SOLO Water

Water Utility Solutions

Catherine Hill Bay Water Utility

Integrated Water Management Plan

Montefiore Street, Catherine Hill Bay

October 2014

Water Utility *Solutions*

Contents

Table Index

Figure Index

Appendices

1 Introduction

Solo Water has entered into an agreement with the Rose Property Group (Coastal Hamlets Pty Ltd) 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 (WIC) Act (NSW Government, 2006) and is administered by the NSW Independent Pricing and Regulatory Tribunal (IPART, 2014).

All water, wastewater and recycled water infrastructure under the scheme will be owned by the newly created entity Catherine Hill Bay Water Utility Pty Ltd (CHBWU). CHBWU will hold the IPART Network Operator Licence and subcontract all design, construction, operation and maintenance activities to Solo Water. Solo Water will be the IPART Retail Licence holder for all Solo Water schemes.

This report outlines the proposed integrated wastewater management strategy and works to be undertaken for the scheme and is being submitted for Part 5 approval under the Environmental Planning and Assessment (EP&A) Act (NSW Government, 1979) by IPART and approval of the Environmental Protection Licence (EPL) from NSW Environmental Protection Authority (EPA). The proposed WWTP is zoned SP2 under the Infrastructure State Environmental Planning Policy (SEPP) (NSW Government, 2007), hence a Part 4 development approval is not required from Lake Macquarie City Council.

CHBWU has previously submitted an IPART Network Operator application and this report represents the final information required by IPART in order to issue the Network Operator licence.

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.

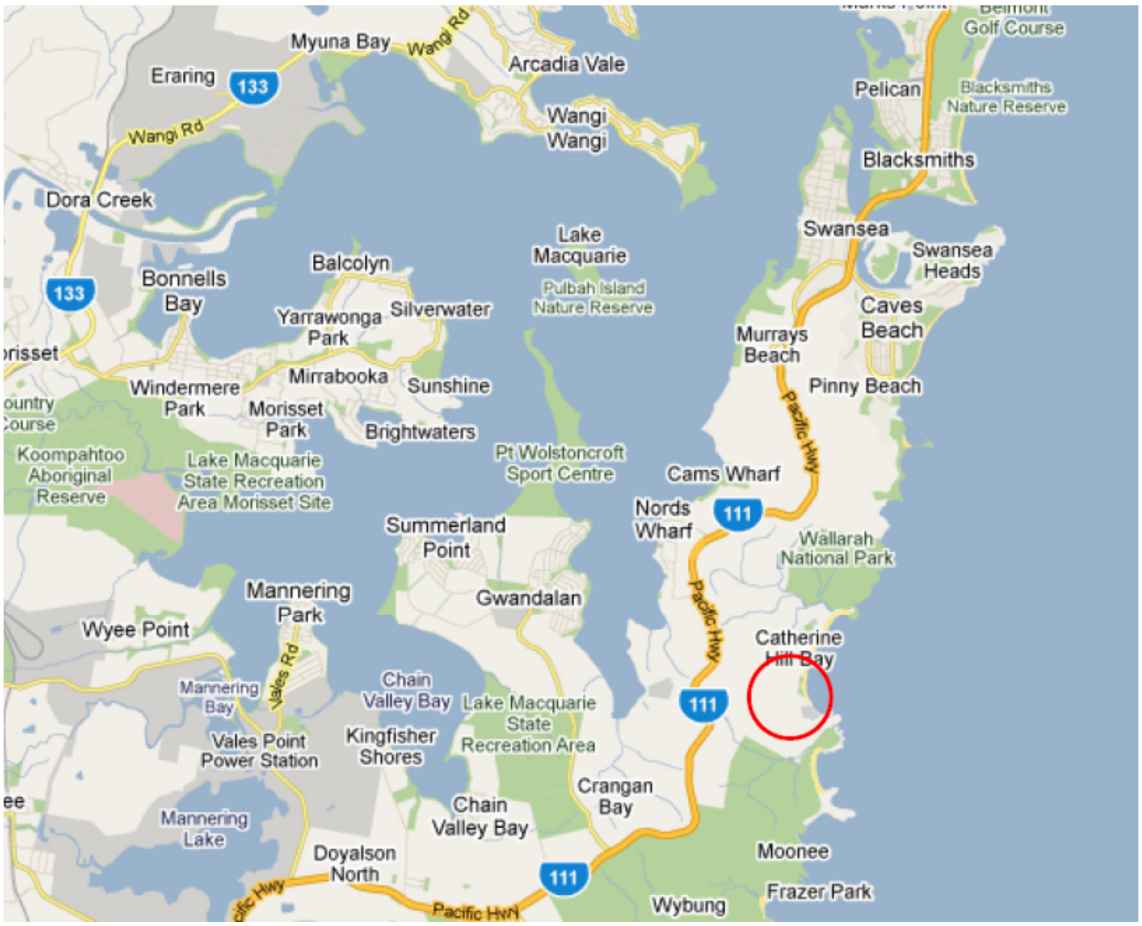

Figure 2.1 Site Location

2.2 Approved Residential 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 under Part 3A of the Environmental Planning and Assessment (EP&A) Act for construction of 540 residential lots, roads and associated parks and open space areas.

The proposed WWTP is located on land zoned SP2 under the infrastructure SEPP as shown in Appendix A, hence development consent is not required and a Part 5 assessment is being undertaken by EPA/IPART.

2.3 Environmental Assessment

Environmental Impact Assessment of the residential subdivision was undertaken as part of the original development approval received in 2008. Under the original approval water and sewerage services were to be provided by Hunter Water. Hunter Water were to be responsible for a Part 5 assessment under the EP&A Act (NSW Government, 1979).

Since the original development approval was received, it has become apparent that servicing the remote site under a standard business as usual model with Hunter Water is not feasible for a number of reasons.

The revised water and wastewater servicing strategy now involves the use of a private water utility licenced under the WIC Act to provide drinking water, wastewater and recycled water services to customers based on a decentralised treatment and water recycling model. Part 5 approval of the scheme is now being sort by CHBWU from IPART.

To facilitate Part 5 approval of the scheme by IPART, the original subdivision approval has been amended by the developer and the Department of Planning to permit construction of the onsite wastewater treatment plant. The land at the proposed WWTP site has been rezoned to SP2 zoning under the Infrastructure SEPP to facilitate Part 5 approval of the scheme by IPART.

This report is being supplied to IPART, along with a Review of Environmental Factors, for Part 5 approval of the scheme. Once this Part 5 approval is received, the IPART Network Operator Licence would be issued to CHBWU.

2.4 Previous Water & Wastewater Investigations

A number of previous water and wastewater investigations and reports have already been prepared for the scheme and issued to IPART with the IPART network operator application. This report should be read in conjunction with the information previously issued to IPART.

The original IPART application and onsite wastewater management proposal proposed an effluent management strategy that relied on water recycling and irrigation of public open space, parks and vegetated buffers to manage all wastewater produced by the scheme.

The irrigation areas in the original proposal were to be located on land that would ultimately be handed over to Lake Macquarie City Council (LMCC). As the ultimate landowner LMCC have refused to allow irrigation of these areas using recycled water and an alternative strategy has now been developed and is presented in this report and involves irrigation of private land owned by the developer.

3 Potable Water Supply

An overview of the proposed works is provided in the Process Flow Diagrams in Appendix B, water treatment equipment supplier information in Appendix C and the WWTP Site Civil Concept Plans in Appendix D.

Potable water for the scheme is being sourced from Wyong Shire Council (WSC) under a volumetric supply agreement. WSC have agreed to supply a peak instantaneous flow of 23.3 L/s from the existing trunk water main located in Kanangra Drive approximately 6 km from the site. This flow is adequate for supply of peak day water demands, backup of the recycled water system and provision of fire flows to the scheme. Under normal operating conditions approximately 5 L/s is required to service the scheme, hence there is sufficient potable water supply capacity to service the scheme.

Potable water will be conveyed to the site via a new 200 mm diameter bulk water main that will be constructed in an existing fire trail easement dedicated to Catherine Hill Bay Water Utility from Kanangra Drive to the site. The water main will be pressurised by a new booster pump station to be constructed within the fire trail easement. Separate approval for construction of the bulk water main and pump station has been obtained from Office of Environment & Heritage (OEH) under the National Parks and Wildlife Act 1974 (OEH, 1974).

Potable water will discharge into a 1 ML potable water storage tank. The tank includes chlorine residual monitoring and dosing system to ensure residual chlorine concentration are always maintained. Potable water from the onsite storage is supplied to customers in the scheme via a variable speed drive booster pump station located at the CHBWU WWTP site.

4 Wastewater Generation & Recycled Water Supply

4.1 Equivalent Population

The CHBWU scheme is designed to service the approved residential subdivision at Catherine Hill Bay. The subdivision approval is for 540 ET worth of wastewater. Long term occupancy for the scheme has been assessed based on an occupancy rate of 3 EP/ET, which equates to an Equivalent Population (EP) of 1620 EP for the 540 ET ultimate scheme. The 540 ET CHBWU scheme will be developed in three stages in line with the rate of build out of the residential subdivision as outlined below in Table 4.1.

Table 4.1 Equivalent Population at each Stage of the CHBWU Scheme

Stage	Description	Treatment	Total ET	Total EP
1	Onsite irrigation	MBR only	112	336
2	Water recycling with irrigation of surplus recycled water	MBR + AWTP	470	1410
3	Water recycling with offsite discharge of surplus recycled water	MBR + AWTP	540	1620

The full capacity of the MBR will be installed in Stage 1. The MBR has capacity to service up to 2000 EP (660 ET) and as such there is spare capacity in the wastewater treatment plant to service the existing villages of Catherine Hill Bay and Middle Camp should there be sufficient support from government agencies, the local community and other stakeholder to enable this to occur.

4.2 Wastewater Minimisation

Wastewater generation in the CHBWU Scheme will be minimised through implementation of wastewater minimisation measures. 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 CHBWU Scheme will include:

- Water efficient fixtures and appliances as per the NSW Building Sustainability Index (BASIX) (NSW Government, 2014);
- New customer contracts and access agreements that outline the responsibilities of the resident with regard to appropriate water usage and waste management practices;
- Connection to the recycled water network is a requirement for all connections to the sewerage network;
- Ongoing awareness and communication with existing customers through additional information provided at each billing cycle and the CHBWU website;
- Welded polyethylene pressure sewer system to minimise infiltration; and

- Continuous monitoring of pressure sewer pump starts and hours run to detect infiltration, high water use and/or inappropriate waste disposal practices, i.e. swimming pools backwash etc.

The water efficiency and demand management requirements will be audited during plumbing inspection.

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. A nominal volumetric allowance of 10% has been made for inflow and infiltration to the pressure sewerage system. This is a conservative allowance given the scheme uses a water tight welded polyethylene sewerage system.

An overview of wastewater generation for the CHBWU scheme is provided below in Table 4.2. During Stage 1 total inflow is estimated to be approximately 55 kL/day, increasing up to 267 kL/day at the end of Stage 3 when 540 ET is connected.

Table 4.2 Wastewater Generation

Stage	Description	Total ET	Total EP	Wastewater Generation (kL/d)	Inflow & Infiltration (kL/d)	Total Inflow (kL/d)
1	MBR only	112	336	50.4	5.04	55.44
2	MBR + AWTP	470	1410	211.5	21.15	232.65
3	MBR + AWTP	540	1620	243	24.3	267.3

All wastewater in the scheme will be treated in a Membrane Bioreactor (MBR) with a peak design capacity of 330 kL/day. There is sufficient capacity in the MBR to treat wastewater from the existing villages of Catherine Hill Bay and Middle Camp should there be sufficient support from government agencies, the local community and other stakeholder to enable this to occur.

4.4 Class A+ Recycled Water Demand

The demand for recycled water taken from the recycled water network was estimated based on an average per property demand of 350 L/ET/day, as per the Sydney Water Version of the WSAA Code (WSAA, 2012). Recycled water will be used for all appropriate non-potable uses including:

- Toilet flushing;
- Laundry washing machine cold water (hard plumbed);
- Outdoor cleaning & wash down, including bin and car washing; and
- Irrigation of private lots and footpaths.

An overview of recycled water demand for each stage of the scheme is outlined below in Table 4.3. The supply of recycled water into the recycled water network will commence in Stage 2 following commissioning of the AWTP. During Stage 1, potable water will be supplied into the recycled water network. At the end of Stage 2 demand for recycled water is estimated to be approximately
165 kL/day and increases up to 189 kL/day at Ultimate development of 540 ET.

Table 4.3 Recycled Water Demands

Stage	Description	Total ET	Recycled Water Demand (kL/d)
1	MBR only	112	0
2	MBR + AWTP	470	164.5
3	MBR + AWTP	540	189

4.5 Surplus MBR + UV Recycled Water

All surplus MBR + UV treated recycled water that is not recycled back to each house is managed by land irrigation of a dedicated irrigation area. During Stage 1 prior to construction of the AWTP, all treated wastewater will be managed by irrigation. During Stage 2 following commissioning of the AWTP, irrigation flows reduce due to the use of recycled water on private allotments.

The estimated surplus recycled water that requires management via irrigation or offsite discharge is outlined below in Table 4.4. It can be seen from Table 4.4 that the average daily volume of surplus recycled water is approximately 55 kL/day at the end of Stage 1. At the start of Stage 2 the surplus recycled water reduces due to the commencement of water recycling back to each house. At the end of Stage 2 the water balance predicts surplus recycled water to be 57.5 kL/day for 470 ET and increases up to approximately 66 kL/day at the end of Stage 3 for 540 ET.

Table 4.4 Surplus Recycled Water

Stage	Total ET	Total Inflow (kL/d)	Recycled Water Demand (kL/d)	Treatment System Losses[1] (kL/d)	Calculated Surplus (kL/d)	Conservative Surplus[2] (kL/d)
1	112	55.4	N/A	≈1	≈ 54.4	55
2	470	232.6	164.5	≈10.6	≈ 57.5	85
3	540	267.3	189	≈12.2	≈ 66.1	100

1. Treatment system losses include 2% waste sludge from the MBR and 15% RO Reject from the AWTP.

2. Conservative assessment of surplus used for assessment of irrigation areas and offsite discharge systems to account for uncertainty in recycled water usage rates.

To be conservative and account for the uncertainty in actual recycled water demands, conservative values for surplus recycled water have been used for assessment of management options, i.e. irrigation and offsite discharge. In Stage 2 the conservative value used for assessment of the irrigation area was 85 kL/day. The future investigations into the offsite discharge for Stage 3 will use the conservative surplus recycled water of 100 kL/day for 540 ET.

5 Pressure Sewer Collection System

All lots in the scheme will be serviced using a pressure sewer system. The pressure sewer units (PSU) are owned by CHBWU and service up to four lots. Each lot connects to the PSU via gravity from the customer connection points provided during construction of the subdivision. The preliminary pressure sewer master plan drawing is provided in Appendix E.

The pressure sewer network is operated by CHBWU and includes a continuous online monitoring and control system to ensure all faults are detected. The pressure sewer network includes:

- Gravity sub sewer with up to four customer connection points on each PSU;
- Duty and standby E-One Extreme grinder pumps;
- 24 hours storage in each pressure sewer unit (PSU);
- Every PSU is fitted with a control panel connected to the central SCADA system for controlling pump operation and provision of monitoring and alarms on:
  - Wet well water level;
  - Number of starts and hours run for each pump;
  - Station voltage, current and power factor;
  - Pump and electrical faults; and
  - Communications signal strength.
- Communication cabling or radio telemetry system to connect all PSU control panels to the central SCADA system to enable central integration, monitoring and control of the pressure sewer network with the WWTP.

The Solo Water pressure sewer network provides the following benefits to the CHBWU scheme compared to a business as usual gravity sewerage system:

- Reduced groundwater and stormwater infiltration;
- Control peak inflows into the wastewater treatment plant by utilising network storage;
- Each PSU provides a minimum of 24 hours storage that would be utilised during power failure or WWTP shutdown;
- Fusion welded PN 16 HDPE pipe network will minimise pressure pipe breakages or leaks.
- Reduced potential for blockages as all sewage is macerated before entering the network;
- Monitoring of pump operation at each PSU allows for detection of abnormal inflows or stormwater connections etc;
- Water quality monitoring probes (i.e. pH, TDS etc) can be installed in specific PSUs if required to detect suspected trade waste or inappropriate waste disposal practices;
- Simple staging in line with the rate of development; and
- The system is continuously monitored with alarms hence residents are not required to respond to audible alarms or flashing lights as is the case with conventional pressure sewer systems.

6 Wastewater Treatment

An overview of the three stages for the proposed CHBWU scheme can be found in the Process Flow Diagrams in Appendix B. The WWTP Site Civil Concept Plans can be found in Appendix D.

6.1 Stage 1 - Membrane Bioreactor

All wastewater is treated in the Solo Water membrane bioreactor (MBR) with a peak design capacity of 330 kL/day. The full capacity of the MBR is provided during Stage 1.

6.1.1 MBR Process Description

The MBR is designed by Solo Water and is a modified activated sludge process with a number of treatment zones as outlined below in Table 6.1.

Table 6.1 Description of MBR Process

MBR Process	Process Description
Primary Treatment	All incoming wastewater undergoes primary treatment in a Huber 2 mm perforated plate inlet screen to ensure removal of gross solids, hair and other pollutants to protect the downstream treatment process and submerged membranes. The screening unit automatically dewaters and stores the screenings in a bagging unit. As each bag is full it will be removed from the site by licenced solid waste contractor and taken to the nearest accepting licenced landfill facility.
Inlet Tank	Primary treated wastewater from the inlet screen is discharged into the inlet tank. The inlet tank provides buffer storage capacity to ensure the flow of wastewater into the downstream treatment process is controlled. If the inlet tank is full during peak periods the flow of wastewater from the pressure sewer network will be reduced by the control system.
Anaerobic Tank	Primary treated wastewater from the inlet tank is pumped into the anaerobic tank in a controlled manner. The anaerobic tank is used to pre-condition wastewater and microorganisms for the downstream biological processes.
Anoxic Tank	Wastewater from the anaerobic tank is pumped into the anoxic tank where it is mixed with nitrified water from the aeration tank to create conditions suitable for denitrification to occur. Excess liquid from the anoxic tank flows back to the anaerobic tank via an overflow weir. Acetic acid will be supplied to the anoxic tank as an additional carbon source for denitrification.

MBR Process	Process Description
Aeration Tank	Wastewater from the anoxic tank is pumped into the aeration tank where microorganisms break down BOD and nitrify ammonia. Excess liquid from the aeration tank flows back to the anoxic tank via an overflow weir. Dissolved Oxygen (DO) in the aeration tank is maintained to an adjustable set point of 2 mg/L via continuous online monitoring of DO and a variable speed drive blower that supplies the submerged fine bubble diffuser grid at the base of the tank. The system operates with a high biomass concentration of around 8000-13000 mg/L Mixed Liquor Suspended Solids (MLSS). MLSS in the aeration tank can be maintained during low demand periods with supplementary carbon dosing into the anoxic tank. Waste Activated Sludge (WAS) is pumped from the aeration tank when MLSS increases above approximately 13,000 mg/L. Average WAS generation is estimated to be <5 kL/day and will be stored in a 20 kL WAS tank until it is removed from the site by licenced liquid waste transport contractor to the nearest accepting licenced facility.
Submerged Membrane Tank	Wastewater from the aeration tank is pumped into the submerged membrane tank. Excess liquid from the membrane tank flows back to the aeration tank via an overflow weir. The MBR tank includes 3 double tier modules of Mitsubishi Rayon Steripore Hollow Fibre submerged membranes (model 50M0210LN on top of each module and model 50M0210LP on the bottom of each module). This provides a total of 1260 m^2 of membrane area and would operate at a flux of 0.26 m/d at peak flow of 330 kL/day. MBR permeate is drawn through the submerged membranes under an outside→inside arrangement from a dry mounted suction pump located adjacent to the membrane tank. The membranes are cleaned by air scour from coarse bubble diffusers the base of the membrane module. The system is continuously monitoring for permeate turbidity, trans-membrane pressure (TMP) and flow to ensure the system is operating effectively. Membrane cleaning regimes are implemented on a routine basis as per manufacturer recommendations, and/or when TMP reaches a set point.
Ultraviolet Disinfection Unit	MBR permeate passes through a pre-validated inline ultraviolet disinfection unit to provide an additional disinfection barrier in the treatment train. The UV unit will achieve a 3 log reduction in bacteria and protozoa. The UV system is continuously monitored for UV intensity, UV transmission, flow and lamp run hours to ensure the system is operating effectively.

6.1.2 MBR Effluent Quality

Typical effluent quality from the MBR is outlined below in Table 6.2.

Table 6.2 Typical effluent quality from the MBR

Parameter	Units	Minimum	Mean	95%ile	Maximum
Biochemical Oxygen Demand	mg/L			10	20
Suspended Solids	mg/L			5	10
Total Nitrogen	mg/L as N		10		20
Total Phosphorus	mg/L as P		0.3		2
pH	pH	6.5			8.5
Turbidity	NTU			1	2
UV Transmission	UVT%	60%			
Faecal Coliforms	cfu/100 mL			10	100
Total Dissolved Solids[1]	mg/L		750		1000

[1] No salt removal is achieved through the MBR process. Effluent salinity = influent salinity.

6.2 Stage 2 - Advanced Water Treatment Plant

The 300 kL/day Advanced Water Treatment Plant (AWTP) that produces recycled water for supply to customers will be installed inside the WWTP building during Stage 2 of the WWTP and will be commissioned and operational by the time 112 lots have connected to the scheme.

The feed water for the AWTP will be taken from the MBR permeate tank. Surplus recycled water would accumulate in the MBR permeate tank and be managed by land irrigation or offsite discharge as outlined in Section 7.2. Once the AWTP becomes operational the volume of surplus recycled water will reduce due to the supply of recycled water to households.

A Recycled Water Management Plan for the AWTP will be documented once the scheme is approved and during detailed design. Preliminary information on recycled water uses, log reduction targets, the proposed treatment train and critical control points are outlined below.

6.2.1 Recycled Water Uses and Log Reduction Targets

Recycled Water supplied to individual customers will be used for the following uses:

- Toilet flushing;
- Laundry washing machine cold water service hard plumbed;
- Outdoor cleaning including bin washing, car washing and general hosing; and
- Irrigation of private lots and footpaths.

The AWTP is designed to produce high quality Class A+ recycled water that complies with the highest bacteria, virus and protozoa log reduction targets for dual reticulation and firefighting from the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC; EPHC; AHMC, 2006).

An overview of the log reduction targets and log reduction credits being claimed for the unit processes in the AWTP are outlined below in Table 6.3. It can be seen from Table 6.3 that the proposed AWTP will achieve the required log reduction targets with some safety factor.

Table 6.3 Pathogen Log Reduction Target and Credits Being Claimed for the AWTP

Target Pathogen	Log Reduction Target[1]	Log Reduction Credits Claimed for AWTP				
		MBR + UV[2]	Ultrafiltration Membrane	Ultraviolet Disinfection	Chlorine Contact	Total Log Reduction
Bacteria	5.3	0	4	3	4	11
Virus	6.5	0	4	0	4	8
Protozoa	5.1	0	4	3	0	7

[1] From Table 3.7 in Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) with recycled water used for dual reticulation with firefighting (NRMMC; EPHC; AHMC, 2006).
[2] No pathogen log reduction is being claimed for the MBR + UV treatment process. In reality the MBR + UV treatment process would achieve a pathogen log reduction of 3 log for the UV alone.

6.2.2 AWTP Processes Description

The AWTP has been designed to achieve the bacteria, protozoa and virus log reduction targets presented above in Table 6.3 through the use of:

- Reverse Osmosis (salinity control only not pathogen control);
- Prevalidated/accredited Ultrafiltration membrane skid;
- Ultraviolet disinfection unit; and
- Chlorine contact tank.

