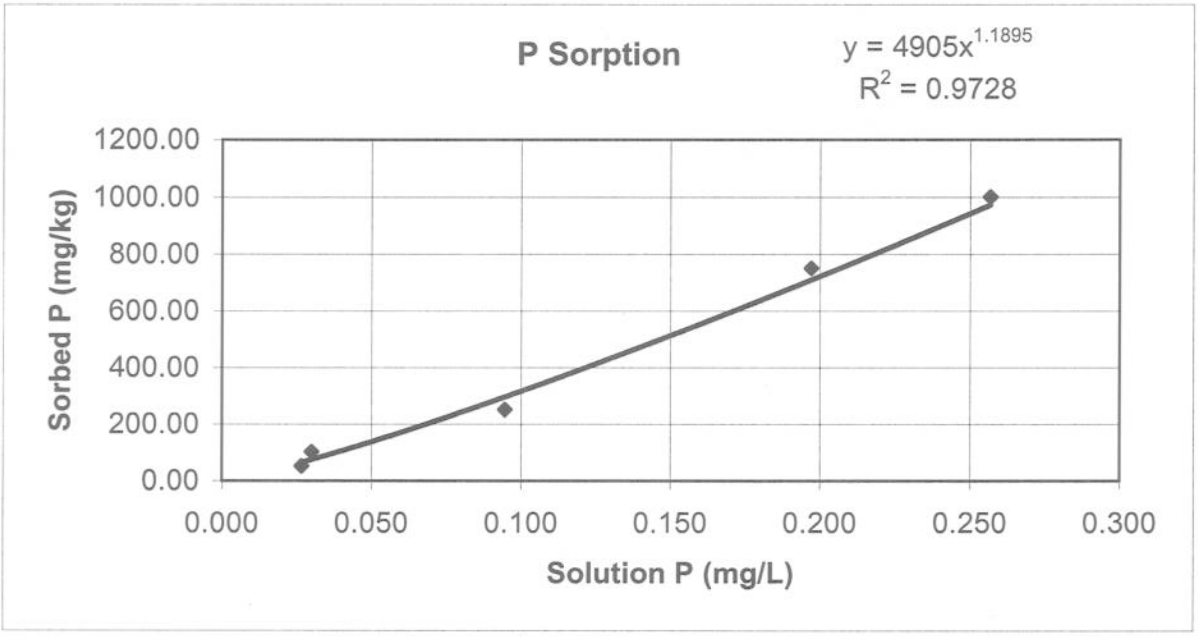
a	4905.003
b	1.190
R^2	0.986

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

2151	4905	33272	75887	173081	514766



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.007 **Marking:** BH4 0.1-0.25

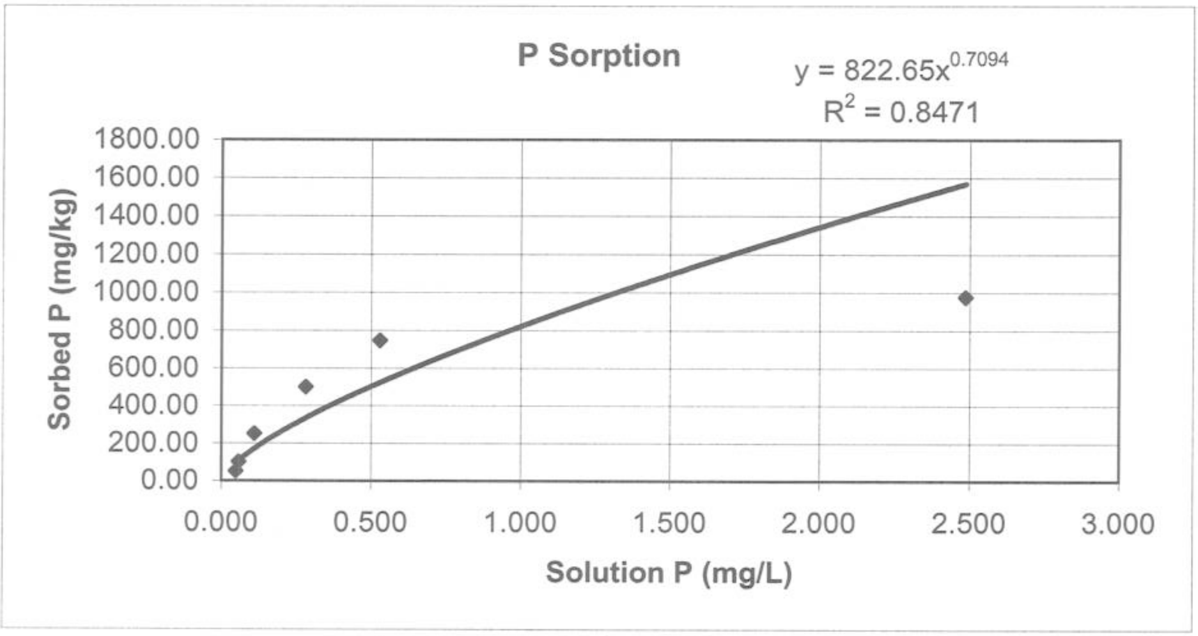
Colwell P mg/kg	2.89

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
50	0.481	5	0.048	52.41	95.63
100	0.580	10	0.058	102.31	109.18
250	1.101	25	0.110	251.79	172.00
500	2.810	50	0.281	500.08	334.29
750	5.292	75	0.529	747.60	523.76
1000	24.868	100	2.487	978.02	1569.91

a	822.645
b	0.709
R^2	0.920

Equilibrium P Concentration mg/L					
0.5	1	5	10	20	50
P Sorbed mg/kg Estimated					
503	823	2577	4213	6889	13196



P ISOTHERM RESULTS

Client: Gilbert & Sutherland Robina
Laboratory No: TW10-03320.008 **Marking:** BH4 0.25-0.65

Colwell P mg/kg	3.37

P Sorbed = a x Equilibrium P Conc.^{b}

Initial P mg/kg	Final P mg/kg	Initial P mg/L	Final P mg/L	P Sorbed mg/kg	P Sorbed Estimated
50	0.306	5	0.031	53.06	86.94
100	0.309	10	0.031	103.06	88.14
250	0.536	25	0.054	252.83	167.71
750	1.736	75	0.174	751.63	661.48
1000	2.937	100	0.294	1000.43	1223.03

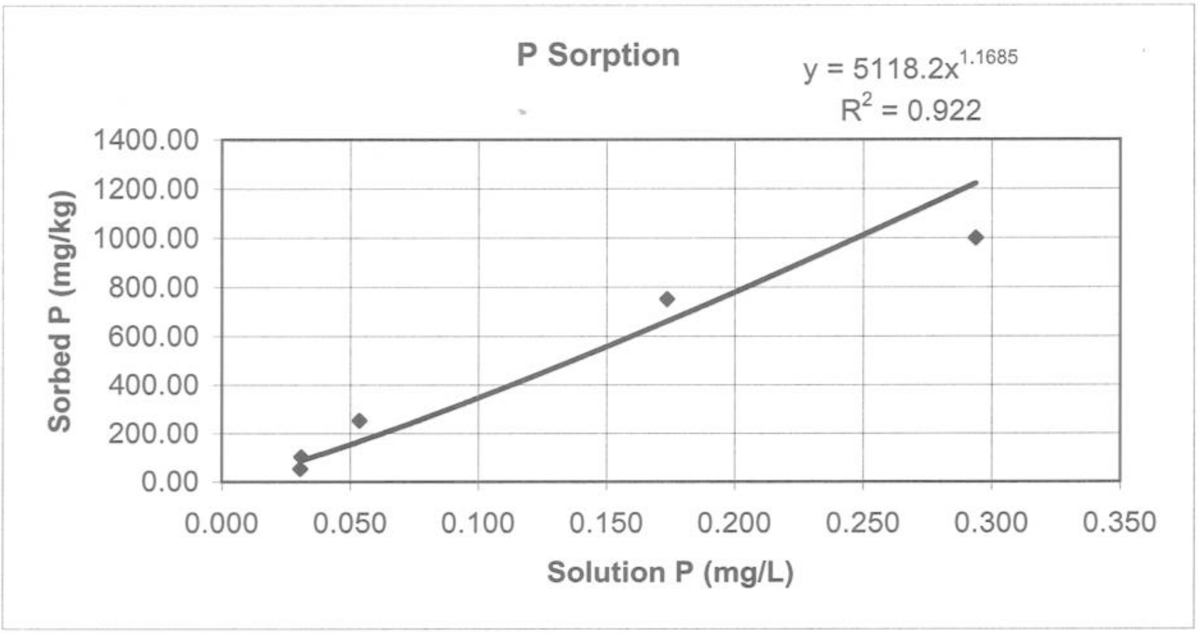
a	5118.231
b	1.168
R^2	0.960

Equilibrium P Concentration mg/L

0.5	1	5	10	20	50

P Sorbed mg/kg Estimated

2277	5118	33562	75438	169563	494666



16) Appendix 5 – Groundwater and surface water results and laboratory certificates

Table 12.1 - 1997 groundwater investigation Lots 12 and 13 in DP848618 and Lot 105 in DP 856767

Borehole	GW depth (m) NSL	GW depth (m) RL (AHD)	pH(6.5-8)	EC (uS/cm)	Total N (mg/L)	Total P (mg/L)
T1A	0.4	2	4.72	648	1720	201
T1B	0.08	1.92	4.53	653	14300	1740
T1C	0.08	1.92	5.57	238	3800	962
T2A	0.65	2.4	4.52	105	227	73
T2B	0.85	2.15	4.24	634	43	55
T2C	0	2.1	5.72	249	12200	1480
T3A	0.65	2.35	4.76		94	26
T3B	0.2	2.33	4.57	318	7130	1630
T3C	0	2.2	5.27	278	87600	1610
T4A	0.9	1.93	4.75	172	171	36
T4B	0.5	2.05	N/A	N/A	171	27
T4C	0	2	5.57	202	8370	2050
T5A	0.75	2	N/A	N/A	138	21
T5B	0.65	1.85	4.54	N/A	398	66
T5C	0.07	1.93	5.12	369	59100	5030
T6A	0.8	1.7	4.55	N/A	682	67
T6B	0.35	1.9	4.22	170	8240	2190
T6C	0.05	1.9	5.27	318	3470	941
T7A	0.34	2.16	4.43	158	51	<20
T7B	0.4	1.9	4.5	240	3340	823
T7C	0.06	1.89	4.91	472	6100	909

Tweed Laboratory Centre, 46 Enterprise Avenue, Tweed Heads South NSW 2486 Australia
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(All Correspondence: Tweed Shire Council PO BOX 816 Murwillumbah NSW 2484)
www.tweedlab.com.au

FINAL CERTIFICATE OF ANALYSIS

Client: Gilbert & Sutherland

Page 1 of 2

Address: PO Box 4115
ROBINA
QLD 4230

Lims1 Report No: 10/0807-B
Attention: Nathan Zurig
Client Reference: GJ0926
Copy To: Fax: 07 5578 9945
Date of Report: 1/04/2010

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Taken By: Client
No of Samples: 3
Date Taken: 31/03/2010
Date Testing Commenced: 31/03/2010
Date Received: 31/03/2010
Date Testing Completed: 1/04/2010

Sample Description: Water Samples - GJ0926 - Bacto

Sample/Site No	Sample/Site Description
1	GW1
2	GW4
3	SW1

COMMENTS:

Results refer to samples as received at the Laboratory.
* Values are considered an estimate.

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Accredited for compliance with ISO/IEC 17025.
Accreditation No: 12754 & 13538

Sally Everson
(Senior Technical Officer – Phycology)
sallye@tweedlab.com.au

Client: Gilbert & Sutherland

Address: PO Box 4115

ROBINA
QLD 4230

Attention: Nathan Zurig

Lims1 Report No: 10/0807-B
Date Testing Completed: 1/04/2010
Date of Report: 1/04/2010

Sample Description: Water Samples - GJ0926 - Bacto

Sample Identification: Date Taken: Date Received: Date Testing Commenced: Test	Method	Units	1 31/03/2010 31/03/2010 31/03/2010 10/0807-B/1	2 31/03/2010 31/03/2010 31/03/2010 10/0807-B/2	3 31/03/2010 31/03/2010 31/03/2010 10/0807-B/3
Thermotolerant coliforms	B1	cfu/100mL	2,178	20*	2,224
E. coli colilert	B12	cfu/100mL	2,178	<10	2,224

Tweed Laboratory Centre, 46 Enterprise Avenue, Tweed Heads South NSW 2486 Australia
Phone: (07) 5569 3103 Fax: (07) 5524 2676 ABN: 90 178 732 496
(All Correspondence: Tweed Shire Council PO BOX 816 Murwillumbah NSW 2484)
www.tweedlab.com.au

FINAL CERTIFICATE OF ANALYSIS

Client:	Gilbert & Sutherland		Page 1 of 3
Address:	PO Box 4115 ROBINA **QLD 4230**		
		Lims1 Report No:	10/0807-C
Attention:	Nathan Zurig	**Client Reference:**	
Copy To:	Fax: 07 5578 9945	**Date of Report:**	20/04/2010

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Taken By:	Client	**No of Samples:**	6
Date Taken:	31/03/2010	**Date Testing Commenced:**	1/04/2010
Date Received:	31/03/2010	**Date Testing Completed:**	20/04/2010

Sample Description: Water Samples - GJ0926 - Chemical

Sample/Site No	Sample/Site Description
1	SW1
2	GW1
3	GW2
4	GW3
5	GW4
6	GW5

COMMENTS:

Results refer to samples as received at the Laboratory.
* Tests not covered by NATA accreditation.
NP = Not Present.
Insufficient quantity of GW3 received and sample bottle contained sulphuric acid.
Nathan Zurig advised Tania Collins no testing required on this sample.
This Report replaces the Interim Report issued on 13/04/2010.

NATA
ACCREDITED FOR TECHNICAL COMPETENCE

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
Accreditation No: 12754 & 13538

Dr Paul J Wright
(Laboratory Coordinator)
paulw@tweedlab.com.au

Client: Gilbert & Sutherland

Address: PO Box 4115

ROBINA
QLD 4230

Attention: Nathan Zurig

Lims1 Report No: 10/0807-C
Date Testing Completed: 20/04/2010
Date of Report: 20/04/2010

Sample Description: Water Samples - GJ0926 - Chemical

Sample Identification:			SW1	GW1	GW2	GW3	GW4
Date Taken:			31/03/2010	31/03/2010	31/03/2010	31/03/2010	31/03/2010
Date Received:			31/03/2010	31/03/2010	31/03/2010	31/03/2010	31/03/2010
Date Testing Commenced:			1/04/2010	1/04/2010	1/04/2010	1/04/2010	1/04/2010
Test	Method	Units	10/0807-C-1	10/0807-C-2	10/0807-C-3	10/0807-C-4	10/0807-C-5
pH	P1	pH units	6.6	2.5	4.3	--	5.7
Conductivity	P2	μScm^{-1}	96	2,361	769	--	575
TDS by Calculation	P6	mg/L	60	1,460	480	--	360
Bicarbonate HCO_3	C10	mg/L	7	NP	NP	--	29
Chloride	C20	mg/L	20	750	110	--	65
Suspended Solids	P4	mg/L	18	4,023.0	24,772.0	--	10,797.0
Total Phosphorus-P	C17	mg/L	0.05	0.30	0.20	--	0.20
Ortho Phosphate-P	C16	mg/L	<0.05	0.12	<0.05	--	<0.05
Total-N	C7	mg/L	0.76	2.03	1.62	--	1.52
Ammonia	C3	mg/L	0.05	0.33	0.34	--	0.11
Nitrate-N	C4	mg/L	0.05	0.18	0.13	--	<0.05
Nitrite-N	C4	mg/L	<0.05	<0.05	<0.05	--	0.06
Calcium	M8	mg/L	1.5	8.8	30.0	--	15.0
Magnesium	M8	mg/L	2.0	15.0	22.0	--	20.0
Sodium	M8	mg/L	15.0	224.0	100.0	--	80.0
Sulphur as Sulphate	M8	mg/L	1.5	244.0	309.0	--	176.0
Potassium M8	M8	mg/L	<5.0	<5.0	<5.0	--	5.0
Aluminium (Soluble)	M8	mg/L	0.02	0.99	0.60	--	1.47
Copper (Soluble)	M8	mg/L	<0.01	0.01	<0.01	--	0.01
Iron (Soluble)	M8	mg/L	1.13	2.12	9.75	--	14.0
Manganese (Soluble)	M8	mg/L	0.07	0.61	0.97	--	0.50
Zinc (Soluble)	M8	mg/L	<0.01	0.20	0.51	--	0.37
Arsenic (Soluble)	M7	mg/L	<0.005	0.006	<0.005	--	<0.005
Cadmium (Soluble)	M8	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Lead (Soluble)	M8	mg/L	<0.01	<0.01	<0.01	--	0.01

Client: Gilbert & Sutherland

Address: PO Box 4115

ROBINA
QLD 4230

Attention: Nathan Zurig

Lims1 Report No: 10/0807-C
Date Testing Completed: 20/04/2010
Date of Report: 20/04/2010

Sample Description: Water Samples - GJ0926 - Chemical

Sample Identification: Date Taken: Date Received: Date Testing Commenced: Test	Method	Units	GW5 31/03/2010 31/03/2010 1/04/2010 10/0807-C-6
pH	P1	pH units	5.5
Conductivity	P2	μScm^{-1}	560
TDS by Calculation	P6	mg/L	350
Bicarbonate HCO_3	C10	mg/L	20
Chloride	C20	mg/L	110
Suspended Solids	P4	mg/L	87,860.0
Total Phosphorus-P	C17	mg/L	0.13
Ortho Phosphate-P	C16	mg/L	<0.05
Total-N	C7	mg/L	2.31
Ammonia	C3	mg/L	0.24
Nitrate-N	C4	mg/L	<0.05
Nitrite-N	C4	mg/L	<0.05
Calcium	M8	mg/L	15.0
Magnesium	M8	mg/L	18.0
Sodium	M8	mg/L	82.0
Sulphur as Sulphate	M8	mg/L	121.0
Potassium M8	M8	mg/L	6.0
Aluminium (Soluble)	M8	mg/L	3.11
Copper (Soluble)	M8	mg/L	0.01
Iron (Soluble)	M8	mg/L	0.88
Manganese (Soluble)	M8	mg/L	0.27
Zinc (Soluble)	M8	mg/L	0.31
Arsenic (Soluble)	M7	mg/L	<0.005
Cadmium (Soluble)	M8	mg/L	<0.001
Lead (Soluble)	M8	mg/L	0.01

17) Appendix 6 – Water supply and wastewater loading calculations

Appendix 6 -Water demand and wastewater loading calculations

Event Scenarios			**Minor**		**Small**		**Moderate**		**30% capacity**		**40% capacity**		**70% capacity**		**100% capacity**	
			Event	Camping	Event	Camping	Event	Camping	Event	Camping	Event	Camping	Event	Camping	Event	Camping
	Population		300	300	3,000	3,000	10,000	10,000	15,000	0	20,000	12,000	35,000	20,000	50,000	25,000
	Staff %	10	30	30	300	300	1,000	1,000	1,500	0	2,000	1,200	3,500	2,000	5,000	2,500
Wastewater Generation	L/person/day	L/person/day														
Portable facilities																
Blackwater	3.5	1.4	1,155	462	11,550	4,620	38,500	15,400	57,750	0	77,000	18,480	134,750	30,800	192,500	38,500
Greywater		27		5,346		53,460		178,200		0		213,840		356,400		445,500
Food prep/cleaning	3		990		9,900		33,000		49,500		66,000		115,500		165,000	
Total wastewater generated	6.5	28.4	2,145	5,808	21,450	58,080	71,500	193,600	107,250	0	143,000	232,320	250,250	387,200	357,500	484,000
Total wastewater for event and camping		34.9		**7,953**		**79,530**		**265,100**		**107,250**		**375,320**		**637,450**		**841,500**
Fixtures																
Blackwater	5	2	1,650	660	16,500	6,600	55,000	22,000	82,500	0	110,000	26,400	192,500	44,000	275,000	55,000
Greywater		27		5,346		53,460		178,200		0		213,840		356,400		445,500
Food prep/cleaning	3		990		9,900		33,000		49,500		66,000		115,500		165,000	
Total wastewater generated	8	29	2,640	6,006	26,400	60,060	88,000	200,200	132,000	0	176,000	240,240	308,000	400,400	440,000	500,500
Total wastewater for event and camping		37		**8,646**		**86,460**		**288,200**		**132,000**		**416,240**		**708,400**		**940,500**
Number of facilities required based on BCA 2010 & Local Govt Reg 2005																
Number of female pedestals			3	7	30	42	101	138	150	0	201	165	351	275	501	344
Number of male pedestals			2	4	11	28	35	92	53	0	70	110	123	184	175	230
Number of urinals			3	3	18	17	60	55	90	0	120	66	210	110	300	138
Number of accessible																
Number of showers				12		84		276		0		330		550		688
Number of handbasins			2	8	15	56	51	184	75	0	101	220	176	368	251	460
Water demand																
For portable facilities	Sub-total		2,145	5,808	21,450	58,080	71,500	193,600	107,250	0	143,000	232,320	250,250	387,200	357,500	484,000
	Total for event and camping			**7,953**		**79,530**		**265,100**		**107,250**		**375,320**		**637,450**		**841,500**
For permanent fixtures	Sub-total		2,640	6,006	26,400	60,060	88,000	200,200	132,000	0	176,000	240,240	308,000	400,400	440,000	500,500
	Total for event and camping			**8,646**		**86,460**		**288,200**		**132,000**		**416,240**		**708,400**		**940,500**

Assumptions - pay per use showers, with an average uptake rate of 60% of campers per day. Average of 4 persons per campsite.

