KUR-World

Appendix 4b

KUR World Water and Wastewater Infrastructure Technical Report

Environmental Impact Statement

Reever and Ocean

KUR-World Integrated Eco-Resort | Environmental Impact Statement

Water and Wastewater Infrastructure | Technical Report

251351-00

Issue 02 | 27 June 2018

Job number 251351-00

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Document Verification

ARUP

Job title		KUR-World Integrated Eco-Resort | Environmental Impact Statement		**Job number** 251351-00	
Document title		Water and Wastewater Infrastructure | Technical Report		**File reference**	
Document ref		251351-00			
Revision	**Date**	**Filename**	KUR-World Water and Wastewater Infrastructure Technical Report.docx		
Issue 01	27 Nov 2017	**Description**	First draft		
			Prepared by	Checked by	Approved by
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		Signature			
Issue 02	27 Jun 2018	**Filename**	KUR-World Water and Wastewater Infrastructure Technical Report v2.0.docx		
		Description	Updated based on CG comments		
			Prepared by	Checked by	Approved by
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		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Glossary of Terms

Term	Definition
Average Day (AD)	AD demand refers to the total annual demand, divided by 365.
Average Dry Weather Flow (ADWF)	The average daily sewage flow, measured following seven days without rain.
Biochemical Oxygen Demand (BOD)	A measure of the organic content in water and wastewater. The amount of dissolved oxygen needed by aerobic biological organisms to break down organic material in a given sample of water at a certain temperature and over a set period of time.
Equivalent Person (EP)	A unit used to equate an equivalent service demand (water demand or sewage load) to that of an average occupant of an average detached residential dwelling.
Gross Floor Area (GFA)	The total floor area inside a building, including external walls but excluding the roof
Membrane Bioreactor (MBR)	The combination of a membrane process like microfiltration or ultrafiltration with a biological wastewater treatment process.
Mean Day Maximum Month (MDMM)	MDMM demand refers to the highest 30 day moving average daily water demand.
Peak Day (PD)	PD demand refers to the maximum demand in any one day of the year.
Peak Dry Weather Flow (PDWF)	The most likely maximum sanitary flow in a sewer during a normal day. Sewage flows typically exhibit a regular diurnal pattern with morning and evening peaks.
Peak Wet Weather Flow (PWWF)	PDWF plus inflow and infiltration from groundwater and stormwater, through cracks and openings in the sewer system.
Total dissolved solids (TDS)	In sewage, the combined content of all inorganic and organic substances which remain when a volume of filtered water is evaporated.
Total nitrogen (TN)	In sewage, the sum total of kjeldahl nitrogen – ammonia, organic and reduced nitrogen – and nitrate-nitrite.
Total phosphorus (TP)	Sum of all phosphorus compounds that occur in various forms

1 Introduction

This technical report has been prepared to document the proposed strategy for the provision of water supply and wastewater services for KUR-World.

It provides further technical information to supplement the Environmental Impact Statement Chapter 7.1 Water and Wastewater Infrastructure, including:

- The Basis of Design (BoD) for the water and wastewater infrastructure of the KUR-World EIS reference design;
- The methodology and outcomes of the water balance analysis undertaken to estimate the water demands and wastewater loads generated during each stage of the development; and
- The water supply and wastewater infrastructure proposed to be constructed both internal and external to the site.

High-level reference designs for the proposed water supply and wastewater infrastructure have been developed based on the analysis, and are included in the following water and wastewater infrastructure master plan drawings:

- Proposed Water Supply (Potable) Infrastructure, Indicative Layout – 253251-00-C-RD-301
- Proposed Water Supply (Non-Potable) Infrastructure, Indicative Layout – 253251-00-C-RD-303
- Proposed Sewerage Infrastructure, Indicative Layout – 253251-00-C-RD-302
- Proposed Effluent Outfall Options, Indicative Layout – 253251-00-C-RD-304
- Proposed Wastewater Treatment Plant and Groundwater Treatment Plant, General Arrangement – 253251-00-C-RD-351
- Proposed Wastewater Treatment Plant, P&ID – 253251-00-C-RD-352
- Proposed Groundwater Treatment Plant, P&ID – 253251-00-C-RD-353.

The water and wastewater infrastructure master plan drawings are provided Appendix A.

2 Overview of water supply and wastewater strategy

KUR-World will implement a best practice, integrated approach to total water cycle management, including:

- Minimising water consumption and wastewater generation through water efficient planning, design, construction and operation
- Facilitating opportunities for rainwater and stormwater harvesting to supplement non-potable water demands across the site where feasible
- Managing stormwater quality and quantity through the integration of best practice water sensitive urban design into the site master plan
- Sustainably abstracting and utilising groundwater, mitigating impacts to the environment and other groundwater users.

The various buildings, facilities and landscapes across the site will generate significant water demands and wastewater loads, which will be managed through a combination of water resources and infrastructure both internal and external to the site.

The schematic diagram shown in Figure 1 illustrates the conceptual water supply and wastewater disposal strategy proposed for KUR-World. The concept strategy has been developed through investigation and analysis of possible options. Investigations included consultation with Mareeba Shire Council regarding existing and future infrastructure, consideration of the Barron River Water Supply Scheme and estimations of yield from groundwater, recycled water, rainwater and storm water. A water balance analysis was carried out for various scenarios, informed by constraints such as design standards, governing legislation and the physical limitations of the site.

Table 1 summarises the key water supply requirements, required water quality, and opportunities for demand management.

Table 2 summarises the key wastewater requirements, the potential for onsite treatment and reuse, and opportunities for minimising wastewater generation.

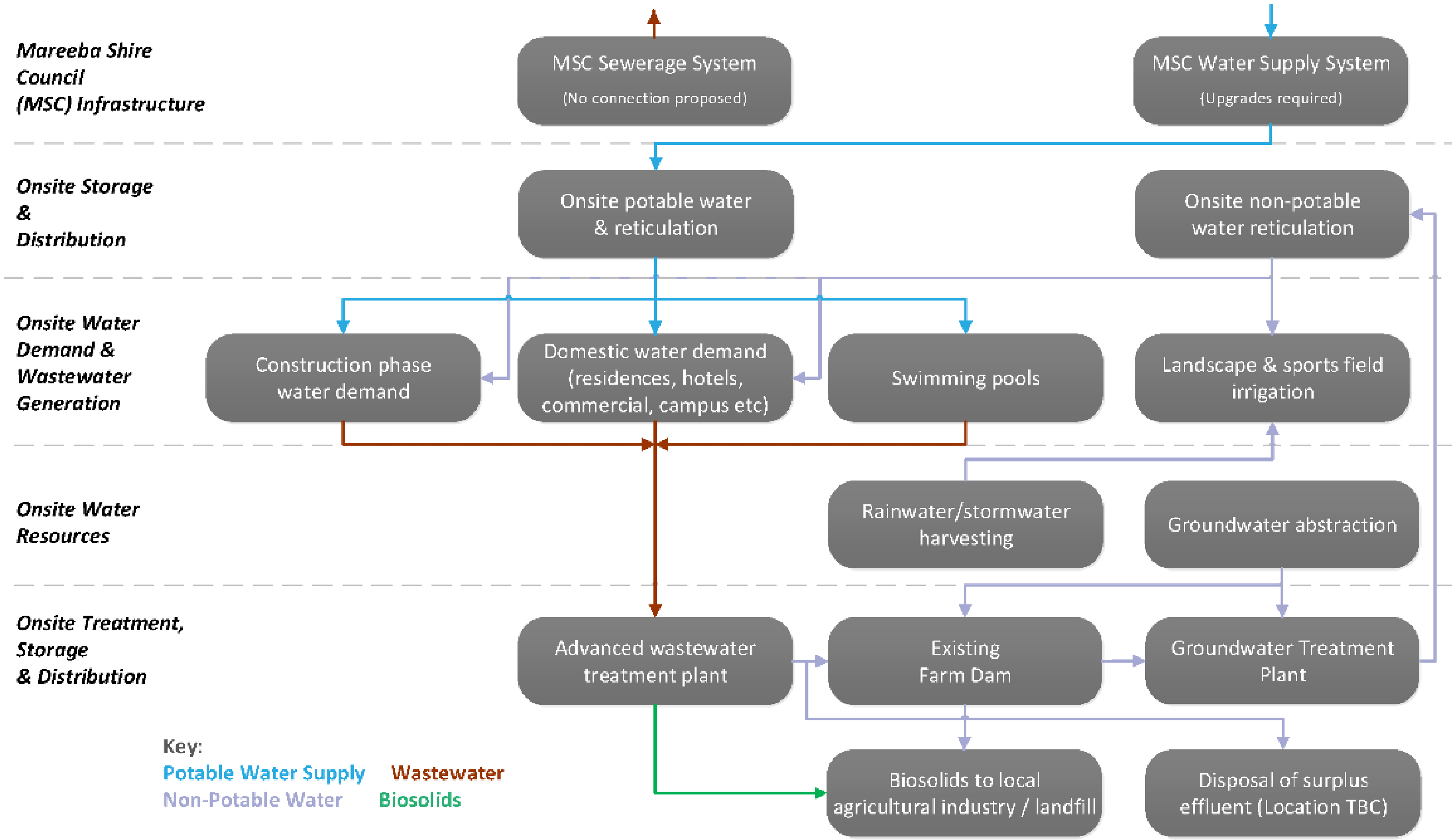

Figure 1: Conceptual water supply strategy schematic for KUR-World

Table 1: Summary of water supply requirements

Application	Required water quality	Opportunities for demand management
Domestic water supply to the various hotel, commercial, residential, educational, health and research facilities	• potable – for drinking water and high human exposure uses • non-potable – for low exposure uses including toilet flushing, laundry facilities etc.	• Water efficient fitting and fixtures. • Design and operational strategies to minimise water use (for example, waterwise education/signage to guests and staff, leak detection and maintenance strategies, and so on). • Dual reticulation across site/facilities with lower quality non-potable water source (for example, site harvested rainwater, stormwater and groundwater).
Irrigation and external wash-down of hotel grounds, residential gardens, public open spaces, agricultural gardens, and golf course.	• non-potable.	• Utilisation of native vegetation/xeriscape (low/no irrigation) gardens wherever possible, and climate appropriate/drought tolerant turf for the golf course. • Irrigation design (low exposure) to permit non-potable quality water for irrigation. • Utilisation of advanced irrigation systems including rain gauges/moisture sensors, water efficient fittings, to minimise irrigating times and volumes/prevent over-watering). • Incorporation of stormwater collection, treatment and re-use into the landscaping (Water Sensitive Urban Design). • Operational strategies to minimise irrigation (for example, water efficient mowing practices, composting, and night time irrigation). • Minimising golf course size.
Swimming pools	• potable.	• collection of filter backwash for re-use as part of the non-potable system • installation of splash/drainage barriers to minimise water loss • limiting hours of pool use • evaporation control.
Construction phase (workforce, dust control, earthworks, concrete manufacture and curing)	• potable – for drinking water and high exposure uses • non-potable – for construction processes.	• utilisation of non-potable water for appropriate construction uses.

Table 2: Summary of wastewater requirements

Application	Potential for onsite treatment and reuse	Opportunities for minimising wastewater generation
Domestic wastewater generated by the various hotel, commercial, residential, educational, health and research facilities	Opportunity for onsite treatment and reuse	• Water efficient fitting and fixtures. • Design and operational strategies to minimise water use (for example, waterwise education/signage to guests and staff, leak detection and maintenance strategies, and so on).
Swimming pool filter backwash water	Opportunity for onsite treatment and reuse	• Diversion of swimming pool filter backwash water to non-potable water supply system.
Trade-waste generated by the various non-standard facilities such as hotels, medical and research facilities.	n/a	• Management of trade waste, including opportunities for onsite treatment and re-use or offsite disposal, to be considered on a case by case basis based on the detailed design of facilities.

3 Basis of design

3.1 KUR-World master plan

The water balance analysis and reference design for all water supply and wastewater infrastructure have been developed on the basis of the proposed master plan for KUR-World at the time of the analysis, as documented in the following:

- KUR-World Concept Master Layout, Revision G (Arup , 2017 (a))
- Architectural Concepts and Gross Floor Areas for all Significant Land-Uses and Buildings, Revision C (Coburn Architecture, 2017)
- Estimated Staff and Patronage Figures (Northern Frontiers, 2017 (b))
- Overall Water Demand Estimates for the KUR-World Golf Course (Lane, 2017) and Hard Edge Golf Course Water Demand Estimates for the KUR-World Golf Course Reports (Ways With Water Pty. Ltd., 2017 (a))

3.2 Design guidelines and standards

The following design guidelines and standards are applicable to and have been considered in developing the water and wastewater infrastructure reference design for KUR-World:

- Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual (FNQROC, 2014)
- Planning Guidelines for Water Supply and Sewerage (Department of Energy and Water Supply, 2010)
- Gravity Sewerage Code of Australia - WSA 02-2014 (Water Services Association of Australia, 2014)
- Water Supply Code of Australia - WSA 03-2011 (Water Services Association of Australia, 2011)
- Sewage Pumping Station Code of Australia - WSA 04-2005 (Water Services Association of Australia, 2005 (b))
- Pressure Sewerage Code of Australia - WSA 07-2005 (Water Services Association of Australia, 2005 (a))
- Efficient Irrigation: A Reference Manual for Turf and Landscape (Connellan, 2002)
- Swimming Pools and Spa Pool Water Quality and Operational Guidelines (Queensland Health , 2004)
- National Water Quality Management Strategy: Overview of the Australian guidelines for water recycling: Managing health and environmental risks – 2008

- Recycled water management plan and validation guidelines QLD (DEWS, 2008)

3.3 Governing legislation

- Queensland Water Supply (Safety and Reliability) Act 2008
- Queensland Public Health Act 2005
- Queensland Public Health Regulation 2005

4 Water balance analysis

A detailed water balance analysis has been undertaken to estimate the water demands and wastewater loads generated during each stage of the development, and to inform the development of robust reference designs for the required water and wastewater infrastructure.

4.1 Method

Given the scale and complexity of the KUR-World development, the water balance analysis required consideration of a diverse range of factors beyond the standard approach prescribed in the Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual (FNQROC, 2014).

The analysis took into consideration the quality of water required for each use (potable and non-potable), the likely yields from onsite water sources (groundwater, recycled water and stormwater harvesting), and the seasonal variation in water demands, in particular those associated with the onsite golf course.

Water demand and wastewater loads were estimated for each element and stage of the proposed master plan by:

- Estimating equivalent population (EP) figures and applying unit water demand and wastewater loading rates prescribed in FNQROC (FNQROC, 2014) to the residential aspects of the development.
- Applying unit water demands and wastewater loading rates prescribed in the Planning Guidelines for Water Supply and Sewerage (Department of Energy and Water Supply, 2010) to the architectural concept Gross Floor Areas (GFAs) for the proposed development for the various different commercial, educational, hotel and restaurant buildings.
- Undertaking first principles water demand and wastewater loading calculations for a variety of non-standard aspects of the development including for example golf course irrigation based on information provided by the golf course designer (Ways With Water Pty. Ltd., 2017 (a)) and (Lane, 2017), swimming pool and pond evaporation, and swimming pool filter backwashing.
- Undertaking first principles calculations to estimate the breakdown of the water demand from each building and facility into potable and non-potable components.

A separate analysis of the water demands and wastewater loads generated by construction phase activities was also undertaken based on first principles calculations and industry benchmarking, and considered as part of the overall water supply and wastewater management strategy.

Table 3 summarises the key references and analysis methods used in undertaking the water balance analysis. Table 4 summarise the key aspects of the proposed masterplan precincts including the proposed floor areas, bed/ room numbers where applicable, staging and demand calculation methods.