An overview of the AWTP process is provided in the PFDs in Appendix B. Information from the water treatment equipment supplier including pre-validation information for UF and UV is provided in Appendix C.

Salinity control in the recycled water system using a side stream Reverse Osmosis process to maintain recycled water TDS less than 600 mg/L.

A description of each of the AWTP unit processes and preliminary Critical Control Points are outlined below in Table 6.4.

Table 6.4 Overview of AWTP Unit Processes

Process	AWTP Process Description and Preliminary Critical Control Points
Side stream Reverse Osmosis	A portion of AWTP flow is treated in by reverse osmosis to maintain TDS in the recycled water supply network below 600 mg/L. The portion of flow directed to the RO is automatically controlled by online TDS monitoring. Depending on feed water salinity approximately 25-30% of AWTP flow will be directed to the RO. The RO is designed to maximise product recovery with a reject rate of approximately 15%.
Ultrafiltration Membranes	An Ultrafiltration membrane unit will be installed into the WWTP building and will draw TDS controlled water from the MBR Permeate Tank when water level in the recycled water storage tank drops below a set point. The proposed UF unit is a skid mounted system being supplied, installed and commissioned by SAS Water Solutions Pty Ltd. The skid is a complete factory tested package system and contains three INGE brand membrane modules. The specific membrane modules being used are the *INGE Dizzer XL 0.9MB60W* and has an approximate membrane pore size of 0.02 µm and a membrane surface area of 60 m^2. The INGE membranes are a multi-bore hollow fibre membrane with 7 x 0.9 mm diameter membrane capillaries in each 4 mm diameter fibre. The membranes have been pre-validated based on USEPA guidelines (USEPA, 2005) to achieve >5 Log virus removal, however 4 log is being claimed for the process. Refer to Appendix Cfor pre-validation and technical information on the INGE membranes. The preliminary Critical Control Points (CCP) and Critical Limits (CL) for the UF system from the manufacturers pre-validation information are: – Max permeate flow 4 L/s (for downstream UV and CCT processes); – Transmembrane Pressure < 201.5 kPa; – Average normalised flux of <100 L/m^2/hr; – Direct Integrity Test pressure decay <1 kPa/minute at 1 bar hold pressure; – Permeate turbidity <0.15 NTU (95%ile) and < 0.5 NTU shut down. All CCPs will be continuously monitored with alarms and automatic shutdown if the critical limits are reached. CCPs and CLs are subject to refinement during detailed design.

Process	AWTP Process Description and Preliminary Critical Control Points
Ultraviolet Disinfection	Permeate from the UF is directed straight into an inline UV disinfection unit. The UV unit is being supplied, installed and commissioned by SAS Water Solutions with the UF skid. The UV unit will be USEPA accredited (USEPA, 2006) unit provided by Wedeco (LBX series) with a pre-validated dose to achieve 3 log reduction in bacteria and protozoa at 60% UVT. Refer to Appendix C for pre-validation and technical information on the Wedeco UV unit. The preliminary Critical Control Point and Critical Limits for the UV from the manufacturers pre-validation information are: – Max flow of <4 L/s as measured on the UF permeate line; – Max pressure < TBC with manufacturer; – UVT of incoming water >60%; – UV Intensity inside the UV reactor > TBC with manufacturer; – Lamp run life; – Lamp faults. The CCPs will be continuously monitored with alarms and automatic shutdown if the critical limits are reached. CCPs and CLs are subject to refinement during detailed design.

Process	AWTP Process Description and Preliminary Critical Control Points
Chlorine Contact Tank	Water from the inline UV disinfection unit is discharged into the chlorine contact tank (CCT). The CCT has been designed to achieve the CT values to achieve a 4-log reduction in viruses as outlined in "Chlor(am)ine disinfection of human pathogenic viruses in recycled waters" (Keegan, Wati, & Robinson, 2012) using the design process documented in the USEPA Disinfection Profiling and Benchmarking Technical Guidance Manual (USEPA, 2003). The CCT will include: – 60 minutes total hydraulic detention time with liquid volume of >14.4 kL; – Baffled reactor to maximise mixing and plug flow. A baffling factor of 0.5 was assumed from the USEPA Disinfection Profiling and Benchmarking Technical Guidance Manual (USEPA, 2003); – Target CT value of 16, based on a pH of 8 and a temperature of 10^0C from Table 4.7B in "Chlor(am)ine disinfection of human pathogenic viruses in recycled waters" (Keegan, Wati, & Robinson, 2012); – Sodium hypochlorite dosing using variable speed dosing pumps; – Continuous online monitoring of pH and free chlorine with dosing facilities. The preliminary Critical Control Points and Critical Limits for the CCT are: – pH 6.5 to 8; – Free chlorine at the CCT outlet >0.6 mg/L; – Maximum flow of 4 L/s as measured on the UF permeate line; – Water level monitoring to ensure detention time control (if a gravity high level gravity overflow from the CCT is not used). The CCPs will be continuously monitored with alarms and automatic shutdown if the critical limits are reached. CCPs and CLs are subject to refinement during detailed design.
Residual Chlorination	Treated water from the CCT with a minimum free chlorine residual of 0.6 mg/L is pumped into the 1 ML recycled water storage tank. Chlorine residual in the recycled water storage tank will be maintained using a recirculation system with continuous chlorine monitoring and dosing. Sufficient free chlorine residual will be maintained in the recycled water storage tank to ensure the minimum free residual chlorine is achieved at the furthest point in the reticulation system. Seasonal chlorine dosing rates will be determined during operation to achieve the minimum residuals required throughout the network. The recycled water storage tank is a sealed tank to prevent vermin and mosquito access. All required tank openings, like overflows, will be screened with mosquito proof mesh. The preliminary Critical Control Points and Critical Limits for the recycled water storage is: – Free chlorine on supply >0.6 mg/L (or higher set point to maintain residuals throughout the network); – Weekly visual inspection for evidence of tank damage or vermin access. The free chlorine CCP will be continuously monitored with alarms and automatic shutdown if the critical limits are reached. CCPs and CLs are subject to refinement during detailed design.

6.3 Treatment Process Waste Products

6.3.1 MBR Screenings

All influent to the MBR receives primary treatment in a Huber 2 mm perforated plate inlet screen to remove hair, gross pollutants and other foreign matter. The screen includes a rotating brush, dewatering auger and automatic bagging unit to avoid operator contact with screenings. As each bag is filled with dewatered screening at approximately fortnightly intervals the waste will be disposed of by a licenced waste transport contractor to an approved solid waste landfill facility.

6.3.2 MBR Waste Sludge

The MBR is an activated sludge process that produces waste activated sludge at approximately 2% of the inflow rate. At ultimate development approximately 5 kL/day of waste activated sludge at solids content of approximately 10,000 mg/L will be generated from the MBR. Waste sludge will be stored in a sealed tank until it is removed from the site at approximately weekly intervals by a licenced liquid waste transport contractor and disposed of to the nearest approved municipal wastewater treatment plant.

6.3.3 RO Reject Evaporation Ponds

The Reverse Osmosis system in the AWTP produces RO reject at a rate of approximately 15% of the feed to the RO unit. At ultimate development approximately 6.4 kL/day of RO reject with a salt concentration of approximately 5000 mg/L will be produced. RO reject will be managed in three HDPE lined evaporation ponds with a total area of 4,870 m^2. The evaporation ponds are 1.5 deep and are filled to a water level of 1.2 meters (0.3 m freeboard) before being rested to evaporate.

Daily water balance modelling of the evaporation ponds system was presented in the Solo Water report *Reverse Osmosis Reject Evaporation Pond Water Balance* (Revision C, dated October 2014). This report shows that the pond system is predicted to overflow in approximately 6% of years. In operation the ponds will be managed to prevent overflows by either shutting off the AWTP to cease reject generation or by removing excess water by road tanker to ensure no overflows occur.

7 Effluent Management

7.1 Recycled Water Supply

All recycled water from the AWTP is stored in the 1 ML recycled water storage tank. The 1 ML recycled water storage tank provides more than 24 hours storage at ultimate peak day recycled water demands.

During Stage 1 the recycled water tank will be filled with potable water. Once the AWTP is commissioned in stage 2 the tank will be filled with recycled water and potable water will only be used for top-up and emergency backup of the recycled water system.

Chlorine residual in the recycled water storage tank will be maintained with continuous chlorine monitoring and dosing on supply. Sufficient free chlorine residual will be maintained in the recycled water storage tank to ensure the minimum free residual chlorine is achieved at the furthest point in the reticulation system. Seasonal chlorine dosing rates will be determined during operation to achieve the minimum residuals required throughout the network.

The recycled water storage tank will be operated based on the set points outlined below in Table 7.1.

Table 7.1 Recycled Water Storage Tank Operation

Operating Parameter[1]	Action
>99% full	Shut down AWTP
<90% full	Start AWTP
>50% full	Close potable water top-up valve
<30% full	Open potable water top up valve - High Alarm
<20% full	Critical alarm
<5% full	Shut off recycled water supply pumps

1. Set points are adjustable and will be optimised by the operator during operation.

Recycled water from 1 ML recycled water storage will be supplied to customers through a separate purple pipe network using a variable speed drive booster pump station located at the WWTP site. An emergency standby diesel generator with automatic changeover switch will be provided to back up the recycled water supply pumps to ensure provision of essential services is continuously maintained.

7.2 Management of Surplus MBR + UV Recycled Water

7.2.1 Irrigation Scheme – up to 470 ET

Under the scheme all surplus MBR + UV treated recycled water will be stored in 2 x 1 ML wet weather storage tanks before being irrigated onto a dedicated irrigation area located on developer land inside the footprint of the approved subdivision. Plans of the proposed irrigation areas can be found in Appendix E.

In addition to irrigation, some minor opportunistic reuse of surplus recycled water will be undertaken for construction related activities like dust suppression and landscape establishment to minimise demand for potable water for these non-potable water uses. Recycled water used for construction will be supplied through a metred truck fill stand pipe provided near the WWTP site.

8.5 ha Irrigation Area

A total of 8.5 ha of restricted access effluent irrigation area will be provided for the scheme servicing 470 ET. The irrigation area will be staged in line with the rate of production of surplus recycled water from the subdivision. The irrigation system will be supplied from its own separate and independent irrigation network with its own irrigation pump.

The 2 ML storage and 8.5 ha irrigation area is adequate to sustainably manage 85 kL/day of surplus recycled water from the 470 ET scheme. The 2 ML storage is predicted to overflow in less than 50% of years, as per the requirements of the NSW Department of Environment and Conservation, *Environmental Guidelines: Use of Effluent by Irrigation* (NSW DEC, 2004). In operation emergency irrigation events will be initiated to avoid uncontrolled overflow from the wet weather storage.

The onsite irrigation system including daily water and nutrient balance modelling is described in the Solo Water report *Land Capability Assessment for Effluent Irrigation* (Revision C, dated October 2014). Plans of the proposed irrigation areas can be found in Appendix E.

Opportunistic Recycled Water Use in Construction

Some opportunistic reuse of MBR + UV treated recycled water for construction related activities may be undertaken during construction of the residential subdivision to minimise the consumption of potable water. The construction uses of recycled water may include dust suppression, irrigation and vegetation establishment.

Any construction uses of recycled water will be undertaken under a Recycled Water Management Plan developed prior to commencement of the intended use. MBR + UV treated recycled water is appropriate for use in construction and dust suppression with the following controls:

- No public access to the construction site;
- Minimise human contact;
- Minimise spray drift and aerosol production;
- Avoid usage during high wind;
- Avoid ponding and/or runoff of recycled water;
- Appropriate worker hygiene practices; and
- Appropriate training of construction staff.

A recycled water management plan incorporating the above will be documented by the civil construction contractor prior to commencing the use of recycled water for construction activities on site.

7.2.2 Ultimate Scheme – Offsite Discharge

The scheme servicing up to 470 ET is the maximum yield that can be sustained within the approved footprint of the residential subdivision. This represents a reduction in yield from the approved subdivision of approximately 70 ET.

To facilitate implementation of the approved subdivision up to its yield of 540 ET an ultimate scheme is currently being investigated to facilitate offsite discharge of surplus recycled water. If required, capacity in the ultimate discharge system can be provided for the existing development at Middle Camp and Catherine Hill Bay. This would increase the ultimate scheme up to 650 ET.

The offsite discharge will be undertaken under the authority of either an Environmental Protection Licence (EPL) issued by the NSW Environmental Protection Agency (EPA) under the POEO Act (NSW Government, 1997), or as a trade waste discharge authorised by Hunter Water or Wyong Shire Council. Separate approval of the pipeline corridor and civil works etc. will be required by IPART under Part 5 of the EP&A Act (NSW Government, 1979). Following this the WICA licence would be updated to include the ultimate arrangement.

The discharge options that will be investigated include:

- Trade waste discharge to Hunter Water sewer;
- Trade waste discharge to Wyong Shire Council sewer;
- Local environment discharge to the ocean;
- Local environment discharge to sand dunes/groundwater; and
- Local environment discharge to Middle Camp Creek.

In general terms, the options that involve a trade waste discharge to a Hunter or Wyong sewerage system will have the least impact at the actual discharge location given that there is already discharge occurring from these systems, however these options will have a greater relative impact for construction and operation of the transfer system due to the relatively long distances involved.

The options involving a local environment discharge could potentially have some impact at the discharge point given there is currently no discharge occurring, however these options will have a lower relative impact for construction and operation of the transfer system due to the relatively short distances involved.

An options investigation will be undertaken by an independent consultant to recommend the preferred offsite discharge option based on assessment of capital and life cycle costs as well as social, economic and environmental criteria.

8 Environmental & Public Health Risk Assessment

A preliminary qualitative risk assessment of the proposed scheme has been undertaken based on the framework outlined in AS/NZS ISO 31000:2009 Risk management—Principles and guidelines (AS/NZS, 2009) and the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC; EPHC; AHMC, 2006). The risk assessment criteria adopted were as per the Australian Guidelines for Water Recycling and are presented along with the risk assessment tables in Appendix F.

An overview of the preliminary risk assessment process undertaken for the CHBWU scheme is described below:

- Define the risk assessment criteria to be used and the context of the risk assessment;
- Develop and review the process flow diagram and description of the system;
- Divide the process flow diagram into a number of individual scheme components, e.g. sewerage collection, wastewater treatment etc.;
- Identify a number of potential hazards and hazardous events for each scheme component;
- Assess the unmitigated risk by estimating the likelihood and consequence of each hazard and hazardous event occurring;
- Document the risk control strategy for each risk;
- Assess the unmitigated risk by estimating the likelihood and consequence of each hazard and hazardous event occurring taking into consideration the risk control measures; and
- Identify the significant risks of the system.

The preliminary risk assessment process is used to inform the detailed design of the scheme to ensure risks are identified, controlled and monitored to minimise potential impacts and risks. The preliminary risk assessment tables presented in Appendix F will be updated during detailed design and operation.

The preliminary risk assessment will be expanded to include Hazard Analysis and Critical Control Point (HACCP) for identification of Critical Control Points (CCP) in the recycled water process as per the Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC; EPHC; AHMC, 2006) prior to commissioning of the AWTP in Stage 2.

9 Monitoring Plan

9.1 MBR + UV Effluent Quality Monitoring

Ongoing verification monitoring of MBR treated effluent will be undertaken from the MBR permeate tank on a monthly basis. In addition to collected water samples continuous operational process monitoring of the MBR is undertaken via the control system and all alarms reported to the operator.

The MBR will be commissioned based on treated water quality monitoring under a range of operating conditions during the commissioning period. An overview of the commissioning and verification monitoring to be undertaken and preliminary critical control points for the MBR + UV WWTP are outlined below in Table 9.1.

Table 9.1 MBR Effluent Quality and Operational Monitoring

Parameter	Units	MBR Effluent Quality Monitoring		Location
		Commissioning	Verification	
BOD	mg/L	Frequent monitoring during commissioning period to test the system under a variety of operating conditions.	Monthly	MBR permeate tank/wet weather storage
Suspended Solids	mg/L		Monthly	
Ammonia as N	mg/L as N		Monthly	
TKN as N	mg/L as N		Monthly	
Oxidised Nitrogen as N	mg/L as N		Monthly	
Total Nitrogen as N	mg/L as N		Monthly	
Total Phosphorus as P	mg/L as P		Monthly	
Faecal Coliforms	cfu/100 mL		Weekly	
All tank water levels	m	Continuous	Continuous	Online
All flows	L/s	Continuous	Continuous	
Dissolved Oxygen (CCP)	mg/L	Continuous	Continuous	
MLSS	mg/L	Continuous	Continuous	
Electrical Conductivity	dS/m	Continuous	Continuous	
pH	pH	Continuous	Continuous	
Transmembrane Pressure (CCP)	ΔkPa	Continuous	Continuous	
Permeate Turbidity (CCP)	NTU	Continuous	Continuous	
UV Intensity (CCP)	mJ/cm^2	Continuous	Continuous	
UVT% (CCP)	%	Continuous	Continuous	

9.2 AWTP Recycled Water Quality Monitoring

The AWTP will be commissioned based on treated water quality monitoring under a range of operating conditions. The AWTP uses only pre-validated equipment accredited to USEPA or equivalent guidelines (USEPA, 2006); (USEPA, 2005). Pre-validation information for the UF and UV from the equipment supplier is provided in Appendix C.

Once the AWTP is commissioned, less frequent verification monitoring will be undertaken to demonstrate the system is producing compliant recycled water. A Recycled Water Management Plan (RWMP) will be documented during detailed design. The RWMP will undertake HACCP risk assessment and identify critical points. An overview of the verification and validation monitoring and preliminary critical control points for the AWTP are presented below in Table 9.2.

Table 9.2 AWTP Validation and Verification Recycled Water Quality Monitoring

Pollutant	Units	Recycled Water Quality Monitoring		Location
		Validation	Verification	
Biochemical Oxygen Demand	mg/L	Frequent monitoring during commissioning period to test the system under a variety of operating conditions.	Monthly	Recycled Water Storage Tank
Suspended Solids	mg/L		Monthly	
Ammonia as N	mg/L as N		Monthly	
TKN as N	mg/L as N		Monthly	
Oxidised Nitrogen as N	mg/L as N		Monthly	
Total Nitrogen as N	mg/L as N		Monthly	
Total Phosphorus as P	mg/L as P		Monthly	
Faecal Coliforms	cfu/100 mL		Weekly	
Free Residual Chlorine	mg/L		Weekly	
Sodium absorption ratio	ratio		Annual	
Campylobacter (bacteria)	cfu/100 mL		Annual	
Cryptosporidium (protozoa)	cfu/100 mL		Annual	
Adenovirus (virus)	pfu/100 mL		Annual	
Rotavirus (virus)	pfu/100 mL		Annual	
Electrical Conductivity (CCP)	dS/m	Continuous	Continuous	Online
UF Permeate Flow (CCP)	L/s	Continuous	Continuous	
UF Permeate Turbidity (CCP)	NTU	Continuous	Continuous	
UF Transmembrane Pressure (CCP)	ΔkPa	Continuous	Continuous	
UF Direct Integrity Testing (CCP)	ΔkPa/time	Continuous	Continuous	
UV Intensity (CCP)	mJ/cm^2	Continuous	Continuous	
UVT% (CCP)	%	Continuous	Continuous	
pH (CCP)	pH	Continuous	Continuous	
Free Residual Chlorine (CCP)	mg/L	Continuous	Continuous	

9.3 Environmental Monitoring of Irrigation Scheme

Environmental monitoring of the irrigation will be undertaken to ensure there are no significant environmental or public health impacts caused as a result of irrigation activities. An overview of the irrigation system environmental monitoring program is outlined below in Table 9.3.

Table 9.3 Environmental Monitoring of Effluent Irrigation Scheme

Type	Parameter	Units	Type	Location	Frequency
Turf and vegetation health	Visual inspection of plant health for signs or stress	General observations	Monitor for change	Irrigation area	Ongoing
	Laboratory biomass analysis of plant nutrients	mg/kg	Identify deficiencies	Irrigation area	If impacts observed
Surface Water monitoring	Faecal Coliform	cfu/100 mL	Monitor for general trends and change	In gully downstream of the northern property boundary of the irrigation area	Quarterly
	BOD	mg/L			
	Total Nitrogen & breakdown	mg/L as N			
	Total Phosphorus	mg/L as P			
	pH	pH units			
	Electrical Conductivity	dS/m			
Ground water monitoring	pH	pH units	Monitor for general trends and change	Groundwater monitoring bore along northern property boundary.	Quarterly
	Faecal Coliform	cfu/100 mL			
	Electrical conductivity	dS/m			
	Total Nitrogen & breakdown	mg/L as N			
	Total Phosphorus	mg/L as P			
	Water level	m AHD (or m BTOC)			
Soil monitoring	Total hydraulic and nutrient load onto each irrigation area	kL/year and kg/year	Monitor for general trends and change.	Select irrigation zones that received the highest hydraulic load. Samples to be taken from top soil and sub soil layers.	Annual
	Electrical conductivity	dS/m			
	Available Phosphorus	mg/kg			
	Available Potassium	mg/kg			
	Chloride	meq/100g			
	Exchangeable cations & CEC	meq/100g			
	Exchangeable Sodium %	%			
	Sodium adsorption ratio	Ratio			
	Total Organic Carbon	%			
	pH	pH units			
	Total Nitrogen	mg/kg			
	Total Phosphorus	mg/kg			

10 Conclusions & Recommendations

The above report outlines the proposed integrated water management strategy to be implemented at the Catherine Hill Bay Water Utility (CHBWU) Scheme. The strategy covers the supply of potable water, sewerage and recycled water services servicing the approved Coastal Hamlets residential subdivision at Catherine Hill Bay and presents the method for the sustainable management of surplus recycled water by irrigation.

The CHBWU scheme represents best practice in urban water cycle management and includes the following measures:

- Potable water usage minimisation and a reduction in potable water demand by >60% compared to a standard development;
- Continuously monitored and controlled pressure sewer system with no wet weather overflows;
- Wastewater minimisation through monitoring the pressure sewer network to detect abnormal flows from stormwater, groundwater and inappropriate residential and trade waste practices;
- All wastewater is treated to tertiary standards using the Solo Water Membrane Bioreactor with a peak capacity of 330 kL/day;
- Advanced Water Treatment Plant with capacity to treat 300 kL/day of MBR permeate to recycled water standards with side stream RO, UF membranes, UV disinfection and chlorine contact tank;
- 8.5 ha irrigation area on developer land can sustainably manage surplus recycled water for up to 470 ET;
- 2 ML wet weather storage is predicted to overflow in less than 50% of years and exceeds the requirements of the NSW EPA effluent irrigation guidelines;
- Future expansion beyond 470 ET will be subject to a separate approval of an offsite discharge regime, following which the WICA Licence would be updated accordingly; and
- Continuous online monitoring and control system with alarms.

The proposed CHBWU scheme represents best practice in urban water cycle management. It is recommended that IPART issue an approval for the CHBWU scheme under Part 5 of the EP&A Act to ensure this essential service can be provided in a timely manner to the residents of Catherine Hill Bay.

