Solo Water

Appendix 4.3.13 **Land Capability Assessment for Effluent Irrigation Report**

Land Capability Assessment for Effluent Irrigation

for the

Catherine Hill Bay Water Utility Scheme, at Montefiore St, Catherine Hill Bay

July 2013

Prepared for: Solo Water & Rose Property Group

Project Number: H10052
Project Name: Catherine Hill Bay
Report Number: H10052_R2B

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DOCUMENT CONTROL

Report Number: H10052_R2

ISSUE	STATUS	DATE	ISSUE DETAILS	AUTHOR	APPROVED
A	DRAFT	16/04/2013	FOR IPART LICENSE APPLICATION	BI	BRAD IRWIN MIEAust, CPEng, NPER
B	DRAFT	11/07/2013	FOR REVISED IPART APPLICATION	BI	BRAD IRWIN MIEAust, CPEng, NPER

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Land Capability Assessment for Effluent Irrigation

for the

Catherine Hill Bay Water Utility Scheme, at Montefiore St, Catherine Hill Bay

Table of Contents

List of Figures

List of Tables

1 Introduction

Solo Water has entered into an agreement with the Rose Property Group to provide an integrated water, sewerage, recycled water and retail service provider solution for the approved residential subdivision at Catherine Hill Bay. The provision of private water services is permitted under the Water Industry Competition Act (WICA: 2006) and is administered by the NSW Independent Pricing and Regulatory Tribunal (IPART).

Once approved the scheme will be 100% owned, operated and maintained by the Catherine Hill Bay Water Utility (CHBWU) and funding of the scheme will be provided through rating of individual customers in the scheme as is the case with conventional water authorities. The CHBWU will take on all risks associated with the scheme and will operate the scheme in accordance with the license issued by IPART.

Harvest Water Management Consultants Pty Ltd was engaged by Solo Water to assist with the preparation of the IPART application and associated investigations. This Land Capability Assessment for Effluent Irrigation has been prepared to demonstrate there is sufficient land available on site for sustainable management of treated effluent by irrigation.

The standard Solo Water integrated water scheme uses advanced water recycling and dual reticulation that allows for approximately 60% of all wastewater generated to be managed by urban non-potable reuse on private lots. The remaining 40% is managed by irrigation of public open space areas within the approved development footprint.

This report focuses on the management of the 40% surplus recycled water by irrigation of public open space. Assessment of the irrigation scheme has generally been undertaken based on the National Guidelines for Water Recycling (AGWR: 2006) and the NSW EPA Guideline Use of Effluent by Irrigation (2005).

The issues associated with the treatment and supply of non-potable to individual lots is not covered in the scope of this report. These issues are addressed in the Recycled Water Management Plan to be developed for the scheme prior to construction of the Advanced Water Treatment Plant used to treat recycled water in Stage 2.

Following IPART approval of the scheme detailed irrigation management plans, landscape plans and irrigation system design will be developed in line with build out of the residential subdivision. These plans will be developed and approved by CHBWU prior to subdivision of each stage.

1.1 Project Scope

The scope of this investigation is to:

- Demonstrate there is sufficient area of public open space available inside the development footprint for the sustainable irrigation of the 40% surplus recycled water;
- Provide sufficient wet weather storage volume onsite to ensure irrigation does not occur during rainfall and that uncontrolled overflow from the storage does not occur;
- Demonstrate through MEDLI modelling that the proposed hydraulic and pollutant loading rates are sustainable and unlikely to result in a significant impact or risk to the local environment;
- Demonstrate through MEDLI modelling that the wet weather storage does not overflow based on historic climate data and provide a safety factor against future climate variations.

2 Background

2.1 Location

The proposed scheme is located inside the approved footprint of the Catherine Hill Bay residential subdivision at Montefiore Street, Catherine Hill Bay in New South Wales. The site is located at the southern end of the Lake Macquarie City Council region. An overview of the approximate site location is provided below in Figure 2.1.

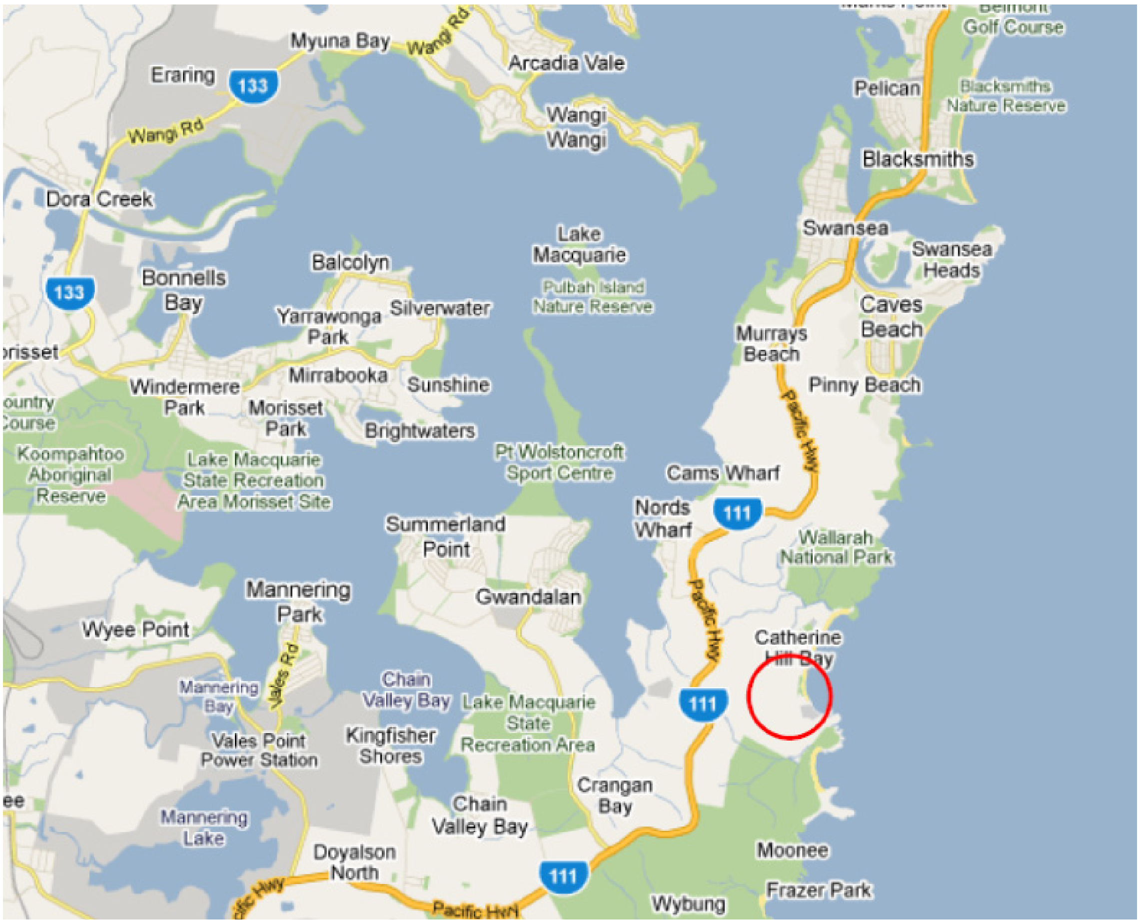

Figure 2.1: Site Location.

2.2 Proposed Development

The Catherine Hill Bay Water Utility (CHBWU) scheme is being proposed under the WIC Act to service the approved residential subdivision at Catherine Hill Bay being undertaken by Rose Property Group (Coastal Hamlets Pty Ltd). This residential subdivision received approval from the Minister for Planning in 2008. The subdivision site is located on a former coal mine and loading facility; hence the site has been highly impacted and modified from coal related activities.

The proposed CHBWU scheme is planned to service up to 470 ET and will be located within the approved footprint of the subdivision.

2.3 Previous Water & Wastewater Investigations

A Water and Wastewater Servicing Strategy was prepared for the original development approval by ADW Johnson Pty Ltd (2009). The original strategy involved connection to the Hunter Water Corporation water and sewerage networks located around 8 km to the north of the site and involved the construction of large water and wastewater transfer systems.

This centralised strategy relied on input from other developments in the area and there is now significant uncertainty as when or if these external developments will proceed. The centralised strategy is considered to be too expensive and not a viable option for servicing the development. The centralised strategy will also experience operational issues during early stages of the development when septicity and water quality issues in the transfer systems will be significant.

To overcome these issues and to promote decentralised wastewater management and water recycling, the Rose Property Group has elected Solo Water as the private water utility to service their Catherine Hill Bay residential subdivision.

2.4 Previous Environmental Assessment & Approvals

The proposed development received a development approval from the Minister for Planning in 2008. An Environmental Impact Assessment was undertaken for this approval in relation to the residential subdivision. Environmental impact assessment for water and sewerage infrastructure was to be undertaken by Hunter Water prior to construction of assets under Part 5 of the Environmental Planning and Assessment Act.

Given the revised proposal involves the private Catherine Hill Bay Water Utility, the existing Development Approval is being modified to allow the proposed wastewater treatment plant building and open space effluent irrigation areas to be located within the approved development footprint. This is being undertaken in parallel to the IPART licensing process.

This report provides sufficient information to demonstrate that irrigation of the proposed open space areas with recycled water will not result in significant environmental impacts. Additional reports will be provided for other aspects of the private water utility scheme requiring some form of environmental assessment, e.g. noise, odour.

3 Overview of the Solo Water Integrated Water & Wastewater Management System

Solo Water has developed a standard model for decentralised wastewater management that has been adapted to the Catherine Hill Bay Water Utility Scheme. This land capability assessment for effluent irrigation has been prepared based on the Solo Water model. The Solo Water model provides a staged approach to servicing development in remote areas using advanced treatment technology, automated control systems and onsite wastewater recycling.

An overview of the Solo Water decentralised wastewater system as it is applied to the Catherine Hill Bay Water Utility Scheme is outlined below in Table 3.1.

Table 3.1: Solo Water decentralised wastewater management model.

Scheme Component	General Description
Wastewater minimisation	Water demand management strategy involving mandatory water efficient fixtures, smart metering, customer awareness and education. Water tight sewerage system to minimise infiltration of stormwater and groundwater to the sewerage system.
Low pressure sewerage network – Constructed in line with development build out	Low pressure sewerage network constructed using PN 16 HDPE pipe with welded joints and fittings to minimise infiltration. Low pressure duplex pump stations service up to 4 lots with duty/standby pumps and 24 hours storage capacity in each pump well. Automated operation of the low pressure sewerage network is integrated with operation of the wastewater treatment plant through the direct digital control system to minimise peak inflow rates. Peak diurnal flows into the wastewater treatment plant are controlled using buffer storage provided in each pump well and at the inlet balance tank.
Membrane bioreactor (MBR) + Ultraviolet disinfection (UV) – Constructed during Stage 1	All wastewater is treated using MBR + UV to produce high quality effluent suitable for controlled irrigation of public open space. Typical MBR effluent quality: • BOD < 10 mg/L • SS < 5 mg/L • TN < 10 mg/L • TP < 0.3 mg/L • Faecal Coliform < 10 cfu/100 mL • Turbidity < 2 NTU The MBR + UV treatment plant has a peak design capacity of 300 kL/day and is sized to provide treatment of average wastewater flows plus a 10% contingency allowance. The full capacity of the MBR is constructed upfront during Stage 1. MBR + UV effluent will only be irrigated during the Stage 1 Temporary irrigation scheme onto a 10.75 ha temporary irrigation area. In the ultimate scheme all irrigation water will be Class A+ recycled water from the AWTP.

Scheme Component	General Description
Advanced Water Treatment Plant (AWTP) – Constructed during Stage 2	Following construction of the AWTP during Stage 2, all MBR treated effluent undergoes further treatment in the AWTP to produce "Class A+" recycled water suitable for supply to customers in the third pipe non-potable water reticulation network. The AWTP uses a multiple barrier approach to achieve log reduction targets outlined in the Australian Guidelines for Water Recycling (2006) using Ultrafiltration membranes, side stream Reverse Osmosis for salinity control, Ultraviolet disinfection and Chlorine contact tank and residual chlorination. All treatment processes in the AWTP will be designed to appropriate USEPA standards using equipment accredited under USEPA guidelines. The AWTP includes a 30% side stream reverse osmosis process with an 85% recovery rate that produces a waste stream of approximately 7.7 kL/day at 4700 mg/L TDS that is lost from the system and managed in evaporation ponds. For information on the management of RO reject waste refer to Question 4.3.15 of the IPART application. The AWTP is sized with a nominal capacity of 200 kL/day of recycled water. The AWTP and RO reject evaporation ponds will be constructed during Stage 2 and will be operational once 240 lots are connected to scheme. Details associated with the AWTP and supply of recycled water to individual lots is not in the scope of this report and is presented in the Recycled Water Management Plan being developed for the scheme (refer to IPART Application Appendix 4.2.11).
Third pipe non-potable water network	Compliant recycled water supplied through the urban non-potable water reticulation system is reused for the following uses: • Toilet flushing • Laundry washing machine cold water (hard plumbed only) • Outdoor cleaning and washdown (including bin and car washing) • Unrestricted irrigation of private lots • Fire hydrants • Irrigation of public open space areas The non-potable water reticulation system is supplied from a 0.85 ML recycled water storage tank using a variable speed drive booster pump set. Pressure in the non-potable water reticulation system is maintained below the pressure in the potable water network. An emergency potable water top-up (with air gap) is used to top-up the recycled water storage tank during consecutive peak day demands for recycled water. During Stage 1 only potable water is used to supply the non-potable water reticulation system until the AWTP is constructed in Stage 2.
10 ML wet weather storage	A 10 ML HDPE lined wet weather storage dam will be provided during Stage 1. The wet weather storage is used to store surplus recycled water when irrigation is not possible due to rainfall, elevated soil moisture or high wind etc. During the Stage 1, MBR+UV treated recycled water for irrigation of the temporary irrigation area will be supplied directly from the wet weather storage. During Stage 2 following construction of the AWTP no irrigation will occur directly from the wet weather storage. Water stored in the wet weather storage will be the feed water for the AWTP and non-potable water network during periods of high demand. Water balance modelling indicates the wet weather storage will not overflow based on historic rainfall data. In operation, storage overflows will be prevented by managing irrigation scheduling. If required surplus water will be carted offsite by licensed contractor to the nearest accepting wastewater treatment facility.

Scheme Component	General Description
Stage 1 temporary irrigation areas	During Stage 1 prior to construction of the AWTP, all MBR+UV treated effluent will be irrigated onto a 10.75 ha temporary irrigation area. The temporary irrigation can cater for average of 100 kL/day of irrigation, or up to 240 Lots. This corresponds to an average irrigation rate of around 1 mm/day and 100 days of wet weather storage. The Stage 1 temporary irrigation area will be supplied MBR+UV treated recycled water direct from the wet weather storage and is of a quality suitable for controlled irrigation. The following health risk controls will be implemented for the temporary irrigation system: • Minimum of 30 metre buffer to a residential dwelling; • Appropriate warning signage and fencing; • Spray drift controls including low pressure sprinkler nozzles with large droplet size and low throw height; • Irrigation scheduling controls to prevent irrigation during high rainfall, elevated soil moisture and high wind conditions; • Irrigation will occur at night during normal operating conditions. Site based stormwater and irrigation scheduling controls will be used to minimise environmental impacts, e.g. soil moisture probes, weather station, appropriately designed irrigation system, diversion drains, buffers etc. These will be documented in the Irrigation Management Plans to be developed for the temporary irrigation system at each stage of the subdivision build out. Decommissioning of temporary irrigation areas will commence once the AWTP is constructed and commissioned, following which open space irrigation water will be sourced from the Class A+ non-potable water network.
Stage 2 open space irrigation areas	Following construction of the AWTP in Stage 2 surplus Class A+ recycled water not reused on private lots will be managed by irrigation of 8.38 ha of public open space areas within the scheme. The surplus recycled water is estimated to be approximately 67 kL/day, which corresponds to approximately 40% of wastewater generation. This corresponds to an average irrigation rate of approximately 0.9 mm/day and approximately 140 days of wet weather storage. The Stage 2 public open space irrigation areas are made up of the following: • Approximately 3.5 ha of vegetated landscape buffers along Montefiore St and the "green links" provided in the subdivision. • Approximately 4.9 ha of new open space and parklands provided in the area that formerly occupied stage 7 of the approved development. During Stage 2 all irrigation water will be taken from the Class A+ non-potable water network, hence there is minimal health risks associated with this activity and surface irrigation will be used with minimal buffers. Site based stormwater and irrigation scheduling controls will be used to minimise environmental impacts, e.g. soil moisture probes, weather station, appropriately designed irrigation system, diversion drains, buffers etc. These will be documented in the Irrigation Management Plans to be developed for each stage of the subdivision build out.

Preliminary Process Flow Diagrams (PFDs) of the proposed sewerage infrastructure under the Catherine Hill Bay Water Utility Scheme are provided in Appendix B.

Preliminary layout plans and maps of the proposed sewerage infrastructure under the Catherine Hill Bay Water Utility Scheme are provided in Appendix C.

4 Wastewater Generation & Recycled Water Supply

4.1 Equivalent Population

Equivalent Population (EP) for the scheme was assessed based on a long term peak occupancy rate of 2.8 EP/ET, which equates to an Equivalent Population of 1316 EP for the 470 ET Catherine Hill Bay Utility Scheme. During Stage 1 prior to construction of the AWTP, a maximum of 240 ET, or 672 EP, can be connected to the scheme.

4.2 Wastewater Minimisation

Wastewater generation in the Catherine Hill Bay Water Utility Scheme will be minimised through implementation of a wastewater minimisation strategy. The wastewater minimisation measures will be mandatory for all lots in the scheme and will be controlled through agreements/contracts with each resident. The wastewater minimisation strategy for the CHB Water Utility Scheme will include:

- Mandatory best practice water efficient fixtures and appliances;
- Smart water metering at each dwelling to provide feedback on water usage patterns and detection of leaks;
- New customer contracts and access agreements that outline the responsibilities of the resident with regard to appropriate water usage and waste management practices;
- Ongoing awareness and communication with existing customers through additional information provided at each billing cycle and the CHBWU website.

The mandatory water efficiency and demand management requirements will be audited during plumbing inspection. Guidelines and information packages will be developed for education of residents and contract plumbers to ensure ongoing compliance.

4.3 Wastewater Generation

Wastewater generation for the proposed development was estimated based on the per capita wastewater generation rate of 150 L/EP/day. No allowance has been made for inflow and infiltration to the sewerage system as the scheme is designed with a water tight welded polyethylene low pressure sewerage network.

Ultimate wastewater generation for the 470 ET (1316 EP) scheme is estimated to be 197 kL/day, as indicated below in Table 4.1. During Stage 1 prior to construction of the AWTP, wastewater generation is estimated to be approximately 100 kL/day for 240 ET.

Table 4.1: Wastewater generation in Catherine Hill Bay Water Utility Scheme.

Stage	Treatment Description	Total ET	Total EP	Wastewater Generation (kL/d)
1	MBR only	240	672	100.8
2	MBR + AWTP	470	1316	197.4

All wastewater in the scheme will be treated in a Membrane Bioreactor (MBR) with a peak design capacity of 300 kL/day, hence there is spare capacity in the treatment plant to handle peak events.

4.4 Class A+ Recycled Water Demand

Following construction and commissioning of the Advanced Water Treatment Plant (AWTP) during Stage 2, all MBR+UV treated effluent will undergo further treatment in the AWTP to produce “Class A+” recycled water suitable for supply in the non-potable water reticulation system. The AWTP will have a nominal capacity to produce 200 kL/day of recycled water.

The demand for “Class A+” recycled water on private lots is estimated to be approximately 118 kL/day based on a per capita recycled water demand of 90 L/EP/day, as outlined below in Table 4.2.

Table 4.2: Typical demands for “Class A+” recycled water on 470 private lots.

Water Use	Average Demand	
	L/EP/day	kL/day
Toilet flushing	20	26.3
Laundry washing machine^	20	26.3
Outdoor irrigation & washdown`	50	65.8
Total	90	118.4

^ Hard plumbed to washing machine cold water tap only.
` Include bin washing and car washing.

The AWTP includes a side stream reverse osmosis (RO) process to maintain salinity in the non-potable water supply system at approximately 500 mg/L TDS. The RO process will produce a reject stream in the order of 7.7 kL/day at 4700 mg/L TDS that is being managed in evaporation ponds and is therefore not available for supply of recycled water, as shown below in Table 4.3.

Note: All health and environmental issues associated with the use of recycled water on private lots are dealt with in the Recycled Water Management Plan being prepared for the Catherine Hill Bay Water Utility scheme (IPART Application refer Appendix 4.2.11).

4.5 Surplus Recycled Water for Open Space Irrigation

All recycled water not reused on private lots will be managed by sustainable land irrigation.

During Stage 1 prior to construction of the AWTP, all MBR+UV treated effluent will be managed by irrigation of a 10.75 ha restricted access temporary irrigation area. Irrigation will occur directly from the wet weather storage via a temporary pump and irrigation supply pipe work.

During Stage 2 following commissioning of the AWTP, surplus recycled water reduces due to the use of recycled water on private allotments. During Stage 2 surplus recycled water will be managed by irrigation of 8.3 ha public open space and parklands using Class A+ recycled water from the dual reticulation network.

The estimated surplus recycled water available for irrigation of public open space during each stage of the scheme is outlined below in Table 4.3. It can be seen from Table 4.3 that during Stage 1 prior to construction of the AWTP, there will be approximately 100 kL/day of MBR+UV treated recycled water to be managed by irrigation of the temporary irrigation area.

At ultimate development there will be approximately 67 kL/day of surplus recycled water that is not reused on private lots. This water will be managed via irrigation of public open space and parklands using Class A+ recycled water.

Table 4.3: Surplus recycled water available for controlled irrigation of public open space.

Stage	Total ET	Wastewater Generation (kL/d)	Non-Potable Water Demand (kL/day)	Treatment System Losses^ (kL/d)	Surplus for Irrigation (kL/d)	Conservative value used in assessment
1-Temporary	240	100.8	N/A	≈2	≈98.8	105 kL/day
2- Ultimate	470	197.4	118.4	≈11.7	≈ 67.3	74 kL/day

^ Treatment system losses include waste sludge from the MBR and RO Reject from the AWTP.
UF retenate is recycled through the MBR.

The be conservative in planning and water balance of the effluent irrigation scheme, average irrigation flows of 105 kL/day for Stage 1, and 74 kL/day ultimate, were adopted for water balance modelling to ensure there will be sufficient land areas available for managing surplus recycled water produced under the scheme.

5 Preliminary Assessment of Irrigation Areas

5.1 Overview of Proposed Irrigation Areas

The effluent irrigation areas provided under the Catherine Hill Bay Water Utility Scheme will include:

Temporary up to 240 Lots or 100 kL/day

- Irrigation of a temporary irrigation area with high quality MBR + UV treated effluent taken directly from the wet weather storage;

Ultimate up to 470 Lots with water recycling

- Uncontrolled irrigation on private lots supplied with Class A+ Recycled Water treated in the AWTP and supplied through the urban non-potable water reticulation network;
- Irrigation of surplus Class A+ recycled water onto open space and park lands.

This report applies to assessment of the water and nutrient loads through irrigation of the temporary and public open space irrigation areas using recycled water. All matters relating to the use of Non-Potable water on private lots supplied through the non-potable water supply network are discussed separately in the Recycled Water Management Plan.

5.1.1 Stage 1 Temporary Restricted Access Irrigation Areas

The proposed temporary irrigation area is 10.75 ha in area and located inside the footprint of the approved residential subdivision. A plan showing the location of the proposed temporary irrigation areas is provided in Appendix D. The area shown in Appendix D can cater for up to 240 Lots or an average irrigation flow of 100 kL/day.

The temporary irrigation area will be provided by the developer in line with the rate of build out of the subdivision. The temporary irrigation area will be developed and planted with appropriate grass species following bulk earth works activities and contouring required for the subdivision.

A detailed irrigation management plan will be documented for the temporary irrigation area during each stage of the development build out. The following health and environmental control measures have been allowed for will be detailed in the IMP:

- Irrigation scheduling controls informed by soil moisture probes and an onsite weather station to ensure irrigation does not occur during periods of high wind, elevated soil moisture or rainfall;
- Maximum irrigation event durations to ensure no ponding, runoff or deep drainage, and automatic shut off of the irrigation system following a predetermined application;
- Appropriate grass species to be established in the temporary irrigation areas;
- Stormwater and site controls including buffers, diversion drains and mounds to minimise the potential for stormwater runoff from irrigation areas;
- Subsurface irrigation will be used in areas where slope exceeds 5%;
- Surface irrigation system designed to minimise spray drift by using low pressure sprinkler nozzles with large droplet size and low throw height;
- Flow monitoring on the irrigation system to assist with the detection of leaks and pipe breaks;

- Groundwater and surface water monitoring will be undertaken to ensure the strategy does not result in significant impacts.

The CHBWU will be responsible for all operation & maintenance activities associated with the temporary irrigation area, including irrigation scheduling and irrigation system maintenance, as well as landscape maintenance, mowing and environmental monitoring.

5.1.2 Stage 2 Public Open Space Irrigation Areas

The proposed Stage 2 public open space irrigation areas total approximately 8.4 ha and are located inside the footprint of the approved residential subdivision. A plan showing the location of the proposed Stage 2 public open space irrigation areas is provided in Appendix D.

The Stage 2 public open space irrigation area is made up of:

- 3.5 ha of vegetated landscape buffers along Montefiore St and the "green links" provided in the subdivision;
- 4.9 ha of new open space and parklands provided in the area that formerly occupied stage 7 of the approved subdivision.

The approved conceptual landscape plans for the subdivision showing the layout and cross sections of the vegetated road buffers and nature strips proposed to be irrigated with recycled water are provided in Appendix A.

Landscape plans for the 4.9 ha public open space parklands have not yet been prepared. This will be undertaken by a landscape architect in consultation with the CHBWU and the developer prior to transitioning to Stage 2 of the scheme. The open space areas will be vegetated with appropriate tree, shrub and grass species suitable for irrigation with recycled water.

A detailed Irrigation Management Plan (IMP) will be documented for the ultimate public open space irrigation areas. Given the ultimate public open space areas will be irrigated with Class A+ recycled water from the dual reticulation network, the health risks associated with this activity are minimal and surface irrigation can occur with minimal buffers or access restrictions. Environmental controls will focus on irrigation scheduling and stormwater controls to mitigate the potential impacts of nutrient seepage or runoff from the irrigation areas.

The following health and environmental control measures have been allowed for and will be detailed in the IMP:

- Irrigation scheduling controls informed by soil moisture probes and an onsite weather station to ensure irrigation does not occur during periods of high wind, elevated soil moisture or rainfall;
- Maximum irrigation event durations to ensure no ponding, runoff or deep drainage, and automatic shut off of the irrigation system following a predetermined application;
- Appropriate tree, shrub and grass species to be established in the open space irrigation areas;
- Stormwater and site controls including buffers, diversion drains and mounds to minimise the potential for stormwater runoff from irrigation areas;
- Subsurface irrigation will be used in areas where slope exceeds 5%;
- Irrigation system designed to minimise spray drift by using low pressure sprinkler nozzles with large droplet size and low throw height.
- The irrigation system will be designed to achieve a distribution uniformity coefficient >85%;

- Flow monitoring on the irrigation system to assist with the detection of leaks and pipe breaks;
- Groundwater and surface water monitoring will be undertaken to ensure the strategy does not result in significant impacts.

The CHBWU will be responsible for all operation & maintenance activities associated with public open space irrigation, including irrigation scheduling and irrigation system maintenance, as well as landscape maintenance, mowing and environmental monitoring.

5.1.3 Future Council Sports Fields

Consultation with Lake Macquarie City Council (LMCC) indicates there is a future sports complex planned to be located in the Catherine Hill Bay area that will require irrigation once it is developed. The sports complex is not expected to be constructed until sometime after the Catherine Hill Bay subdivision is completed. This irrigation area is not required for the scheme but is being allowed for as a beneficial reuse opportunity for the community.

Based on preliminary plans provided by LMCC in Appendix D, the future sports field will provide a total area of approximately 2.5 ha, as indicated below in Table 5.1. The sports fields would be a high use facility and it is likely would require high irrigation rates to maintain the fields in top playing condition.

Table 5.1: Possible irrigation areas at future LMCC sports complex.

Future Sports Facility	Approximate Area (ha)
Lawn bowls green	0.13
Rugby/Soccer	2
Cricket field	0.37^
TOTAL	2.5

^ Approximate area of cricket field that is not overlapped by the rugby/soccer fields.

When the above sports fields are constructed by LMCC at some point in the future, the CHBWU can supply Class A+ recycled water for irrigation of the sports fields. Should this be pursued by LMCC at a later date, a recycled water supply agreement will be entered into between CHBWU and LMCC.

5.2 Preliminary Site & Soil Assessment

A preliminary desktop site assessment for effluent irrigation has been undertaken for the open space effluent irrigation areas provided within the Catherine Hill Bay Water Utility Scheme.

A desktop site and soil assessment has been undertaken based on the existing information provided to Harvest WMC from the Environmental Assessment prepared for the existing planning approval of the residential subdivision. Following approval of the IPART license more detailed assessment will be undertaken as each of the future development stages through detailed soil testing and documentation of effluent irrigation area management plans.

The preliminary site assessment in this report was generally undertaken in accordance with the following effluent irrigation and recycled water guidance documents:

- NSW EPA effluent irrigation guidelines (DEC: 2004);
- Australian recycled water guidelines (EPHC: 2006);
- Australian Standard for onsite domestic wastewater management AS1547 (SIA: 2012).

A summary of the preliminary site assessment is provided below in Table 5.2.

Table 5.2: Summary of site assessment.

Parameter	Preliminary Assessment of Site Constraints for Effluent Irrigation
Climate	Review of BOM and MEDLI model climate data indicates average annual pan evaporation exceeds average annual rainfall. Site specific MEDLI climate data derived for the site by the QLD Department of Science, Information Technology, Innovation and the Arts, indicates the site receives an average annual rainfall of 1217 mm/yr and average annual pan evaporation of 1431 mm/yr. This corresponds to an average annual rainfall-evaporation deficit of 214 mm/year, or approximately 0.6 mm/day. Given that evaporation exceeds rainfall, climate is not likely to be a significant constraint to effluent irrigation, provided there is sufficient irrigation area and wet weather storage. Site specific water balance modelling using MEDLI has been undertaken to ensure the irrigation area and wet weather storage are appropriate for site climate conditions.
Topo-graphy	The overall residential development site is located on undulating terrain on the coastal plain with levels varying from approximately RL 10 m AHD up to RL 50 m AHD. Some area of the site are quite steep with slopes >5-10%. Earthworks and surface contouring will be undertaken during bulk earth works to minimise slopes on areas to be irrigated with recycled water. Subsurface irrigation will be used on all irrigation areas where the post development slope exceeds 5% to minimise risks associated with surface runoff and soil erosion. Earthen mounds and vegetated buffers will also be used along the down gradient side of all irrigation areas as a further stormwater runoff control.
Surface Water and Flooding	All effluent irrigation areas are located within the urban development footprint of the approved residential subdivision, hence flooding will not be an issue. No irrigation is proposed inside the council parks and drainage reserves. The proposed effluent irrigation scheme includes a 10 ML wet weather storage to enable storage of recycled water during periods of rainfall when surface runoff and localised ponding may occur.
Vegetation	The effluent irrigation areas will be located within the urban development footprint of the approved residential subdivision; hence vegetation is not considered a significant constraint to effluent irrigation. Public open space areas that contain significant or protected vegetation identified through future detailed landscape design processes will be avoided for effluent irrigation. Such areas will be documented in the Effluent Irrigation Management Plan and prepared for each phase of the development build out. Landscape design of the subdivision will ensure appropriate species are used in all irrigation areas. MEDLI modelling indicates all nutrients applied in irrigation are managed inside the boundary of the irrigation area by plant uptake and soil absorption, hence the potential for offsite export of nutrients to impact on surrounding vegetation is considered low, provided irrigation scheduling controls are implemented.