Table 3: Basis of site water balance

Aspect of Water Balance Analysis	Key References	Analysis Method
Average water demands and sewage loads	Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual, Version 6, 2014 '*Planning guidelines for water supply and sewerage*, Queensland Government Department of Energy and Water Supply', April 2010.	Calculation of Equivalent Populations (EP's) for all applicable land-use types within development, and conversion of EP's to average water demands and sewage in accordance with FNQROC (2014): • Average day demand (water): 500L/EP/day; and • Average dry weather flow (sewage): 270L/EP/day Application of unit rates from DEWS (2010) to estimate average water demands and sewage loads from other (non-residential) land-use types, based on: • Peak occupancy (staff, visitor, guest, and student) numbers in each precinct. • Gross floor areas for each building • Numbers of rooms (accommodation facilities) • Numbers of beds (medical facilities)
Peak domestic water demands and sewage generation rates, fire flow requirements, storage requirements to inform infrastructure sizing	Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual, Version 6, 2014	Water: • Average Day Demand = 500L/EP/day (baseline) • Mean Day Maximum Month = 1.5 x AD • Peak Day = 2.25 x AD • Peak Hour = 1/12 x PD • Min Storage Capacity = 3 x (PD-MDMM) + (Max of Emergency and Fire Flow Storage) Sewerage: • Average Dry Weather Flow = 270L/ EP/ Day • Peak Wet Weather Flow = 5 x ADWF • Peak Dry Weather Flow = C2 x ADWF (C2 is 4.7EP-.105) • Vaccum/ Smart Sewer PWWF = 4 x ADWF
Irrigation Demand	*Efficient Irrigation: A Reference Manual For Turf and Landscape*, Geoff Connellan, 2002	First principles calculation based on master plan designated areas for: • Native Landscaping/ Xeriscapes • Irrigated gardens • Turf • Sports field • Irrigation takes place 26 weeks of the year, 4 days a week, over 8 hours.
Golf Course Irrigation Demand	*Kur World Golf Course Water Usage Estimate, by Greg Norman Golf Course Design, 2017*	Estimated golf course demands provided by golf course designer (Greg Norman Golf Course Design, 2017)
Swimming Pool Demand	*Queensland Health Swimming and Spa Pool Water Quality and Operational Guidelines, 2004*	Water: Sum of – • Evaporation rates interpolated from across four different sites

Aspect of Water Balance Analysis	Key References	Analysis Method
		• Top up of total volume of water backwashed to sewage (see below) Sewage: • 5-10% of total volume treated daily backwashed to sewage • Treatment rates (turnover of 5-6 hours, i.e. each pool treated twice-thrice daily assuming pool in operation for 12 hours) • Backwashing frequency every 3 to 5 days.
Construction phase water demands and sewage generation	First principles calculation	First principles calculation of: • Workforce demand (based on workforce numbers provided by quantity surveyor) • Equipment wash down • Pool filling • Revegetation and landscaping • Earthworks • Concrete requirements
Available groundwater resource	*Kur World Golf Course Water Usage Estimate, Greg Norman Golf Course Design, 2017*	Maximum sustainable yield determined from groundwater report.
Available rainwater/ stormwater resource	First principles calculation	Estimate of technically feasible yield from site generated rainwater/ stormwater based on application of extended simulation (10 year) analysis of rainfall data.
Available recycled water resource	First principles calculation	Estimate of technically feasible recycled water production based on proposed capacity of onsite wastewater treatment system.
Available Barron River resource	Water Plan (Barron) Act 2002, Barron Resource Operations Plan 2005 Amended 2015	Assess potential to buy or lease an allocation from the Mareeba Dimbulah Water Supply Scheme for high and/or medium priority water

Table 4: Precinct stages, areas and assumptions

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
Farm Theme Park	Chapel/ Function Centre	1A	316	n/a		PGWSS, Place of Worship Rates applied to GFA.
	Arrival Points 1 & 2	1A	3451	n/a		PGWSS, Shop Rates applied to GFA.
	Restaurant	1A	1953	n/a		PGWSS, Restaurant Rates applied to GFA.

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
	Stables	1A	1697	100	Assume 100 head of stock	Assumed watering 100 head of stock
	Homestead, L1	1A	350	n/a		PGWSS, Shop Rates applied to GFA.
	Homestead, L2	1A	472	n/a		PGWSS, Restaurant Rates applied to GFA.
	Activities Cluster	1A	765	n/a		PGWSS, Shop Rates applied to GFA.
	Show Ring	1A	1213	n/a		Seqcode, Stadium Rates Applied to GFA
	Pavillion	1A	335	n/a		No demand/ sewer load assumed
	Café Cluster	1A	406	n/a		PGWSS, Restaurant Rates applied to GFA.
	Grand Arena	1A	3499	n/a		Seqcode, Stadium Rates Applied to GFA
	Farm Dam Evaporation top-up	1A	1600 0	n/a		Evaporation losses
	Farm Stay Accommodation	1B	1250	110	3 detached bunkhouse s + kitchen/ dining	PGWSS, Hostel Accommodati on Rates applied to bed numbers
	Native Flower Garden	1B	900	n/a		Max 4 day/week irrigation days (and 10hrs/day)
Produce garden	Additional Planting	1A	2000 0	n/a		Max 4 day/week irrigation days (and 10hrs/day)

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
Residential Lots	Queenslander Lots	1A	4200	21	21, 3-bed villa	FNQROC single family dwelling (low scenario @ 85%, med @100%, high @115%)
	Lifestyle Villas	1B	11200	56	56, 3-bed villa	FNQROC single family dwelling (low scenario @ 85%, med @100%, high @115%)
	Premium Villas	1B	7800	39	253, 3-bed villas	FNQROC single family dwelling (low scenario @ 85%, med @100%, high @115%)
	Premium Villas	2	42800	214	253, 3-bed villas	FNQROC single family dwelling (low scenario @ 85%, med @100%, high @115%)
	Premium Villas	3	18600	93	93, 3-bed villas	FNQROC single family dwelling (low scenario @ 85%, med @100%, high @115%)
Kur-Village, Business & Leisure Hotel	Retail and Restaurant Precinct	1B	2719	n/a		PGWSS, Restaurant Rates applied to GFA.
	Lobby, Function & Restaurant	1B	2965	n/a		PGWSS, Restaurant Rates applied to GFA.
	Village Plaza and Tower	1B	2934	n/a		No demand/ sewer load assumed
	Café Cluster 1 & 2	2	670	n/a		PGWSS, Restaurant Rates applied to GFA.

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
	Accomodation - 1 Bed Apartments (stage 1 B)	1B	n/a	25	25 x 1 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Accomodation - 2 Bed Apartments (stage 1 B)	1B	n/a	11	11 x 2 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Accomodation - 3 Bed Apartments (stage 1 B)	1B	n/a	24	24 x 3 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Accomodation - 1 Bed Apartments (stage 2)	2	n/a	36	89 x 1 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Accomodation - 2 Bed Apartments (stage 2)	2	n/a	63	108 x 2 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Accomodation - 3 Bed Apartments (stage 2)	2	n/a	34	72 x 3 bed apartments	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Pools	1B	3508	n/a		Evap + backwashing based on standard industry rates
Sporting Precinct, Golf Club-	Golf clubhouse	2	6161	n/a		PGWSS, Shop Rates applied to GFA.

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
House & Function Centre	Grandstand	2	742	n/a	Includes canteen/ changerooms/ bathrooms, excludes grandstand seating (no demand)	PGWSS, Shop Rates applied to GFA.
	Bar + Ammenities	2	500	n/a	Fraction of 'gym' GFA, first floor	PGWSS, Restaurant Rates applied to GFA.
	Gym	2	500	n/a	Fraction of 'gym' GFA, ground floor	PGWSS, Shop Rates applied to GFA.
	Soccer Field	2	6800	n/a	Assume other courts are not irrigated (astroturf or concrete)	Max 4 day/week irrigation days (and 8hrs/day)
Golf Course	12 Holes	2	300000	n/a	22.5ha golf course + 19.6ha natural veg	Note, this is annual demand averaged over whole year. Actual demand will be continuous (max 4 day/week irrigation days, 26 weeks per year (and 8hrs/day)), accounted in hydraulics
5-Star Eco-Resort	Lobby, Function & Restaurant	3	1175	n/a		PGWSS, Restaurant Rates applied to GFA.
	Spa	3	365	n/a		PGWSS, Hotel Rates applied to GFA.
	Restaurant	3	450	n/a		PGWSS, Restaurant

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
						Rates applied to GFA.
	Villas	3	15000	n/a	200 villas @75m2 each	PGWSS, Hotel Rates applied to GFA.
	Pool	3	1080	n/a		Evap + backwashing based on standard industry rates
Kur-World University Campus	Student Accommodation - 1 bed units	3	n/a	100	100 x 1 bed units	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Student Accommodation - 1 bed units	3	n/a	100	200 x 2 bed units	FNQROC multi-unit accom (low scenario @ 85%, med @100%, high @115%)
	Refect	3	400	n/a		PGWSS, Restaurant Rates applied to GFA.
	Lecture/ Research/ Office	3	14000	n/a		PGWSS, Education Tertiary Rates applied to GFA.
	Building 1 - library/ labs/ lectures	3	10401	n/a		PGWSS, Education Tertiary Rates applied to GFA.
	Building 2 - lectures/ office	3	4800	n/a		PGWSS, Education Tertiary Rates applied to GFA.
Pony Club	Clubhouse	1B	425	n/a		PGWSS, Shop Rates applied to GFA.
	Stables	1B	190	12	Assume 12 horses	Assumed watering 100 head of stock

Precinct	Activity / Description	STAGE	GFA (m2)	Total No. Beds/ Rooms	Notes	Water Demand/ Sewer Load Assumptions
Wellness Centre	Clinical Treatment Facility	3	700	n/a		PGWSS, Medical Centre Rates applied to GFA.
	Wellnesss Treatment Facility	3	300	n/a		PGWSS, Medical Centre Rates applied to GFA.
	Meditation & Yoga Bale'	3	400	n/a		No demand/ sewer load assumed
	Suites	3	5920	n/a		PGWSS, Hotel Rates applied to GFA.
	Lagoon	3	1000	70	70 suites + balcony & circulation	Evap top up
Rainforest Education Centre and Adventure Park	Bunkhouse Accommodation	1B	6720	350	350 beds - 315 students, 35 supervisors	PGWSS, Hostel Accommodati on Rates applied to GFA.
	Education Centre	1B	1380	n/a		PGWSS, Education Tertiary Rates applied to GFA.
	Function Centre	1B	1380	n/a		PGWSS, Education Tertiary Rates applied to GFA.

4.2 Water balance scenarios

Three alternative scenarios were considered as part of the analysis, reflecting the varying degrees to which opportunities for water efficiency and demand management could be integrated into the detailed design and construction of the development:

- Low Scenario – reflecting an industry best practice approach (assuming implementation of many of the demand management opportunities outlined in Table 1 and Table 2).
- Medium Scenario – reflecting a ‘business as usual’ approach involving bare minimum compliance with applicable design guidelines and standards.
- High Scenario – reflecting a below ‘business as usual’, worst case approach.

Consistent with its sustainable development objectives, KUR-World has committed to delivering a best practice water management approach, targeting the 'Low Scenario' estimates. These estimates have therefore been adopted as the basis for the reference design and broader EIS. As such, only the 'Low Scenario' estimates are presented in the Environmental Impact Statement. Details of the medium and high scenario estimates are provided in the following sections.

It is noted that a total water cycle management plan will need to be developed during the detailed design phase to support the realisation of these objectives as the project design and construction progresses.

4.3 Peaking factors

Peaking factors were applied in accordance with FNQROC (2014) to calculate the range of expected flows under each scenario, for both water demand and wastewater loads:

- Water demands: Average Day (AD), Mean Day Maximum Month (Month), Peak Day (PD) and Peak Hour (PH); and
- Wastewater loads: Average Dry Weather Flow (ADWF) and Peak Wet Weather Flow (PWWF).

Due to the site's significant irrigation requirements, and in particular the irrigation requirements associated with the onsite golf course, daily water demand will vary considerably throughout the year with higher demands in the dry season and lower demands in the wet season.

As a result, the standard peaking factors prescribed in FNQROC (2014) underestimate MDMM and PD demands, and so adjustments have been made in the water balance analysis to ensure the estimated MDMM and PD demand figures reflect the higher demands anticipated to occur during the dry season. As a result, the MDMM and PD flows presented below are higher than those calculated by applying the standard peaking factors prescribed in FNQROC (2014).

4.4 Water balance outcomes

4.4.1 Estimated water demands (total)

The total water demands have been estimated for each stage of the development under the low, medium and high scenarios. The estimates have been split into the required water quality (potable vs. non potable).

The water demand estimates under AD, MDMM and PD conditions are shown in Figure 2, Figure 3, and Figure 4 respectively.

As shown in the figure:

- The AD water demand estimates range from:
    - Stage 1A: 0.22 ML/day (low) to 0.31 ML/day (high);
    - Stage 1B: 0.65 ML/day (low) to 1.49 ML/day (high);

    - Stage 2: 1.50 ML/day (low) to 2.71 ML/day (high);
    - Stage 3 (ultimate): 1.96 ML/day (low) to 3.53 ML/day (high);
- The MDMM (Golf Course adjusted) water demand estimates range from:
    - Stage 1A: 0.34 ML/day (low) to 0.47 ML/day (high);
    - Stage 1B: 0.97 ML/day (low) to 2.24 ML/day (high);
    - Stage 2: 2.66 ML/day (low) to 4.68 ML/day (high);
    - Stage 3 (ultimate): 3.35 ML/day (low) to 5.92 ML/day (high);
- The PD (Golf Course adjusted) water demand estimates range from:
    - Stage 1A: 0.50 ML/day (low) to 0.71 ML/day (high);
    - Stage 1B: 1.46 ML/day (low) to 3.36 ML/day (high);
    - Stage 2: 3.46 ML/day (low) to 6.18 ML/day (high);
    - Stage 3 (ultimate): 4.50 ML/day (low) to 8.04 ML/day (high);
- Around 50-60% of the total water demand requires potable quality water, with remainder being serviced from non-potable sources.