11 References

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Appendix A

Site Zoning Map

Lake Macquarie Local Environmental Plan 2004— South Wallarah Peninsula— Land Zoning Map

Sheet LZN_001

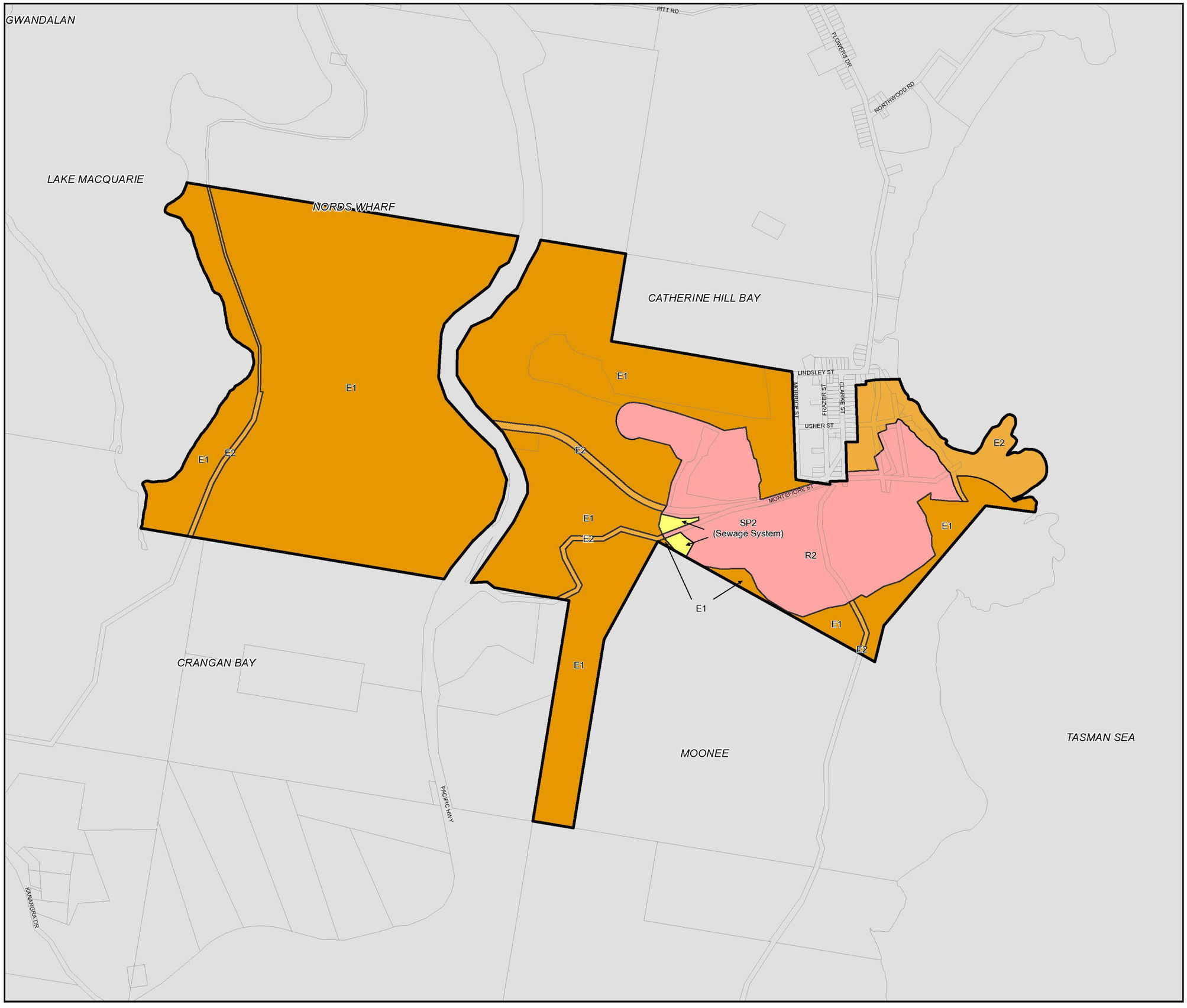
Subject Land

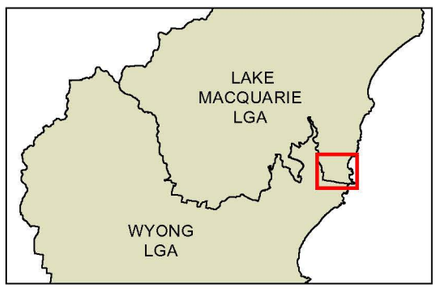
Zone

- E1 National Parks and Nature Reserves
- E2 Environmental Conservation
- R2 Low Density Residential
- SP2 Infrastructure

Cadastre

Cadastre 07/11/2012 © NSW LPI





Projection: MGA Zone 56
Datum: GDA94

0 100 200 300 400 500 m

Scale: 1:15,000 @ A3

Map Identification Number

4650_SWP_LZN_001_015_20131121

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.

adw johnson

ROSE Creating a quality way of living

LANDSCAPE ARCHITECT
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PO Box A866 Sydney South NSW 1235
T. 61 2 8244 8900 F. 61 2 82448988
E. context@context.net.au
www.context.net.au ACN 055 972 248
context

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
Dwg No	10629-L-101	Issue	B

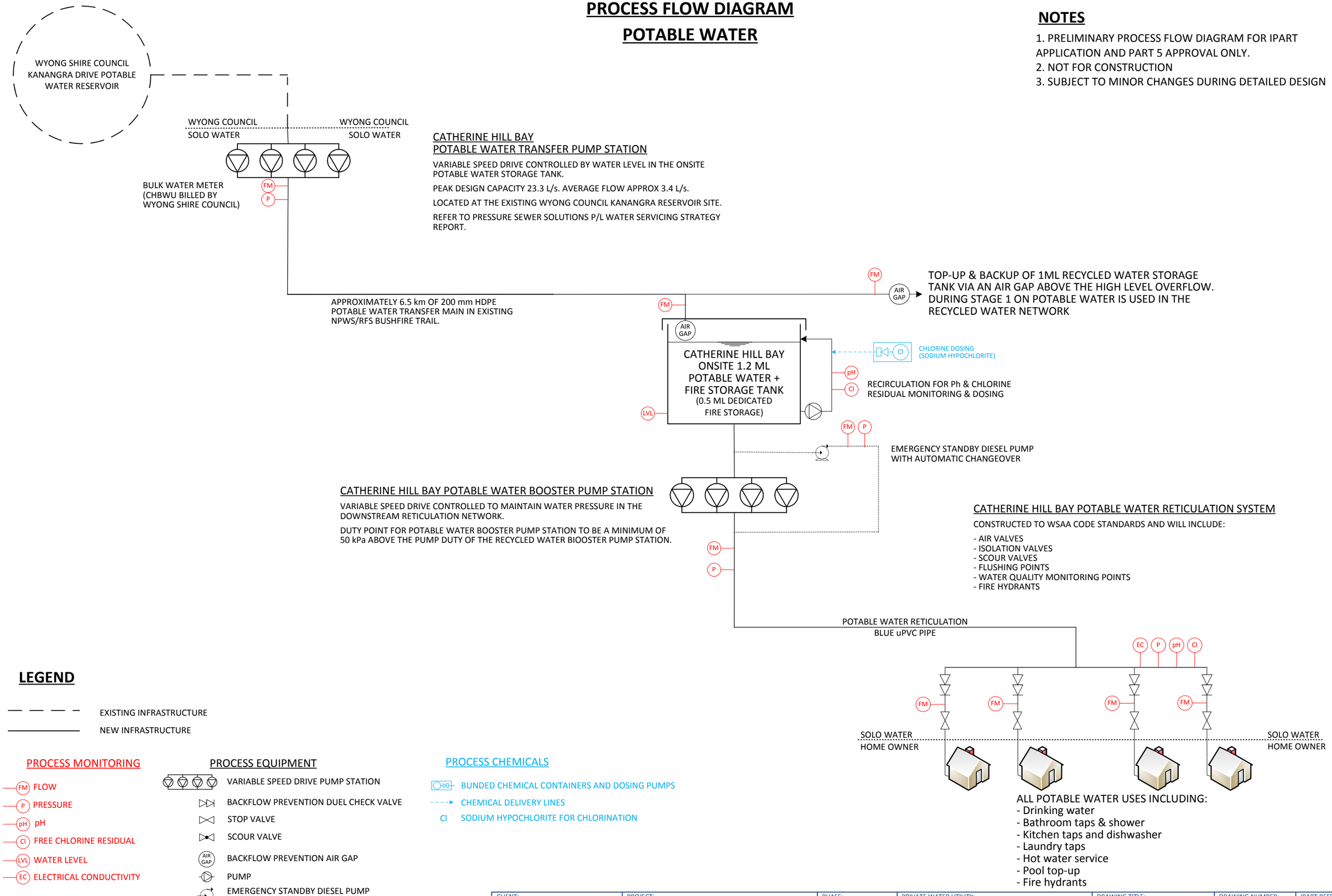
Appendix B

Process Flow Diagrams

PROCESS FLOW DIAGRAM
POTABLE WATER

NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION AND PART 5 APPROVAL ONLY.
2. NOT FOR CONSTRUCTION
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN



LEGEND

EXISTING INFRASTRUCTURE

NEW INFRASTRUCTURE

PROCESS MONITORING

- FM FLOW
- P PRESSURE
- pH pH
- Cl FREE CHLORINE RESIDUAL
- LVL WATER LEVEL
- EC ELECTRICAL CONDUCTIVITY

PROCESS EQUIPMENT

- VARIABLE SPEED DRIVE PUMP STATION
- BACKFLOW PREVENTION DUEL CHECK VALVE
- STOP VALVE
- SCOUR VALVE
- AIR GAP BACKFLOW PREVENTION AIR GAP
- PUMP
- EMERGENCY STANDBY DIESEL PUMP WITH AUTOMATIC CHANGEOVER

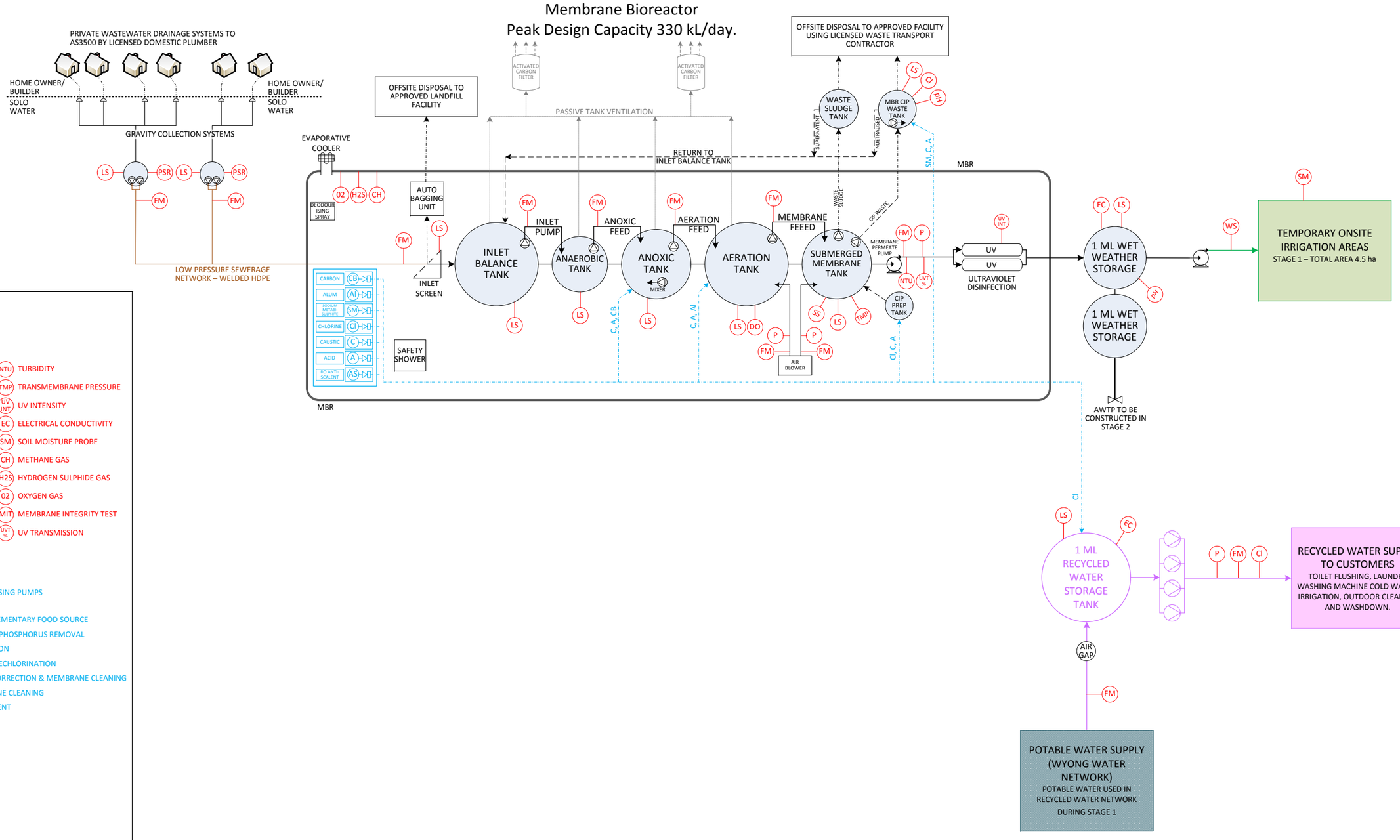
PROCESS CHEMICALS

- BUNDED CHEMICAL CONTAINERS AND DOSING PUMPS
- CHEMICAL DELIVERY LINES
- Cl SODIUM HYPOCHLORITE FOR CHLORINATION

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 & PART 5 APPROVAL	CATHERINE HILL BAY WATER UTILITY PTY LTD	PROCESS FLOW DIAGRAM POTABLE WATER	H10052_P02D DATE: 19/06/2014	APPENDIX A

PROCESS FLOW DIAGRAM
STAGE 1 WASTEWATER TREATMENT PLANT
(UP TO 112 ET)

Membrane Bioreactor
Peak Design Capacity 330 kL/day.



LEGEND

PROCESS MONITORING

- FM FLOW METER
- 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
- MIT MEMBRANE INTEGRITY TEST
- UVT % UV TRANSMISSION

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 & MEMBRANE CLEANING
- A ACID FOR pH CORRECTION AND MEMBRANE CLEANING
- AS REVERSE OSMOSIS MEMBRANE ANTISCALENT

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

ULTRAVIOLET DISINFECTION SYSTEM
SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
UV TRANSMISSION OF 60%
USEPA ACCREDITED UV DISINFECTION SYSTEM

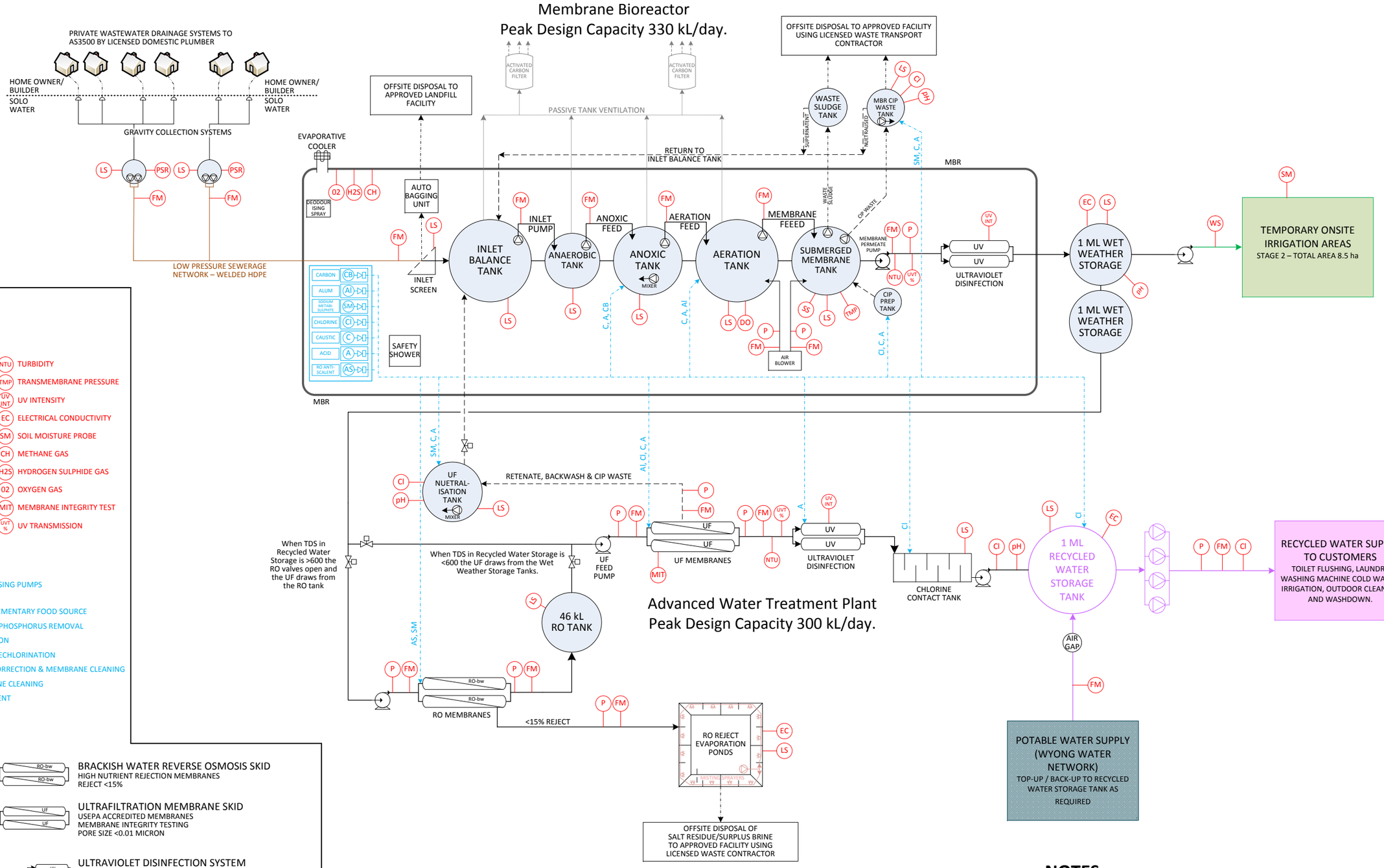
NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION.
2. NOT TO SCALE.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN.

CLIENT:	PROJECT:	PHASE:	PRIVATE WATER UTILITY:	DRAWING TITLE:	DRAWING NUMBER:
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 STAGE 1 WASTEWATER TREATMENT PLANT (UP TO 112 ET)	H10052_P04E
					DATE: 26/09/2014

PROCESS FLOW DIAGRAM
STAGE 2 WASTEWATER TREATMENT PLANT
(UP TO 470 ET)

Membrane Bioreactor
Peak Design Capacity 330 kL/day.



LEGEND

PROCESS MONITORING

- FM FLOW METER
- P PRESSURE
- PSR PUMP STARTS AND RUN HOURS
- LS WATER LEVEL
- DO DISSOLVED OXYGEN
- SS MIXED LIQUOR SUSPENDED SOLIDS
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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

BRACKISH WATER REVERSE OSMOSIS SKID
HIGH NUTRIENT REJECTION MEMBRANES
REJECT <15%

ULTRAFILTRATION MEMBRANE SKID
USEPA ACCREDITED MEMBRANES
MEMBRANE INTEGRITY TESTING
PORE SIZE <0.01 MICRON

ULTRAVIOLET DISINFECTION SYSTEM
SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
UV TRANSMISSION OF 60%
USEPA ACCREDITED UV DISINFECTION SYSTEM

CHLORINE CONTACT TANK
CONTACT TANK TO BE DESIGNED TO USEPA GUIDELINES TO ACHIEVE CT VALUES FOR THE REQUIRED LOG REMOVAL TARGETS

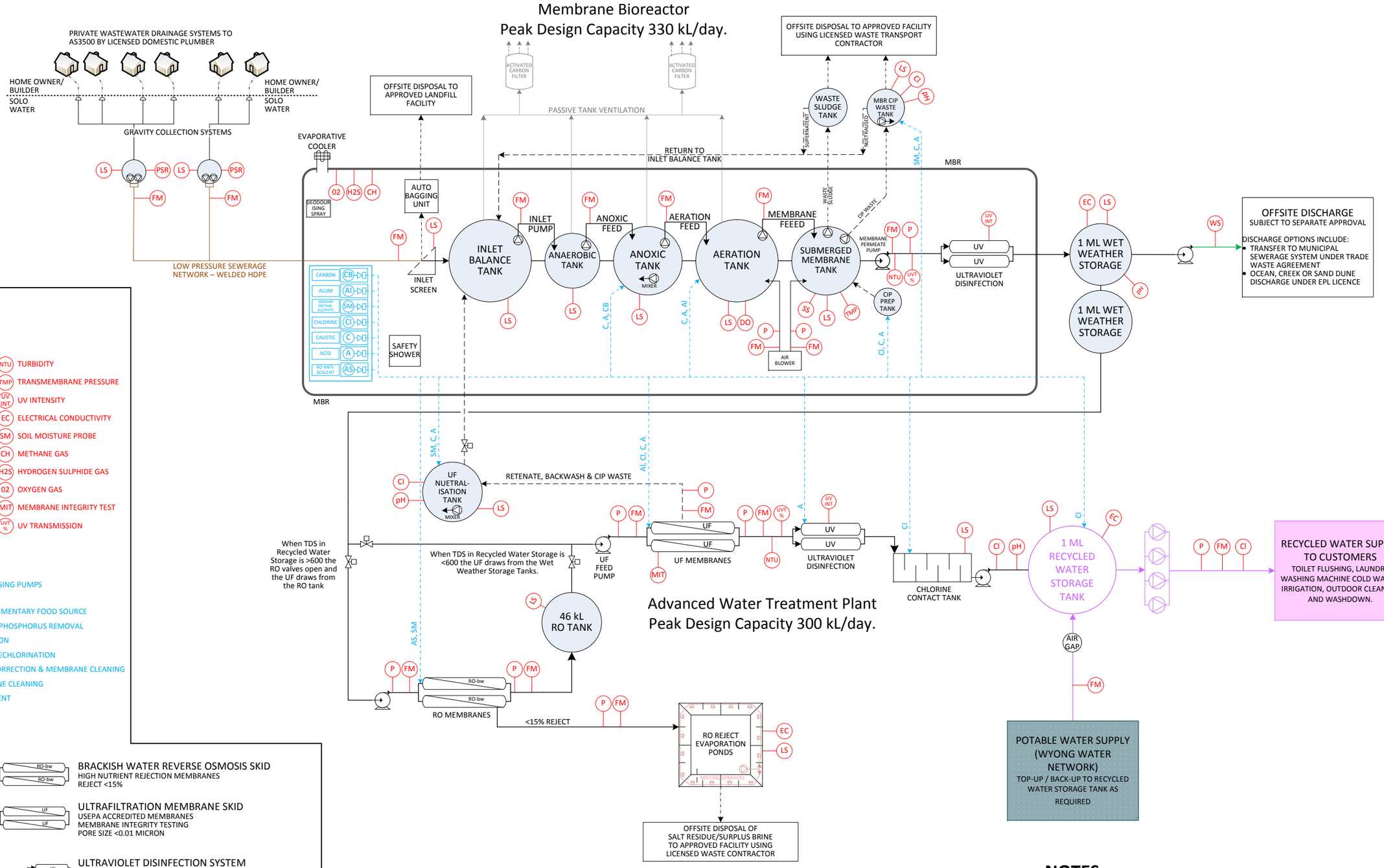
NOTES

1. PRELIMINARY PROCESS FLOW DIAGRAM FOR IPART APPLICATION ONLY. NOT FOR CONSTRUCTION.
2. NOT TO SCALE.
3. SUBJECT TO MINOR CHANGES DURING DETAILED DESIGN.

CLIENT:	PROJECT:	PHASE:	PRIVATE WATER UTILITY:	DRAWING TITLE:	DRAWING NUMBER:
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 STAGE 2 WASTEWATER TREATMENT PLANT (UP TO 470 ET)	H10052_P03E
					DATE: 26/09/2014

PROCESS FLOW DIAGRAM
STAGE 3 WASTEWATER TREATMENT PLANT
(UP TO 540 ET)

Membrane Bioreactor
Peak Design Capacity 330 kL/day.