Parameter	Preliminary Assessment of Site Constraints for Effluent Irrigation
Soils	Geotechnical investigation of the site undertaken by Geotech Solutions Pty Ltd (2010) indicates the natural soils across the site consist of: • Clean Aeolian quartz sand overlying silty and clayey quartz sand • A mixture of sand, gravel, clay and silt overlying extremely to highly weathered rock • Higher plasticity clays at depth near the interface of bedrock • Triassic and late Permian age bedrock Given the sites former use as a coal mine, topsoil conditions vary across the site based on the specific mining activities that have previously occurred, e.g. stockpiles, tailings dams, earthworks etc. Post development soil conditions will vary from what is currently on site due to the remediation works being undertaken by the coal mine and the bulk earth works that will occur as part of the residential subdivision. Detailed evaluation of soil physical and chemical properties will be undertaken during each phase of the subdivision build out and reassessed following bulk earthworks. Appropriate management measures will be incorporated in to the Irrigation Management Plans. Given the high sand content of the top soil layers where effluent will be applied, issues associated with poor drainage, Sodicity, soil pH and soil salinity are not expected to be a significant constraint to effluent irrigation. During establishment of the open space areas by the developer, a minimum of 200-300 mm of high quality sandy loam topsoil sourced from the site and other areas will be used to develop suitable soil conditions for plant growth in the irrigation areas.
Ground water	Geotechnical investigation undertaken by Geotech Solutions Pty Ltd (2010) indicated minimal groundwater was encountered in the upper soil profile where effluent irrigation will occur. Groundwater is expected to occur at depth in the rock strata that underlies the site. The potential for contamination groundwater from deep drainage of effluent at the proposed average irrigation rate of <0.9 mm/day is considered low, provided irrigation scheduling controls are implemented. Some localised areas of the site were noted to be susceptible to water logging during extensive rain periods, particularly in areas of the site impacted by mining activities, e.g. where dams and ponds had been filled. No irrigation is proposed in low lying areas of the site in the drainage reserves. The proposed irrigation scheme includes a 10 ML wet weather storage to enable effluent to be stored during and following periods of heavy rainfall when localised saturated soil conditions may occur. Irrigation of public open space will use Class A+ recycled water. Given the high quality water, depth to groundwater and low irrigation rates, the risk of contamination of groundwater with pathogens as a result of recycled water irrigation is low. MEDLI modelling indicates all nutrients applied in irrigation are managed inside the boundary of the irrigation area by plant uptake and soil absorption, hence the potential for export of nutrients groundwater is considered low, provided irrigation scheduling controls are implemented.

Parameter	Preliminary Assessment of Site Constraints for Effluent Irrigation
SEPP 14 Wetlands	A SEPP 14 wetland exists to the south of the site. Planning and environmental assessment undertaken for development approval of the residential subdivision provided >50 metre setback from SEPP 14 wetland that will be maintained for the effluent irrigation system. A further 25 metres buffer is provided from the irrigation areas to the subdivision boundary to provide an additional buffer to protect the SEPP 14 wetland. Irrigation scheduling controls and site based stormwater controls will be used in all irrigation areas, hence the potential for surface runoff into the SEPP14 wetland as a result of effluent irrigation is considered low.
Rock Outcrops	The geotechnical report noted minimal rock outcrops are present in the site, except for some areas around the headland in the eastern extreme of the site. Irrigation of the headland and coastal walk using recycled water is not proposed. Any areas of rock outcrop with less than 300 mm top soil coverage identified during detailed landscape design processes will be avoided for effluent irrigation. Any such areas identified will be included in the Effluent Irrigation Management Plan prepared at each stage of the development build out.
Land use	All effluent irrigation will be on land zoned as public open space inside the urban development footprint of the approved residential subdivision. There is a minimum of 25 metre buffer between the open space irrigation areas and the site boundary. MEDLI modelling indicates all nutrients applied in irrigation are managed inside the boundary of the irrigation area by plant uptake and soil absorption, hence the potential for offsite export of nutrients to impact on surrounding land uses is considered low, provided irrigation scheduling controls are implemented.
Site water supply	There is currently no potable water supply in the area and all existing dwellings rely on the use of rainwater tanks and water cartage. The Catherine Hill Bay Water Utility will be providing a potable water supply to the future residential subdivision. The water source for the drinking water supply will be verified potable water supplied under a bulk supply agreement with Wyong Council. Given the recycled water use at the site, a cross connection and backflow prevention strategy will be employed to ensure water quality in the potable water system is maintained.

6 Preliminary Effluent Quality Hazard Assessment

6.1 Stage 1 Temporary – MBR + UV Effluent

A preliminary effluent quality hazard assessment has been undertaken for the proposed temporary irrigation scheme. The Stage 1 temporary irrigation system uses MBR + UV treated effluent irrigated directly from the wet weather storage.

Although the proposed MBR + UV treatment train will produce high quality recycled water, no pathogen log reduction credits are being claimed for the MBR. Site controls are being implemented to minimise human contact with recycled water during irrigation. This strategy will reduce the commissioning and validation requirements for the MBR during early stages of subdivision build out when wastewater flows are low. The MBR will be commissioned and validated based on effluent quality monitoring data.

An overview of the preliminary effluent quality hazard assessment for the proposed open space irrigation system is outlined below in Table 6.1.

Table 6.1: Preliminary effluent quality hazard assessment for MBR+UV treated recycled water for the Stage 1 temporary irrigation system.

Effluent Quality Hazard	Stage 1 MBR + UV Effluent Quality	Control Measures
Micro biological hazards – bacteria, protozoa and viruses	Faecal Coliform: < 10 cfu/100 mL Turbidity: < 1 NTU	The main control measure is high quality MBR+ UV treated recycled water • Faecal Coliform < 10 cfu/100 mL (weekly monitoring); • Turbidity < 1 NTU (continuous online with alarms); The MBR includes continuous online monitoring and alarms on permeate turbidity, trans-membrane pressure, UV intensity and other critical process parameters to ensure high product quality and system reliability. Access restriction on the temporary irrigation area will be implemented to minimise the potential for human contact, including: • Restricted access to irrigation areas • Irrigate at night during normal operating conditions • >30 metre buffer to residential dwellings • Spray drift controls on the irrigation system • Irrigation scheduling controls to avoid irrigation during high wind or rainfall • Appropriate warning signage
pH	pH: 6.5 – 8.5	The WWTP includes continuous online monitoring of pH and automated pH correction dosing facilities. Irrigation using recycled water with pH close to neutral is unlikely to result in impact on soil pH.
BOD	BOD: < 10 mg/L	The WWTP includes continuous online monitoring of DO and MLSS with automated alarm systems. Air supply to the MBR is controlled using a variable speed aeration system.

Effluent Quality Hazard	Stage 1 MBR + UV Effluent Quality	Control Measures
Nutrients – Nitrogen and Phosphorus	Total Nitrogen: <10 mg/L (as N) Total Phosphorus: <0.3 mg/L (as P)	High quality MBR effluent with low nutrients. Low irrigation rates and per hectare nutrient loads. Irrigation controls will reduce the potential for surface runoff of nutrients to waterways or excessive deep percolation to groundwater. pace Irrigation Areast loads using MEDLI indicated nutrients applied in irrigation are managed by plant uptake and soil adsorption, as discussed in Section 7.
Salts	TDS <1000 mg/L, varies with inflow	Appropriate selection of vegetation species in effluent irrigation areas that can tolerate salt concentrations. Assessment of salt loads using MEDLI indicated no impact on plant growth due to salinity, as discussed in Section 7.
Sodium Adsorption Ratio (SAR)	No effluent quality target is proposed for SAR.	Soil profile dominated by halocene sand hence minimal potential Sodicity impacts. Baseline soil ESP will be assessed following bulk earthworks at the site and prior to commencement of irrigation. Irrigation water SAR and soil ESP will be monitored annually to identify any change. If Sodicity impacts are observed in operation then Gypsum will be routinely applied to the temporary irrigation area.
Trace contamin-ants	Majority domestic catchment with minimal trade waste inputs, hence there is low likelihood of trace contaminants being present.	The temporary scheme will be operational for less than 5 years; hence there is minimal risk of long term impacts due to trace contaminants. Residential customer supply agreements, trade waste agreements and ongoing awareness and education with water bills will assist to reduce this risk. Detailed annual monitoring for trace metals and other contaminants will be undertaken during operation. If detected an investigation into the source will be undertaken and rectified. Given the use of low pressure sewerage system, raw water quality monitoring from individual pump wells can be undertaken to identify the source of contaminants if required.

6.2 Stage 2 – AWTP Class A+ Recycled Water

Following construction and commissioning of the AWTP in Stage 2 only Class A+ recycled water will be used for irrigation of public open space and parklands. The health risks associated with irrigation of public open space with Class A+ recycled water are minimal and minimal health buffers and withholding periods are required. A preliminary effluent quality hazard assessment for Class A+ recycled water is provided below in

The effluent quality hazard assessment and HACCP analysis for the proposed non-potable water supply system that supplies AWTP treated recycled water to individual lots is included in the Recycled Water Management Plan for the scheme. Commissioning and validation requirements of the AWTP are outlined in the (RWMP) and will be undertaken prior to the supply of recycled water to individual lots.

Table 6.2: Preliminary effluent quality hazard assessment for Class A+ Recycled Water from the AWTP for open space irrigation.

Effluent Quality Hazard	Stage 2 MBR + UV + AWTP Recycled Water Quality	Control Measures
Micro biological hazards – bacteria, protozoa and viruses	Validated Class A+ Recycled Water Faecal Coliforms <1 cfu/100 mL Turbidity < 1 NTU Log Reduction Targets from AGWR (2006): • Bacteria – 5.3 log • Protozoan – 5.1 log • Viruses – 6.5 log	The AWTP uses a multiple barrier approach to achieve log reduction targets outlined in the Australian Guidelines for Water Recycling (AGWR: 2006) using Ultrafiltration membranes, side stream Reverse Osmosis for salinity control, Ultraviolet disinfection and Chlorine contact tank and residual chlorination. All treatment processes in the AWTP will be designed to appropriate USEPA standards using equipment accredited under USEPA guidelines. The AWTP includes online monitoring and alarms on the following critical control points: • Ultrafiltration membrane permeate turbidity, trans-membrane pressure and direct membrane integrity testing by air pressure decay; • Ultraviolet disinfection UV intensity, flow, run hours, lamp faults; • Chlorine contact tank free chlorine concentration, flow, temperature and dosing pump faults; • Free residual chlorine in the recycled water supply tank and network.
pH	pH: 6.5 – 8.5	The AWTP includes continuous online monitoring of pH and automated pH correction dosing facilities. Irrigation using recycled water with pH close to neutral is unlikely to result in impact on soil pH.
BOD	BOD: < 10 mg/L	The MBR includes continuous online monitoring of DO and MLSS with automated alarm systems. Air supply to the MBR is controlled using a variable speed aeration system. The AWTP will further reduce BOD concentrations compared to MBR effluent.

Effluent Quality Hazard	Stage 2 MBR + UV + AWTP Recycled Water Quality	Control Measures
Nutrients – Nitrogen and Phosphorus	Total Nitrogen: <7 mg/L (as N) Total Phosphorus: <0.25 mg/L (as P)	High quality Class A+ recycled water with low nutrients. The AWTP has a side stream reverse osmosis process that will reduce nutrient concentrations in Class A+ recycled water by a further 20-30% compared to MBR effluent. Low irrigation rates and per hectare nutrient loads. Irrigation controls will reduce the potential for surface runoff of nutrients to waterways or excessive deep percolation to groundwater. Assessment of nutrient loads using MEDLI indicated nutrients applied in irrigation are managed by plant uptake and soil adsorption, as discussed in Section 7.
Salts	TDS <600 mg/L,	The AWTP has a side stream reverse osmosis process that reduces salt concentration of Class A+ recycled water to <600 mg/L TDS. Appropriate selection of vegetation species in effluent irrigation areas that can tolerate salt concentrations. Assessment of salt loads using MEDLI indicated no impact on plant growth due to salinity, as discussed in Section 7.
Sodium Adsorption Ratio (SAR)	No effluent quality target is proposed for SAR.	Soil profile dominated by halocene sand hence minimal potential Sodicity impacts. Baseline soil ESP will be assessed following bulk earthworks at the site and prior to commencement of irrigation. Irrigation water SAR and soil ESP will be monitored annually to identify any change. If Sodicity impacts are observed in operation then Gypsum will be routinely applied to the open space irrigation areas. If required the SAR of Class A+ recycled water will be maintained <5 through the addition of calcium and/or magnesium at the AWTP.
Trace contamin-ants	Majority domestic catchment with minimal trade waste inputs, hence there is low likelihood of trace contaminants being present.	The AWTP has a side stream reverse osmosis process that will reduce the concentration of trace contaminants by a further 20-30% compared to MBR effluent. Residential customer supply agreements, trade waste agreements and ongoing awareness and education with water bills will assist to reduce this risk. Detailed annual monitoring for trace metals and other contaminants will be undertaken during operation. If detected an investigation into the source will be undertaken and rectified. Additional treatment using activated carbon, ion exchange or additional reverse osmosis can be installed if required. Given the use of low pressure sewerage system, raw water quality monitoring from individual pump wells can be undertaken to identify the source of contaminants if required.

7 Effluent Irrigation Scheme Water Balance Modelling

7.1 Introduction

Water and pollutant balance modelling of the open space effluent irrigation scheme was undertaken using the MEDLI model version 1.3 (Model for Effluent Disposal by Land Irrigation) developed by the Queensland Department of Natural Resources (DNR, 1999).

MEDLI is a daily water and pollutant balance model that uses derived site specific daily rainfall, pan evaporation, temperature and solar radiation data to simulate the water balance, plant growth and nutrient and salt transport in an irrigation system.

MEDLI modelling was undertaken to demonstrate the proposed Catherine Hill Bay Water Utility Scheme exceeds the requirements outlined in *NSW Government - Department of Environment and Conservation - Environmental Guideline - Use of Effluent by Irrigation (DEC: 2004)*.

Under the DEC (2004) effluent irrigation guideline, schemes involving irrigation of "low strength" effluent are permitted an overflow discharge from the wet weather storage in 50% of years. Effluent quality requirements for DEC (2004) low strength effluent and a comparison with the proposed CHBWU MBR effluent quality and AWTP recycled water quality is provided below in Table 7.1.

Table 7.1: Comparison DEC (2004) low strength effluent with CHBWU MBR & AWTP effluent.

Parameter	DEC (2004) Low Strength Effluent	Stage 1 Temporary Irrigation Area MBR + UV	Stage 2 Public Open Space Irrigation MBR+UV+AWTP
Indicative Treatment Level	Secondary treatment	Tertiary treatment MBR + UV Faecal Coliforms <10 cfu/100 mL Turbidity < 1 NTU	Validated Class A+ Recycled Water Faecal Coliforms <1 cfu/100 mL Turbidity < 1 NTU
Biochemical Oxygen Demand	<50 mg/L	<10 mg/L	<5 mg/L
Total Nitrogen	<50 mg/L	<10 mg/L	<7 mg/L
Total Phosphorus	<10 mg/L	<0.3 mg/L	<0.25 mg/L
Total Dissolved Solids	<600 mg/L	500 - 1000 mg/L dependant on influent conditions	<600 mg/L
Storage Overflow Performance Target	Storage overflow in 50% of years	No storage overflows based on historic climate data Storage level managed via increased irrigation rates when the storage contains water	No storage overflows based on historic climate data Storage level managed using via increased irrigation rates when the storage contains water

As indicated above in Table 7.1, the proposed CHBWU MBR and AWTP treatment systems produce high quality effluent with low nutrient concentrations that greatly exceeds the effluent quality requirements for low strength effluent under the DEC (2004) guidelines. The water balance has also been designed so the wet weather storage does not overflow by using a large wet weather storage and large irrigation area with low average irrigation rates. This strategy will therefore result in less environmental impacts than the standard DEC model.

7.2 Performance Objectives

The following performance and environmental objectives have been developed for the planning and design of the effluent irrigation scheme:

- Provide sufficient irrigation area, wet weather storage and appropriate irrigation rates to achieve no overflow based on historic climate data;
- Maximise plant uptake of nutrients and ensure long term build up or export of nutrients from irrigation areas does not occur;
- Minimise the potential for contamination of surface and groundwater by scheduling irrigation events to replenish soil moisture and avoid irrigation during or shortly after rainfall;
- Minimise the size of irrigation area and wet weather storage by scheduling irrigation events to generally occur every day except rain days;
- Ensure the salt loading onto irrigation areas does not result in reductions in plant yield or accumulation within the soil profile.

The above performance objectives have been demonstrated through MEDLI modelling of the proposed effluent irrigation scheme, as outlined in the following sections of the report.

7.3 MEDLI Modelling

MEDLI modelling of the proposed effluent irrigation scheme was undertaken for two scenarios, being Stage 1 and Ultimate based on the conservative irrigation flows presented in Table 4.3 and the proposed irrigation areas presented in Section 5.1. MEDLI modelling has shown the above performance objectives have been achieved under the temporary and ultimate scenarios when modelled over a 100 year period.

7.3.1 Model Input Parameters

The input parameters used in MEDLI modelling are summarised below in Table 7.2. More information on the MEDLI modelling inputs is provided in the MEDLI Summary Output in Appendix E.

Table 7.2: Summary of input parameters used in MEDLI modelling.

Modelling Parameter	Adopted Value
Irrigation Flow	Stage 1 Temporary: 105 kL/day Ultimate: 74 kL/day
Effluent quality	Total Nitrogen – 10 mg/L Total Phosphorus – 1 mg/L (lowest allowable phosphorous concentration in MEDLI) Total Dissolved Solids – 1,500 mg/L (600 mg/L Ultimate)
Irrigation area	Stage 1: 10.75 ha Ultimate: 8.38 ha
Wet weather storage	10 ML HDPE lined open pond
Climate data	Derived daily climate data for Catherine Hill Bay sourced from DERM for the coordinates 33.2° S, 151.6° E for the modelling period.
Modelling period	100-year historic modelling period from 1/1/1912 to 31/12/2011.

Modelling Parameter	Adopted Value
Soil type	The standard MEDLI soil type "sand" was used with minor adjustments to the number of layers and layer thickness. A conservative soil profile was modelled using the standard MEDLI "sand" soil type with a 100 mm sandy topsoil layer over a 500 mm sandy subsoil layer.
Crop type	Standard MEDLI crop type "temperate pasture".
Irrigation scheduling	General philosophy: "Irrigate every day except rain days" Low average irrigation rates, with higher irrigation rates used when the wet weather storage contains water and during periods of high evapotranspiration demand. Ultimate: • Irrigation Trigger: Soil moisture < 100% Plant Available Water Capacity • Average day irrigation rate < 0.9 mm/day • Maximum Irrigation Amount: Drained upper limit + 2 mm (only when water in storage) • Average Annual Irrigation: 346 mm/year Stage 1 Temporary: • Irrigation Trigger: Soil moisture < 100% Plant Available Water Capacity • Average day irrigation rate < 0.9 mm/day • Maximum Irrigation Rate: Drained upper limit + 3 mm (only when water in storage) • Average Annual Irrigation: 374 mm/year

7.3.2 Modelling Results

7.3.2.1 Average Water Balance Results

MEDLI modelling was undertaken based on the input parameters and performance targets presented above. A summary of average water balance results from MEDLI is provided below in Table 7.3. Water balance modelling indicates the proposed scheme is predicted to achieve 100% reuse with no overflows from the wet weather storage based on historic rainfall data.

Table 7.3: Summary of average water balance results.

	Parameter	Ultimate	Stage 1 (temporary)
Wet weather storage	Pond volume (ML)	10 ML (≈130 days)	10 ML (≈100 days)
	Average volume (ML)	1.41 ML (14% full)	1.28 ML (12.8% full)
	Effluent inflow (ML/year)	27.03 (74 kL/day)	38.35 (105 kL/day)
	Climate inputs (ML/year)	1.95	1.97
	Irrigation (ML/year)	28.98	40.32
	Pond overflow (ML/year)	0.00	0.00
	Volumetric % Reuse (%)	100%	100%
	Average overflow frequency and duration	No overflow events in the 100-year modelling period	No overflow events in the 100-year modelling period

	Parameter	Ultimate	Stage 1 (temporary)
Irrigation area	Irrigation Area (ha)	8.38 ha	10.75 ha
	Rainfall (mm/year)	≈ 1217 mm/year	≈ 1217 mm/year
	Irrigation (mm/year)	≈ 346 mm/year	≈ 374 mm/year
	Evapotranspiration (mm/year)	≈ 729 mm/year	≈ 726 mm/year
	Runoff (mm/year)	≈ 2 mm/year	≈ 2 mm/year
	Deep drainage (mm/year)	≈ 832 mm/year	≈ 863 mm/year

MEDLI modelling predicted no overflows from the wet weather storage under the Ultimate scenario across the entire 100-year modelling period. This was achieved by adopted low average irrigation rates of less than 0.9 mm/day, with higher irrigation rates permitted during periods when the wet weather storage contains water. Pollutant balance modelling in MEDLI indicates the proposed irrigation strategy does not result in pollutant accumulation or export from the irrigation areas, as discussed below in Section 7.3.2.2.

7.3.2.2 Average Pollutant Balance Results

Review of nutrient and salt loadings on the Stage 1 temporary and Stage 2 public open space irrigation areas was undertaken using MEDLI. A summary of this assessment is provided in Table 7.4.

Table 7.4: Summary of average nutrient and salt balance results from MEDLI.

	Parameter	Ultimate	Stage 1
Nitrogen Balance	Nitrogen added in irrigation	26.4 kg/ha/year	30.8 kg/ha/year
	Nitrogen removed by plant uptake	41.5 kg/ha/year	45.8 kg/ha/year
	Nitrate concentration in deep drainage	<0.1 mg/L	<0.1 mg/L
	Comment: The irrigation scheme is considered sustainable in terms of nitrogen loading as the plant uptake of nitrogen is predicted to exceed the amount of nitrogen applied in effluent irrigation. Some supplementary organic nitrogen fertilisers may be required. Nitrate export from the irrigation area is minimal as the predicted nitrate concentration in deep drainage is 0.1 mg/L, which is the lowest concentration predicted by MEDLI.		
Phosphorus Balance	Phosphorus applied in irrigation	3.2 kg/ha/year	3.6 kg/ha/year
	Plant uptake of Phosphorus	2.9 kg/ha/year	3.3 kg/ha/year
	Phosphorus sorption into soil profile	0.3 kg/ha/year	0.3 kg/ha/year
	Soil P-sorption capacity and life	166 to 500 years	166 to 500 years
	Phosphorus concentration in deep drainage	<0.1 mg/L	<0.1 mg/L
	Comment: The irrigation scheme is considered sustainable in terms of phosphorous loading as the plant uptake of phosphorous is predicted to account for in excess of 90% of the phosphorous applied in effluent irrigation with the remaining 10% adsorbed into the soil profile. A conservative estimate P-Sorption capacity of clean Holocene sand is 150 kg/ha (DEC: 2004), with a critical P-sorption capacity estimated at 50 kg/ha (DEC: 2004). This equates to a P-Sorption life of 166-500 years at the predicted adsorption rate of 0.3 kg/ha/year. The actual P-sorption life is expected to exceed this given the clay content of the sandy top soils and the increasing clay content with depth in the soil profile.		

	Parameter	Ultimate	Stage 1
Salt Balance	Salinity	Effluent: 600 mg/L Rainwater: 20 mg/L	Effluent: 1500 mg/L Rainwater: 20 mg/L
	Salt Load on Irrigation Area	Effluent: 16.21 t/yr Rainwater: 2.05 t/yr Total: 18.26 t/yr	Effluent: 57.49 t/yr Rainwater: 2.63 t/yr Total: 60.12 t/yr
	Average salinity at base of root zone	0.4 dS/m (≈268 mg/L)	1 dS/m (≈670 mg/L)
	Salt load in deep drainage flushed through the soil profile	833 mm/year @ 268 mg/L 18.7 t/year	864 mm/year @ 670 mg/L 62.2 t/year
	Average salinity in root zone	0.1 dS/m s.e.	0.4 dS/m s.e.
	Reduction in crop yield due to salinity	Zero	Zero
	Comment: The irrigation scheme is considered sustainable in terms of salt loads and soil salinity as MEDLI predicted no reduction in plant yield due to salinity. During landscape design processes plant species need to be selected that can tolerate the above salt concentrations. Given the sandy soil on the site and high rainfall, deep drainage of water will assist with flushing salt through the soil profile. Based on deep drainage rates and salt concentrations predicted in MEDLI, all salt applied in effluent is flushed through the soil profile during heavy rain events and is unlikely to accumulate over time and result in vegetation stress.		

It can be seen from Table 7.4 that all nutrients (nitrogen and phosphorus) applied in irrigation are managed by plant uptake and soil adsorption inside the irrigation area, hence excessive nutrient accumulation or export from the irrigation area is not likely to occur. MEDLI modelling also indicated there was no reduction in plant yield due to soil salinity and that salt accumulation within the irrigation area is not occurring.

The proposed open space effluent irrigation scheme is therefore considered sustainable and there is sufficient area available onsite of the sustainable management of water and pollutants.

7.3.2.3 Review of Daily Irrigation Rates & Wet Weather Storage Volumes

Review of the MEDLI model daily output data was undertaken by exporting the detailed daily model output data into excel. Review of daily data was undertaken to demonstrate how the proposed scheme would have operated during the historic 100-year modelling period used in the analysis.

The scheduling of irrigation is dependent on climatic conditions and soil moisture, hence future performance of the system during a finite time period will depend on future climatic conditions. Information presented below is based on historic climate data used in MEDLI modelling.

For effluent irrigation schemes that utilise a wet weather storage, irrigation rates are not the same every day as demands change throughout the year based on climatic conditions. Such systems generally utilise the following three modes of operation throughout a year:

- "No irrigation" due to rainfall or high soil moisture → The wet weather storage fills.
- "Normal irrigation" at average flows during dry periods → The wet weather storage is empty and the supply of irrigation water is the limiting factor;
- "Higher irrigation" when the storage contains water → The wet weather storage empties and the evapotranspiration demand of the crop is the limiting factor.

A plot of the daily irrigation rate for the 100-year modelling period arranged in 1%ile increments is provided below in Figure 7.1.

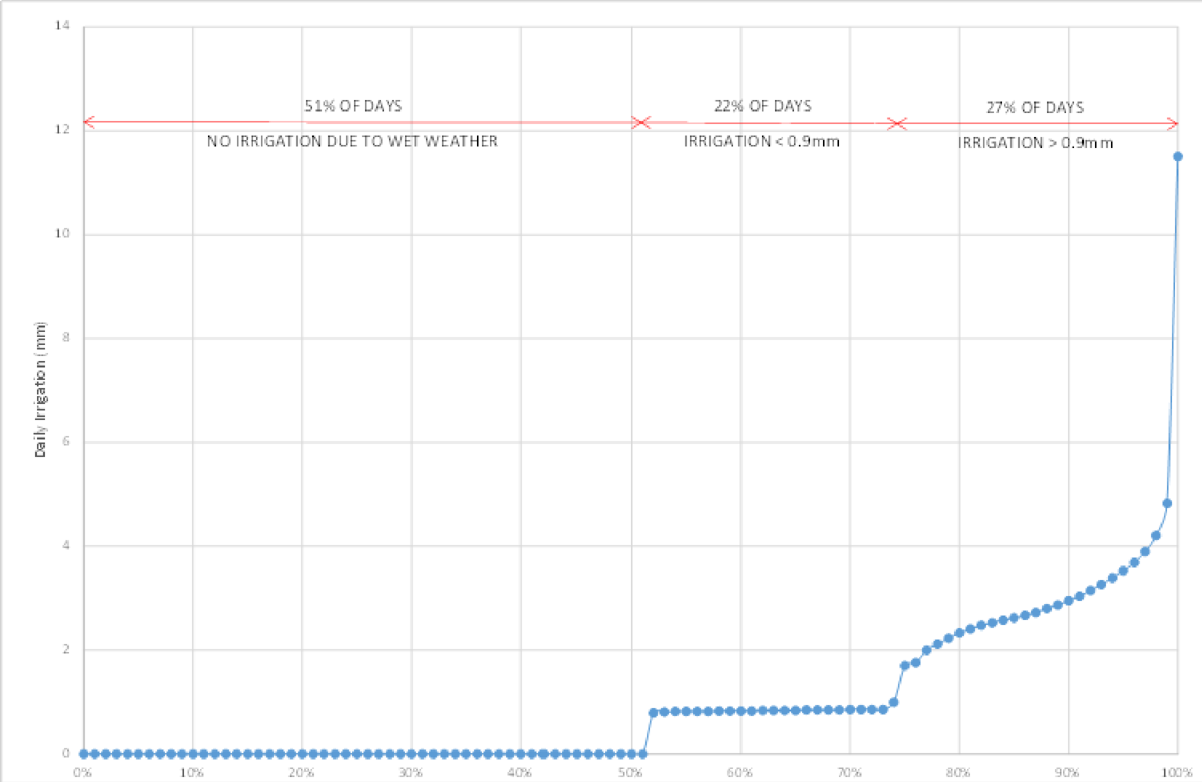

Figure 7.1: Daily irrigation rate –percentile plot.

Review of Figure 7.1 indicates that during the historic modelling period:

- Days with "No irrigation" due to rainfall and elevated soil moisture conditions occurred on approximately 51% of days. During such periods the wet weather storage would accumulate water.
- Days where "Normal irrigation" at average rate of <0.9 mm/day occurred for approximately 22% of days. During such periods the wet weather storage would typically be empty and irrigation is limited by the supply of effluent.
- Days with "Higher irrigation" >0.9 mm/day occurred for approximately 27% of days. During such periods the wet weather storage typically contains water and irrigation is limited by the evapotranspiration demands of the crop.
- High irrigation rates above 5 mm/day occurred infrequently on less than 1% of days and only during periods of peak evapotranspiration demand.

A review of the daily water levels in the 10 ML wet weather storage was also undertaken to assess performance of the storage over time. A plot of the daily volume in the wet weather storage in 1%ile increments is provided below in Figure 7.2, and a plot of volume in the wet weather storage verses time is shown in Figure 7.3.

The figures show that the end of day volume in the wet weather storage is at the assumed minimum operating volume on approximately 28% of days. For a large proportion of the year the majority of the storage capacity is not utilised. The maximum volume in the storage was approximately 9.5 ML and occurred once in the modelling period during a wet period around 1950, as shown in Figure 7.3.

The 10 ML wet weather storage therefore include some conservatism in the design and provides 0.5 ML of reserve storage that will provide some buffer against future variation in climate and irrigation demands.