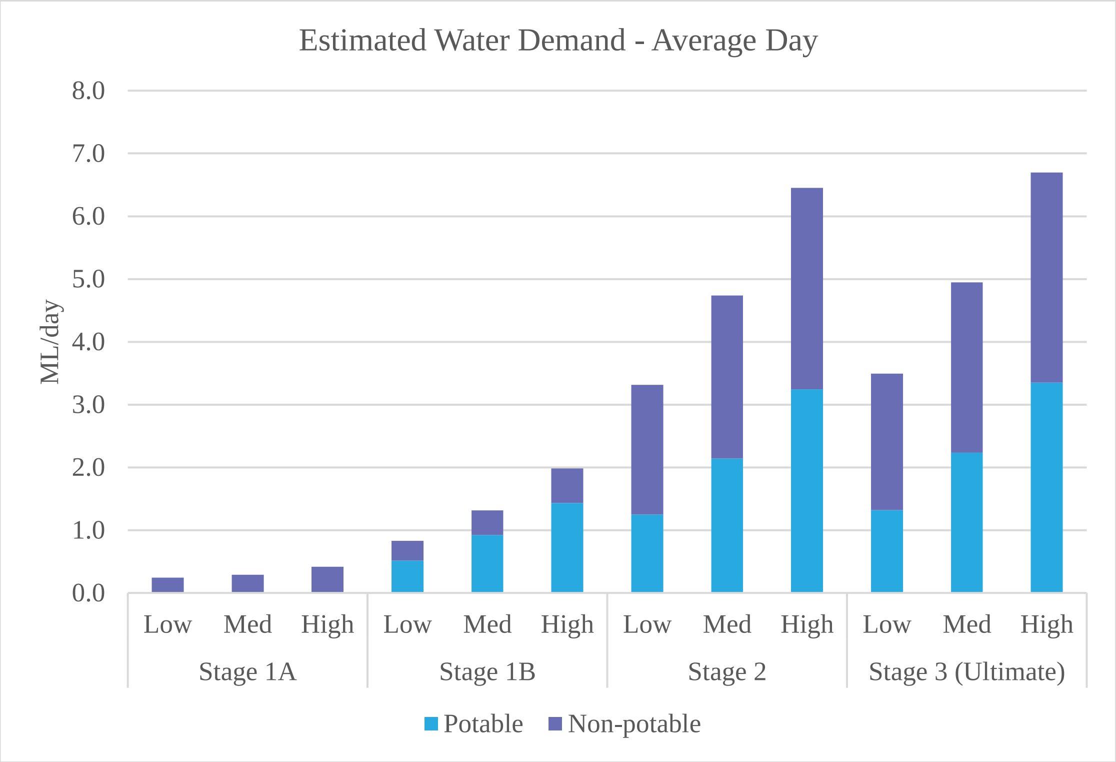

Figure 2: Average Day (AD) water demand estimates

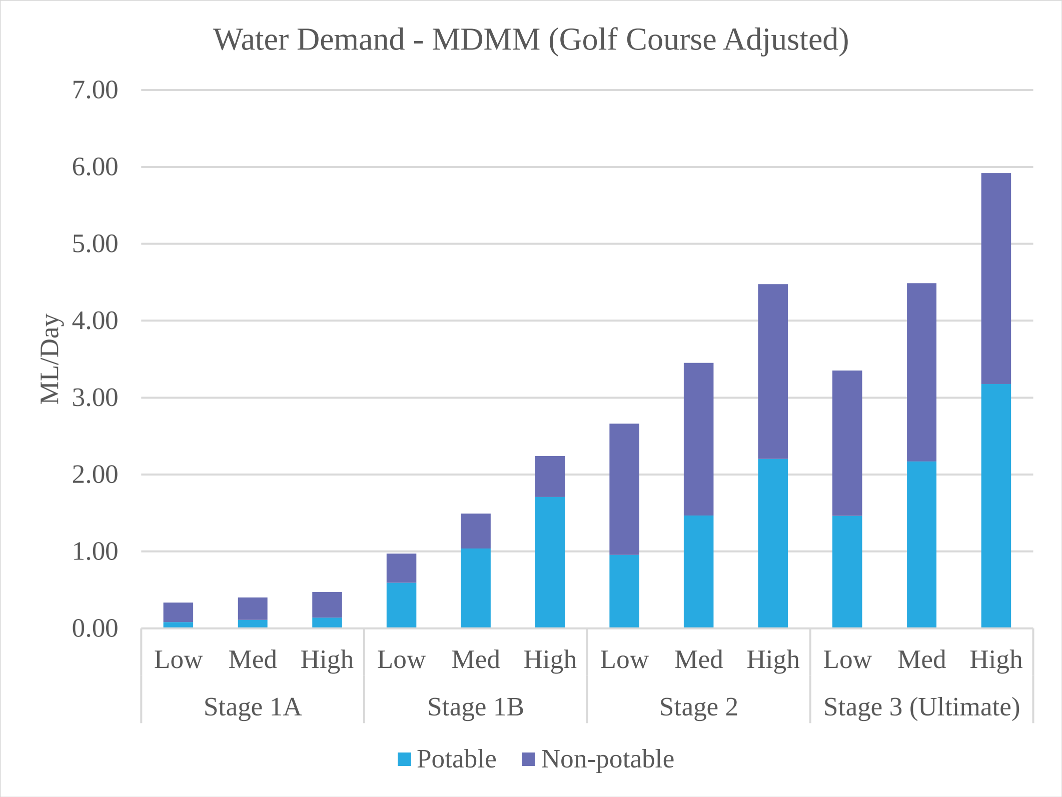

Figure 3: Mean Day Maximum Month (MDMM) water demand estimates

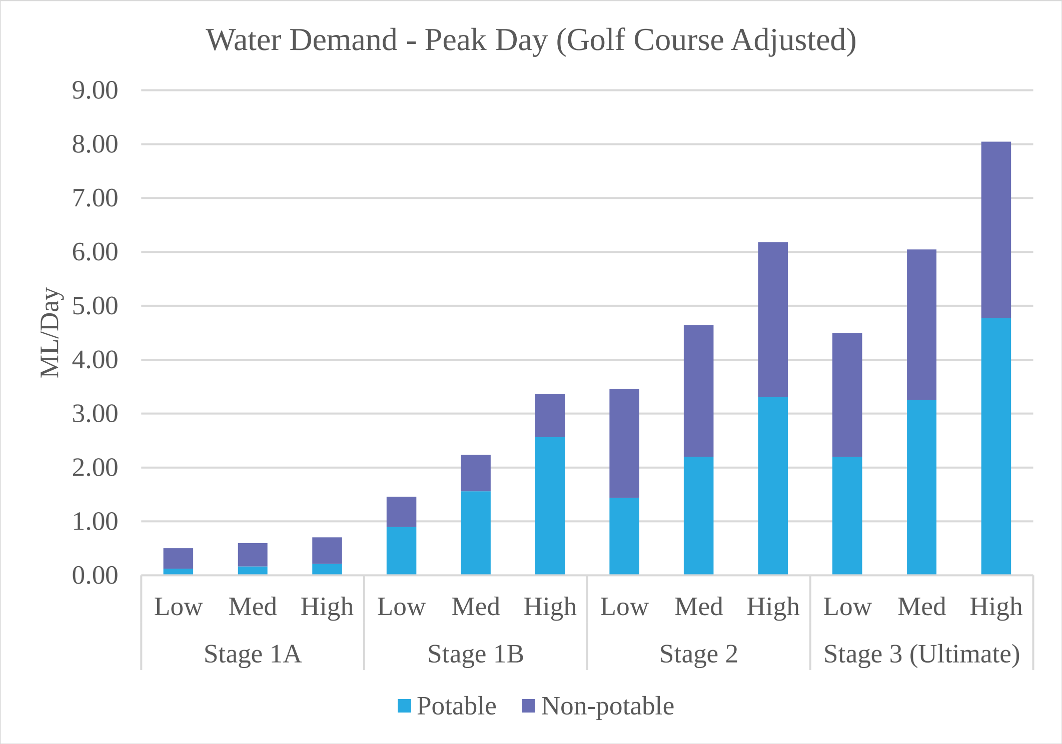

Figure 4: Peak day (PD) water demand estimates

4.4.2 Estimated water demands (to be imported from MSC network)

It is important to note that the demands presented in Figure 2, Figure 3 and Figure 4 represent the total estimated water demands, to be met by a combination of onsite sources (including groundwater, recycled water, rainwater and stormwater), as well as the Mareeba Shire Council (MSC) water network.

The demands on the MSC network are estimated to be significantly less than these figures. The total estimated AD, MDMM and PD demands on the MSC water network (under the low scenario only), are presented in Figure 5.

As shown in the figure, the low estimate water demands on the MSC water network range from:

- The AD water demand estimates range from:
    - Stage 1A: 0.05 ML/day;
    - Stage 1B: 0.40 ML/day;
    - Stage 2: 0.64 ML/day;
    - Stage 3 (ultimate): 0.97 ML/day;
- The MDMM (Golf Course adjusted) water demand estimates range from:
    - Stage 1A: 0.08 ML/day;
    - Stage 1B: 059 ML/day;
    - Stage 2: 1.63 ML/day;
    - Stage 3 (ultimate): 2.10 ML/day;
- The PD (Golf Course adjusted) water demand estimates range from:
    - Stage 1A: 0.12 ML/day;
    - Stage 1B: 0.89 ML/day;
    - Stage 2: 2.42 ML/day;
    - Stage 3 (ultimate): 3.24ML/ day.

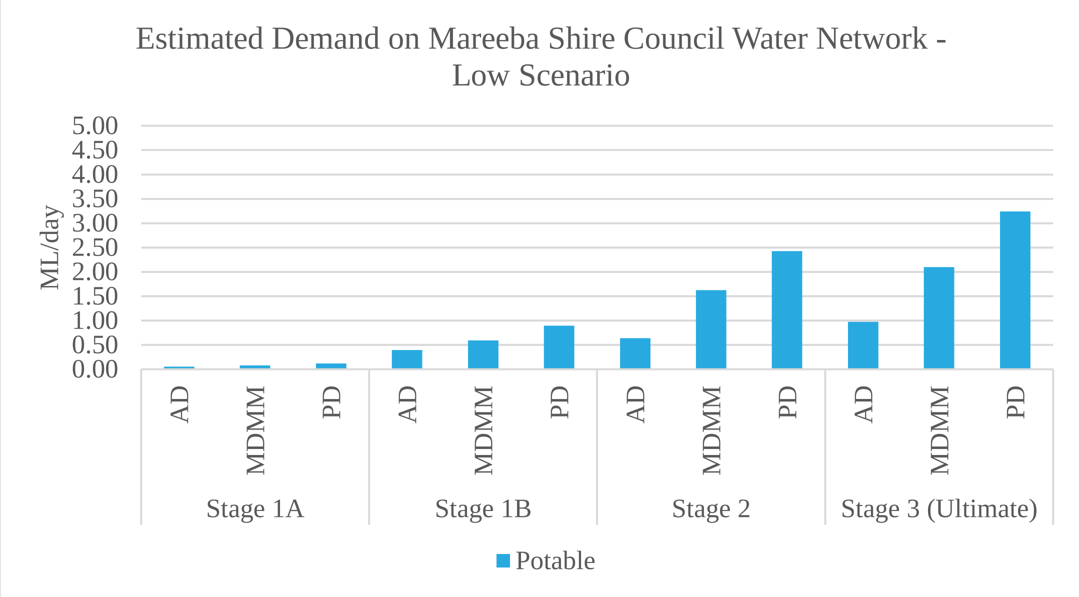

Figure 5: Estimated demand on MSC water network – low scenario

4.4.3 Estimated wastewater loads

The total wastewater loads have been estimated for each stage of the development under the low, medium and high scenarios. The estimated ADWF loads are shown in Figure 6.

As shown in the figure, the ADWF loads range from:

- Stage 1A: 0.05 ML/day (low) to 0.08 ML/day (high);
- Stage 1B: 0.34 ML/day (low) to 0.97 ML/day (high);
- Stage 2: 0.55 ML/day (low) to 1.26 ML/day (high);
- Stage 3 (ultimate): 0.77 ML/day (low) to 1.77 ML/day (high);

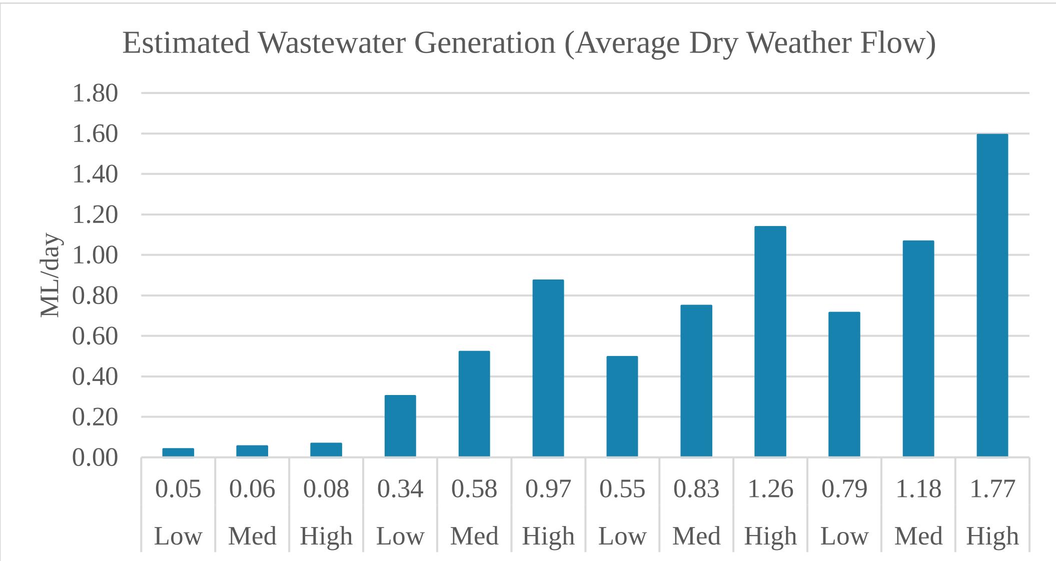

Figure 6: Average wastewater demand estimates for KUR-World

4.4.4 Estimated groundwater supply

A detailed hydrogeological investigation has been undertaken to provide an understanding of the regional and local hydrology at the site, and ultimately to confirm the maximum long-term sustainable groundwater yield to mitigate impacts on the environment and surrounding groundwater users. The hydrogeological investigation is detailed in the Rob Lait & Associates (2017) KUR-World Groundwater Report.

In summary, the report found groundwater abstraction was viable from five of the existing bores, with the recommended maximum long-term pumping rates from each of the bore as summarised in Table 5.

Table 5: Recommended Long Term Pumping Rates from Existing Groundwater Bores (extracted from Rob Lait and Associates, 2017)

	Individual Pumping Rate	Recommended maximum pumping time per day		Volume/ day based on 14-hour pumping day	
Bore	L/s	hours	seconds	L	L/s (over 24-hour day)
WB7	3.5	14	50400	176400	2.04
WB6	4	14	50400	201600	2.33
WB5	1	14	50400	50400	0.58
WB2* or WB3	1.7	14	50400	85680	0.99
WB8*	0.5	14	50400	25200	0.29
Total	-	-	-	539280	6.24

*Bores not pump tested

The report notes that “the almost ubiquitous slow recovering in each of the bores limits the combined use of the bores as the sole water source for the KUR-World development. If groundwater were to be considered as a component of the water source for KUR-World, a rigid pumping and recovery schedule (14 hours pumping followed by 10 hours recovering for all tested bores) would need to be adopted.” (Rob Lait and Associates, 2017).

The report also found that in general the groundwater is of good chemical quality with low salinity, sulfate and nitrate levels, and few metal exceedances. The pH of the groundwater is regularly lower than the Australian Drinking Water Guidelines (ADWG) aesthetic guideline vales. The groundwater quality is therefore considered suitable for the proposed non-potable uses following treatment by the proposed Groundwater Treatment Plant (GWTP).

On the basis of these recommendations, the water balance analysis has considered a maximum available groundwater supply of 0.54ML/day, based on abstraction from all five bores at 14 hours per day, at the rates in Table 5.

4.4.5 Estimated recycled water supply

The estimated recycled water supply assumed in the water balance analysis was based on the estimated wastewater loads summarised in 4.4.3, as well as the high level reference design for the proposed advanced wastewater treatment plant.

In accordance with the reference design, a recovery efficiency of 90% was assumed, meaning 90% of the site generated wastewater would be converted to class A+ recycled water, with the remainder removed as part of the bio solids waste stream. As the proposed WWTP will not be constructed until Stage 1B, no recycled water supply has been assumed during Stage 1A.

Figure 7 shows the estimated average recycled water supply for each stage of the KUR-World development.

As shown in the figure, the average recycled water supply ranges from:

- Stage 1A: 0.00 ML/day (no WWTP);
- Stage 1B: 0.0 ML/day (low) to 1.14 ML/day (high);
- Stage 3 (ultimate): 0.71 ML/day (low) to 1.59 ML/day (high).

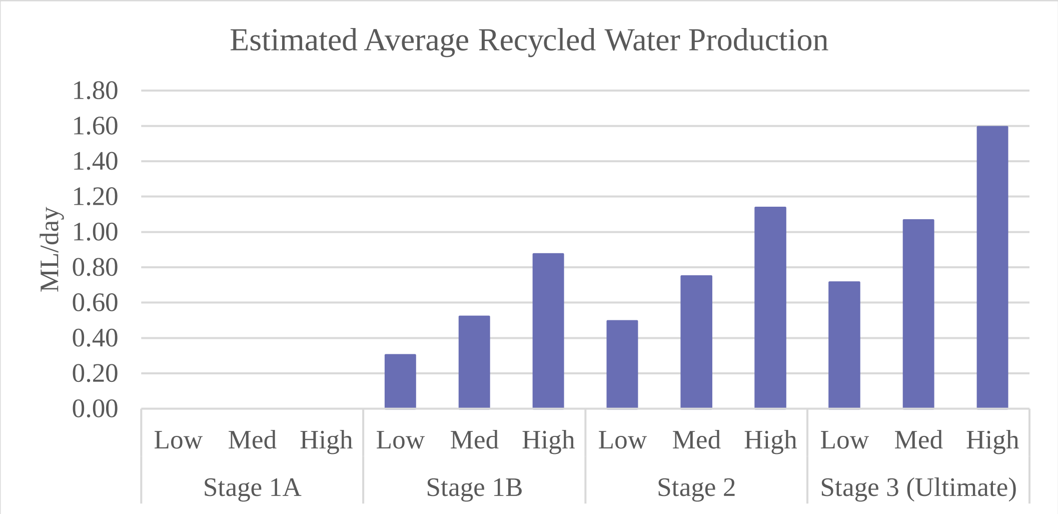

Figure 7: Estimated recycled water production

4.4.6 Estimated rainwater and stormwater supply

KUR-World will adopt a best practice approach to stormwater management through the integration of Water Sensitive Urban Design (WSUD) across the development. This approach will assist in both:

- Mitigating flood and water quality impacts on the receiving environment
- Facilitating opportunities for rainwater and stormwater harvesting to supplement non-potable water demands across the site where feasible.

The proposed development will increase the impervious fraction of the site, increasing the volume of stormwater generated by any rainfall event. WSUD features (such as rainwater tanks, swales, detention basins, bio-retention systems, ponds and lakes) will be used to detain excess rainwater and stormwater, and enable harvesting for re-use onsite where feasible. The stormwater reference design for the site is described in Chapter 7.4 and shown in drawing 253251-00-C-RD-202.

The tropical climate at the site location means that rainfall predominantly occurs in the summer months, with major rainfall events typically associated with cyclonic events and other low pressure systems. There are no rainfall gauging stations located within or adjacent to the KUR-World site, with the closest long-term stations located at the Cairns Airport (Gauge: 'Cairns Aero' 031011) and Mareeba Airport (Gauge: 'Mareeba Airport' 031210) (Bureau of Meteorology, 2017). There is a strong rainfall gradient between these two locations, with significantly higher rainfall received in Cairns which is directly on the coast, and lower rainfall in Mareeba which is around 60km inland. The KUR-World site is roughly centrally located between the two gauging stations, and so receives lower rainfall than Cairns but higher rainfall than Mareeba. For the purposes of evaluating rainfall and evapotranspiration in the various analyses undertaken in the EIS, an interpolation between the climate statistics from the two stations was adopted using isohyet contours published by the Bureau of Meteorology (Bureau of Meteorology, 2017).

Figure 8, Figure 9, and Figure 10 respectively show the mean, maximum and minimum monthly rainfall figures recorded for the Cairns Airport, Mareeba Airport and interpolated for the KUR-World site. As shown in the figures, the climate includes a distinct 'wet season' at the site, with the vast majority of total rainfall occurring between the months of November to April, and limited rainfall occurring throughout the remainder of the year. In addition, there is significant inter-annual variability in rainfall, with total rainfall in the driest years at around 60% lower than the mean figures, and total rainfall in the wettest years around 60% higher than the mean.