Permanent infrastructure

Conference centre 300 person conference centre Accommodation Annual - assume 200 days use per annum***

	cc per person*	acc per person*	300	150	200 cc	accom	Total/annum
Water demanc	100	100	30,000 /day	15,000 /day	6,000,000	3,000,000	9,000,000
Sewage flow	50	80	15,000 /day	12,000 /day	3,000,000	2,400,000	5,400,000

*80L/p/day accepted by DoP for previous major development application
**basd on education institution
***assume 5 days per week, minus event periods

Community centre 2 Full time staff + 12 part time staff Assume operation 6 days/week
Assume 300m2 floor space, with 380L/ sewage flow/100m2 in accordance with the Qld Planning Guidelines (in the absence of equivalent for NSW)
Assume water demand of 550L/100m2 floor space.

Wastewater Generation	Water Demand
1,140 /day	1,650 /day
6,840 /week	9,900 /week
355,680 /year	514,800 /year

Maximum Site Usage

		Wastewater					**Water Demand**
		Event Size	100% capacit	Moderate	Small	Minor	
		Event days	12	4	4	4	
Assume w fixtures							
Fixtures	Event		50,000	10,000	3,000	300	
	Camping		25,000	10,000	3,000	300	
			11,286,000	1,152,800	345,840	34,584	
				Annual Event Total		12,819,224	12,819,224
Annual Conference centre and Accommodation						5,400,000	9,000,000
Annual Community Centre						355,680	514,800
				Annual Site total		**18,574,904**	**22,334,024**

18) Appendix 7 – RUSTIC model output

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                  STATISTICS REPORT FOR GJ0926 - BPT (combined storages - event)10019


NOMINATED DEMAND `NomDemand2'
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Annual Reliability
------------------

Results based on 50 complete years of data.

    % of Years in which the Full Demand was Supplied All Year           40.0

    % of Years in which there were Restricted Demands Supplied,
        but No Failures of Supply                                        0.0

    % of Years in which there were Failures of Supply, due to
        Restrictions Cutting Off Supply Completely, or the
        Storage Level Falling to Environmental Reserve                  60.0

                                                                     -------
                                                                       100.0
Daily Reliability
-----------------

    % of Days on which the Full Demand was Supplied                     86.6

    % of Days on which a Restricted Demand was Supplied                  0.0

    % of Days on which a Failure of Supply occurred due to
        Restrictions Cutting Off Supply Completely, or the Storage
        Level Falling to Environmental Reserve                          13.4

                                                                     -------
                                                                       100.0
Overall Performance
-------------------

Nominated Demand Performance Factor                                     86.5
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                              STATISTICS REPORT FOR GJ0926 - BPT (combined storages - event)

SUMMARY OF MAIN STORAGE PERFORMANCE
PERIOD OF ANALYSIS 01/01/1960 to 01/04/2010


The main storage was full for 804 days, which represents 4.381 % of the analysis period.
The main storage was empty for 17 days, which represents 0.093 % of the analysis period.
The main storage overflowed on 804 days, which represents 4.381 % of the analysis period.



  Elevation (m)    Volume (ML)    Days At Or Below        %
       0.0            0.000              17              < 1
       0.0           26.400           18354              100



The main storage was below 5.000 ML during the following periods

                                         Days      Percent
    Jan 01, 1960 to Jan 05, 1961          371        2.021

    Totals                                371        2.021




AVERAGE ANNUAL VOLUMES AT STORAGE
PERIOD OF ANALYSIS 01/01/1960 to 01/04/2010


The following data is based on 50 complete years of information.


Total Inflow To Storage From All Runoff Sources                      69.491 ML/a


Total Supplied From The Storage For All Nominated Demands           16.918 ML/a
```

WATER SUPPLIED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1961	2.880	0.818	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.381
1962	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1963	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1964	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.275	18.928
1965	0.000	0.000	0.000	0.000	0.000	0.180	4.030	0.930	0.900	3.530	0.900	0.930	11.400
1966	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1967	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1968	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1969	0.238	0.000	1.050	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	15.291
1970	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	1.809	0.900	0.930	17.832
1971	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.219	0.000	0.000	17.412
1972	2.580	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.133
1973	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1974	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1975	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1976	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.330	18.983
1977	0.000	0.210	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.660	0.000	14.723
1978	0.000	0.000	1.230	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	15.233
1979	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1980	3.030	0.870	1.400	0.000	0.840	0.953	4.030	0.930	0.900	3.530	0.900	0.930	18.313
1981	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1982	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.850	0.270	3.530	0.900	0.930	18.843
1983	0.905	0.120	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	16.708
1984	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1985	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1986	0.750	0.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.930	1.710
1987	0.210	0.000	1.590	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	15.803
1988	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1989	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1990	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1991	0.600	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	17.122
1992	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.690	0.000	18.443
1993	0.000	0.000	1.230	0.900	0.930	0.360	3.530	0.000	0.000	0.000	0.000	0.720	7.670
1994	0.885	0.270	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.500	0.000	0.870	15.848
1995	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	1.882	0.390	0.930	17.395
1996	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1997	0.360	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	16.883
1998	3.030	0.840	0.030	0.450	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	17.453
1999	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2000	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.780	0.000	18.533
2001	0.000	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.150	0.000	14.843
2002	0.000	0.000	0.000	0.000	0.930	0.953	4.030	0.930	0.900	0.712	0.000	0.150	8.605
2003	1.939	0.750	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.221	17.663
2004	2.053	0.420	1.680	0.900	0.930	0.953	4.030	0.930	0.723	0.420	0.900	0.930	14.869
2005	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2006	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2007	3.030	0.840	0.881	0.000	0.000	0.000	0.000	0.330	0.900	3.530	0.900	0.930	11.341
2008	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2009	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.570	0.060	18.353

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER SUPPLIED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	2.675	0.660	1.680	0.030									5.045
AVERAGES	2.216	0.664	1.463	0.768	0.854	0.868	3.778	0.861	0.830	3.125	0.749	0.741	16.686
MTHS OF DATA	51/51	51/51	51/51	51/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	51/51

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER REQUIRED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1961	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1962	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1963	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1964	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1965	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1966	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1967	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1968	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1969	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1970	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1971	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1972	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1973	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1974	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1975	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1976	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1977	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1978	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1979	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1980	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1981	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1982	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1983	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1984	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1985	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1986	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1987	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1988	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1989	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1990	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1991	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1992	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1993	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1994	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1995	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1996	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1997	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1998	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1999	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2000	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2001	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2002	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2003	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2004	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2005	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2006	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2007	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2008	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2009	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER REQUIRED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	3.030	0.840	1.680	0.030									5.580
AVERAGES	3.030	0.848	1.680	0.883	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.286
MTHS OF DATA	51/51	51/51	51/51	51/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	51/51

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

STORAGE VOLUME (ML) FOR MAIN STORAGE [Storage]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1960	0.393	0.451	2.616	2.630	3.083	2.970	2.922	2.546	2.020	1.716	2.063	1.594
1961	10.579	25.880	23.991	23.726	26.400	24.876	21.446	20.329	18.527	15.157	15.415	24.493
1962	22.390	21.519	24.570	25.252	25.665	23.953	21.965	25.046	22.565	16.988	14.521	26.400
1963	22.649	21.679	26.394	26.270	25.600	26.400	20.854	20.131	18.146	13.634	22.511	22.594
1964	17.714	25.855	26.400	25.664	26.157	24.399	19.746	17.530	15.777	11.019	10.274	8.997
1965	8.166	7.545	6.470	8.004	7.945	19.657	22.756	22.545	20.222	16.167	13.456	16.982
1966	11.825	13.984	11.519	12.823	11.728	24.934	19.753	25.687	23.126	19.558	22.458	21.334
1967	26.399	25.794	24.591	25.784	25.246	26.299	23.074	23.787	20.631	21.928	18.524	16.261
1968	22.396	25.682	23.849	21.908	24.881	23.288	19.111	24.991	21.741	15.652	12.679	10.545
1969	8.526	9.487	11.542	10.088	26.248	24.563	20.613	26.301	23.540	26.158	24.978	20.922
1970	18.374	26.221	26.400	25.040	22.658	20.734	15.515	13.695	11.963	18.949	18.106	26.400
1971	26.352	26.392	25.743	24.677	22.593	21.359	17.525	16.005	14.306	9.414	8.473	8.090
1972	26.400	26.400	24.729	24.333	25.864	25.760	20.534	18.109	15.686	26.289	24.273	19.899
1973	18.217	26.400	23.795	22.637	26.075	24.963	23.195	21.283	19.435	19.805	17.457	16.649
1974	26.400	25.459	24.589	26.136	26.063	24.719	18.966	24.733	22.465	17.280	21.800	18.098
1975	13.326	26.400	24.039	22.993	21.569	24.302	19.578	21.956	22.139	25.437	24.442	25.856
1976	22.392	26.400	25.002	25.429	25.954	26.039	22.212	19.545	17.332	12.645	10.824	9.438
1977	8.413	26.282	23.781	22.136	25.696	23.526	20.280	17.809	15.441	10.942	9.510	7.950
1978	7.985	7.422	26.103	23.964	25.394	23.592	18.626	18.849	17.294	14.056	13.084	24.701
1979	26.242	24.763	22.876	26.261	24.276	25.928	26.400	23.434	20.209	15.564	19.116	15.367
1980	12.551	12.438	9.840	8.985	25.666	24.753	21.206	19.552	16.387	14.096	12.709	17.321
1981	14.106	26.157	22.562	24.327	25.750	23.876	19.004	17.310	14.875	10.324	13.333	12.830
1982	17.135	16.074	16.413	15.141	14.906	13.693	10.769	9.938	11.833	15.092	12.218	11.088
1983	9.302	16.870	25.395	26.400	26.125	26.078	22.662	23.716	24.508	20.200	26.400	26.400
1984	24.869	26.308	24.791	25.322	25.516	25.750	23.000	20.532	17.873	19.892	23.696	21.181
1985	16.040	20.742	25.545	26.174	26.314	24.878	21.696	19.700	18.287	15.668	13.825	11.393
1986	10.115	8.816	8.315	7.807	8.400	8.211	8.417	8.080	7.143	6.556	7.339	10.456
1987	8.871	8.936	24.118	23.962	25.437	25.703	22.091	26.400	23.094	19.026	15.920	15.455
1988	26.400	23.684	25.446	25.571	23.437	25.854	22.146	22.185	24.666	18.408	16.152	26.038
1989	26.163	26.103	25.700	26.155	26.276	25.581	21.426	20.408	17.834	12.525	12.188	17.885
1990	20.488	26.400	26.166	25.463	26.274	25.571	21.160	18.759	16.788	11.881	12.456	10.515
1991	11.166	25.042	24.979	22.583	26.365	25.068	21.734	18.927	15.788	13.230	11.071	24.771
1992	21.044	23.062	25.689	26.250	26.400	24.968	20.968	18.743	16.286	11.413	9.677	8.997
1993	7.839	8.323	11.650	11.216	10.291	9.785	9.982	9.411	9.172	8.361	7.994	10.816
1994	9.692	10.402	26.400	25.456	24.868	23.691	19.834	17.875	15.173	9.962	8.225	22.686
1995	18.446	25.775	23.180	22.192	21.821	20.576	15.134	14.235	12.445	9.792	18.519	16.603
1996	24.722	23.419	23.713	21.323	25.773	25.367	21.268	19.466	16.835	11.986	11.569	10.280
1997	22.968	23.833	20.020	17.617	25.706	25.509	23.047	20.482	18.973	14.554	17.552	15.871
1998	11.546	10.042	8.521	15.081	19.581	18.444	14.573	16.139	16.790	11.705	15.582	13.590
1999	14.112	26.400	24.336	24.773	25.878	26.400	23.212	26.400	24.982	21.445	20.435	19.020
2000	23.100	21.311	19.980	23.242	23.459	24.444	19.505	17.508	14.664	10.332	9.742	8.917
2001	7.954	24.112	24.943	24.195	22.994	21.503	20.370	17.817	15.679	10.411	9.564	8.090
2002	6.788	6.930	9.509	9.857	14.417	17.147	12.030	13.467	11.259	9.357	8.039	13.160
2003	9.210	26.400	24.292	26.298	26.393	26.137	21.690	19.832	16.473	12.637	10.153	9.028
2004	9.821	25.802	23.952	22.709	20.440	18.639	13.749	11.555	9.746	25.011	23.804	24.052
2005	20.775	17.747	14.454	13.829	14.461	26.400	22.353	20.519	18.093	13.677	13.200	10.926
2006	24.795	24.626	24.086	25.043	23.312	26.131	23.137	26.400	24.982	18.848	19.057	16.439
2007	12.597	11.465	9.840	9.280	8.931	9.359	8.626	21.752	19.881	15.976	18.778	21.430
2008	23.170	25.650	22.694	25.327	24.233	25.187	22.980	20.500	19.430	14.753	22.281	19.890
2009	16.090	25.249	26.400	25.007	26.096	26.003	21.189	18.399	15.522	10.541	9.396	13.800

The data for this report DAILY FLT to MTHLY FLT (filter :- LAST VALUE)

STORAGE VOLUME (ML) FOR MAIN STORAGE [Storage]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	9.730	25.617	24.531									

The data for this report DAILY FLT to MTHLY FLT (filter :- LAST VALUE)

STATISTICS REPORT FOR GJ0926 - BPT (combined storages - ~~event~~ Event & Daily)

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NOMINATED DEMAND `NomDemand2'
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Annual Reliability
------------------

Results based on 50 complete years of data.

    % of Years in which the Full Demand was Supplied All Year          58.0

    % of Years in which there were Restricted Demands Supplied,
        but No Failures of Supply                                       0.0

    % of Years in which there were Failures of Supply, due to
        Restrictions Cutting Off Supply Completely, or the
        Storage Level Falling to Environmental Reserve                 42.0

                                                                    -------
                                                                      100.0

Daily Reliability
-----------------

    % of Days on which the Full Demand was Supplied                    90.7

    % of Days on which a Restricted Demand was Supplied                 0.0

    % of Days on which a Failure of Supply occurred due to
        Restrictions Cutting Off Supply Completely, or the Storage
        Level Falling to Environmental Reserve                          9.3

                                                                    -------
                                                                      100.0

Overall Performance
-------------------

Nominated Demand Performance Factor                                    90.5
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STATISTICS REPORT FOR GJ0926 - BPT (combined storages - ~~event)~~ Event + Daily

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SUMMARY OF MAIN STORAGE PERFORMANCE
PERIOD OF ANALYSIS 01/01/1960 to 01/04/2010


The main storage was full for 794 days, which represents 4.326 % of the analysis period.
The main storage was empty for 17 days, which represents 0.093 % of the analysis period.
The main storage overflowed on 794 days, which represents 4.326 % of the analysis period.



  Elevation (m)   Volume (ML)     Days At Or Below        %
       0.0           0.000               17              < 1
       0.0          29.400            18354              100



The main storage was below 5.000 ML during the following periods

                                           Days      Percent
     Jan 01, 1960 to Jan 05, 1961           371        2.021

     Totals                                 371        2.021




AVERAGE ANNUAL VOLUMES AT STORAGE
PERIOD OF ANALYSIS 01/01/1960 to 01/04/2010


The following data is based on 50 complete years of information.


Total Inflow To Storage From All Runoff Sources                 69.489 ML/a


Total Supplied From The Storage For All Nominated Demands       17.683 ML/a
```

WATER SUPPLIED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1961	2.880	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.403
1962	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1963	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1964	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1965	0.473	0.000	0.000	0.000	0.000	0.420	4.030	0.930	0.900	3.530	0.900	0.930	12.113
1966	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1967	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1968	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1969	1.983	0.360	1.050	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	17.396
1970	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1971	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.731	0.060	18.514
1972	2.610	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.163
1973	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1974	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1975	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1976	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1977	1.382	0.210	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.750	17.095
1978	0.000	0.000	1.650	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	15.653
1979	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1980	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1981	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1982	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1983	2.820	0.120	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	18.623
1984	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1985	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1986	3.030	0.240	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.930	4.200
1987	0.370	0.000	1.590	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	15.963
1988	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1989	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1990	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1991	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1992	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1993	0.300	0.000	1.230	0.900	0.930	0.953	4.030	0.030	0.000	0.000	0.000	0.720	9.093
1994	1.132	0.270	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.843	0.930	17.028
1995	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1996	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1997	2.635	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.158
1998	3.030	0.840	0.288	0.450	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	17.711
1999	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2000	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2001	0.210	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.600	16.403
2002	0.000	0.000	0.060	0.754	0.930	0.953	4.030	0.930	0.900	1.285	0.000	0.150	9.992
2003	2.187	0.750	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	18.619
2004	3.028	0.813	1.680	0.900	0.930	0.953	4.030	0.930	0.900	1.884	0.900	0.930	17.877
2005	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2006	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2007	3.030	0.840	1.680	0.900	0.151	0.150	0.030	0.330	0.900	3.530	0.900	0.930	13.371
2008	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2009	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.834	19.457

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER SUPPLIED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2010	3.030	0.840	1.680	0.030									5.580
AVERAGES	2.511	0.687	1.499	0.818	0.859	0.888	3.789	0.863	0.846	3.240	0.823	0.862	17.446
MTHS OF DATA	51/51	51/51	51/51	51/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	51/51

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER REQUIRED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1960	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1961	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1962	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1963	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1964	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1965	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1966	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1967	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1968	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1969	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1970	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1971	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1972	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1973	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1974	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1975	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1976	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1977	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1978	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1979	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1980	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1981	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1982	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1983	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1984	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1985	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1986	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1987	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1988	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1989	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1990	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1991	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1992	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1993	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1994	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1995	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1996	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
1997	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1998	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
1999	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2000	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2001	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2002	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2003	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2004	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2005	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2006	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2007	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553
2008	3.030	0.870	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.583
2009	3.030	0.840	1.680	0.900	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.553

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

WATER REQUIRED (ML) FOR NOMINATED DEMAND [Event and Daily]

Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
2010	3.030	0.840	1.680	0.030									5.580
AVERAGES	3.030	0.848	1.680	0.883	0.930	0.953	4.030	0.930	0.900	3.530	0.900	0.930	19.286
MTHS OF DATA	51/51	51/51	51/51	51/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	50/51	51/51

The data for this report DAILY FLT to MTHLY FLT (filter :- TOTAL VALUES)

19) Appendix 8 –MEDLI output

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*****************************************
         SUMMARY OUTPUT
      MEDLI  Version 1.30

Data Set:   GJ0926-woodlot
Run Date: 13/05/10   Time:18:48:46.70
*****************************************

GENERAL INFORMATION
*******************
Title:    North Byron Parklands
Subject:  Irrigation assessment
Client:   Billinudgel Property Trust
User:     NTZ
Time:     Thu May 13 18:43:14 2010
Comments: Irrigation of average 36,000L/day to 2.8Ha wood lot irrigation area.


RUN PERIOD
**********

Starting Date  1/ 1/1901
Ending Date   31/12/2009
Run Length    109 years   0 days
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CLIMATE INFORMATION
*******************

Enterprise site: Yelgun                             -28.5 deg S  153.5 deg E
Weather station: Yelgun rad

  ANNUAL TOTALS    10 Percentile  50 percentile  90 Percentile
Rainfall mm/year        1313.        1827.        2481.
Pan Evap mm/year        1390.        1390.        1517.