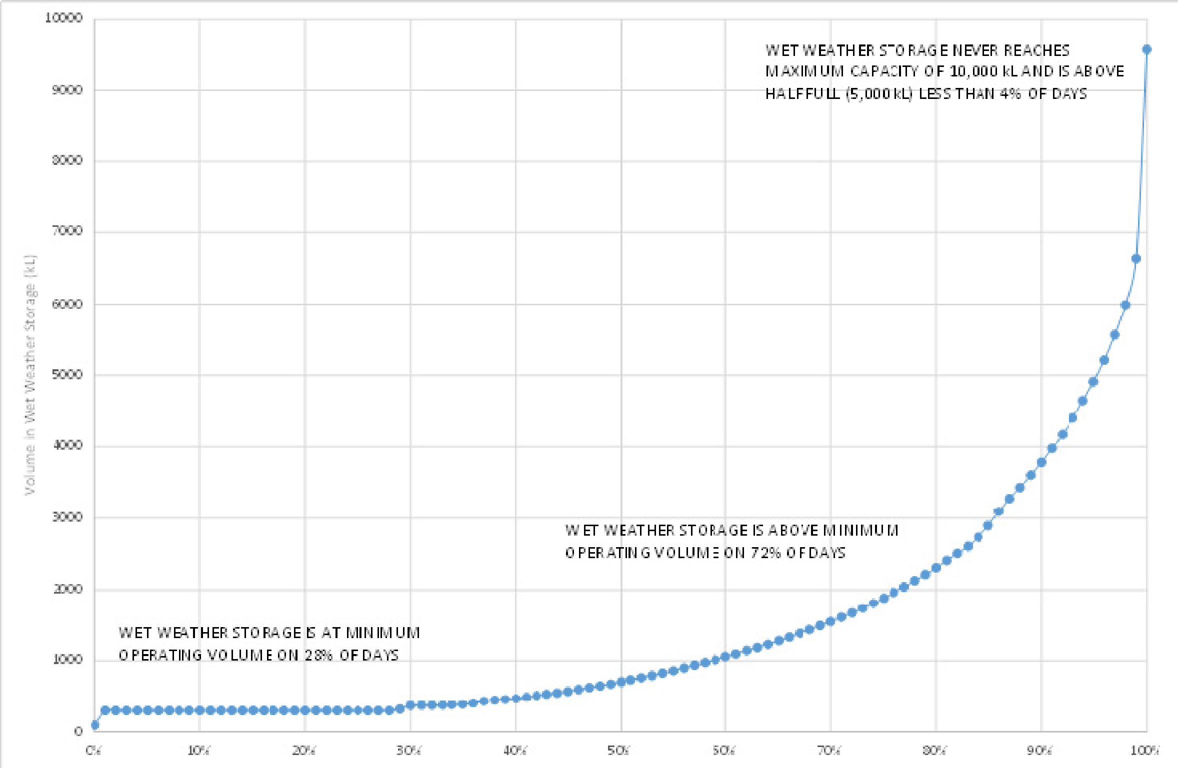

Figure 7.2: Daily volume in wet weather storage – percentile plot.

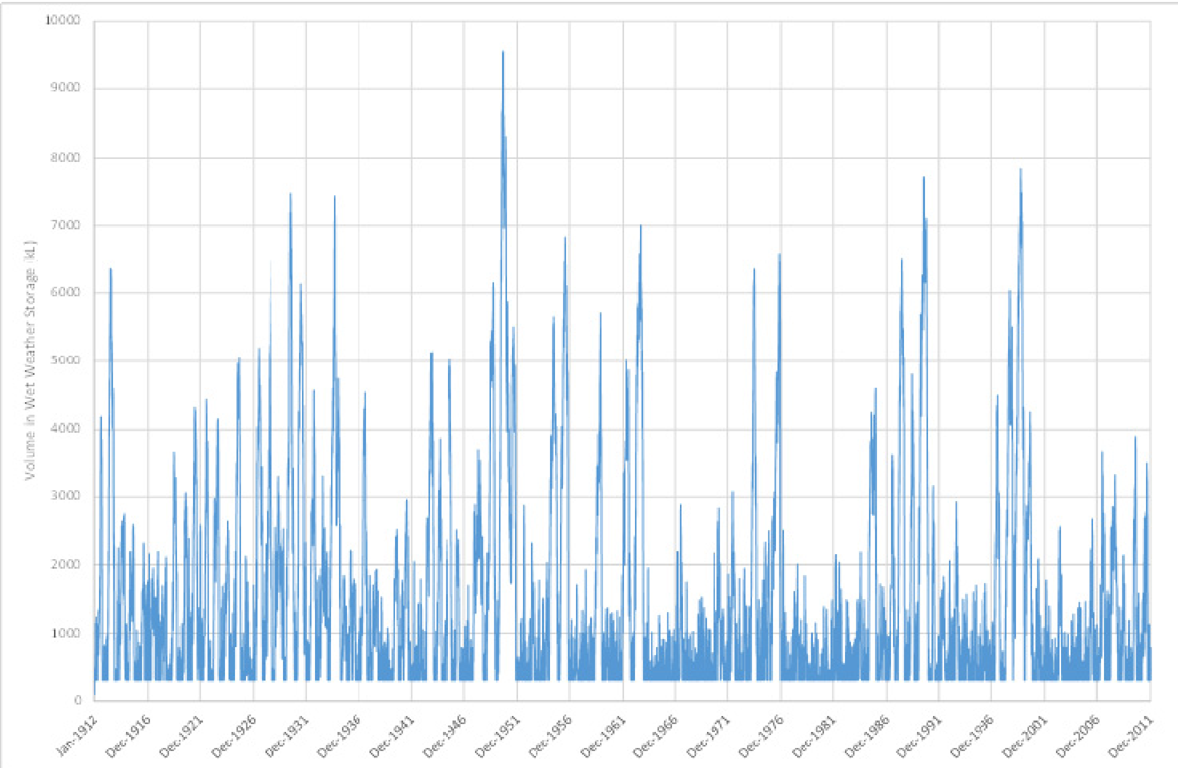

Figure 7.3: Daily volume in wet weather storage.

8 Environmental & Public Health Risk Assessment

A preliminary environmental and public health risk assessment of the proposed open space effluent irrigation scheme has been undertaken. The preliminary risk assessment was undertaken based on the methodologies outlined Risk management - Principles and guidelines (ISO31000: 2009) and Australian Guidelines for Water Recycling (AGWR: 2006). These documents provide a similar methodology for assessing risks that were adapted for the project as follows:

- Define context, assessment boundaries and scheme component for assessment;
- Identify hazards relevant, hazardous events and potential impacts;
- Assessment of unmitigated risk using the risk criteria in the Australian guidelines for water recycling (AGWR: 2006);
- Document the risk control strategy and control measures;
- Assessment of mitigated risk.

The preliminary risk assessment was undertaken for the following components of the onsite wastewater scheme:

- Wastewater generation and source controls
- Wastewater Collection - Low pressure sewerage collection system
- Wastewater Treatment Plant - Membrane bioreactor + Ultraviolet disinfection
- Wet weather storage pond
- Public open space effluent irrigation system

Overview of hazards and controls is presented below in Table 8.1.

The preliminary risk assessment tables are presented in Appendix F of this report and in Appendix 4.3.9 of the IPART application.

Risk assessment for the urban non-potable water supply system that supplies "Class A+" recycled water to individual dwellings in the scheme is included in the Recycled Water Management Plan to be developed for the scheme prior to Stage 2 when the AWTP is constructed and commissioned (refer to IPART application Appendix 4.2.11).

Table 8.1: Overview of wastewater scheme hazards and control measures.

Scheme Component	Typical Hazards	Typical Controls
Wastewater generation and source controls	Indoor water usage Stormwater drainage Gross pollutants Chemical usage Cross connections	Supply agreements with residential customers. Trade waste agreements with non-residential customers. Water demand management with efficient fixtures and smart metering. Domestic plumbing contractor induction and training. Domestic plumbing inspections during house construction.

Scheme Component	Typical Hazards	Typical Controls
Wastewater Collection - Low pressure sewerage collection system	Inflow and infiltration Sewer blockages Pump faults Power outage Pressure main breaks	24 hours storage in each pressure sewer unit (PSU). High level alarms and flow monitoring in all PSUs. PSUs are centrally controlled through the direct digital control system at the WWTP. PSU start-up procedures integrated into the central control system logic to minimise peak flows to the MBR following power blackout. Grinder pumps macerate sewage to minimise blockages. Pressure and flow monitoring throughout the network to detect breakages. Continuous online monitoring, data logging and alarms on wet well water level, pump faults, flow, electrical faults.
Wastewater Treatment Plant - Membrane bioreactor + Ultraviolet disinfection	Equipment failure Process upset Noise & Odour Peak inflows Power failure	Continuous online monitoring, control and alarm system for MLSS, DO, pH, transmembrane pressure, turbidity, UV intensity. Continuous online fault detection for all critical mechanical electrical items. Inlet buffer tank to absorb peak flows. The MBR is located inside the WWTP building to minimise noise and odour impacts. Sealed tanks with externally ventilated through activated carbon filters on the building roof. Noise enclosures around specific noisy mechanical items. High level gravity overflows from treatment tanks directed to the inlet balance tank. Automated power failure recovery procedure integrated into direct digital control system logic. Monthly effluent quality monitoring. Neutralisation of MBR CIP waste and recirculation back through the MBR.
Wet weather storage pond	Human access Vermin/mosquitoes Algae growth Pond overflows	10 ML storage capacity (>100 days) to avoid uncontrolled overflows. Continuous online monitoring of wet weather storage level and control of Irrigation scheduling to avoid pond overflows. Algae management and monitoring. Fenced and warning signage to prevent access. Safe egress point from pond.
Public open space effluent irrigation	Human contact Irrigation rates Nutrient loads	Subsurface irrigation. Appropriate vegetation selection and soil preparation within irrigation areas. Low water and pollutant loading rates in irrigation. Centrally controlled irrigation scheduling and monitoring. Cross connection controls. Appropriate buffer distances to sensitive receptors. Detailed irrigation management plans to be prepared at each development stage.

9 Irrigation Management

Detailed Irrigation Management Plans (IMP) will be prepared for the scheme and updated at each stage of the build out of the proposed residential subdivision. The IMP will be documented in parallel with the public open landscape and irrigation design for the subdivision.

The detailed IMP will include specific controls for health and environmental risks identified in the risk assessment processes. An overview of the controls to be included in the IMP for the scheme is outlined below in Table 9.1.

Table 9.1: Irrigation management requirements.

Issue	Measures to be Incorporated into detailed Irrigation Management Plan
Preparation of irrigation areas	During development of each stage of the residential subdivision, a minimum of 300 mm of good quality sandy loam topsoil cover is to be provided in all open space irrigation areas. Detailed soil testing will be undertaken following the bulk earthworks activities for each development stage. Soil testing will include assessment of top soil and sub soil physical and chemical properties as well as field permeability testing. Detailed landscape design, vegetation species selection and irrigation system design plans are to be prepared for each stage of the development prior to construction. Irrigation schedules to each irrigation zone will be updated based on specific site conditions and vegetation types in each irrigation zone.
Pathogen exposure controls	Subsurface irrigation. No irrigation permitted within 1 metre of a potable water service line. Warning/advisory signage in all irrigation areas.
Cross connection controls	Irrigation supply pipes to be located in a separate trench to all other water services. Irrigation supply pipe to be constructed from unique pipe materials. Lilac uPVC pipe for all irrigation supply mains and lilac subsurface irrigation pipe. Identification tape and above ground signage. Water pressure in the irrigation network is to be maintained a minimum of 50 kPa below the non-potable water network and a minimum of 100 kPa below the potable water network. Dual check valves on all potable water connections.
Irrigation scheduling controls	Irrigation scheduling to be controlled by the central control system with adjustable settings to control the time of day, frequency and duration of irrigation events. Rain sensor over ride on the irrigation supply pump to ensure irrigation does not occur during or shortly after rain.
Buffers	1-metre buffer to private lot boundaries, driveways and footpaths etc 10-metre buffer to permanent water bodies and macrophyte stormwater treatment areas 5-metre buffer to identified protected vegetation 1-metre buffer to potable water services trenches Minimum 0.6 metre vertical buffer to the groundwater table
Monitoring	Continuous online monitoring of turbidity and UV intensity at the WWTP. Monthly effluent quality compliance monitoring. Detailed annual effluent quality monitoring for trace contaminants. Annual soil monitoring Continuous online monitoring and data logging of flows to each irrigation zone.

10 Responsibilities

The CHBWU will be responsible for all aspects of the operation and maintenance of the entire scheme including the temporary and public open space recycled water irrigation systems. This would include:

- Irrigation scheduling and system operation;
- Irrigation system maintenance and renewal,
- Landscape and vegetation maintenance, including mowing, pruning etc
- Environmental monitoring of surface water, groundwater, soil and vegetation during operation to demonstrate the scheme is not resulting in significant environmental impacts.

Given that a portion of the open space irrigation area will be the landscaped road buffers and green links that will ultimately be owned by Lake Macquarie City Council (LMCC), the CHBWU will enter an agreement with LMCC to indemnify Council against any future cost burden or risk associated with the proposal. This agreement will include standards for:

- Irrigation system design, maintenance and renewal to be implemented by CHBWU;
- Landscape maintenance and vegetation pruning to be implemented by the CHBWU;
- Reporting of environmental monitoring results to LMCC;
- CHBWU to indemnify LMCC from any future costs and risks associated with irrigation of landscaped road buffers and green links using recycled water.

The CHBWU is the ultimate owner of all infrastructure under the scheme and takes on all operation and maintenance responsibilities and risk management. All future O&M and renewal costs associated with irrigation of open space areas with recycled water will be fully funded by the CHBWU.

11 Conclusion

This report has been prepared to demonstrate there is sufficient area of public open space land provided within the 470 lot Catherine Hill Bay residential subdivision to allow for the sustainable irrigation of surplus recycled water.

During Stage 1 prior to construction of the AWTP, all wastewater produced will be irrigated onto a 10.75 ha restricted access temporary irrigation area. The irrigation water source will be MBR + UV treated effluent sourced directly from the wet weather storage using a temporary pump and irrigation pipe work. Decommissioning of the temporary irrigation area will commence following commissioning of the AWTP once 240 lots (or 100 kL/day) have connected to the scheme.

At Ultimate development following commissioning of the AWTP the 470 ET scheme is estimated to produce around 67 kL/day of surplus recycled water that is not reused on private lots. This surplus water will be managed through irrigation of 8.38 hectares of public open space and parklands using Class A+ recycled water supplied from the recycled water reticulation network.

The scheme includes a 10 ML HDPE lined wet weather storage that provide in excess of 130 days storage at ultimate development and 100 days storage during Stage 1. The proposed minimum irrigation area of 8.38 ha allows for irrigation to occur at the low average daily rate of <0.9 mm/day (<3.3 ML/ha/year). Uncontrolled overflows from the wet weather storage will be avoided by increasing irrigation rates when water is available in the storage and during periods of high irrigation demand.

Water and pollutant balance modelling was undertaken using MEDLI and demonstrated the proposed scheme is sustainable. Modelling indicated the proposed 10 ML wet weather storage did not overflow based on historic climate data. MEDLI modelling has also demonstrated that the nutrients applied in irrigation are managed inside the irrigation area by plant uptake and soil adsorption.

This report demonstrates there is sufficient public open space areas provided within the footprint of the residential subdivision to allow for the sustainable management of the 40% surplus recycled water by irrigation of 8.38 ha of public open space and parklands.

References

AS1547 (2000) *Australian/New Zealand Standard - On-site domestic wastewater management*, Standards Australia, 24 July 2000.

AS 3500 (2003) *Australian/New Zealand Standard Plumbing & Drainage*, Standards Australia, 15 December 2003.

AGWR (2006) *Australian Guidelines for Water Recycling - Managing Health and Environmental Risks Phase 1*, Environment Protection and Heritage Council, the Natural Resource Management Ministerial Council and the Australian Health Ministers' Conference, November 2006.

NSW EPA (2004) *Environmental Guidelines – Use of Effluent by Irrigation*, NSW Government, October 2004.

Appendices

Appendix A:
Catherine Hill Bay Development Landscape Master Plan

LEGEND

- EXISTING TREES
- PROPOSED FEATURE TREES
- PROPOSED NATIVE TREES
- SHRUB / HEATH PLANTING
- MACROPHYTE PLANTING IN BASIN
- DRY CREEK BED
- TURF
- FOOTPATHS & DRIVEWAYS
- CONCRETE SERVICE PATHS
- PICNIC TABLES & BBQ
- CHILDRENS' INTERPRETIVE PLAY

LANDSCAPE VISION

The landscape setting will be residential development nestled within a restored and enhanced coastal landscape. A framework of planted streets and parks will provide habitat corridors, shade and environmental amenity to the development, enriching the character and identity of the site. Existing trees in the Village Park and Hamlet 1 will be retained.

The Village Park will be enhanced with new plantings, pathway and interpretive playground for the enjoyment of the residents and visitors to Catherine Hill Bay. Landscaped pocket parks are spaced around the perimeter, terminating major street views with a green vista.

Montefiore Street will be widened and planted with Eucalypts to establish an East-West 'Green Ridge'. The planted ridge defines the entry to the proposed development and forms a landscape screen and buffer from the village of Catherine Hill Bay. A compact village square will be centred within the retail precinct at the corner of Hale Street and Montefiore Street.

A pair of North South 'Green links' – pedestrian pathways with widened park verges planted with endemic trees and shrubs - will thread through the development and link the open spaces north of Montefiore Street and the Village Park to Munmorah Conservation area and Monee Beach.

A Coastal Walk is proposed to link Middle Camp Beach with the Headland. Running roughly parallel to the cliff line, the Coastal Walk will include directional and interpretive signage and connect with pedestrian pathways in the development.

LANDSCAPE PRINCIPLES

The key landscape principles will include the following:

- Provide a robust and attractive framework of landscaped streets and local open spaces to complement the development.
- Reinforce the Coastal Villages feel by using predominantly endemic coastal species in the public and private domain
- New landscaping will ensure that the development is unified and integrated with the Conservation area backdrop
- Keep the principal ridge line(s) green, with tree canopies as the dominant feature.
- Create public open spaces for passive recreation suited to all age groups.
- Establish a safe and permeable pedestrian network throughout the development .
- Create major 'Green Links' and new pathways to linking Middle Camp Beach and parks to Monee Beach and the Headland
- Provide a high standard of design for private gardens, integrated with the new housing and contoured slopes
- Introduce water sensitive urban design principles to manage and control runoff from the site.
- Retain significant trees where possible.
- Establish a landscape maintenance and management strategy for the public domain to ensure a consistent standard and healthy vegetation cover throughout the year.

PLANTING PRINCIPLES

The planting principles focus on the creation of a relaxed and informal coastal development dominated by landscape. The planting designs will:

- Encourage a sense of place
- Frame and enhance desirable views and screen undesirable views
- Provide scale, colour, and soften the dwellings
- Define edges
- Provide shade, windbreaks and environmental amenity
- Encourage wildlife habitat areas

The proposed planting palette is based on endemic species and select cultural plantings typical of coastal villages in the region.

0 10 20 50 100 200m 1:2500 @ A1

PRELIMINARY Not for Construction

Date	Amendment	Issue
13.12.10	Planning Approval	B
12.11.10	Draft Issue for Client Review	A

NOTES:
VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK.
REPORT ALL DISCREPANCIES TO LANDSCAPE ARCHITECT PRIOR TO CONSTRUCTION.
USE FIGURED DIMENSIONS IN PREFERENCE TO SCALED DIMENSIONS.

DRAWINGS MADE TO LARGER SCALES AND THOSE SHOWING PARTICULAR PARTS OF THE WORKS SHALL TAKE PRECEDENCE OVER DRAWINGS MADE TO SMALLER SCALE AND FOR GENERAL PURPOSES.

ALL WORK IS TO CONFORM TO RELEVANT AUSTRALIAN STANDARDS AND OTHER CODES AS APPLICABLE TOGETHER WITH OTHER AUTHORITIES' REQUIREMENTS AND REGULATIONS.

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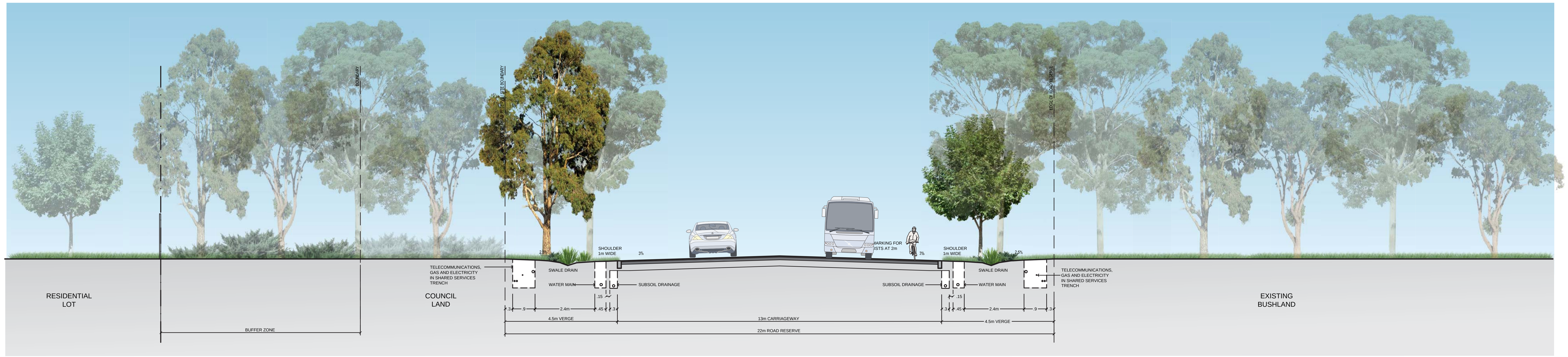
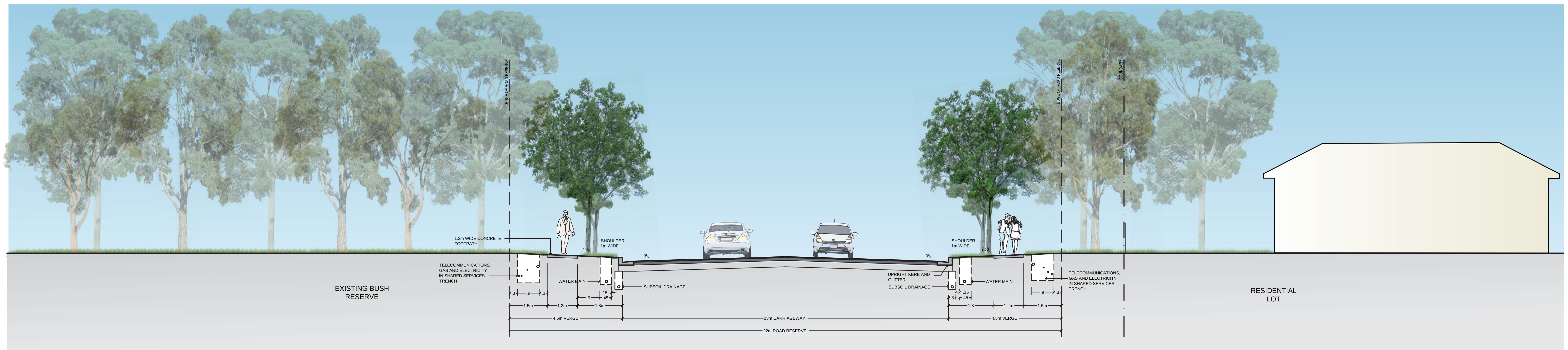
PROJECT APPLICATION

Project	The Moonee Hamlets Catherine Hill Bay
Client	Rose Property Group Pty Ltd

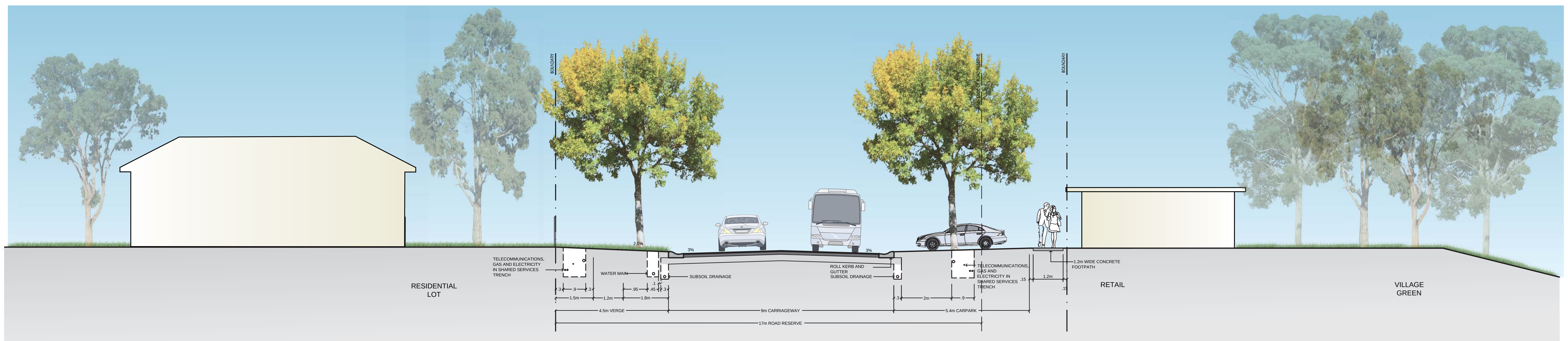
Title	Landscape Master Plan		
Date	November 2010	Dn/Ch	JR-JD/UB
Drwg No	10629-L-101	Issue	B



Section A - 22m Wide Road Reserve With Swale - Montefiore Street
Scale 1:100



Section B - 22m Wide Road Reserve Without Swale - Montefiore Street
Scale 1:100



Section C - 17m Wide Road Reserve - Montefiore Street
Scale 1:100

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PRELIMINARY Not for Construction

Date	Amendment	Issue
13.12.10	Planning Approval	B
12.11.10	Draft Issue for Client Review	A

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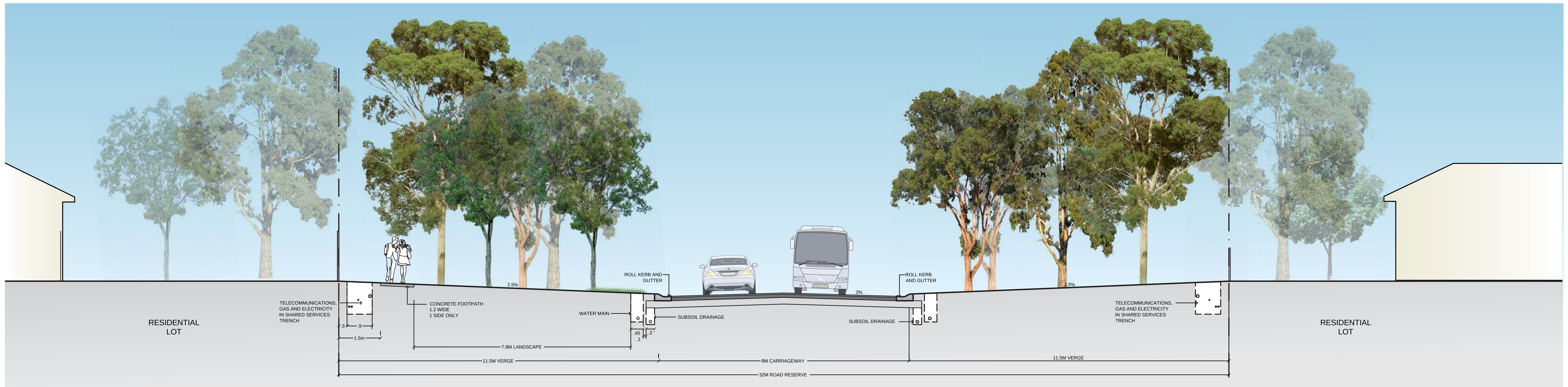
PROJECT APPLICATION

Project	The Moonee Hamlets Catherine Hill Bay
Client	Rose Property Group Pty Ltd
Title	Street Cross Sections (Sheet 1 of 3)
Date	November 2010
Dn/Ch	JR-JD/UB
Drwg No	10629-L-401
Issue	B

Section D - 22m Wide Road - Primary Road / Greenlink
Scale 1:100



Section E - 32m Wide Road - Primary Road / Greenlink
Scale 1:100

Section F - 32m Wide Road - Primary Road / Greenlink
Scale 1:100

0 1 2 3 4 5m 1:100 @ A1

PRELIMINARY Not for Construction

Date	Amendment	Issue
13.12.10	Planning Approval	B
12.11.10	Draft Issue for Client Review	A

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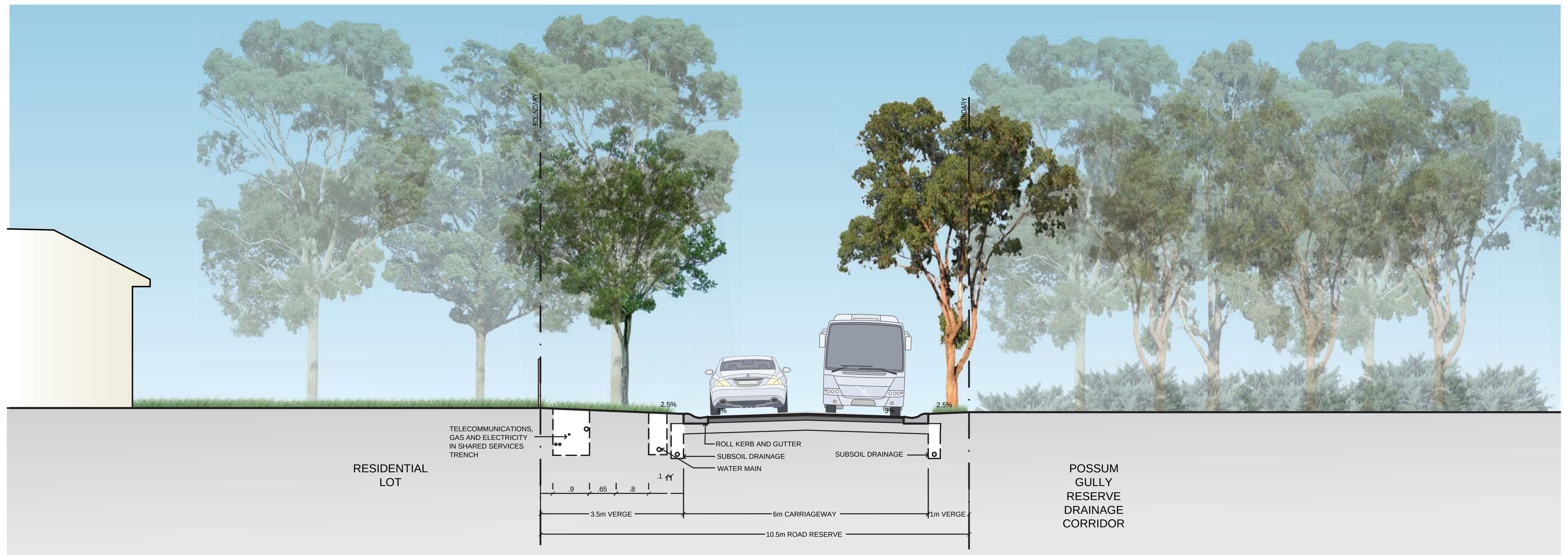
PROJECT APPLICATION