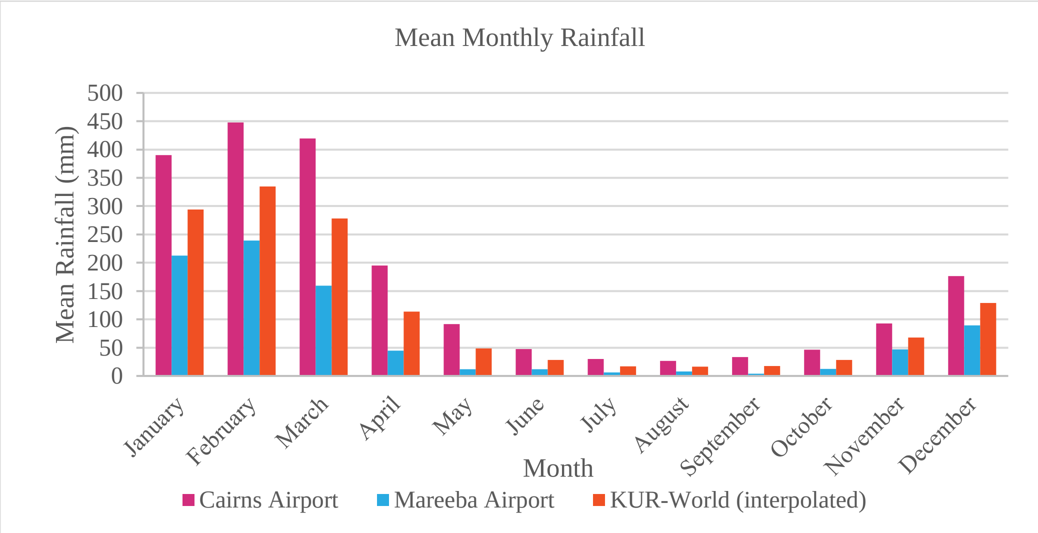

Figure 8: Mean monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

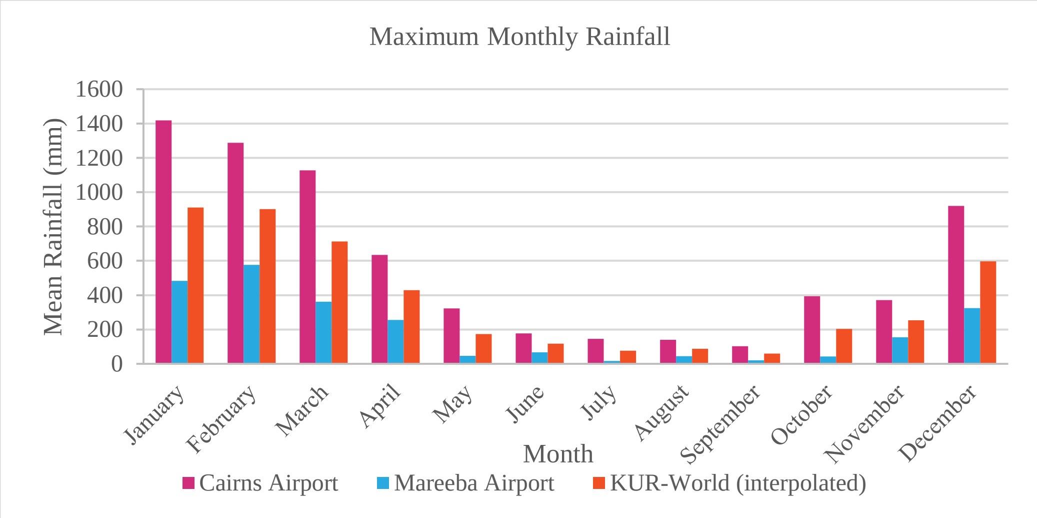

Figure 9: Maximum monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

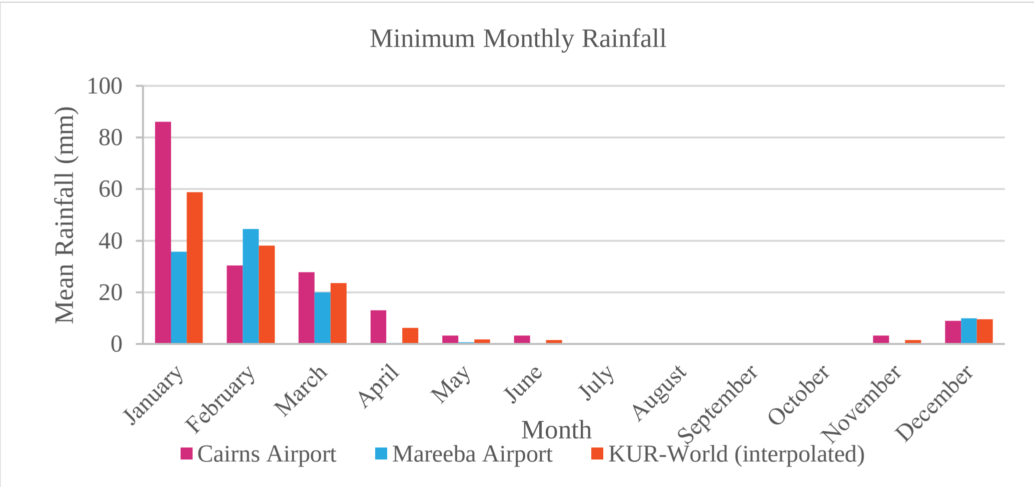

Figure 10: Minimum monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

The potential yield from rainwater and stormwater harvesting will be heavily dependent on the detailed design of buildings, stormwater and storage infrastructure, as well as environmental constraints including the requirement to maintain the existing hydrological regime, as well as limitations to the application of recycled water to land in times of surplus supply.

Estimates of the theoretical potential rainwater and stormwater yield have been developed based on:

- Historic rainfall data from the Bureau of Meteorology rain gauge stations at the Cairns and Mareeba Airports (rainfall statistics at KUR-World have been interpolated from the two rain gauge stations based on published isohyet contours) (Bureau of Meteorology, 2017).

- Consideration of the low (10th percentile), medium (50th percentile) and high (90th percentile) rainfall figures due to the significant inter-annual variability in rainfall.
- The total estimated building roof areas and road/car-park other hardstand areas indicated in the proposed master plan.
- Application of conservative rainwater harvesting efficiency factors of 50% for roof-harvested rainwater, and 5% for hardstand-harvested stormwater.

A summary of the estimated theoretical rainwater and stormwater yield is presented in Figure 11.

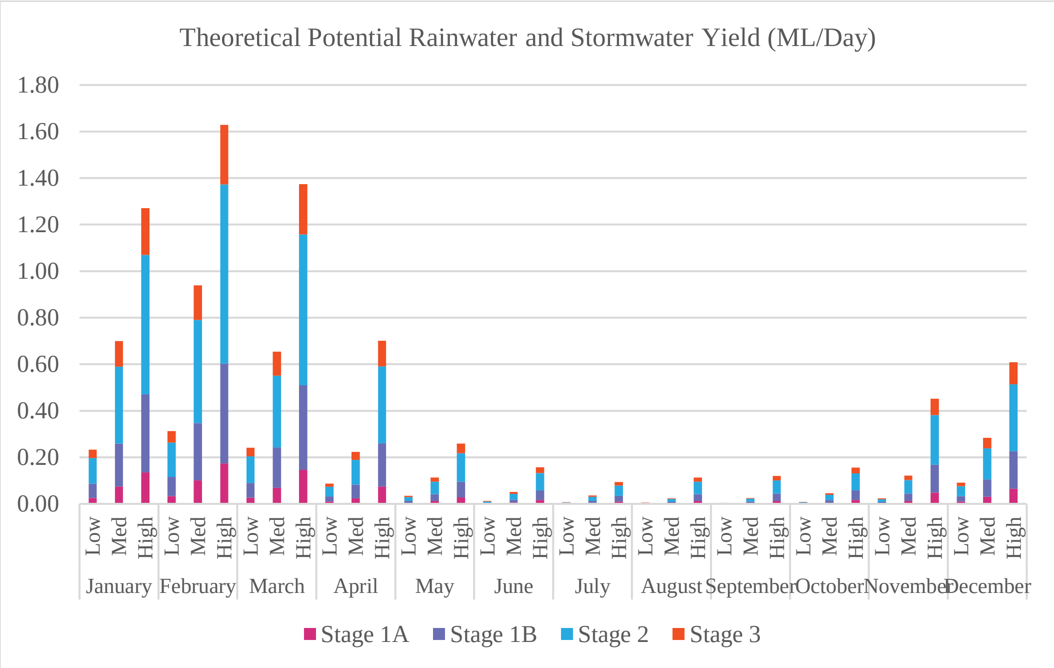

Figure 11: Theoretical potential rainwater and stormwater yield

As shown in the figure, the potential rainwater and stormwater yield varies substantially across the year with almost negligible yields occurring in the dry season. As a result, considerable rainwater and stormwater storage infrastructure (for example, tanks, reservoirs and dams) would be required to maintain a consistent and reliable supply throughout the year, at a scale which is considered to be unviable for KUR-World. This is further complicated by the reduced non-potable water demands anticipated in the wet season due to the lower irrigation requirement at this time.

Based on these factors, the potential rainwater and stormwater yield has not been included in the water balance analysis and all demand and infrastructure sizing calculations have assumed zero supply from rainwater or stormwater sources.

Opportunities for rainwater and stormwater harvesting will be considered and integrated into the development, and as a minimum will include:

- 5kL rainwater tanks installed in all residential lots
- 20kL rainwater tanks for all commercial precincts.

Other opportunities for stormwater harvesting and re-use will be considered in locations that prove to be economically viable and provide other aesthetic and environmental benefits. These will need to be assessed and confirmed at the detailed design stage.

4.4.7 Water balance summary

Table 6 provides a summary of the key outcomes from the water balance analysis for the *low scenario*, including the key water supply, demand and wastewater loads adopted in developing the high level water and wastewater infrastructure reference designs.

Table 6: Water balance summary

Parameter	ML/ day											
	Stage 1A			Stage 1B			Stage 2			Stage 3 (Ultimate)		
	AD	MDMM	PD	AD	MDMM	PD	AD	MDMM	PD	AD	MDMM	PD
Water Demand												
Potable Water Demand	0.05	0.11	0.12	0.40	0.59	0.89	0.95	0.95	1.43	0.97	1.46	2.19
Non-Potable Water Demand	0.17	0.29	0.38	0.25	0.38	0.57	1.71	1.71	2.03	0.98	1.89	2.31
Total Water Demand	***0.22***	***0.40***	***0.50***	***0.65***	***0.97***	***1.46***	***2.66***	***2.66***	***3.46***	***1.96***	***3.35***	***4.50***
Water Supply												
Ground Water Supply (non-potable)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Recycled Water Supply (non-potable)	0.04	0.05	0.04	0.30	0.30	0.30	0.50	0.50	0.50	0.71	0.71	0.71
Stormwater Water Supply (non-potable)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Non-Potable Water Supply	***0.58***	***0.59***	***0.58***	***0.84***	***0.84***	***0.84***	***1.03***	***1.03***	***1.03***	***1.25***	***1.25***	***1.25***
Deficit in Non-Potable Water Supply	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.67	0.99	0.00	0.64	1.05
Total Potable Water Required from MSC network (potable water demand + deficit in non-	***0.05***	***0.11***	***0.12***	***0.40***	***0.59***	***0.89***	***1.63***	***1.63***	***2.42***	***0.97***	***2.10***	***3.24***

Parameter	ML/ day											
	Stage 1A			Stage 1B			Stage 2			Stage 3 (Ultimate)		
	AD	MDMM	PD	AD	MDMM	PD	AD	MDMM	PD	AD	MDMM	PD
potable water supply)												
Wastewater Load (ADWF only)												
Average Wastewater Generation	0.05	-	-	0.34	-	-	0.55	-	-	0.79	-	-

4.4.8 Construction water demand and wastewater loads

In addition to the operational water demands described above, potable and non-potable water will be required for the construction workforce and for the various construction activities throughout the construction phase. Similarly, wastewater will be generated by the construction workforce, and will be managed and disposed of appropriately.

Table 7 summarises the proposed staged construction program, adopted as the basis for the construction phase water demand and wastewater load assessment.

Table 7: Construction and Operational Staging by Year

Year	Stage 1A	Stage 1B	Stage 2	Stage 3	No. workers[3]	MDMM (ML/d)
0	Construction[1]				102	0.27
1	Operation	Construction[2]			273	0.47
2					302	0.48
3		Operation	Construction[2]		273	0.57
4					228	0.57
5					307	0.58
6			Operation	Construction[2]	351	0.19
7					194	0.17
8					55	0.15
9				Operation	-	-
10					-	-

[1] Construction duration 78 days in year 0

[2] Construction duration 312 days in years 0-8

[3] Construction workers using 120 L/d and 4 office workers using 57 L/d

4.4.8.1 Construction phase water demand

Estimates of the temporary construction phase water demands have been developed based on first principles calculations and industry benchmarking, for each stage of the proposed construction program. Water demand estimates have been developed for the construction workforce (120L/person/day) and construction phase activities including earthworks and dust suppression (non-potable), revegetation and landscape irrigation (non-potable), on-site concrete batching and curing (non-potable), equipment wash-down (non-potable), pool filling (potable), and site amenities (potable). The construction phase water demands will vary throughout the construction period, and throughout each year, with higher demands expected during the dry season where water demand for dust suppression, earthworks and landscape irrigation will be highest.

Figure 12 summarises the estimates of construction water demand, operational water demand and total (combined construction and operation) water demand throughout the projected construction phase, along with the available onsite water supply over the same period, and the deficit in water supply which will need to be imported from the MSC network. Mean Day Maximum Month (MDMM) demand figures are used as the basis of the analysis, reflecting the higher daily demands expected to occur throughout the dry season.

As shown in Figure 12

- Construction water demands are estimated to increase from year 0 to year 5, during the construction of Stages 1A, 1B and 2, reaching a peak MDMM demand of approximately 0.6ML/day, before dropping to a MDMM demand of around 0.2ML/day throughout the construction of Stage 3.
- The total water demand occurring during the construction phase (combination of construction water demand and operational water demand) peaks during years 6 & 7 at 2.85ML/day. This is significantly less than the ultimate operational water demand of 3.35ML/day.

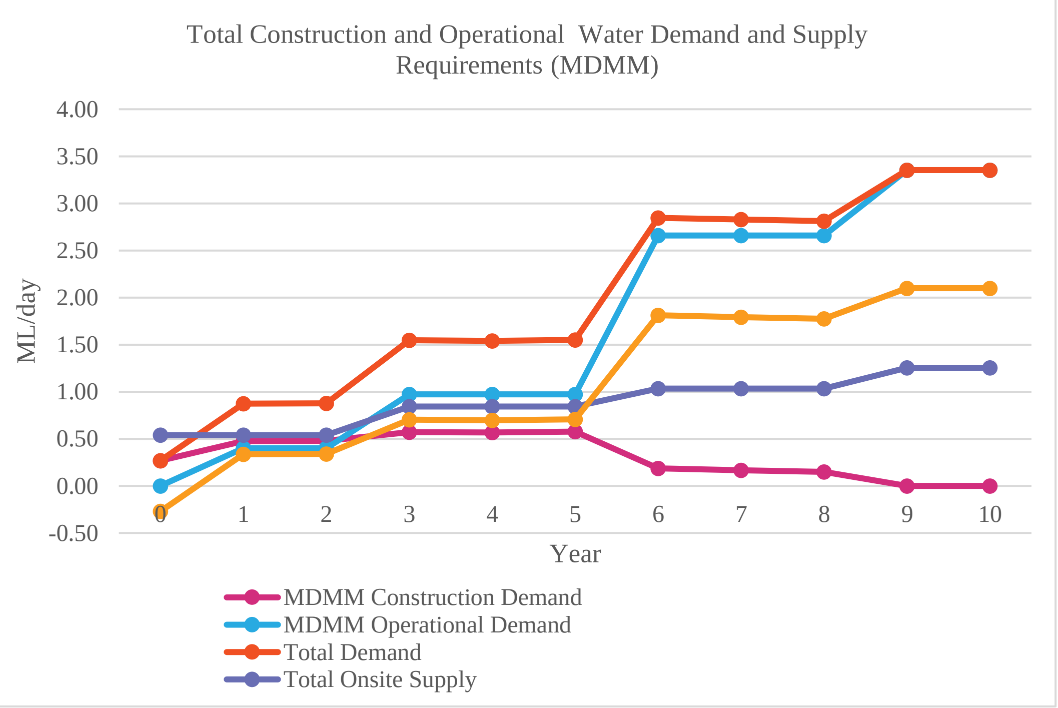

Figure 12: Total water demand and supply throughout construction period

The proposed strategy for the supply of construction phase water demands is as follows:

- During construction of Stage 1A: Non-potable water demands will be supplied via temporary intakes from the existing farm dam and groundwater bores, until the onsite groundwater treatment plant is commissioned. Potable water will be supplied via tankers from the MSC network and stored in rainwater tanks for onsite use (estimated maximum 15kL/day).
- During construction of Stage 1B: Non-potable water demands will be supplied by the groundwater treatment plant and non-potable water network, treating and distributing water from the farm dam and groundwater bores. Potable water and any additional demand which cannot be met by the onsite supply (estimated maximum 0.3ML/day or approximately 15 x 20kL tanker vehicles per day) will be supplied via tankers from the MSC network.
- During construction of Stages 2 and 3: All construction and operational water demands will be supplied by a combination of the groundwater treatment plant, wastewater treatment plant, and potable water network in accordance with the ultimate development water supply strategy.