      MONTHLY       Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec  Year
Rainfall     (mm)  221  253  258  189  170  134   96   74   61  109  130  159 1853
Pan Evap     (mm)  164  128  122   95   73   65   75   97  124  146  155  172 1416
Ave Max Temp DegC   28   28   27   25   22   20   20   21   23   25   26   28   24
Ave Min Temp DegC   20   20   18   16   13   10    9   10   12   15   17   18   14
Rad   (MJ/m2/day)   22   21   18   16   13   12   13   16   20   22   23   23   18
------------------------------------------------------------------------------------
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MONTHLY IRRIGATION
******************

Irrigation   (mm)   45   37   40   38   35   36   47   61   66   62   53   50  569
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SOIL PROPERTIES
***************

Soil type: Med Perm Red Brown Earth

SOIL WATER PROPERTIES

                                             Layer 1     Layer 2     Layer 3
Bulk Density                         (g/cm3)    1.9         1.9         2.0
Porosity                          (mm/layer)   30.2       141.5       158.5
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Saturated Water Content           (mm/layer)   30.0      140.0      156.0
Drained Upper Limit               (mm/layer)   25.0      125.0      144.0
Lower Storage Limit               (mm/layer)   15.0       80.0       96.0
Air Dry Moisture Content          (mm/layer)   10.0
Layer Thickness                         (mm)  100.0      500.0      600.0

                                             Profile  Max Rootzone
Total Saturated Water Content           (mm)  326.0      326.0
Total Drained Upper Limit               (mm)  294.0      294.0
Total Lower Storage Limit               (mm)  191.0      191.0
Total Air Dry Moisture Content          (mm)   11.1       11.1
Total Depth                             (mm) 1200.0     1200.0

Maximum Plant Available Water Capacity        103.0
Saturated Hydraulic Conductivity
                At Surface           (mm/hr)   10.0
                Limiting             (mm/hr)    1.0

RUNOFF

Runoff curve No II                             80.0

SOIL EVAPORATION

CONA                        (mm/day^0.5)    4.0
URITCH                                  (mm)   10.0
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AVERAGE WASTE STREAM
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Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume                      (ML/year)   13.15
Nitrogen                        (tonne/year)    0.39
Phosphorus                      (tonne/year)    0.13
Salinity                        (tonne/year)    0.13

Nitrogen Concentration                (mg/L)   30.00
Phosphorus Concentration              (mg/L)   10.00
Salinity                              (mg/L)   10.00
Salinity                              (dS/m)    0.02

WASTE STREAM DETAILS (for last inflow event):
Nitrogen Concentration                (mg/L)   30.00
Phosphorus Concentration              (mg/L)   10.00
TDS Concentration                     (mg/L)   10.00
Salinity                              (dS/m)    0.02
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IRRIGATION WATER
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Irrigation triggered on a soil water deficit of (mm):    1.0
Irrigating upto upper storage limit +   2 mm
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AREA

Total Irrigation Area                   (ha)    2.80

VOLUMES

Total Irrigation                   (ML/year)   15.95
Minimum Volume Irrigated by Pump (ML/ha/day)    0.00
Maximum Volume Irrigated by Pump (ML/ha/day)    5.71
Maximum Vol. Available For Shandying (ML/yr)    0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation        (dS/m)    0.01
Average salinity of Irrigation        (mg/L)    8.18
Average Nitrogen Conc of Irrigation
                Before ammonia loss   (mg/L)   13.63
                After ammonia loss    (mg/L)   13.49
Average Phosphorus Conc of Irrigation (mg/L)    8.18
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FRESH WATER USAGE
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Irrigation (shandying) water         (ML/yr)   0.00

Avg volume of fresh water used       (ML/yr)   0.00

Annual allocation                    (ML/yr)    N/A


POND INFORMATION
****************

POND GEOMETRY
                                              Pond 1      Pond 2

Final pond volume                    (ML)       1.50        1.17
Final liquid volume                  (ML)       1.50        1.17
Final sludge volume                  (ML)       0.00        0.00
Average pond volume                  (ML)       1.50        2.22
Average active volume                (ML)       1.50        2.22
Maximum pond volume                  (ML)       1.50        8.00
Minimum allowable pond volume        (ML)       0.00        0.67
Average pond depth                    (m)       4.00        1.25
Pond depth at outlet                  (m)       4.00        4.00
Maximum water surface area     (m2 x1000)       0.38        2.37
Pond catchment area            (m2 x1000)       0.46        2.57
Pond footprint length                 (m)      21.43       50.66
Pond footprint width                  (m)      21.43       50.66

POND WATER BALANCE

Inflow of Effluent to pond system    (ML/yr)   13.15
Recycle Volume from pond system      (ML/yr)    0.00
Rain water added to pond system      (ML/yr)    4.76
Evaporation loss from pond system    (ML/yr)    1.84
Seepage loss from pond system        (ML/yr)    0.08
Irrigation from last pond            (ML/yr)   15.95
Volume of overtopping                (ML/yr)    0.01
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Sludge accumulated                  (ML/yr)    0.00
    Sludge accumulated            (t DM/yr)    0.00
Sludge removed                      (ML/yr)    0.00
No of desludging events every 10 years         0.00
Increase in pond water volume       (ML/yr)    0.02

OVERTOPPING EVENTS

Volume of overtopping               (ML/yr)    0.01
No. of days pond overtops per 10 years         2.84
Average Length of overtopping events  (days)   3.88
% Reuse                                       99.41
No. of overtopping events every 10 years
          >  0.000 ML         0.73
          >  0.002 ML*        0.73
          >  1.000 ML         0.00
          >  2.000 ML         0.00
          >  5.000 ML         0.00
          > 10.000 ML         0.00
          > 20.000 ML         0.00
          > 50.000 ML         0.00
* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

%Days rain prevents irrigation                38.68
%Days water demand too small to trigger irr.  13.33
%Days pond volume below min. vol. for irrig.   0.13
No. periods/year without irrigable effluent    0.01
Average Length of such periods        (days)  52.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent        (tonne/yr)   0.39  Irrig. from pond (ML/yr)
15.9
Nitrogen removed by Irrigation    (tonne/yr)   0.22
Nitrogen removed by Volatilisation(tonne/yr)   0.18
Nitrogen removed by Seepage       (tonne/yr)   0.00
Nitrogen accumulated in Sludge    (tonne/yr)   0.00
Nitrogen lost by Overtopping      (tonne/yr)   0.00
Nitrogen involved in Recycling    (tonne/yr)   0.00
Increase in pond Nitrogen         (tonne/yr)   0.00

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent      (tonne/yr)   0.13  Irrig. from pond (ML/yr)
15.9
Phosphorus removed by Irrigation  (tonne/yr)   0.13
Phosphorus removed by Seepage     (tonne/yr)   0.00
Phosphorus accumulated in Sludge  (tonne/yr)   0.00
Phosphorus lost by Overtopping    (tonne/yr)   0.00
Phosphorus involved in Recycling  (tonne/yr)   0.00
Increase in pond Phosphorus       (tonne/yr)   0.00

POND SALINITY BALANCE

Salinity Added by Effluent        (tonne/yr)   0.13
Salinity removed by Irrigation    (tonne/yr)   0.13
Salinity removed by Seepage       (tonne/yr)   0.00
Salinity lost by Overtopping      (tonne/yr)   0.00
Salinity involved in Recycling    (tonne/yr)   0.00
Increase in pond Salinity         (tonne/yr)   0.00
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POND CONCENTRATIONS
                                              Pond 1      Pond 2

Average Nitrogen Conc of Pond Liquid  (mg/L)   26.1        12.4
Average Phosphorus Conc of Pond Liquid(mg/L)   10.0         7.4
Average TDS Conc of Pond Liquid       (mg/L)   10.0         7.4
Average Salinity of Pond Liquid       (dS/m)    0.0         0.0
Average Potassium Conc of Pond Liquid (mg/L)    0.0         0.0

(On final day of simulation)
Nitrogen Conc of Pond Liquid          (mg/L)   26.1        11.8
Phosphorus Conc of Pond Liquid        (mg/L)   10.0         7.7
TDS Conc of Pond Liquid               (mg/L)   10.0         7.7
EC of Pond Liquid                     (dS/m)    0.0         0.0
Potassium Conc of Pond Liquid         (mg/L)    0.0         0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)   (kg/tonne)    0.00
Phosphorus in removed Sludge (db) (kg/tonne)    0.00
Salt in removed Sludge (db)       (kg/tonne)    0.00
Potassium in removed Sludge (db)  (kg/tonne)    0.00

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge        (tonne/yr)    0.00
Phosphorus in removed Sludge      (tonne/yr)    0.00
Salt in removed Sludge (mass bal.)(tonne/yr)    0.00
Salt in removed Sludge            (tonne/yr)    0.00
Potm. in removed Sludge (mass bal.)(tonne/yr    0.00
Potassium in removed Sludge       (tonne/yr)    0.00
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LAND DISPOSAL AREA
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WATER BALANCE
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(Initial soil water assumed to be at field capacity)
(Irrigated up to   25.69% of field capacity)
Rainfall                         (mm/year)   1853.2   Irrigation Area     (ha)
2.8
Irrigation                       (mm/year)    569.6
Soil Evaporation                 (mm/year)    338.1
Transpiration                    (mm/year)    889.9
Runoff                           (mm/year)    569.7
Drainage                         (mm/year)    625.1
Change in soil moisture          (mm/year)      0.1

ANNUAL TOTALS

 Year  Rain     Irrig    Sevap    Trans    Runoff     Drain    Change
       (mm)     (mm)     (mm)     (mm)     (mm)       (mm)     (mm)
_____________________________________________________________________________
 1901  1769.0   492.4    994.9      5.1    555.5      716.2    -10.3
 1902  1017.0   499.4    962.7     46.3    116.5      392.5     -1.6
 1903  2005.0   581.6    502.6    731.1    591.4      752.2      9.3
 1904  1936.0   584.7    409.1    868.3    710.1      535.9     -2.7
 1905  1904.0   565.8    269.5    939.1    655.7      599.8      5.7
 1906  2217.0   575.8     92.0   1163.3    739.7      779.8     18.0
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1907	2142.0	625.8	373.8	900.3	749.8	754.3	-10.4
1908	1725.0	571.1	424.4	840.9	499.7	589.9	-58.7
1909	1017.0	480.9	247.0	917.7	30.7	246.8	55.8
1910	2326.0	584.1	135.1	1129.4	746.7	903.9	-5.0
1911	1554.0	587.4	365.0	878.8	417.7	578.4	-98.5
1912	1301.0	525.6	367.1	825.8	248.9	322.4	62.4
1913	1950.0	579.5	123.9	1070.6	669.9	697.6	-32.5
1914	1855.0	515.2	214.0	998.5	284.5	794.1	79.1
1915	816.0	535.0	363.2	780.3	99.2	191.5	-83.2
1916	1631.0	547.1	249.7	955.4	374.1	529.3	69.7
1917	1824.0	548.3	142.1	1110.7	542.3	574.4	2.9
1918	1663.0	584.3	415.6	862.7	418.3	590.6	-40.0
1919	1809.0	562.6	303.2	867.2	634.9	551.8	14.4
1920	1866.0	578.9	53.7	1205.6	419.8	797.3	-31.5
1921	2427.0	593.5	389.9	882.3	776.8	892.6	78.8
1922	1421.0	564.7	457.3	686.3	422.5	520.0	-100.4
1923	1195.0	499.0	907.9	8.0	285.6	416.9	75.6
1924	1565.0	559.8	1038.6	67.3	451.9	556.2	10.9
1925	2505.0	622.2	359.3	924.4	898.3	928.3	16.7
1926	1627.0	546.2	382.1	801.4	499.4	514.1	-23.7
1927	2461.0	618.7	284.0	951.7	1139.4	708.3	-3.7
1928	1544.0	571.3	142.4	1075.8	405.6	578.0	-86.5
1929	2280.0	606.8	454.1	770.7	1076.8	572.6	12.7
1930	2151.0	600.4	304.9	953.9	527.8	901.8	62.9
1931	2211.0	603.1	68.9	1186.0	913.3	636.0	10.0
1932	939.0	492.6	358.3	859.9	30.4	280.2	-97.2
1933	2074.0	578.6	365.4	839.4	621.9	723.3	102.5
1934	2100.0	571.2	55.2	1201.4	691.8	726.4	-3.5
1935	1438.0	570.6	409.5	869.6	186.4	612.3	-69.2
1936	1213.0	506.9	338.2	843.2	70.8	395.3	72.4
1937	2382.0	565.7	33.7	1220.7	834.6	856.7	2.1
1938	2223.0	666.7	424.2	853.0	898.3	784.4	-70.2
1939	1762.0	562.0	403.3	834.1	484.0	592.1	10.6
1940	1400.0	533.9	105.5	1118.0	253.9	409.9	46.6
1941	1566.0	544.6	397.8	805.4	306.8	675.5	-75.0
1942	1935.0	561.7	409.1	820.1	510.7	640.0	116.8
1943	1665.0	545.5	90.2	1162.5	342.7	629.9	-14.8
1944	1428.0	566.1	359.1	892.4	389.0	428.9	-75.3
1945	2036.0	586.6	415.6	849.8	589.2	737.2	30.7
1946	1455.0	537.7	109.7	1079.6	487.2	348.5	-32.3
1947	2167.0	540.3	353.4	916.5	657.8	722.2	57.5
1948	2035.0	641.1	389.7	879.6	728.5	725.9	-47.5
1949	1619.0	549.9	32.5	1220.8	373.4	559.0	-16.8
1950	2680.0	497.1	449.5	799.1	855.3	1009.3	63.9
1951	1597.0	682.3	215.0	996.4	573.9	518.8	-24.7
1952	1634.0	551.0	104.9	1104.8	356.6	643.4	-24.6
1953	1886.0	578.1	383.1	838.6	864.8	387.0	-9.4
1954	2621.0	534.1	172.9	1065.1	1069.6	789.1	58.4
1955	2268.0	599.6	192.4	1077.8	926.3	670.7	0.4
1956	2379.0	689.0	443.9	835.9	1143.8	640.2	4.1
1957	1473.0	547.1	176.3	968.4	364.0	537.7	-26.4
1958	1974.0	573.9	157.6	1098.9	594.6	674.8	21.9
1959	2363.0	553.8	467.7	814.2	775.9	858.8	0.3
1960	1124.0	579.1	135.1	1061.7	73.5	457.4	-24.7
1961	1933.0	566.7	290.2	969.3	414.6	800.1	25.4
1962	2535.0	608.0	428.7	844.3	1038.0	814.1	17.9
1963	2502.0	587.8	24.6	1228.9	961.1	877.1	-1.9
1964	1705.0	634.3	396.1	884.6	449.1	651.2	-41.8
1965	1603.0	534.8	408.7	841.2	400.8	459.6	27.5
1966	1424.0	545.3	60.0	1178.5	337.7	385.2	7.9
1967	2447.0	630.5	425.1	847.7	878.5	975.4	-49.1
1968	1325.0	528.0	262.0	825.0	364.9	431.8	-30.8
1969	1611.0	552.5	1076.4	51.1	369.7	603.3	63.0

```
 1970  1859.0   536.5  1120.6    37.9   590.2   628.5    18.3

 1971  1580.0   573.3   801.3   485.4   275.1   626.1   -34.5
 1972  3228.0   688.9   289.8  1022.8  1655.4   953.6    -4.7
 1973  2201.0   599.5   135.8  1229.2   744.5   666.0    25.1
 1974  3115.0   679.8   462.4   886.1  1744.8   767.9   -66.5
 1975  2055.0   572.3   248.2   933.6   613.4   761.7    70.3
 1976  2194.0   617.2   156.5  1171.3   764.4   762.4   -43.5
 1977  1539.0   537.0   418.6   901.0   457.7   354.4   -55.7
 1978  2199.0   573.6   166.7  1060.9   671.7   742.0   131.4
 1979  1622.0   576.5   237.5  1034.7   543.7   511.0  -128.4
 1980  1893.0   561.8   395.9   915.6   592.7   431.5   119.1
 1981  1699.0   547.7   133.2  1177.7   416.5   536.1   -16.8
 1982  1497.0   560.4   306.3   915.7   291.5   586.2   -42.3
 1983  2500.0   562.4   392.9   806.6   875.5   931.4    56.0
 1984  2075.0   650.8    50.6  1195.0   868.1   648.5   -36.4
 1985  1735.0   571.2   401.9   822.6   453.9   668.0   -40.3
 1986   998.0   494.5   334.0   812.3    69.6   237.3    39.3
 1987  2284.0   604.7    68.0  1157.8   940.0   682.6    40.3
 1988  2863.0   616.4   393.9   837.7  1313.2   957.6   -23.1
 1989  2187.0   542.9   170.6   924.9   591.1  1045.7    -2.3
 1990  1964.0   661.5   227.5   932.5   691.3   780.3    -6.1
 1991  1700.0   561.6   358.0   803.5   520.3   570.4     9.5
 1992  1377.0   534.6    52.9  1102.0   141.9   618.2    -3.3
 1993  1248.0   516.8   336.5   920.8   126.5   443.9   -62.9
 1994  1658.0   546.7   326.4   905.2   391.5   568.0    13.6
 1995  1427.0   532.8    49.3  1254.1   261.8   351.7    42.8
 1996  2033.0   585.7   407.7   917.1   663.1   644.2   -13.3
 1997  1488.0   536.5   332.6   956.3   126.9   590.7    17.9
 1998  1481.0   539.0    66.5  1230.2   212.5   521.2   -10.2
 1999  2845.0   506.1   446.1   808.5   827.6  1259.8     9.2
 2000  1401.0   662.8   130.5  1140.6   233.1   548.8    10.8
 2001  1653.0   555.5   253.9   985.1   651.5   403.3   -85.4
 2002  1228.0   496.6   417.0   778.0   136.7   315.4    77.4
 2003  1829.0   580.6  1039.8     6.0   676.0   695.3    -7.5
 2004  1635.0   548.4   979.9    50.8   664.2   482.5     5.9
 2005  1626.0   548.3   456.1   809.5   572.2   396.1   -59.5
 2006  2027.0   586.2   378.2   923.6   678.3   649.8   -16.7
 2007  1356.0   511.8    30.3  1300.6   155.0   279.4   102.5
 2008  2271.0   610.9   466.8   863.7   821.0   751.8   -21.4
 2009  2199.0   589.2   288.5   974.6   902.7   612.0    10.4
______________________________________________________________________________


NUTRIENT BALANCE
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NITROGEN

Total N irrigated from ponds  (kg/ha/year)     77.6   % of Total as ammonium
5.0
Nitrogn lost by ammonia volat.(kg/ha/year)      0.8   Deep Drainage (mm/year)
625.1
Nitrogen added in irrigation  (kg/ha/year)     76.9
Nitrogen added in seed        (kg/ha/year)      0.0
Nitrogen removed by crop      (kg/ha/year)     76.3
Denitrification               (kg/ha/year)      2.0
Leached NO3-N                 (kg/ha/year)      4.1
Change in soil organic-N      (kg/ha/year)     -5.0
Change in soil solution NH4-N (kg/ha/year)      0.0
Change in soil solution NO3-N (kg/ha/year)     -0.5
Change in adsorbed NH4-N      (kg/ha/year)      0.0
Initial soil organic-N             (kg/ha)    565.0
```

```
Final soil organic-N               (kg/ha)      17.5
Initial soil inorganic-N           (kg/ha)      57.6
Final soil inorganic-N             (kg/ha)       0.0
Average N03-N conc in the root zone (mg/L)       0.3
Average N03-N conc below root zone  (mg/L)       8.2
Average N03-N conc of deep drainage (mg/L)       0.7

PHOSPHORUS

Phosphorus added in irrigatn  (kg/ha/year)      46.6   % of Total as phosphate
100.0
Phosphorus added in seed      (kg/ha/year)       0.0
Phosphorus removed by crop    (kg/ha/year)      20.0
Leached PO4-P                 (kg/ha/year)       0.6
Change in dissolved PO4-P     (kg/ha/year)       0.0
Change in adsorbed PO4-P      (kg/ha/year)      26.0
Average P04-P conc in the root zone (mg/L)       0.8
Average P04-P conc below root zone  (mg/L)       0.5

SOIL P STORAGE LIFE

 Year YearNo.  Tot P stored    P leached in year
                  kg/ha              kg/ha
_____________________________________________________________________________
 1901    1       1891.7          0.1
 1902    2       1937.9          0.0
 1903    3       1975.4          0.1
 1904    4       1998.6          0.1
 1905    5       2014.6          0.1
 1906    6       2037.7          0.1
 1907    7       2059.1          0.1
 1908    8       2088.8          0.1
 1909    9       2106.8          0.0
 1910   10       2126.1          0.1
 1911   11       2151.3          0.1
 1912   12       2181.6          0.0
 1913   13       2195.5          0.1
 1914   14       2220.7          0.1
 1915   15       2247.5          0.0
 1916   16       2275.6          0.1
 1917   17       2295.7          0.1
 1918   18       2318.1          0.1
 1919   19       2339.4          0.1
 1920   20       2370.5          0.2
 1921   21       2388.8          0.2
 1922   22       2413.9          0.1
 1923   23       2453.4          0.1
 1924   24       2506.0          0.1
 1925   25       2529.1          0.3
 1926   26       2553.8          0.1
 1927   27       2575.2          0.2
 1928   28       2606.8          0.1
 1929   29       2625.3          0.2
 1930   30       2645.4          0.2
 1931   31       2671.5          0.2
 1932   32       2707.1          0.1
 1933   33       2722.2          0.2
 1934   34       2745.2          0.2
 1935   35       2772.8          0.2
 1936   36       2803.5          0.1
 1937   37       2818.6          0.3
 1938   38       2843.5          0.3
 1939   39       2867.4          0.2
```