LEGEND

PROCESS MONITORING

- FM FLOW METER
- 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
- MIT MEMBRANE INTEGRITY TEST
- UVT % UV TRANSMISSION

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 METABISULPHITE DOSING FOR DECHLORINATION
- C SODIUM HYDROXIDE (CAUSTIC) FOR pH CORRECTION & MEMBRANE CLEANING
- A ACID FOR pH CORRECTION AND MEMBRANE CLEANING
- AS REVERSE OSMOSIS MEMBRANE ANTISCALENT

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

BRACKISH WATER REVERSE OSMOSIS SKID
HIGH NUTRIENT REJECTION MEMBRANES
REJECT <15%

ULTRAFILTRATION MEMBRANE SKID
USEPA ACCREDITED MEMBRANES
MEMBRANE INTEGRITY TESTING
PORE SIZE <0.01 MICRON

ULTRAVIOLET DISINFECTION SYSTEM
SELF CLEANING SYSTEM WITH UV INTENSITY MONITORING
UV TRANSMISSION OF 60%
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NOTES

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CLIENT:	PROJECT:	PHASE:	PRIVATE WATER UTILITY:	DRAWING TITLE:	DRAWING NUMBER:
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 STAGE 3 WASTEWATER TREATMENT PLANT (UP TO 540 ET)	H10052_P11A
					DATE: 26/09/2014

Appendix C

Treatment Process Information from Equipment Suppliers

inge®
heart of pure water

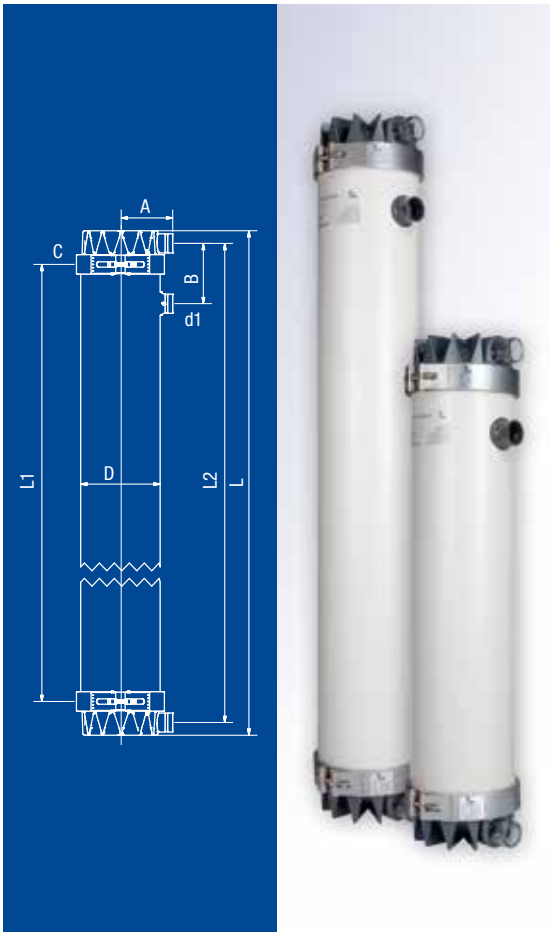
dizzer® XL

Ultrafiltration modules

BASF
The Chemical Company

dizzer® XL - Ultrafiltration modules

- Excellent efficiency and high output
- Easy installation, plug-and-play operation
- Compact design
- Low operating costs



Modules for large scale application

Module designation:

dizzer® XL 0.9 MB 60 W

- Active membrane area
- Multibore® membrane
- Capillary diameter
- Modules for large scale application

dizzer® modules with Multibore® 0.9 membrane

Module data			dizzer® XL 0.9 MB 60 W		dizzer® XL 0.9 MB 38 W	
Part number			VK-0068		VK-0070	
Membrane area	m^2	sq.ft.	60	645	38	410
Length with end cap (L)	mm	inch	1680 ± 3	66 1/8	1180 ± 3	46 1/2
Length without end cap (L1)	mm	inch	1486 ± 1.5	58 1/2	986 ± 1.5	38 3/4
Distance feed connectors (L2)	mm	inch	1600 ± 3	63	1100 ± 3	43 1/2
Distance feed – module center axis (A)	mm	inch	165	6 1/2	165	6 1/2
Distance feed – filtrate connector (B)	mm	inch	190 ± 1.5	7 1/2	190 ± 1.5	7 1/2
Outer diameter end cap coupling max. (C)	mm	inch	295	11 5/8	295	11 5/8
Outer diameter module (D)	mm	inch	250	9 7/8	250	9 7/8
Connector flexible victaulic (d1)		inch	2			
Weight* (wet)	kg	lbs.	55	120	40	90

dizzer® modules with Multibore® 1.5 membrane

Module data			dizzer® XL 1.5 MB 40 W		dizzer® XL 1.5 MB 25 W	
Part number			VK-0069		VK-0071	
Membrane area	m^2	sq.ft.	40	430	25	270
Length with end cap (L)	mm	inch	1680 ± 3	66 1/8	1180 ± 3	46 1/2
Length without end cap (L1)	mm	inch	1486 ± 1.5	58 1/2	986 ± 1.5	38 3/4
Distance feed connectors (L2)	mm	inch	1600 ± 3	63	1100 ± 3	43 1/3
Distance feed – module center axis (A)	mm	inch	165	6 1/2	165	6 1/2
Distance feed – filtrate connector (B)	mm	inch	190 ± 1.5	7 1/2	190 ± 1.5	7 1/2
Outer diameter end cap coupling max. (C)	mm	inch	295	11 5/8	295	11 5/8
Outer diameter module (D)	mm	inch	250	9 7/8	250	9 7/8
Connector flexible victaulic (d1)		inch	2			
Weight* (wet)	kg	lbs.	55	120	40	90

Technical information

Material			
Housing		PVC-U, white	
End cap		PVC-U, grey	
End cap coupling		SS (sealing EPDM)	
Operation parameters			
Pressure max.	bar	psi	5	70
Temperature range	°C	°F	1 – 40	34 – 104

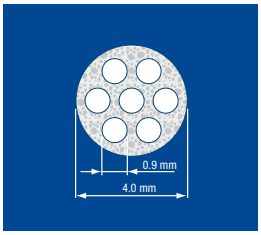
* shipping weight

® = Registered trademark of BASF

Multibore® 0.9 and 1.5 membranes

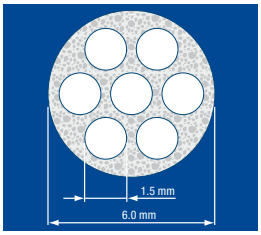
Multibore® 0.9 membrane

Membrane data		
Capillaries per fibre		7
Inner diameter	mm	0.9
Outer diameter	mm	4.0
Pore size	µm	approx. 0.02
Material		PESM



Multibore® 1.5 membrane

Membrane data		
Capillaries per fibre		7
Inner diameter	mm	1.5
Outer diameter	mm	6.0
Pore size	µm	approx. 0.02
Material		PESM



Technical information

Cleaning/disinfection chemicals			Multibore® 0.9 and 1.5 membrane	
Free chlorine	ppm ppm x h		max. 200 max. 200,000 (at pH ≥ 9.5)	
H_2O_2 (Hydrogenperoxide)	ppm		max. 500	
Caustic Soda pH			max. 13	
Acid pH			min. 1	
Flux rate				
Filtration*	l/(m²h)	gfd	60 – 180	35 – 105
Backwash standard	l/(m²h)	gfd	230	135
Backwash range	l/(m²h)	gfd	230 – 300	135 – 175
Transmembrane pressure (TMP)				
Filtration*	bar	psi	0.1 – 1.5	1.5 – 20
Backwash standard*	bar	psi	0.3 – 3.0	5 – 40
Burst pressure membrane	bar	psi	> 10	> 150

* Specifications apply to common operating conditions.

Subject to technical modifications and errors. Modules are to be operated in accordance with the relevant “Installation, Operation and Maintenance Guidelines“. Customized configurations are available on request. Please contact the inge GmbH team if you require any further information.

Note

The descriptions, designs, data and information („Product Information“) contained herein are presented in good faith and are based on inge GmbH’s current knowledge and experience. inge GmbH cannot accept any liability for the accuracy of this Product Information, which is provided at no charge and for guidance only.

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INGE Membrane Validation

Consultancy performed at Mt Barker Wastewater Treatment Plant, Mt Barker, SA
March, 2012

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Australian Water Quality Centre

IMPORTANT:

In assessing this document please REFERENCE:

'VALIDATION OF INGE PROCESS' Document, where LRVs are described as credited to the process under conditions as follows (these, therefore, represent critical limits for the application of the LRVs for the INGE UF membrane):

- Transmembrane pressure (TMP) ≤ 201.5kPa
- Average normalised flux of = ≤ 100.0 L/m^2/Hr
- Unit to contain sufficient membrane integrity testing capacity and sensitivity to ensure 4---log Cryptosporidium and Giardia removal
- Direct integrity test pressure decay rate: < 10m/bar per min (sensitivity equalized to 4 LRV ms2 phage –{INGE supplied data})
- NTU: Must be ≤ 0.15 95%ile. Must never exceed 0.5 NTU

This report credits LRV's under the following process conditions, therefore, conservatively within the set critical limits:

- Transmembrane pressure (TMP) ≤ 109.7kPa max. value
- Average normalised flux of = 66.6 L/m^2/Hr
- Unit to contain sufficient membrane integrity testing capacity and sensitivity to ensure 4---log Cryptosporidium and Giardia removal
- Direct integrity test pressure decay rate: < 1m/bar per min (sensitivity equalized to 4 LRV ms2 phage –{INGE supplied data})
- NTU: 0.09 NTU max. value detected

Table of Contents

SCOPE

Australian Water Quality Centre

The Australian Water Quality Centre (AWQC) was engaged by Waterform Technologies to assist with virus surrogate challenge testing of an INGE ultrafiltration pilot plant that had been installed at the Mount Barker wastewater treatment plant (WWTP). This represents typical real life operational conditions. AWQC's role was to provide MS-2 bacteriophage for use as the challenge organism, to oversee the dosing of the MS-2 into the pilot plant during testing, to collect water samples pre and post the filters and to analyse the samples for MS-2. The pilot plant and dosing equipment was provided and operated by Waterform Technologies. The challange test protocol was according to the USEPA Membrane Filtration Guidance Manual LT2 (EPA 815-R-06-009) to ensure relevance to Australian Regulatory Government Departments. 3 separate surrogate dosing runs were completed however only 2 used for experimental data analysis as the results were uniform across all 3 surrogate challenge tests.

PURPOSE

The purpose of this UF membrane validation procedure was to build on existing extensive validation data compiled by INGE, in order to ensure relevance to Australian Regulatory Government Departments and existing or potential INGE clients, that are utilising the UF membrane in water reuse projects requiring Log Reduction Credits for certain pathogenic microorganisms.

Experimental Protocol

1. The pilot plant was supplied with secondary treated effluent (Actiflo clarifier) from the Mt Barker WWTP (Aerated Lagoon). A schematic of the treatment plant is provided in Appendix A.
2. The pilot plant operating conditions are given in Appendix B. The total filter run time was 25 minutes and the 2 filter modules were operated in parallel to achieve the desired flow rate.
3. A 20L dosing tank was filled with UF filtrate. MS-2 was added prior to challenge testing and the tank contents recirculated for 10 minutes at 12 L/min prior to testing. The injection point was immediately after the pre-UF filter (as shown on schematic), with sufficient distance and right angle bends in the pipes to allow for efficient mixing with the test water.
4. Sample taps were flame sterilised prior to sample collection and all samples were collected in duplicate. The times for sample collection are with reference to the start of the filter run.
5. In the first test run, the influent samples collected at approximately 3 minutes and 14 minutes and the filtrate samples were collected at 5 minutes and 12 minutes.
6. In the second test run, the influent sample was collected at 13 minutes and the filtrate sample was collected at 15 minutes.
7. Samples were placed on ice post collection. On completion of the filter trials the samples were transported to the AWQC laboratories and analysed as detailed below.

MS-2 Analysis

Counts for MS2 phage by plaque assay were performed as described in Appendix C. Briefly, the *E. coli* host strain was grown in tryptone soy broth supplemented with ampicillin until the culture reached log phase (approximately 5 hours at 35℃). 100 µL of sample and 20 µL *E. coli* were added to molten tryptone soy agar overlays, mixed and poured onto TSA plates containing ampicillin. Plates were incubated at 35℃ overnight and plaques were enumerated the following day.

Experimental {PLC Logged} results – INGE Multibore LRV

Feed Water Quality Data (Actiflo Clarified Effluent)

11.53am – 12.15pm RUN 1 SAMPLE

pH	TDS @ 180	SS	Turbidity	Al-Dissolved	Al- Total	Ammonia as N	NO x	TKN	Total N	Total P	BOD
6.5	600	13	4.6		0.38	3.69	21.50	8.3	29.8	0.37	<2

13.00pm – 13.15pm RUN 3 SAMPLE (RUN 2 Excluded from Analysis due to uniformity)

pH	TDS @ 180	SS	Turbidity	Al-Dissolved	Al- Total	Ammonia as N	NO x	TKN	Total N	Total P	BOD
6.3	598	9	3.0		0.26	1.47	22.20	4.3	26.5	0.37	<2

Temperature of the feedwater: 21° Deg C.

Operational parameters measured:

TMP = Trans Membrane Pressure. This is compensated as plant was feeding to atmospheric pressure.
Flow = m^3/Hr
Flux rate = 66.6 L/m2/hr
DIT (Direct Integrity Test – PASS <0-1 KPA pressure loss at 1bar hold pressure over 1 minute)

Time	Filtrate Pressure (kPa)	Flow (L/m^2/hr)	BW Flow (m^3/hr)	Filtrate Turbidity (NTU)	TMP (Kpa)	Mode	
11:53:00	9	66.7	8	<0.09	63.7	1	Filtration Bottom
11:55:00	12	66.7	8	0.08	69.7	1	Filtration Bottom
11:57:00	12	66.6	8	0.08	74.7	1	Filtration Bottom
11:59:00	12	66.7	8	0.08	80.2	1	Filtration Bottom
12:01:00	12	66.8	8	0.05	84.7	1	Filtration Bottom
12:03:00	12	66.7	8	0.05	90.2	1	Filtration Bottom
12:05:00	11	66.7	8	0.06	93.7	1	Filtration Bottom
12:12:52	12	66.8	8	0.09	93.2	1	Filtration Bottom
12:14:52	12	66.7	8	0.05	98.7	1	Filtration Bottom
12:16:28	4		3	0	32	3	Forward Flush Bottom
12:17:28	3		0	0	37	3	Forward Flush Bottom
12:17:30	2		0	0	12	5	Backwash Bottom
12:18:46	-3		17	0	-353	5	Backwash Bottom
12:20:46	8		8	0	1042	2	Filtration Top
12:22:46	12		8	0	1097	2	Filtration Top
12:24:34	4		4	0	62	4	Forward Flush Top
12:25:44	3		0	0	37	4	Forward Flush Top

12:25:46	3		0	0	37	6	Backwash Top
12:27:04	-3		12	0	-83	6	Backwash Top
12:31:44	9	66.8	8	0.05	69.7	1	Filtration Bottom
12:33:44	13	66.9	8	0.03	75.2	1	Filtration Bottom
12:35:44	12	66.6	8	0.03	81.2	1	Filtration Bottom
12:37:44	12	66.6	8	0.06	85.7	1	Filtration Bottom
12:39:44	13	66.7	8	0.06	90.2	1	Filtration Bottom
12:41:44	12	66.9	8	0.07	93.7	1	Filtration Bottom
12:42:38	4		3	0	37	3	Forward Flush Bottom
12:43:38	4		0	0	22	3	Forward Flush Bottom
12:43:40	3		0	0	27	5	Backwash Bottom
12:44:56	-3		16	0	-73	5	Backwash Bottom
12:46:56	9		8	0	1087	2	Filtration Top
12:48:42	4		3	0	67	4	Forward Flush Top
12:49:54	3		0	0	27	4	Forward Flush Top
12:49:56	2		0	0	27	6	Backwash Top
12:51:12	-4		12	0	-73	6	Backwash Top
13:00:14	9	66.9	8	0.05	95.7	1	Filtration Bottom
13:02:14	12	66.8	8	0.05	77.7	1	Filtration Bottom
13:04:14	12	66.8	8	0.09	82.7	1	Filtration Bottom
13:06:14	12	66.7	8	0.03	87.7	1	Filtration Bottom
13:08:14	12	66.9	8	0.06	91.7	1	Filtration Bottom
13:10:14	12	66.6	8	0.06	97.2	1	Filtration Bottom
13:12:14	12	66.6	8	0.08	100.7	1	Filtration Bottom
13:15:16	12	66.7	8	0	104.2	1	Filtration Bottom

Experimental Conclusion

The raw MS-2 data are presented in Appendix D. The trip controls (a phage aliquot kept at AWQC at 4℃ and a phage aliquot transported on ice with the phage used for dosing) show that transport had no effect on phage viability. The phage numbers in the influent water for all test conditions were similar, within 2 fold of each other for two batches of phage used in the separate filter runs.

Table 1. Observed log_{10} removals for MS-2 phage

INGE UF Multibore Ultra Filtration Membrane Demonstrated LRV's

	Filter run time		
Filter	5 min	12 min	15 min
Membrane 1	**5.86**	**5.75**	**6.37**
Membrane 2	**5.60**	**5.15**	**5.74**

The INGE Ultra Filtration membrane as subjected to virus surrogate challenge testing described herein, demonstrated high, consistant Log_{10} Reduction Values with a combined average of 5.76 across varying feed conditions and a constant flux rate of 66.6L/m2/HR.

The minimum membrane operating TMP (5 min Run Time) as opposed to the maximum membrane operating TMP (15 min Run Time) as indicative of solids loading, and the minimum influent NTU as opposed to the maximum influent NTU marginally though inconclusively influenced demonstrated LRVs.

Appendix A Pilot Plant Schematic

The Pilot plant consisted of two INGE Multibore UF modules manufactured by INGE Water Technologies, Germany.

Model: dizzer® XL 0.9 MB 60 x 2

Membrane Data:

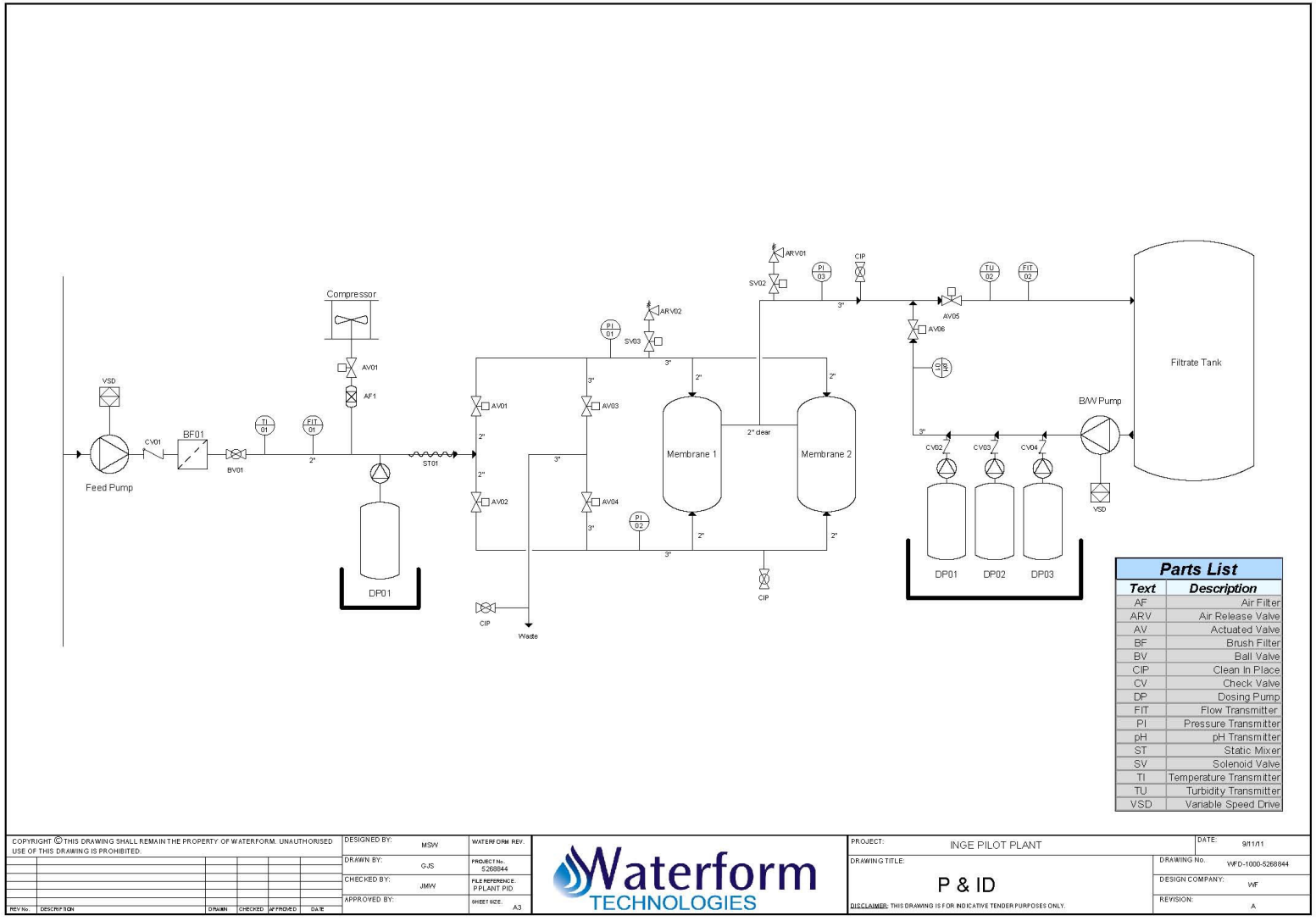
Capillaries per fibre 7
Inside diameter mm 0.9
Outside diamter mm 4.0
Pore size µm approx. 0.02
Material PESM

Free chlorine ppm
max. 200
max. 200,000 ppm x h

H_2O_2 (Hydrogenperoxide) ppm max. 500
Caustic Soda pH max. 13
Acid pH min. 1

Filtration lmh 60 – 180
Backwash standard range
lmh 230 – 300

Filtration bar 0.1 – 1.5
Backwash bar 0.3 – 3.0
Burst pressure bar 10


Compressor
VSD
AV01
AF1
CV01
BF01
BV01
TI 01
FIT 01
ST01
Feed Pump
DP01
AV01
AV02
AV03
AV04
ARV02
SV03
PI 01
PI 02
Membrane 1
Membrane 2
2" clear
CIP
Waste
ARV01
SV02
PI 03
CIP
TU 02
FIT 02
AV05
AV06
Filtrate Tank
B/W Pump
CV02
CV03
CV04
VSD
DP01
DP02
DP03
Parts List
Text
Description
AF
Air Filter
ARV
Air Release Valve
AV
Actuated Valve
BF
Brush Filter
BV
Ball Valve
CIP
Clean In Place
CV
Check Valve
DP
Dosing Pump
FIT
Flow Transmitter
PI
Pressure Transmitter
pH
pH Transmitter
ST
Static Mixer
SV
Solenoid Valve
TI
Temperature Transmitter
TU
Turbidity Transmitter
VSD
Variable Speed Drive
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REV No.
DESCRIPTION
DRAWN
CHECKED
APPROVED
DATE
DESIGNED BY: MSW
DRAWN BY: GJS
CHECKED BY: JMW
APPROVED BY:
WATERFORM REV.
PROJECT No. 5268844
FILE REFERENCE. P PLANT PID
SHEET SIZE. A3
Waterform TECHNOLOGIES
PROJECT: INGE PILOT PLANT
DATE: 9/11/11
DRAWING TITLE: P & ID
DRAWING No. WFD-1000-5268844
DESIGN COMPANY: WF
REVISION: A
DISCLAIMER: THIS DRAWING IS FOR INDICATIVE TENDER PURPOSES ONLY.