4.4.8.2 Construction phase wastewater load

Estimates of the temporary construction phase wastewater loads have been developed based on first principles calculations and industry benchmarking, for each stage of the proposed construction program.

Figure 13 summarises the estimates of construction wastewater load, operational wastewater load and total (combined construction and operation) wastewater load throughout the projected construction phase, along with the capacity of the onsite wastewater treatment plant at each stage. Average Dry Weather Flow (AD) figures are shown, reflecting the typical daily loads expected from construction activities given that no inflow or infiltration is expected.

As shown in Figure 13:

- Construction wastewater loads are estimated to increase from year 0 to year 6 during the construction of Stages 1A, 1B and 2, and commencement of Stage 3, reaching a peak ADWF sewage load of 0.04ML/day, before reducing over the final two years of construction.
- The peak construction phase wastewater load of 0.59ML/day is below the ultimate development operational wastewater load and well within the capacity of the proposed onsite wastewater treatment plant, following commissioning of the first stage of the plant in parallel with Stage 2 of the development.

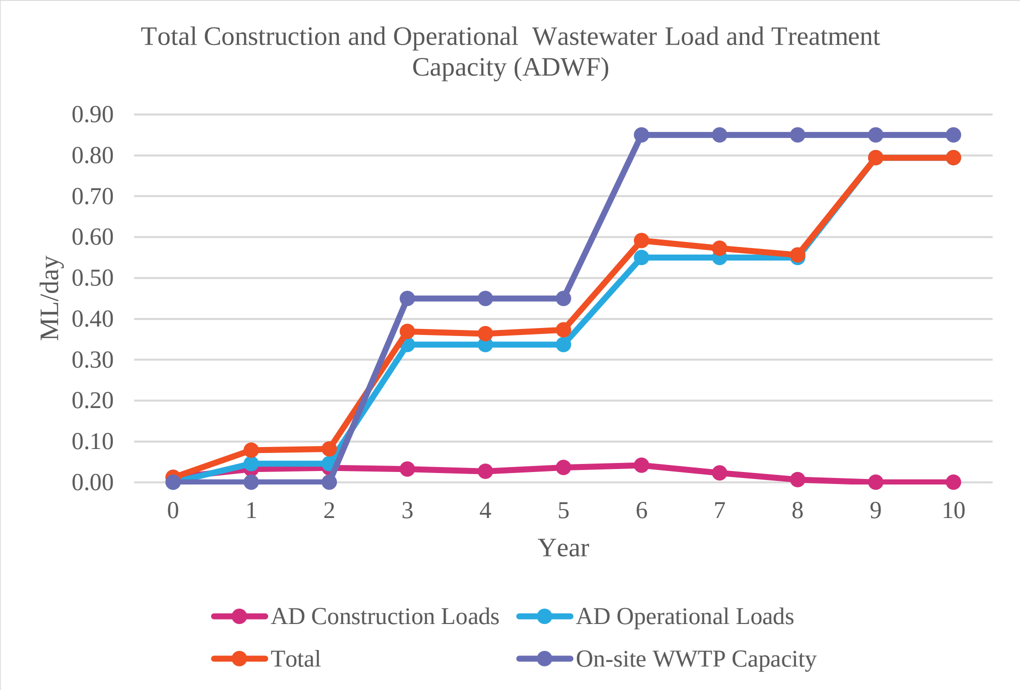

Figure 13: Total wastewater load and treatment capacity throughout construction period

The proposed strategy for the supply of construction phase water demands is as follows:

- During construction of Stages 1A & 1B: portable toilets will be used for all construction activities, with all wastewater to be transported for offsite disposal to the Kuranda wastewater treatment plant (estimated maximum 0.04ML/day or approximately 2x20kL tanker vehicles per day).
- During construction of Stages 2 and 3: all site generated wastewater will be collected either via tankers or established parts of the proposed sewerage network, and discharged to the proposed onsite wastewater treatment plant.

5 Water supply infrastructure

5.1 Existing water supply infrastructure

5.1.1 Existing onsite water supply infrastructure

There is limited existing water supply infrastructure on the KUR-World site. The site is not currently connected to MSC's water network, with all of the site's water demands currently met by groundwater and domestic rainwater tanks at the homestead building.

The existing onsite water supply infrastructure is limited to:

- Seven groundwater bores varying in depth from 60 metres to 80 metres that were constructed as part of the KUR-World groundwater investigations, at various locations across the site. As outlined in section 4.4.4, the KUR-World Groundwater Report (Rob Lait & Associates, 2017) found groundwater abstraction was only viable from four of the existing bores (WB3, WB5, WB6 and WB7). These bore locations are shown in the reference design drawing 253251-00-C-RD-303.
- Temporary headworks, pumps, power supplies and rural polyethylene supply mains connecting two of the existing groundwater bores (WB3 and WB5) to the existing farm dam.
- An approximately 19ML earth farm dam constructed under separate approval from MSC.

5.1.2 Mareeba Shire Council water supply infrastructure

MSC owns and operates the existing water supply system servicing the township of Kuranda.

In summary, the existing MSC water supply system includes:

- A raw water intake from the Barron River and a water treatment plant (Kuranda WTP) located off Kuranda Heights Road, including a 0.5ML onsite ground level clear water storage reservoir.
- Three elevated service reservoir sites located at Myola Road (approximately 2ML), Warril Drive (approximately 0.5ML) and Mason Road (approximately 0.6ML).
- Three pump stations located at the WTP, Warril Drive and Mason Road.
- A distribution network of predominantly 100mm to 450mm diameter water mains.

Treated water is pumped from the Kuranda WTP to the primary service reservoirs on Myola Road, and is then distributed throughout the network via gravity. Pump stations at Warril Drive and Mason Road boost supply to the service reservoirs at the same locations, providing additional storage and balancing demand in these parts of the network.

The map in Figure 14 illustrates the key features of the water supply system in the vicinity of the KUR-World site.

As outlined in Section 5.2.1.2, a connection to the MSC water network is proposed to meet KUR-World's potable water demands as well as to supplement the site's non-potable water supply.

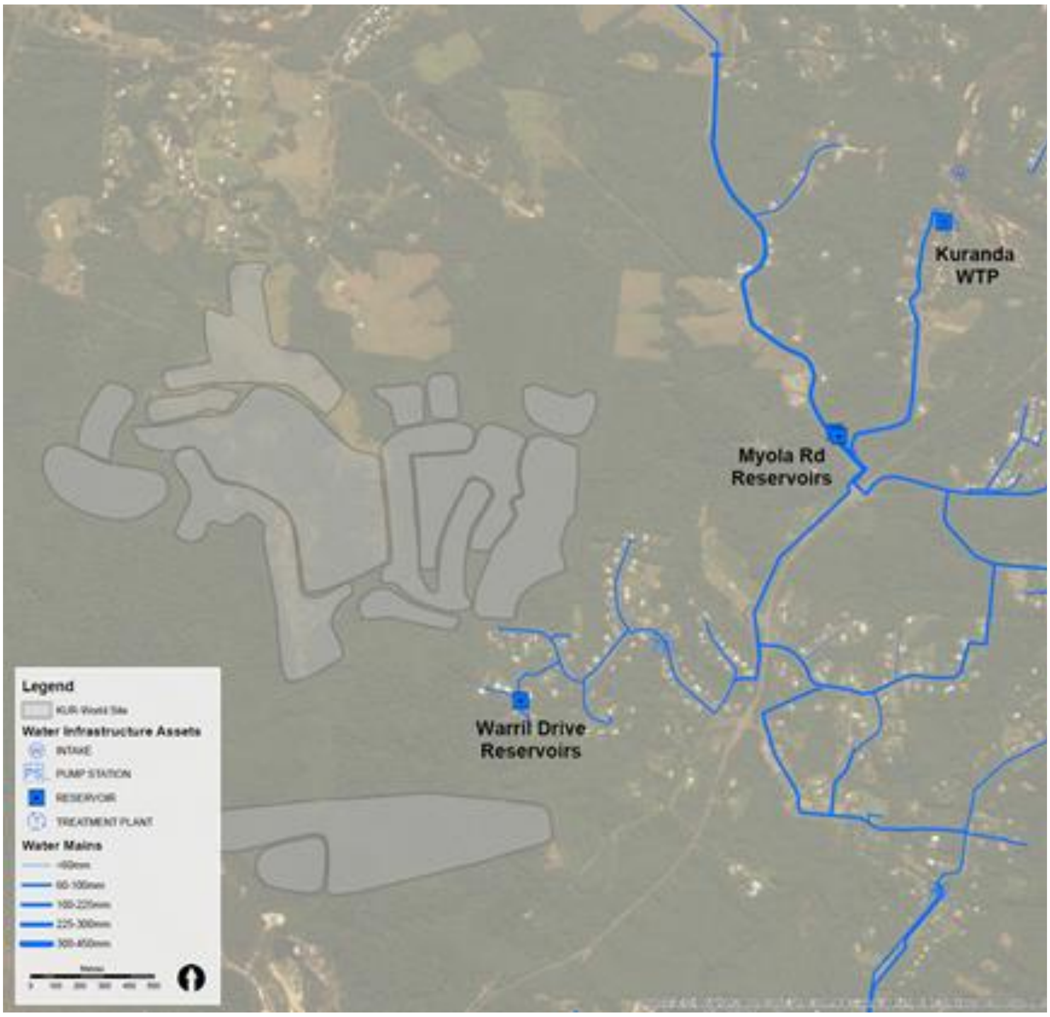

Figure 14: Key features of existing MSC water network in vicinity of KUR-World

5.1.2.1 Existing Kuranda Water Treatment Plant (WTP)

The Kuranda Water Treatment Plant located at Kuranda Heights Road, is the primary source of potable water for the Kuranda community. It is a conventional water treatment plant, drawing water from the Barron River under the Mareeba Dimbulah Water Supply Scheme (MDWSS). Consultation was undertaken with MSC to understand water available from their network, based on existing capacity and planned upgrades.

Information provided by MSC indicates:

- The Council holds a high priority allocation with no termination date under the MDWSS, with a total allocation of 460ML per annum.
- The design capacity of the existing Kuranda WTP is approximately 6.0ML/day, with a peak instantaneous treatment capacity of 70L/s.

A high level assessment of the spare capacity available at the Kuranda WTP was undertaken for both existing and ultimate conditions, based on population and water demand projections contained within the recent Aurecon (2014) MSC planning report, and in accordance with the design criteria outlined in the FNQROC Development Manual (FNQROC, 2014). The results are summarised in Table 8.

As shown in the table, the existing Kuranda WTP is estimated to have sufficient spare capacity under ultimate conditions to meet the AD and MDMM demand requirements of the Kuranda Township and KUR-World development.

Although the spare capacity of the Kuranda WTP is insufficient to meet the PD demand requirements of both the Kuranda Township and KUR-World, excess demands under such ‘peak’ circumstances would need to be managed through appropriately sized storage reservoirs, as described in the following section.

In summary, based on the projected demands of the Kuranda Township and KUR-World development, it is considered that the additional demand imposed by KUR-World will not trigger the requirement for significant upgrades to the Kuranda WTP, provided it is capable of operating at its design capacity.

It is noted that based on the above figures, the existing demand on the Kuranda water supply network (1.19ML/day or 434 ML/annum) is approaching the limit of MSC’s existing allocation under the MDWSS (460ML/annum). The estimated ultimate demand excluding KUR-World (1.88ML/day or 686ML/annum significantly exceeds this allocation. With the additional demand from KUR-World (0.97ML/day or 354ML/annum), the allocation is further exceeded. As such, regardless of whether KUR-World proceeds, it appears MSC will be required to obtain additional allocation to cater for planned growth in its water demand, and this will be necessary to facilitate the proposed supply of potable water to KUR-World.

Table 8: Kuranda WTP current and projected capacity analysis

Parameter	Total Population (EP)	AD (ML/day)	MDMM (ML/day)	PD (ML/day)
Existing WTP design capacity	-	6.0		
Existing scenario (2016)				
Existing demand	1923	1.19	1.79	2.68
Estimated spare WTP capacity	-	4.81	4.21	3.32
Ultimate scenario (2030) (excluding KUR-World)				
Ultimate demand (excluding KUR-World)	3029	1.88	2.82	4.23
Estimated spare WTP capacity (excluding KUR-World)	-	4.12	3.18	1.77
Additional Demand from Kur-World				
Ultimate demand	-	0.97	2.20	3.34
Sufficient spare capacity at Kuranda WTP	-	Yes	Yes	No

5.1.2.2 Existing Kuranda water storage reservoirs

Three main service reservoirs provide the necessary storage capacity within the Kuranda water supply system.

The MSC planning report, Service Reservoir Assessments – Kuranda, Mount Molloy and Chillagoe (Aurecon 2014), provides an assessment of the storage capacity required to service Kuranda, and makes recommendations for future upgrades to meet ultimate population growth. The results of the analysis are summarised in Table 9.

Table 9: Kuranda Township water supply reservoirs

Reservoir	Current Capacity (ML)	Immediate Future Capacity (ML)1	Planned Future Capacity (ML)2
Myola Road	1.0	~2.01	3.0
Warril Drive	0.32	~0.52	0.5
Mason Road	0.6		1.1

[1] Discussions with MSC and site observations indicate a second reservoir has already been built at Myola Road
[2] Discussions with MSC indicate a new reservoir is currently being constructed at Warril Drive

The planned future storage requirements were recommended on the basis of population projections in the respective catchments for each reservoir, however, no population growth was assumed for the KUR-World development area.

On this basis, it is assumed that any significant additional demand generated by KUR-World will require additional storage to be constructed either onsite or at an alternative location on MSC's network. Based on preliminary advice from MSC, additional storage is proposed at the Myola Road reservoir site to meet the additional requirement generated by KUR-World. Details are outlined in Section 5.2 below.

5.1.2.3 Existing Kuranda water distribution network

GIS information provided by MSC, indicates no existing trunk water mains of any significant size/capacity within a reasonable proximity to the KUR-World site. Upgrades to the existing Kuranda water distribution network are therefore proposed to service the KUR-World development, as outlined in Section 5.2 below.

5.2 Proposed water supply infrastructure

The proposed water supply infrastructure for KUR-World includes:

Potable Water Supply Infrastructure:

- Upgrades to the MSC water supply network to meet the site's potable water demands and supplement the non-potable supply (including construction of additional reservoir storage and a new trunk water supply main)

- A potable water reticulation network delivering potable water to all of the proposed buildings and facilities across the site.

Non-Potable Water Supply Infrastructure:

- Groundwater supply infrastructure interconnecting the existing five viable bores, and delivering ground water to the proposed Groundwater Treatment Plant (GWTP) and existing farm dam.
- A GWTP producing class A+ non-potable water from a combination of groundwater and water abstracted from the existing farm dam, co-located at the WWTP site.
- Provisions for the supply of class A+ non-potable water from the onsite Waste Water Treatment Plant (WWTP), including a supply main delivering recycled water to the non-potable water network and existing farm dam.
- A 1.7ML non-potable water storage reservoir co-located at the WWTP site, storing class A+ non-potable water produced by both the GWTP and WWTP.
- A dedicated non-potable water (dual) reticulation network delivering water from the non-potable storage reservoir to proposed buildings and facilities across the site, via a pressure boosting pump station located at the WWTP site.
- Potential utilisation of the existing farm dam to balance non-potable supply and demand (surplus non-potable water from the onsite WWTP may be discharged to the farm dam, for re-use after treatment via the GWTP), pending further investigations at the detailed design stage.

The key elements of the proposed potable and non-potable water supply networks are provided in drawings 253251-00-C-RD-301 (Proposed Water Supply [Potable] Infrastructure, Indicative Layout, issue 1A) and 253251-00-C-RD-303 (Proposed Water Supply [Non-Potable] Infrastructure, Indicative Layout, issue 1A) which can be found in Appendix A.

It is noted that the high level reference designs for all proposed water supply infrastructure have been developed to limited level of detail, sufficient to confirm the technical feasibility and assess the potential environmental impacts of the proposed works. Further investigations and design will be required as part of future planning for KUR-World to develop the designs and ensure compliance with all relevant guides and standards, including the FNQROC Development Manual (FNQROC, 2014). This will need to be undertaken in consultation with Mareeba Shire Council and other relevant state and federal agencies.