1940	40	2902.3	0.2
1941	41	2918.2	0.3
1942	42	2942.4	0.3
1943	43	2969.2	0.3
1944	44	3003.8	0.2
1945	45	3015.2	0.3
1946	46	3042.7	0.2
1947	47	3064.2	0.4
1948	48	3099.0	0.4
1949	49	3115.3	0.3
1950	50	3140.4	0.6
1951	51	3162.0	0.3
1952	52	3204.3	0.4
1953	53	3223.1	0.3
1954	54	3240.2	0.5
1955	55	3266.2	0.4
1956	56	3300.1	0.5
1957	57	3320.9	0.4
1958	58	3345.4	0.5
1959	59	3368.7	0.7
1960	60	3405.4	0.3
1961	61	3422.2	0.6
1962	62	3444.9	0.8
1963	63	3467.2	0.8
1964	64	3506.2	0.6
1965	65	3521.3	0.4
1966	66	3546.5	0.4
1967	67	3569.1	1.0
1968	68	3606.9	0.5
1969	69	3633.6	0.6
1970	70	3679.8	0.7
1971	71	3715.6	0.6
1972	72	3745.9	1.2
1973	73	3765.9	0.9
1974	74	3787.2	1.0
1975	75	3813.4	1.0
1976	76	3847.5	1.0
1977	77	3864.2	0.5
1978	78	3886.7	1.1
1979	79	3914.1	0.7
1980	80	3949.7	0.6
1981	81	3962.7	0.8
1982	82	3988.7	0.8
1983	83	4009.2	1.5
1984	84	4046.4	1.1
1985	85	4060.6	1.0
1986	86	4087.8	0.3
1987	87	4110.5	1.2
1988	88	4147.3	1.7
1989	89	4152.2	1.8
1990	90	4179.3	1.4
1991	91	4211.4	1.1
1992	92	4242.2	1.1
1993	93	4262.8	0.9
1994	94	4284.1	1.2
1995	95	4311.9	0.7
1996	96	4348.7	1.4
1997	97	4359.3	1.2
1998	98	4385.2	1.1
1999	99	4403.9	2.9
2000	100	4441.8	1.2
2001	101	4460.3	0.9
2002	102	4486.0	0.8

```
 2003  103       4522.3          1.6
 2004  104       4581.3          1.2
 2005  105       4604.7          0.9
 2006  106       4624.7          1.8
 2007  107       4649.8          0.9
 2008  108       4686.0          2.2
 2009  109       4695.1          1.9
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PLANT
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Plant species:  Melaleuca alternifolia

PLANT WATER USE

Irrigation                         (mm/year)   570.   Totl Irrigation Area(ha)
2.8
Pan coefficient                          (%)     1.0
Maximum crop coefficient                 (%)     0.9
Average Plant Cover                      (%)    72.
Average Plant Total Cover                (%)    73.
Average Plant Rootdepth                 (mm)  1103.
Average Plant Available Water Capacity  (mm)    98.
Average Plant Available Water           (mm)    92.
Yield produced per unit transp.   (kg/ha/mm)    19.

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)         (kg/ha/yr) 16686.
Net nitrogen removed by plant     (kg/ha/yr)    76.   Shoot Concn        (%DM)
0.46
Net phosphorus removed by plant   (kg/ha/yr)    20.   Shoot Concn        (%DM)
0.12

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)


Month Yield     Nitr  Temp   Water  Water
      kg/ha                  Defic Logging
____________________________________________
  1   1688.     0.4    0.0    0.1    0.0
  2   1368.     0.4    0.0    0.0    0.0
  3   1339.     0.4    0.0    0.0    0.0
  4   1132.     0.4    0.0    0.0    0.0
  5    968.     0.4    0.0    0.0    0.0
  6    799.     0.4    0.2    0.0    0.0
  7    905.     0.4    0.3    0.0    0.0
  8   1232.     0.4    0.2    0.0    0.0
  9   1599.     0.3    0.0    0.0    0.0
 10   1854.     0.3    0.0    0.0    0.0
 11   1890.     0.4    0.0    0.0    0.0
 12   1912.     0.4    0.0    0.1    0.0

>>> NO-PLANT EVENTS <<<

%Days due to water stress                       0.1
No. of forced harvests per year                 0.0
No. of normal harvests per year                 0.6
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SALINITY
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Salt tolerance - plant species: tolerant

Average EC of Irrigation Water        (dS/m)    0.0   Irrigation     (mm/year)
569.6
Average EC of Rainwater           (dS/m x10)    0.3   Rainfall       (mm/year)
1853.2
Average EC of Infiltrated water       (dS/m)    0.0
Av. water-upt-weightd rootzone EC(dS/m s.e.)    0.0
EC soil soln (FC) at base of rootzone (dS/m)    0.1   Deep Drainage  (mm/year)
625.1
Reduction in Crop yield due to Salinity  (%)    0.0
Percentage of yrs that crop yld falls below
  90% of potential because of soil salinity     0.0

     Period     ECrootzone  ECbase  Rel Yield
                  sat ext  in situ
                  (dS/m)    (dS/m)     (%)
____________________________________________
   1901 - 1910      0.02      0.07      100.
   1902 - 1911      0.02      0.07      100.
   1903 - 1912      0.02      0.08      100.
   1904 - 1913      0.02      0.08      100.
   1905 - 1914      0.02      0.07      100.
   1906 - 1915      0.02      0.08      100.
   1907 - 1916      0.02      0.08      100.
   1908 - 1917      0.02      0.08      100.
   1909 - 1918      0.02      0.08      100.
   1910 - 1919      0.02      0.08      100.
   1911 - 1920      0.02      0.08      100.
   1912 - 1921      0.02      0.08      100.
   1913 - 1922      0.02      0.07      100.
   1914 - 1923      0.02      0.08      100.
   1915 - 1924      0.02      0.08      100.
   1916 - 1925      0.02      0.07      100.
   1917 - 1926      0.02      0.07      100.
   1918 - 1927      0.02      0.07      100.
   1919 - 1928      0.02      0.07      100.
   1920 - 1929      0.02      0.07      100.
   1921 - 1930      0.02      0.07      100.
   1922 - 1931      0.02      0.07      100.
   1923 - 1932      0.02      0.07      100.
   1924 - 1933      0.02      0.07      100.
   1925 - 1934      0.02      0.07      100.
   1926 - 1935      0.02      0.07      100.
   1927 - 1936      0.02      0.07      100.
   1928 - 1937      0.02      0.07      100.
   1929 - 1938      0.02      0.07      100.
   1930 - 1939      0.02      0.07      100.
   1931 - 1940      0.02      0.08      100.
   1932 - 1941      0.02      0.08      100.
   1933 - 1942      0.02      0.07      100.
   1934 - 1943      0.02      0.07      100.
   1935 - 1944      0.02      0.08      100.
   1936 - 1945      0.02      0.07      100.
   1937 - 1946      0.02      0.07      100.
   1938 - 1947      0.02      0.08      100.
```

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1939 - 1948       0.02       0.08       100.
1940 - 1949       0.02       0.08       100.
1941 - 1950       0.02       0.07       100.
1942 - 1951       0.02       0.07       100.
1943 - 1952       0.02       0.07       100.
1944 - 1953       0.02       0.07       100.
1945 - 1954       0.02       0.07       100.
1946 - 1955       0.02       0.07       100.
1947 - 1956       0.02       0.07       100.
1948 - 1957       0.02       0.07       100.
1949 - 1958       0.02       0.07       100.
1950 - 1959       0.02       0.07       100.
1951 - 1960       0.02       0.07       100.
1952 - 1961       0.02       0.07       100.
1953 - 1962       0.02       0.07       100.
1954 - 1963       0.02       0.07       100.
1955 - 1964       0.02       0.07       100.
1956 - 1965       0.02       0.07       100.
1957 - 1966       0.02       0.07       100.
1958 - 1967       0.02       0.07       100.
1959 - 1968       0.02       0.07       100.
1960 - 1969       0.02       0.07       100.
1961 - 1970       0.02       0.07       100.
1962 - 1971       0.02       0.07       100.
1963 - 1972       0.02       0.07       100.
1964 - 1973       0.02       0.07       100.
1965 - 1974       0.02       0.07       100.
1966 - 1975       0.02       0.07       100.
1967 - 1976       0.02       0.07       100.
1968 - 1977       0.02       0.07       100.
1969 - 1978       0.02       0.07       100.
1970 - 1979       0.02       0.07       100.
1971 - 1980       0.02       0.07       100.
1972 - 1981       0.02       0.07       100.
1973 - 1982       0.02       0.08       100.
1974 - 1983       0.02       0.07       100.
1975 - 1984       0.02       0.07       100.
1976 - 1985       0.02       0.08       100.
1977 - 1986       0.02       0.08       100.
1978 - 1987       0.02       0.08       100.
1979 - 1988       0.02       0.07       100.
1980 - 1989       0.02       0.07       100.
1981 - 1990       0.02       0.07       100.
1982 - 1991       0.02       0.07       100.
1983 - 1992       0.02       0.07       100.
1984 - 1993       0.02       0.07       100.
1985 - 1994       0.02       0.07       100.
1986 - 1995       0.02       0.07       100.
1987 - 1996       0.02       0.07       100.
1988 - 1997       0.02       0.07       100.
1989 - 1998       0.02       0.07       100.
1990 - 1999       0.02       0.07       100.
1991 - 2000       0.02       0.08       100.
1992 - 2001       0.02       0.08       100.
1993 - 2002       0.02       0.08       100.
1994 - 2003       0.02       0.08       100.
1995 - 2004       0.02       0.08       100.
1996 - 2005       0.02       0.08       100.
1997 - 2006       0.02       0.08       100.
1998 - 2007       0.02       0.08       100.
1999 - 2008       0.02       0.08       100.
2000 - 2009       0.02       0.08       100.
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GROUNDWATER
************

Average Groundwater Recharge        (m3/day)   47.9
Average Nitrate-N Conc of Recharge    (mg/L)    0.7

Thickness of the Aquifer                 (m)   10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated   500.0

Concentration of NITRATE-N in Groundwater (mg/L)
----------------------------------------------

       Year     Depth Below Water Table Surface
                   0.0 m     5.0 m     9.0 m
____________________________________________
       1905        0.3       0.3       0.3
       1910        0.4       0.4       0.4
       1915        0.4       0.4       0.4
       1920        0.4       0.4       0.4
       1925        0.5       0.5       0.5
       1930        0.5       0.5       0.5
       1935        0.5       0.5       0.5
       1940        0.5       0.5       0.5
       1945        0.5       0.5       0.5
       1950        0.5       0.5       0.5
       1955        0.5       0.5       0.5
       1960        0.5       0.5       0.5
       1965        0.5       0.5       0.5
       1970        0.5       0.5       0.5
       1975        0.5       0.5       0.5
       1980        0.5       0.5       0.5
       1985        0.5       0.5       0.5
       1990        0.5       0.5       0.5
       1995        0.5       0.5       0.5
       2000        0.5       0.5       0.5
       2005        0.5       0.5       0.5
Last   2009        0.5       0.5       0.5
____________________________________________________________________________________
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ACKNOWLEDGMENTS
***************
This run brought to you courtesy of:

MEDLIEXE.EXE  :  1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE   :  1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE    :   439296 bytes Fri Dec 11 12:28:08 1998

__________________________________________
OTHER INDUSTRY INPUT PARAMETERS - DATA SUMMARY

Nature of Industry: other
__________________________________________
```

UNCONDITIONAL FINISH

```
*****************************************
         SUMMARY OUTPUT
      MEDLI  Version 1.30

Data Set:   GJ0926-pasture
Run Date: 13/05/10   Time:18:40:51.70
*****************************************

GENERAL INFORMATION
*******************
Title:    North Byron Parklands
Subject:  Irrigation assessment
Client:   Billinudgel Property Trust
User:     NTZ
Time:     Wed May 12 17:16:28 2010
Comments: Effluent irrigation of average 14,900L day to 3ha pasture irrigation area.


RUN PERIOD
**********

Starting Date  1/ 1/1901
Ending Date   31/12/2009
Run Length    109 years   0 days
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CLIMATE INFORMATION
*******************

Enterprise site: Wooyung                           -28.5 deg S  153.5 deg E
Weather station: Yelgun rad

  ANNUAL TOTALS    10 Percentile  50 percentile  90 Percentile
Rainfall mm/year        1313.         1827.         2481.
Pan Evap mm/year        1390.         1390.         1517.

      MONTHLY      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec  Year
Rainfall     (mm)  221  253  258  189  170  134   96   74   61  109  130  159 1853
Pan Evap     (mm)  164  128  122   95   73   65   75   97  124  146  155  172 1416
Ave Max Temp DegC   28   28   27   25   22   20   20   21   23   25   26   28   24
Ave Min Temp DegC   20   20   18   16   13   10    9   10   12   15   17   18   14
Rad   (MJ/m2/day)   22   21   18   16   13   12   13   16   20   22   23   23   18
------------------------------------------------------------------------------------
-
MONTHLY IRRIGATION
******************


Irrigation   (mm)   20   17   21   20   21   21   26   29   30   27   23   21  277
____________________________________________________________________________________
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SOIL PROPERTIES
***************

Soil type: Med Perm Red Brown Earth

SOIL WATER PROPERTIES

                                             Layer 1     Layer 2     Layer 3
Bulk Density                        (g/cm3)    1.9         1.9         2.0
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Porosity                          (mm/layer)   30.2      141.5      158.5
Saturated Water Content           (mm/layer)   30.0      140.0      156.0
Drained Upper Limit               (mm/layer)   25.0      125.0      144.0
Lower Storage Limit               (mm/layer)   15.0       80.0       96.0
Air Dry Moisture Content          (mm/layer)   10.0
Layer Thickness                         (mm)  100.0      500.0      600.0

                                             Profile  Max Rootzone
Total Saturated Water Content           (mm)  326.0      170.0
Total Drained Upper Limit               (mm)  294.0      150.0
Total Lower Storage Limit               (mm)  191.0       95.0
Total Air Dry Moisture Content          (mm)   11.1       10.5
Total Depth                             (mm) 1200.0      600.0

Maximum Plant Available Water Capacity         55.0
Saturated Hydraulic Conductivity
                At Surface           (mm/hr)   10.0
                Limiting             (mm/hr)    1.0

RUNOFF

Runoff curve No II                             80.0

SOIL EVAPORATION


CONA                            (mm/day^0.5)    4.0
URITCH                                  (mm)   10.0
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AVERAGE WASTE STREAM
********************

Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume                      (ML/year)    5.442
Nitrogen                        (tonne/year)    0.163
Phosphorus                      (tonne/year)    0.054
Salinity                        (tonne/year)    0.054

Nitrogen Concentration                (mg/L)   30.000
Phosphorus Concentration              (mg/L)   10.000
Salinity                              (mg/L)   10.000
Salinity                              (dS/m)    0.016

WASTE STREAM DETAILS (for last inflow event):
Nitrogen Concentration                (mg/L)   30.000
Phosphorus Concentration              (mg/L)   10.000
TDS Concentration                     (mg/L)   10.000
Salinity                              (dS/m)    0.016
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IRRIGATION WATER
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Irrigation triggered on a soil water deficit of (mm):    1.0
Irrigating upto upper storage limit +   2 mm
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AREA

Total Irrigation Area                   (ha)    3.000

VOLUMES

Total Irrigation                   (ML/year)    8.313
Minimum Volume Irrigated by Pump (ML/ha/day)    0.000
Maximum Volume Irrigated by Pump (ML/ha/day)    5.333
Maximum Vol. Available For Shandying (ML/yr)    0.000

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation        (dS/m)    0.010
Average salinity of Irrigation        (mg/L)    6.452
Average Nitrogen Conc of Irrigation
                Before ammonia loss   (mg/L)    6.863
                After ammonia loss    (mg/L)    6.795
Average Phosphorus Conc of Irrigation (mg/L)    6.452
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FRESH WATER USAGE
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Irrigation (shandying) water         (ML/yr)   0.00

Avg volume of fresh water used       (ML/yr)   0.00

Annual allocation                    (ML/yr)    N/A


POND INFORMATION
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POND GEOMETRY
                                              Pond 1      Pond 2

Final pond volume                    (ML)       1.500       1.039
Final liquid volume                  (ML)       1.500       1.039
Final sludge volume                  (ML)       0.000       0.000
Average pond volume                  (ML)       1.498       1.552
Average active volume                (ML)       1.498       1.552
Maximum pond volume                  (ML)       1.500       8.000
Minimum allowable pond volume        (ML)       0.000       0.675
Average pond depth                    (m)       3.995       0.897
Pond depth at outlet                  (m)       4.000       4.000
Maximum water surface area     (m2 x1000)       0.378       2.368
Pond catchment area            (m2 x1000)       0.459       2.566
Pond footprint length                 (m)      21.432      50.659
Pond footprint width                  (m)      21.432      50.659

POND WATER BALANCE

Inflow of Effluent to pond system    (ML/yr)    5.442
Recycle Volume from pond system      (ML/yr)    0.000
Rain water added to pond system      (ML/yr)    4.756
Evaporation loss from pond system    (ML/yr)    1.782
Seepage loss from pond system        (ML/yr)    0.080
Irrigation from last pond            (ML/yr)    8.313
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Volume of overtopping                (ML/yr)    0.000
Sludge accumulated                   (ML/yr)    0.000
    Sludge accumulated             (t DM/yr)    0.000
Sludge removed                       (ML/yr)    0.000
No of desludging events every 10 years          0.000
Increase in pond water volume        (ML/yr)    0.023

OVERTOPPING EVENTS

Volume of overtopping              (ML/year)    0.00
Average Length of overtopping events  (days)    0.00
% Reuse                                         0.00
No. of overtopping events per 10 years          0.00

>>> NO-IRRIGATION EVENTS <<<

%Days rain prevents irrigation                 38.682
%Days water demand too small to trigger irr.   23.576
%Days pond volume below min. vol. for irrig.    0.186
No. periods/year without irrigable effluent     0.037
Average Length of such periods        (days)   18.500

POND NITROGEN BALANCE

Nitrogen Added by Effluent        (tonne/yr)    0.163 Irrig. from pond (ML/yr)
8.3
Nitrogen removed by Irrigation    (tonne/yr)    0.057
Nitrogen removed by Volatilisation(tonne/yr)    0.105
Nitrogen removed by Seepage       (tonne/yr)    0.001
Nitrogen accumulated in Sludge    (tonne/yr)    0.000
Nitrogen lost by Overtopping      (tonne/yr)    0.000
Nitrogen involved in Recycling    (tonne/yr)    0.000
Increase in pond Nitrogen         (tonne/yr)    0.000

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent      (tonne/yr)    0.054 Irrig. from pond (ML/yr)
8.3
Phosphorus removed by Irrigation  (tonne/yr)    0.054
Phosphorus removed by Seepage     (tonne/yr)    0.001
Phosphorus accumulated in Sludge  (tonne/yr)    0.000
Phosphorus lost by Overtopping    (tonne/yr)    0.000
Phosphorus involved in Recycling  (tonne/yr)    0.000
Increase in pond Phosphorus       (tonne/yr)    0.000

POND SALINITY BALANCE

Salinity Added by Effluent        (tonne/yr)    0.054
Salinity removed by Irrigation    (tonne/yr)    0.054
Salinity removed by Seepage       (tonne/yr)    0.001
Salinity lost by Overtopping      (tonne/yr)    0.000
Salinity involved in Recycling    (tonne/yr)    0.000
Increase in pond Salinity         (tonne/yr)    0.000

POND CONCENTRATIONS
                                              Pond 1      Pond 2

Average Nitrogen Conc of Pond Liquid  (mg/L)   22.2         6.2
Average Phosphorus Conc of Pond Liquid(mg/L)   10.0         5.8
Average TDS Conc of Pond Liquid       (mg/L)   10.0         5.8
Average Salinity of Pond Liquid       (dS/m)    0.0         0.0
Average Potassium Conc of Pond Liquid (mg/L)    0.0         0.0
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(On final day of simulation)
Nitrogen Conc of Pond Liquid          (mg/L)   22.2         6.2
Phosphorus Conc of Pond Liquid        (mg/L)   10.0         7.4
TDS Conc of Pond Liquid               (mg/L)   10.0         7.4
EC of Pond Liquid                     (dS/m)    0.0         0.0
Potassium Conc of Pond Liquid         (mg/L)    0.0         0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)   (kg/tonne)    0.000
Phosphorus in removed Sludge (db) (kg/tonne)    0.000
Salt in removed Sludge (db)       (kg/tonne)    0.000
Potassium in removed Sludge (db)  (kg/tonne)    0.000

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge        (tonne/yr)    0.000
Phosphorus in removed Sludge      (tonne/yr)    0.000
Salt in removed Sludge (mass bal.)(tonne/yr)    0.000
Salt in removed Sludge            (tonne/yr)    0.000
Potm. in removed Sludge (mass bal.)(tonne/yr    0.000
Potassium in removed Sludge       (tonne/yr)    0.000
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LAND DISPOSAL AREA
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WATER BALANCE
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(Initial soil water assumed to be at field capacity)
(Irrigated up to   22.25% of field capacity)
Rainfall                         (mm/year)   1853.2   Irrigation Area     (ha)
3.0
Irrigation                       (mm/year)    277.1
Soil Evaporation                 (mm/year)    105.6
Transpiration                    (mm/year)    667.7
Runoff                           (mm/year)    589.1
Drainage                         (mm/year)    767.8
Change in soil moisture          (mm/year)      0.2