Appendix B Pilot Plant Operation

Test Unit with continuous seeding from a stock solution reservoir, chemical metering pump, and in-line mixer according to section 3.11.1, Membrane Filtration Guidance Manual, EPA 815-R-06-009

1.1. feed pressure created by VSD driven pumps
1.2. Digital pressure sensors at inlet and outlet of the modules
1.3. Pressure-free permeate outlet for sampling TMP-F is the trans-membrane pressure TMP1 or TMP2 of the membrane process
1.4. Collection of permeate on a digital balance and PC data recording for a real-time measurement of the current filtrate volume, flow rate or flux.
1.5. Flow meter in the feed
1.6. Digital thermometer in the permeate (Temp.)
1.7. Sampling points for feed and permeate
1.8. Flow meter in the permeate for a Backflush of a module with vBF = 2·vflux filtration

2. Modules

2.1. Recording the following information / parameter from the manufacturer

- Manufacturer, address of its head office
- Trade name and general type of the membrane
- Number of the module / membrane series
- Number of the module lot / membrane lot
- active membrane area
- flux for the filtration mode during testing (66.6 /(m²·h)
- expected trans-membrane pressure
- Temperature for testing

3. Preliminary Steps

3.1. Assessment of the source water
3.2. Temperature

4. Testing Steps (for Each Module)

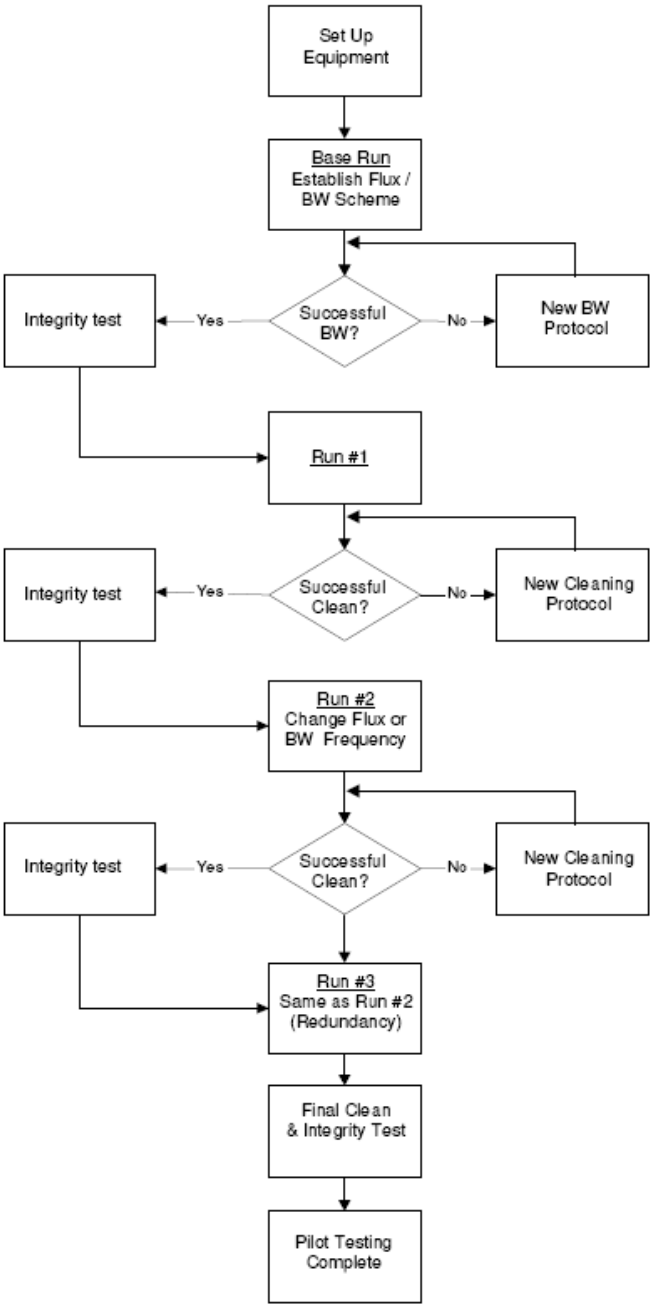
4.1. Pressurising feed with VSD driven pumps (PfW) and backwash of the module with the double filtration flux or flow rate
4.2. DIT
4.3. Start of filtration, start of data recording from the balance, first adjustment of the flow rate from the flow meter (automatic)
4.4. Reading of the trans-membrane pressure TMP1j = TMPF
4.5. Reading of permeate temperature (Temp.)
4.6. after 5 min filtration:
- Reading of the permeate weight (balance) V1j
- Reading of the trans-membrane pressure TMP2j = TMPF
- corresponding sampling for both modules sequentially: P1-INj (Feed) und P1-OUTj (Filtrate)

4.7. Backwash of both modules
4.8. DIT
4.9. Again start of filtration, start of data recording from the balance, first adjustment of the flow rate from the flow meter (feed valve) and fine tuning with the recorded data
4.10. Reading of the trans-membrane pressure TMP3j = TMPF
4.11. Reading of permeate temperature (Temp.)
4.12. after 5 min filtration:
- Reading of the permeate weight (balance) V2j
- Reading of the trans-membrane pressure TMP4j = TMPF
- corresponding sampling for both modules sequentially: P2-INj (Feed) und P2-OUTj (Filtrate)

4.13. Backwash of both modules
4.14. DIT
4.15. Again start of filtration, start of data recording from the balance, first adjustment of the flow rate from the flow meter (feed valve) and fine tuning with the recorded data
4.16. Reading of the trans-membrane pressure TMP3j = TMPF
4.17. Reading of permeate temperature (Temp.)
4.18. after 5 min filtration:
- Reading of the permeate weight (balance) V2j
- Reading of the trans-membrane pressure TMP4j = TMPF
- corresponding sampling for both modules sequentially: P2-INj (Feed) und P2-OUTj (Filtrate)

4.19. Backwash of both modules
4.20. Complete protocol with all data
4.21. Demounting of the seeding & pilot mechanisms

Figure 6.2 Sample Pilot Study Sequence Overview



Appendix C MS-2 Phage Methodology

Background

Bacteriophage are viruses that infect bacteria. MS2 belongs to the F-RNA bacteriophage. They are called this because they infect bacterial cells that have a molecule on their cell wall known as an F-pilus and their genomes are made of RNA (many other organisms like humans and viruses have DNA genomes).

Enumeration of MS2

MS2 are counted by a technique known as a plaque count using one of the species of bacteria that can be infected by MS2, *Escherichia coli*. The *E. coli* host is grown in a nutrient broth and mixed with the sample containing the MS2 phage and liquid agar (called an overlay). This is poured onto a petri dish containing growth medium and allowed to set before being incubated overnight. The *E. coli* grow to cover the plate, forming a "lawn" of bacteria. MS2 bacteriophage infection kills host cells, so areas on the plate containing phage have no cell growth, showing as clear zones in the bacterial lawn (called plaques). Each plaque represents an individual MS2 bacteriophage. The number of plaques are counted and the density of phage in the original sample is calculated taking into account the volume of sample analysed and any dilution of the sample during processing.

Preparation of MS2

There are several ways that phage can be prepared in large quantities. Our current method is to mix *E. coli* and phage and plate them as above. We use enough phage so that the whole plate is covered in plaques (there are so many that it is not possible to see individual plaques). The top layer of cells is scraped into a liquid buffer and any remaining cells are removed by centrifugation. This is done for many plates to produce the number of phage required for filtration or disinfection validation. The buffer is then filtered to ensure that only MS2 are left in the liquid. This preparation is counted as per above to determine the number phage produced.

Technical description of MS-2 methods
(based on methods for MS-2 described in the USEPA LT2ESWTR)

MS2 Phage Assay
The concentration of MS2 phage (ATCC 15597-B1) in water samples can be assayed using agar overlay technique with *E. coli* (ATCC 15597) as a host bacterium [(Adams (1959), Yahya et al. (1992), Oppenheimer et al. (1993), and Meng and Gerba (1996)]. Each test sample should be assayed in triplicate and the sample concentration calculated as the arithmetic average of the three measured values. The following procedure can be used:

Procedure:
1. Inoculate sterile TSB (Difco, Detroit, Michigan) containing 150 µg/mL Ampicillin and 150 µg/mL Streptomycin with the host bacterium (*E. coli* 700891) and incubate at 35°C for 18 to 24 hours to obtain an approximate concentration of 10^8 cfu/mL.
2. Transfer 1 mL of the host bacterial culture to 50 mL of fresh TSB and incubate at 35 to 37°C for 4 to 6 hours with continuous shaking at 100 Hz to obtain a culture in its log growth phase.
3. Obtain serial dilutions of the sample containing MS2 phage using TSB.
4. Combine and gently mix 20 µL of host cell solution, 100 µL of diluted MS2 phage sample, and 5 mL of molten tryptic soy agar (TSA) (0.7 percent agar, 45 to 48°C) (Difco).
5. Pour the mixture onto solidified TSA (1.5 percent agar) contained in petri dishes. The time between mixing the MS2 phage sample with the *E. coli* host and plating the top agar layer should not exceed 10 minutes. After plating, the agar should harden in less than 10 minutes.
6. After the top agar layer hardens, cover and invert the petri dishes, and incubate 16 to 24 hours at 37°C.
7. Count the plaques. Plaques are identified as clear circular zones 1 to 5 millimeter (mm) in diameter in the lawn of host bacteria.
8. Record the number of plaques per dish and the MS2 phage sample volume and dilution. If individual plaques cannot be distinguished because of confluent growth, record the plate counts as “TNTC” (too numerous to count). Ideally count plates with >20 but <200 plaques.
9. Calculate the MS2 phage concentration in the water samples:

$$\text{pfu/mL} = \frac{(\text{count rep 1 + rep 2 + rep3})}{\text{Number replicates}} \times \frac{1}{\text{dilution factor } (10^{-x})} \times \frac{1}{\text{volume plated (mL)}}$$

Appendix D Raw results

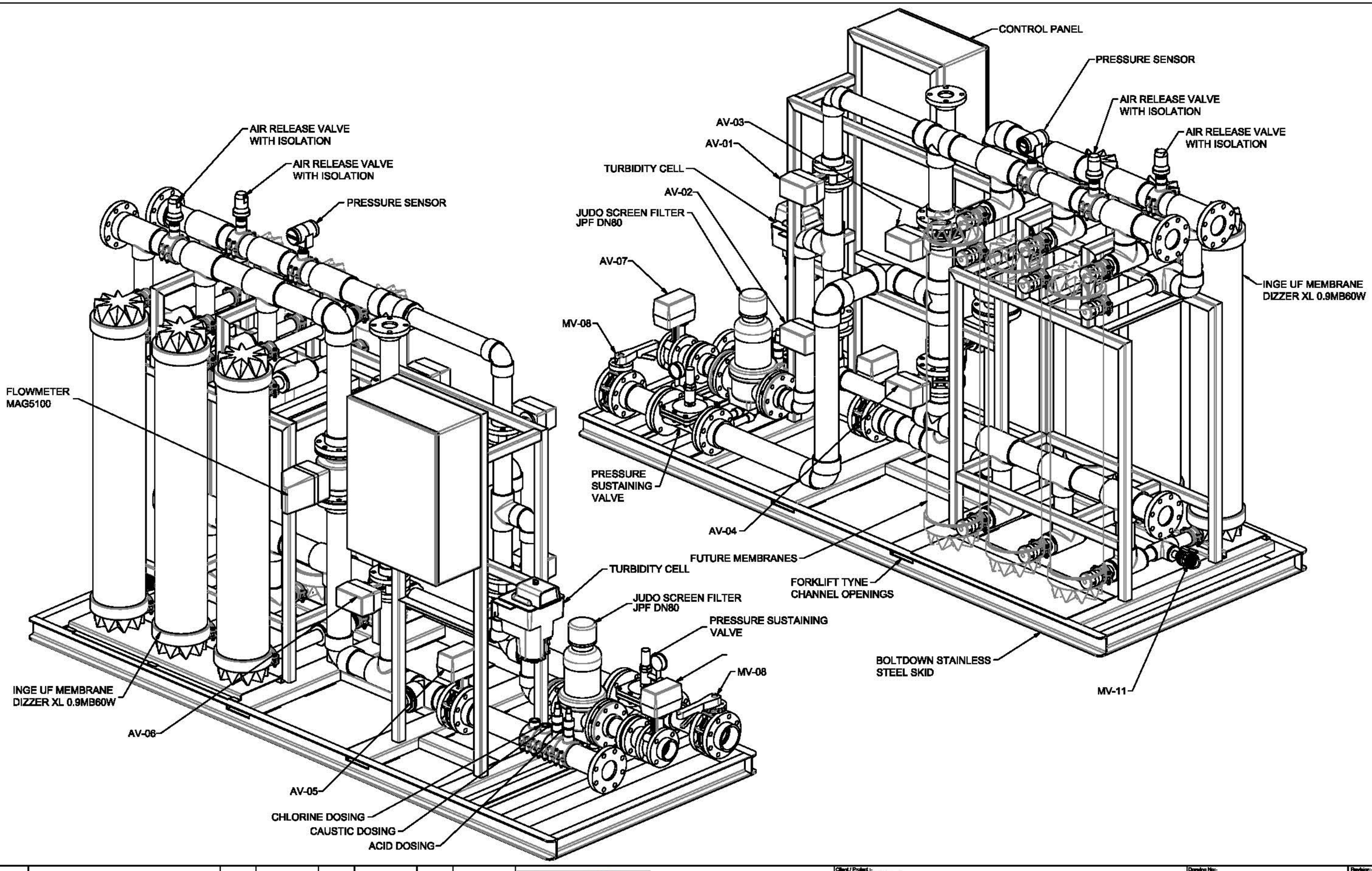
		Dilution									
Description	**Sample**	**N**	**-1**	**-2**	**-3**	**-4**	**-5**	**-6**	**-7**	**Pfu/mL**	**log removal**
Inlet	1A				TNTC	TNTC	TNTC	275		2.75E+09	
	1B				TNTC	TNTC	TNTC	166		1.66E+09	
	2A				TNTC	TNTC	TNTC	93		9.30E+08	
	2B				TNTC	TNTC	TNTC	163		1.63E+09	
	3A				TNTC	TNTC	TNTC	351		3.51E+09	
	3B				TNTC	TNTC	TNTC	385		3.85E+09	
Left Filter	1A	TNTC	29	2						2.90E+03	5.86
	1B	TNTC	32	5						3.20E+03	
	2A	TNTC	25	3						2.50E+03	5.75
	2B	TNTC	21	1						2.10E+03	
	3A	170	15	0						1.70E+03	6.37
	3B	143	15	0						1.43E+03	
Right Filter	1A	TNTC	38	4						3.80E+03	5.60
	1B	TNTC	72	8						7.20E+03	
	2A	TNTC	97	4						9.70E+03	5.15
	2B	TNTC	85	11						8.50E+03	
	3A	TNTC	57	8						5.70E+03	5.74
	3B	TNTC	78	9						7.80E+03	
trip control, stay									144	1.44E+10	
trip control, travel									127	1.27E+10	

TNTC = too numerous to count (too many plaques to count)
1 = sample from 5 minutes, 2 = sample from 12 minutes, 3 = sample from 15 minutes filter run time
A, B indicates the replicate

Appendix E Attendees

Dr Paul Monis – AWQC - Microbiology Research Leader
Paul has hands on experience with microorganism challenge testing & validation of critical components in various water reuse projects, with a thorough understanding of the protocols contained within the USEPA Membrane Filtration Guidance Manual LT2 (EPA 815-R-06-009) and the USEPA Ultra Violet Disinfection Guidance Manual LT 2 (EPA 815-R-06-007)
Kamran Mangi – SA Health - Dept Wastewater Management Section
Kamran, as a senior engineer within SA Health Wastewater Management Section, has a key role in assessments and approvals relevant to wastewater reuse technologies including membranes.
Madhawa Rupsinghe - CWMS Engineer - The District Council of Mount Barker
Madhawa is a senior engineer and responsible for wastewater treatment processes and associated assest creation.
Mark Millington – DCMB Operations Manager
Mark is a senior operations manager and oversees day to day running of various water and wastewater treatment facilities.
Simon Page – CRC Operations
Simon is a senior operations manager with CRC and oversees day to day running of various water and wastewater treatment facilities.
Jonathan Ham - CRC Engineer
Jonathan is a process engineer with CRC.
Tim Way – Waterform Technical Manager
Tim is technical manager for INGE business development in Australia / NZ.

Appendix F Membrane Validation Pilot Plant Photo



REVISIONS

Version	Description	Drawn By	Date and Signature	Checked By	Date and Signature	Client Approval By	Date and Signature
A	Concept ONLY	BP	08/10/2012	JW	09/10/2012		

SAS Water Solutions Pty Ltd
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Ph: +61 2 9620 4900 Fax: +61 2 9620 4388
ABN 52 100 723 402

Client / Project :-
SOLO Water
Catherine Hill Bay

Drawing No:- **E11014**

Revision:- **A**

Title:-
SPC Ultrafiltration
GENERAL ARRANGEMENT

A3

Client File Name:-
N/A

SHEET 1 OF 1

WEDECO
a xylem brand

Description — Series LBX

Main Applications

Disinfection of effluents with low or highly variable UV transmittance:

- Biologically treated waste water
- Process water for industrial use
- Specific drinking water qualities

Water temperature	LBX 3 – LBX 50:	recommended range	5 - 25°C (41 – 77°F)
		possible range	0 - 35°C (32 – 95°F)
	LBX 90e – LBX 1500e:	recommended range	5 - 45°C (41 – 113°F)
		possible range	0 – 60°C (32 – 140°F)
Water UV transmittance (@ 254 nm, 1 cm)			35-100% (LBX 850e, LBX 1500e: 20-100%)
Flow capacity			max. 2121 m³/h (9340 GPM)

Technical Description

- Cylindrical stainless steel reactor with integrated baffle plates
- High efficiency low pressure UV lamp(s), easily removable, concentrically arranged
- Calibrated UV intensity monitoring system
- Electronic UV lamp supervision system
- Automatic wiping system (option)
- Dose pacing incl. variable lamp power (option for LBX 90e – LBX 1500e)
- UVDGM conform validation for LBX 90e, LBX 400e, LBX 850e, LBX 1000e, LBX 1500e
- NWRI conform validation for LBX 90e, LBX 400e, LBX850e, LBX 1000e, LBX1500e

UV REACTOR	*Material*:	Stainless steel 1.4404/1.4435 (ASTM 316L)
	Mounting:	preferably horizontal
	Pipe connection:	flanges (DIN-EN 1092 or ANSI B16.5 150 lbs.)
	Reactor Shape:	'U' shape standard, optional 'Z' shape (LBX 850e, LBX 1500e: 'L'-shape only)
	Seals:	O-rings, Fluorocarbon-India rubber (FDA-, DVGW and KTW-approved)
	Components:	baffle plates, UV sensor, cleaning valves
UV Lamp	LBX 3 – LBX 50: Spektrotherm UV lamps LBX 90e – LBX 1500e: ECORAY® Indium-Amalgam UV lamps for higher ambient temperatures and longer lamp life	
UV Sensor	Calibrated, ÖVGW certified, 100% day-light blind, accuracy ± 3%, selectivity 240 – 290 nm > 90%, temperature stability up to 70°C (158°F) during continuous operation	

Description — Series LBX

CONTROL BOX

ELECTRICAL CABINET

LBX 3: Painted Polystyrene enclosure, wall mounted

LBX 10 – LBX 50: Painted sheet steel enclosure, wall mounted

LBX 90e – LBX 200e: Painted sheet steel enclosure, wall mounted

LBX 400e – LBX1500e: Painted sheet steel enclosure, stand-alone incl. plinth 100 mm

Design

Ready for connection, incl. lamp cables of 5 m CE or 12m cUL standard, other cable length optional

Power factor ~ 0.98

Supply voltage LBX 3 – LBX 50:
230 V / 50 - 60 Hz (TN-S-net, TN-C-net)
LBX 90e – LBX 1500e
CE: 400/230 +/- 10 %, 50 Hz (TN-S Net)
cUL: 480/277 +/- 10 %, 60 Hz (5 Wire WYE; L1,L2,L3,N,GND)

Ambient temperature for LBX 3 – 50 max. 35 °C / 95 °F
for LBX 90e - LBX 1500e max. 40 °C / 104 °F
(with A/C: 50 °C / 122 °F)

Components

LBX 3: Selector switch (Hand - O - Auto), thermal fuse
LBX 10 - LBX 50: Main switch, selector switch (Test - O – Normal), cooling fan
LBX 3 - LBX 50: SEC controller with blue illuminated operator panel
LBX 90e – LBX 1500e: Main switch, cooling fan, EcoTouch controller with operator touch panel

Electronic ballasts (with ECORAY® technology for LBX 90e - 1500e)
UV intensity measuring system with norm signal-output
Electronic single lamp surveillance
LED indicators: *normal operation, pre-alarm, alarm*
LC display*:* *W/m²* (UV intensity),
operation hours (2x: total, UV lamps),
on/off cycles,
status messages (available languages: English, German, Spanish, French and Italian)

Terminals

Remote *ON/OFF*
Signal *'UV intensity'* adjustable 4 - 20 mA
Volt-free contacts: *system running, low priority warning, high priority alarm*, *enable flow*, *enable wiper*
Power supply *wiper* (if automatic wiping system is selected)

Opti Dose (option)

LBX systems that are equipped with WEDECO's latest ECORAY® lamp technology allow for variable UV-C output (50 - 100%) without need for costly PLC control. With the Ecoray technology the advanced WEDECO "Opti Dose" control philosophy can be applied resulting in optimized energy consumption (for power savings up to 20%) and extended lamp life with no compromise to the disinfection performance.

Automatic Wiping System (option)

Each lamp sleeve is kept clean by several wiper rings; also the UV sensor window is kept clean by brushes. The electrical motor and its electronic controls are the main components of this external actuator unit. Wiping intervals per hour are adjustable directly at the operator touch panel.