Project	The Moonee Hamlets Catherine Hill Bay
Client	Rose Property Group Pty Ltd

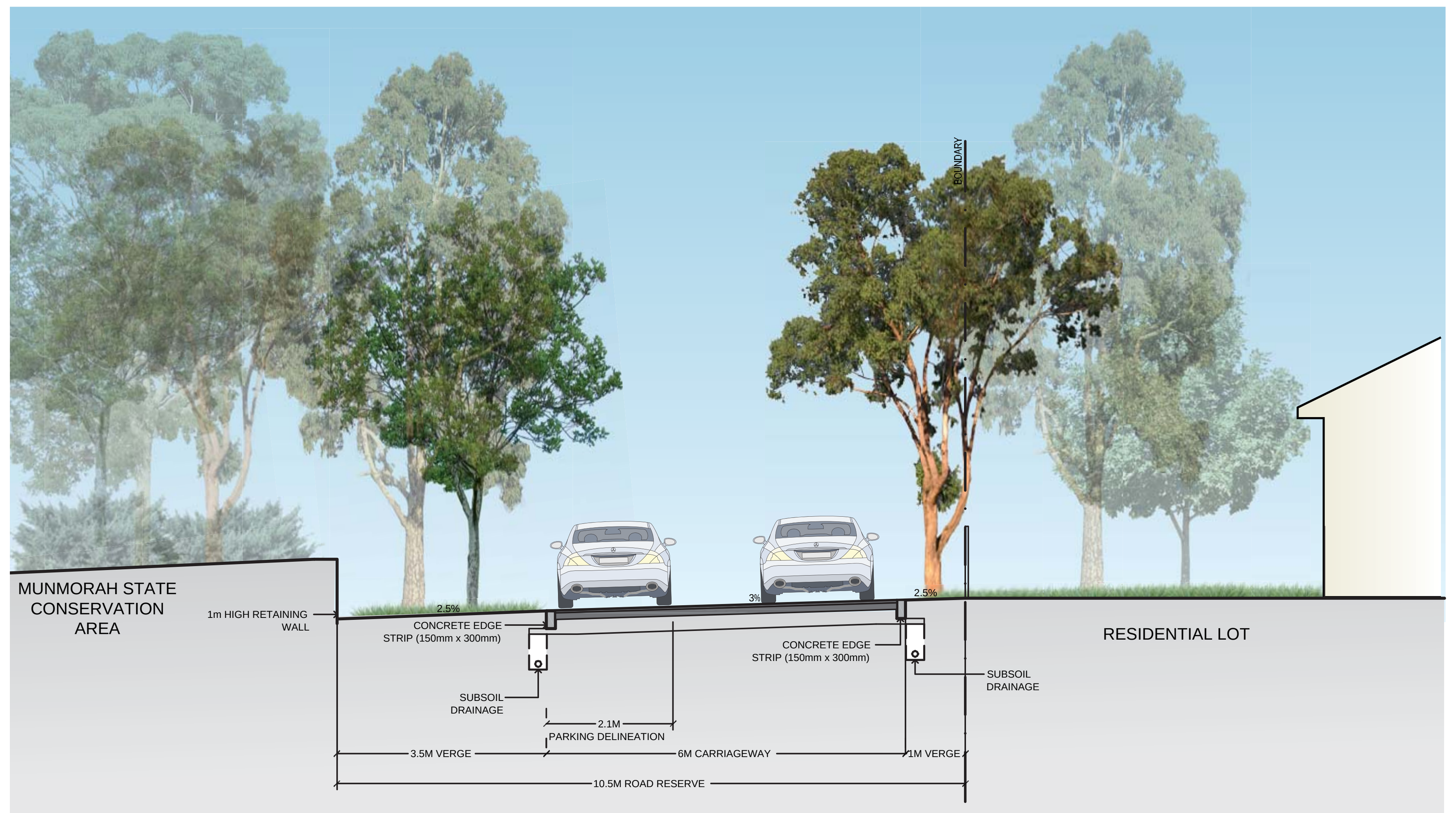
Title	Street Cross Sections (Sheet 2 of 3)		
Date	November 2010	Dn/Ch	JR-JD/UB
Drwg No	10629-L-402	Issue	B

Section G - 14m Wide Road Reserve - Roads 4,5,6,8,9,13,16,18
Scale 1:100

Section H - 16m Wide Road Reserve - Roads 1,3,7,10,12,14,17,19
Scale 1:100



Section I - 10.5m Wide Road Reserve - Road 15
Scale 1:100



Section J - 10.5m Wide Road Reserve - Road 20 Perimeter Road
Scale 1:100

0 1 2 3 4 5m 1:100 @ A1

PRELIMINARY Not for Construction

Date	Amendment	Issue
13.12.10	Planning Approval	B
12.11.10	Draft Issue for Client Review	A

NOTES:
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PROJECT APPLICATION
Project: The Moonee Hamlets Catherine Hill Bay
Client: Rose Property Group Pty Ltd

Title: Street Cross Sections (Sheet 3 of 3)
Date: November 2010 — Dn/Ch JR-JD/UB
Drwg No: 10629-L-403 — Issue B

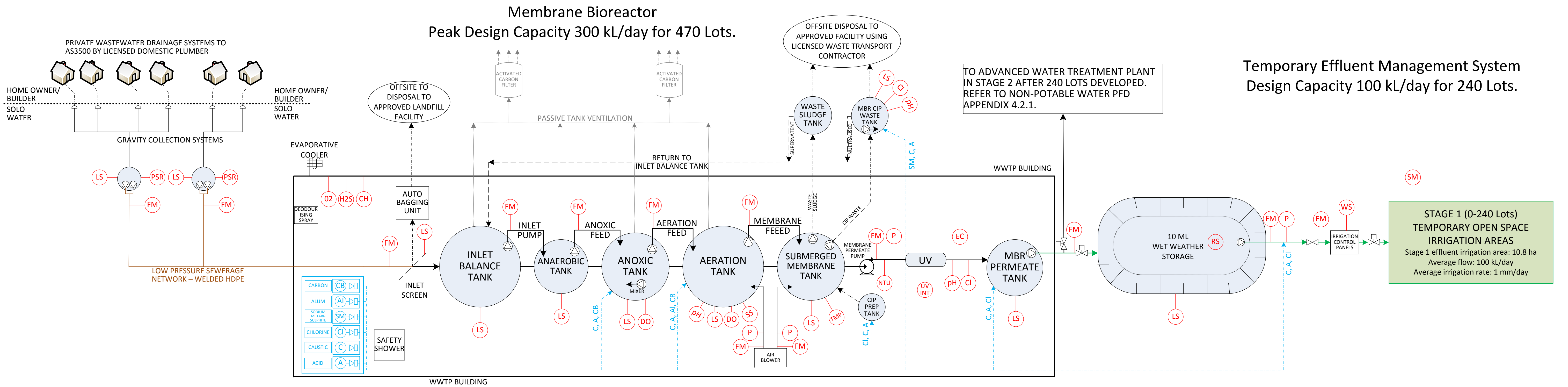
Appendix B:
Onsite Wastewater Scheme Process Flow Diagrams

i) Process Flow Diagram – Sewerage *(IPART Application Reference APPENDIX 4.3.1)*

iii) Process Flow Diagram – Non-Potable Water *(IPART Application Reference APPENDIX 4.2.1)*

PROCESS FLOW DIAGRAM

STAGE 1 WASTEWATER TREATMENT PLANT



LOW PRESSURE SEWERAGE SYSTEM

- WASTEWATER WILL DRAIN THROUGH A GRAVITY SEWERAGE COLLECTION SYSTEMS TO A NUMBER OF DUPLEX LOW PRESSURE SEWAGE PUMP STATIONS THAT SERVICE 1 TO 4 LOTS EACH.

- WASTEWATER IS PUMPED IN A CONTROLLED MANNER THROUGH THE LOW PRESSURE SEWERAGE NETWORK TO THE INLET BALANCE TANK AT THE WWTP. OPERATION OF THE PRESSURE SEWER NETWORK PUMPS IS CONTROLLED BY THE DIRECT DIGITAL CONTROL SYSTEM AT THE WWTP TO CONTROL PEAK INFLOWS TO THE MBR.

- LOW PRESSURE SEWER NETWORK TO BE CONSTRUCTED WITH BROWN-STRIPED PN 16 HDPE PIPE WITH WELDED PIPE JOINTS AND FITTINGS.

- EACH LOW PRESSURE SEWERAGE PUMP STATION WILL INCLUDE:
  - PUMP HEAD AND FLOW CAPACITY TO SERVICE BETWEEN 1 AND 4 LOTS.
  - DUTY AND STANDBY PUMPS WITH ONLINE FAULT DETECTION AND ALARMS.
  - 24 HOURS EMERGENCY STORAGE CAPACITY IN THE WET WELL.
  - HARD WIRED COMMUNICATION CABLING BACK TO THE DIRECT DIGITAL CONTROL SYSTEM AT THE WWTP.
  - CONTINUOUS ONLINE WET WELL WATER LEVEL AND FLOW MONITORING WITH ALARMS.
  - AUTOMATED SYSTEM START-UP AND RECOVERY FOLLOWING POWER OUTAGE VIA THE DIRECT DIGITAL CONTROL SYSTEM.
  - ABILITY TO INSTALL ADDITIONAL ONLINE WATER QUALITY MONITORING PROBES, E.G. PH, TDS, TOC, FOR DETECTION OF INAPPROPRIATE CHEMICAL DISPOSAL OR TRADE WASTE PRACTICES, IF REQUIRED DURING OPERATION.

FOR FURTHER INFORMATION ON THE LOW PRESSURE SEWER NETWORK REFER TO PRESSURE SEWERAGE SOLUTIONS PTY LTD.

STAGE 1 WASTEWATER TREATMENT PLANT – MEMBRANE BIOREACTOR

- ALL WASTEWATER TREATED IN THE MEMBRANE BIOREACTOR TO PRODUCE "CLASS A" RECYCLED WATER SUITABLE FOR CONTROLLED IRRIGATION OF TEMPORARY IRRIGATION AREAS. MBR TARGET EFFLUENT QUALITY:
  - BIOCHEMICAL OXYGEN DEMAND < 10 mg/L
  - SUSPENDED SOLIDS < 10 mg/L
  - TOTAL NITROGEN < 10 mg/L
  - TOTAL PHOSPHOROUS < 0.3 mg/L
  - pH 6.5 TO 8.5
  - FAECAL COLIFORMS < 10 cfu/100 mL
  - TURBIDITY < 2 NTU

- PEAK DESIGN CAPACITY OF MBR PROCESS TRAIN OF 300 kL/DAY WILL CATER FOR ULTIMATE DEVELOPMENT OF 470 LOTS WITH RESERVE CAPACITY.

- THE ADVANCED WATER TREATMENT PLANT TO PRODUCE "CLASS A+ RECYCLED WATER" WILL BE OPERATIONAL ONCE 240 LOTS ARE CONNECTED TO THE SYSTEM, OR WHEN FLOWS REACH 100 kL/day.

- OPERATION OF THE WWTP IS FULLY AUTOMATED AND INTEGRATED WITH OPERATION OF THE PRESSURE SEWER NETWORK TO CONTROL PEAK FLOWS INTO THE MBR USING THE DIRECT DIGITAL CONTROL SYSTEM.

- ENERGY CONSUMPTION IN THE PROCESS IS MINIMISED THROUGH THE USE OF VARIABLE SPEED DRIVE CONTROLLERS ON ALL PROCESS PUMPS AND AIR BLOWERS.

- ALL ONLINE MONITORING, CONTROL AND ALARM SYSTEM CAN BE REMOTELY ACCESSED THROUGH THE INTERNET. ALL DATA IS LOGGED FOR LATER REVIEW AND TROUBLE SHOOTING.

- THE MBR IS LOCATED INSIDE THE WWTP SHED TO MINIMISE NOISE AND ODOUR IMPACTS. ALL TANKS ARE ENCLOSED WITH PASSIVE VENTILATION THROUGH ACTIVATED CARBON FILTERS. AMBIENT AIR QUALITY INSIDE THE WWTP BUILDING IS CONTINUOUSLY MONITORED WITH ALARMS FOR ELEVATED HYDROGEN SULPHIDE, METHANE & OXYGEN CONCENTRATIONS. AIR CONDITIONING UNITS AND DEODORISING SPRAYS OPERATE AUTOMATICALLY TO MAINTAIN INDOOR AIR QUALITY WITHIN APPROPRIATE LIMITS.

STAGE 1 TEMPORARY EFFLUENT MANAGEMENT SYSTEM

- THE STAGE 1 EFFLUENT MANAGEMENT SYSTEM WILL SERVICE UP TO 240 LOTS, OR UP TO APPROX 100 kL/day.

- ALL MBR TREATED EFFLUENT IS STORED IN A HDPE LINED 10 ML WET WEATHER STORAGE DAM, WHICH PROVIDES APPROXIMATELY 100 DAYS STORAGE AT AVERAGE IRRIGATION FLOWS.

- EFFLUENT MANAGEMENT IS VIA CONTROLLED, RESTRICTED ACCESS, NIGHT TIME IRRIGATION OF TEMPORARY IRRIGATION AREAS USING MBR EFFLUENT.

-APPROXIMATELY 10.8 ha OF TEMPORARY, RESTRICTED ACCESS IRRIGATION AREAS WILL BE PROVIDED DURING STAGE 1 TO SERVICE UP TO 240 LOTS. AVERAGE IRRIGATION RATES DURING STAGE 1 ARE UP TO 1 mm/day.

- ALL TEMPORARY IRRIGATION AREAS, LANDSCAPING AND IRRIGATION INFRASTRUCTURE WILL BE PROVIDED BY THE DEVELOPER DURING CONSTRUCTION OF EACH DEVELOPMENT STAGE.

- DECOMMISSIONING OF THE TEMPORARY STAGE 1 IRRIGATION AREA WILL COMMENCE AFTER 240 LOTS ARE CONNECTED.

- AN IRRIGATION MANAGEMENT PLAN WILL BE DEVELOPED FOR THE TEMPORARY SCHEME THAT WILL OUTLINE SITE SPECIFIC IRRIGATION, ENVIRONMENTAL AND PUBLIC HEALTH CONTROL MEASURES FOR EACH IRRIGATION AREA. TYPICAL IRRIGATION CONTROLS WILL INCLUDE:
  - IRRIGATION SCHEDULING CONTROLS TO CONTROL THE TIME, FREQUENCY AND DURATION OF IRRIGATION EVENTS.
  - SOIL MOISTURE PROBES AND WEATHER STATION OVERRIDE ON IRRIGATION CONTROLLERS TO PREVENT IRRIGATION DURING RAINFALL, HIGH WIND OR ELEVATED SOIL MOISTURE.
  - SECURE, RESTRICTIVE ACCESS AREAS INCLUDING APPROPRIATE WARNING SIGNS, IDENTIFICATION AND LABELLING.
- SITE BASED STORM WATER, RUN OFF AND ENVIRONMENTAL CONTROLS.
- SURFACE SPRINKLERS WITH SPRAY DRIFT CONTROL INCLUDING SPRINKLER NOZZLES THAT OPERATE UNDER LOW PRESSURE WITH A LARGE DROPLET SIZE AND LOW THROW HEIGHT.

LEGEND

PROCESS MONITORING

- FM FLOW
- P PRESSURE
- PSR PUMP STARTS AND RUN HOURS
- LS WATER LEVEL
- DO DISSOLVED OXYGEN
- SS MIXED LIQUOR SUSPENDED SOLIDS
- pH pH
- Cl FREE CHLORINE RESIDUAL
- WS WEATHER STATION
- NTU TURBIDITY
- TMP TRANSMEMBRANE PRESSURE
- UV INT UV INTENSITY
- EC ELECTRICAL CONDUCTIVITY
- SM SOIL MOISTURE PROBE
- CH METHANE GAS
- H2S HYDROGEN SULPHIDE GAS
- 02 OXYGEN GAS

PROCESS EQUIPMENT

- INLET SCREEN
- MEMBRANE BIOREACTOR PROCESS TANKS
- SUBMERSIBLE PUMP
- DRY-MOUNTED PUMP
- MIXING PUMP
- MOTORISED VALVE
- HOUSEHOLD SEWERAGE CONNECTION POINT
- EVAPORATIVE AIR CONDITIONING UNIT

PROCESS CHEMICALS

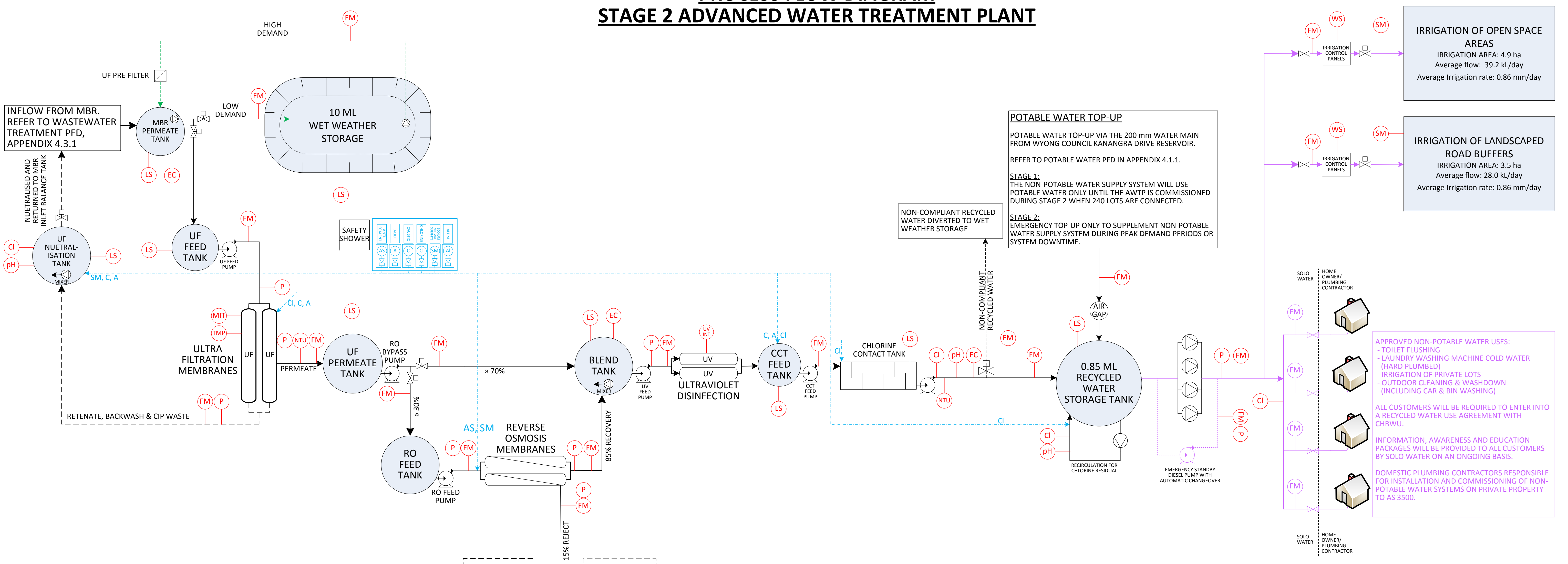
- BUNDED CHEMICAL STORAGE AREA
- BUNDED CHEMICAL CONTAINERS AND DOSING PUMPS
- CHEMICAL DELIVERY LINES
- CB ACETIC ACID (CARBON) DOSING AS SUPPLEMENTARY FOOD SOURCE
- Al POLYALUMINIUM CHLORIDE DOSING FOR PHOSPHORUS REMOVAL
- Cl SODIUM HYPOCHLORITE FOR CHLORINATION
- SM SODIUM METABISULPHIDE DOSING FOR DECHLORINATION
- C SODIUM HYDROXIDE (CAUSTIC) FOR pH CORRECTION AND MEMBRANE CLEANING
- A HYDROCHLORIC ACID FOR pH CORRECTION AND MEMBRANE CLEANING

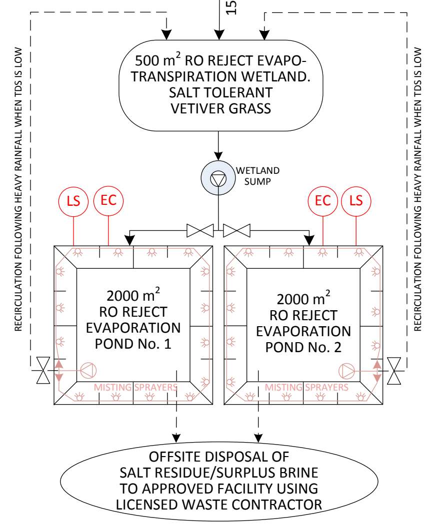
NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION
2. NOT TO SCALE. FOR WWTP SITE LAYOUT PLANS REFER TO APPENDIX 4.3.2.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN

CLIENT:	PROJECT:	PHASE:	PRIVATE WATER UTILITY:	DRAWING TITLE:	DRAWING NUMBER:	IPART REFERENCE:
ROSE PROPERTY GROUP PTY LTD ROSE	CATHERINE HILL BAY RESIDENTIAL SUBDIVISION MONTEFIORE STREET, CATHERINE HILL BAY	IPART LICENSE APPLICATION	CATHERINE HILL BAY WATER UTILITY PTY LTD Solo Water	PROCESS FLOW DIAGRAM WASTEWATER TREATMENT	H10052_P04C DATE: 05/07/2013	APPENDIX 4.3.1

PROCESS FLOW DIAGRAM
STAGE 2 ADVANCED WATER TREATMENT PLANT





LEGEND

PROCESS MONITORING

- FM FLOW METRE
- P PRESSURE
- LS WATER LEVEL
- EC ELECTRICAL CONDUCTIVITY
- TMP TRANSMEMBRANE PRESSURE
- MIT MEMBRANE INTEGRITY TEST
- NTU TURBIDITY
- UV INT UV INTENSITY
- pH pH
- CI FREE CHLORINE RESIDUAL
- SM SOIL MOISTURE PROBE
- WS WEATHER STATION

PROCESS EQUIPMENT

- ADVANCED WATER TREATMENT PLANT PROCESS TANKS
- ULTRAFILTRATION MEMBRANE SKID
  NOMINAL MEMBRANE PORE SIZE 0.03 UM
  INTEGRITY TESTING BY PRESSURE DECAY
  USEPA ACCREDITED MEMBRANES SUPPLIED BY X-FLOW
- BRACKISH WATER REVERSE OSMOSIS SKID
- ULTRAVIOLET DISINFECTION SYSTEM
  SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
  NOMINAL UV DOSE OF 85 J/m2 @ UV TRANSMISSION OF 60%
  USEPA ACCREDITED UV DISINFECTION SYSTEM SUPPLIED BY ORICA
- CHLORINE CONTACT TANK
  CONTACT TANK WILL BE DESIGNED TO USEPA GUIDELINES TO ACHIEVE CT VALUES FOR THE REQUIRED LOG REMOVAL TARGETS.
- SUBMERSIBLE PUMP
- DRY-MOUNTED PUMP
- MIXING PUMP
- MOTORISED VALVE
- MANUAL VALVE
- EVAPORATION MISTING SPRAYERS
- UF PRE FILTER

PROCESS CHEMICALS

- BUNDED CHEMICAL STORAGE AREA
- BUNDED CHEMICAL CONTAINERS AND DOSING PUMPS
- CHEMICAL DELIVERY LINES
- AS REVERSE OSMOSIS MEMBRANE ANTISCALENT
- CI SODIUM HYPOCHLORITE FOR CHLORINATION
- SM SODIUM METABISULPHIDE DOSING FOR DECHLORINATION
- C SODIUM HYDROXIDE (CAUSTIC) FOR pH CORRECTION AND MEMBRANE CLEANING
- A HYDROCHLORIC ACID FOR pH CORRECTION AND MEMBRANE CLEANING

NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION
2. NOT TO SCALE. FOR WWTP SITE LAYOUT PLANS REFER TO APPENDIX 4.2.2.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN

STAGE 2 WWTP – ADVANCED WATER TREATMENT PLANT AND EFFLUENT MANAGEMENT STRATEGY

- THE ADVANCED WATER TREATMENT PLANT (AWTP) WILL BE COMMISSIONED ONCE 240 LOTS HAVE CONNECTED TO THE SYSTEM.
- THE AWTP HAS A NOMINAL DESIGN CAPACITY OF 200 KL/DAY OF CLASS A+ RECYCLED WATER SUITABLE FOR SUPPLY IN THE DUAL RETICULATION SYSTEM.
- LOG REDUCTION TARGETS FOR THE AWTP BASED ON TABLE 3.7 IN THE NATIONAL GUIDELINES FOR WATER RECYCLING (EPHC: 2006) ARE:
  - BACTERIA: >5.3 LOG REDUCTION
  - VIRUSES: >6.5 LOG REDUCTION
  - PROTOZOAN: >5.1 LOG REDUCTION
- LOG REDUCTION TARGETS WILL BE ACHIEVED USING ULTRAFILTRATION MEMBRANES, ULTRAVIOLET DISINFECTION AND CHLORINE CONTACT TANK. ALL PROCESSES AND EQUIPMENT USED TO ACHIEVE LOG REDUCTION TARGETS WILL BE ACCREDITED TO USEPA GUIDELINES AND VALIDATED ONSITE PRIOR TO COMMENCEMENT OF SUPPLY OF RECYCLED WATER.
- PRIOR TO COMMISSIONING AND VALIDATION OF THE AWTP DURING STAGE 2, POTABLE WATER WILL BE USED TO SUPPLY THE DUAL RETICULATION SYSTEM.
- APPROXIMATELY 30% OF AWTP FLOW IS TREATED IN A SIDE STREAM REVERSE OSMOSIS PROCESS TO REDUCE THE SALT AND NUTRIENT CONCENTRATIONS IN SUPPLIED RECYCLED WATER TO APPROXIMATELY:
  - TOTAL DISSOLVED SOLIDS: < 500 mg/L
  - TOTAL NITROGEN: < 7 mg/L
  - TOTAL PHOSPHORUS: < 0.25 mg/L
- OPERATION OF THE AWTP IS FULLY AUTOMATED AND INTEGRATED WITH THE OPERATION OF THE MBR & DUAL RETICULATION SYSTEM USING THE DIRECT DIGITAL CONTROL SYSTEM.
- ALL ONLINE MONITORING, CONTROL AND ALARM SYSTEMS CAN BE REMOTELY ACCESSED THROUGH THE INTERNET. ALL DATA IS LOGGED FOR REVIEW AND TROUBLE SHOOTING.
- THE AWTP IS DESIGNED TO AUTOMATICALLY SHUT DOWN IF NON-COMPLIANT RECYCLED WATER IS DETECTED THROUGH CONTINUOUS ONLINE MONITORING.
- THE NON-POTABLE WATER STORAGE TANK PROVIDES APPROXIMATELY 1-DAY STORAGE AT PEAK RECYCLED WATER DEMANDS. THE DUAL RETICULATION SYSTEM WILL BE SUPPLEMENTED BY A POTABLE WATER TOP-UP DURING PERIODS OF EXTENDED PEAK DEMAND OR SYSTEM FAILURE.
- A RECYCLED WATER MANAGEMENT PLAN (RWMP) WILL BE DEVELOPED FOR THE SCHEME DURING DETAILED DESIGN. THE RWMP WILL THE OUTLINE RISK ASSESSMENT, CRITICAL CONTROL POINTS, MONITORING AND VALIDATION REQUIREMENTS FOR THE SCHEME.
- SURPLUS CLASS A+ RECYCLED WATER NOT REUSED ON PRIVATE LOTS (APPROXIMATELY 40% OF 67 KL/DAY) WILL BE MANAGED BY IRRIGATION OF 4.9 HA OF OPEN SPACE AREAS AND 3.5 HA OF LANDSCAPED ROAD BUFFERS

CLIENT:	PROJECT:	PHASE:	PRIVATE WATER UTILITY:	DRAWING TITLE:	DRAWING NUMBER:	IPART REFERENCE:
ROSE PROPERTY GROUP PTY LTD	CATHERINE HILL BAY RESIDENTIAL SUBDIVISION MONTEFIORE STREET, CATHERINE HILL BAY	IPART LICENSE APPLICATION	CATHERINE HILL BAY WATER UTILITY PTY LTD	PROCESS FLOW DIAGRAM NON-POTABLE WATER	H10052_P03B DATE: 05/07/2013	APPENDIX 4.2.1

Appendix C: Onsite Wastewater Management Layout Plan

i) Layout Plan – Pressure Sewer Master Plan *(IPART Application Reference APPENDIX 4.3.2)*

ii) Layout Plan – WWTP Site Layout Plan *(IPART Application Reference APPENDIX 4.3.2)*

Date: 04/04/2013

Drawing No: SK001

Rev: A

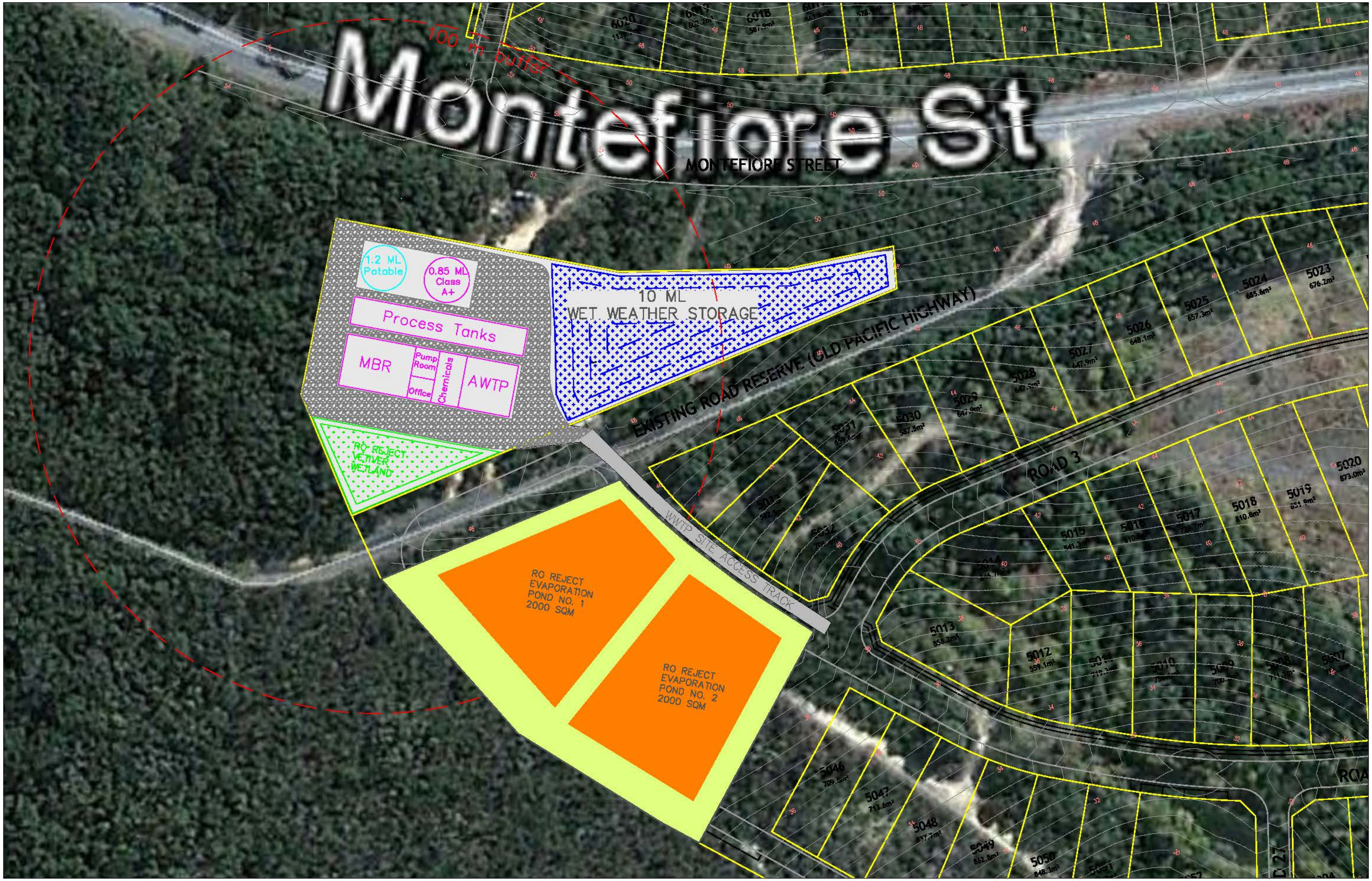
Scale: SCALE 1:2000 AT A1

CATHERINE HILL BAY PRESSURE SEWERAGE SCHEME
MASTER PLAN

Solo Water

Pressure System Solutions Pty Ltd
PLANNING, DESIGN & IMPLEMENTATION OF WATER & WASTEWATER
Our Understanding and Experience Provides Certainty