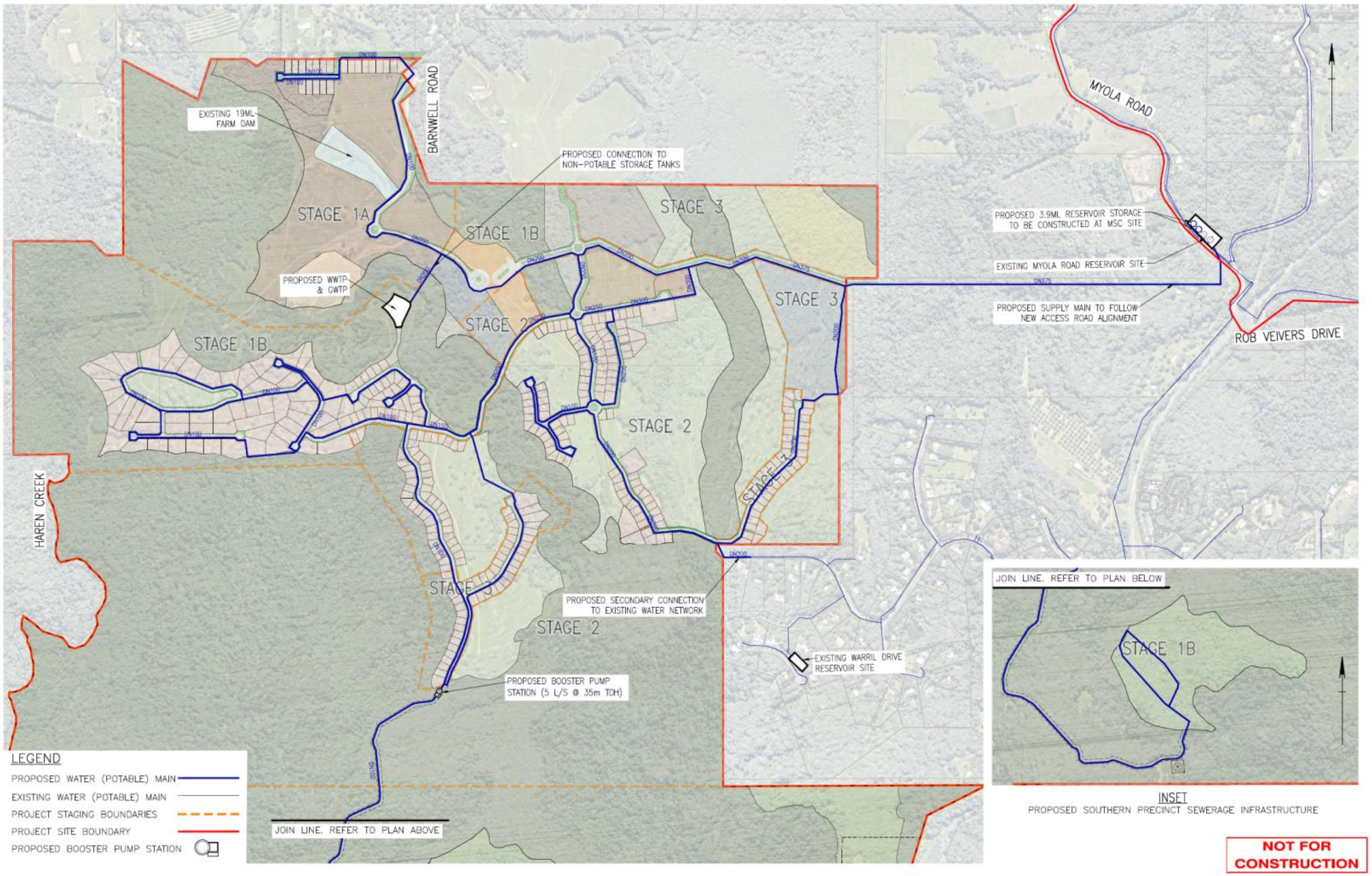

Figure 15: Indicative layout of proposed potable water supply infrastructure

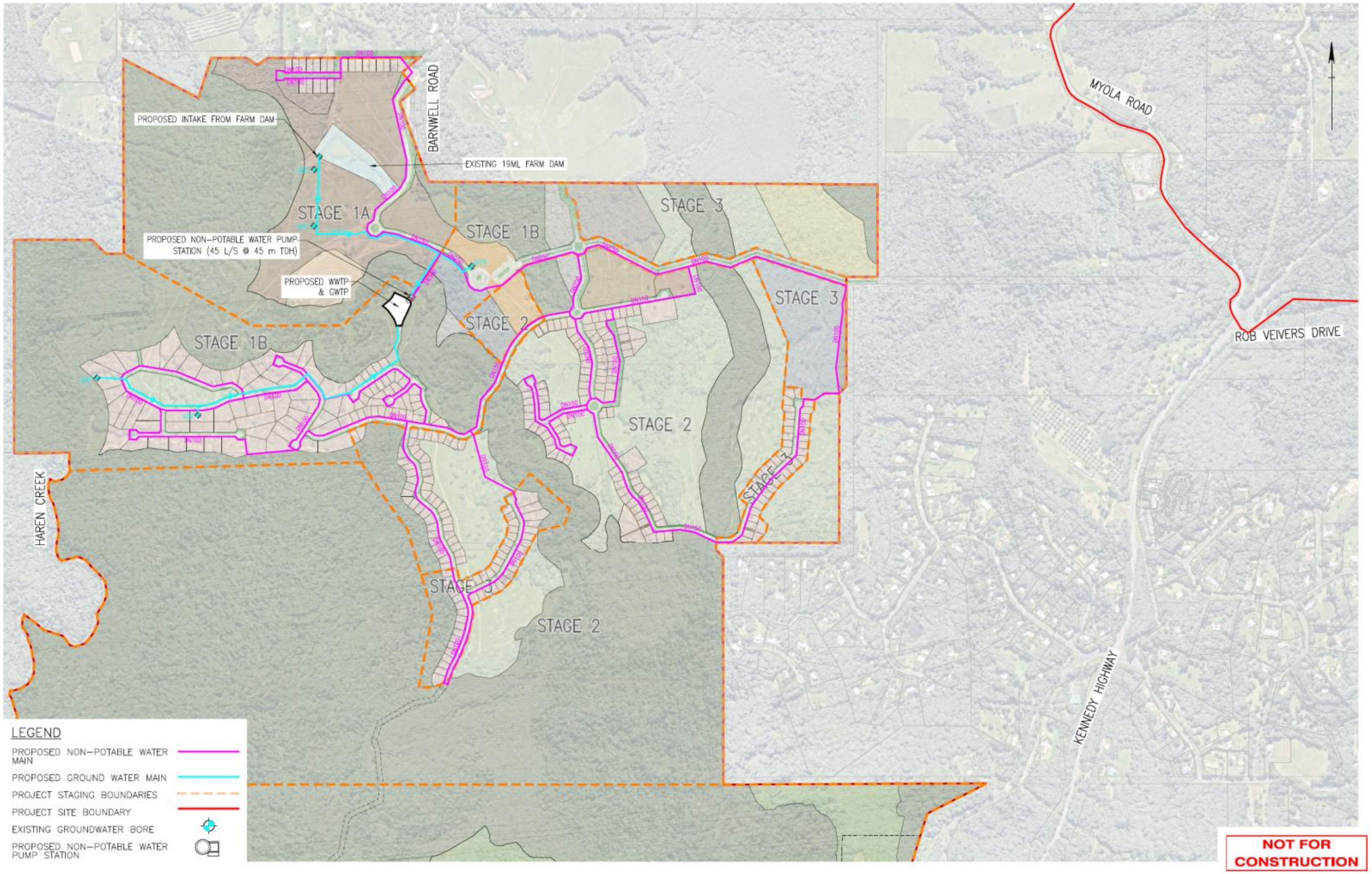

Figure 16: Indicative layout of proposed non-potable water supply infrastructure

5.2.1 Upgrades to Mareeba Shire Council (MSC) water supply infrastructure

5.2.1.1 Upgrades to Kuranda water storage reservoir capacity

Additional storage will be required in the MSC water network to provide for the forecast demand from KUR-World.

The required storage capacity has been calculated in accordance with the design requirements prescribed in FNQROC (FNQROC, 2014), based on the "low" estimates of the total water required from Mareeba Shire Council Water Network, as summarised in Section 4.4.2.

The additional storage capacity required for each stage of the development is summarised in Table 10.

Table 10: Estimated potable water storage reservoir capacity requirements

Design Parameter	Stage 1A	Stage 1B	Stage 2	Stage 3 (Ultimate)
Average Day (AD) Demand (ML/day)	0.05	0.40	0.64	0.97
Mean Day Maximum Month (MDMM) Demand (ML/day)	0.08	0.59	1.63	2.10
Peak Day Demand (PD) Demand (ML/day)	0.12	0.89	2.42	3.24
Fire Flow Storage (ML)	0.43	0.43	0.43	0.43
Emergency Storage (ML)	0.02	0.13	0.21	0.32
Required Reservoir Capacity (ML)	0.55	1.32	2.83	3.87

The preferred location for the proposed storage is MSC's existing Myola Road Reservoir compound, as shown in drawing 253251-00-C-RD-301. This site is at a sufficient elevation to gravity feed the majority of the KUR-World development, is located at the point of greatest capacity within the existing MSC water network (close to the Kuranda WTP), and MSC has advised a preference for the additional storage to be located at this site.

Further investigations will be required in future design stages to confirm the feasibility of the site, determine the optimal site layout and design, and confirm a suitable strategy for staging the reservoir construction if required. The design and construction of the proposed additional storage will be subject to further consultation and approvals from MSC.

5.2.1.2 Upgrades to Kuranda water distribution network

In order to deliver the required flows to site, a new trunk water supply main will also be required from the Myola Road reservoir site to the proposed onsite potable water reticulation network. The high level reference design alignment for the trunk supply main follows the proposed major development access road from Myola Road, as shown in drawing 253251-00-C-RD-301.

A hydraulic model was used to confirm the required size of the required trunk water main (nominal diameter DN375). The detailed design of the trunk water main, including interconnections with the Myola Road reservoirs, will need to be completed at the detailed design stage.

The design and construction of the proposed trunk water supply main will be subject to further consultation and approvals from MSC.

5.2.2 Proposed potable water reticulation network

A dedicated potable water reticulation network is proposed to deliver potable water to all of the proposed buildings and facilities across the site.

The high level reference design for the potable water reticulation network was developed in accordance with FNQROC (FNQROC, 2014), and is shown in drawing 253251-00-C-RD-301. The detailed design of the potable water reticulation network, including confirmation of the alignments in relation to the various other services within the service corridors and compliance with the FNQROC development manual, will need to be undertaken at the detailed design stage, in consultation with Mareeba Shire Council.

A hydraulic model was used to determine appropriate network sizing and confirm compliance with the FNQROC (FNQROC, 2014) design requirements. The network is predominantly gravity fed, however one small booster pump station is required to deliver adequate flows and pressures to the southern precinct which is located at a higher elevation than the rest of the site.

5.2.3 Proposed groundwater supply infrastructure

The proposed groundwater supply infrastructure includes:

- Permanent headworks, pumps and power supplies installed to the existing groundwater bores WB3, WB5, WB6 and WB7
- Interconnecting pipelines delivering groundwater from the four existing bores to the GWTP and existing farm dam.

The high level reference design layout for the groundwater supply network is shown in drawing 253251-00-C-RD-303.

5.2.4 Proposed groundwater treatment plant (GWTP)

5.2.4.1 Overview

An onsite groundwater treatment plant (GWTP) has been proposed to treat groundwater abstracted from the onsite bores and farm dam (a combination of groundwater, stormwater and potentially treated recycled water discharged from the WWTP), prior to distribution to the non-potable reticulation network.

The high level reference design for the proposed GWTP is provided in drawings 253251-00-C-RD-351, and 253251-00-C-RD-353. The high-level reference design of the GWTP has been based on a number of assumptions and limited water quality data. Further investigations will be undertaken to confirm the unit processes and undertake the detailed design of the GWTP.

5.2.4.2 Design capacity

The GWTP has been designed with a maximum capacity of 1.2ML/day.

This corresponds with the total (ultimate) mean day maximum month (MDMM) non-potable demand (1.89ML/day), less the total (ultimate) design production capacity from the onsite WWTP (0.71ML.day).

5.2.4.3 Influent water quality

The GWTP will treat groundwater abstracted from the onsite bores and farm dam (a combination of groundwater, stormwater and potentially treated recycled water discharged from the WWTP).

Based on the general site configuration and groundwater quality data reported in the Rob Lait & Associates (2017) KUR-World Groundwater Report, the key water quality characteristics to be treated by the GWTP include:

- Suspended solids;
- Manganese;
- Iron;
- Low pH;
- Aluminium; and
- Arsenic.

Further information is required in relation to the existing groundwater quality to support the next stages of design.

5.2.4.4 Treated effluent water quality

The required water quality for the treated effluent from both the GWTP and WWTP is described in Section 6.2.2.4.

5.2.4.5 Treatment processes and equipment

As shown in the block flow diagram in Figure 17, the proposed GWTP includes oxidation and filtration processes, followed by disinfection by sodium hypochlorite to produce Class A+ non-potable water.

The main process equipment includes:

- Oxidation vessel
- Filters, including backwash pumps which will service the media filters, and a compressed air system for backwash of the sand filtration unit, which will be also be used to service the actuated valves

- Sodium hypochlorite for oxidation and disinfection
- Recycled water storage tank
- Waste storage and/or disposal.

Figure 17: GWTP Block Flow Diagram

Ancillary Plant and Equipment

A number of ancillary systems are required for the operation of the GWTP plant including chemical dosing, and transfer pumping systems.

Utilities Requirement

The GWTP will require the provision of the following utilities:

- Telecommunication for plant remote monitoring
- Electricity supply
- Mains water supply

Chemical Storage

Sodium hypochlorite will be stored on-site. Chemical storage, dosing system will be required as part of the GWTP system and designed in accordance with the relevant Australian Standards and the Dangerous Goods Code.

Approximate chemical requirements for the GWTP include 45 L/day of sodium hypochlorite

5.2.5 Non-Potable supply from onsite Wastewater Treatment Plant

An advanced onsite WWTP has been proposed to treat all of the wastewater generated by KUR-World, producing class A+ non-potable water for re-use onsite. Details of the proposed WWTP are provided in Section 5.2.9.

The high level reference design for the proposed WWTP is provided in the drawings 253251-00-C-RD-351, and 253251-00-C-RD-352.

5.2.6 Non-potable storage reservoir

A 1.7ML non-potable water storage reservoir is proposed to be co-located at the WWTP site, storing class A+ non-potable water produced by both the GWTP and WWTP.

The required storage capacity was calculated in accordance with the design requirements prescribed in FNQROC (FNQROC, 2014), as summarised in Table 10.

Table 11: Estimated potable water storage reservoir capacity requirements

Design Parameter	Stage 1A	Stage 1B	Stage 2	Stage 3 (Ultimate)
Average Day (AD) Demand (ML/day)	0.17	0.25	0.86	0.98
Mean Day Maximum Month (MDMM) Demand (ML/day)	0.25	0.38	1.71	1.89
Peak Day Demand (PD) Demand (ML/day)	0.38	0.57	2.03	2.31
Fire Flow Storage (ML)	0.43	0.43	0.43	0.43
Emergency Storage (ML)	0.06	0.08	0.29	0.33
Required Reservoir Capacity (ML)	0.81	1.00	1.40	1.68

5.2.7 Non-Potable water (dual) reticulation network

A dedicated non-potable water (dual) reticulation network is proposed to distribute Class A+ non-potable water to buildings, facilities and irrigation areas (including golf course) across the site.

A dedicated pressure boosting pump station with a design duty of approximately 45L/s @ 45m total dynamic head, is proposed to pressurise the non-potable water (dual) reticulation network.

The proposed configuration and sizing of the non-potable water reticulation network is indicated in in drawing 253251-00-C-RD-303. A hydraulic model was used to determine appropriate network sizing and confirm compliance with the FNQROC (FNQROC, 2014) design requirements. The detailed design of the non-potable water reticulation network, including confirmation of the alignments in relation to the various other services within the service corridors and compliance with the FNQROC development manual, will need to be undertaken at the detailed design stage, in consultation with Mareeba Shire Council.

It is noted that the proposed dual reticulation network has been designed to meet the peak estimated demands for non-potable water from the various buildings, facilities and irrigation areas across the site. It has not been sized to accommodate any additional land-based disposal of surplus effluent during the wet season, beyond what would be required to maintain acceptable plant growth. Should significant onsite disposal of surplus effluent be adopted as part of the final effluent management strategy, further expansion of the network and additional pumping capacity may be required.

5.2.8 Staging of water supply infrastructure construction

The construction of the proposed water supply infrastructure will be staged in accordance with proposed staging of the KUR-World development. Table 12 describes the water supply infrastructure to be constructed, and the operational water supply at each proposed development stage.