ANNUAL TOTALS

 Year  Rain     Irrig    Sevap    Trans    Runoff    Drain    Change
       (mm)     (mm)     (mm)     (mm)     (mm)      (mm)     (mm)
_____________________________________________________________________________
 1901  1769.0   204.3    212.6    579.4    465.2    770.9    -54.9
 1902  1017.0   209.5     41.7    675.9     93.6    383.7     31.7
 1903  2005.0   289.5     41.7    754.4    602.4    872.8     23.2
 1904  1936.0   288.5     41.8    690.2    734.7    765.9     -8.1
 1905  1904.0   276.5     41.7    698.2    676.0    749.7     14.8
 1906  2217.0   289.5     41.7    699.5    815.9    937.6     11.7
 1907  2142.0   323.4     41.7    723.0    758.9    941.8     -0.1
 1908  1725.0   275.0     41.8    692.7    522.2    784.6    -41.3
 1909  1017.0   198.2     41.7    740.2     36.7    361.6     35.0
 1910  2326.0   317.0     41.7    677.4    784.6   1154.9    -15.5
 1911  1554.0   264.4     41.7    710.4    417.0    700.2    -50.9
 1912  1301.0   233.7     41.8    640.8    274.3    531.8     46.1
 1913  1950.0   286.9    104.6    632.8    702.1    840.8    -43.5
 1914  1855.0   266.2    384.2    591.1    284.6    797.9     63.4
 1915   816.0   206.7     41.7    666.2     90.7    249.9    -25.8
 1916  1631.0   258.6     41.8    757.6    365.2    712.1     12.8
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1917	1824.0	251.7	41.7	741.6	583.3	710.1	-1.0
1918	1663.0	290.3	41.7	675.3	481.6	771.5	-16.9
1919	1809.0	272.0	41.7	697.1	671.7	660.8	9.6
1920	1866.0	283.9	41.8	750.5	455.5	941.2	-39.0
1921	2427.0	303.5	41.7	680.5	871.3	1062.5	74.5
1922	1421.0	265.5	41.7	649.3	425.0	604.3	-33.7
1923	1195.0	212.5	41.7	615.6	269.8	473.4	7.0
1924	1565.0	263.6	41.8	736.6	435.0	610.3	4.9
1925	2505.0	329.9	41.7	756.1	930.0	1085.6	21.5
1926	1627.0	253.2	41.7	628.7	569.8	663.3	-23.3
1927	2461.0	312.2	41.7	679.1	1181.3	874.0	-2.9
1928	1544.0	282.4	41.8	694.7	420.8	710.7	-41.6
1929	2280.0	312.2	41.7	707.7	1124.4	704.9	13.6
1930	2151.0	305.4	41.7	738.5	559.6	1108.4	8.1
1931	2211.0	307.1	41.7	702.7	957.8	795.7	20.3
1932	939.0	203.0	41.8	688.8	24.1	421.3	-34.1
1933	2074.0	275.7	41.7	678.5	661.8	929.7	38.0
1934	2100.0	310.9	41.7	708.5	742.2	923.6	-5.1
1935	1438.0	255.9	41.7	721.5	184.5	768.4	-22.1
1936	1213.0	213.0	41.8	704.4	105.5	543.3	30.9
1937	2382.0	320.6	41.7	758.6	847.9	1058.3	-3.9
1938	2223.0	325.4	41.7	729.8	930.3	903.6	-57.0
1939	1762.0	270.3	41.7	672.6	516.3	768.9	32.8
1940	1400.0	242.6	500.2	413.8	322.0	417.2	-10.6
1941	1566.0	255.6	396.5	448.8	295.1	697.5	-16.2
1942	1935.0	273.0	287.4	592.1	499.2	749.8	79.4
1943	1665.0	246.9	41.7	699.7	385.9	797.5	-12.9
1944	1428.0	273.2	41.8	703.1	388.0	584.1	-15.7
1945	2036.0	296.5	41.7	718.0	586.1	992.0	-5.4
1946	1455.0	246.0	41.7	650.4	535.2	500.3	-26.7
1947	2167.0	291.6	41.7	721.0	721.7	948.4	25.9
1948	2035.0	306.1	41.8	695.5	741.5	877.8	-15.6
1949	1619.0	259.5	41.7	715.5	409.1	717.0	-4.8
1950	2680.0	303.5	41.7	737.0	894.6	1287.2	23.0
1951	1597.0	296.4	41.7	606.6	602.3	655.6	-12.7
1952	1634.0	260.4	81.5	609.9	443.0	761.3	-1.3
1953	1886.0	283.6	537.8	431.3	884.7	333.8	-17.9
1954	2621.0	345.5	426.0	667.4	1037.8	831.2	4.1
1955	2268.0	258.5	41.7	673.1	918.6	865.3	27.9
1956	2379.0	359.2	41.8	700.0	1198.6	795.8	1.9
1957	1473.0	259.7	41.7	602.9	345.3	756.1	-13.2
1958	1974.0	285.3	41.7	691.1	614.9	900.7	10.9
1959	2363.0	308.3	41.7	722.8	807.9	1100.7	-1.8
1960	1124.0	235.7	41.8	625.9	70.6	635.0	-13.6
1961	1933.0	272.1	41.7	705.2	415.5	1028.2	14.5
1962	2535.0	321.4	41.7	698.2	1093.9	999.8	22.9
1963	2502.0	353.8	41.7	719.9	1002.9	1097.1	-5.8
1964	1705.0	267.5	41.8	702.3	468.7	773.6	-14.0
1965	1603.0	241.0	41.7	671.6	398.5	736.2	-4.0
1966	1424.0	260.6	41.7	687.9	384.8	552.5	17.7
1967	2447.0	331.2	41.7	710.4	924.3	1135.5	-33.7
1968	1325.0	235.5	96.8	513.0	413.2	555.3	-17.8
1969	1611.0	259.9	446.7	569.4	302.1	567.2	-14.4
1970	1859.0	246.4	56.8	763.7	546.6	673.9	64.4
1971	1580.0	277.3	43.7	664.0	293.0	878.4	-22.0
1972	3228.0	387.6	43.7	754.0	1694.5	1134.5	-11.1
1973	2201.0	302.8	45.5	782.6	806.4	857.3	12.0
1974	3115.0	378.2	43.9	714.7	1786.1	982.4	-33.9
1975	2055.0	282.1	42.9	718.6	633.4	901.6	40.5
1976	2194.0	315.6	44.3	734.9	809.8	931.1	-10.5
1977	1539.0	244.8	47.6	712.3	535.5	532.3	-44.0
1978	2199.0	283.2	44.0	698.7	690.6	961.9	87.0
1979	1622.0	279.0	43.4	674.8	588.0	669.6	-74.6

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 1980  1893.0   268.6    46.2   725.3   655.6   659.8    74.6
 1981  1699.0   260.0    44.6   727.3   513.1   695.5   -21.6
 1982  1497.0   258.1    42.3   649.1   311.7   764.6   -12.6
 1983  2500.0   304.3    40.6   660.1   917.2  1165.5    20.8
 1984  2075.0   323.8    41.5   714.6   897.1   764.3   -18.8
 1985  1735.0   275.0    41.8   694.5   479.0   835.9   -41.2
 1986   998.0   205.0    43.8   724.3    69.5   338.2    27.2
 1987  2284.0   309.7    41.2   678.6   940.4   896.1    37.4
 1988  2863.0   333.7    40.2   689.3  1339.6  1154.6   -26.9
 1989  2187.0   319.5    36.6   613.7   605.0  1249.9     1.3
 1990  1964.0   315.0    37.9   632.3   718.0   922.7   -31.9
 1991  1700.0   267.6    40.9   644.2   518.2   733.9    30.3
 1992  1377.0   243.5    39.1   652.6   144.3   784.1     0.4
 1993  1248.0   226.1    43.8   738.1   187.3   551.4   -46.6
 1994  1658.0   256.7   557.9   352.6   426.1   566.6    11.4
 1995  1427.0   241.5   474.5   538.3   274.2   364.4    17.1
 1996  2033.0   291.3   485.2   589.7   607.0   647.7    -5.3
 1997  1488.0   239.3   330.2   641.1   118.0   613.0    25.0
 1998  1481.0   252.7    44.3   730.7   220.9   735.3     2.5
 1999  2845.0   311.6    40.8   720.7   915.4  1483.2    -3.6
 2000  1401.0   277.3    44.5   675.0   237.1   713.1     8.6
 2001  1653.0   259.7    47.3   679.0   679.6   546.7   -40.0
 2002  1228.0   211.2   493.2   424.6   133.1   356.9    31.4
 2003  1829.0   281.6   503.3   427.3   627.2   577.0   -24.2
 2004  1635.0   254.9   543.2   410.7   523.0   404.0     8.9
 2005  1626.0   256.0   575.9   477.5   527.3   325.8   -24.5
 2006  2027.0   291.6   304.9   720.2   607.8   654.2    31.4
 2007  1356.0   224.4    45.5   745.0   198.8   558.9    32.1
 2008  2271.0   312.0    43.6   734.7   816.7  1005.3   -17.4
 2009  2199.0   296.0    46.8   694.6   941.3   796.1    16.3
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NUTRIENT BALANCE
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NITROGEN

Total N irrigated from ponds  (kg/ha/year)     19.0   % of Total as ammonium
5.0
Nitrogn lost by ammonia volat.(kg/ha/year)      0.2   Deep Drainage (mm/year)
767.8
Nitrogen added in irrigation  (kg/ha/year)     18.8
Nitrogen added in seed        (kg/ha/year)      0.3
Nitrogen removed by crop      (kg/ha/year)     24.4
Denitrification               (kg/ha/year)      0.1
Leached NO3-N                 (kg/ha/year)      0.3
Change in soil organic-N      (kg/ha/year)     -5.1
Change in soil solution NH4-N (kg/ha/year)      0.0
Change in soil solution NO3-N (kg/ha/year)     -0.5
Change in adsorbed NH4-N      (kg/ha/year)      0.0
Initial soil organic-N             (kg/ha)    565.0
Final soil organic-N               (kg/ha)      5.5
Initial soil inorganic-N           (kg/ha)     57.6
Final soil inorganic-N             (kg/ha)      0.0
Average N03-N conc in the root zone (mg/L)      0.0
Average N03-N conc below root zone  (mg/L)      0.1
Average N03-N conc of deep drainage (mg/L)      0.0

PHOSPHORUS
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Phosphorus added in irrigatn  (kg/ha/year)     17.9   % of Total as phosphate
100.0
Phosphorus added in seed      (kg/ha/year)      0.0
Phosphorus removed by crop    (kg/ha/year)     12.6
Leached PO4-P                 (kg/ha/year)      0.8
Change in dissolved PO4-P     (kg/ha/year)      0.0
Change in adsorbed PO4-P      (kg/ha/year)      4.5
Average P04-P conc in the root zone (mg/L)      0.3
Average P04-P conc below root zone  (mg/L)      0.1

SOIL P STORAGE LIFE

 Year YearNo.  Tot P stored    P leached in year
                 kg/ha               kg/ha
______________________________________________________________________________
 1901    1       3127.8          0.7
 1902    2       3124.5          0.4
 1903    3       3123.8          0.8
 1904    4       3130.5          0.7
 1905    5       3121.9          0.7
 1906    6       3122.1          0.9
 1907    7       3120.8          0.9
 1908    8       3130.9          0.7
 1909    9       3123.2          0.3
 1910   10       3121.9          1.1
 1911   11       3124.7          0.7
 1912   12       3134.3          0.5
 1913   13       3126.4          0.8
 1914   14       3130.0          0.8
 1915   15       3130.9          0.2
 1916   16       3142.7          0.7
 1917   17       3136.3          0.7
 1918   18       3137.7          0.7
 1919   19       3140.7          0.6
 1920   20       3152.2          0.9
 1921   21       3144.8          1.0
 1922   22       3149.1          0.6
 1923   23       3152.7          0.4
 1924   24       3166.0          0.6
 1925   25       3159.4          1.0
 1926   26       3163.0          0.6
 1927   27       3166.1          0.8
 1928   28       3177.6          0.7
 1929   29       3173.4          0.7
 1930   30       3176.0          1.0
 1931   31       3179.6          0.7
 1932   32       3193.6          0.4
 1933   33       3189.6          0.9
 1934   34       3193.8          0.9
 1935   35       3198.3          0.7
 1936   36       3211.5          0.5
 1937   37       3206.8          1.0
 1938   38       3209.5          0.9
 1939   39       3214.1          0.7
 1940   40       3229.6          0.4
 1941   41       3226.6          0.7
 1942   42       3233.0          0.7
 1943   43       3237.9          0.8
 1944   44       3252.2          0.6
 1945   45       3248.5          1.0
 1946   46       3254.8          0.5
 1947   47       3259.1          0.9
 1948   48       3275.7          0.9
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1949	49	3272.2	0.7
1950	50	3277.1	1.3
1951	51	3283.0	0.7
1952	52	3299.1	0.8
1953	53	3296.8	0.3
1954	54	3303.2	0.8
1955	55	3306.7	0.9
1956	56	3320.1	0.8
1957	57	3319.4	0.8
1958	58	3324.2	0.9
1959	59	3328.9	1.1
1960	60	3344.6	0.7
1961	61	3340.6	1.1
1962	62	3345.2	1.0
1963	63	3350.0	1.2
1964	64	3365.8	0.8
1965	65	3363.1	0.8
1966	66	3369.0	0.6
1967	67	3372.9	1.2
1968	68	3389.4	0.6
1969	69	3386.7	0.6
1970	70	3391.7	0.7
1971	71	3396.3	0.9
1972	72	3410.5	1.2
1973	73	3407.7	0.9
1974	74	3411.6	1.1
1975	75	3418.6	1.0
1976	76	3432.3	1.0
1977	77	3429.1	0.6
1978	78	3434.7	1.1
1979	79	3440.0	0.7
1980	80	3455.2	0.7
1981	81	3451.6	0.8
1982	82	3457.0	0.8
1983	83	3461.9	1.3
1984	84	3478.4	0.9
1985	85	3472.9	0.9
1986	86	3480.1	0.4
1987	87	3484.8	1.0
1988	88	3499.6	1.3
1989	89	3493.8	1.4
1990	90	3500.5	1.1
1991	91	3507.4	0.8
1992	92	3521.5	0.9
1993	93	3518.9	0.6
1994	94	3525.1	0.7
1995	95	3532.8	0.4
1996	96	3548.6	0.8
1997	97	3545.2	0.7
1998	98	3551.2	0.9
1999	99	3554.8	1.8
2000	100	3571.3	0.8
2001	101	3568.0	0.7
2002	102	3575.1	0.4
2003	103	3582.7	0.7
2004	104	3600.1	0.5
2005	105	3597.8	0.4
2006	106	3603.5	0.8
2007	107	3609.6	0.7
2008	108	3624.5	1.2
2009	109	3620.5	1.0

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PLANT
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Plant species:  Ryegrass pasture

PLANT WATER USE

Irrigation                         (mm/year)   277.   Totl Irrigation Area(ha)
3.0
Pan coefficient                          (%)     1.0
Maximum crop coefficient                 (%)     0.8
Average Plant Cover                      (%)    63.
Average Plant Total Cover                (%)    91.
Average Plant Rootdepth                 (mm)   564.
Average Plant Available Water Capacity  (mm)    55.
Average Plant Available Water           (mm)    49.
Yield produced per unit transp.   (kg/ha/mm)     6.

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)         (kg/ha/yr)  4213.
Net nitrogen removed by plant     (kg/ha/yr)    24.   Shoot Concn        (%DM)
0.57
Net phosphorus removed by plant   (kg/ha/yr)    13.   Shoot Concn        (%DM)
0.30

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)


Month Yield     Nitr  Temp   Water  Water
      kg/ha                  Defic Logging
____________________________________________
  1    385.      0.8    0.4    0.1    0.0
  2    322.      0.8    0.4    0.0    0.0
  3    328.      0.8    0.3    0.0    0.1
  4    287.      0.8    0.2    0.0    0.0
  5    255.      0.8    0.0    0.0    0.0
  6    230.      0.8    0.0    0.0    0.0
  7    282.      0.8    0.0    0.0    0.0
  8    359.      0.8    0.0    0.0    0.0
  9    417.      0.8    0.0    0.1    0.0
 10    450.      0.8    0.1    0.1    0.0
 11    463.      0.8    0.2    0.1    0.0
 12    437.      0.8    0.3    0.1    0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress                 0.0
%Days due to scorching                          0.0
%Days due to water stress                       0.9
%Days due to nitrogen stress                    0.0
No. of forced harvests per year                 0.2
No. of normal harvests per year                 1.0
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SALINITY
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Salt tolerance - plant species: tolerant

Average EC of Irrigation Water        (dS/m)    0.0   Irrigation     (mm/year)
277.1
Average EC of Rainwater           (dS/m x10)    0.3   Rainfall       (mm/year)
1853.2
Average EC of Infiltrated water       (dS/m)    0.0
Av. water-upt-weightd rootzone EC(dS/m s.e.)    0.0
EC soil soln (FC) at base of rootzone (dS/m)    0.1   Deep Drainage  (mm/year)
767.8
Reduction in Crop yield due to Salinity  (%)    0.0
Percentage of yrs that crop yld falls below
  90% of potential because of soil salinity     0.0

     Period     ECrootzone  ECbase  Rel Yield
                  sat ext  in situ
                  (dS/m)    (dS/m)     (%)
_____________________________________________
   1901 - 1910      0.02       0.05       100.
   1902 - 1911      0.02       0.05       100.
   1903 - 1912      0.02       0.05       100.
   1904 - 1913      0.02       0.05       100.
   1905 - 1914      0.02       0.05       100.
   1906 - 1915      0.02       0.05       100.
   1907 - 1916      0.02       0.06       100.
   1908 - 1917      0.02       0.06       100.
   1909 - 1918      0.02       0.06       100.
   1910 - 1919      0.02       0.05       100.
   1911 - 1920      0.02       0.06       100.
   1912 - 1921      0.02       0.05       100.
   1913 - 1922      0.02       0.05       100.
   1914 - 1923      0.02       0.06       100.
   1915 - 1924      0.02       0.06       100.
   1916 - 1925      0.02       0.05       100.
   1917 - 1926      0.02       0.05       100.
   1918 - 1927      0.02       0.05       100.
   1919 - 1928      0.02       0.05       100.
   1920 - 1929      0.02       0.05       100.
   1921 - 1930      0.02       0.05       100.
   1922 - 1931      0.02       0.05       100.
   1923 - 1932      0.02       0.05       100.
   1924 - 1933      0.02       0.05       100.
   1925 - 1934      0.02       0.05       100.
   1926 - 1935      0.02       0.05       100.
   1927 - 1936      0.02       0.05       100.
   1928 - 1937      0.02       0.05       100.
   1929 - 1938      0.02       0.05       100.
   1930 - 1939      0.02       0.05       100.
   1931 - 1940      0.02       0.05       100.
   1932 - 1941      0.02       0.05       100.
   1933 - 1942      0.02       0.05       100.
   1934 - 1943      0.02       0.05       100.
   1935 - 1944      0.02       0.06       100.
   1936 - 1945      0.02       0.05       100.
   1937 - 1946      0.02       0.05       100.
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1938 - 1947      0.02      0.05      100.
1939 - 1948      0.02      0.05      100.
1940 - 1949      0.02      0.06      100.
1941 - 1950      0.02      0.05      100.
1942 - 1951      0.02      0.05      100.
1943 - 1952      0.02      0.05      100.
1944 - 1953      0.02      0.05      100.
1945 - 1954      0.02      0.05      100.
1946 - 1955      0.02      0.05      100.
1947 - 1956      0.02      0.05      100.
1948 - 1957      0.02      0.05      100.
1949 - 1958      0.02      0.05      100.
1950 - 1959      0.02      0.05      100.
1951 - 1960      0.02      0.05      100.
1952 - 1961      0.02      0.05      100.
1953 - 1962      0.02      0.05      100.
1954 - 1963      0.02      0.05      100.
1955 - 1964      0.02      0.05      100.
1956 - 1965      0.02      0.05      100.
1957 - 1966      0.02      0.05      100.
1958 - 1967      0.02      0.05      100.
1959 - 1968      0.02      0.05      100.
1960 - 1969      0.02      0.05      100.
1961 - 1970      0.02      0.05      100.
1962 - 1971      0.02      0.05      100.
1963 - 1972      0.02      0.05      100.
1964 - 1973      0.02      0.05      100.
1965 - 1974      0.02      0.05      100.
1966 - 1975      0.02      0.05      100.
1967 - 1976      0.02      0.05      100.
1968 - 1977      0.02      0.05      100.
1969 - 1978      0.02      0.05      100.
1970 - 1979      0.02      0.05      100.
1971 - 1980      0.02      0.05      100.
1972 - 1981      0.02      0.05      100.
1973 - 1982      0.02      0.05      100.
1974 - 1983      0.02      0.05      100.
1975 - 1984      0.02      0.05      100.
1976 - 1985      0.02      0.05      100.
1977 - 1986      0.02      0.05      100.
1978 - 1987      0.02      0.05      100.
1979 - 1988      0.02      0.05      100.
1980 - 1989      0.02      0.05      100.
1981 - 1990      0.02      0.05      100.
1982 - 1991      0.02      0.05      100.
1983 - 1992      0.02      0.05      100.
1984 - 1993      0.02      0.05      100.
1985 - 1994      0.02      0.05      100.
1986 - 1995      0.02      0.05      100.
1987 - 1996      0.02      0.05      100.
1988 - 1997      0.02      0.06      100.
1989 - 1998      0.02      0.06      100.
1990 - 1999      0.02      0.06      100.
1991 - 2000      0.02      0.06      100.
1992 - 2001      0.02      0.06      100.
1993 - 2002      0.02      0.06      100.
1994 - 2003      0.02      0.06      100.
1995 - 2004      0.02      0.06      100.
1996 - 2005      0.02      0.06      100.
1997 - 2006      0.02      0.06      100.
1998 - 2007      0.02      0.06      100.
1999 - 2008      0.02      0.06      100.
2000 - 2009      0.02      0.06      100.
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GROUNDWATER
************

Average Groundwater Recharge        (m3/day)   63.1
Average Nitrate-N Conc of Recharge    (mg/L)    0.0

Thickness of the Aquifer                 (m)   10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated   500.0

Concentration of NITRATE-N in Groundwater (mg/L)
----------------------------------------------

       Year     Depth Below Water Table Surface
                  0.0 m     5.0 m     9.0 m
____________________________________________
       1905       0.0       0.0       0.0
       1910       0.0       0.0       0.0
       1915       0.0       0.0       0.0
       1920       0.0       0.0       0.0
       1925       0.0       0.0       0.0
       1930       0.0       0.0       0.0
       1935       0.0       0.0       0.0
       1940       0.0       0.0       0.0
       1945       0.0       0.0       0.0
       1950       0.0       0.0       0.0
       1955       0.0       0.0       0.0
       1960       0.0       0.0       0.0
       1965       0.0       0.0       0.0
       1970       0.0       0.0       0.0
       1975       0.0       0.0       0.0
       1980       0.0       0.0       0.0
       1985       0.0       0.0       0.0
       1990       0.0       0.0       0.0
       1995       0.0       0.0       0.0
       2000       0.0       0.0       0.0
       2005       0.0       0.0       0.0
Last   2009       0.0       0.0       0.0
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ACKNOWLEDGMENTS
***************
This run brought to you courtesy of:

MEDLIEXE.EXE  :  1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE   :  1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE    :   439296 bytes Fri Dec 11 12:28:08 1998