Saved: 04.04.2013, By: kgao
J:\700-Projects\800-Preliminary-Tender\Catherine Hill Bay\Catherine Hill Bay\Drawings\Street Mains\Catherine Hill Bay_SK001 Pressure Sewer Masterplan.dwg



ISSUE	DATE	ISSUE DETAILS
C	10/7/13	ADJUSTED RO REJECT POND & ADDED WWTP SITE ACCESS TRACK
B	15/5/13	ADJUSTED RO REJECT POND
A	30/3/13	WWTP LAYOUT FOR 8PART APPLICATION

harvest water management consultants pty ltd
184 Rivergum Drive
Burpengary, Qld 4505
0488 427 878
office@harvestwmc.com.au
www.harvestwmc.com.au
ABN: 54140 844 047

CLIENT: SOLO WATER – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY RESIDENTIAL SUBDIVISION ROSE GROUP

Solo Water

SITE: MONTEFIORE ROAD CATHERINE HILL BAY NSW

DESIGN: BI | DRAWN: BI | APPROVED: BI

Bradley Irwin RPEQ (10837) CPENG NPER Environmental Engineer

Signed ______ Date ______

for and on behalf of Harvest Water Management Consultants Pty Ltd

DRAWING TITLE: WASTEWATER TREATMENT PLANT SITE LAYOUT

PROJECT NO.: H10052

SCALE: 1:1000 at A3 (0 10 20 30 40 50)

DWG TYPE: CONCEPT ONLY NOT FOR CONSTRUCTION

DWG NO.: P10

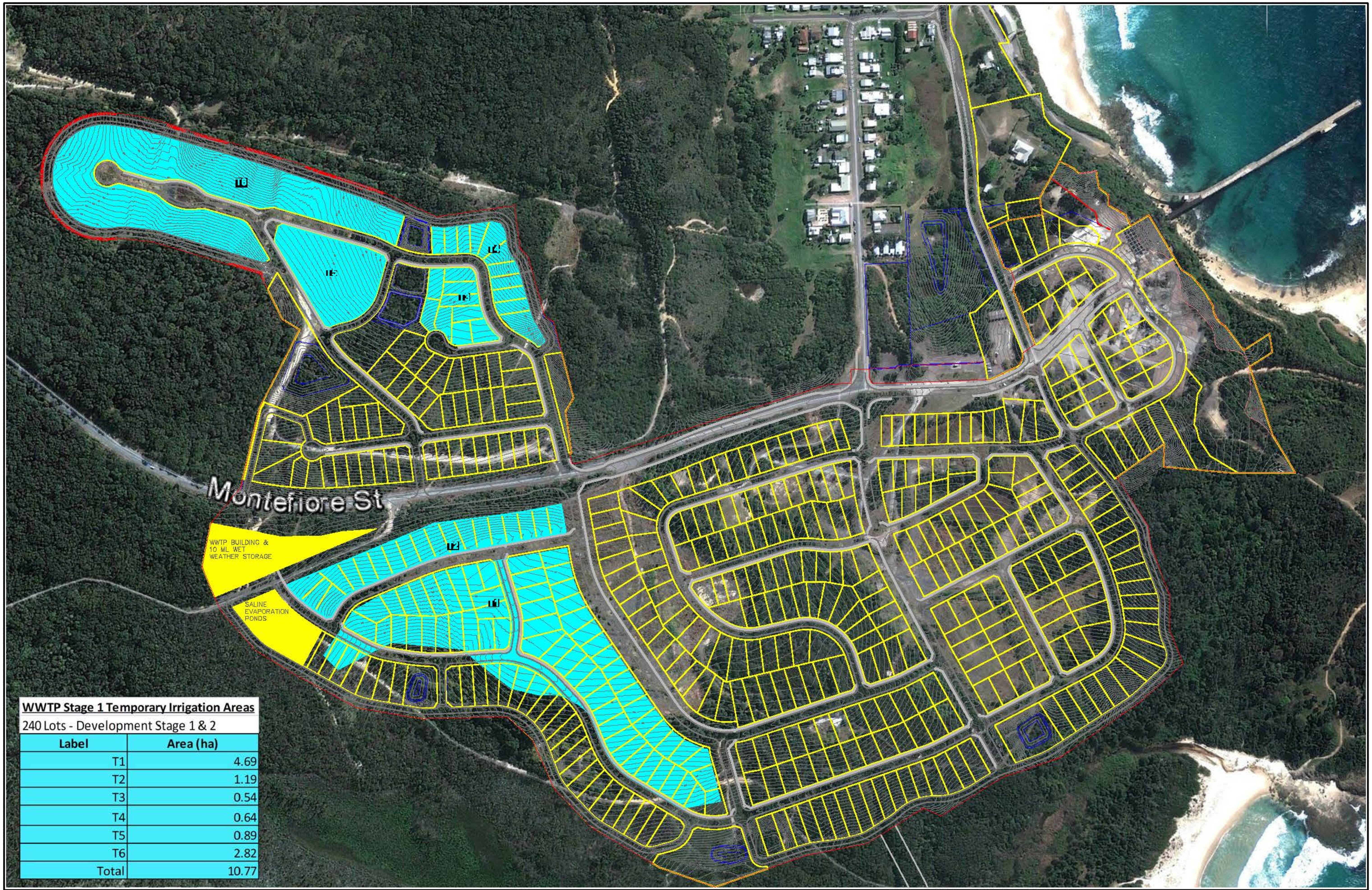
ISSUE: C

Appendix D:
Potential Public Open Space Effluent Irrigation Areas

i) Proposed Stage 1 Temporary Irrigation Area *(IPART Application Reference APPENDIX 4.3.3)*

ii) Proposed Stage 2 Public Open Space Irrigation Area *(IPART Application Reference APPENDIX 4.2.3)*

iii) Layout Plan – LMCC Preliminary Sports Field Plan



WWTP Stage 1 Temporary Irrigation Areas

240 Lots - Development Stage 1 & 2

Label	Area (ha)
T1	4.69
T2	1.19
T3	0.54
T4	0.64
T5	0.89
T6	2.82
Total	10.77

ISSUE	DATE	ISSUE DETAILS
C	1/7/2013	REVISED IRRIGATION AREAS FOR IPART APPLICATION
B	26/6/2013	REVISED IRRIGATION AREAS FOR DISCUSSION
A	13/3/2013	FOR LMCC COMMENT

harvest
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164 Rivergum Drive
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0488 427 879
brad@harvestwmc.com.au
www.harvestwmc.com.au
ABN: 54140 944 047

CLIENT: SOLO WATER – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY
RESIDENTIAL SUBDIVISION
ROSE GROUP

Solo Water

SITE: MONTEFIORE ROAD
CATHERINE HILL BAY
NSW

DESIGN: BI | DRAWN: BI | APPROVED: BI

Bradley Irwin RPEQ (10637) CPENG NPER
Environmental Engineer

SIGNED ____ DATE ____
for and on behalf of Harvest Water Management Consultants Pty Ltd

DRAWING TITLE: 10.75 ha TEMPORARY EFFLUENT IRRIGATION AREA
WWTP STAGE 1 – 240 LOTS NO RECYCLING

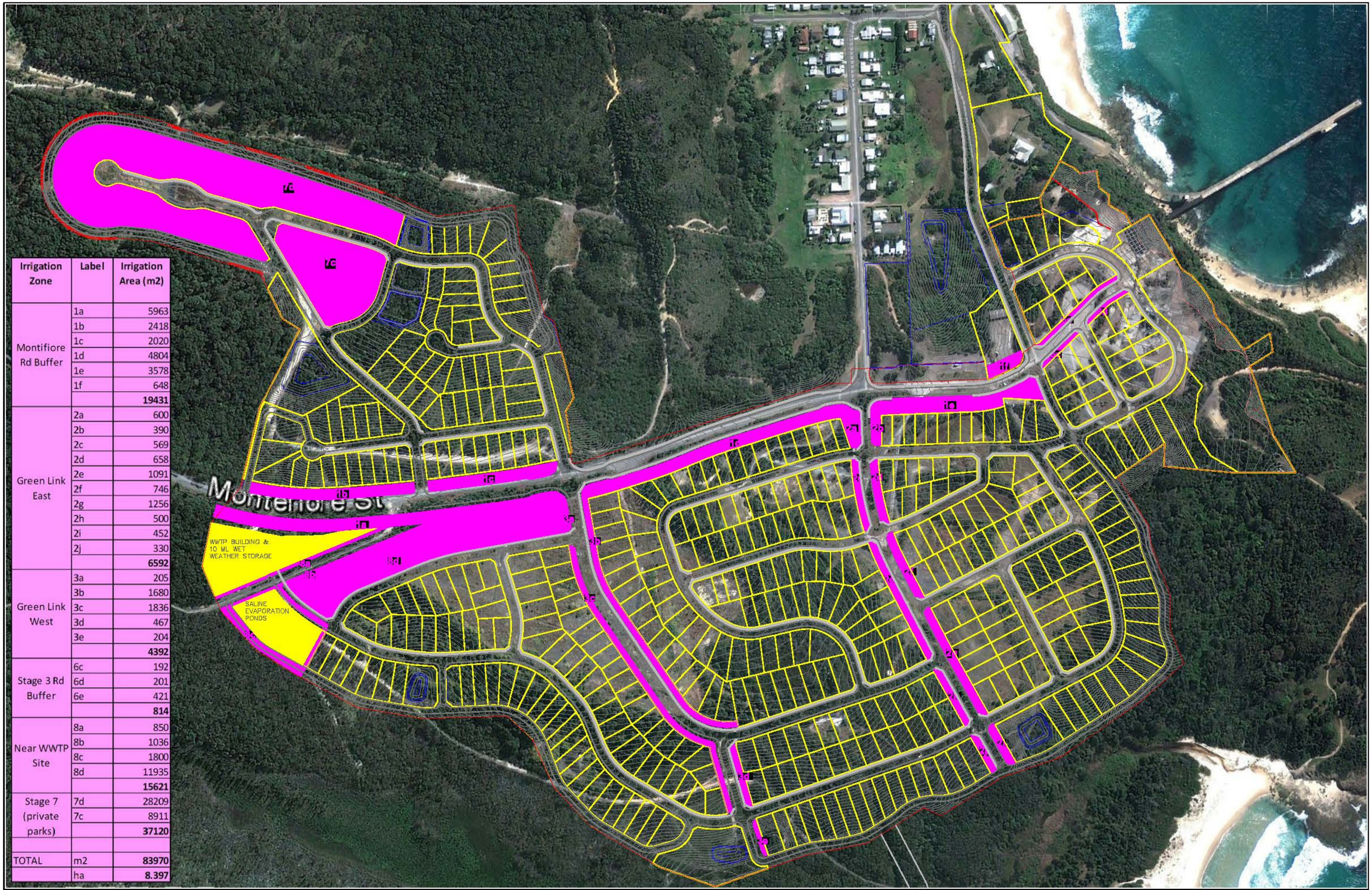
PROJECT NO. H10052

SCALE: 1:4000 at A3 (0, 40, 80, 120, 160, 200)

DWG TYPE: CONCEPT NOT FOR CONSTRUCTION

DWG NO. P09–1

ISSUE C



Irrigation Zone	Label	Irrigation Area (m2)
Montifiore Rd Buffer	1a	5963
	1b	2418
	1c	2020
	1d	4804
	1e	3578
	1f	648
		19431
Green Link East	2a	600
	2b	390
	2c	569
	2d	658
	2e	1091
	2f	746
	2g	1256
	2h	500
	2i	452
	2j	330
		6592
Green Link West	3a	205
	3b	1680
	3c	1836
	3d	467
	3e	204
		4392
Stage 3 Rd Buffer	6c	192
	6d	201
	6e	421
		814
Near WWTP Site	8a	850
	8b	1036
	8c	1800
	8d	11935
		15621
Stage 7 (private parks)	7d	28209
	7c	8911
		37120
TOTAL	m2	83970
	ha	8.397

ISSUE	DATE	ISSUE DETAILS
C	8/7/2013	REVISED IRRIGATION AREAS FOR IPART APPLICATION
B	26/8/2013	REVISED IRRIGATION AREAS FOR DISCUSSION
A	13/3/2013	FOR LMCC COMMENT

harvest
water management consultants pty ltd
184 Rivergum Drive
Burpengary, Qld 4505
0488 427 878
brad@harvestwmc.com.au
www.harvestwmc.com.au
ABN: 54140 844 047

CLIENT: SOLO WATER – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY RESIDENTIAL SUBDIVISION ROSE GROUP

Solo Water

SITE: MONTEFIORE ROAD CATHERINE HILL BAY NSW

DESIGN: BI | DRAWN: BI | APPROVED: BI

Bradley Irwin MPEQ (10837) CPENG NPER Environmental Engineer

SIGNED ____ DATE ____
for and on behalf of Harvest Water Management Consultants Pty Ltd

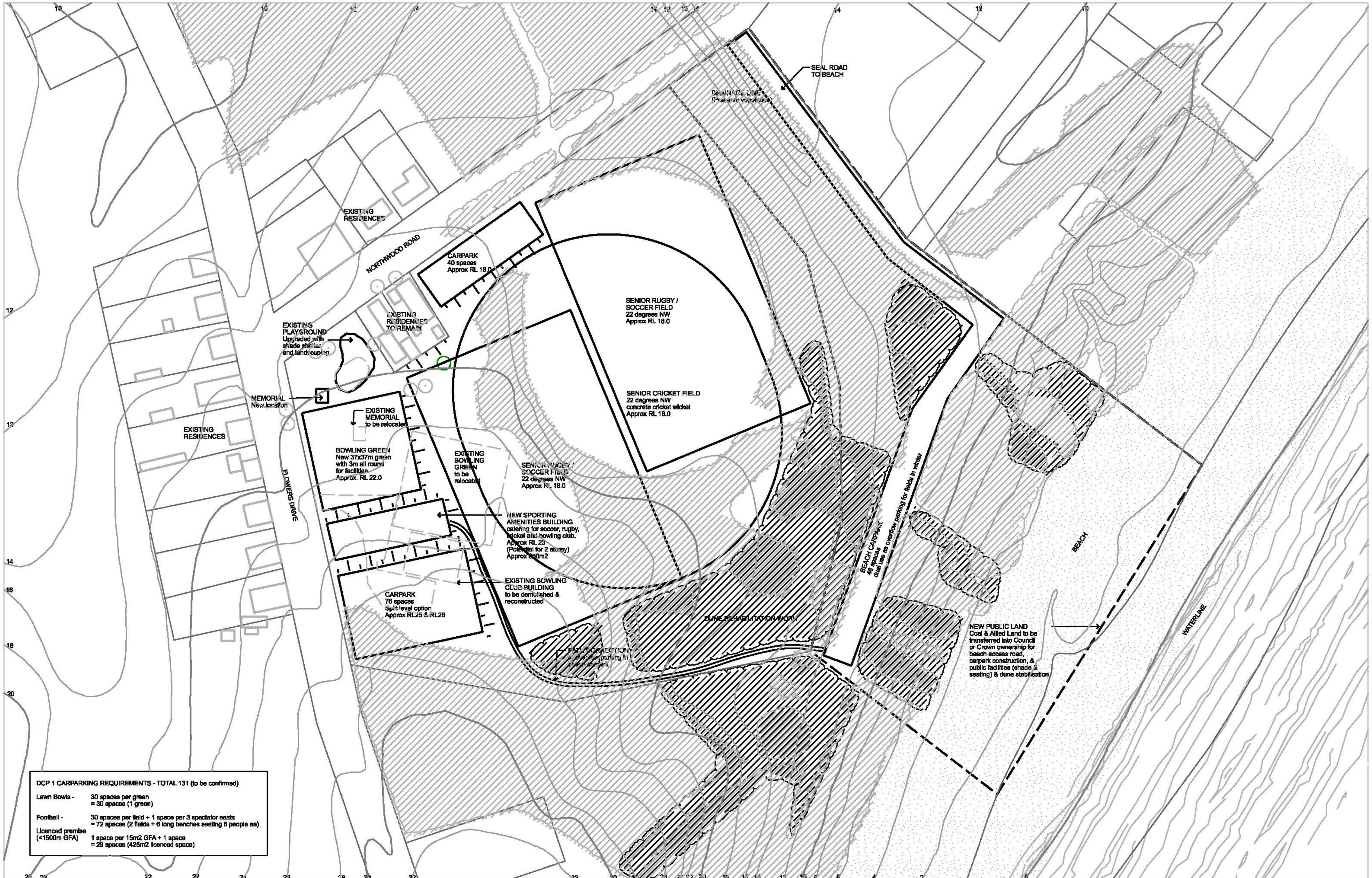
DRAWING TITLE: 8.3 ha OPEN SPACE EFFLUENT IRRIGATION AREAS WWTP STAGE 2 – 470 LOTS WITH RECYCLING

PROJECT NO. H10052

SCALE: 1:4000 at A3 (0 40 80 120 160 200)

DWG TYPE: CONCEPT NOT FOR CONSTRUCTION

DWG NO. P09–2 | ISSUE C



PRELIMINARY DRAFT ONLY
SHOWING SUITABILITY OF SITE

VERSION	DATE	COMMENTS	CHK BY	APPD BY
B	30/6/09	DRAFT MASTERPLAN	GW	HS
A	11/7/08	DRAFT MASTERPLAN	GW	HS

CAD FILES: Model: Sheet 3
DRAWN BY: LP
DESIGNED BY:
SURVEYED BY:

SCALE 1:750 (A1)
0 10 20 30 40 50 METERS
HEIGHT DATUM
COORDINATES ISG
ORIG. SHEET SIZE A1

THIS DRAWING IS AN UNCONTROLLED COPY UNLESS STATED OTHERWISE

126-138 MAIN ROAD
SPEERS POINT
PHONE (02) 49210333
FAX (02) 49587257
WWW.LAKEMAC.NSW.GOV.AU

PROJECT NAME
CATHERINE HILL BAY SPORTS / BOWLING CLUB PRECINCT

DRAWING TITLE
CONCEPT MASTERPLAN

PROJECT ADDRESS & DETAILS
Lot 1 &2 DP535976; L223 DP1102989; L7079 DP1029250

FOLDER NO: F2008/01275
CAD: S:/MICRO/LANDARCH/PRELIM/Cath4a_s.dgn
SHEET NO OF SHEETS: 1/1
VERSION: B

...\LANDARCH\PRELIM\Cath4a_s.dgn 30/06/2009 3:00:19 PM

Appendix E:
MEDLI Model Summary Output File

i) Proposed Stage 1 Temporary Irrigation Scheme

ii) Proposed Stage 2 Public Open Space Irrigation Scheme

****

SUMMARY OUTPUT
MEDLI Version 1.30

Data Set: H52 Ult Stg1 105kl
Run Date: 11/07/13 Time:10:40:56.57

****

GENERAL INFORMATION

Title: H10052 CHB
Subject: Prelim Effluent Irrigation Area
Client: Solo Water/Rose Group
User: BI
Time: Thu Jul 11 10:23:28 2013
Comments: [no entry]

RUN PERIOD

Starting Date 1/ 1/1912
Ending Date 31/12/2011
Run Length 100 years 0 days

CLIMATE INFORMATION

Enterprise site: Cath -33.2 deg S 151.6 deg E
Weather station: CatherineHillBay_33.15S_151.60E

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	884.	1181.	1614.
Pan Evap mm/year	1341.	1417.	1545.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	106	122	128	129	124	125	84	70	74	77	82	95	1217
Pan Evap (mm)	179	142	127	96	69	59	68	91	117	143	161	181	1431
Ave Max Temp DegC	26	26	25	23	20	18	17	18	21	23	24	26	22
Ave Min Temp DegC	19	19	18	15	12	9	8	9	11	13	16	18	13
Rad (MJ/m2/day)	22	20	17	14	11	9	11	14	18	20	22	23	16

MONTHLY IRRIGATION

Irrigation (mm)	31	29	30	28	29	29	32	34	33	34	31	33	374

SOIL PROPERTIES

Soil type: CHB Sand

SOIL WATER PROPERTIES

		Layer 1	Layer 2
Bulk Density	(g/cm3)	1.3	1.5
Porosity	(mm/layer)	50.6	213.2
Saturated Water Content	(mm/layer)	50.1	211.5
Drained Upper Limit	(mm/layer)	10.9	68.0
Lower Storage Limit	(mm/layer)	4.0	32.0
Air Dry Moisture Content	(mm/layer)	4.0	
Layer Thickness	(mm)	100.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	261.6	261.6
Total Drained Upper Limit	(mm)	78.9	78.9
Total Lower Storage Limit	(mm)	36.0	36.0
Total Air Dry Moisture Content	(mm)	4.5	4.5
Total Depth	(mm)	600.0	600.0

Maximum Plant Available Water Capacity 42.9
Saturated Hydraulic Conductivity
At Surface (mm/hr) 50.0

Limiting	(mm/hr)	50.0

RUNOFF

Runoff curve No II		70.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.5
URITCH	(mm)	10.0

AVERAGE WASTE STREAM
****

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

Inflow Volume	(ML/year)	38.35
Nitrogen	(tonne/year)	0.38
Phosphorus	(tonne/year)	0.04
Salinity	(tonne/year)	57.53
Nitrogen Concentration	(mg/L)	10.00
Phosphorus Concentration	(mg/L)	1.00
Salinity	(mg/L)	1500.00
Salinity	(dS/m)	2.34

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	10.00
Phosphorus Concentration	(mg/L)	1.00
TDS Concentration	(mg/L)	1500.00
Salinity	(dS/m)	2.34

IRRIGATION WATER
****

Irrigation triggered when plant available water falls to (%PAWC) 100.0
Irrigating upto upper storage limit + 3 mm

AREA

Total Irrigation Area	(ha)	10.77

VOLUMES

Total Irrigation	(ML/year)	40.32
Minimum Volume Irrigated by Pump	(ML/ha/day)	0.00
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	2.23
Average salinity of Irrigation	(mg/L)	1424.91
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	8.23
After ammonia loss	(mg/L)	8.06
Average Phosphorus Conc of Irrigation	(mg/L)	0.95

FRESH WATER USAGE
****

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
Final pond volume	(ML)	0.71
Final liquid volume	(ML)	0.71
Final sludge volume	(ML)	0.00
Average pond volume	(ML)	1.28
Average active volume	(ML)	1.28
Maximum pond volume	(ML)	10.00
Minimum allowable pond volume	(ML)	0.30
Average pond depth	(m)	1.16
Pond depth at outlet	(m)	6.00
Maximum water surface area	(m2 x1000)	2.47
Pond catchment area	(m2 x1000)	2.67
Pond footprint length	(m)	51.71
Pond footprint width	(m)	51.71

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	38.35
Recycle Volume from pond system	(ML/yr)	0.00
Rain water added to pond system	(ML/yr)	3.26
Evaporation loss from pond system	(ML/yr)	1.23
Seepage loss from pond system	(ML/yr)	0.05
Irrigation from last pond	(ML/yr)	40.32
Volume of overtopping	(ML/yr)	0.00
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)	0.01

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		36.87
%Days water demand too small to trigger irr.		17.22
%Days pond volume below min. vol. for irrig.		0.01
No. periods/year without irrigable effluent		0.01
Average Length of such periods	(days)	2.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	0.38	Irrig. from pond (ML/yr)	40.3
Nitrogen removed by Irrigation	(tonne/yr)	0.33		
Nitrogen removed by Volatilisation	(tonne/yr)	0.05		
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)	0.04	Irrig. from pond (ML/yr)	40.3
Phosphorus removed by Irrigation	(tonne/yr)	0.04		
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)	57.53
Salinity removed by Irrigation	(tonne/yr)	57.45
Salinity removed by Seepage	(tonne/yr)	0.06
Salinity lost by Overtopping	(tonne/yr)	0.00

Salinity involved in Recycling	(tonne/yr)	0.00
Increase in pond Salinity	(tonne/yr)	0.01

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	7.6
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	1356.1
Average Salinity of Pond Liquid	(dS/m)	2.1
Average Potassium Conc of Pond Liquid	(mg/L)	0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	8.3
Phosphorus Conc of Pond Liquid	(mg/L)	1.0
TDS Conc of Pond Liquid	(mg/L)	1455.8
EC of Pond Liquid	(dS/m)	2.3
Potassium Conc of Pond Liquid	(mg/L)	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

LAND DISPOSAL AREA
****

WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 33.28% of field capacity)

Rainfall	(mm/year)	1217.6	Irrigation Area	(ha)	10.8
Irrigation	(mm/year)	374.4			
Soil Evaporation	(mm/year)	149.1			
Transpiration	(mm/year)	576.6			
Runoff	(mm/year)	2.0			
Drainage	(mm/year)	864.3			
Change in soil moisture	(mm/year)	0.0			

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1912	1433.0	377.7	162.3	622.7	0.0	1053.3	-27.7
1913	1638.0	383.0	40.8	640.0	6.6	1348.1	-14.5
1914	1543.0	376.7	40.1	617.3	0.0	1215.2	47.1
1915	890.0	369.8	41.3	630.4	0.0	598.6	-10.5
1916	914.0	371.0	36.4	622.4	0.0	628.5	-2.4
1917	1266.0	375.9	36.2	628.9	0.0	981.1	-4.3
1918	1019.0	369.7	39.3	625.1	0.0	753.9	-29.6
1919	1285.0	370.7	42.3	641.4	0.0	938.7	33.2
1920	1174.0	379.1	37.2	646.3	12.9	867.5	-10.7
1921	1633.0	368.9	38.2	667.7	0.0	1237.4	58.6
1922	1061.0	384.8	40.8	672.0	0.0	811.6	-78.5
1923	979.0	359.4	40.6	588.6	0.0	671.6	37.6
1924	1156.0	383.2	38.1	649.4	1.2	876.3	-25.8
1925	1325.0	371.1	38.1	639.5	0.0	967.0	51.5
1926	1294.0	366.2	227.0	510.5	21.4	926.9	-25.6
1927	1340.0	389.0	37.5	653.8	15.0	1021.8	1.0
1928	1014.0	371.5	38.0	604.6	0.0	784.3	-41.5
1929	1476.0	379.8	38.5	613.3	0.0	1196.9	7.1
1930	1541.0	372.3	37.9	638.2	10.9	1190.8	35.5

1931	1592.0	390.1	38.8	646.2	1.8	1311.2	-16.0
1932	947.0	366.0	39.9	639.8	0.4	631.3	1.6
1933	1154.0	357.4	38.5	675.0	0.0	785.4	12.5
1934	1487.0	375.3	37.8	679.6	0.0	1144.2	0.7
1935	763.0	380.3	39.2	646.6	0.0	477.0	-19.5
1936	867.0	361.7	40.3	642.0	0.0	527.5	19.0
1937	1173.0	377.4	40.2	708.0	0.0	819.4	-17.2
1938	1098.0	373.5	40.3	650.5	0.0	786.2	-5.5
1939	1006.0	369.8	271.6	530.2	0.0	592.2	-18.2
1940	976.0	369.2	41.3	581.9	0.0	680.2	41.8
1941	827.0	362.6	37.3	608.1	0.0	586.0	-41.8
1942	1002.0	371.3	249.0	481.8	0.3	586.5	55.8
1943	1194.0	355.6	36.9	600.5	0.0	926.8	-14.5
1944	647.0	379.5	40.5	613.3	0.0	414.0	-41.3
1945	1025.0	369.2	37.9	607.9	0.0	709.2	39.2
1946	1105.0	372.0	138.7	581.4	2.8	794.1	-40.0
1947	1121.0	357.5	344.8	481.8	0.0	607.5	44.4
1948	1151.0	386.1	38.3	646.4	2.1	862.8	-12.5
1949	2009.0	395.8	37.2	623.3	3.4	1735.4	5.4
1950	2056.0	360.5	35.1	607.7	2.1	1745.8	25.8
1951	1250.0	404.4	38.6	615.9	0.0	1038.3	-38.3
1952	1274.0	375.5	264.8	520.7	2.1	836.6	25.2
1953	1013.0	372.5	36.9	595.3	1.0	777.2	-24.8
1954	1053.0	368.9	296.7	525.3	0.1	581.6	18.2
1955	1464.0	374.5	35.5	634.3	0.0	1175.3	-6.6
1956	1286.0	382.5	36.7	615.7	0.0	1025.3	-9.1
1957	652.0	357.1	73.8	533.5	0.0	372.8	29.0
1958	1054.0	371.6	293.8	569.3	0.0	576.1	-13.6
1959	1451.0	382.5	35.9	646.9	0.0	1166.7	-16.0
1960	1201.0	376.0	302.3	570.4	0.0	692.9	11.4
1961	1037.0	347.4	300.3	537.5	0.0	541.8	4.8
1962	1224.0	395.5	36.6	617.1	0.0	965.8	0.1
1963	1722.0	384.2	35.3	649.4	2.1	1429.4	-9.9
1964	1035.0	372.8	319.8	539.2	6.1	552.8	-10.0
1965	749.0	363.4	353.4	424.3	0.0	339.1	-4.5
1966	964.0	368.0	242.0	544.2	0.0	521.7	24.1
1967	1495.0	382.9	335.2	523.0	4.4	1033.9	-18.5
1968	878.0	367.6	389.5	390.1	0.0	461.7	4.3
1969	1235.0	375.9	337.8	475.3	0.1	789.6	8.2
1970	1106.0	364.9	43.8	739.7	1.0	682.2	4.1
1971	1262.0	380.6	42.9	703.8	0.0	911.9	-15.9
1972	1317.0	376.2	51.6	631.4	0.0	999.4	10.9
1973	1111.0	370.7	383.4	550.7	0.1	538.9	8.7
1974	1646.0	385.0	39.0	643.0	4.6	1353.6	-9.2
1975	1349.0	377.1	41.0	649.2	0.0	1032.3	3.6
1976	1661.0	383.2	38.3	675.9	0.0	1368.4	-38.3
1977	1050.0	370.1	321.1	502.9	13.2	575.5	7.4
1978	1718.0	384.5	37.8	623.9	4.3	1402.0	34.5
1979	875.0	368.6	352.6	425.1	0.0	477.2	-11.3
1980	724.0	357.5	512.3	289.5	2.7	226.3	50.7
1981	1328.0	381.7	304.1	511.0	15.8	918.5	-39.7
1982	1152.0	373.4	316.4	454.5	2.1	769.0	-16.6
1983	1281.0	369.2	438.9	415.7	9.4	769.1	17.1
1984	1406.0	384.2	341.9	532.7	1.8	905.5	8.4
1985	1239.0	378.0	37.1	606.7	0.0	988.2	-15.0
1986	1038.0	369.5	39.7	709.7	0.0	692.3	-34.2
1987	1136.0	370.2	37.3	590.6	0.0	839.3	39.0
1988	1565.0	387.1	143.2	551.4	0.1	1266.0	-8.6
1989	1576.0	383.6	254.6	573.2	0.0	1134.6	-2.7
1990	2025.0	390.5	43.7	578.8	29.2	1756.2	7.6
1991	915.0	363.4	518.5	179.9	0.1	573.4	6.5
1992	1278.0	367.1	230.0	528.6	1.0	886.3	-0.8
1993	885.0	381.7	36.6	645.4	0.0	625.3	-40.6
1994	896.0	366.0	56.7	614.2	0.0	557.8	33.3
1995	1229.0	375.7	407.3	463.6	0.0	744.4	-10.6
1996	1185.0	373.4	270.4	586.8	1.3	686.6	13.3
1997	1235.0	376.9	37.9	638.6	0.0	954.8	-19.4
1998	1622.0	383.6	38.1	670.8	0.0	1302.4	-5.7
1999	1473.0	356.3	33.2	537.7	0.0	1229.5	29.0
2000	882.0	388.6	36.7	602.5	0.0	663.8	-32.3
2001	1343.0	378.5	319.6	480.3	2.5	901.4	17.6
2002	1177.0	372.8	41.2	629.5	0.0	865.3	13.9
2003	1090.0	371.9	437.9	393.1	0.0	672.4	-41.6
2004	1053.0	372.0	484.9	383.9	0.0	519.3	37.0
2005	1023.0	370.3	312.3	495.0	0.0	589.2	-3.2
2006	1067.0	371.3	309.8	508.5	0.0	614.2	5.7