Table 12: Proposed staging of water supply infrastructure construction

KUR-World Development Stage	Proposed Water Supply Infrastructure to be Constructed	Description of Operational Water Supply
Stage 1A	19ML Farm Dam (existing) Groundwater Treatment Plant (GWTP) Groundwater supply infrastructure interconnecting the existing five viable bores, and delivering ground water to the proposed GWTP and existing farm dam 1.7ML non-potable storage reservoir portion of potable and dual-reticulation networks within Stage 1A of development footprint Non-potable water network pump station (staging of mechanical and electrical equipment to be confirmed at detailed design).	As the pipeline connecting the site to the MSC network will not be constructed until Stage 1B, water demands for Stage 1A will be primarily met by groundwater abstracted from the onsite bores, and treated via the GWTP. It is proposed that treated groundwater is reticulated through both the potable and non-potable water networks servicing the Stage 1A facilities, until the connections to the MSC network are commissioned at Stage 1B. Over this period, the GWTP is proposed to be operated and monitored to produce potable quality water, compliant with the Australian Drinking Water Guidelines. However, to mitigate risks to consumers and KUR-World patrons, all reticulated water will be advised as 'non-potable', and alternative bottled drinking water provided. Private owners of the 21 Queenslander lots will also be required to install domestic rainwater tanks which may also be used for drinking water purposes.
Stage 1B	Upgrades to the MSC water supply network including construction of additional reservoir storage and new trunk water supply main to site (staging of the proposed reservoir storage to be confirmed through detailed design) First stage of WWTP to produce class A+ recycled water from site generated wastewater (ADWF capacity 0.45ML/day) Portion of potable and dual-reticulation networks servicing the Stage 1B development footprint.	Upon commissioning of the potable water reservoir and trunk water supply main to site, all potable water demands will be met by the MSC water network. Non-potable water produced by the WWTP and GWTP will be reticulated throughout the non-potable water network to meet non-potable demands. A connection from the potable water network to the non-potable storage reservoir onsite will also be used to supplement the non-potable supply during times of peak demand.
Stage 2	Second stage of MSC potable water reservoir storage upgrades (if not constructed during Stage 1B) Second stage of WWTP to produce class A+ recycled water from site generated wastewater (ADWF capacity 0.85ML/day) Portion of potable and dual-reticulation networks servicing the Stage 2 development footprint.	Upon completion of stage 2 construction, all of the proposed water supply infrastructure will be completed and fully operational, with the exception of the portion of the reticulation networks within the Stage 3 footprint. All potable water demands will be met by the potable water network, supplied from the connection to the town supply. Non-potable water demands will be met by the non-potable network, supplied by the WWTP and GWTP, and supplemented by the town supply as required.

Stage 3	Portion of potable and dual-reticulation networks servicing the Stage 3 development footprint.	As per Stage 2.

5.2.9 Redundancy in water supply infrastructure

Redundancy will be built into critical elements of the water supply system to ensure adequate reliability, in accordance with the requirements of FNQROC (FNQROC, 2014).

The following key provisions are noted:

- The proposed potable and non-potable water reservoirs have been sized in accordance with FNQROC (FNQROC, 2014), to provide sufficient storage in the event of failure of the water supply system.
- In addition to the trunk water main from the Myola Road Reservoir site, a secondary connection to the existing MSC water network along Warril Drive has also been proposed to increase redundancy in the network. It is noted however, that the existing water network along Warril Drive does not have sufficient capacity to fully service KUR-World, and further upgrades would be required to enable this secondary connection to fully service the site. Such upgrades are not proposed at this stage.
- All critical water supply system assets will be monitored with a supervisory control and data acquisition (SCADA) system, which will enable issues with the potential to cause damage or environmental harm to be identified and rectified early, and to facilitate an adaptive management approach. This will include but not be limited to monitoring of groundwater levels and abstraction rates, water treatment plant performance and storage levels, water demand and usage, recycled water (and effluent) water quality and discharge rates.

6 Wastewater infrastructure

6.1 Existing wastewater infrastructure

6.1.1 Existing onsite wastewater infrastructure

The existing wastewater infrastructure on the KUR-World site is limited to a small-scale (domestic) septic tank system servicing the existing homestead building. There is no existing connection to MSC's wastewater network at the site.

6.1.2 Mareeba Shire Council (MSC) wastewater infrastructure

MSC owns and operates the existing sewerage system servicing the township of Kuranda. The map in Figure 18, illustrates the key features of the wastewater network in the vicinity of the KUR-World site. In summary, the existing MSC wastewater network includes:

- A sewage treatment plant (STP) located off Arara Street
- A sewerage reticulation network comprised of a large number of gravity sewers, around 15 sewage pump stations and rising mains discharging to the STP.

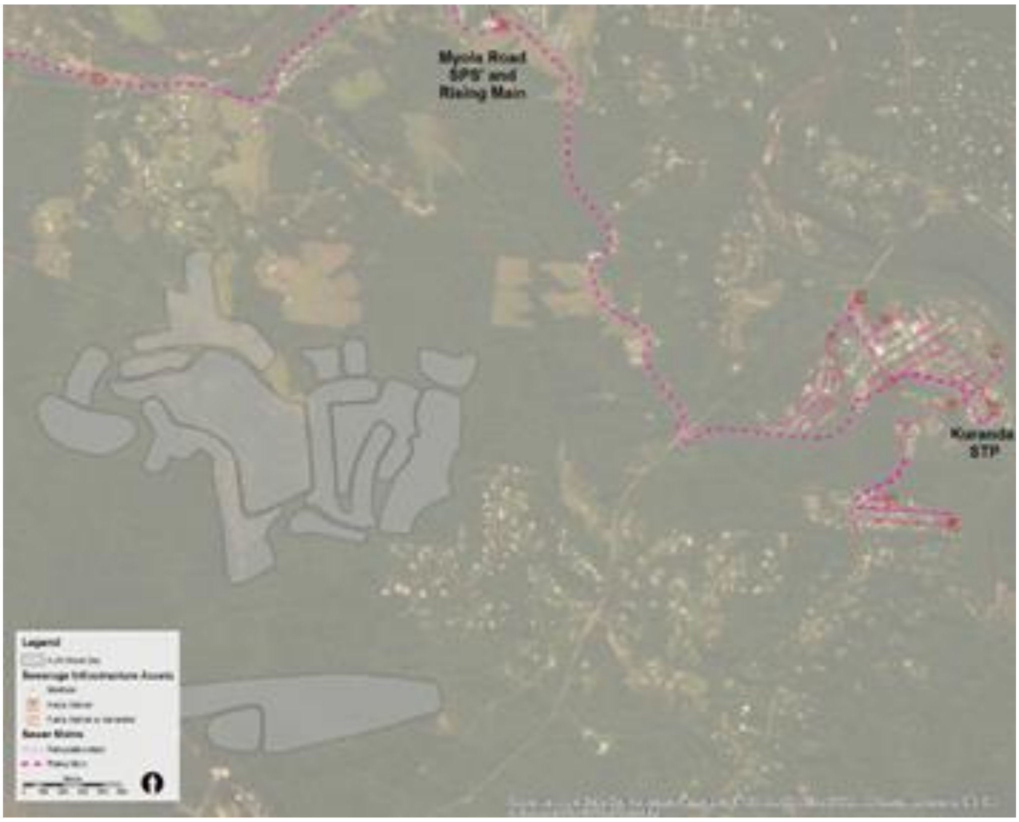

Figure 18: Key features of existing MSC water network in vicinity of KUR-World

6.1.2.1 Existing Kuranda Wastewater Treatment Plant (WWTP)

The existing Kuranda Wastewater Treatment Plant (WWTP) treats wastewater generated by the portion of the Kuranda Township connected to the reticulated sewer network. Information provided by MSC indicates the existing Kuranda WWTP has been designed for an ADWF rate of 0.69ML/day (8L/s), with a maximum design capacity of approximately 2.2ML/day (25L/s) for full and continuous biological treatment.

A high level assessment of the spare capacity available at the Kuranda WWTP was undertaken under both existing and ultimate conditions, based on the current average wastewater flows delivered to the Kuranda WWTP (as reported by MSC), and adopting the same population growth projections used for the water supply assessment (described in Section 6.2.2). Table 13 summarises the results.

As shown in Table 13, the existing Kuranda WWTP has sufficient capacity to treat ADWF and PWWF for the projected ultimate sewage load from the Kuranda community (excluding KUR-World). The estimated ultimate spare capacity at the Kuranda WWTP is 1.4ML/day under ADWF conditions, and 0.2ML/day under PWWF conditions. Given the limited spare capacity during PWWF conditions, the discharge of any significant new wastewater loads from KUR-World to the Kuranda STP is expected to trigger the need for capital upgrades to the STP, including additional balancing storage to prevent peak flows from overloading the WWTP.

Due to this limited capacity in the existing WWTP, and the significant demand for non-potable water onsite, a new advanced WWTP has been proposed to be constructed on the KUR-World site, and no connection to the MSC sewerage network is proposed.

Table 13: Kuranda STP current/projected capacity analysis

Parameter	Average Dry Weather Flow (ADWF) (ML/day)	Peak Wet Weather Flow (PWWF) (ML/day)
Existing STP design capacity	2.2	
Existing scenario (2016)		
Existing load[1]	0.25	1.25
Estimated spare STP capacity	1.95	0.95
Ultimate scenario (2030)		
Ultimate load[2]	0.4	2
Estimated spare STP capacity	1.4	0.2

[1] Based on average daily wastewater loads for the 2016 calendar year provided by MSC (October 2017)

[2] Based on application of the projected population growth rates adopted for the water supply assessment (described in Section 6.2.2) to the existing load

6.1.2.2 Existing Kuranda wastewater network

As indicated in Figure 18 above, the only wastewater infrastructure within a reasonable proximity to the KUR-World site is the Myola Road Sewage Pump Station (SPS) and Rising Main system. MSC has advised that the system is relatively new, was not sized to cater for significant urban expansion within the catchment, and would therefore be unlikely to service the proposed KUR-World development. Any significant wastewater loads would therefore be expected to trigger the requirement for upgrades to the existing wastewater network, likely including a new pump station and approximately five kilometre rising main to the Kuranda STP.

On the basis of the capacity constraints associated with both the existing Kuranda STP and wastewater network, as well as the high demand for non-potable water onsite, an advanced onsite WWTP has been proposed to treat all of the wastewater generated by KUR-World.

6.2 Proposed wastewater infrastructure

The proposed wastewater infrastructure for KUR-World includes:

- Interim wastewater treatment for Stage 1A, comprising a series of small scale biological wastewater treatment systems, with a centralised collection and irrigation system, treating the relatively small wastewater load generated by the 21 residential lots and farm theme park facilities constructed under Stage 1A of the proposed development.
- A site-wide wastewater reticulation network collecting wastewater from the various buildings and facilities across the site for treatment by the onsite advanced WWTP, constructed progressively from Stage 1B of the proposed development.
- An advanced WWTP treating all of the site generated wastewater and producing class A+ non-potable water for onsite re-use as part of the non-potable water-supply system (via the non-potable water supply network).
- An effluent outfall pump station and pipeline to enable disposal of surplus effluent in times of excess supply.

The key elements of the proposed sewerage reticulation network are shown in drawing 253251-00-C-RD-302 Proposed Sewerage Infrastructure, Indicative Layout, issue 1A (see Appendix A).

It is noted that the high level reference designs for all proposed wastewater infrastructure have been developed to limited level of detail, sufficient to confirm the technical feasibility and assess the potential environmental impacts of the proposed works. Further investigations and design will be completed as part of future planning for KUR-World to develop the designs and ensure compliance with all relevant guides and standards, including the FNQROC Development Manual (FNQROC, 2014). This will need to be undertaken in consultation with Mareeba Shire Council and other relevant state and federal agencies.

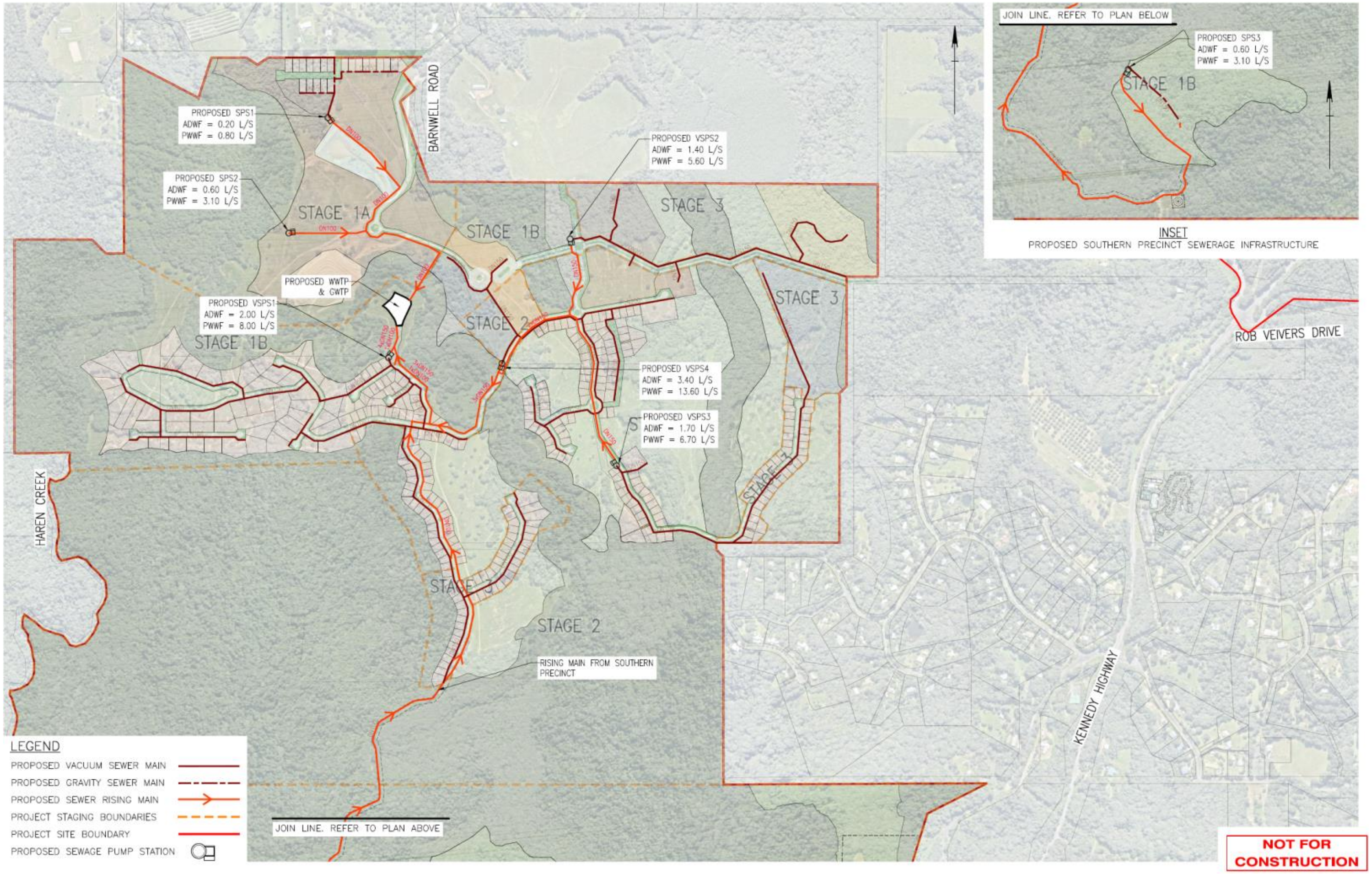

Figure 19: Indicative layout of proposed sewerage reticulation network

Proposed interim Stage 1A wastewater infrastructure

Given the relatively small wastewater load generated by Stage 1A (ADWF of approximately 0.05ML/day), it would not be economical to construct the onsite WWTP until additional wastewater loads are generated by Stage 1B.

As such, it is proposed that the Stage 1A wastewater load is managed by:

- Small scale biological wastewater treatment systems within each of the 21 residential lots, with a common effluent drainage (CED) system draining effluent to the proposed Sewage Pump Station (SPS1);
- Separate biological wastewater treatment systems servicing the facilities in the farm theme park area, with effluent draining to the proposed Sewage Pump Station (SPS2);
- Effluent storage provided through a combination of the biological wastewater treatment systems and the pump station wet wells; and
- Pumping of the treated effluent from SPS1 and SPS2 via temporary, above ground rising mains to a dedicated area of approximately 5ha, where it will be irrigated to the existing open pasture. Any suitable pasture area complying with the requirements described in Section 6.2.3.1 may be utilised.

The small scale biological wastewater treatment systems would be ‘off-the-shelf’ products similar to those widely used in the un-sewered parts of Kuranda and would be designed, constructed and operated in accordance with local regulations. The systems would be expected to produce Class A quality effluent, with a total nitrogen (TN) content of around 50mg/L, total phosphorus (TP) content of around 12mg/L and total dissolved solids (TDS) content of around 520mg/L.

In addition to the treatment systems themselves, the gravity sewerage networks and pump stations indicated with the Stage 1A area of the reference design drawing 253251-00-C-RD-302 (Proposed Sewerage Infrastructure Indicative Layout, Issue 1A, 01/11/2017 (refer to Appendix 2A) would also be constructed to collect the effluent from all systems and transfer it to the nominated irrigation areas. When the proposed WWTP comes online in Stage 1B, the permanent rising mains to the WWTP will be commissioned.

Effluent modelling for the project shows that with approximately 1ML of storage, and an irrigation area of 5ha, over 80% of the Class A effluent produced during Stage 1A could be applied to land without generating any significant runoff or nutrient export to adjacent waterways. The modelling further indicates that excess effluent which exceeds the soil plant system capacity during wet weather would only result in runoff to adjacent water courses on around four occasions per year, contributing total nitrogen and total phosphorus loads of 127kg/year and 31kg/year respectively (NRA, 2017 (a)). The methods and results of effluent modelling are further described in (NRA, 2017 (a)).

The direct irrigation of effluent from the Stage 1A biological wastewater treatment systems will occur for around two years until the first stage of the onsite advanced WWTP is constructed as part of Stage 1B, at which point SPS1 and SPS2 and the common rising main would be commissioned, delivering the effluent to the WWTP for advanced treatment and re-use as part of the site-wide non-potable water (dual) reticulation network.