__________________________________________
OTHER INDUSTRY INPUT PARAMETERS - DATA SUMMARY

Nature of Industry: other
__________________________________________

UNCONDITIONAL FINISH
```

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*****************************************
         SUMMARY OUTPUT
      MEDLI  Version 1.30

Data Set:   GJ0926-base
Run Date: 13/05/10   Time:18:53:41.43
*****************************************

GENERAL INFORMATION
*******************
Title:    North Byron Parklands
Subject:  Irrigation assessment
Client:   Billinudgel Property Trust
User:     NTZ
Time:     Thu May 13 18:43:14 2010
Comments: Base case on Tropical Pasture - no irrigation.


RUN PERIOD
**********

Starting Date  1/ 1/1901
Ending Date   31/12/2009
Run Length    109 years   0 days
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CLIMATE INFORMATION
*******************

Enterprise site: Yelgun                               -28.5 deg S  153.5 deg E
Weather station: Yelgun rad

  ANNUAL TOTALS    10 Percentile  50 percentile  90 Percentile
Rainfall mm/year        1313.        1827.        2481.
Pan Evap mm/year        1390.        1390.        1517.

      MONTHLY      Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec  Year
Rainfall     (mm)  221  253  258  189  170  134   96   74   61  109  130  159 1853
Pan Evap     (mm)  164  128  122   95   73   65   75   97  124  146  155  172 1416
Ave Max Temp DegC   28   28   27   25   22   20   20   21   23   25   26   28   24
Ave Min Temp DegC   20   20   18   16   13   10    9   10   12   15   17   18   14
Rad   (MJ/m2/day)   22   21   18   16   13   12   13   16   20   22   23   23   18
------------------------------------------------------------------------------------
-
MONTHLY IRRIGATION
******************

Irrigation   (mm)    0    0    0    0    0    0    0    0    0    0    0    0    0
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SOIL PROPERTIES
***************

Soil type: Med Perm Red Brown Earth

SOIL WATER PROPERTIES

                                             Layer 1     Layer 2     Layer 3
Bulk Density                        (g/cm3)    1.9         1.9         2.0
Porosity                        (mm/layer)   30.2       141.5       158.5
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Saturated Water Content           (mm/layer)   30.0      140.0      156.0
Drained Upper Limit               (mm/layer)   25.0      125.0      144.0
Lower Storage Limit               (mm/layer)   15.0       80.0       96.0
Air Dry Moisture Content          (mm/layer)   10.0
Layer Thickness                         (mm)  100.0      500.0      600.0

                                             Profile  Max Rootzone
Total Saturated Water Content           (mm)  326.0      222.0
Total Drained Upper Limit               (mm)  294.0      198.0
Total Lower Storage Limit               (mm)  191.0      127.0
Total Air Dry Moisture Content          (mm)   11.1       10.7
Total Depth                             (mm) 1200.0      800.0

Maximum Plant Available Water Capacity         71.0
Saturated Hydraulic Conductivity
                At Surface           (mm/hr)   10.0
                Limiting             (mm/hr)    1.0

RUNOFF

Runoff curve No II                             80.0

SOIL EVAPORATION

CONA                            (mm/day^0.5)    4.0
URITCH                                  (mm)   10.0
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AVERAGE WASTE STREAM
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Other waste stream
(All values relate to influent after any screening and recycling, if applicable).

Inflow Volume                      (ML/year)   13.15
Nitrogen                        (tonne/year)    0.39
Phosphorus                      (tonne/year)    0.13
Salinity                        (tonne/year)    0.13

Nitrogen Concentration                (mg/L)   30.00
Phosphorus Concentration              (mg/L)   10.00
Salinity                              (mg/L)   10.00
Salinity                              (dS/m)    0.02

WASTE STREAM DETAILS (for last inflow event):
Nitrogen Concentration                (mg/L)   30.00
Phosphorus Concentration              (mg/L)   10.00
TDS Concentration                     (mg/L)   10.00
Salinity                              (dS/m)    0.02
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IRRIGATION WATER
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Irrigation triggered every   1 days
Irrigating a fixed amount of   0 mm
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AREA

Total Irrigation Area                   (ha)    2.80

VOLUMES

Total Irrigation                   (ML/year)    0.00
Minimum Volume Irrigated by Pump (ML/ha/day)    0.00
Maximum Volume Irrigated by Pump (ML/ha/day)    5.71
Maximum Vol. Available For Shandying (ML/yr)    0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation        (dS/m)    0.00
Average salinity of Irrigation        (mg/L)    0.00
Average Nitrogen Conc of Irrigation
                Before ammonia loss   (mg/L)    0.00
                After ammonia loss    (mg/L)    0.00
Average Phosphorus Conc of Irrigation (mg/L)    0.00
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FRESH WATER USAGE
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Irrigation (shandying) water         (ML/yr)   0.00


Avg volume of fresh water used       (ML/yr)   0.00

Annual allocation                    (ML/yr)    N/A


POND INFORMATION
****************

POND GEOMETRY
                                              Pond 1      Pond 2

Final pond volume                    (ML)       1.50        8.00
Final liquid volume                  (ML)       1.50        8.00
Final sludge volume                  (ML)       0.00        0.00
Average pond volume                  (ML)       1.50        7.98
Average active volume                (ML)       1.50        7.98
Maximum pond volume                  (ML)       1.50        8.00
Minimum allowable pond volume        (ML)       0.00        0.67
Average pond depth                    (m)       4.00        3.99
Pond depth at outlet                  (m)       4.00        4.00
Maximum water surface area     (m2 x1000)       0.38        2.37
Pond catchment area            (m2 x1000)       0.46        2.57
Pond footprint length                 (m)      21.43       50.66
Pond footprint width                  (m)      21.43       50.66

POND WATER BALANCE

Inflow of Effluent to pond system    (ML/yr)   13.15
Recycle Volume from pond system      (ML/yr)    0.00
Rain water added to pond system      (ML/yr)    4.76
Evaporation loss from pond system    (ML/yr)    2.34
Seepage loss from pond system        (ML/yr)    0.10
Irrigation from last pond            (ML/yr)    0.00
Volume of overtopping                (ML/yr)   15.37
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Sludge accumulated                   (ML/yr)    0.00
    Sludge accumulated             (t DM/yr)    0.00
Sludge removed                       (ML/yr)    0.00
No of desludging events every 10 years          0.00
Increase in pond water volume        (ML/yr)    0.09

OVERTOPPING EVENTS

Volume of overtopping                (ML/yr)   15.37
No. of days pond overtops per 10 years       3634.98
Average Length of overtopping events  (days)39621.00
% Reuse                                         0.00
No. of overtopping events every 10 years
          >  0.000 ML         0.09
          >  0.002 ML*        0.00
          >  1.000 ML         0.00
          >  2.000 ML         0.00
          >  5.000 ML         0.00
          > 10.000 ML         0.00
          > 20.000 ML         0.00
          > 50.000 ML         0.00
* Volume equivalent to 1 mm depth of water

>>> NO-IRRIGATION EVENTS <<<

Irrigation fixed at 0 mm/day
>>>No effluent irrigation occurred!<<<
No. periods/year without irrigable effluent     0.01
Average Length of such periods        (days)   52.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent        (tonne/yr)    0.39  Irrig. from pond (ML/yr)
0.0
Nitrogen removed by Irrigation    (tonne/yr)    0.00
Nitrogen removed by Volatilisation(tonne/yr)    0.20
Nitrogen removed by Seepage       (tonne/yr)    0.00
Nitrogen accumulated in Sludge    (tonne/yr)    0.00
Nitrogen lost by Overtopping      (tonne/yr)    0.19
Nitrogen involved in Recycling    (tonne/yr)    0.00
Increase in pond Nitrogen         (tonne/yr)    0.00

POND PHOSPHORUS BALANCE

Phosphorus Added by Effluent      (tonne/yr)    0.13  Irrig. from pond (ML/yr)
0.0
Phosphorus removed by Irrigation  (tonne/yr)    0.00
Phosphorus removed by Seepage     (tonne/yr)    0.00
Phosphorus accumulated in Sludge  (tonne/yr)    0.00
Phosphorus lost by Overtopping    (tonne/yr)    0.13
Phosphorus involved in Recycling  (tonne/yr)    0.00
Increase in pond Phosphorus       (tonne/yr)    0.00

POND SALINITY BALANCE

Salinity Added by Effluent        (tonne/yr)    0.13
Salinity removed by Irrigation    (tonne/yr)    0.00
Salinity removed by Seepage       (tonne/yr)    0.00
Salinity lost by Overtopping      (tonne/yr)    0.13
Salinity involved in Recycling    (tonne/yr)    0.00
Increase in pond Salinity         (tonne/yr)    0.00
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POND CONCENTRATIONS
                                              Pond 1      Pond 2

Average Nitrogen Conc of Pond Liquid  (mg/L)   26.1        12.6
Average Phosphorus Conc of Pond Liquid(mg/L)   10.0         8.5
Average TDS Conc of Pond Liquid       (mg/L)   10.0         8.5
Average Salinity of Pond Liquid       (dS/m)    0.0         0.0
Average Potassium Conc of Pond Liquid (mg/L)    0.0         0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid          (mg/L)   26.1        13.2
Phosphorus Conc of Pond Liquid        (mg/L)   10.0         8.9
TDS Conc of Pond Liquid               (mg/L)   10.0         8.9
EC of Pond Liquid                     (dS/m)    0.0         0.0
Potassium Conc of Pond Liquid         (mg/L)    0.0         0.0

REMOVED SLUDGE - NUTRIENT & SALT CONCENTRATIONS

Nitrogen in removed Sludge (db)   (kg/tonne)    0.00
Phosphorus in removed Sludge (db) (kg/tonne)    0.00
Salt in removed Sludge (db)       (kg/tonne)    0.00
Potassium in removed Sludge (db)  (kg/tonne)    0.00

REMOVED SLUDGE - NUTRIENT & SALT MASSES

Nitrogen in removed Sludge        (tonne/yr)    0.00
Phosphorus in removed Sludge      (tonne/yr)    0.00
Salt in removed Sludge (mass bal.)(tonne/yr)    0.00
Salt in removed Sludge            (tonne/yr)    0.00
Potm. in removed Sludge (mass bal.)(tonne/yr    0.00
Potassium in removed Sludge       (tonne/yr)    0.00
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LAND DISPOSAL AREA
******************

WATER BALANCE
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(Initial soil water assumed to be at field capacity)
(Irrigated up to    0.00% of field capacity)
Rainfall                         (mm/year)   1853.2   Irrigation Area     (ha)
2.8
Irrigation                       (mm/year)      0.0
Soil Evaporation                 (mm/year)    557.4
Transpiration                    (mm/year)    304.3
Runoff                           (mm/year)    514.9
Drainage                         (mm/year)    476.5
Change in soil moisture          (mm/year)      0.2

ANNUAL TOTALS

 Year  Rain     Irrig   Sevap   Trans   Runoff    Drain   Change
       (mm)     (mm)    (mm)    (mm)    (mm)      (mm)    (mm)
_____________________________________________________________________________
 1901  1769.0     0.0   101.9   809.0   402.2   550.1   -94.3
 1902  1017.0     0.0     0.0   873.8    29.0   107.4     6.7
 1903  2005.0     0.0     0.0  1062.5   435.1   477.1    30.3
 1904  1936.0     0.0    19.0   792.4   668.1   418.9    37.7
 1905  1904.0     0.0   529.6   295.1   609.0   457.7    12.5
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1906	2217.0	0.0	201.2	862.3	546.7	581.2	25.7
1907	2142.0	0.0	0.0	897.6	704.0	558.2	-17.8
1908	1725.0	0.0	0.0	913.2	383.9	463.9	-36.0
1909	1017.0	0.0	0.0	849.9	19.3	135.2	12.6
1910	2326.0	0.0	0.0	1078.8	605.5	670.0	-28.4
1911	1554.0	0.0	76.3	892.1	319.5	322.5	-56.5
1912	1301.0	0.0	394.5	534.1	149.2	206.2	17.0
1913	1950.0	0.0	192.7	678.5	565.3	531.1	-17.5
1914	1855.0	0.0	478.1	558.9	173.4	535.7	108.9
1915	816.0	0.0	194.3	635.2	31.4	44.0	-88.9
1916	1631.0	0.0	447.6	626.7	280.3	198.9	77.6
1917	1824.0	0.0	84.8	983.1	427.3	362.9	-34.0
1918	1663.0	0.0	142.7	792.5	293.3	432.6	1.9
1919	1809.0	0.0	492.6	200.5	610.8	484.7	20.4
1920	1866.0	0.0	388.7	722.4	339.0	469.3	-53.5
1921	2427.0	0.0	154.6	803.6	700.6	674.5	93.7
1922	1421.0	0.0	546.0	221.1	324.4	396.1	-66.6
1923	1195.0	0.0	507.5	172.9	216.8	261.5	36.2
1924	1565.0	0.0	400.3	572.6	339.2	303.3	-50.4
1925	2505.0	0.0	300.6	709.8	714.5	697.3	82.9
1926	1627.0	0.0	510.1	236.4	457.6	453.3	-30.4
1927	2461.0	0.0	565.5	372.7	1005.8	519.7	-2.7
1928	1544.0	0.0	417.3	469.0	342.0	406.9	-91.2
1929	2280.0	0.0	545.8	248.9	1068.3	347.7	69.2
1930	2151.0	0.0	522.0	440.9	429.5	763.7	-5.1
1931	2211.0	0.0	567.0	333.2	872.0	426.2	12.6
1932	939.0	0.0	591.4	173.8	23.3	183.3	-32.8
1933	2074.0	0.0	625.7	286.1	529.4	574.0	58.7
1934	2100.0	0.0	544.2	460.5	592.1	508.9	-5.7
1935	1438.0	0.0	540.0	450.3	109.6	364.7	-26.6
1936	1213.0	0.0	587.5	248.9	86.1	258.4	32.0
1937	2382.0	0.0	633.4	349.3	689.7	738.8	-29.2
1938	2223.0	0.0	495.9	358.9	782.2	609.3	-23.3
1939	1762.0	0.0	614.6	240.9	483.8	418.8	4.0
1940	1400.0	0.0	543.4	320.6	279.3	238.5	18.3
1941	1566.0	0.0	476.8	265.7	253.0	579.6	-9.1
1942	1935.0	0.0	623.9	294.7	471.5	476.3	68.7
1943	1665.0	0.0	667.8	332.4	312.6	363.3	-11.1
1944	1428.0	0.0	615.1	245.5	338.5	274.3	-45.4
1945	2036.0	0.0	646.0	278.1	528.4	591.3	-7.8
1946	1455.0	0.0	501.9	193.8	448.5	333.8	-23.0
1947	2167.0	0.0	683.7	254.3	634.0	564.6	30.3
1948	2035.0	0.0	620.3	255.9	652.4	517.2	-10.8
1949	1619.0	0.0	566.6	313.0	304.9	454.7	-20.2
1950	2680.0	0.0	669.0	368.5	781.9	844.5	16.1
1951	1597.0	0.0	412.6	304.5	521.1	357.2	1.5
1952	1634.0	0.0	647.7	178.8	350.2	468.2	-10.9
1953	1886.0	0.0	587.5	158.5	845.1	272.4	22.4
1954	2621.0	0.0	700.3	356.2	979.6	607.6	-22.8
1955	2268.0	0.0	703.5	192.7	774.9	557.9	39.0
1956	2379.0	0.0	627.8	169.3	1065.5	517.1	-0.7
1957	1473.0	0.0	597.4	156.5	326.7	407.8	-15.4
1958	1974.0	0.0	744.8	222.3	487.0	534.0	-14.1
1959	2363.0	0.0	808.7	256.5	660.1	610.1	27.6
1960	1124.0	0.0	605.7	206.3	35.0	300.2	-23.2
1961	1933.0	0.0	774.6	217.6	378.7	549.1	13.0
1962	2535.0	0.0	722.5	196.3	911.2	664.1	40.9
1963	2502.0	0.0	773.2	207.5	859.5	692.3	-30.5
1964	1705.0	0.0	710.8	151.4	377.5	465.4	-0.2
1965	1603.0	0.0	738.4	145.7	344.9	381.2	-7.2
1966	1424.0	0.0	641.2	122.0	315.5	314.7	30.7
1967	2447.0	0.0	721.2	185.3	754.2	827.3	-41.1
1968	1325.0	0.0	575.1	136.4	354.9	273.3	-14.6

```
 1969  1611.0     0.0   704.3   128.2   295.6   467.7    15.2
 1970  1859.0     0.0   728.1   156.2   475.6   453.5    45.7
 1971  1580.0     0.0   719.1   157.2   259.9   471.3   -27.5
 1972  3228.0     0.0   698.0   156.9  1570.6   838.2   -35.6
 1973  2201.0     0.0   761.7   170.2   724.1   514.4    30.5
 1974  3115.0     0.0   702.8   157.9  1653.3   609.3    -8.3
 1975  2055.0     0.0   726.3   138.6   627.8   543.3    19.0
 1976  2194.0     0.0   724.9   157.7   703.3   626.4   -18.3
 1977  1539.0     0.0   648.0   130.7   458.9   314.3   -13.0
 1978  2199.0     0.0   766.0   135.6   672.6   554.7    70.2
 1979  1622.0     0.0   674.0   128.1   445.6   451.0   -76.8
 1980  1893.0     0.0   695.8   109.8   678.8   339.6    69.0
 1981  1699.0     0.0   675.7   119.4   429.2   491.3   -16.7
 1982  1497.0     0.0   699.4   121.3   267.0   431.8   -22.5
 1983  2500.0     0.0   728.9   136.4   819.1   767.2    48.4
 1984  2075.0     0.0   656.6   102.6   827.3   523.2   -34.7
 1985  1735.0     0.0   744.3   106.8   405.7   506.3   -28.0
 1986   998.0     0.0   624.9    99.0    76.2   179.4    18.4
 1987  2284.0     0.0   672.7   108.2   931.1   536.5    35.5
 1988  2863.0     0.0   749.4    87.0  1236.6   821.4   -31.5
 1989  2187.0     0.0   739.0    99.6   582.7   776.1   -10.4
 1990  1964.0     0.0   636.7    82.0   652.2   596.9    -3.9
 1991  1700.0     0.0   583.3    89.6   483.0   527.6    16.6
 1992  1377.0     0.0   641.3    78.4   170.0   496.8    -9.6
 1993  1248.0     0.0   686.1    93.5   156.1   329.6   -17.2
 1994  1658.0     0.0   644.7    86.7   400.0   525.4     1.3
 1995  1427.0     0.0   678.2   101.4   293.0   340.4    14.1
 1996  2033.0     0.0   718.8    89.9   633.1   593.7    -2.4
 1997  1488.0     0.0   738.2    98.1   170.6   469.3    11.8
 1998  1481.0     0.0   759.8    86.1   236.8   410.0   -11.8
 1999  2845.0     0.0   855.7    91.4   792.1  1093.6    12.2
 2000  1401.0     0.0   725.8    80.8   217.7   364.4    12.3
 2001  1653.0     0.0   675.9    65.7   647.6   293.1   -29.3
 2002  1228.0     0.0   639.6    72.8   164.5   334.1    17.0
 2003  1829.0     0.0   661.8    63.9   601.0   517.4   -15.1
 2004  1635.0     0.0   611.1    70.5   562.7   392.8    -2.2
 2005  1626.0     0.0   686.4    61.5   550.9   323.5     3.7
 2006  2027.0     0.0   724.7    63.8   652.1   582.4     4.0
 2007  1356.0     0.0   692.5    65.3   224.0   337.6    36.6
 2008  2271.0     0.0   804.4    65.5   768.3   651.5   -18.7
 2009  2199.0     0.0   636.0    56.4   899.7   587.4    19.6
______________________________________________________________________


NUTRIENT BALANCE
-----------------

NITROGEN

Total N irrigated from ponds  (kg/ha/year)      0.0   % of Total as ammonium
5.0
Nitrogn lost by ammonia volat.(kg/ha/year)      0.0   Deep Drainage (mm/year)
476.5
Nitrogen added in irrigation  (kg/ha/year)      0.0
Nitrogen added in seed        (kg/ha/year)      2.0
Nitrogen removed by crop      (kg/ha/year)      7.7
Denitrification               (kg/ha/year)      0.0
Leached NO3-N                 (kg/ha/year)      0.0
Change in soil organic-N      (kg/ha/year)     -5.2
Change in soil solution NH4-N (kg/ha/year)      0.0
Change in soil solution NO3-N (kg/ha/year)     -0.5
Change in adsorbed NH4-N      (kg/ha/year)      0.0
Initial soil organic-N             (kg/ha)    565.0
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Final soil organic-N               (kg/ha)      2.3
Initial soil inorganic-N           (kg/ha)     57.6
Final soil inorganic-N             (kg/ha)      0.0
Average N03-N conc in the root zone (mg/L)      0.0
Average N03-N conc below root zone  (mg/L)      0.0
Average N03-N conc of deep drainage (mg/L)      0.0

PHOSPHORUS

Phosphorus added in irrigatn  (kg/ha/year)      0.0   % of Total as phosphate
100.0

Phosphorus added in seed      (kg/ha/year)      0.2
Phosphorus removed by crop    (kg/ha/year)      0.2
Leached PO4-P                 (kg/ha/year)      0.0
Change in dissolved PO4-P     (kg/ha/year)      0.0
Change in adsorbed PO4-P      (kg/ha/year)     -0.1
Average P04-P conc in the root zone (mg/L)      0.0
Average P04-P conc below root zone  (mg/L)      0.0