2007	1606.0	384.2	37.9	645.3	13.2	1292.1	1.8
2008	1415.0	381.4	35.0	652.0	0.0	1127.4	-18.1
2009	834.0	358.7	360.7	390.8	0.0	423.1	18.1
2010	1210.0	382.4	365.5	479.7	0.0	754.1	-6.9
2011	1560.0	380.9	281.1	484.1	0.0	1168.4	7.2

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	30.8	% of Total as ammonium	10.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.6	Deep Drainage (mm/year)	864.3
Nitrogen added in irrigation	(kg/ha/year)	30.2		
Nitrogen added in seed	(kg/ha/year)	0.5		
Nitrogen removed by crop	(kg/ha/year)	45.8		
Denitrification	(kg/ha/year)	0.0		
Leached NO3-N	(kg/ha/year)	0.4		
Change in soil organic-N	(kg/ha/year)	-14.9		
Change in soil solution NH4-N	(kg/ha/year)	0.0		
Change in soil solution NO3-N	(kg/ha/year)	-0.6		
Change in adsorbed NH4-N	(kg/ha/year)	0.0		
Initial soil organic-N	(kg/ha)	1522.5		
Final soil organic-N	(kg/ha)	27.8		
Initial soil inorganic-N	(kg/ha)	62.4		
Final soil inorganic-N	(kg/ha)	0.0		
Average N03-N conc in the root zone	(mg/L)	0.1		
Average N03-N conc below root zone	(mg/L)	0.8		
Average N03-N conc of deep drainage	(mg/L)	0.1		

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	3.6	% of Total as phosphate	100.0
Phosphorus added in seed	(kg/ha/year)	0.0		
Phosphorus removed by crop	(kg/ha/year)	3.2		
Leached PO4-P	(kg/ha/year)	0.1		
Change in dissolved PO4-P	(kg/ha/year)	0.0		
Change in adsorbed PO4-P	(kg/ha/year)	0.3		
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 kg/ha	P leached in year kg/ha
1912	1	148.1	0.1
1913	2	150.9	0.1
1914	3	154.1	0.1
1915	4	156.8	0.1
1916	5	159.9	0.1
1917	6	161.6	0.1
1918	7	163.5	0.1
1919	8	165.3	0.1
1920	9	167.2	0.1
1921	10	167.9	0.1
1922	11	168.9	0.1
1923	12	170.1	0.1
1924	13	171.4	0.1
1925	14	171.4	0.1
1926	15	172.4	0.1
1927	16	172.8	0.1
1928	17	173.5	0.1
1929	18	173.7	0.1
1930	19	173.7	0.1
1931	20	173.8	0.1
1932	21	174.7	0.1
1933	22	174.5	0.1
1934	23	174.4	0.1
1935	24	174.7	0.0
1936	25	175.3	0.1
1937	26	175.1	0.1
1938	27	175.2	0.1
1939	28	175.7	0.1

1940	29	176.7	0.1
1941	30	176.1	0.1
1942	31	176.7	0.1
1943	32	176.7	0.1
1944	33	177.0	0.0
1945	34	176.6	0.1
1946	35	176.8	0.1
1947	36	177.4	0.1
1948	37	177.7	0.1
1949	38	177.0	0.1
1950	39	176.5	0.1
1951	40	176.7	0.1
1952	41	177.8	0.1
1953	42	177.1	0.1
1954	43	177.7	0.1
1955	44	177.3	0.1
1956	45	177.5	0.1
1957	46	177.2	0.0
1958	47	177.9	0.1
1959	48	177.4	0.1
1960	49	178.0	0.1
1961	50	177.7	0.1
1962	51	177.3	0.1
1963	52	177.0	0.1
1964	53	178.2	0.0
1965	54	178.5	0.0
1966	55	179.4	0.0
1967	56	179.1	0.1
1968	57	179.8	0.0
1969	58	180.1	0.1
1970	59	179.4	0.1
1971	60	178.8	0.1
1972	61	179.1	0.1
1973	62	179.3	0.1
1974	63	178.9	0.1
1975	64	178.8	0.1
1976	65	178.8	0.1
1977	66	179.0	0.0
1978	67	179.1	0.1
1979	68	179.4	0.0
1980	69	181.3	0.0
1981	70	182.0	0.1
1982	71	181.5	0.1
1983	72	181.9	0.1
1984	73	181.9	0.1
1985	74	180.7	0.1
1986	75	180.2	0.1
1987	76	179.8	0.1
1988	77	180.0	0.1
1989	78	179.8	0.1
1990	79	179.4	0.1
1991	80	180.8	0.1
1992	81	182.1	0.1
1993	82	180.6	0.1
1994	83	180.3	0.1
1995	84	180.7	0.1
1996	85	181.6	0.1
1997	86	180.4	0.1
1998	87	180.1	0.1
1999	88	179.5	0.1
2000	89	180.2	0.1
2001	90	180.0	0.1
2002	91	180.0	0.1
2003	92	180.4	0.1
2004	93	182.3	0.1
2005	94	181.8	0.1
2006	95	181.9	0.1
2007	96	181.0	0.1
2008	97	180.7	0.1
2009	98	180.5	0.0
2010	99	181.3	0.1
2011	100	180.9	0.1

PLANT

Plant species: Temperate pasture

PLANT WATER USE

Irrigation	(mm/year)	374.	Totl Irrigation Area(ha)	10.8
Pan coefficient	(%)	0.9		
Maximum crop coefficient	(%)	0.8		
Average Plant Cover	(%)	62.		
Average Plant Total Cover	(%)	86.		
Average Plant Rootdepth	(mm)	522.		
Average Plant Available Water Capacity	(mm)	43.		
Average Plant Available Water	(mm)	37.		
Yield produced per unit transp.	(kg/ha/mm)	10.		

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	5732.			
Net nitrogen removed by plant	(kg/ha/yr)	45.	Shoot Concn	(%DM)	0.79
Net phosphorus removed by plant	(kg/ha/yr)	3.	Shoot Concn	(%DM)	0.05

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

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	548.	0.7	0.3	0.1	0.0
2	465.	0.6	0.3	0.1	0.0
3	504.	0.7	0.2	0.1	0.0
4	411.	0.7	0.1	0.0	0.0
5	354.	0.7	0.0	0.0	0.0
6	314.	0.7	0.0	0.0	0.0
7	385.	0.7	0.0	0.0	0.0
8	483.	0.7	0.0	0.0	0.0
9	541.	0.7	0.0	0.1	0.0
10	585.	0.7	0.1	0.1	0.0
11	571.	0.7	0.1	0.1	0.0
12	570.	0.7	0.2	0.1	0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress	0.2
%Days due to scorching	0.2
%Days due to water stress	2.3
%Days due to nitrogen stress	0.1
No. of forced harvests per year	0.5
No. of normal harvests per year	1.3

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water	(dS/m)	2.2	Irrigation	(mm/year)	374.4
Average EC of Rainwater	(dS/m x10)	0.3	Rainfall	(mm/year)	1217.6
Average EC of Infiltrated water	(dS/m)	0.6			
Av. water-upt-weightd rootzone EC	(dS/m s.e.)	0.4			
EC soil soln (FC) at base of rootzone	(dS/m)	1.0	Deep Drainage	(mm/year)	864.3
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 sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1912 - 1921	0.34	0.90	100.
1913 - 1922	0.35	0.93	100.
1914 - 1923	0.37	1.00	100.
1915 - 1924	0.38	1.04	100.
1916 - 1925	0.37	0.99	100.

1917 - 1926	0.36	0.96	100.
1918 - 1927	0.35	0.96	100.
1919 - 1928	0.35	0.96	100.
1920 - 1929	0.35	0.93	100.
1921 - 1930	0.34	0.90	100.
1922 - 1931	0.34	0.90	100.
1923 - 1932	0.34	0.91	100.
1924 - 1933	0.34	0.90	100.
1925 - 1934	0.33	0.87	100.
1926 - 1935	0.34	0.92	100.
1927 - 1936	0.35	0.96	100.
1928 - 1937	0.36	0.98	100.
1929 - 1938	0.36	0.98	100.
1930 - 1939	0.38	1.05	100.
1931 - 1940	0.40	1.12	100.
1932 - 1941	0.43	1.23	100.
1933 - 1942	0.43	1.24	100.
1934 - 1943	0.43	1.21	100.
1935 - 1944	0.47	1.36	100.
1936 - 1945	0.46	1.30	100.
1937 - 1946	0.44	1.25	100.
1938 - 1947	0.45	1.29	100.
1939 - 1948	0.45	1.28	100.
1940 - 1949	0.40	1.10	100.
1941 - 1950	0.36	0.96	100.
1942 - 1951	0.35	0.93	100.
1943 - 1952	0.34	0.90	100.
1944 - 1953	0.34	0.92	100.
1945 - 1954	0.34	0.90	100.
1946 - 1955	0.32	0.86	100.
1947 - 1956	0.32	0.84	100.
1948 - 1957	0.33	0.86	100.
1949 - 1958	0.33	0.88	100.
1950 - 1959	0.35	0.94	100.
1951 - 1960	0.39	1.06	100.
1952 - 1961	0.40	1.11	100.
1953 - 1962	0.39	1.10	100.
1954 - 1963	0.37	1.02	100.
1955 - 1964	0.37	1.02	100.
1956 - 1965	0.40	1.13	100.
1957 - 1966	0.42	1.21	100.
1958 - 1967	0.39	1.11	100.
1959 - 1968	0.40	1.13	100.
1960 - 1969	0.41	1.18	100.
1961 - 1970	0.41	1.18	100.
1962 - 1971	0.40	1.14	100.
1963 - 1972	0.40	1.13	100.
1964 - 1973	0.44	1.27	100.
1965 - 1974	0.40	1.14	100.
1966 - 1975	0.37	1.05	100.
1967 - 1976	0.35	0.95	100.
1968 - 1977	0.36	1.00	100.
1969 - 1978	0.33	0.90	100.
1970 - 1979	0.34	0.93	100.
1971 - 1980	0.36	0.98	100.
1972 - 1981	0.36	0.98	100.
1973 - 1982	0.37	1.01	100.
1974 - 1983	0.36	0.98	100.
1975 - 1984	0.37	1.03	100.
1976 - 1985	0.37	1.04	100.
1977 - 1986	0.40	1.12	100.
1978 - 1987	0.39	1.09	100.
1979 - 1988	0.40	1.11	100.
1980 - 1989	0.37	1.02	100.
1981 - 1990	0.33	0.87	100.
1982 - 1991	0.34	0.90	100.
1983 - 1992	0.33	0.89	100.
1984 - 1993	0.34	0.90	100.
1985 - 1994	0.35	0.94	100.
1986 - 1995	0.35	0.96	100.
1987 - 1996	0.35	0.96	100.
1988 - 1997	0.35	0.95	100.
1989 - 1998	0.35	0.95	100.
1990 - 1999	0.35	0.93	100.
1991 - 2000	0.38	1.06	100.
1992 - 2001	0.37	1.02	100.

1993 - 2002	0.37	1.02	100.
1994 - 2003	0.37	1.01	100.
1995 - 2004	0.37	1.02	100.
1996 - 2005	0.38	1.04	100.
1997 - 2006	0.38	1.05	100.
1998 - 2007	0.37	1.01	100.
1999 - 2008	0.37	1.03	100.
2000 - 2009	0.40	1.14	100.
2001 - 2010	0.40	1.12	100.
2002 - 2011	0.39	1.08	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 254.8
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

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

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1916	0.0	0.0	0.0
	1921	0.0	0.0	0.0
	1926	0.0	0.0	0.0
	1931	0.0	0.0	0.0
	1936	0.0	0.0	0.0
	1941	0.0	0.0	0.0
	1946	0.0	0.0	0.0
	1951	0.0	0.0	0.0
	1956	0.0	0.0	0.0
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
	2006	0.0	0.0	0.0
	2011	0.0	0.0	0.0
Last	2011	0.0	0.0	0.0

ACKNOWLEDGMENTS
****
This run brought to you courtesy of:

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

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UNCONDITIONAL FINISH

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

Data Set:   H52 Ult 470et 838ha F
Run Date: 11/07/13   Time:10:03:21.39
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GENERAL INFORMATION

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******************
Title:    H10052 CHB
Subject:  Prelim Effluent Irrigation Area
Client:   Solo Water/Rose Group
User:     BI
Time:     Thu Jul 11 09:56:21 2013
Comments: [no entry]
```

RUN PERIOD

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

Starting Date  1/ 1/1912
Ending Date   31/12/2011
Run Length    100 years   0 days
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CLIMATE INFORMATION

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

Enterprise site: Cath                            -33.2 deg S  151.6 deg E
Weather station: CatherineHillBay_33.15S_151.60E
```

ANNUAL TOTALS	10 Percentile	50 percentile	90 Percentile
Rainfall mm/year	884.	1181.	1614.
Pan Evap mm/year	1341.	1417.	1545.

MONTHLY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	106	122	128	129	124	125	84	70	74	77	82	95	1217
Pan Evap (mm)	179	142	127	96	69	59	68	91	117	143	161	181	1431
Ave Max Temp DegC	26	26	25	23	20	18	17	18	21	23	24	26	22
Ave Min Temp DegC	19	19	18	15	12	9	8	9	11	13	16	18	13
Rad (MJ/m2/day)	22	20	17	14	11	9	11	14	18	20	22	23	16

MONTHLY IRRIGATION

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Irrigation (mm)	30	27	28	26	24	24	27	31	34	34	30	32	345

SOIL PROPERTIES

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Soil type: CHB Sand

SOIL WATER PROPERTIES

		Layer 1	Layer 2
Bulk Density	(g/cm3)	1.3	1.5
Porosity	(mm/layer)	50.6	213.2
Saturated Water Content	(mm/layer)	50.1	211.5
Drained Upper Limit	(mm/layer)	10.9	68.0
Lower Storage Limit	(mm/layer)	4.0	32.0
Air Dry Moisture Content	(mm/layer)	4.0	
Layer Thickness	(mm)	100.0	500.0

		Profile	Max Rootzone
Total Saturated Water Content	(mm)	261.6	261.6
Total Drained Upper Limit	(mm)	78.9	78.9
Total Lower Storage Limit	(mm)	36.0	36.0
Total Air Dry Moisture Content	(mm)	4.5	4.5
Total Depth	(mm)	600.0	600.0

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Maximum Plant Available Water Capacity          42.9
Saturated Hydraulic Conductivity
                At Surface            (mm/hr)   50.0
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Limiting	(mm/hr)	50.0

RUNOFF

Runoff curve No II		70.0

SOIL EVAPORATION

CONA	(mm/day^0.5)	4.5
URITCH	(mm)	10.0

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)	27.03
Nitrogen	(tonne/year)	0.27
Phosphorus	(tonne/year)	0.03
Salinity	(tonne/year)	16.22

Nitrogen Concentration	(mg/L)	10.00
Phosphorus Concentration	(mg/L)	1.00
Salinity	(mg/L)	600.00
Salinity	(dS/m)	0.94

WASTE STREAM DETAILS (for last inflow event):

Nitrogen Concentration	(mg/L)	10.00
Phosphorus Concentration	(mg/L)	1.00
TDS Concentration	(mg/L)	600.00
Salinity	(dS/m)	0.94

IRRIGATION WATER
****

Irrigation triggered when plant available water falls to (%PAWC) 100.0
Irrigating upto upper storage limit + 2 mm

AREA

Total Irrigation Area	(ha)	8.38

VOLUMES

Total Irrigation	(ML/year)	28.98
Minimum Volume Irrigated by Pump	(ML/ha/day)	0.00
Maximum Volume must be full irrig. requiremt		
Maximum Vol. Available For Shandying	(ML/yr)	0.00

IRRIGATION CONCENTRATIONS

Average salinity of Irrigation	(dS/m)	0.87
Average salinity of Irrigation	(mg/L)	558.56
Average Nitrogen Conc of Irrigation		
Before ammonia loss	(mg/L)	7.65
After ammonia loss	(mg/L)	7.49
Average Phosphorus Conc of Irrigation	(mg/L)	0.93

FRESH WATER USAGE
****

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
Final pond volume	(ML)	0.45
Final liquid volume	(ML)	0.45
Final sludge volume	(ML)	0.00
Average pond volume	(ML)	1.41
Average active volume	(ML)	1.41
Maximum pond volume	(ML)	10.00
Minimum allowable pond volume	(ML)	0.30
Average pond depth	(m)	1.23
Pond depth at outlet	(m)	6.00
Maximum water surface area	(m2 x1000)	2.47
Pond catchment area	(m2 x1000)	2.67
Pond footprint length	(m)	51.71
Pond footprint width	(m)	51.71

POND WATER BALANCE

Inflow of Effluent to pond system	(ML/yr)	27.03
Recycle Volume from pond system	(ML/yr)	0.00
Rain water added to pond system	(ML/yr)	3.26
Evaporation loss from pond system	(ML/yr)	1.25
Seepage loss from pond system	(ML/yr)	0.05
Irrigation from last pond	(ML/yr)	28.98
Volume of overtopping	(ML/yr)	0.00
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)	0.00

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		36.87
%Days water demand too small to trigger irr.		14.82
%Days pond volume below min. vol. for irrig.		0.01
No. periods/year without irrigable effluent		0.01
Average Length of such periods	(days)	3.00

POND NITROGEN BALANCE

Nitrogen Added by Effluent	(tonne/yr)	0.27	Irrig. from pond (ML/yr)	29.0
Nitrogen removed by Irrigation	(tonne/yr)	0.22		
Nitrogen removed by Volatilisation	(tonne/yr)	0.05		
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)	0.03	Irrig. from pond (ML/yr)	29.0
Phosphorus removed by Irrigation	(tonne/yr)	0.03		
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)	16.22
Salinity removed by Irrigation	(tonne/yr)	16.19
Salinity removed by Seepage	(tonne/yr)	0.03
Salinity lost by Overtopping	(tonne/yr)	0.00

Salinity involved in Recycling	(tonne/yr)	0.00
Increase in pond Salinity	(tonne/yr)	0.00

POND CONCENTRATIONS

		Pond 1
Average Nitrogen Conc of Pond Liquid	(mg/L)	7.0
Average Phosphorus Conc of Pond Liquid	(mg/L)	0.9
Average TDS Conc of Pond Liquid	(mg/L)	530.2
Average Salinity of Pond Liquid	(dS/m)	0.8
Average Potassium Conc of Pond Liquid	(mg/L)	0.0

(On final day of simulation)

Nitrogen Conc of Pond Liquid	(mg/L)	7.8
Phosphorus Conc of Pond Liquid	(mg/L)	1.0
TDS Conc of Pond Liquid	(mg/L)	576.0
EC of Pond Liquid	(dS/m)	0.9
Potassium Conc of Pond Liquid	(mg/L)	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

LAND DISPOSAL AREA
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WATER BALANCE

(Initial soil water assumed to be at field capacity)
(Irrigated up to 26.83% of field capacity)

Rainfall	(mm/year)	1217.6	Irrigation Area	(ha)	8.4
Irrigation	(mm/year)	345.9			
Soil Evaporation	(mm/year)	159.8			
Transpiration	(mm/year)	569.2			
Runoff	(mm/year)	2.1			
Drainage	(mm/year)	832.4			
Change in soil moisture	(mm/year)	0.0			

ANNUAL TOTALS

Year	Rain (mm)	Irrig (mm)	Sevap (mm)	Trans (mm)	Runoff (mm)	Drain (mm)	Change (mm)
1912	1433.0	349.6	156.3	620.9	0.0	1033.2	-27.8
1913	1638.0	356.4	40.8	637.9	6.6	1323.7	-14.5
1914	1543.0	348.2	40.1	621.1	0.0	1182.7	47.3
1915	890.0	340.8	41.3	615.4	0.0	581.1	-7.0
1916	914.0	339.3	36.4	630.7	0.0	584.9	1.3
1917	1266.0	349.6	36.2	628.6	0.0	954.5	-3.7
1918	1019.0	340.2	39.3	625.9	0.0	730.2	-36.2
1919	1285.0	342.3	42.3	667.3	0.0	879.4	38.3
1920	1174.0	351.0	37.2	629.9	12.9	844.7	0.3
1921	1633.0	341.9	38.2	661.6	0.0	1233.8	41.3
1922	1061.0	356.4	40.8	686.8	0.0	755.7	-65.8
1923	979.0	327.5	40.6	563.3	0.0	677.2	25.3
1924	1156.0	355.3	38.1	664.5	1.2	819.0	-11.5
1925	1325.0	343.6	38.1	664.7	0.0	915.7	50.1
1926	1294.0	336.9	233.0	481.9	21.4	933.5	-38.9
1927	1340.0	361.2	37.5	659.9	15.0	988.6	0.2
1928	1014.0	342.4	38.0	608.0	0.0	751.2	-40.8
1929	1476.0	352.2	38.5	590.1	0.0	1194.4	5.2
1930	1541.0	345.4	37.9	602.3	10.9	1197.3	38.0

1931	1592.0	364.3	38.8	680.4	1.8	1238.0	-2.6
1932	947.0	336.0	39.9	683.6	0.4	592.5	-33.4
1933	1154.0	321.9	38.5	616.1	0.0	788.0	33.3
1934	1487.0	327.3	37.8	660.6	0.0	1115.4	0.5
1935	763.0	374.5	39.2	701.1	0.0	430.7	-33.5
1936	867.0	330.7	40.3	619.8	0.0	504.3	33.4
1937	1173.0	347.8	40.2	699.0	0.0	799.7	-18.1
1938	1098.0	344.0	40.3	644.8	0.0	761.3	-4.4
1939	1006.0	340.5	278.1	524.9	0.0	561.7	-18.3
1940	976.0	338.7	41.3	624.1	0.0	619.9	29.4
1941	827.0	331.4	37.3	586.5	0.0	563.8	-29.3
1942	1002.0	340.4	257.2	455.2	0.3	571.7	58.0
1943	1194.0	306.9	36.9	598.5	0.0	885.2	-19.7
1944	647.0	367.3	40.5	637.8	0.0	374.6	-38.5
1945	1025.0	338.9	37.9	655.1	0.0	644.3	26.6
1946	1105.0	342.7	125.5	540.6	2.9	806.0	-27.3
1947	1121.0	326.4	355.1	473.5	0.0	575.4	43.5
1948	1151.0	358.4	38.3	650.9	2.1	829.3	-11.2
1949	2009.0	371.2	37.2	674.9	3.4	1653.8	10.9
1950	2056.0	315.1	35.1	574.5	2.1	1739.4	19.9
1951	1250.0	395.2	38.6	651.8	0.0	1004.8	-50.0
1952	1274.0	348.1	269.4	506.4	2.4	824.8	19.1
1953	1013.0	342.9	36.9	583.8	1.0	742.3	-8.1
1954	1053.0	337.8	303.7	526.3	0.1	541.4	19.4
1955	1464.0	346.4	35.5	610.0	0.0	1170.9	-5.9
1956	1286.0	355.8	36.7	675.7	0.0	965.9	-36.4
1957	652.0	325.1	72.0	474.1	0.0	376.2	54.7
1958	1054.0	341.2	302.1	565.5	0.0	540.2	-12.7
1959	1451.0	347.1	35.9	622.9	0.0	1141.8	-2.5
1960	1201.0	357.5	315.5	568.4	0.0	678.1	-3.5
1961	1037.0	317.9	313.7	527.5	0.0	507.7	6.0
1962	1224.0	365.1	36.6	603.9	0.0	949.3	-0.7
1963	1722.0	322.6	35.3	614.4	2.1	1397.6	-4.7
1964	1035.0	379.8	343.6	539.7	6.0	545.9	-20.4
1965	749.0	332.2	350.3	400.5	0.0	328.5	1.8
1966	964.0	338.4	250.3	541.9	0.0	484.7	25.5
1967	1495.0	357.1	349.8	516.8	4.4	1013.6	-32.5
1968	878.0	337.1	399.6	356.1	0.0	444.4	15.0
1969	1235.0	348.3	345.4	480.8	0.1	747.3	9.7
1970	1106.0	335.9	43.8	715.0	0.6	678.2	4.2
1971	1262.0	352.1	42.9	689.2	0.0	890.3	-8.2
1972	1317.0	349.2	39.8	714.8	0.0	912.1	-0.6
1973	1111.0	342.1	396.6	548.6	0.1	495.4	12.4
1974	1646.0	358.9	39.0	634.6	4.6	1329.8	-3.1
1975	1349.0	349.6	41.0	646.7	0.0	1011.2	-0.2
1976	1661.0	356.9	38.3	667.4	0.0	1335.9	-23.7
1977	1050.0	340.9	365.5	469.6	13.8	550.9	-8.9
1978	1718.0	359.7	331.4	535.5	16.7	1160.9	33.3
1979	875.0	339.1	434.4	328.4	0.0	473.1	-21.9
1980	724.0	325.0	501.6	266.4	2.7	216.5	61.8
1981	1328.0	354.8	316.0	499.2	16.0	891.2	-39.6
1982	1152.0	345.2	327.7	429.8	2.3	753.3	-16.1
1983	1281.0	346.7	464.6	421.4	9.4	716.3	16.0
1984	1406.0	352.8	353.6	533.0	2.2	860.6	9.5
1985	1239.0	330.8	37.1	590.3	0.0	951.7	-9.3
1986	1038.0	357.6	39.7	687.0	0.0	709.7	-40.8
1987	1136.0	340.7	37.3	628.1	0.0	773.3	38.0
1988	1565.0	360.4	141.5	534.3	0.1	1256.7	-7.3
1989	1576.0	358.2	271.1	555.3	0.0	1109.2	-1.4
1990	2025.0	349.8	43.7	573.8	29.2	1720.4	7.7
1991	915.0	350.0	527.3	174.6	0.1	558.0	5.0
1992	1278.0	338.6	243.5	527.0	1.1	846.8	-1.7
1993	885.0	352.4	36.6	623.7	0.0	612.6	-35.5
1994	896.0	335.8	50.9	643.7	0.0	511.7	25.6
1995	1229.0	348.3	433.6	435.3	0.0	714.9	-6.5
1996	1185.0	345.4	290.3	580.8	1.4	644.0	13.9
1997	1235.0	348.6	37.9	628.7	0.0	933.4	-16.3
1998	1622.0	331.4	38.1	636.4	0.0	1259.4	19.5
1999	1473.0	327.4	33.2	585.8	0.0	1183.3	-1.9
2000	882.0	383.0	36.7	646.9	0.0	621.3	-39.9
2001	1343.0	351.6	429.7	385.1	2.7	870.9	6.3
2002	1177.0	345.2	282.9	524.0	0.0	681.0	34.2
2003	1090.0	343.0	436.9	380.9	0.0	656.9	-41.7
2004	1053.0	342.9	481.6	365.3	0.0	512.1	36.9
2005	1023.0	341.1	325.8	479.2	0.0	562.1	-3.1
2006	1067.0	342.3	322.8	494.0	0.0	585.8	6.7

2007	1606.0	356.2	37.9	629.1	13.2	1280.6	1.5
2008	1415.0	356.1	35.0	601.2	0.0	1138.1	-3.2
2009	834.0	328.3	359.6	401.9	0.0	398.3	2.6
2010	1210.0	354.5	380.2	488.4	0.0	710.2	-14.3
2011	1560.0	357.7	297.1	486.4	0.0	1119.9	14.2

NUTRIENT BALANCE

NITROGEN

Total N irrigated from ponds	(kg/ha/year)	26.4	% of Total as ammonium	10.0
Nitrogn lost by ammonia volat.	(kg/ha/year)	0.5	Deep Drainage (mm/year)	832.4
Nitrogen added in irrigation	(kg/ha/year)	25.9		
Nitrogen added in seed	(kg/ha/year)	0.5		
Nitrogen removed by crop	(kg/ha/year)	41.5		
Denitrification	(kg/ha/year)	0.0		
Leached NO3-N	(kg/ha/year)	0.4		
Change in soil organic-N	(kg/ha/year)	-14.9		
Change in soil solution NH4-N	(kg/ha/year)	0.0		
Change in soil solution NO3-N	(kg/ha/year)	-0.6		
Change in adsorbed NH4-N	(kg/ha/year)	0.0		
Initial soil organic-N	(kg/ha)	1522.5		
Final soil organic-N	(kg/ha)	28.3		
Initial soil inorganic-N	(kg/ha)	62.4		
Final soil inorganic-N	(kg/ha)	0.0		
Average N03-N conc in the root zone	(mg/L)	0.1		
Average N03-N conc below root zone	(mg/L)	0.9		
Average N03-N conc of deep drainage	(mg/L)	0.1		

PHOSPHORUS

Phosphorus added in irrigatn	(kg/ha/year)	3.2	% of Total as phosphate	100.0
Phosphorus added in seed	(kg/ha/year)	0.0		
Phosphorus removed by crop	(kg/ha/year)	2.9		
Leached PO4-P	(kg/ha/year)	0.1		
Change in dissolved PO4-P	(kg/ha/year)	0.0		
Change in adsorbed PO4-P	(kg/ha/year)	0.3		
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 kg/ha	P leached in year kg/ha
1912	1	147.9	0.1
1913	2	150.3	0.1
1914	3	153.2	0.1
1915	4	155.8	0.1
1916	5	158.6	0.1
1917	6	160.1	0.1
1918	7	161.9	0.1
1919	8	163.5	0.1
1920	9	165.3	0.1
1921	10	165.9	0.1
1922	11	166.9	0.1
1923	12	168.0	0.1
1924	13	169.2	0.1
1925	14	169.1	0.1
1926	15	170.1	0.1
1927	16	170.4	0.1
1928	17	171.0	0.1
1929	18	171.1	0.1
1930	19	171.2	0.1
1931	20	171.3	0.1
1932	21	172.1	0.1
1933	22	171.8	0.1
1934	23	171.6	0.1
1935	24	171.9	0.0
1936	25	172.5	0.0
1937	26	172.2	0.1
1938	27	172.3	0.1
1939	28	172.9	0.1

1940	29	173.7	0.1
1941	30	173.1	0.1
1942	31	173.8	0.1
1943	32	173.7	0.1
1944	33	174.1	0.0
1945	34	173.6	0.1
1946	35	173.8	0.1
1947	36	174.7	0.1
1948	37	174.9	0.1
1949	38	174.0	0.1
1950	39	173.7	0.1
1951	40	173.7	0.1
1952	41	175.0	0.1
1953	42	174.4	0.1
1954	43	174.9	0.1
1955	44	174.4	0.1
1956	45	174.5	0.1
1957	46	174.4	0.0
1958	47	175.0	0.1
1959	48	174.5	0.1
1960	49	175.2	0.1
1961	50	174.9	0.0
1962	51	174.5	0.1
1963	52	174.1	0.1
1964	53	175.4	0.0
1965	54	175.7	0.0
1966	55	176.6	0.0
1967	56	176.3	0.1
1968	57	177.1	0.0
1969	58	177.4	0.1
1970	59	176.7	0.1
1971	60	176.1	0.1
1972	61	176.4	0.1
1973	62	176.5	0.1
1974	63	176.2	0.1
1975	64	176.0	0.1
1976	65	175.9	0.1
1977	66	176.1	0.0
1978	67	176.9	0.1
1979	68	177.1	0.0
1980	69	179.1	0.0
1981	70	179.6	0.1
1982	71	179.1	0.1
1983	72	179.4	0.1
1984	73	179.4	0.1
1985	74	178.0	0.1
1986	75	177.5	0.1
1987	76	177.2	0.1
1988	77	177.3	0.1
1989	78	177.2	0.1
1990	79	176.7	0.1
1991	80	178.1	0.1
1992	81	179.3	0.1
1993	82	177.9	0.1
1994	83	177.5	0.0
1995	84	178.0	0.1
1996	85	179.0	0.1
1997	86	177.8	0.1
1998	87	177.3	0.1
1999	88	176.8	0.1
2000	89	177.3	0.1
2001	90	177.4	0.1
2002	91	178.0	0.1
2003	92	178.2	0.1
2004	93	179.8	0.1
2005	94	179.3	0.1
2006	95	179.3	0.1
2007	96	178.3	0.1
2008	97	177.9	0.1
2009	98	177.7	0.0
2010	99	178.5	0.1
2011	100	178.2	0.1

PLANT

Plant species: Temperate pasture

PLANT WATER USE

Irrigation	(mm/year)	346.	Totl Irrigation Area(ha)	8.4
Pan coefficient	(%)	0.9		
Maximum crop coefficient	(%)	0.8		
Average Plant Cover	(%)	61.		
Average Plant Total Cover	(%)	85.		
Average Plant Rootdepth	(mm)	515.		
Average Plant Available Water Capacity	(mm)	43.		
Average Plant Available Water	(mm)	37.		
Yield produced per unit transp.	(kg/ha/mm)	10.		