Description — Series LBX

Model	LBX 3	LBX 10	LBX 20	LBX 33	LBX 50

UV Reactor					
Flange connections	R 1 ½"	DN 50	DN 80		DN 100
Cleaning valves	¼"	½"			
Dimensions	please refer to the respective drawing				
Volume (l/gal) approx.	1.6/.4	13/3	21/6	29/8	41/11
Total weight, dry (kg/lb) approx.	10/22	29/64	36/79	45/99	60/132
Weight reactor inserts (kg/lb) approx.	3.5/8	10/22	14/31	15/33	26/57
Operating pressure (bar/PSI), max.	10/145	16/232			
Protection class	IP 65, with wiper IP54				

UV Lamps					
Type	XLR10				
Lamp power (W)	70				
UV-C output 254 nm (W)	25				
Quantity	1	3	6	8	12
Lamp life (h)	8,760				

Calibrated UV Monitoring System	
UV sensor	SO 13599 (UCA) acc. ÖNORM
Electronics	SEC
Standard output signal	0/4 – 20 mA
Quantity	1

Control Box/ Electrical Cabinet					
Width (mm/in) approx.	295/11.6	380/15			600/23.6
Height (mm/in) approx.	310/12.2	600/23.6			600/23.6
Depth (mm/in) approx.	175/6.9	210/8.3			350/13.8
Weight (kg/lb) approx.	8/17.6	22/48.5	23/50.7	25/55.1	56/123.5
Colour painting	RAL 7035, grey				
Supply voltage (V/Hz)	230/50-60				
Power consumption (kW) approx.	0.1	0.34	0.6	0.76	1.1
Approvals	CE				
Protection class	IP 54				
Mains terminals	L / N / PE				

Options / Accessories (extra charges)

- Stainless steel Electrical cabinet 1.4301 (ASTM 304)
- Reactor vessel in 'Z'-design
- Sample valve (R ¼"-male)
- Automatic wiping system (not available for LBX 3)
- Cable length 7 or 10 m

Description — Series LBX

Model	LBX 90e	LBX 120e	LBX 200e	LBX 400e
UV Reactor				
Flange connections	DN 150/ANSI 6”		DN 200/ANSI 8”	DN 250/ANSI 10”
Cleaning valves	½”		¾“	
Dimensions	please refer to the respective drawing			
Volume approx. (l/gal)	45/12	61/16	107/28	140/37
Total weight, dry approx. (kg/lb)	90/198	110/242	170/375	180/397
Weight reactor inserts (kg/lb) approx.	21/46	27/60	60/132	65/143
Operating pressure, max. (bar/PSI)	16/232	10/145		
Protection class	IP 65 / with wiper IP54 (for US Nema 4x)			
UV Lamps				
Type	ECORAY® ELR30-1			
Lamp power (W)	285			
UV-C output 254 nm (W)	150			
Quantity	4	6	10	16
Lamp life (h)	up to 14,000			
Calibrated UV Monitoring System				
UV sensor	SO 13599 (UCA) acc. ÖNORM			
Electronics	EcoTouch			
Standard output signal	4 – 20 mA			
Quantity	1			
EcoTouch Electrical Cabinet (for optional PLC cabinets see Cabinet layout drawings)				
Width (mm/in) approx. (with AC)	600/24			800/31.5 (1188/46.8)
Height (mm/in) approx. (with AC)	600/24 (1015/40)			2100/83 (2200/87)
Depth (mm/in) approx.	400/16			600/24
Weight (kg/lb) approx. (with AC)	52/115 (90/199)	53/117 (91/201)	54/119 (92/203)	330/728 (400/882)
Colour painting	RAL 7035, grey			
Supply voltage (V / V / Hz)	400..480/230..277 / 50-60			
Power consumption (kW) approx. Fan (Air Condition)	1.41 (2.11)	2.01 (2.71)	3.21 (3.91)	5.20 (8.30)
Protection class	IP 54 / cUL Type 12 (IP 55 and cUL Type 4X optional)			
Mains terminals	(3) L / N / PE			

WEDECO
a xylem brand

Description — Series LBX

Model	LBX 550e	LBX 1000e	LBX 850e	LBX 1500e
UV Reactor				
Flange connections	DN 300/ ANSI 12”	DN 400/ ANSI 16”	DN 400/ ANSI 16”	DN 500/ ANSI 20”
Cleaning valves	1"			
Dimensions	please refer to the respective drawing			
Volume approx. (l/gal)	260/69	685/181	460/122	778/206
Total weight, dry approx. (kg/lb)	450/992	570/1257	550/1213	853/1881
Weight reactor inserts (kg/lb) approx.	160/353	220/485	50/110	79/174
Operating pressure, max. (bar/PSI)	10/145			
Protection class	IP 65 / with wiper IP54 (for US Nema 4x)			
UV Lamps				
Type	ECORAY® ELR30-1			
Lamp power (W)	285			
UV-C output 254 nm (W)	150			
Quantity	24	40	32	60
Lamp life (h)	up to 14,000			
Calibrated UV Monitoring System				
UV sensor	SO 13599 (UCA)*		S20101* UVDGM	
Electronics	EcoTouch			
Standard output signal	4 – 20 mA			
Quantity	1			

* gem. ÖNORM M5873-1

EcoTouch Electrical Cabinet (for optional PLC cabinets see Cabinet layout drawings)				
Width (mm/in) approx. (with AC)	800/31.5 (1188/46.8)			1000/39.4 (1588/62.5)
Height (mm/in) approx. (with AC)	2100/83 (2200/87)			
Depth (mm/in) approx.	600/24			
Weight (kg/lb) approx. (with AC)	330/728 (400/882)	345/761 (415/915)	350/772 (425/937)	450/992 (533/1175)
Colour painting	RAL 7035, grey			
Supply voltage (V / V / Hz)	400..480/230..277 / 50-60			
Power consumption (kW) approx. Fan (Air Condition)	7.60 (10.70)	12.40 (15.50)	10.00 (13.10)	18.40 (21.50)
Protection class	IP 54 / cUL Type 12 (IP 55 and cUL Type 4X optional)			
Mains terminals	(3) L / N / PE			

Options / Accessories (extra charges)

- Stainless steel cabinet enclosure, material stainless steel 1.4301 /ASTM304
- Reactor vessel in 'Z'-design (850e available in L design only)
- DN or ANSI flanges alternatively available
- Sample valve (R ¼”-male)
- Dose pacing incl. variable lamp power
- Automatic wiping system (for LBX 850e/LBX1500e optional stainless steel wiper brushes available)
- Cable length 10m,15m or 25 m for CE, or 25m for UL
- Air conditioning for max. ambient temperatures of 50°C/122°F

Options not included in the sales pricelist have to be requested at the Sales Support Team in Herford

TORAY
Innovation by Chemistry

High rejection BWRO, enhanced chemical tolerance

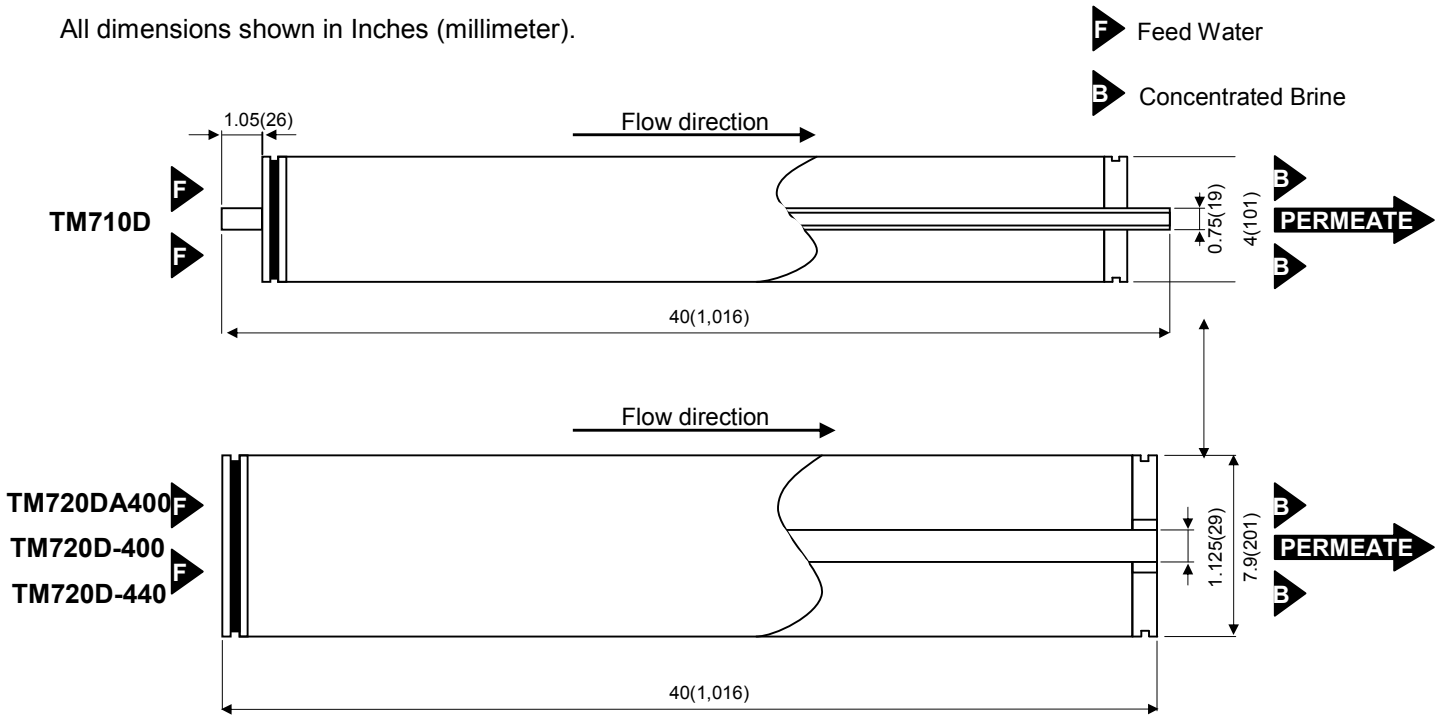
T M 7 0 0D

Type	Diameter Inch	Membrane Area $ft^2(m^2)$	Salt Rejection %	Product Flow Rate $gpd(m^3 / d)$	Feed Spacer Thickness mil
TM710D	4”	87(8)	99.8	2,600(9.8)	31
TM720DA400	8”	400(37)	99.8	11,000(41.6)	31
TM720D-400	8”	400(37)	99.8	11,000(41.6)	34
TM720D-440	8”	440(41)	99.8	12,100(45.8)	28

1. Membrane Type		Cross Linked Fully Aromatic Polyamide Composite
2. Test Conditions	Feed Water Pressure Feed Water Temperature Feed Water Concentration Recovery Rate Feed Water pH	225 psi(1.55MPa) 77° F(25℃) 2,000 mg/l Nacl 15% 7
3. Minimum Salt Rejection		99.65%
4. Minimum Product Flow Rate		2,150gpd(8.2m^3/d)(TM710D) 8,900gpd(33.6m^3/d)(TM720DA400) 8,900gpd(33.6m^3/d)(TM720D-400) 9,800gpd(37.0m^3/d)(TM720D-440)

Dimensions

All dimensions shown in Inches (millimeter).



Operating Limits

Maximum Operating Pressure	600psi (4.1 MPa)
Maximum Feed Water Temperature	113° F (45℃)
Maximum Feed Water SDI_{15}	5
Feed Water Chlorine Concentration	<0.1ppm
Feed Water pH Range, Continuous Operation	2-11
Feed Water pH Range, Chemical Cleaning	1-13
Maximum Pressure Drop per Element	20psi (0.14 MPa)
Maximum Pressure Drop per Vessel	60psi (0.4 MPa)

Operating Information

1. For the recommended design range, please consult the latest Toray technical bulletin, design guide lines, computer design program, and/ or call an application specialist. If the operating limits given in this Product Information Bulletin are not strictly followed, the Limited Warranty will be null and void.
2. All elements are wet tested, treated with a 1% by weight percent sodium bisulfite storage solution, and then vacuum packed in oxygen barrier bags, or treated with tested feed water solution, and then vacuum packed in oxygen barrier bags with deoxidant inside. To prevent biological growth during short term storage, shipment, or system shutdown, it is recommended that Toray elements be immersed in a protective solution containing 500 - 1,000 ppm of sodium bisulfite (food grade) dissolved in permeate.
3. The presence of free chlorine and other oxidizing agents under certain conditions, such as heavy metals which acts as oxidation catalyst in the feed water will cause unexpected oxidation of the membrane. It is strongly recommended to remove these oxidizing agents contained in feed water before operating RO system.
4. Permeate from the first hour of operation shall be discarded.
5. The customer is fully responsible for the effects of chemicals that are incompatible with the elements. Their use will void the element Limited Warranty.

Notice

1. Toray accepts no responsibility for results obtained by the application of this information or the safety or suitability of Toray's products, either alone or in combination with other products. Users are advised to make their own tests to determine the safety and suitability of each product combination for their own purposes.
2. All data may change without prior notice, due to technical modifications or production changes.

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JUL. 2013

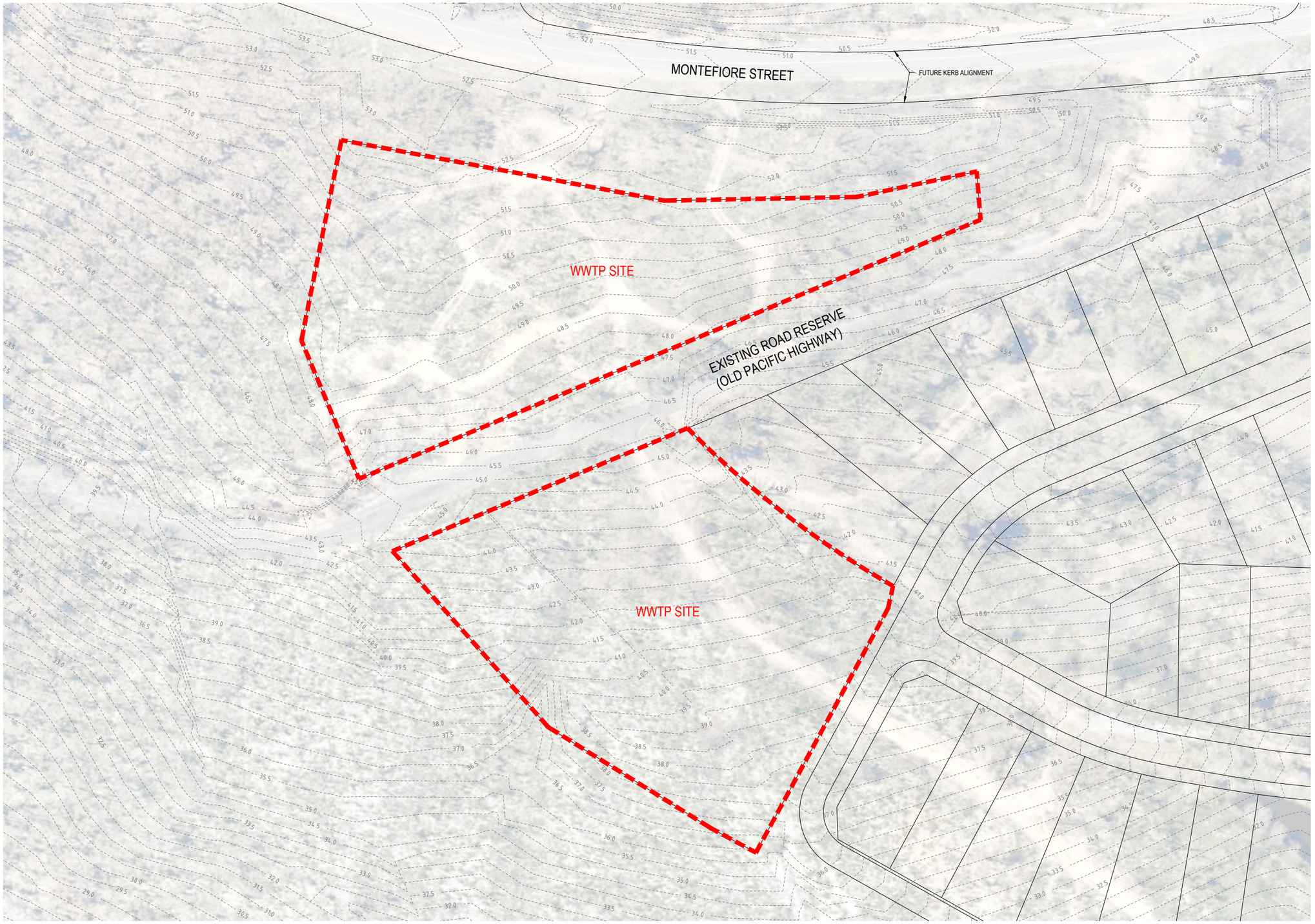
Appendix D

WWTP Site Civil Engineering Plans

DATE PLOTTED: 13 June 2014 4:34 PM BY : LUKE WARD

XREFs: x_STAGE_1_BASE; X-CO-Contours-Existing-500

CAD FILE: U:\PY\141058-02_Catherine Hill Bay WWTP\02 - Catherine Hill Bay WWTP\Drawings\Build\82014058-02-C5001.dwg



NORTH

LEGEND

PROPOSED WWTP BOUNDARY

30.0 EXISTING CONTOURS (0.5m INTERVAL)

EXISTING SITE PLAN

SCALE 1:500

0 10 20 30 40 50m

SCALE 1:500 @A1

SCALE 1:1000 @A3

Rev	Date	Description	Des.	Verif.	Appr.
1	13/06/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

SOLO Water
Water Utility Solutions

Cardno
Shaping the Future
ABN: 95 001 145 035
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Phone (+61 2) 4228 4133 Fax (+61 2) 4228 6811
Email: CFR@cardno.com.au Web: www.cardno.com.au

Drawn	LJW	Date	12/06/2014
Checked	JMW	Date	12/06/2014
Designed	JMK	Date	12/06/2014
Verified	JMK	Date	12/06/2014
Approved	JMK	Date	13/06/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

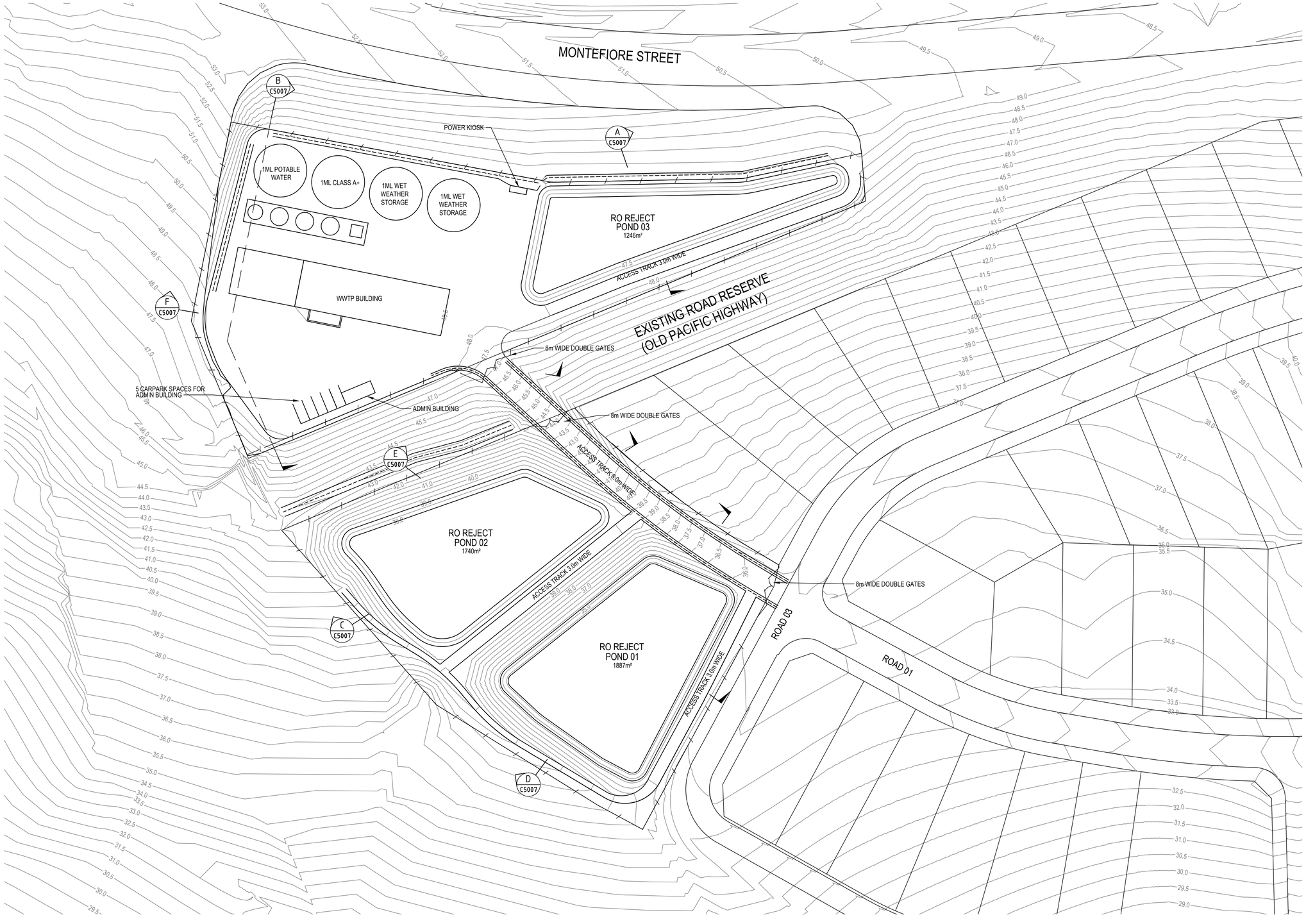
EXISTING SITE PLAN

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Datum	Register	Scale	Size
A.H.D.	----	1:500	A1

Drawing Number: 8201405802-C5001

Revision: 1



SITE PLAN
SCALE 1:500

LEGEND

PROPOSED FENCE

30.0 CONTOURS (0.5m INTERVAL)

0 10 20 30 40 50m

SCALE 1:500 @A1

SCALE 1:1000 @A3

Rev	Date	Description	Des.	Verif.	Appr.
5	2/10/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
4	23/09/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
3	30/07/2014	GENERAL AMENDMENTS	LJW	JMK	JMK
2	25/07/2014	GENERAL AMENDMENTS	LJW	JMK	JMK
1	13/06/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

SOLO Water
Water Utility Solutions

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		Date
Drawn	LJW	28/07/2014
Checked	JMW	28/07/2014
Designed	JMK	28/07/2014
Verified	JMK	28/07/2014
Approved	JMK	28/07/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

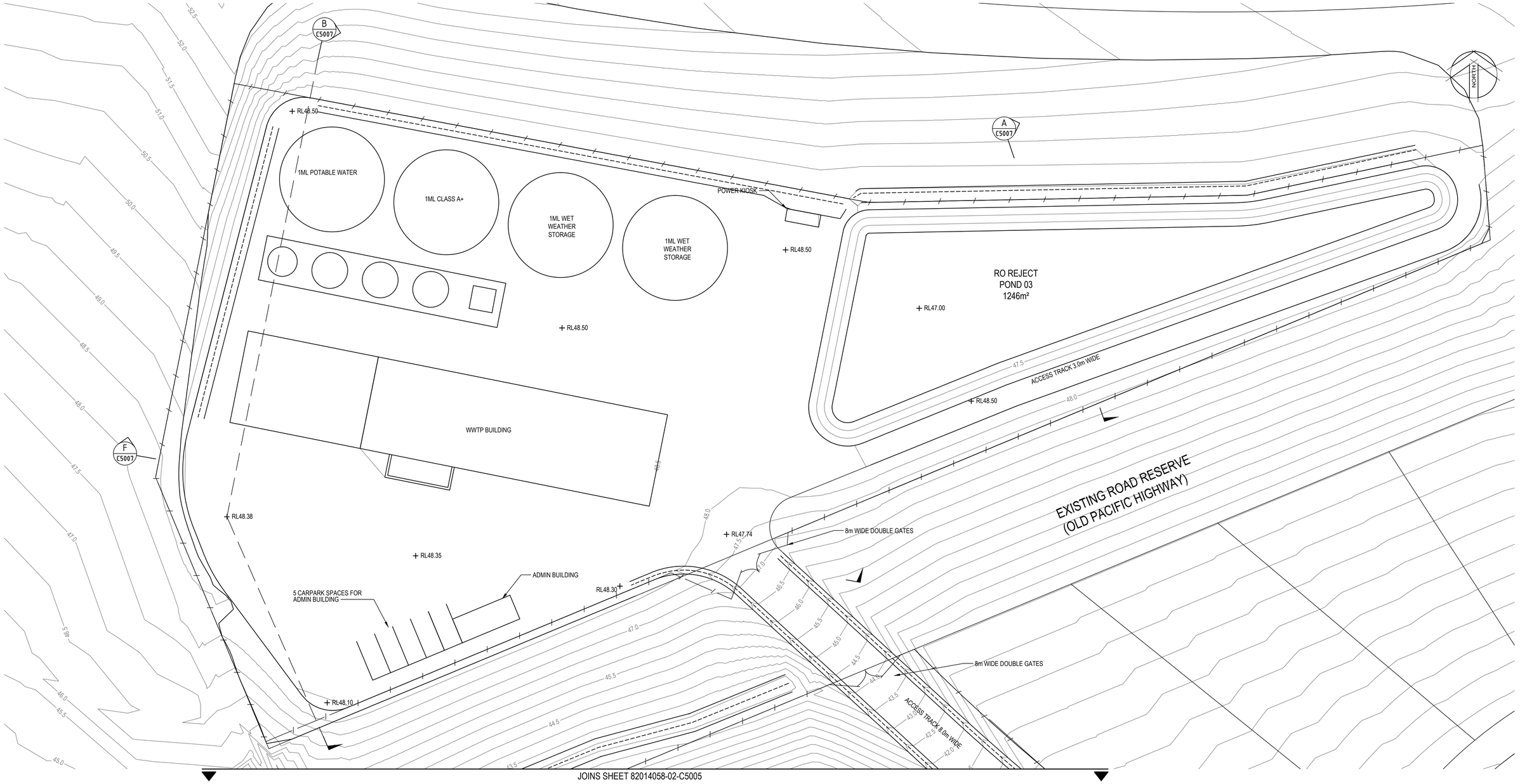
SITE PLAN

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

AHD	Register	Scale	Size
Datum	----	1:500	A1

Drawing Number: 82014058-02-C5002

Revision: 5



GENERAL ARRANGEMENT PLAN 1

SCALE 1:250

LEGEND

- PROPOSED FENCE
- 30.0 CONTOURS (0.5m INTERVAL)