SOIL P STORAGE LIFE

 Year YearNo.  Tot P stored    P leached in year
                  kg/ha                kg/ha
-----------------------------------------------------------------------------
 1901    1       1876.6          0.1
 1902    2       1876.5          0.0
 1903    3       1876.5          0.0
 1904    4       1881.6          0.0
 1905    5       1876.4          0.0
 1906    6       1876.3          0.1
 1907    7       1876.2          0.1
 1908    8       1881.3          0.0
 1909    9       1876.1          0.0
 1910   10       1876.0          0.1
 1911   11       1876.0          0.0
 1912   12       1881.1          0.0
 1913   13       1875.9          0.1
 1914   14       1875.8          0.1
 1915   15       1875.8          0.0
 1916   16       1880.9          0.0
 1917   17       1875.7          0.0
 1918   18       1875.7          0.0
 1919   19       1875.6          0.0
 1920   20       1880.7          0.0
 1921   21       1875.5          0.1
 1922   22       1875.4          0.0
 1923   23       1875.4          0.0
 1924   24       1880.5          0.0
 1925   25       1875.3          0.1
 1926   26       1875.2          0.0
 1927   27       1875.2          0.1
 1928   28       1880.3          0.0
 1929   29       1875.1          0.0
 1930   30       1875.0          0.1
 1931   31       1875.0          0.0
 1932   32       1880.1          0.0
 1933   33       1874.9          0.1
 1934   34       1874.9          0.1
 1935   35       1874.8          0.0
 1936   36       1879.9          0.0
 1937   37       1874.8          0.1
 1938   38       1874.7          0.1
```

1939	39	1874.6	0.0
1940	40	1879.7	0.0
1941	41	1874.5	0.1
1942	42	1874.5	0.0
1943	43	1874.5	0.0
1944	44	1879.6	0.0
1945	45	1874.4	0.1
1946	46	1874.3	0.0
1947	47	1874.3	0.1
1948	48	1879.4	0.1
1949	49	1874.2	0.0
1950	50	1874.1	0.1
1951	51	1874.1	0.0
1952	52	1879.2	0.0
1953	53	1874.0	0.0
1954	54	1873.9	0.1
1955	55	1873.9	0.1
1956	56	1879.0	0.1
1957	57	1873.8	0.0
1958	58	1873.7	0.1
1959	59	1873.7	0.1
1960	60	1878.8	0.0
1961	61	1873.6	0.1
1962	62	1873.5	0.1
1963	63	1873.5	0.1
1964	64	1878.5	0.0
1965	65	1873.4	0.0
1966	66	1873.4	0.0
1967	67	1873.3	0.1
1968	68	1878.4	0.0
1969	69	1873.2	0.0
1970	70	1873.2	0.0
1971	71	1873.1	0.0
1972	72	1878.2	0.1
1973	73	1873.0	0.1
1974	74	1872.9	0.1
1975	75	1872.9	0.1
1976	76	1877.9	0.1
1977	77	1872.7	0.0
1978	78	1872.7	0.1
1979	79	1872.7	0.0
1980	80	1877.8	0.0
1981	81	1872.6	0.0
1982	82	1872.5	0.0
1983	83	1872.5	0.1
1984	84	1877.5	0.1
1985	85	1872.4	0.1
1986	86	1872.3	0.0
1987	87	1872.3	0.1
1988	88	1877.4	0.1
1989	89	1872.1	0.1
1990	90	1872.1	0.1
1991	91	1872.0	0.1
1992	92	1877.1	0.0
1993	93	1871.9	0.0
1994	94	1871.9	0.1
1995	95	1871.9	0.0
1996	96	1876.9	0.1
1997	97	1871.7	0.0
1998	98	1871.7	0.0
1999	99	1871.6	0.1
2000	100	1876.7	0.0
2001	101	1871.5	0.0

```
 2002  102       1871.5          0.0
 2003  103       1871.4          0.1
 2004  104       1876.5          0.0
 2005  105       1871.4          0.0
 2006  106       1871.3          0.1
 2007  107       1871.3          0.0
 2008  108       1876.4          0.1
 2009  109       1871.2          0.1
_____________________________________________________________________________
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PLANT
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Plant species:  Tropical pasture

PLANT WATER USE

Irrigation                        (mm/year)     0.   Totl Irrigation Area(ha)
2.8
Pan coefficient                         (%)     1.0
Maximum crop coefficient                (%)     0.8
Average Plant Cover                     (%)    34.
Average Plant Total Cover               (%)    38.
Average Plant Rootdepth                (mm)   323.
Average Plant Available Water Capacity  (mm)    57.
Average Plant Available Water          (mm)    38.
Yield produced per unit transp.   (kg/ha/mm)     3.

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)         (kg/ha/yr)   888.
Net nitrogen removed by plant     (kg/ha/yr)     6.   Shoot Concn        (%DM)
0.64
Net phosphorus removed by plant   (kg/ha/yr)     0.   Shoot Concn        (%DM)
0.00

AVERAGE MONTHLY GROWTH STRESS (0=no stress, 1=full stress)


Month Yield     Nitr  Temp   Water  Water
      kg/ha                  Defic Logging
____________________________________________
  1      85.     0.8    0.0    0.2    0.0
  2      99.     0.9    0.0    0.1    0.0
  3      92.     0.9    0.0    0.1    0.0
  4      72.     0.9    0.1    0.1    0.0
  5      57.     0.9    0.3    0.1    0.0
  6      52.     0.8    0.5    0.1    0.0
  7      61.     0.8    0.6    0.1    0.0
  8      64.     0.7    0.5    0.2    0.0
  9      69.     0.7    0.3    0.2    0.0
 10      77.     0.7    0.2    0.3    0.0
 11      79.     0.8    0.1    0.3    0.0
 12      80.     0.8    0.0    0.2    0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress                 0.0
%Days due to water stress                      12.8
%Days due to nitrogen stress                    5.4
```

```
No. of forced harvests per year                 1.7
No. of normal harvests per year                 0.0
______________________________________________________________________________________
_


SALINITY
--------

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water        (dS/m)    0.0   Irrigation     (mm/year)
0.0
Average EC of Rainwater           (dS/m x10)    0.3   Rainfall       (mm/year)
1853.2

>>>No salinity calculations<<<
No. of years chosen for running averages       10
______________________________________________________________________________________
_

GROUNDWATER
************

Average Groundwater Recharge        (m3/day)   36.5
Average Nitrate-N Conc of Recharge    (mg/L)    0.0

Thickness of the Aquifer                 (m)   10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated   500.0

Concentration of NITRATE-N in Groundwater (mg/L)
----------------------------------------------

       Year     Depth Below Water Table Surface
                   0.0 m     5.0 m     9.0 m
____________________________________________
       1905        0.0       0.0       0.0
       1910        0.0       0.0       0.0
       1915        0.0       0.0       0.0
       1920        0.0       0.0       0.0
       1925        0.0       0.0       0.0
       1930        0.0       0.0       0.0
       1935        0.0       0.0       0.0
       1940        0.0       0.0       0.0
       1945        0.0       0.0       0.0
       1950        0.0       0.0       0.0
       1955        0.0       0.0       0.0
       1960        0.0       0.0       0.0
       1965        0.0       0.0       0.0
       1970        0.0       0.0       0.0
       1975        0.0       0.0       0.0
       1980        0.0       0.0       0.0
       1985        0.0       0.0       0.0
       1990        0.0       0.0       0.0
       1995        0.0       0.0       0.0
       2000        0.0       0.0       0.0
       2005        0.0       0.0       0.0
Last   2009        0.0       0.0       0.0
______________________________________________________________________________________
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ACKNOWLEDGMENTS
***************
This run brought to you courtesy of:

MEDLIEXE.EXE  :  1300468 bytes Fri Mar 12 10:26:56 1999

CRCPROJ.EXE   :  1286656 bytes Wed Apr 28 15:18:26 1999

GRAPHS.EXE    :   439296 bytes Fri Dec 11 12:28:08 1998

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OTHER INDUSTRY INPUT PARAMETERS - DATA SUMMARY

Nature of Industry: other
__________________________________________

>>> Dryland run! <<<
>>>No effluent irrigation occurred!<<<
UNCONDITIONAL FINISH
```

20) Appendix 9 – Water management plan

GILBERT+SUTHERLAND
agriculture · water · environment

Water Management Plan
North Byron Parklands
Tweed Valley Way and
Jones Road, Yelgun
New South Wales

Prepared for
North Byron Parklands
A project of:
Billinudgel Property Pty Ltd
(Billinudgel Property Trust)

July, 2010

Document control

Document:	**GJ0896-1_WMP_REH1F.doc**	Gilbert & Sutherland P/L ABN 56 077 310 840 Originating Office: Robina Riverwalk One 5/232 Robina Town Centre Drive, Q4230 PO Box 4115, Robina Q4230 Telephone 07 5578 9944 Facsimile 07 5578 9945 gsrobina@access.gs Also at Kawana, Cairns and Brisbane
Title:	**Water Cycle Management Plan, North Byron Parklands, Tweed Valley Way and Jones Road, Yelgun NSW**	
Project Manager:	Nathan Zurig	
Author:	Khan Thorne / Nathan Zurig / Chris Anderson	
Client:	Billinudgel Property Trust	
Client Contact:		
Client Reference:		
Synopsis:	This management plan establishes responsibilities and procedures for the maintenance, monitoring and management of the water supply system, wastewater management process and stormwater quality control during the construction and operational phases the North Byron Parklands site.	

Revision History

Revision #	Date	Edition By		Approved By	
1	18.05.10	K.Thorne	N. Zurig	C. Anderson	L. Varcoe
2	21/07/10	N.Zurig		C. Anderson	L. Varcoe

Distribution

	Revision Number									
Distribution	1	2	3	4	5	6	7	8	9	10
Billinudgel Property Trust	1	1								
SJ Connelly	1	1								
Balanced Systems	1	1								
G&S Library + File	1	1								

Summary

Gilbert & Sutherland (G&S) was commissioned by Billinudgel Property Trust to prepare a Water Management Plan (WMP) for a proposed cultural, arts and events facility known as North Byron Parklands, at Tweed Valley Way, Yelgun NSW.

This document constitutes the Water Management Plan for the development and provides procedures to ensure that the projected water quality levels are met during the construction and operational phases of the works. This WMP addresses, but is not limited to the following issues:

- *environmental commitments*
- *control measures to minimise the likelihood of environmental harm*
- *contingency plans and emergency procedures for non-routine situations*
- *effective communication*
- *monitoring of the contaminant releases*
- *record keeping*
- *periodic review of environmental performance and continual improvement*

This WMP, properly implemented, will ensure stormwater management, potable water supply and on-site wastewater treatment and irrigation is managed in an environmentally responsible manner and will achieve the stated environmental goals.

Table of contents

1) Water management plan

1.1 Objectives and implementation

1.1.1 Objectives

The principal objective of this WMP is to provide mitigation measures to minimise the potential impacts to receiving waters and the environment more generally, from the proposed management of stormwater and irrigation of effluent which would occur as a result of the proposed development.

The WMP provides information on specific site management issues relating to potential environmental impacts from the development during the construction and operational phases.

The control measures detailed in this WMP have been developed to minimise impacts on the environment and achieve the following objectives:

- protection of downstream surface water quality and associated ecological values
- confirmation of the success of impact control measures by the means of monitoring during construction and operational phases
- compliance with statutory requirements
- preservation of the existing groundwater conditions.

1.1.2 Implementation

The management plan requires the Proponent to mitigate the potential environmental impacts associated with the construction and operational phases of the North Byron Parklands site.

It is intended that the WMP will provide a set of performance criteria and guiding principles with which the engineering designs for the development will comply.

1.2 WMP structure

This WMP acknowledges the environmental impacts associated with the development and details strategies to mitigate them.

Each control strategy is based upon proven environmental management methods and is presented as a commitment.

The WMP is based on a series of tables. 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 WMP. The format is presented below for reference purposes.

#Table 1

Person responsible	This is the person who has accepted the responsibility of implementing the WMP 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, if any, are designed to 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 #
A promise made by management.

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

1.3 General commitments

Commitment 1
The Proponents undertake to comply with the environmental implementation strategy as contained within the approved Water Management Plan (WMP).

Commitment 2
The Proponents undertake to fulfil all commitments made in this WMP and to carry out their activities on the site in accordance with relevant current statutory requirements and approved amendments.

1.4 Definitions

In this WMP the terms have the following meanings:

BSC means Byron Shire Council.

WMP means the approved Water Management Plan and includes any amendments that may be approved from time to time.

Development means the proposed North Byron Parklands site at Tweed Valley Way, Yelgun NSW.
DECCW means the Department of Environment, Climate Change and Water
DoP means the Department of Planning
ESC means erosion and sedimentation control
ESCP means erosion and sedimentation control plan
POEO Act means the Protection of the Environment Operations Act 1997.
Proponent means the person undertaking the development of the land and includes the person nominated by the Proponent as having the responsibility for implementing the provisions of the WMP.
SQIDs means stormwater quality improvement devices.
STP means sewage treatment plant

1.5 Contact details

The following persons shall be responsible for the implementation of the management measures described in the individual tables of the WMP.

Contractor's Site Manager, Consulting Engineer & Environmental Consultant

Prior to the commencement of the project the proponent will notify the DoP & BSC of the names and addresses of the Contractor, Consulting Engineer, Environmental Consultant and their respective representatives.

2) Management of potential impacts –construction phase

The WMP requires the Proponent to mitigate potential impacts to receiving waters during the construction & operational phases of site operation.

Erosion and sediment control measures must be installed in disturbed areas during the construction phase. These measures should be maintained until landscaping or revegetation is complete and becomes established.

Nutrient transport from the site during the construction phase should be minimised by implementation of appropriate control measures.

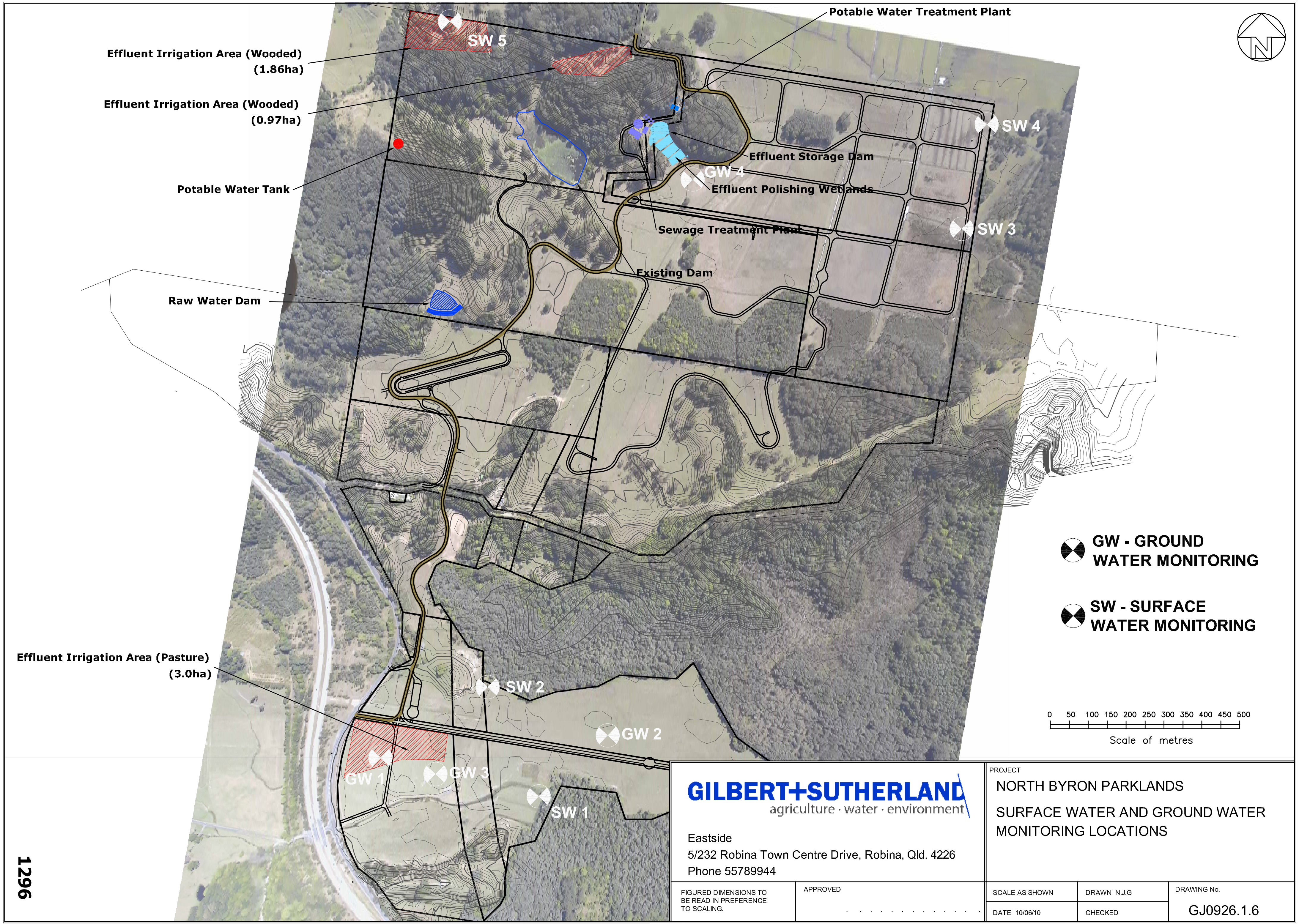
The following detachable pages detail the provisions of this WMP for the construction phase.

2.1 Construction phase sediment and erosion controls

Person responsible	Proponent, Contractor’s Site Manager

Issue	Sediment and Erosion Controls.
Operational policy	To prevent the displacement of sediment and soil across and offsite and preserve water quality in receiving environments.
Performance criteria	Offsite discharges to comply with requirements for suspended sediments as detailed in Section 2.2 of the WMP. No visual indication of erosion on areas under construction, including evidence of rilling (an indicator of sheet erosion).
Implementation strategy	Erosion and sediment control plans shall be prepared in support of construction certificate applications. Erosion and sediment control devices shall be installed prior to commencement of work. Temporary erosion measures (eg. silt fences) are to be employed onsite during construction where reasonably deemed necessary. Such measures should be in accordance with the recommendations in the *Best Practice Erosion & Sediment Control Guidelines,* International Erosion and Sediment Control Guidelines, November 2008. Stockpiled soil should be stored/bunded in a manner to prevent soil being washed offsite (i.e. bunding where necessary.) Outside the construction area existing surface water conditions should be maintained wherever possible.
Monitoring	Carry out visual inspections daily and after rainfall events (>25mm in 24hrs) to ensure that erosion measures are in place and operational to suit the activities taking place at the time. Surface water quality monitoring in accordance with Section 2.2.
Reporting	Site contractor to keep records of maintenance to erosion and sedimentation control devices and augmentation of documented ESC plans.
Identification of incident or failure	Signs of erosion on site. ESC devices not installed in accordance with approved ESCP. Damaged or inoperable erosion control devices. Declining water quality as identified by monitoring results. Build-up of sediment.
Corrective action	Undertake necessary maintenance of ESC devices. Review ESCP in consultation with contractor and supervising engineer and install additional ESC devices as required.

Commitment 3
Erosion and sedimentation control shall be undertaken in accordance with industry best practice for construction sites.



GILBERT+SUTHERLAND
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PROJECT
NORTH BYRON PARKLANDS

SURFACE WATER AND GROUND WATER MONITORING LOCATIONS

FIGURED DIMENSIONS TO BE READ IN PREFERENCE TO SCALING.

APPROVED

SCALE AS SHOWN

DRAWN N.J.G

DATE 10/06/10

CHECKED

DRAWING No.
GJ0926.1.6

2.2 Construction phase surface water monitoring

Person responsible	Contractor's Site Manager, Environmental Consultant

Issue	Surface water controls on site.
Operational policy	To maintain water quality conditions of runoff during the construction phase.
Performance criteria	All controlled discharges of water from the site during the construction phase should comply with the following criteria:
Implementation strategy	Stormwater control should be achieved by directing as much runoff as practicable from disturbed areas to temporary control measures. 'Clean' runoff from undisturbed areas should be diverted around disturbed areas if possible. All samples must be analysed at a NATA registered laboratory for the relevant parameters.
Monitoring	Surface water monitoring shall be undertaken during the first rainfall event (>25mm in a 24 hour period) of each month. Monitoring shall be undertaken at the monitoring locations illustrated on Drawing GJ0926.1.6. Where sedimentation ponds are in use and need to be emptied to maintain capacity, sampling shall be undertaken and the water quality above must be met, if the water is to be discharged to a drain. Samples collected for suspended solids analysis should be analysed at a NATA registered laboratory.
Auditing	The Consulting Engineer or environmental consultant shall audit water quality results to ensure all discharges comply with the performance criteria above.
Reporting	Result sheets to be compiled for monitoring results. All results to be kept on site for inspection by local and state government officers at all times.
Identification of Incident or failure	Degradation of surface water quality at the monitoring points in relation to the 'Performance Criteria' above. Visible changes in water body conditions.

Performance criteria:

Water Quality Parameter	Release Criteria	Criteria Type
pH	6.5 – 8.5	Range
Turbidity	<50NTU	Maximum
Suspended Solids	<50mg/L	Maximum

Corrective action	If pH is detected outside the criteria range (6.5 to 9.0) then waters should be contained and the pH adjusted to within the range prior to release. If total suspended solids exceed the water quality criteria for this parameter, then water must be contained on site for a period sufficient to allow suspended solids to settle out prior to release, or settling should be aided by dosing with flocculation agents at the rate recommended by the manufacturer (for example Gypsum at dose rate of 30kg/100m^3). Immediate inspection and maintenance (if necessary) of erosion controls. Additional erosion control devices should be installed if the existing controls are inadequate, to prevent future breaches of the suspended solids criteria. The placement of stockpiles and management of disturbed areas should be reviewed with regard to sediment and silt control.

Commitment 4
The Proponent will ensure that all waters discharged from the site meet the performance criteria set out above.

3) Management of potential impacts – operational phase

3.1 Intent

This part of the WMP specifies those matters that must be complied with by the Proponent for the duration of the site's operation as a cultural, arts and events facility.

3.2 Implementation

Permanent water quality control devices are to be monitored and maintained as detailed in the following tables.

Monitoring requirements to assess the impacts of the development with respect to stormwater management and on-site irrigation of effluent are also described.

3.3 Operational phase sediment and erosion controls

Person responsible	Proponent

Issue	Sediment and erosion controls.
Operational policy	To prevent the displacement of sediment and soil across and off site.
Performance criteria	There should be no evidence of erosion on site or movement of sediment offsite during or following rainfall events.
Implementation strategy	The proponent or its representative shall instigate a proactive regime of site inspections during and following events. Where significant areas of soil have been exposed, erosion and sedimentation control devices shall be implemented and maintained until the area has restabilised. Seeding of disturbed areas may be conducted to expedite revegetation and stabilisation.
Monitoring	Temporary erosion control measures are to be inspected monthly and after rainfall events. Permanent control measures including swales and vegetated filters are to be inspected monthly and after rainfall events.
Reporting	Records shall be kept identifying areas affected, controls implemented and maintenance undertaken.
Identification of incident or failure	Signs of erosion on site Sedimentation Declining water quality
Corrective action	Install new or additional ESC devices as required. Repair or maintain temporary sediment and erosion control measures. Check permanent measures for build up of sediment and maintain as required.

Commitment 5
Proactive monitoring of the site shall be undertaken and ESC devices shall be installed as required to prevent sediment related water quality impacts. Permanent water quality control devices shall be monitored and maintained throughout the operational phase of the site.

3.4 Operational phase maintenance of swales

Person responsible	Proponent

Issue	Maintenance of swales.
Operational policy	To maintain the water quality control structures (swales) to ensure adequate performance during the operational phase.
Performance criteria	Swales must be maintained and operational.
Implementation strategy	Ensure inlets and outlets are not blocked and are structurally stable. Prevent vehicular access/egress via swales. All waste to be disposed of at Council approved waste facilities. Ensure that sediment accumulation does not impair operation of the swales (particularly during establishment of vegetation). Ensure that landscaping is growing healthily. Ensure no scouring or rill erosion. Ensure no rubbish or litter accumulation. Remove any weeds. Ensure swale field inlet pits are structurally sound and free of blockages and debris. Regular watering/irrigation of vegetation until plants are established and actively growing. Mowing of grass as required and removal of clippings.
Monitoring	Monthly rainfall event based inspections (>25mm in 24 hours) of swales. Water quality monitoring to be conducted in accordance with Table 3.7. Any damage to the control structures to be rectified including re-profiling and/or re-vegetating to original specifications if required.
Auditing	Management to carry out quarterly inspections to verify that the control measures are properly maintained.
Reporting of monitoring results	Records of inspections, maintenance requirements and maintenance undertaken to be retained and kept on site for inspection by Council and or Statutory authorities upon request.
Identification of incident or failure	Blockage of stormwater system. Re-entrainment of trapped sediments or nutrients. Deterioration of water quality within or downstream of control structure. Death of vegetation.
Corrective action	Clean or maintain stormwater control structures as appropriate. Take necessary steps to address the problem to prevent a recurrence.

Commitment 6
Swales will be monitored and maintained during operational phase to ensure continued efficacy for stormwater quality control.

3.5 Operational phase maintenance of vegetated filters

Person responsible	Proponent

Issue	Maintenance of vegetated filters/buffers
Operational policy	To maintain the water quality control structures (vegetated filters) to ensure adequate performance during the operational phase.
Performance criteria	Vegetated filters must be maintained and operational.
Implementation strategy	Ensure inlets and outlets are not blocked and are structurally stable. Prevent vehicular access/egress via filters/buffers. All waste removed during maintenance works to be disposed of at council approved waste facilities. Ensure that sediment accumulation does not impair operation of the vegetative filters. Ensure no scouring or rill erosion. Ensure no rubbish or litter accumulation. Remove any weeds. Replacement of dead vegetation.
Monitoring	Monthly rainfall event based inspections (>25mm in 24 hours) of vegetated filters. Water quality monitoring to be conducted in accordance with Table 3.7. Any damage to the control structures to be rectified including re-profiling and/or re-vegetating to original specifications if required.
Auditing	Management to carry out quarterly inspections to verify that the control measures are properly maintained.
Reporting of monitoring results	Records of inspections, maintenance requirements and maintenance undertaken to be retained and kept on site for inspection by Council and or Statutory authorities upon request.
Identification of incident or failure	Blockage of stormwater system. Re-entrainment of trapped sediments. Deterioration of water quality within or downstream of control structure. Death of vegetation.
Corrective action	Clean or maintain stormwater control structure as appropriate. Take necessary steps to address the problem to prevent a recurrence.

Commitment 7
Vegetated filters and buffers will be adequately maintained during the operational phase to ensure continued efficacy for stormwater quality control.

3.6 Operational phase maintenance of rainwater tanks

Person Responsible	Proponent

Issue	Operation and maintenance of the rainwater tank.
Operational policy	To maintain the rainwater tank and ensure adequate performance during the operational period.
Performance criteria	The rainwater tanks are maintained and operational.
Implementation strategy	Ensure inlets and outlets are not blocked or do not impair operation. Verify that inlet screens are insect proof.
Monitoring	Inspect inlets and outlets from tanks quarterly and following major rainfall events. Pumps to be checked in accordance with manufacturer's specifications and maintained as required.
Auditing	NA
Reporting of monitoring results	Records of inspections, maintenance requirements and maintenance undertaken to be retained and kept on site for inspection by Council and or Statutory authorities upon request.
Identification of incident or failure	Complaints about odours or increased mosquito numbers. Reduced availability of tank water for non-potable use. Pump failure.
Corrective action	Clean or maintain rainwater tank and/or pump as appropriate.

Commitment 8
Rainwater tanks will be monitored and maintained to maximise the contribution to the water supply and stormwater quality control.

3.7 Water quality of receiving waters

Person responsible:	Proponent

<table>
<tr><td>Issue</td><td>To ensure that any water discharged from the site complies with the specified water quality objectives and that water quality in the receiving environment is preserved.</td></tr>
<tr><td>Performance criteria</td><td>1. No contamination of receiving waters resulting from stormwater discharge.
2. No contamination of receiving waters resulting from the storage or irrigation of the recycled effluent.
3. No public nuisance or health problems resulting from unacceptable water quality.
4. No complaints from patrons, staff, the public or government agencies.</td></tr>
<tr><td>Implementation strategy</td><td>1. Monthly surface water quality monitoring shall be undertaken in accordance with the following monitoring schedule.</td></tr>
<tr><td>Monitoring</td><td>Surface water monitoring shall be undertaken in the locations illustrated on Drawing GJ0926.1.6.

The following parameters shall be measured or analysed.
<table>
<tr><th>Parameter</th><th>Guideline#</th></tr>
<tr><td>pH</td><td>6.5 – 8.5</td></tr>
<tr><td>Electrical Conductivity</td><td><10% increase from background</td></tr>
<tr><td>Dissolved Oxygen</td><td>>6 mg/L</td></tr>
<tr><td>Turbidity</td><td><50 NTU</td></tr>
<tr><td>Suspended solids</td><td><50 mg/L</td></tr>
<tr><td>Thermotolerant coliforms</td><td><10 cfu/100ml</td></tr>
<tr><td>Total Nitrogen</td><td><1.0 mg/L</td></tr>
<tr><td>Total Phosphorus</td><td><0.5 mg/L</td></tr>
</table>
Subject to the agreement of the DoP, the above water quality objectives may be adjusted on the basis of water quality upstream of the site or based on pre-development baseline water quality data.

Water quality monitoring to be conducted following the first monthly rainfall event of greater than 25mm in a 24 hour period.

Sample recovery and in-situ analysis will be performed in accordance with the <i>Australian Guidelines for Water Quality Monitoring and Reporting – Summary, October 2000</i> (Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand).

Laboratory testing will be performed by an independent laboratory holding current NATA accreditation for the relevant analytes.</td></tr>
<tr><td>Reporting of monitoring results</td><td>1. All results to be compiled and kept on site.
2. Any complaints to be recorded in a complaints register.
3. Results of monitoring, maintenance and servicing to be made available upon request to BSC and DoP.</td></tr>
</table>

Identification of incident or failure	1. Deteriorating surface water quality in receiving waters and at site discharge locations. 2. Contamination of waterways. 3. Signs of deterioration or overtopping of stormwater quality improvement devices, effluent storage and/or irrigation area. 4. Damaged or failed SQIDs, effluent storage or application system. 5. Public nuisance or health problems recorded resulting from deteriorating water quality. 6. Complaints from patrons, staff, the public or government agencies.
Corrective Corrective action	1. Determine whether any surface water impacts are attributable to a failure of the sewage treatment plant. If so ensure maintenance is undertaken to provide water quality consistent with the required performance criteria. 2. Determine whether any surface water impacts are attributable to a failure of the SQIDs. If so ensure maintenance is undertaken to ensure continued functioning. 3. Investigate reason for failure and implement procedures to prevent a reoccurrence. 4. Improve/maintain permanent and temporary erosion and sediment controls. 5. Consult with Environmental consultant and install additional controls if required.

Commitment 9

Management practices would be implemented to minimise the potential for adverse impacts to downstream water quality. A monitoring program would be implemented to ensure any impacts are identified and appropriate measures are taken to prevent or minimise any environmental harm or human health impacts.

3.8 Groundwater quality

Person responsible:	Proponent

Issue	To ensure that groundwater quality and water quality in the receiving environment is preserved.
Performance criteria	5. No contamination of groundwater resulting from stormwater discharge. 6. No contamination of groundwater resulting from the storage of effluent or irrigation of the recycled effluent. 7. No public nuisance or health problems resulting from unacceptable water quality. 8. No complaints from patrons, staff, the public or government agencies.
Implementation strategy	2. Monthly groundwater quality monitoring shall be undertaken in accordance with the following monitoring schedule. 3. All staff to be trained and aware of the environmental issues and potential impacts relating to the water reclamation plant and irrigation of recycled water. 4. All staff to be capable of recognising environmental issues and reporting them to management if identified.
Monitoring	Groundwater monitoring shall be undertaken on a monthly basis in the locations illustrated on Drawing GJ0926.1.6. The following parameters shall be measured or analysed. **Parameter** — **Guideline#** pH — 6.5 – 8.5 Electrical Conductivity — <10% increase from background Thermotolerant coliforms — <10 cfu/100ml Total Nitrogen — <1.0 mg/L Total Phosphorus — <0.5 mg/L # Subject to the agreement of the DoP, the above groundwater quality objectives may be adjusted on the basis of pre-development baseline data. Sample recovery and in-situ analysis will be performed in accordance with the *Australian Guidelines for Water Quality Monitoring and Reporting – Summary, October 2000* (Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand). Laboratory testing will be performed by an independent laboratory holding current NATA accreditation for the relevant analytes.
Reporting of monitoring results	4. All results to be compiled and kept on site. 5. Any complaints to be recorded in a complaints register. 6. Results of monitoring, maintenance and servicing to be made available upon request to BSC and DoP.
Identification of incident or failure	7. Deteriorating surface and groundwater quality in on-site and downgradient hydrogeological environments. 8. Signs of deterioration or overtopping of stormwater quality improvement devices, effluent storage and/or irrigation area. 9. Damaged or failed SQIDs, effluent storage or application system.

	10. Public nuisance or health problems recorded resulting from deteriorating water quality. 11. Complaints from patrons, staff, the public or government agencies.
Corrective Corrective action	6. Determine whether any groundwater impacts are attributable to a failure of the sewage treatment plant. If so ensure maintenance is undertaken to provide water quality consistent with the required performance criteria. 7. Determine whether any groundwater impacts are attributable to a failure of the SQIDs. If so ensure maintenance is undertaken to ensure continued functioning. 8. Investigate reason for failure and implement procedures to prevent a reoccurrence.

Commitment 10

Management practices would be implemented to minimise the potential for adverse impacts to groundwater. A monitoring program would be implemented to ensure any impacts are identified and appropriate measures are taken to prevent or minimise any environmental harm or human health impacts.

3.9 Monitoring of effluent quality

Person responsible:	STP manufacturer / Maintenance staff

Issue	Validate the consistent production of the required effluent quality and maintain delivery of effluent at this quality.
Performance criteria	Wastewater shall meet the following quality requirements. The criteria include:

Parameter	**Guideline**			
	Minimum	**50th Percentile**	**80th Percentile**	**Maximum**
BOD_5			5mg/L	15mg/L
Suspended Solids			10mg/L	30mg/L
pH	6.0			9.5
Dissolved Oxygen	2mg/L			
Total Nitrogen		10mg/L		30mg/L
Total Phosphorus		8mg/L		24mg/L
Faecal coliforms	10 colony forming units/100ml as a median value with 4 of the five samples not containing more than 40 colony forming units/100ml.			

Implementation strategy	1. Quarterly monitoring of effluent quality shall be undertaken for the duration of the plant's operation.
Monitoring	Monitoring of the effluent quality shall be undertaken at least quarterly. Samples shall be collected and analysed by a suitably certified laboratory, for the parameters listed above, with the exception of dissolved oxygen, which should be measured in situ. During plant operation, staff shall monitor the STP continuously
Reporting of monitoring results	1. Results of monitoring to be collated on site and provided to DoP and DECCW upon request. 2. Bi-monthly maintenance checklist for the STP with reports available to DoP and DECCW upon request.
Identification of incident or failure	1. Failure of plant to consistently produce the required effluent quality. 2. Contamination of waterways by the effluent treatment system. 3. Public nuisance or health problems recorded resulting from deteriorating water quality. 4. Complaints from patrons or staff.
Corrective action	1. Failure demonstrated by monitoring results will be investigated to determine where the treatment process has failed. 2. Undertake necessary maintenance as appropriate, in accordance with the manufacturer's maintenance handbook or augment the treatment process with chemical dosing in consultation with the manufacturer. 3. Repeat water quality monitoring until effluent quality meets the above criteria.

Commitment 11

Monitoring of the effluent quality shall be undertaken to demonstrate continual performance of the STP and the suitability of water for irrigation to land.

3.10 Potable water quality

Person responsible:	Potable water treatment plant manufacturer / maintenance staff

Issue	Validate the consistent production of potable water.
Performance criteria	Potable water shall meet the requirements of the Australian Drinking Water Guidelines (2004).
Implementation strategy	Drinking water quality shall be analysed at least monthly and prior to major events.
Monitoring	Samples of potable water shall be collected from the point of delivery on a monthly basis and analysed by a suitably certified laboratory, for comparison to the ADWG. Free chlorine shall be measured in situ.
Reporting of monitoring results	Results of monitoring and plant maintenance shall be collated on site and provided to BSC and DoP upon request.
Identification of incident or failure	Failure of plant to consistently produce water of potable quality. Reduced amenity or health problems resulting from inadequate water quality. Complaints from patrons or staff.
Corrective action	Failure demonstrated by monitoring results will be investigated to determine where the treatment process has failed. Undertake necessary maintenance as appropriate, in accordance with the manufacturer's maintenance handbook or augment the treatment process in consultation manufacturer. Repeat monitoring until water supply meets potable standards.

Commitment 12
Monitoring and maintenance of the potable water supply shall be undertaken to ensure the delivery of potable quality water to consumers.

3.11 Land contamination

Person responsible:	Proponent

Issue	Prevention of land contamination from the STP and land application areas.
Performance criteria	1. No land contamination identified from monitoring. 2. No equipment malfunction or failure.
Implementation strategy	1. Wastewater treated to the specified quality. 2. All staff to be trained and aware of land contamination issues. 3. Plant and irrigation system to be maintained in accordance with manufacturer's specifications.
Monitoring	1. Monitoring of effluent quality in accordance with section 3.9. 2. Maintenance of the STP in accordance with the manufacturer's requirements. 3. Verification testing to confirm treatment quality. 4. Monitoring of the soils within the application area to be undertaken once a year by an environmental consultant for the following parameters: • Arsenic • Cadmium • Chromium • Copper • Lead • Mercury • Nickel • Zinc • Faecal coliforms • P-sorption
Reporting of monitoring results	1. Results of monitoring, maintenance and servicing to be compiled and kept on site and made available upon request to BSC and DoP. 2. All complaints to be recorded in a complaints register. 3. Reporting of identified contamination to DECCW as required by the *Contaminated Land Management Amendment Act 2008.*
Identification of incident or failure	1. Identification of land contamination. 2. Signs of deterioration or overtopping of effluent system and/or irrigation area. 3. Release of untreated or partially treated sewage identified by verification testing. 4. Damaged or failed effluent treatment system. 5. Public nuisance or health problems recorded resulting from land contamination. 6. Complaints from patrons or staff.
Corrective action	1. Determine if possible the cause of contamination and whether it was due to plant failure. If verification testing demonstrates failure of the treatment process it is possible that this has caused land contamination. 2. Investigate reason for failure and undertake necessary maintenance. 3. Review treatment process and land application area and upgrade process to prevent delivery of contaminants to land. 4. Increase size of irrigation area to reduce concentration of contaminants.

[redacted]	5. Environmental consultant to assess the need for remediation and provide advice on methodology.

Commitment 13

Monitoring and maintenance would be undertaken to minimise the potential for land contamination. If contamination is identified, appropriate steps will be undertaken to minimise potential environmental harm or human health impacts.

3.12 Contingency plans and emergency procedures

Person responsible:	Proponent / STP operator

Issue	Emergency situations including catastrophic system failure or fire
Performance criteria	1. Successful implementation of contingency and emergency procedures should catastrophic system failure or fire occurs. 2. No overtopping or release of untreated or partially treated sewage. 3. No land contamination occurring from system failure. 4. No staff or patrons endangered/injured due to system failure or fire.
Implementation strategy	1. Emergency services to be contacted immediately upon identification of a fire. 2. In the event of a catastrophic system failure, the STP is equipped with a self diagnostic system (level and temperature switches) and will alert personnel with visible and audible alarms. 3. The STP operator will be automatically informed via remote monitoring. 4. The STP is designed to have a level of redundancy, whereby in the event of a system failure, the plant is designed to run at half capacity. It is unlikely that a system failure would result in a total plant shut down. Storage in the balance tank and effluent storage pond will also provide time to repair any failing components 5. The STP has storage capacity in balance tanks and effluent storage dam to accommodate all wastewater flow from the largest proposed event. Should the entire STP be inoperable for an extended period of time (>48 hours) whilst the cause of the failure is identified and repair works undertaken, sewage from the balance tanks shall be pumped to a tanker by a licensed contractor and disposed of at a licensed disposal station. This process will continue until the plant is operational. 6. All STP maintenance staff to be suitably trained in the operation of the plant and emergency and fire fighting procedures. 7. Plant and irrigation system to be maintained in accordance with manufacturer's specifications.
Monitoring	1. Continual monitoring of the STP by staff, during operational periods. 2. Periodic inspection/maintenance of the STP by qualified service staff in accordance with system maintenance guidelines. 3. Fire extinguishers to be regularly checked and located in suitable positions.
Reporting	1. Results of monitoring, maintenance and servicing to be compiled and kept on site and made available upon request to BSC and DoP. 2. All complaints to be recorded in a complaints register. 3. Any release of sewage or overtopping of effluent from the treatment ponds may constitute a 'Pollution incident' in accordance with the POEO Act and must be reported to DoP (or relevant approval authority).

Identification of incident or failure	1. Immediate and/or obvious signs of catastrophic failure and/or fire. 2. Identification of land contamination. 3. Signs of deterioration or overtopping of effluent system and/or irrigation area. 4. Release of untreated or partially treated sewage. 5. Damaged or failed STP. 6. Complaints from patrons or staff.
Corrective action	1. Emergency services to be contacted immediately upon identification of fire. 2. Isolate staff and patrons from location of failure or fire 3. Investigate reason for failure. 4. Provide a contingency power source to manage wastewater treatment until power is restored. 5. Contact authorised service agent and environmental consultant. The service agent will be responsible for the rectification of the system. 6. Review treatment process and land application area and upgrade process to prevent delivery of contaminants to land. 7. Increase size of irrigation area to reduce concentration of contaminants. 8. Environmental consultant to assess the need for remediation and provide advice on methodology.

Commitment 14

Emergencies and/or failures will be handled in a timely and efficient manner to minimise the potential for environmental harm or human health impacts. Appropriate monitoring, maintenance and corrective actions will follow to minimise the potential for land contamination.

4) Administration of the WMP

4.1 Amendment of the WMP

The proponent may make an application to the DoP to amend the provisions of this WMP. The application shall:

a. be in writing
b. specify the provisions of the WMP to which the application relates
c. state how the proposed amendment(s) achieve the objectives of the provisions to which the amendment(s) relate.

DoP shall approve the amendment(s) where the Department is satisfied acting reasonably that the proposed amendment(s) achieve the objective of the provisions to which the amendment(s) relates.

4.2 Incident management

The Proponent and any person appointed by the Proponent as having responsibility for a control strategy set out in this WMP have clearly defined responsibilities under Section 148 of the *Protection of the Environment Operations Act 1997* to report any pollution incidents likely to cause material or serious environmental harm.