PLANT NUTRIENT UPTAKE

Dry Matter Yield (Shoots)	(kg/ha/yr)	5409.			
Net nitrogen removed by plant	(kg/ha/yr)	41.	Shoot Concn	(%DM)	0.76
Net phosphorus removed by plant	(kg/ha/yr)	3.	Shoot Concn	(%DM)	0.05

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

Month	Yield kg/ha	Nitr	Temp	Water Defic	Water Logging
1	523.	0.7	0.3	0.1	0.0
2	458.	0.6	0.3	0.1	0.0
3	489.	0.7	0.2	0.1	0.0
4	390.	0.7	0.1	0.0	0.0
5	330.	0.7	0.0	0.0	0.0
6	285.	0.7	0.0	0.0	0.0
7	345.	0.7	0.0	0.0	0.0
8	452.	0.7	0.0	0.0	0.0
9	520.	0.7	0.0	0.1	0.0
10	566.	0.7	0.1	0.1	0.0
11	519.	0.7	0.1	0.1	0.0
12	532.	0.7	0.2	0.1	0.0

>>> NO-PLANT EVENTS <<<

%Days due to temperature stress	0.2
%Days due to scorching	0.2
%Days due to water stress	2.7
%Days due to nitrogen stress	0.1
No. of forced harvests per year	0.5
No. of normal harvests per year	1.2

SALINITY

Salt tolerance - plant species: tolerant

Average EC of Irrigation Water	(dS/m)	0.9	Irrigation	(mm/year)	345.9
Average EC of Rainwater	(dS/m x10)	0.3	Rainfall	(mm/year)	1217.6
Average EC of Infiltrated water	(dS/m)	0.2			
Av. water-upt-weightd rootzone EC	(dS/m s.e.)	0.1			
EC soil soln (FC) at base of rootzone	(dS/m)	0.4	Deep Drainage	(mm/year)	832.4
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 sat ext (dS/m)	ECbase in situ (dS/m)	Rel Yield (%)
1912 - 1921	0.13	0.36	100.
1913 - 1922	0.14	0.37	100.
1914 - 1923	0.15	0.40	100.
1915 - 1924	0.15	0.42	100.
1916 - 1925	0.15	0.40	100.

1917 - 1926	0.14	0.39	100.
1918 - 1927	0.14	0.39	100.
1919 - 1928	0.14	0.38	100.
1920 - 1929	0.14	0.37	100.
1921 - 1930	0.13	0.36	100.
1922 - 1931	0.13	0.36	100.
1923 - 1932	0.14	0.36	100.
1924 - 1933	0.13	0.36	100.
1925 - 1934	0.13	0.35	100.
1926 - 1935	0.14	0.37	100.
1927 - 1936	0.14	0.38	100.
1928 - 1937	0.14	0.39	100.
1929 - 1938	0.14	0.39	100.
1930 - 1939	0.15	0.42	100.
1931 - 1940	0.16	0.45	100.
1932 - 1941	0.17	0.49	100.
1933 - 1942	0.17	0.50	100.
1934 - 1943	0.17	0.49	100.
1935 - 1944	0.19	0.55	100.
1936 - 1945	0.18	0.53	100.
1937 - 1946	0.18	0.50	100.
1938 - 1947	0.18	0.52	100.
1939 - 1948	0.18	0.52	100.
1940 - 1949	0.16	0.45	100.
1941 - 1950	0.14	0.39	100.
1942 - 1951	0.14	0.37	100.
1943 - 1952	0.14	0.36	100.
1944 - 1953	0.14	0.37	100.
1945 - 1954	0.13	0.36	100.
1946 - 1955	0.13	0.35	100.
1947 - 1956	0.13	0.34	100.
1948 - 1957	0.13	0.35	100.
1949 - 1958	0.13	0.36	100.
1950 - 1959	0.14	0.37	100.
1951 - 1960	0.15	0.43	100.
1952 - 1961	0.16	0.45	100.
1953 - 1962	0.16	0.44	100.
1954 - 1963	0.15	0.40	100.
1955 - 1964	0.15	0.41	100.
1956 - 1965	0.16	0.45	100.
1957 - 1966	0.17	0.48	100.
1958 - 1967	0.16	0.45	100.
1959 - 1968	0.16	0.45	100.
1960 - 1969	0.17	0.48	100.
1961 - 1970	0.16	0.47	100.
1962 - 1971	0.16	0.45	100.
1963 - 1972	0.16	0.45	100.
1964 - 1973	0.18	0.52	100.
1965 - 1974	0.16	0.46	100.
1966 - 1975	0.15	0.42	100.
1967 - 1976	0.14	0.39	100.
1968 - 1977	0.15	0.40	100.
1969 - 1978	0.14	0.38	100.
1970 - 1979	0.14	0.39	100.
1971 - 1980	0.15	0.41	100.
1972 - 1981	0.15	0.41	100.
1973 - 1982	0.15	0.41	100.
1974 - 1983	0.15	0.40	100.
1975 - 1984	0.15	0.43	100.
1976 - 1985	0.15	0.43	100.
1977 - 1986	0.16	0.46	100.
1978 - 1987	0.16	0.45	100.
1979 - 1988	0.16	0.44	100.
1980 - 1989	0.15	0.41	100.
1981 - 1990	0.13	0.35	100.
1982 - 1991	0.13	0.36	100.
1983 - 1992	0.13	0.36	100.
1984 - 1993	0.14	0.36	100.
1985 - 1994	0.14	0.38	100.
1986 - 1995	0.14	0.39	100.
1987 - 1996	0.14	0.39	100.
1988 - 1997	0.14	0.38	100.
1989 - 1998	0.14	0.38	100.
1990 - 1999	0.14	0.37	100.
1991 - 2000	0.15	0.43	100.
1992 - 2001	0.15	0.41	100.

1993 - 2002	0.15	0.42	100.
1994 - 2003	0.15	0.42	100.
1995 - 2004	0.15	0.42	100.
1996 - 2005	0.15	0.43	100.
1997 - 2006	0.15	0.43	100.
1998 - 2007	0.15	0.41	100.
1999 - 2008	0.15	0.42	100.
2000 - 2009	0.16	0.47	100.
2001 - 2010	0.16	0.46	100.
2002 - 2011	0.16	0.44	100.

GROUNDWATER
****

Average Groundwater Recharge (m3/day) 191.0
Average Nitrate-N Conc of Recharge (mg/L) 0.1

Thickness of the Aquifer (m) 10.0
Distance (m) from Irrigation Area to where
Nitrate-N Conc in Groundwater is Calculated 1000.0

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

	Year	Depth Below Water Table Surface 0.0 m	5.0 m	9.0 m
	1916	0.0	0.0	0.0
	1921	0.0	0.0	0.0
	1926	0.0	0.0	0.0
	1931	0.0	0.0	0.0
	1936	0.0	0.0	0.0
	1941	0.0	0.0	0.0
	1946	0.0	0.0	0.0
	1951	0.0	0.0	0.0
	1956	0.0	0.0	0.0
	1961	0.0	0.0	0.0
	1966	0.0	0.0	0.0
	1971	0.0	0.0	0.0
	1976	0.0	0.0	0.0
	1981	0.0	0.0	0.0
	1986	0.0	0.0	0.0
	1991	0.0	0.0	0.0
	1996	0.0	0.0	0.0
	2001	0.0	0.0	0.0
	2006	0.0	0.0	0.0
	2011	0.0	0.0	0.0
Last	2011	0.0	0.0	0.0

ACKNOWLEDGMENTS
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UNCONDITIONAL FINISH

Appendix F:
Environmental and Public Health Risk Assessment

i) Sewerage Infrastructure Preliminary Risk Assessment (IPART Application Appendix 4.3.9)

ii) Non-potable Infrastructure Preliminary Risk Assessment (IPART Application Appendix 4.2.10)

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Sewerage Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Wastewater generation	Trace contaminants in domestic wastewater	Poor household chemical use and disposal practices resulting in excessive contaminant levels in recycled water	Potential environmental impacts on effluent irrigation areas	C	Possible	2	Minor	Moderate	1. Customer supply contracts and recycled water use agreement will be developed with each customer and will include obligations and education regarding appropriate substances to be disposed of to sewerage and substances that should be avoided. 2. Ongoing customer awareness campaigns and information provided with each water bill and through the CHB Water Utility website.	B	Unlikely	2	Minor	Low
	Trace contaminants in commercial wastewater	Poor trade waste management practices resulting in excessive contaminant levels in recycled water	Potential environmental impacts on effluent irrigation areas	D	Likely	2	Minor	Moderate	1. Predominately residential sewerage catchment with non-residential customers account for less than 1% of all wastewater generated. 2. Trade waste agreement will be developed with each non-residential customers to ensure wastewater is pretreated to domestic standards before discharge into the sewerage system. 3. Each non-residential customer will have its own low pressure sewage pump station to enable monitoring compliance of trade waste agreements.	B	Unlikely	2	Minor	Low
	Shock load of chemical	Poor chemical or trade waste management practices resulting in shock load of contaminants on MBR	Potential biomass die off and reduction in MBR effluent quality. Chemicals may also be an OHS hazard.	A	Rare	2	Minor	Low	1. Continuous online monitoring of MLSS, DO, pH, EC and other process parameters to detect potential impacts on the treatment process. 2. Investigation will be undertaken into the source of contamination. This may involve review of Pressure Sewer Unit (PSU) operational data, water usage data, trade waste agreement etc. 3. Additional online water quality monitoring probes can be installed into suspect PSUs for tracing persistent sources of contamination if required. 4. Road tanker pump out of contaminated water from the inlet balance tank if required.	B	Unlikely	1	Insignificant	Low
	Gross pollutants in raw wastewater	Poor solid waste management practices resulting sewer blockage and overflow.	Potential sewer blockage and overflow	E	Almost certain	2	Minor	Moderate	1. Low pressure sewerage system with grinder pumps will macerate sewage prior to entering the pipe network. 2. Appropriately designed network with self cleansing velocities and high head pumps will minimise the potential for network blockage. 3. Sewer/pump blockage Emergency Response Plan will be developed for the scheme and will include step for identification of route cause and preventative actions. Where multiple blockages have occurred on the same pump station, specific customer awareness/education will be implemented or compliance notices issued. 4. Flushing and maintenance regime will be developed for the pressure sewer network.	C	Possible	2	Minor	Moderate
	Excessive wastewater generation	Peak tourist population or excessive water usage	Build up of raw wastewater in the inlet balance tank and PSUs. Potential overflow to the environment.	C	Possible	2	Minor	Moderate	1. Water demand management strategy including mandatory best practice water efficient fixtures, smart water metres, customer awareness. 2. MBR capacity based on treatment of average daily flows plus 10% contingency at 2.8 EP/ET. 3. Flow and level monitoring at each pump unit to detect sources of inflow. 4. Road tanker pumpout from individual PSUs if required.	B	Unlikely	1	Insignificant	Low
Low Pressure Sewerage Collection System	Inflow and infiltration to the sewerage network	Inflow and infiltration to the sewerage network	Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR	D	Likely	2	Minor	Moderate	1. Low pressure sewerage system constructed with PN16 HDPE with welded joints and fittings. 2. Contractor induction and education. 3. Inspection and quality assurance during construction. 4. Flow and level monitoring at each pump unit to detect sources of inflow. 5. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority. 6. Road tanker pumpout from individual pump units if required.	C	Possible	2	Minor	Moderate
	Inflow and infiltration upstream of Pressure Sewer Unit (PSU)	Inflow and infiltration upstream of Pressure Sewer Unit (PSU)	Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR	E	Almost certain	2	Minor	Moderate	1. Plumbing inspection of all household plumbing installation prior to connection. 2. Induction and awareness training for all domestic plumbing contractors working in the scheme. 3. Flow and level monitoring at each PSU to identify sources of inflow. Customer education and rectification notices will be provided if required. 4. Road tanker pumpout from individual PSUs if required.	C	Possible	2	Minor	Moderate
	High peak diurnal flows	Excessive peak inflows	Potential overflow from PSU or inlet balance tank if combined inflows exceed capacity of MBR	C	Possible	2	Minor	Moderate	1. Inlet balance tank at WWTP provides buffer storage for diurnal flows. 2. Storage capacity in each PSU provides buffer storage for diurnal flows. 3. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority in the control system. 4. Road tanker pumpout from individual pump units if required.	A	Rare	2	Minor	Low
	Pressure main break	Pressure main failure or breakage due to unapproved excavation activity	Discharge of raw sewage to the environment	C	Possible	3	Moderate	High	1. All mains constructed with PN16 HDPE pipe with welded joints and fittings. 2. All mains are pressure tested and certified during construction. 3. Pressure sewer mains are generally located at the bottom of a common services trench, hence other pipes will be damaged from poor excavation practices before the pressure sewer. 4. Signage and identification tape to be installed above all pressure mains. 5. All sewer pipe locations registered with dial before you dig service. 6. Flow monitoring at the WWTP will identify major variations in daily flow. 7. Customer Service Centre and fault reporting with maximum response times for operations staff. 8. Sewer spill Emergency Response Plan and cleanup procedures will be developed. 9. Pressure and flow monitoring in the pressure sewer network.	B	Unlikely	2	Minor	Low

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Low Pressure Sewerage Collection System continued..	Leakage from PSU wet well	Failure of PSU wet well resulting in subsurface leakage	Discharge of raw sewage to groundwater	C	Possible	2	Minor	Moderate	1. Clean water static pressure test of each wet well during construction. 2. Wet well designed to include allowances for all structural loads including hydrostatic and soil pressures. 3. Timber bollards or fencing around all PSUs to prevent vehicle access. 4. Water level and flow monitoring at each PSU.	B	Unlikely	2	Minor	Low
	Pump Failure	Pump failure by power surge, blockage, loss of suction etc	Potential discharge of raw sewage to the environment	D	Likely	3	Moderate	High	1. Duty and standby pumps in each PSU. 2. Fail safe in electrical system so pump can operate with failed network connections. 3. High quality robust pumps with long design life. Likely supplier is E-One. 4. Standard pumps with spare pumps maintained onsite for quick changeover if required.	B	Unlikely	3	Moderate	Moderate
	Power failure	Extended power failure across pressure sewer network	Potential discharge of raw sewage to the environment	E	Almost certain	3	Moderate	High	1. 24 hours emergency storage is provided in all PSUs. 2. Low pressure sewer network start up and recovery process is included in Direct Digital Control System logic to avoid excessive simultaneous pump operation. 3. Road tanker pump out from individual PSUs if required.	B	Unlikely	2	Minor	Low
Wastewater Treatment - Membrane Bioreactor + UV Disinfection	Structural failures of tanks and pipes	Tank failure	Discharge of process water to environment	C	Possible	3	Moderate	High	1. Stainless steel tanks with appropriately designed footings. 2. Quality assurance during tank manufacture and installation.	A	Rare	3	Moderate	Low
	Process tank overflows	Blockage or fault causing overflow of process tanks	Discharge of process water to environment	C	Possible	2	Minor	Moderate	1. All process tanks gravity overflow back to inlet balance tank. 2. Screening system on inlet to MBR to remove gross solids.	B	Unlikely	2	Minor	Low
	Mechanical/ electrical items	Failure of mechanical electrical items	Non-compliant recycled water	E	Almost certain	3	Moderate	High	1. Fault detection on all critical mechanical electrical components. 2. Continuous online water quality monitoring of critical process parameters, e.g. DO, pH, MLSS, transmembrane pressure, turbidity, UV intensity	C	Possible	2	Minor	Moderate
	Power blackouts	Extended power blackout	Loss of treatment capacity	E	Almost certain	3	Moderate	High	1. No sewage inflow to MBR during power blackout as pressure sewer system will also be down 2. Wastewater will build up in 24 hours emergency storage at each PSU. 3. Road tanker pump out from each PSU if required. 4. Electrical connection point for mobile power generator to power MBR if required.	C	Possible	2	Minor	Moderate
	Blockage of inlet screening unit	Blockage of screening unit caused by excessive solids in raw wastewater	Carryover of solids to MBR with reduced treatment performance and increased risk of membrane failure	C	Possible	2	Minor	Moderate	1. Only grinder pump macerated sewage will enter the plant. 2. Water level monitoring and high level alarm in screening unit. 3. If screening blockage occurs undertake investigation into source of gross solids and implement preventative actions.	B	Unlikely	2	Minor	Low
	Hydraulic overload during diurnal peak flows	Excessive sewerage flows	Build up of raw wastewater in the inlet balance tank and PSUs. Potential overflow to the environment.	C	Possible	2	Minor	Moderate	1. When peak capacity of the MBR is exceeded the inlet balance tank provides buffer storage for diurnal flows. 2. 24 hour storage capacity in each PSU can also provide buffer storage in extreme events. 3. PSU pump operation centrally controlled by the Direct Digital Control System. PSUs with high water level are given pumping priority through the control system logic. 4. Road tanker pump out from individual PSUs if required during operation.	B	Unlikely	2	Minor	Low
	Pollutant overload	Excessive BOD or ammonia load	Non-compliant recycled water	C	Possible	3	Moderate	High	1. Continuous online monitoring of MBR process DO, MLSS, pH with alarms. 2. Variable speed drive aeration system to match air supply with inflow. Reserve capacity is designed into the aeration system. 3. If process impacts due to high pollutant loads are observed a source control investigation will be undertaken using raw wastewater and trade waste data.	B	Unlikely	3	Moderate	Moderate
	Membrane CIP waste	Return of chemical laden CIP waste through MBR	Potential upset of treatment process and biomass die off	D	Likely	3	Moderate	High	1. MBR CIP waste is stored and neutralised prior to return to the inlet balance tank. 2. If operational problems are experienced MBR CIP waste will be trucked off site to nearest approved facility.	B	Unlikely	3	Moderate	Moderate
	Process chemicals	Spillage of process chemicals	Potential release of chemicals to the environment Potential OH&S impacts.	C	Possible	3	Moderate	High	1. Appropriate bunding and separation of chemicals in chemical storage and delivery area. 2. Standard operating procedures for the transport, receipt and use of chemicals.	A	Rare	2	Minor	Low
	Waste activated sludge	Inadequate sludge wastage rates	High MLSS in MBR, decline in effluent quality & increased membrane fouling.	E	Almost certain	3	Moderate	High	1. Continuous online monitoring of MLSS, DO and TMP with alarms. 2. When MLSS reaches maximum set point sludge is pumped from the bottom of the MBR tank to a sludge holding tank before offsite disposal to approved facility.	B	Unlikely	3	Moderate	Moderate
	Membrane failure	Membrane failure resulting in carryover of human pathogens	Non-compliant recycled water	D	Likely	4	Major	Very high	1. Continuous online monitoring of membrane permeate turbidity and transmembrane pressure. 2. If event occurs, identify and isolate failed membrane module and if required replace failed membrane module. 3. Shut off irrigation supply pump and undertake monitoring of pond water quality to ensure compliance. 4. Chemical treatment of pond water can be undertaken if necessary. 5. An Emergency Response Plan will be developed for MBR membrane failure.	B	Unlikely	4	Major	High

Project: Catherine Hill Bay Water Utility
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Solo Water

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Wastewater Treatment - Membrane Bioreactor + UV Disinfection continued…	UV failure	Inadequate UV dose due to lamp failure, reactor fouling, high flow or high turbidity	Non-compliant recycled water	E	Almost certain	3	Moderate	High	1. Continuous online monitoring UV intensity, flow, upstream permeate turbidity and lamp failure. 2. If Low UV dose is recorded investigate and rectify. 3. Shut off irrigation supply pump and undertake monitoring of pond water quality to ensure compliance. 4. Chemical treatment of pond water can be undertaken if necessary. 5. An Emergency Response Plan will be developed for UV lamp failure.	C	Possible	3	Moderate	High
	Sabotage/ vandalism	Sabotage/vandalism	Potential loss of treatment function	C	Possible	4	Major	Very high	1. Lockable site with 6-foot secure fencing. 2. Lockable shed for all treatment equipment. 3. Remotely accessible CCTV system at WWTP site. 4. Community awareness and involvement in the local water scheme.	B	Unlikely	3	Moderate	Moderate
	Noise	Excessive noise generation	Noise complaints for nearby residents	C	Possible	2	Minor	Moderate	1. All treatment equipment is located inside the WWTP building. 2. 100 metre buffer to the nearest residential dwelling. 3. Noisy equipment items will be enclosed in purpose built noise enclosures or insulated plant room. 4. Equipment specification and design will ensure compliance with NSW Industrial Noise Policy of 5 dBA above background noise level at the nearest residential dwelling. 5. WWTP building located on Montefiore Road, which is impacted by background traffic noise. 6. Noise complaint management system through customer service processes.	A	Rare	2	Minor	Low
	Odour	Excessive odour generation	Odour complaints by nearby residents	C	Possible	2	Minor	Moderate	1. All treatment tanks are located inside the WWTP building. 2. 100 metre buffer to the nearest residential dwelling. 3. All treatment tanks are sealed with passive ventilation through Mcberns activated carbon filters located on the roof of the WWTP building. 4. WWTP building includes deodorising sprayers for use if required. 5. Odour complaint management system through customer service processes.	A	Rare	2	Minor	Low
	Aesthetics	Excessive visual impacts	Complaints from nearby residents	C	Possible	2	Minor	Moderate	1. All treatment equipment is located inside the WWTP building. 2. 100 metre buffer to the nearest residential dwelling. 3. Vegetation screening around the WWTP site.	A	Rare	2	Minor	Low
	Indoor air quality inside MBR shed	Contamination of indoor air with harmful sewer gases	OH&S impacts	B	Unlikely	4	Major	High	1. All treatment tanks are sealed and externally ventilated. 2. Continuous online monitoring of indoor air quality for oxygen, hydrogen sulphide and methane gas inside the WWTP building, with automated air conditioner/ventilation system operation and alarm systems.	B	Unlikely	3	Moderate	Moderate
Wet Weather Storage	Vector borne diseases	Vermin/mosquito invasion of wet weather storage	Potential spread of diseases	D	Likely	3	Moderate	High	1. Steep batters to minimise potential for mosquito growth. 2. Regular inspection for evidence vermin access, e.g. mosquito larvae, bird nests etc.	C	Possible	3	Moderate	High
	Unintended contact with recycled water	Human access into storage	Potential spread of disease. Potential drowning.	D	Likely	2	Minor	Moderate	1. Wet weather storage is fenced with appropriate warning signage. 2. Remote CCTV system used at WWTP site. 3. Safe egress point from storage.	A	Rare	3	Moderate	Low
	Blue green algae	Blue green algae outbreak in storage	Inhalation or contact with blue green algae toxins	D	Likely	3	Moderate	High	1. Low nutrient concentrations in MBR effluent (TP< 0.3 mg/L, TN < 10 mg/L) 2. Ongoing monitoring for early detection of algae outbreaks. Algae speciation will be undertaken if outbreak occurs. 3. Chemical treatment and/or aeration/mixing of pond will be undertaken if algae outbreak occurs. 4. If frequent outbreaks occur a permanent aeration/mixer will be installed into the pond.	B	Unlikely	2	Minor	Low
	Leakage to groundwater	Leakage to groundwater	Contamination of groundwater	C	Possible	3	Moderate	High	1. HDPE lined storage. 2. Continuous online monitoring of pond water level to detect leaks. 3. Groundwater monitoring	B	Unlikely	3	Moderate	Moderate
	Stormwater inputs	Stormwater runoff into storage during rain events	Increased potential for overflow	D	Likely	2	Minor	Moderate	1. Turkey nested dam to avoid inputs from stormwater runoff.	A	Rare	1	Insignificant	Low
	Uncontrolled overflow	Uncontrolled overflow from the wet weather storage during extended wet weather	Stormwater contamination	D	Likely	3	Moderate	High	1. MEDLI modelling indicates the 10 ML did not overflow based on 100-years of historic climate data. 2. Continuous online monitoring of storage water level with automatic scheduling of emergency irrigation events to irrigation areas will be undertaken as required to avoid uncontrolled overflow. 3. Removal of excess water by road tanker pump out if required.	A	Rare	2	Minor	Low
	Dam wall failure	Dam wall failure	Surface runoff and flooding	C	Possible	4	Major	Very high	1. Design of dam walls with scour protection in the unlikely event of uncontrolled overflow. 2. MEDLI modelling predicts the storage will not overflow based on historic rainfall data. 3. Continuous online monitoring of storage water level with automatic scheduling of emergency irrigation events as required to avoid uncontrolled overflow.	B	Unlikely	2	Minor	Low

Project: Catherine Hill Bay Water Utility
Client: Rose Group
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Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Stage 1 temporary, restricted access Irrigation System	Cross connection with potable or non-potable water networks	Cross connection between temporary irrigation network and other water networks	Contamination of other water supplies	C	Possible	5	Catastrophic	Very high	Temporary irrigation management plan will be developed for the scheme and will include the following cross connection controls: 1. Temporary irrigation system to operate under low pressure. 2. Unique pipe materials. Temporary Irrigation Network is to use Lilac striped HDPE pipe. 3. Temporary Irrigation Network pipes to be laid in their own separate trench with identification tape and above ground signage. 4. Only approved, trained and supervised plumbing contractors are permitted to work on reticulation systems.	B	Unlikely	3	Moderate	Moderate
	Unintended uses or human contact with recycled water	Unintended uses or human contact with recycled water	Potential health impacts	D	Likely	3	Moderate	High	Log reduction targets for the temporary irrigation system will be achieved with the following site based controls: 1. Secure, restrictive access temporary irrigation areas including warning signs, identification and labelling. 2. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height. 3. A minimum 30 m buffer distance between the edge of the temporary irrigation areas and the closest dwelling. 4. No above ground taps or fixtures in temporary irrigation areas. 5. Lockable irrigation valves pits and controllers etc. 6. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture. 7. Irrigation at night time only under normal conditions. 8. Non-irrigated, vegetated buffer strips down gradient of the temporary irrigation areas.	A	Rare	3	Moderate	Low
	Spray drift during irrigation	Spray drift onto sensitive receptor	Potential ingestion of recycled water	E	Almost certain	3	Moderate	High	1. Weather station override on irrigation controllers to prevent irrigation during high wind. 2. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height. 3. A minimum 30 m buffer distance between the edge of the temporary irrigation areas and the closest dwelling.	A	Rare	2	Minor	Low
	Irrigation during wet weather	Irrigation during wet weather resulting in surface runoff or deep percolation of effluent	Contamination of surface and/or groundwaters	E	Almost certain	3	Moderate	High	1. 10 ML wet weather storage provides approximately 100 days storage at average irrigation rates. 2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture. 3. Non-irrigated, vegetated buffer strips down gradient of the temporary irrigation areas.	A	Rare	2	Minor	Low
	Irrigation rates and scheduling	Inappropriate irrigation scheduling	Increased risk of surface and ground water contamination	C	Possible	2	Minor	Moderate	1. Irrigation scheduling will use programmable irrigation controllers to control irrigation frequency, time and duration. Irrigation rates will be calibrated to ensure no ponding. 2. Irrigation rates will be seasonally adjusted in the irrigation controller to match seasonal irrigation demand.	B	Unlikely	2	Minor	Low
	Recycled water	Surface runoff during irrigation	Potential contamination of surface water	C	Possible	3	Moderate	High	1. All temporary irrigation areas to use irrigation scheduling controls to control the time, frequency and duration of irrigation events. 2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall or elevated soil moisture. 3. Site based storm water run off and environmental controls. 4. Non-irrigated, vegetated buffer strips down gradient of the temporary irrigation areas.	B	Unlikely	2	Minor	Low
	Nitrogen	Excessive nitrogen load resulting in leaching of nitrate from irrigation areas	Contamination of groundwater	C	Possible	3	Moderate	High	1. Irrigation of "Class A" recycled water with total nitrogen concentration of 10 mg/L and low average irrigation rates of around 0.9 mm/day. 2. MEDLI modelling indicates all nitrogen applied in irrigation is taken up by vegetation. 3. MEDLI modelling indicates negligible nitrate concentration in deep drainage.	B	Unlikely	2	Minor	Low
	Phosphorus	Excessive phosphorous load resulting in leaching of phosphate from irrigation area	Contamination of groundwater	C	Possible	3	Moderate	High	1. Irrigation of "Class A" recycled water with total phosphorus concentration of 0.3 mg/L and low average irrigation rates of around 0.9 mm/day. 2. MEDLI modelling indicates the majority of phosphorus applied in irrigation is taken up by vegetation. 3. MEDLI modelling indicates negligible phosphate concentration in deep drainage. 4. MEDLI modelling predicted Phosphorus adsorption into soil at a low rate of 0.3 kg/ha/year. 5. Critical P-sorption life of the soil is conservatively estimated to be >166 years based on P-sorption capacity of holocene sand.	B	Unlikely	2	Minor	Low
	Effluent Salinity	Impacts on plant growth due to salinity	Reduction in plant growth and water and nutrient uptake rates	C	Possible	2	Minor	Moderate	1. MEDLI modelling indicated no impacts on plant growth due to salinity based on a conservative effluent TDS of 1500 mg/L. 2. Landscape design processes will ensure appropriate vegetation is selected in temporary irrigation areas that can tolerate the required salt concentrations. 3. The natural sandy top soil profile and relatively high rainfall at the site will assist with flushing of salt through the soil profile to minimise potential salinity impacts on vegetation.	B	Unlikely	3	Moderate	Moderate