0 5 10 15 20 25m

SCALE 1:250 @A1

SCALE 1:500 @A3

Rev	Date	Description	Des.	Verif.	Appr.
3	2/10/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
2	23/09/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
1	30/07/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

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		Date
Drawn	LJW	28/07/2014
Checked	JMW	28/07/2014
Designed	JMK	28/07/2014
Verified	JMK	28/07/2014
Approved	JMK	28/07/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

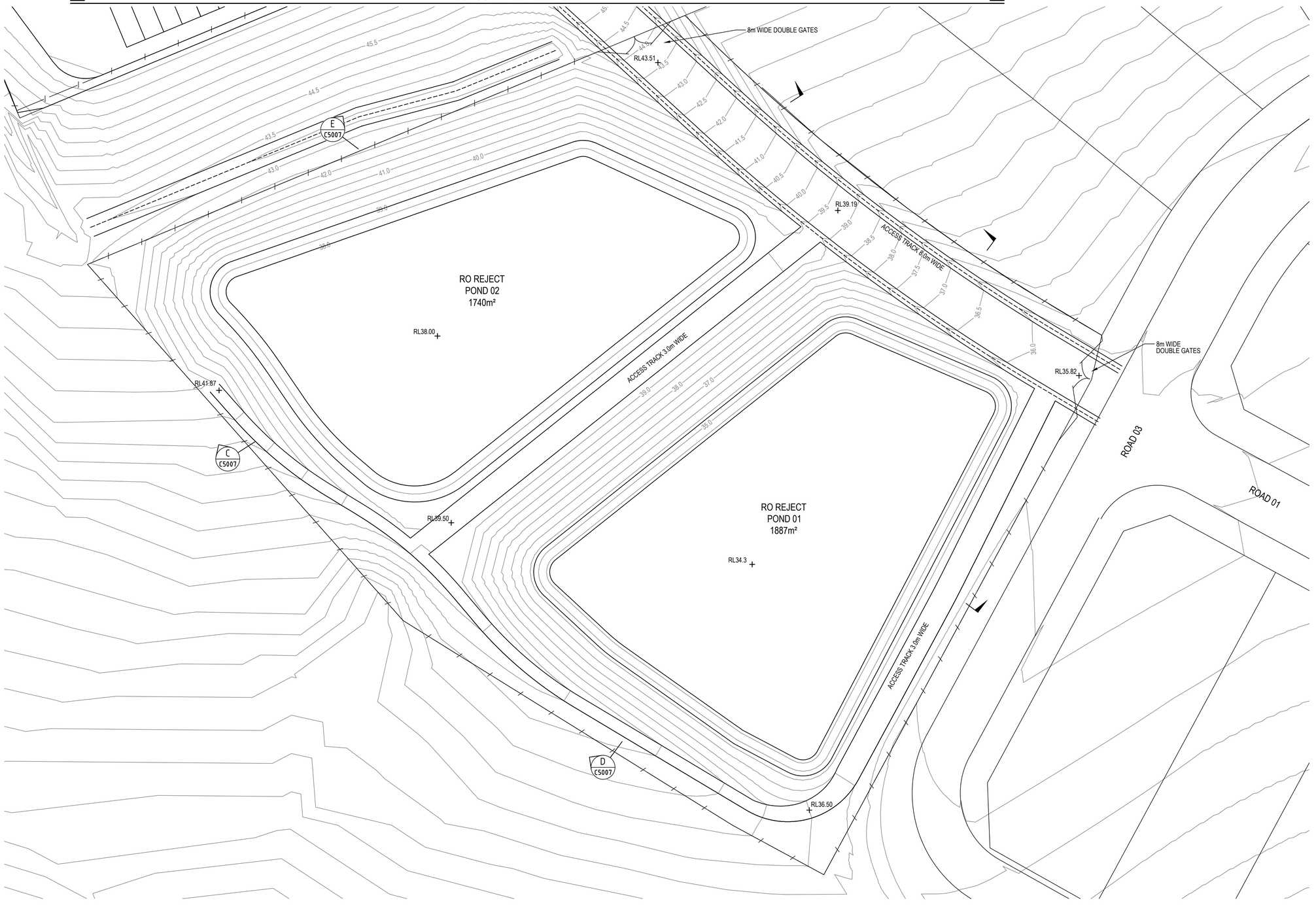
GENERAL ARRANGEMENT PLAN 1

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

AHD	Register	Scale	Size
Datum	----	1:250	A1

Drawing Number: 82014058-02-C5004
Revision: 3

JOINS SHEET 82014058-02-C5004



GENERAL ARRANGEMENT PLAN 2
SCALE 1:250

LEGEND

PROPOSED FENCE

30.0 CONTOURS (0.5m INTERVAL)

0 5 10 15 20 25m

SCALE 1:250 @A1

SCALE 1:500 @A3

Rev	Date	Description	Des.	Verif.	Appr.
3	2/10/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
2	23/09/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
1	30/07/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

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		Date
Drawn	LJW	28/07/2014
Checked	JMW	28/07/2014
Designed	JMK	28/07/2014
Verified	JMK	28/07/2014
Approved	JMK	28/07/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

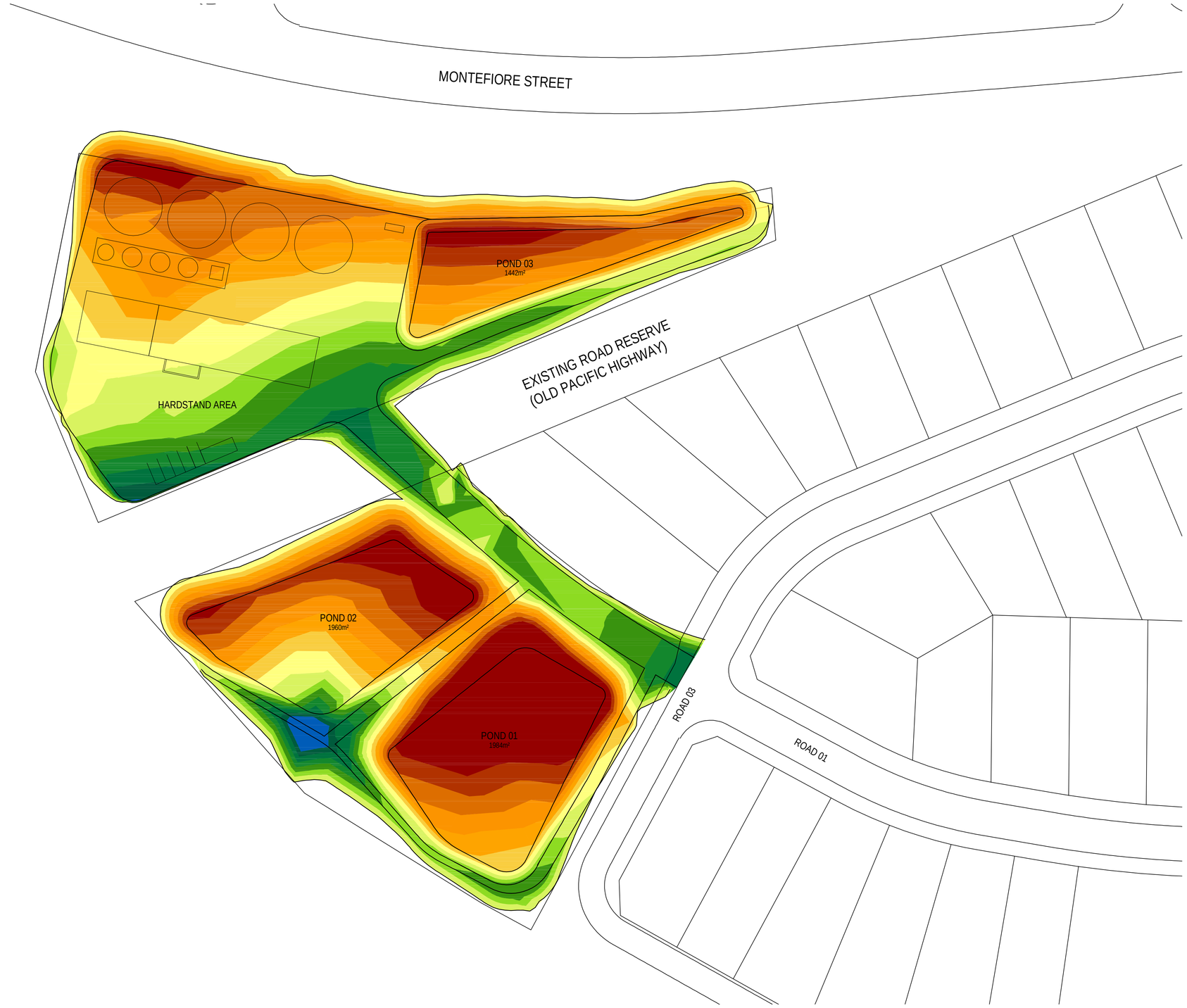
GENERAL ARRANGEMENT PLAN 2

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

AHD	Register	Scale	Size
Datum	-----	1:250	A1

Drawing Number: 82014058-02-C5005

Revision: 3



CUT/FILL PLAN
SCALE 1:500

Rev	Date	Description	Des.	Verif.	Appr.
2	30/07/2014	AMEND CUT FILL TO MATCH DESIGN	LJW	JMK	JMK
1	13/06/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

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		Date
Drawn	LJW	12/06/2014
Checked	JMW	12/06/2014
Designed	JMK	12/06/2014
Verified	JMK	12/06/2014
Approved	JMK	13/06/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

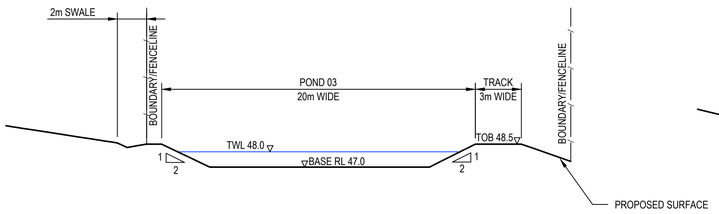
CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

CUT/FILL PLAN

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

Datum	Register	Scale	Size
A.H.D.	----	1:500	A1

Drawing Number: 8201405802-C5006
Revision: 2



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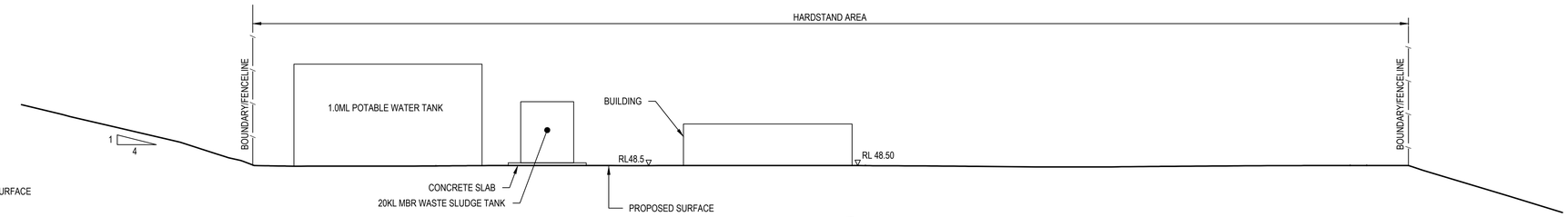
SCALE 1:200 C5002



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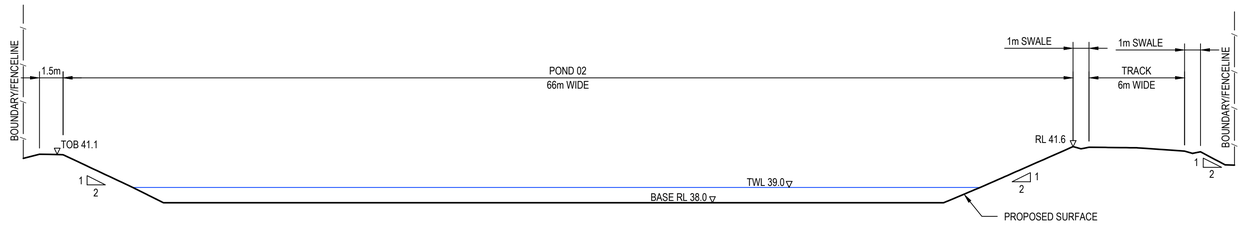

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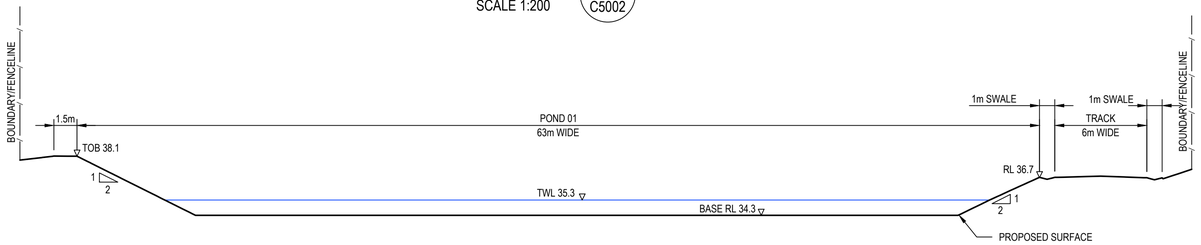

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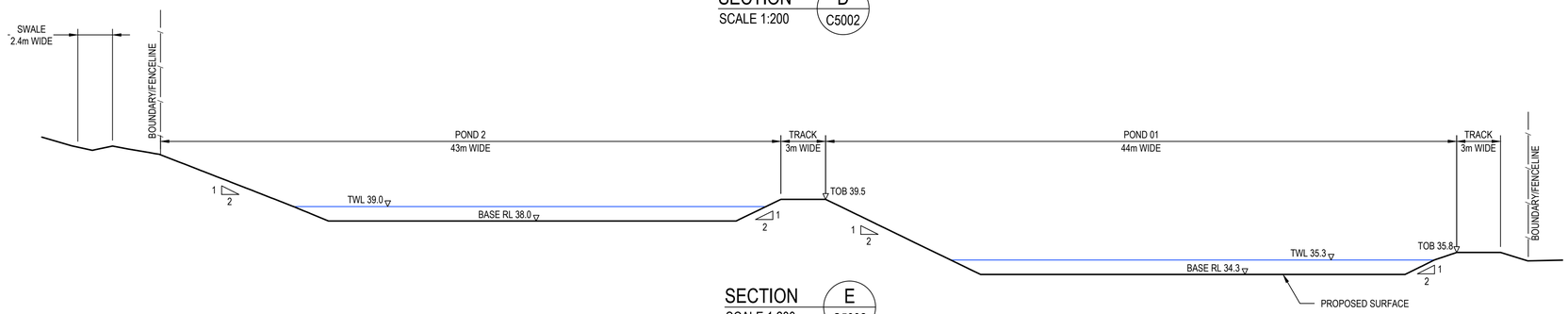
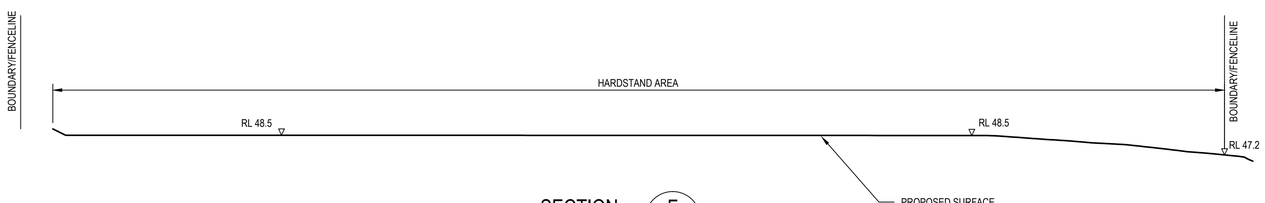
SCALE 1:200 C5002



SECTION E
SCALE 1:200 C5002



SECTION F
SCALE 1:200 C5002

0 5 10 15 20m
SCALE 1:200 @A1
SCALE 1:400 @A3

Rev	Date	Description	Des.	Verif.	Appr.
5	2/10/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
4	23/09/2014	SITE LEVELS AMENDED	DAC	JMK	JMK
3	28/07/2014	GENERAL AMENDMENTS	LJW	JMK	JMK
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1	13/06/2014	ISSUED FOR REVIEW	LJW	JMK	JMK

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Drawn	LJW	Date	12/06/2014
Checked	JMW	Date	12/06/2014
Designed	JMK	Date	12/06/2014
Verified	JMK	Date	12/06/2014
Approved	JMK	Date	13/06/2014

Client: SOLO WATER - CATHERINE HILL BAY WATER UTILITY

CATHERINE HILL BAY
WASTE WATER TREATMENT PLANT
CIVIL ENGINEERING DESIGN

TYPICAL CROSS SECTIONS

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION PURPOSES

AHD	Register	Scale	Size
Datum	----	1:200	A1

Drawing Number: 82014058-02-C5007
Revision: 5

Appendix E

Onsite Wastewater Layout Plans

Date: 04/04/2013

Drawing No: SK001

Rev: A

Scale: 0 20 40 60 80 100m
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
PO Box 630 Jannali NSW 2226
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F: +61 2 9584 1477

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

VEGETATED BUFFERS

IRRIGATION AREA B – 4 ha

IRRIGATION AREA A – 4.5 ha

Montefiore St

WWTP SITE INCLUDING WWTP BUILDING, STORAGES AND EVAPORATION PONDS. REFER TO CARDNO CIVIL PLANS

RO REJECT EVAPORATION PONDS

ISSUE	DATE	ISSUE DETAILS
D	26/8/2014	TEMPORARY IRRIGATION AREA FOR PART 5 APPROVAL
C	5/7/2013	REVISED IRRIGATION AREAS FOR IPART APPLICATION
B	26/6/2013	REVISED IRRIGATION AREAS FOR DISCUSSION
A	13/3/2013	FOR LMCC COMMENT

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ROSE

CLIENT: COASTAL HAMLETS – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY RESIDENTIAL SUBDIVISION ROSE GROUP

SITE: MONTEFIORE ROAD CATHERINE HILL BAY NSW

DESIGN	DRAWN	APPROVED
BI	BI	BI

Bradley Irwin RPEQ (10637) CPENG NPER Environmental Engineer
SIGNED for and on behalf of Solo Water Pty Ltd DATE

DRAWING TITLE: ONSITE WASTEWATER PLAN

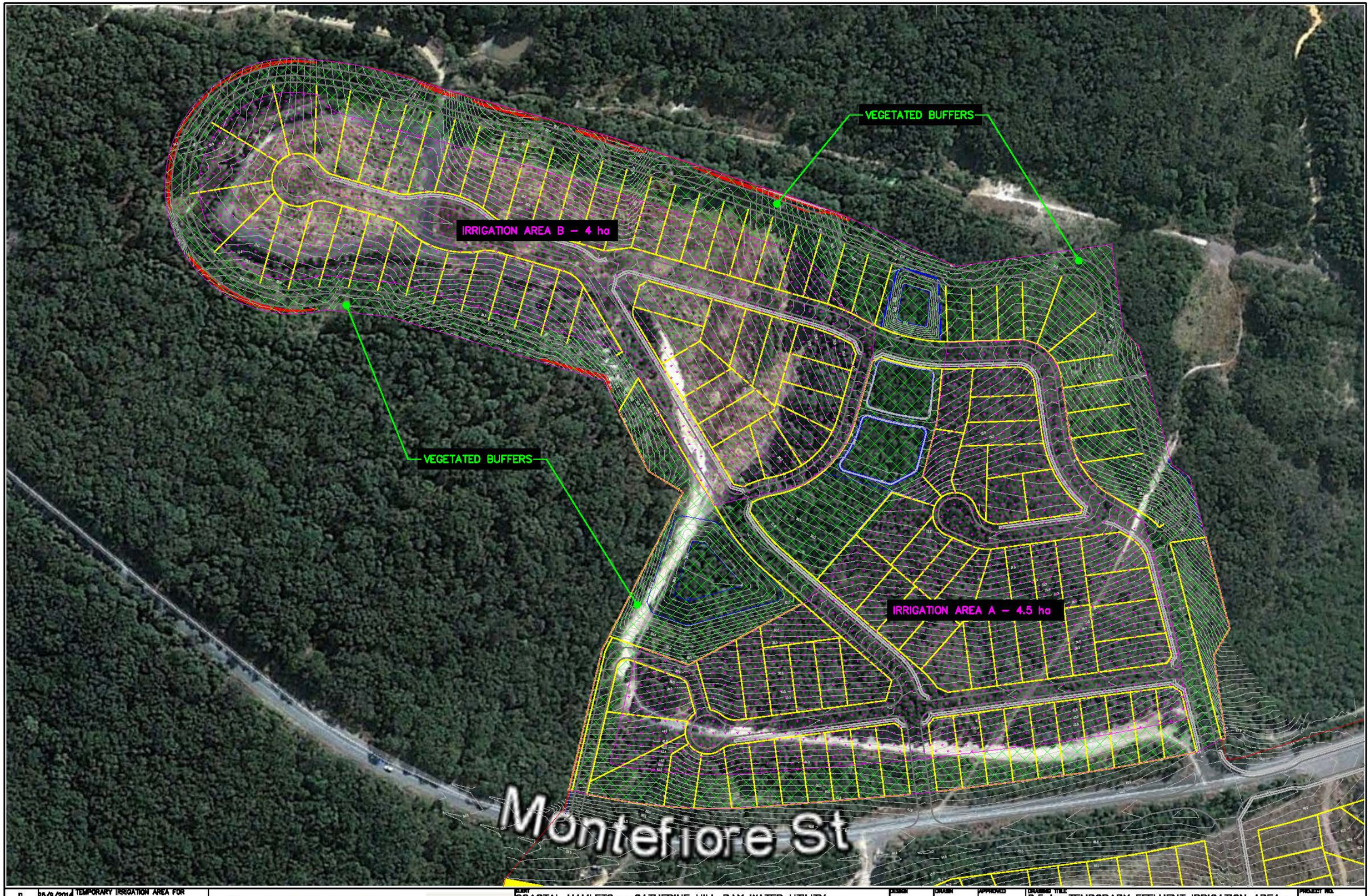
SCALE: 1:4000 at A3 (0 40 80 120 160 200)

DWG TYPE: CONCEPT NOT FOR CONSTRUCTION

PROJECT NO.: H10052

DWG NO.: P09–2

ISSUE: D



ISSUE	DATE	ISSUE DETAILS
D	25/9/2014	TEMPORARY IRRIGATION AREA FOR PART 5 ACCROVAL
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

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Water Utility Solutions
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Maroochydore QLD 4558
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ROSE

CLIENT: COASTAL HAMLETS – CATHERINE HILL BAY WATER UTILITY

PROJECT: CATHERINE HILL BAY RESIDENTIAL SUBDIVISION ROSE GROUP

NSW: MONTEFIORE ROAD CATHERINE HILL BAY NSW

DESIGN	DRAWN	APPROVED
BI	BI	BI

Bradley Irwin RPEQ (10637) CPENG NPER Environmental Engineer

SIGNED: For and on behalf of Solo Water Pty Ltd DATE:

DRAWING TITLE: 8.5 ha TEMPORARY EFFLUENT IRRIGATION AREA– 470 ET WITH WATER RECYCLING

SCALE: 1:2000 at A3 (0, 20, 40, 60, 80, 100)