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Sewerage Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Stage 1 temporary, restricted access Irrigation System continued…	Effluent SAR	Long term sodicity impacts on soil	Soil dispersion, reduction in permeability	C	Possible	2	Minor	Moderate	1. Topsoil profile is dominated by sand, hence the likelihood of sodicity impacts is low. 2. Detail geotechnical testing to be undertaken for each development stage will avoid areas with high clay content and Exchangeable Sodium Percentage (ESP). 3. Ongoing monitoring of soil cations will detect changes in soil ESP over time. 4. If required gypsum/lime application to irrigation areas will be undertaken. 5. If required the irrigation water SAR will be adjusted through addition of calcium/magnesium or reduction in sodium inputs to maintain effluent SAR<5.	B	Unlikely	2	Minor	Low
	Metals and trace contaminants	Trace contaminants in irrigation supply resulting in long term accumulation in irrigation area	Contamination of soil and groundwater	C	Possible	2	Minor	Moderate	1. Source catchment is >99% domestic wastewater hence the likelihood of trace contaminants is low. 2. Customer awareness campaigns, supply contracts, trade waste agreements and recycled water use agreements will further reduce the likelihood of events occurring. 3. Detailed monitoring of effluent quality for trace contaminant will be undertaken annually using a NATA accredited laboratory. 4. Soil monitoring in temporary irrigation area will identify any build up or increase in contaminants. 5. If contaminants are detected then an investigation into the likely source will be undertaken and trade waste/source controls implemented. 6. If required additional treatment processes can be installed, e.g. BAC, ion exchange.	B	Unlikely	2	Minor	Low
	Recycled water	Pipe breakage	Potential contamination of surface or groundwater	C	Possible	2	Minor	Moderate	1. Flow and pressure monitoring in the temporary irrigation supply system. 2. Visual inspection to identify boggy areas or erosion etc.	B	Unlikely	2	Minor	Low
	Odour	Odour released during irrigation	Odour impacts on nearby residents	B	Unlikely	2	Minor	Low	1. Irrigation of high quality "Class A" recycled water with low BOD 2. Algae control in the wet weather storage 3. Irrigation at night time only. 4. A minimum 30 m buffer distance between the edge of the temporary irrigation areas and the closest dwelling.	A	Rare	2	Minor	Low
	Stormwater runon	Stormwater running onto irrigation areas from upgradient	Water logging of irrigation area	D	Likely	2	Minor	Moderate	1. Stormwater diversion drains to divert all upgradient stormwater runoff around temporary effluent irrigation areas. 2. Appropriate buffers to waterways, ponds, stormwater drains and SEPP14 wetlands	A	Rare	2	Minor	Low
	Percolation to groundwater	Excessive percolation of effluent to groundwater	Contamination of groundwater	C	Possible	3	Moderate	High	1. Low long term average irrigation rate of approximately 0.9 mm/day, hence low risk of groundwater contamination. 2. Minimal presence of groundwater within 3 metres of ground surface in geotechnical investigation. 3. Irrigation of high quality "Class A" recycled water with low nutrients. 4. MEDLI modelling indicates negligible concentrations of nutrients in deep drainage for conservative sandy soil profile. 5. A minimum of 600mm sandy loam topsoil cover will be provided on irrigation areas if there is potential for seasonal high water table.	B	Unlikely	2	Minor	Low

SEWERAGE

QUALITATIVE ENVIRONMENTAL AND PUBLIC HEALTH RISK ASSESSMENT CRITERIA

From tables 2.5, 2.6 and 2.7 on Page 39 of the Australian Guidelines for Water Recycling Managing Health & Environmental Risks Phase 1 (2006)

Qualitative measures of likelihood

Level	Descriptor	Example Description from AGWR
A	Rare	May occur only in exceptional circumstances. May occur once in 100 years
B	Unlikely	Could occur within 20 years or in unusual circumstances
C	Possible	Might occur or should be expected to occur within a 5- to 10-year period
D	Likely	Will probably occur within a 1-to 5-year period
E	Almost certain	Is expected to occur with a probability of multiple occurrences within a year

Qualitative measures of consequence or impact

Level	Descriptor	Example Description from AGWR
1	Insignificant	Insignificant impact or not detectable
2	Minor	Health — Minor impact for small population Environment — Potentially harmful to local ecosystem with local impacts contained to site
3	Moderate	Health — Minor impact for large population Environment — Potentially harmful to regional ecosystem with local impacts primarily contained to on-site
4	Major	Health — Major impact for small population Environment — Potentially lethal to local ecosystem; predominantly local, but potential for off-site impacts
5	Catastrophic	Health — Major impact for large population Environment — Potentially lethal to regional ecosystem or threatened species; widespread on-site and off-site impacts

Qualitative risk analysis matrix: Level of risk

		Consequences				
Likelihood		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Catastrophic
A	Rare	Low	Low	Low	High	High
B	Unlikely	Low	Low	Moderate	High	Very high
C	Possible	Low	Moderate	High	Very high	Very high
D	Likely	Low	Moderate	High	Very high	Very high
E	Almost certain	Low	Moderate	High	Very high	Very high

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Non-Potable Water Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
MBR treated source water	Trace contaminants in MBR effluent feed water	Trace contaminants following MBR treatment	Potential impacts on recycled water uses	C	Possible	2	Minor	Moderate	1. Majority residential catchment hence there is a low likelihood of significant trace contaminants being present in recycled water. Refer to sewerage wastewater generation risk assessment table. 2. Customer supply contracts, recycled water use agreements and ongoing awareness and education through information provided with rates notices and via the CHB Water Utility Website. 3. Detailed annual recycled water quality monitoring for trace contaminants. 4. If contaminants are detected a source control investigation will be undertaken through analysis of trade waste and raw wastewater data. 5. If required additional treatment will be provided in the AWTP using reverse osmosis, activated carbon or ion exchange.	B	Unlikely	2	Minor	Low
	Poor water quality from MBR	MBR blower failure, shock loads, membrane failure etc	Poor quality feed water to AWTP	D	Likely	3	Moderate	High	1. Continuous online monitoring and alarms on critical MBR process parameters MLSS, DO, Permeate Turbidity, UV Intensity, transmembrane pressure. 2. Shut down AWTP if MBR produces poor quality effluent.	B	Unlikely	2	Minor	Low
Wet weather storage dam	Contamination of wet weather storage	Contaminants in wet weather storage going to AWTP during high demand	Poor quality feed water to AWTP	D	Likely	3	Moderate	High	During certain high demand situations the AWTP will take water from the wet weather storage. 1. Regular inspection for evidence of vermin access, e.g. mosquito larvae, bird nests etc or early detection of algae outbreaks. 2. UF prefilter on supply line from wet weather storage into AWTP. 3. Emergency response plan for algae outbreak which will include chemical treatment and/or aeration/mixing of pond. 4. If contamination detected, shut off supply from wet weather storage to AWTP. Note: Potable water top up available if recycled water storage tank levels get too low.	B	Unlikely	3	Moderate	Moderate
Advanced Water Treatment Plant	Pathogen break through from UF membranes	Rupture of membrane fibres	Non-compliant recycled water	D	Likely	4	Major	Very high	1. Use USEPA accredited ultrafiltration membranes. 2. Membrane integrity testing by air pressure decay as per manufacturer requirements. 3. Continuous online monitoring of UF permeate turbidity with alarms and automatic shutdown. 4. Continuous online monitoring and alarms on transmembrane pressure. 5. High quality MBR permeate as feed water. 6. Membrane chemical cleaning in line with manufacturer requirements to maximise membrane life. 7. Design flux, TMP and other process parameters as per manufacturer recommendations to maximise membrane life.	B	Unlikely	4	Major	High
	Inadequate pathogen inactivation due to low UV dose	Inadequate UV dose caused by lamp failure, reactor fouling, high flow, poor feed water quality	Non-compliant recycled water	D	Likely	4	Major	Very high	1. Use USEPA accredited UV disinfection system. 2. Continuous online monitoring of UV intensity and UV lamp faults with alarms and automatic shutdown. 3. Continuous online monitoring of flow through the UV reactor with alarms and automatic shutdown. 4. UV unit to include self cleaning functions. 5. Design and operation of UV unit as per manufacturer recommendations. 6. Replace UV lamps every 12 months.	B	Unlikely	4	Major	High
	Inadequate pathogen die off due to low CT in chlorine contact tank	Inadequate CT due to low chlorine concentration, high flow, low level in CCT, high COD, high temperature, incorrect pH	Non-compliant recycled water	D	Likely	4	Major	Very high	1. Chlorine contact tank designed to USEPA standards. 2. Continuous online monitoring of free chlorine residual and pH at outlet of the CCT with alarms and automatic shutdown. 3. Continuous online monitoring of flow and water level in the CCT with alarms and automatic shutdown.	B	Unlikely	4	Major	High
	High salt concentration	High salt concentration in feed water	Non-compliant recycled water	C	Possible	2	Minor	Moderate	1. Continuous online monitoring and control of EC/TDS in blended product water. The ratio of UF permeate diverted to the RO automatically increases as feed water EC/TDS increases. 2. Continuous online monitoring of feed water MBR permeate EC/TDS with alarms. 3. If there is persistent high TDS in MBR permeate feed water then a source control investigation will be undertaken through review of catchment raw wastewater quality and trade waste data.	B	Unlikely	2	Minor	Low
	Process chemicals	Spillage of chemicals used in the AWTP process	Potential OH&S and public health impacts. Potential environmental impacts in receiving environment	D	Likely	3		High	1. Appropriate bunding and separation in chemical storage and delivery areas. 2. Standard operating procedures to be developed for use of all chemicals. 3. MSDS of all chemicals maintained onsite. 4. Emergency Response Plan for chemical spillages.	B	Unlikely	2	Minor	Low

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Non-Potable Water Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Advanced Water Treatment Plant continued…	Metals, organic chemicals and other potential trace contaminants.	Presence of excessive amounts of metals, organic chemicals and other trace contaminants in treated water	Potential OH&S, public health and environmental impacts.	C	Possible	2	Minor	Moderate	1. Prevention strategy based around Trade Waste Agreements, Residential Supply Agreements, ongoing awareness and education at each billing cycle. 2. Predominately residential catchment, hence the likelihood of significant levels of contaminants is low. 3. Detailed annual monitoring of treated recycled water quality for trace contaminants at NATA laboratory. 4. If contaminants are detected a source control investigation will be undertaken through review of catchment raw wastewater and trade waste data. 5. If required additional treatment will be provided in the AWTP through activated additional RO treatment, carbon adsorption and/or ion exchange processes.	C	Possible	2	Minor	Moderate
	UF membrane chemical cleaning wastewater or UV acid clean wastewater	Management of chemical contaminated wastewater	Potential impacts on the MBR treatment process if inappropriately managed	E	Almost certain	4	Major	Very high	1. Temporary storage or all chemical contaminated wastewater from UF membrane and/or UV disinfection unit cleaning. 2. Neutralisation of all chemical contaminated wastewater before controlled trickle feed back to the MBR inlet balance tank. 3. If process impacts are observed on the MBR then offsite disposal of chemical wastewater will be undertaken by licensed waste contractor.	C	Possible	3	Moderate	High
Non-Potable Water Storage Tank	Vector borne diseases	Vermin or mosquito access to recycled water storage tank	Non-compliant recycled water	E	Almost certain	3	Moderate	High	1. Storage tank constructed to potable water standards with mosquito screens on all tank openings and overflows. 2. Regular monitoring and inspection for evidence of vermin or mosquito access. 3. If observed contaminated water will be wasted or if appropriate chemical treatment of the storage will be undertaken by addition of chlorine tablets, hydrogen peroxide or similar.	B	Unlikely	3	Moderate	Moderate
	Overflows	Tank overflow due to failure of level controls	Overflow to the environment	C	Possible	2	Minor	Moderate	1. Storage tank overflows directly to the wet weather storage or inlet balance tank.	B	Unlikely	1	Insignificant	Low
	Decay of free chlorine residual during storage	Loss of adequate free chlorine residual due to equipment failure, high temperature, long detention time or high COD	Non-compliant recycled water	D	Likely	3	Moderate	High	1. Recirculation system with free chlorine monitoring and sodium hypochlorite dosing and alarms on the recycled water storage tank. 2. If required chlorine tablets can be manually applied to the storage.	B	Unlikely	3	Moderate	Moderate
	Blue green algae	Blue green algae growth in non-potable water storage tank	Non-compliant recycled water	B	Unlikely	2	Minor	Low	1. Storage tank covered to prevent sunlight access and algae growth. 2. Regular inspection and monitoring of non-potable water storage tank.	A	Rare	2	Minor	Low
	Unintended contact with recycled water in storage	Human access to storage	Potential public health impacts	D	Likely	2	Minor	Moderate	1. Storage located inside the fenced and secure WWTP site. 2. Warning signage around the perimeter of the site and on each storage tank. 3. CCTV recording at the WWTP site. 4. Lockable manhole access points.	B	Unlikely	2	Minor	Low
	Tank failure	Tank failure	Flooding, contamination of surface water	C	Possible	2	Minor	Moderate	1. Tank constructed from steel panel tanks with civil/structural engineer certification for tank and footings. 2. Quality assurance in construction. 3. Bollard fence around tanks if there is a risk of vehicular or machinery damage.	B	Unlikely	2	Minor	Low
	Tank materials	Dissolution of trace metals into recycled water	Non-compliant recycled water	C	Possible	2	Minor	Moderate	1. Ensure all tank materials are compatible for use with potable water. 2. Metallic tanks to be lined with a food grade polymer liner to avoid dissolution of metals.	A	Rare	2	Minor	Low
Non-Potable Water Supply System	Cross connections	Cross connection with the CHB Water Utility potable water network	Contamination of potable water supply for up to 470 ET	D	Likely	4	Major	Very high	1. Only approved contractors or staff that have undergone CHB Water Utility induction can perform work on water utility infrastructure. 2. Potable and non-potable reticulation networks to be designed, constructed and tested in accordance with WSAA standards. 3. Water pressure in non-potable network to be maintained a minimum of 50 kPa below pressure in the potable network. 4. Quality assurance, inspection and pressure testing during construction. 5. Ongoing monitoring of water pressure and electrical conductivity in both networks during operation to assist with detection of cross connections. 6. Unique pipe materials in each water network. Potable network will use blue PVC and the non-potable will use lilac striped HDPE pipe. 7. Minimum pipe separation distances to be maintained in common trenches. Potable water pipework to be located above non-potable water pipework. 8. Identification tape and signage on all trenches. 9. Potable water is used in the non-potable water network until Stage 2 when the AWTP is constructed. Compliance audits will be undertaken prior to introducing recycled water to the network. 10. Conservative AWTP log reduction targets based on Table 3.7 in AGWR (2006).	B	Unlikely	4	Major	High

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Non-Potable Water Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Non-Potable Water Supply System continued…	Cross connections continued…	Cross connection with potable water line on private property	Potential use of non-potable water for potable uses inside the affected property (up to say 6 EP)	D	Likely	3	Moderate	High	1. All plumbing work on private property to be undertaken by Licensed plumber in compliance with AS3500 and the NSW Plumbing Code. 2. Plumbing inspection during house construction. 3. Dual check valve to be located at the potable water connection point for each property. 4. Residential Customer Supply Contracts outlining responsibilities under the scheme. 5. Ongoing customer awareness and education with information provided at each billing cycle and on the CHB Water Utility website. 6. Conservative AWTP log reduction target based on Table 3.7 in AGWR (2006).	C	Possible	3	Moderate	High
	Unintended or inappropriate uses of recycled water	Unintended uses of recycled water like swimming pool top up, drinking from outdoor taps, ingestion from excessive spray drift etc	Potential use of non-potable water for potable uses	E	Almost certain	3	Moderate	High	1. Residential customer supply contracts and recycled water use agreements. 2. Ongoing awareness and education with information provided at each billing cycle and on the CHB Water Utility website. 3. Appropriate identification and signage to be installed by plumbing contractor and verified during construction and plumbing inspection. 4. Appropriate pricing levels so non-potable water is not significantly lower in cost than potable water. 5. Flow monitoring to detect larger than normal flows 6. Conservative AWTP log reduction targets based on Table 3.7 in AGWR (2006).	B	Unlikely	3	Moderate	Moderate
	Loss of chlorine residual	Loss of chlorine residual due to long detention time, high temperature, high COD	Non-compliant recycled water	D	Likely	3	Moderate	High	1. Chlorine dosing regime will be calibrated for each season to ensure the minimum required free chlorine residual is maintained at the furthest point in the reticulation system. 2. Weekly monitoring of free chlorine throughout the reticulation system and in select private dwellings.	B	Unlikely	3	Moderate	Moderate
	Pipe breakage	Pipe breakage due to excavation or machinery that leads to surface runoff of recycled water	Potential contamination of surface waters	C	Possible	2	Minor	Moderate	1. PN16 HDPE pipe with welded joints and fittings. 2. Quality assurance and pressure testing during construction. 3. Above ground signage and identification tape in all trenches. 4. Register all work as executed plans with dial before you dig service and on the CHB Water Utility GIS. 5. Pressure and flow monitoring in the network to assist with detecting pipe breaks. 6. Visual inspection for wet, green, boggy areas or signs of soil erosion. 7. Customer fault reporting and response procedures in customer service. 8. Emergency Response Plan for main breaks. 9. All stormwater at the site is treated using bioretention basins in the stormwater treatment train.	B	Unlikely	2	Minor	Low
	Minor pipe leaks	Minor leaks from pipe joints and fittings	Potential contamination of groundwater	D	Likely	2	Minor	Moderate	1. PN16 HDPE pipe with welded joints and fittings. 2. Quality assurance and pressure testing during construction. 3. Visual inspection for green, wet and boggy areas. 4. Monitor flows throughout the network to identify water losses. 5. Use leak detection systems if required.	B	Unlikely	2	Minor	Low
Indoor uses on private lots for toilet flushing and washing machine cold water	Pathogens	Unintended uses	Potential public health impacts	E	Almost certain	3	Moderate	High	1. Class A+ recycled water with conservative log reduction targets. 2. Laundry washing machine cold water supply to be hard plumbed. 3. Residential customer supply contracts and recycled water use agreements. 4. Ongoing awareness and education with information provided at each billing cycle and on the CHB Water Utility website. 5. Appropriate identification and signage to be installed by plumbing contractor and verified during construction and plumbing inspection. 6. Appropriate pricing levels so non-potable water is not significantly lower in cost than potable water. 7. Flow monitoring to detect larger than normal flows.	B	Unlikely	3	Moderate	Moderate
Uncontrolled outdoor non-potable uses on private lots, i.e. irrigation and washdown	Pathogens	Human contact and ingestion of spray drift or surface runoff	Potential public health impacts	C	Possible	2	Minor	Moderate	1. Conservative AWTP log reduction target based on Table 3.7 in AGWR (2006). 2. Customer supply contracts, recycled water use agreements and ongoing customer education and awareness.	B	Unlikely	1	Insignificant	Low
	Nutrients	Excessive nutrient loads in irrigation	Potential contamination of soil and groundwater	C	Possible	2	Minor	Moderate	1. AWTP treated recycled water contains low nutrients of TN<7 mg/L & TP<0.25 mg/L and under normal irrigation rates and recycled water availability should not result in excessive nutrient impacts. 2. Detailed soil monitoring will be undertaken annually on private land on the 3 biggest users of non-potable water in the scheme based on customer non-potable water meter readings. 3. If required customers will be advised to reduce irrigation rates or other management measure as per the recycled water supply agreement.	B	Unlikely	2	Minor	Low

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Non-Potable Water Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Uncontrolled outdoor non-potable uses on private lots, i.e. irrigation and washdown continued…	Salinity	Irrigation with high salt recycled water	Reduction in plant growth and poor appearance	C	Possible	2	Minor	Moderate	1. The AWTP includes a side stream reverse osmosis process to maintain salt concentrations at around 500 mg/L TDS as per potable water standards. 2. Irrigation at 500 mg/L TDS is unlikely to result in vegetation impacts, except for some specific species that may have very low tolerance to salt. 3. Customer supply contracts and recycled water use agreements will advise customers not to irrigate specific plants with very low tolerance to salt.	A	Rare	2	Minor	Low
		Washdown using high salt recycled water	Corrosion of customer private assets	C	Possible	2	Minor	Moderate	1. The AWTP includes a side stream reverse osmosis process to maintain salt concentrations at around 500 mg/L TDS as per potable water standards.	A	Rare	2	Minor	Low
	SAR	Irrigation with high SAR recycled water	Potential impacts on soil structure	C	Possible	2	Minor	Moderate	1. Sandy soil profile hence the sodicity issues should not be significant. 2. Annual soil monitoring of Exchangeable Sodium Percent will be undertaken on the 3 biggest recycled water users based on customer non-potable water metre records. 3. If required customers will be required to reduce irrigation rates or undertake a gypsum application based on the recycled water use agreement. 4. If required the SAR of the recycled water supply will be reduced to <5 through by addition of calcium and magnesium and/or by reducing sodium inputs.	B	Unlikely	2	Minor	Low
	pH	Irrigation with low or high pH recycled water	Long term pH impacts on soil	D	Likely	2	Minor	Moderate	1. Maintain pH between 6.5 and 8.5 as per potable water standards. 2. Continuous online monitoring, control and alarms on pH correction system.	B	Unlikely	2	Minor	Low
		Washdown with high or low pH recycled water	Potential corrosion of private assets	D	Likely	2	Minor	Moderate		B	Unlikely	2	Minor	Low
	Chlorine	Irrigation using recycled water with high chlorine concentration	Potential impacts on vegetation and soil microorganisms	D	Likely	2	Minor	Moderate	1. Maximum free residual chlorine concentration of 2 mg/L. 2. Develop site specific chlorine dosing regimes across all seasons.	B	Unlikely	2	Minor	Low
	Trace metals, organic chemicals and other potential trace contaminants.	Trace contaminants present during irrigation	Potential impacts on soil and vegetation	C	Possible	3	Moderate	High	1. Majority residential catchment hence there is a low likelihood of significant trace contaminants being present in recycled water. 2. Customer supply contracts, recycled water use agreements and ongoing awareness and education through information provided with rates notices and via the CHB Water Utility Website. 3. Detailed annual recycled water quality monitoring for trace contaminants. 4. If contaminants are detected a source control investigation will be undertaken through analysis of trade waste and raw wastewater data. 5. If required additional treatment in the AWTP will be provided using reverse osmosis, activated carbon or ion exchange.	B	Unlikely	3	Moderate	Moderate
Stage 2 ultimate Public Open Space Irrigation System	Cross connection with potable network	Cross connection between open space irrigation network and potable water networks	Contamination of potable water supplies	D	Likely	5	Catastrophic	Very high	Cross connection control plan will be developed for the scheme and will include the following requirements for the Open Space Irrigation Network: 1. Water pressure in Open Space Irrigation Network to be maintained a minimum of 50 kPa pressure below the pressure in the potable network. 2. Unique pipe materials. Open Space Irrigation Network is to use Lilac PVC pipe. 3. Only approved, trained and supervised plumbing contractors are permitted to work on reticulation systems. 4. Monitoring of pressure and salinity differential between potable and non-potable water networks	B	Unlikely	3	Moderate	Moderate
	Unintended uses or human contact with recycled water	Unintended uses or human contact with recycled water	Potential health impacts	D	Likely	3	Moderate	High	1. Irrigation of high quality "Class A+" recycled water only 2. No above ground taps or fixtures in public open space irrigation areas. 3. Appropriate warning signage in all open space irrigation areas. 4. Lockable irrigation valves pits and controllers etc. 5. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture. 6. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height.	A	Rare	3	Moderate	Low
	Spray drift during irrigation	Spray drift onto sensitive receptor	Potential ingestion of recycled water	E	Almost certain	3	Moderate	High	1. Irrigation of high quality "Class A+" recycled water only 2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture. 3. Surface sprinklers with spray drift control including sprinkler nozzles that operate under low pressure with a large droplet size and low throw height.	A	Rare	2	Minor	Low
	Irrigation during wet weather	Irrigation during wet weather resulting in surface runoff or deep percolation of effluent	Contamination of surface and/or groundwaters	E	Almost certain	3	Moderate	High	1. A 10 ML wet weather storage dam and a 0.85 ML recycled water storage tank provides sufficient storage during wet weather. 2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture.	A	Rare	2	Minor	Low

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Non-Potable Water Preliminary Risk Assessment for IPART Application
Author: BI
Date (Revision): 10/07/2013 (Revision B)
Risk Criteria: As per Tables 2.5, 2.6 & 2.7: Australian Guidelines for Water Recycling: Managing Health and Environmental Risks-phase 1 (2006)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Stage 2 ultimate Public Open Space Irrigation System continued…	Irrigation rates and scheduling	Inappropriate irrigation scheduling	Increased risk of surface and ground water contamination	C	Possible	2	Minor	Moderate	1. Irrigation scheduling will use programmable irrigation controllers to control irrigation frequency, time and duration. Irrigation rates will be calibrated to ensure no ponding. 2. Irrigation rates will be seasonally adjusted in the irrigation controller to match seasonal irrigation demand.	B	Unlikely	2	Minor	Low
	Recycled water	Surface runoff during irrigation	Potential contamination of surface water	C	Possible	3	Moderate	High	1. All irrigation areas to use irrigation scheduling controls to control the time, frequency and duration of irrigation events. 2. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall or elevated soil moisture. 3. Site based storm water run off and environmental controls.	B	Unlikely	2	Minor	Low
	Nitrogen	Excessive nitrogen load resulting in leaching of nitrate from irrigation areas	Contamination of groundwater	C	Possible	3	Moderate	High	1. Irrigation of "Class A+" recycled water with total nitrogen concentration of 7 mg/L and low average irrigation rates of around 0.9 mm/day. 2. MEDLI modelling indicates all nitrogen applied in irrigation is taken up by vegetation. 3. MEDLI modelling indicates negligible nitrate concentration in deep drainage.	B	Unlikely	2	Minor	Low
	Phosphorus	Excessive phosphorous load resulting in leaching of phosphate from irrigation area	Contamination of groundwater	C	Possible	3	Moderate	High	1. Irrigation of "Class A+" recycled water with total phosphorus concentration of 0.25 mg/L and low average irrigation rates of around 0.9 mm/day. 2. MEDLI modelling indicates the majority of phosphorus applied in irrigation is taken up by vegetation. 3. MEDLI modelling indicates negligible phosphate concentration in deep drainage. 4. MEDLI modelling predicted Phosphorus adsorption into soil at a low rate of 0.3 kg/ha/year. 5. Critical P-sorption life of the soil is conservatively estimated to be >166 years based on P-sorption capacity of holocene sand.	B	Unlikely	2	Minor	Low
	Effluent Salinity	Impacts on plant growth due to salinity	Reduction in plant growth and water and nutrient uptake rates	C	Possible	2	Minor	Moderate	1. MEDLI modelling indicated no impacts on plant growth due to salinity based on a conservative effluent TDS of 1500 mg/L. 2. Landscape design processes will ensure appropriate vegetation is selected in temporary irrigation areas that can tolerate the required salt concentrations. 3. The natural sandy top soil profile and relatively high rainfall at the site will assist with flushing of salt through the soil profile to minimise potential salinity impacts on vegetation.	B	Unlikely	3	Moderate	Moderate
	Effluent SAR	Long term sodicity impacts on soil	Soil dispersion, reduction in permeability	C	Possible	2	Minor	Moderate	1. Topsoil profile is dominated by sand, hence the likelihood of sodicity impacts is low. 2. Detail geotechnical testing to be undertaken for each development stage will avoid areas with high clay content and Exchangeable Sodium Percentage (ESP). 3. Ongoing monitoring of soil cations will detect changes in soil ESP over time. 4. If required gypsum/lime application to irrigation areas will be undertaken. 5. If required the irrigation water SAR will be adjusted through addition of calcium/magnesium or reduction in sodium inputs to maintain effluent SAR<5.	B	Unlikely	2	Minor	Low
	Metals and trace contaminants	Trace contaminants is irrigation supply resulting in long term accumulation in irrigation area	Contamination of soil and groundwater	C	Possible	2	Minor	Moderate	1. Source catchment is >99% domestic wastewater hence the likelihood of trace contaminants is low. 2. Customer awareness campaigns, supply contracts, trade waste agreements and recycled water use agreements will further reduce the likelihood of events occurring. 3. Detailed monitoring of effluent quality for trace contaminant will be undertaken annually using a NATA accredited laboratory. 4. Soil monitoring in open space irrigation area will identify any build up or increase in contaminants. 5. If contaminants are detected then an investigation into the likely source will be undertaken and trade waste/source controls implemented. 6. If required additional treatment processes can be installed, e.g. BAC, ion exchange.	B	Unlikely	2	Minor	Low
	Recycled water	Pipe breakage	Potential contamination of surface or groundwater	C	Possible	2	Minor	Moderate	1. Flow and pressure monitoring in the irrigation supply system. 2. Visual inspection to identify boggy areas or erosion etc. 3. Fault and main break reporting system through customer service processes.	B	Unlikely	2	Minor	Low
	Odour	Odour released during irrigation	Odour impacts on nearby residents	B	Unlikely	2	Minor	Low	1. Irrigation of high quality "Class A+" recycled water with low BOD	A	Rare	2	Minor	Low
	Stormwater runon	Stormwater running onto irrigation areas from upgradient	Water logging of irrigation area	D	Likely	2	Minor	Moderate	1. Stormwater diversion drains to divert all upgradient stormwater runoff around effluent irrigation areas. 2. Appropriate buffers to waterways, ponds, stormwater drains and SEPP14 wetlands	A	Rare	2	Minor	Low
	Percolation to groundwater	Excessive percolation of effluent to groundwater	Contamination of groundwater	C	Possible	3	Moderate	High	1. Low long term average irrigation rate of approximately 0.9 mm/day, hence low risk of groundwater contamination. 2. Minimal presence of groundwater within 3 metres of ground surface is geotechnical investigation. 3. High quality effluent with low nutrients. 4. MEDLI modelling indicates negligible concentrations of nutrients in deep drainage for conservative sandy soil profile. 5. A minimum of 600mm sandy loam topsoil cover will be provided on irrigation areas if there is potential for seasonal high water table.	B	Unlikely	2	Minor	Low

NON-POTABLE WATER

QUALITATIVE ENVIRONMENTAL AND PUBLIC HEALTH RISK ASSESSMENT CRITERIA

From tables 2.5, 2.6 and 2.7 on Page 39 of the Australian Guidelines for Water Recycling Managing Health & Environmental Risks Phase 1 (2006)

Qualitative measures of likelihood

Level	Descriptor	Example Description from AGWR
A	Rare	May occur only in exceptional circumstances. May occur once in 100 years
B	Unlikely	Could occur within 20 years or in unusual circumstances
C	Possible	Might occur or should be expected to occur within a 5- to 10-year period
D	Likely	Will probably occur within a 1-to 5-year period
E	Almost certain	Is expected to occur with a probability of multiple occurrences within a year

Qualitative measures of consequence or impact

Level	Descriptor	Example Description from AGWR
1	Insignificant	Insignificant impact or not detectable
2	Minor	Health — Minor impact for small population Environment — Potentially harmful to local ecosystem with local impacts contained to site
3	Moderate	Health — Minor impact for large population Environment — Potentially harmful to regional ecosystem with local impacts primarily contained to on-site
4	Major	Health — Major impact for small population Environment — Potentially lethal to local ecosystem; predominantly local, but potential for off-site impacts
5	Catastrophic	Health — Major impact for large population Environment — Potentially lethal to regional ecosystem or threatened species; widespread on-site and off-site impacts

Qualitative risk analysis matrix: Level of risk

		Consequences				
Likelihood		1	2	3	4	5
		Insignificant	Minor	Moderate	Major	Catastrophic
A	Rare	Low	Low	Low	High	High
B	Unlikely	Low	Low	Moderate	High	Very high
C	Possible	Low	Moderate	High	Very high	Very high
D	Likely	Low	Moderate	High	Very high	Very high
E	Almost certain	Low	Moderate	High	Very high	Very high