DWG TYPE: CONCEPT NOT FOR CONSTRUCTION

PROJECT NO.: H10052

DWG NO.: P09

ISSUE: D

Appendix F

Risk Assessment Tables

POTABLE WATER

QUALITATIVE ENVIRONMENTAL AND PUBLIC HEALTH RISK ASSESSMENT CRITERIA

From tables 3.1, 3.2 & 3.3 on Page 3-8 of the Australian Drinking Water Guidelines (2011)

Qualitative measures of likelihood

Level	Descriptor	Example Description from ADWG
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur or should occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Qualitative measures of consequence or impact

Level	Descriptor	Example description from ADWG
1	Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs
2	Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs
3	Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
4	Major	Major impact for small population, systems significantly compromised and abnormal operation if at all, high level of monitoring required
5	Catastrophic	Major impact for large population, complete failure of system

Qualitative risk analysis matrix: Level of risk

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

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Potable Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
Risk Criteria: As per Tables 3.1, 3.2 & 3.3: Australia Drinking Water Guidelines 6 (2011)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Bulk Water Supply	Contaminants in bulk water source	Contaminants detected in Wyong Shire Councils monitoring systems	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Bulk water agreement from Wyong Shire Council guarantees bulk water supply will be compliant with the Australian Drinking Water Guidelines. Wyong Shire Council is responsible for all upstream water quality, treatment and catchment management issues. 2. Develop notification and communication protocols with Wyong Shire Council to ensure Catherine Bay Water Utility is notified of all water quality events in a timely manner.	D	Unlikely	3	Moderate	Moderate
Potable Water Transfer Pump Station	Oil and pump lubricants	Water supply contaminated with oil/lubricant from failed pump seal	Supply of non-compliant potable water	C	Possible	2	Minor	Moderate	1. Appropriate pump selection and design. 2. Routine inspection and maintenance of transfer pump station	D	Unlikely	2	Minor	Low
	Transfer Pump Station Failure	Mechanical, electrical or control system failure or power outage	Loss of supply capacity	C	Possible	4	Major	Very High	1. Multiple pump set with standby capacity 2. 24 hours storage provided in onsite potable water storage tank 3. Continuous online monitoring for pump faults, hours run, number of starts etc to detect potential pump failures 4. Electrical connection for mobile generator to be connected during power outage 5. Emergency potable water cartage from a designated tanker filling point by a water carter licensed with Wyong Council	D	Unlikely	3	Moderate	Moderate
Potable Water Transfer Pipeline	Microbiological contamination	Water main break	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Design, construction, pressure testing and commissioning of the transfer main to WSAA Standards. 2. Emergency Response Plan to be developed for water main breaks will include water main sterilisation procedure	D	Unlikely	3	Moderate	Moderate
	Microbiological contamination	Cross contamination due to poor maintenance practices	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Standard operating and maintenance procedures will be developed for the scheme. Procedures will include water main flushing, hygiene and disinfection requirements. 2. Separate tools to be used on water and sewerage systems.	D	Unlikely	3	Moderate	Moderate
	Microbiological contamination	Backflow and cross connections	Supply of non-compliant potable water	C	Possible	2	Minor	Moderate	1. No direct connections to the transfer pipeline. The only connection point to the pipeline is the onsite potable water and fire storage tank via a 300 mm air gap.	D	Unlikely	2	Minor	Low
	Sedimentation in pipeline	Excessive sedimentation in pipeline during off peak periods	Taste, odour and colour complaints	C	Possible	2	Minor	Moderate	1. Undertake routine flushing of the water transfer main 2. Customer taste and odour complaint monitoring system with Customer Service.	B	Likely	1	Insignificant	Moderate
	Pipeline breakage	Major pipeline breakage	Localised flooding, soil erosion, loss of supply	C	Possible	4	Major	Very High	1. Brand new 200 mm HDPE pipe to be constructed with fusion welded joints. 2. Construction quality assurance. 3. Flow monitoring at each end of the pipeline to detect flow differential. 4. 24 hours storage provided in onsite potable water storage tank. 5. Emergency Response Plan for water main breaks. 6. Frequent inspection along water main corridor to detect leaks and breaks. 7. Continuous online monitoring of pump performance to detect potential pipe breakage 8. Emergency potable water cartage from a designated tanker filling point by a water carter licensed with Wyong Council	D	Unlikely	3	Moderate	Moderate
	Pipeline leakage	Minor leaks	Water wastage	B	Likely	2	Minor	High	1. Use VSD controlled transfer pump station to minimise operating pressure during low flows. Pumps will only ramp up to maximum pressure when pumping peak flows. 2. Flow meters and pressure sensors on the transfer pipeline for monitoring of "midnight flows" for identification of leaks. 3. Walk over and visual inspection along water main corridor to identify leaks. 4. Use leak detection equipment if required.	B	Likely	1	Insignificant	Moderate
Onsite Potable Water Storage Tank	Microbiological contamination	Vermin, animal and mosquito access to storage	Supply of non-compliant potable water	B	Likely	4	Major	Very High	1. Sealed tank designed to potable water storage standards with screens on all tank openings. 2. Ongoing inspection & maintenance program 3. Chlorine reticulation and dosing system (described below)	D	Unlikely	3	Moderate	Moderate
	Material compatibility	Dissolution of tank materials into potable water supply	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Tank constructed to potable water storage standards using materials compatible with potable water supply 2. Metallic tanks to use food grade HDPE liner.	D	Unlikely	3	Moderate	Moderate
Onsite Potable Water Storage Tank continued…	Cross connection	Backflow into water transfer main	Supply of non-compliant potable water	C	Possible	3	Moderate	High	1. Connection of transfer main uses an Air gap above the high water overflow level in the tank.	E	Rare	3	Moderate	Moderate

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Potable Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
Risk Criteria: As per Tables 3.1, 3.2 & 3.3: Australia Drinking Water Guidelines 6 (2011)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Recirculation & Chlorine Dosing	Chlorine residual	Inadequate chlorine residual (low or high)	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Continuous online monitoring of free chlorine residual with alarms for low and high concentrations. 2. Duty and standby chlorine dosing pumps. 3. Fault detection and alarms on dosing pumps.	D	Unlikely	3	Moderate	Moderate
Potable Water Supply Booster Pump Station	Pump seals and lubricants	Water supply contaminated from failed pump seal	Supply of non-compliant potable water	C	Possible	2	Minor	Moderate	1. Appropriate pump selection and design. 2. Routine inspection and maintenance of transfer pump station.	D	Unlikely	2	Minor	Low
	Low pressure	Water pressure in potable network below that in the recycled water networks	Increased risk of backflow if a cross connection occurs	B	Likely	4	Major	Very High	1. Compliant Class A+ recycled water with conservative AWTP log reduction targets & treatment train design based on Table 3.7 in AGWR (2006) 2. Only approved contractors or staff that have undergone CHB Water Utility induction can perform work on water utility infrastructure. 3. Potable and Recycled Water reticulation networks to be designed, constructed and tested in accordance with WSAA standards. 4. Water pressure in recycled network to be maintained a minimum of 50 kPa below pressure in the potable network. 5. Quality assurance, inspection and pressure testing during construction. 6. Routine cross connection detection procedure during operation 7. Ongoing monitoring of water pressure and electrical conductivity in both networks during operation to assist with detection of cross connections. 8. Unique pipe colours in each water network. Potable network will use blue pipe and the recycled water network will use lilac pipe. 9. Minimum pipe separation distances to be maintained in common trenches. Potable water pipework to be located above recycled water pipework. 10. Identification tape and signage on all trenches. 11. Potable water is used in the recycled water network until Stage 2 when the AWTP is constructed. Compliance audits will be undertaken prior to introducing recycled water to the network.	D	Unlikely	3	Moderate	Moderate
	Booster pump station failure	Mechanical, electrical or control system failure or power outage	Loss of supply capacity	C	Possible	4	Major	Very High	1. VSD pressure booster pump set with standby capacity. 2. Routine inspection and maintenance of booster pump station. 3. Standby emergency diesel pump with automatic changeover	D	Unlikely	3	Moderate	Moderate
Potable Water Reticulation System	Class A+ recycled water network	Cross connection with the Class A+ recycled water network	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Compliant Class A+ recycled water with conservative AWTP log reduction targets & treatment train design based on Table 3.7 in AGWR (2006) 2. Only approved contractors or staff that have undergone CHB Water Utility induction can perform work on water utility infrastructure. 3. Potable and recycled water reticulation networks to be designed, constructed and tested in accordance with WSAA standards. 4. Water pressure in recycled network to be maintained a minimum of 50 kPa below pressure in the potable network. 5. Quality assurance, inspection and pressure testing during construction. 6. Routine cross connection detection procedure during operation. 7. Ongoing monitoring of water pressure and electrical conductivity in both networks during operation to assist with detection of cross connections. 8. Unique colour pipe materials in each water network. Potable network will use blue and the recycled will use lilac pipe. 9. Minimum pipe separation distances to be maintained in common trenches. Potable water pipework to be located above recycled water pipework. 10. Identification tape and signage on all trenches. 11. Potable water is used in the recycled water network until Stage 2 when the AWTP is constructed. Compliance audits will be undertaken prior to introducing recycled water to the network.	D	Unlikely	3	Moderate	Moderate
	Sedimentation and slime growth	Excessive sedimentation in reticulation system during off peak periods	Taste, odour and colour complaints	B	Likely	1	Insignificant	Moderate	1. Routine monitoring and water main flushing program 2. Monitoring of taste and odour complaints through customer service processes	C	Possible	1	Insignificant	Low
	Microbiological contamination	Water main break	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Design, construction, pressure testing and commissioning to WSAA Standards. 2. Emergency Response Plan for water main breaks will include water main sterilisation procedure	D	Unlikely	3	Moderate	Moderate

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Potable Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
Risk Criteria: As per Tables 3.1, 3.2 & 3.3: Australia Drinking Water Guidelines 6 (2011)

Scheme Component	Hazard	Hazardous Event	Impact	Unmitigated Risk					Control Strategy	Mitigated Risk				
				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Potable Water Reticulation System continued..	Microbiological contamination	Cross contamination due to poor maintenance practices	Supply of non-compliant potable water	C	Possible	4	Major	Very High	1. Standard operating and maintenance procedures will be developed for the scheme. Procedures will include hygiene and disinfection requirements. 2. Separate tools to be used on water and sewerage systems.	D	Unlikely	3	Moderate	Moderate
	Microbiological contamination	Backflow and cross connections	Supply of non-compliant potable water	C	Possible	2	Minor	Moderate	1. No direct connections to the transfer pipeline. The only connection point to the pipeline is the onsite potable water and fire storage tank via an air gap.	D	Unlikely	2	Minor	Low
	Reticulation pipe breakage	Major breakage	Localised flooding, soil erosion, loss of supply	C	Possible	3	Moderate	High	1. Design, construction, pressure testing and commissioning to WSAA Standards. 2. Emergency Response Plan for water main breaks will include water main sterilisation procedure 3. 24 hour call centre for reporting any main breaks 4. On call emergency response teams with target response time for main breaks < 4hrs	D	Unlikely	3	Moderate	Moderate
	Reticulation pipe leakage	Minor leaks	Water wastage	C	Possible	2	Minor	Moderate	1. Use VSD controlled booster pump station to minimise operating pressure during low flows. 2. Flow meters and pressure sensors on reticulation network for monitoring of "midnight flows" for identification of leaks. 3. Walk over and visual inspection along water main corridor to identify leaks. 4. Use leak detection equipment if required.	C	Possible	1	Insignificant	Low
	Fire hydrants on potable water network	Reduction in water pressure in potable network during fire flows	Increased risk of backflow if a cross connection occurs	B	Likely	4	Major	Very High	1. Cross connection controls. 2. Network design to minimise pressure losses during fire flow. 3. Use VSD controlled transfer pump station to maintain pressure during fire flows. 4. Procedure for testing for cross connections in the network	D	Unlikely	3	Moderate	Moderate
Customer Consumption and Private Water Systems	Onsite Class A+ recycled water pipes	Cross connection on private land	Supply of non-compliant potable water	B	Likely	4	Major	Very High	1. Domestic plumbing systems installed and tested for compliance with AS3500 and the NSW Code of Practice for Plumbing and Drainage by licensed plumbing contractors. 2. Catherine Hill Bay Water Utility to provide induction, training and compliance auditing for all domestic plumbing contractors. 3. Dual check valve for backflow prevention at all connection points. 4. Class A+ recycled water with conservative AWTP log reduction target based on Table 3.7 in AGWR (2006).	D	Unlikely	3	Moderate	Moderate
	Excessive water use	Poor user behaviour	Excessive water use, Potential overload of onsite water systems	C	Possible	3	Moderate	High	1. Customer supply and trade waste agreement will outline expected water consumptions rates. 2. Ongoing customer awareness and education 3. Smart water meters at all connection points to provide feedback on water use 4. Water efficient fixtures and appliances to comply with BASIX 5. 10% contingency allowance in the water balance for surplus recycled water disposal 6. Conservative recycled water usage and surplus irrigation estimates used in the water balance	D	Unlikely	3	Moderate	Moderate
	Leaks	Leaks in onsite water systems	Water wastage	B	Likely	1	Insignificant	Moderate	1. Smart water meters at all connection points to enable detection of leaks by residents	C	Possible	1	Insignificant	Low

RECYCLED 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
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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: Recycled Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
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 tanks	Contamination of wet weather storage tanks	Contaminants in wet weather storage tanks going to AWTP	Poor quality feed water to AWTP	D	Likely	3	Moderate	High	1. Closed tanks to eliminate vermin access with mosquito screens on all tank openings and overflows. 2. Storage tank covered to prevent sunlight access and algae growth. 3. Regular monitoring and inspection for evidence of vermin or mosquito access. 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. Treatment plant automatic shut down when critical limits are reached. 6. Potable water backup 7. Proactive calibration & maintenance of online probes 8. Treatment process audited by IPART certified auditor 9. High quality MBR permeate as feed water. 10. Membrane chemical cleaning in line with manufacturer requirements to maximise membrane life. 11. Design flux, TMP and other process parameters as per manufacturer recommendations to maximise membrane life.	B	Unlikely	3	Moderate	Moderate
	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. Treatment plan automatic shut down when critical limits are reached.. 5. Potable water backup 6. Proactive calibration & maintenance of online probes 7. Treatment process audited by IPART certified auditor 8. UV unit to include self cleaning functions. 9. Design and operation of UV unit as per manufacturer recommendations. 10. Replace UV lamps every 12 months.	B	Unlikely	3	Moderate	Moderate
	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. 3. Treatment plan automatic shut down when critical limits are reached.. 4. Potable water backup 5. Proactive calibration & maintenance of online probes 6. Treatment process audited by IPART certified auditor	B	Unlikely	3	Moderate	Moderate
	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 flow 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

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Recycled Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
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…	Process chemicals	Spillage of chemicals used in the AWTP process	Potential OH&S, public health and 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
	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. Monitoring of pH, chlorine and level in the neutralisation tank 4. If process impacts are observed on the MBR then offsite disposal of chemical wastewater will be undertaken by licensed waste contractor.	B	Unlikely	3	Moderate	Moderate
Recycled 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. Continuous online monitoring of tank Level sensor with high level switch with automatic shut down of advanced plant as fail safe.	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 Recycled 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 Recycled 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

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Recycled Water Preliminary Risk Assessment
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Date (Revision): 01/10/2014 (Revision D)
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
Recycled 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. Compliant Class A+ recycled water with conservative AWTP log reduction targets & treatment train design based on Table 3.7 in AGWR (2006) 2. Only approved contractors or staff that have undergone CHB Water Utility induction can perform work on water utility infrastructure. 3. Potable and Recycled reticulation networks to be designed, constructed and tested in accordance with WSAA standards. 4. Water pressure in Recycled network to be maintained a minimum of 50 kPa below pressure in the potable network. 5. Quality assurance, inspection and pressure testing during construction. 6. Routine cross connection detection procedure during operation 7. Ongoing monitoring of water pressure and electrical conductivity in both networks during operation to assist with detection of cross connections. 8. Unique pipe materials in each water network. Potable network will use blue PVC and the Recycled will use lilac striped HDPE pipe. 9. Minimum pipe separation distances to be maintained in common trenches. Potable water pipework to be located above Recycled water pipework. 10. Identification tape and signage on all trenches. 11. Potable water is used in the Recycled water network until Stage 2 when the AWTP is constructed. Compliance audits will be undertaken prior to introducing recycled water to the network.	B	Unlikely	3	Moderate	Moderate
		Cross connection with potable water line on private property	Potential use of Recycled water for potable uses inside the affected property (up to say 6 EP)	D	Likely	3	Moderate	High	1. Compliant Class A+ recycled water with conservative AWTP log reduction targets & treatment train design based on Table 3.7 in AGWR (2006) 2. All plumbing work on private property to be undertaken by Licensed plumber in compliance with AS3500 and the NSW Plumbing Code. 3. Plumbing inspection during house construction by Lake Macquarie City Council 4. Solo Water will not undertake connection until plumping inspection and cross flow test procedure is undertaken. 5. Dual check valve to be located at the potable water connection point for each property. 6. Residential Customer Supply Contracts outlining responsibilities under the scheme. 7. Ongoing customer awareness and education with information provided at each billing cycle and on the CHB Water Utility website. 8. Conservative AWTP log reduction target based on Table 3.7 in AGWR (2006).	C	Possible	2	Minor	Moderate
	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 Recycled 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 Recycled 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

Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Recycled Water Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
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
Recycled Water Supply System continued…	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 Recycled 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 recycled water 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 recycled water in the scheme based on customer recycled 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
	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 recycled water metre records. 3. If required customers will be required to reduce irrigation rates or undertake 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

SEWERAGE

QUALITATIVE ENVIRONMENTAL AND PUBLIC HEALTH RISK ASSESSMENT CRITERIA

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Qualitative risk analysis matrix: Level of risk

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Project: Catherine Hill Bay Water Utility
Client: Rose Group
Title: Sewerage Preliminary Risk Assessment
Author: BI
Date (Revision): 01/10/2014 (Revision D)
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

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				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

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				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Wastewater Treatment - Membrane Bioreactor + UV Disinfection continued…	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. Proactive calibration and maintenance of online probes 3. Alarms raised and treatment plant shut down if critical limits are reached. 4. Potable water emergency backup 5. If event occurs, identify and isolate failed membrane module and if required replace failed membrane module. 6. Shut off irrigation supply pump and undertake monitoring of wet weather storage water quality to ensure compliance. 7. Chemical treatment of wet weather storage water can be undertaken if necessary. 8. An Emergency Response Plan will be developed for MBR membrane failure.	B	Unlikely	3	Moderate	Moderate
	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. Proactive calibration and maintenance of online probes 3. Alarms raised and treatment plant shut down if critical limits are reached. 4. Potable water emergency backup 5. If Low UV dose is recorded investigate and rectify. 6. Shut off irrigation supply pump and undertake monitoring of wet weather storage water quality to ensure compliance. 7. Chemical treatment of wet weather storage water can be undertaken if necessary. 8. An Emergency Response Plan will be developed for UV lamp failure.	B	Unlikely	3	Moderate	Moderate
	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 Tanks	Vector borne diseases	Vermin/mosquito invasion of wet weather storage tank	Potential spread of diseases	C	Possible	2	Minor	Moderate	1. Closed tanks to eliminate vermin access with mosquito screens on all tank openings and overflows. 2. Regular monitoring and inspection for evidence of vermin or mosquito access.	B	Unlikely	2	Minor	Low
	Unintended contact with recycled water in storage	Human access into 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
	Blue green algae	Blue green algae growth in wet weather storage tanks	Non-compliant recycled water	C	Possible	2	Minor	Moderate	1. Storage tank covered to prevent sunlight access and algae growth. 2. Regular inspection and monitoring of storage tank. 3. Low nutrient concentrations in MBR effluent (TP< 0.3 mg/L, TN < 10 mg/L)	B	Unlikely	2	Minor	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

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				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Wet Weather Storage Tanks continued..	Overflows	Excessive wet weather leading to tank overflow	Uncontrolled overflow	C	Possible	4	Major	Very high	1. High level switch will initiate emergency irrigation events to avoid uncontrolled overflows. 2. MEDLI modelling predicts the wet weather 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	3	Moderate	Moderate
	Tank failure	Tank failure	Uncontrolled release of 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
Opportunistic Construction Reuse of MBR+UV recycled water e.g. dust suppression, establishment of landscaping	Unintended uses or human contact with recycled water	Unintended uses or human contact with recycled water	Potential health impacts	D	Likely	2	Minor	Moderate	1. Minimise human contact by restricted access at construction site with low number of workers. 2. Appropriate training of all construction workers. 3. Appropriate worker health and hygiene practices (e.g. hand washing with disinfectent). 4. Avoid recycled water use during high wind. 5. Spray drift controls 6. Maintain appropriate buffers to sensitive receptors. 7. Avoid ponding and surface run-off. 8. Construction recycled water management plan will be developed based on the specific proposed uses prior to supply commencing.	B	Unlikely	2	Minor	Low
Stage 1 temporary, restricted access Irrigation System	Cross connection with potable or recycled 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. Temporary Irrigation Network is to use Lilac 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. Existing village of CHB located approximately 400m east of the irrigation areas. 4. Minimum 30m buffer to down gradient property boundary. 5. 20m buffer to up gradient property boundary. 6. No irrigation within the 40m wide future waterway corridor. 7. Minimum buffer to the nearest future residential dwelling is 70m. 8. No above ground taps or fixtures in temporary irrigation areas. 9. Lockable irrigation valves pits and controllers etc. 10. Soil moisture probes and weather station override on irrigation controllers to prevent irrigation during rainfall, high wind or elevated soil moisture. 11. Irrigation at night time only under normal operating conditions.	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. Existing village of CHB located approximately 400m east of the irrigation areas. 4. Minimum buffer to the nearest future residential dwelling is 70m. 5. Irrigation at night time only under normal operating conditions.	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. 2 ML wet weather storage tanks provides approximately >23 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. Minimum of 30m non-irrigated, vegetated buffer strip down gradient of the temporary irrigation areas. 4. Diversion drains along uphill slope to divert upslope stormwater around the irrigation areas. 5. Catch drain/swale along the downhill boundary of irrigation areas. 6. Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture. 7. Contour mounds will be constructed at intervals of approximately 30-50 metres. 8. Groundwater monitoring will be undertaken during operation.	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

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				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Stage 1 temporary, restricted access Irrigation System continued…	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. Minimum of 30m non-irrigated, vegetated buffer strip down gradient of the temporary irrigation areas. 4. Diversion drains along uphill slope to divert upslope stormwater around the irrigation areas. 5. Catch drain/swale along the downhill boundary of irrigation areas. 6. Dense deep rooted grass vegetation will be established, e.g. kikuyu pasture. 7. Contour mounds will be constructed at intervals of approximately 30-50 metres.	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 1 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 1 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 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. Irrigation at night time only. 3. A minimum 70m 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 3. Catch drain/swale along the downhill boundary of irrigation areas. 4. Contour mounds will be constructed at intervals of approximately 30-50 metres.	A	Rare	2	Minor	Low

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				Likelihood		Consequence		Risk		Likelihood		Consequence		Risk
Stage 1 temporary, restricted access Irrigation System continued…	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 around 1 mm/day, hence low risk of groundwater contamination. 2. No 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. Groundwater monitoring will be undertaken during operation.	B	Unlikely	2	Minor	Low

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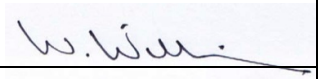
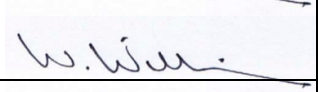
Document Status

Rev No.	Author	Approved for Issue		
		Name	Signature	Date
A	BRAD IRWIN Environmental Engineer	WAYNE WILLIAMSON Project Director		1/07/2014
B	BRAD IRWIN Environmental Engineer	WAYNE WILLIAMSON Project Director		3/10/2014