6.2.1 Proposed onsite wastewater reticulation network

A wastewater reticulation network is proposed to service all of the proposed buildings and facilities, delivering wastewater to the onsite WWTP.

Due to the highly variable, undulating nature of the site, a vacuum sewerage system has been proposed to service the majority of the development, with relatively small, conventional pump stations servicing the southern precinct (Rainforest Education Centre and Adventure Park) and the Stage 1A precinct (21 residential lots and farm facilities) once the WWTP has been brought online.

The benefits of the predominantly vacuum sewerage system for proposed KUR-World site include:

- Significantly reduced number of pump stations (a total of seven pump stations have been proposed, compared with approximately 20-25 which would be required if a conventional gravity wastewater network was adopted)
- Significantly reduced excavation depths and disturbance footprint associated with constructing gravity sewers in the highly variable and undulating topography
- Increased emergency wastewater storage distributed across the network, with each collection point typically providing 4-6 hours of ADWF emergency storage for its respective catchment
- Lower risk of system failure and a reduced number of backup generators required to maintain system operation in the event of power failure
- Significantly reduced inflow and infiltration entering the wastewater system, thereby reducing the required capacity of pump stations and the WWTP, and reducing the risk of system failure and wastewater spills during extreme weather events.

The wastewater reticulation network comprises:

- Two small conventional sewage pump stations servicing the Stage 1A precinct (21 residential lots and farm facilities), with a common rising main to the onsite WWTP
- One conventional sewage pump station servicing the southern precinct (Rainforest Education Centre and Adventure Park), with a dedicated rising main to the onsite WWTP
- Four vacuum pump stations servicing the remainder of the site, each with separate rising mains to the onsite WWTP
- The provision of emergency storage within the vacuum collection chambers and conventional sewage pump station wet-wells, as well as backup generators on all pump stations, designed in accordance with FNQROC (FNQROC, 2014) in order to minimise the risk of wastewater overflows

The high-level reference design for the onsite wastewater reticulation network is provided in drawing 253251-00-C-RD-302 (Proposed Sewerage Infrastructure Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A). The detailed design of the wastewater reticulation network, including confirmation of the alignments in relation to the various other services within the service corridors and compliance with the FNQROC development manual, will need to be undertaken at the detailed design stage, in consultation with Mareeba Shire Council.

6.2.2 Proposed onsite Wastewater Treatment Plant (WWTP)

6.2.2.1 Overview

An onsite advanced wastewater treatment plant (WWTP) is proposed to be constructed in Stage 1B, to treat all site-generated wastewater, and produce high quality, Class A+ recycled water for non-potable re-use onsite.

The high-level reference design for the proposed WWTP is provided in the drawings 253251-00-C-RD-351 and 253251-00-C-RD-352. The proposed reference design for the WWTP has been developed based on a number of assumptions, and further investigations will be required as part of the ongoing planning for KUR-World to progress and optimise the design including the adopted treatment processes.

6.2.2.2 Design capacity

The reference design has been developed to enable the staged construction of the WWTP, and ensure efficient operation throughout the project construction stages. Two biological treatment trains are proposed:

- Train 1 will provide sufficient capacity to treat Stage 1A and 1B flows, with an ADWF capacity of 0.45ML/day.
- Train 2 will provide sufficient capacity to treat the ultimate Stage 3 flows, with an ADWF capacity of 0.85ML/day.

6.2.2.3 Influent wastewater quality

The influent wastewater quality was estimated using Planning Guidelines for Water Supply and Sewerage (DEWS, 2010) using typical composition of domestic sewage for a resort as well as typical quality parameters from Wastewater Engineering, Metcalf & Eddy.

Table 14: Influent Flow Characteristics

Item	Unit	Stage 1B Value	Stage 2/3 Value	Comment
Flow				
Average Dry Weather Flow (ADWF)	kL/d	450	850	-

Item	Unit	Stage 1B Value	Stage 2/3 Value	Comment
Peak Wet Weather Flow (PWWF)	kL/d	2250	4250	5 x ADWF
Minimum Flow Rate	kL/d	112.5	212.5	0.25 x ADWF
Peak Wet Weather Flow (PWWF) (instantaneous)	L/s	36.50	68.85	7 x ADWF
Water Quality				
pH		6.0-8.0		-
EC @ 25 deg C	µS/cm	700		-
Total Disolved Salts	mg/L	500		-
Suspended Solids	mg/L	400		-
Ammonia as N	mg/L N	60		-
Total Phosphorus as P	mg/L P	20		-
Reactive Phosphorus as P	mg/L P	15		-
Total Sulphide	Mg/L	5		-
Hydrogen Sulphate	Mg/L	1		-
Oil and Grease	mg/L	60		-
BOD	mg/L	450		-
TOC	mg/L	200		-
Alkalinity	mg/L	225		-

6.2.2.4 Treated effluent water quality

Given the WWTP and GWTP effluent will be utilised extensively as part of the site’s non-potable water supply, and may potentially discharge to sensitive downstream ecosystems during times of surplus supply, it is important that the proposed WWTP maintains stringent effluent water quality throughout all stages of operation. Relevant criteria are described in the sections below.

Biological criteria for protection of human health

The Queensland Water quality guidelines for recycled water schemes (Department of Energy and Water Supply, 2008) specify biological water quality criteria for Class A+ recycled water used for dual reticulation, with reference to the Queensland Public Health Act (Queensland Health, 2005 (a)) and Queensland Public Health Regulation (Queensland Health, 2005 (b)). The key water quality criteria are summarised in Table 15.

Table 15: Biological water quality criteria for Class A+ recycled water (from Queensland Public Health Regulation, 2005)

Parameter	Unit	95th Percentile
Free Chlorine (chlorine residual)	mg/L	0.5

Clostridium perfringens	cfu/100mL	<1
Escherichia coli	cfu/100mL	<1
F-RNA bacteriophages	pfu/100mL	<1
Somatic coliphages	pfu/100mL	<1
Turbidity	NTU	<2

Physical and chemical criteria for protection of freshwater ecosystems

In addition, stringent physical and chemical water quality criteria are also required to mitigate impacts on downstream ecosystems and sensitive ecological receptors.

Specific Surface Water Quality Objectives (WQO) were developed for the site based on the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000), Environmental Protection Policy (water) (Department of Environment and Heritage Protection, 2009), and site based monitoring of surface water quality. The WQOs are summarised in (NRA, 2017 (a)). Selected WQOs for parameters relevant to the effluent water quality were developed with reference to ecological requirements and are summarised in Table 16.

Table 16: Water Quality Objectives (WQOs) for protection of freshwater ecosystems

Parameter	Units	Water quality objectives for relevant environmental values
		Aquatic ecosystems
pH	pH units	6.0-8.0
Electrical conductivity	µS/cm	106
Total suspended solids	mg/L	8
Total oxidised nitrogen	mg/L	0.05
Ammonia as nitrogen	mg/L	0.01
Total nitrogen	mg/L	0.34
Filterable reactive phosphorous	mg/L	0.008
Total phosphorous	mg/L	0.025

The following points are noted in regard to the WQOs for protection of freshwater ecosystems:

- The WQOs relate to water quality in the receiving waterway, and not necessarily the water quality of the effluent being discharged.
- The nominated levels for total nitrogen and total phosphorus are extremely stringent, and it is unlikely that effluent produced by any economically designed WWTP would contain nutrient levels this low.
- Onsite monitoring of background water quality undertaken to date indicates these WQOs are not being met for the existing conditions. The monitoring was carried out over a single wet-season period, and further monitoring is

required to better understand the variability in stream water quality experienced at the site and refine the site specific WQOs.

- The potential discharge of effluent is only expected to occur during wet periods, when there is insufficient opportunity for irrigation of surplus effluent to land. As such, any discharge of effluent to onsite water courses would be heavily diluted by high stream flows.

As such, it is not proposed that the WWTP effluent water quality is limited to the total nitrogen and phosphorus levels specified in Table 16, and instead typical best practice values for advanced WWTP effluent have been adopted as listed in Table 17. Detailed modelling and analysis of in-stream dilution and dispersion of effluent to confirm the WQOs are maintained in the adopted effluent disposal strategy. This will be undertaken as part of the Environmentally Relevant Activity application.

Adopted effluent water quality criteria

Table 17 summarises the target effluent water quality criteria adopted for the KUR-World WWTP, based on a combination of the biological, physical and chemical criteria described above.

Table 17: Target WWTP Effluent Quality

Parameter	Unit	95th Percentile limit
pH	pH	6.0 – 8.0
BOD	mg/L	10
Total Suspended Solids	mg/L	5
Turbidity	NTU	2
Total Nitrogen (TN)	mg/L	<5
Total Phosphorus (TP)	mg/L	<1
Free Chlorine	mg/L	0.5
Faecal Coliform	cfu/100ml	<1
Clostridium perfringens	cfu/100mL	<1
Escherichia coli	cfu/100mL	<1
Virus Removal	log reduction	6.5 log
Bacteria	log reduction	5 log
Protozoa	log reduction	5 log
Helminths	log reduction	5 log

Although the adopted WWTP effluent water quality targets for total nitrogen and phosphorus are higher than the WQOs for protection of freshwater ecosystems, they are still considered to be very low and in line with best practice advanced wastewater treatment. By way of example, the total nitrogen and phosphorus limits at <5mg/L and <1mg/L respectively, are more stringent than the effluent water quality required under the Great Barrier Reef Marine Park Authority Wastewater Discharge Policy (Great Barrier Reef Marine Park Authority, 2005) for Wastewater Discharges from Marine Outfalls directly to the Great Barrier Reef Marine Park.

The impacts of any potential effluent discharge will be further assessed through more detailed modelling and analysis of in-stream dilution and dispersion, in the context of the site specific WQOs as part of future planning and design stages. Should it be determined that the adopted effluent water quality criteria result in unacceptable environmental risks, additional treatment processes (such as reverse osmosis) will be investigated, or alternative discharge outfall options considered as described in Section 6.2.3.2.

6.2.2.5 Treatment processes and equipment

The main process components for the proposed WWTP are shown in the block flow diagram in Figure 20. A brief description of each of the treatment process are provided below. A process diagram has been provided in drawing 253251-00-C-RD-352 (Proposed Wastewater Treatment Plant (P&ID)).

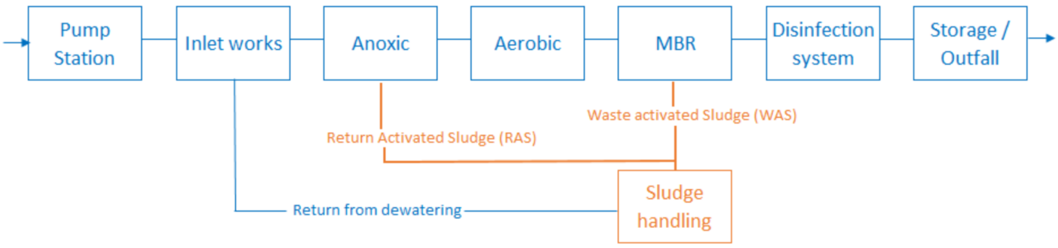

Figure 20: WWTP Block Flow Diagram

Inlet Works

The inlet works will consist of fine screens and grit removal facilities. Proprietary units are available to undertake this function. Screenings will be automatically washed and dewatered and stored within an adjacent bin or hopper. Grit will also be washed and dewatered and stored in the same bin as the screenings.

Bioreactor

The bioreactor where the biological treatment processes take place will consist of a tank or tanks with dedicated aerobic and anoxic zones to reduce the organic content of the sewage as measured by BOD or COD to an acceptable concentration.

The presence of aerobic and anoxic cells will enable the ammonia in the influent wastewater to be reduced to nitrate, nitrite and nitrogen gas.

The dosing of Alum (Aluminium Sulphate) is used to remove Phosphorus from the effluent by reacting with the soluble phosphates and producing an insoluble material that is removed by the membrane process.

Membrane Bioreactor

The membrane bioreactor consists of submerged membrane filters which are able to separate the treated water from the biosolids. The MBR process requires significantly less footprint as this removal process takes place in the tank, and can handle much higher solids loading compared with conventional solids-liquids separation techniques. Submerged membrane processes also provide greater pathogen reductions, due to the physical barrier provided by the membrane itself.

Disinfection System

Disinfection is required to ensure the effluent meets the effluent quality as far as pathogens are concerned. To meet Class A+ quality requirements, both UV irradiation and chlorine dosing are required.

UV irradiation is a disinfection method that uses short-wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms by disrupting their DNA, leaving them unable to perform vital cellular functions.

Chlorine is most commonly used either in gaseous form or as hypochlorite solution. This design is based on the use of the hypochlorite solution. Chlorine has the advantage that it has a residual effect and the presence of a “free chlorine residual” is accepted as an indicator that the water is free of pathogens.

Onsite Clean Water Storage

A small onsite clean water storage tank will be provided to meet the recycled water needs of the treatment plant operation (such as wash down) and backwashing of membranes. Class A+ recycled water is transferred from the tank to the storage dam.

Biosolids Handling

The solids in the sludge are mainly of a biological nature (biosolids) produced as a waste product of the biological purification. In general, the biosolids are in the order of 70 - 80% organic matter with the balance being inert, inorganic material.

The biosolids handling process has been designed to allow for the potential reuse of treated and stabilised biosolids for land application. If suitable sites cannot be found for land application of biosolids, the treated waste can be transferred to landfill.

The biosolids handling facility will comprise:

- Thickening to reduce the water content of the biosolids being removed from the bioreactor
- Aerobic digestion to stabilise the waste and reduce the volatile organic compound concentrations
- Drying to further reduce water content and overall biosolids volume for transfer to land application or landfill.

Ancillary Plant and Equipment

A number of ancillary systems are required for the operation of the treatment plant including chemical dosing, odour control, and water transfer pumping systems.

Utilities Requirement

The WWTP will require the provision of the following utilities:

- Telecommunication for plant remote monitoring
- Electricity supply
- Mains water supply

Chemical Storage

Sodium hypochlorite and alum will be stored on-site. Chemical storage, dosing system will be required as part of the WWTP and GWTP system and design in accordance with the relevant Australian Standards and the Dangerous Goods Code.

Approximate chemical requirements for the WWTP include:

- 35 L/day of sodium hypochlorite
- 90 L/day of Alum

6.2.2.6 Waste, noise, odour, energy and emissions

Inlet screenings and grit removal

The inlet works consists of screening and grit removal. The inlet works have been designed to remove coarse materials from the flow stream which can damage equipment downstream, reduce process efficiency and contaminate waterways.

Various health and environmental concerns exist for screenings:

- Health and safety – regarding pathogenic organisms and insects
- Odour potential
- Organics and non-organic disposal

The design includes a number of mitigation strategies to address potential concerns such as:

- Frequent disposal of collected solids and management of waste systems to prevent odour and pest issues
- Odour handling and treatment systems
- Education of visitors to the resort on suitable disposal of wastes.

Design Outputs: The WWTP reference design incorporates a package inlet works process consisting of a 2mm perforated screen and grit system. The inlet works will be covered and provided with odour extraction, with odours treated via the onsite odour control system. Waste by-products, screenings, will be disposed via waste collection to landfill. Based on the current concept design, it has been estimated that the plant will produce approx. 170 litres per day of screenings and grit which is to be collected in a waste bin for weekly removal.

Biosolids

Biological wastewater treatment generates excess sludge, or biosolids, requiring disposal. This sludge contains high fractions of volatile solids (VS) and retains large amounts of water (>95 %wt) resulting in large volumes of residual solids being produced.

Biosolids disposal options have been considered and are generally subject to stringent environmental quality concerns. Potential disposal options for this plant include:

- Land application
- Landfill

The design will ensure that the biosolids quality is suitable for landfill and/or land application (if applicable). The biosolids handling design includes:

- Sludge thickening – To reduce the water content of the biosolids reducing the capacity and footprint required for the digester.
- Aerobic digestion – Higher rate of digestion compared to anaerobic digestion further reducing footprint and improving the stabilisation of dried biosolids.
- Odours and emissions – to be captured and treated (to reduce odours)

Further analysis of the potential for land application of biosolids is required, including a land capability assessment should suitable land areas be identified.

Design Outputs: The WWTP design will utilize sludge thickening, aerobic digestion as well as a belt filter press to ensure sludge is treated to a suitable standard and the volume of waste is minimized.

The treatment process is expected to produce approx. 37.61 kL/day of wet sludge for disposal prior to thickening and drying. The wet sludge after dewatering in the belt filter press, will be disposed via skip and sent to landfill (off site). The volume of dry sludge generated by the plant is estimated to be approx. 1.15 kL/day at 20% solids.

Noise

Process plants emit noise emissions due to the nature of machinery, operations and maintenance. Numerous sources of noise exist within a wastewater plant most notably the pumps and drives.

The design for the WWTP and GWTP will account for noise mitigation by:

- Specifying low noise equipment (where applicable)
- Sizing appropriately such that equipment is not running at their upper limits
- Path of noise to be controlled using acoustic enclosures, barriers and ducts

Odour

Wastewater treatment plants may be the source of objectionable odours irrespective of how well they are operated.

Odours may be generated from the following areas of the plant:

- Influent wastewater
- Screenings and grit storage
- Plant biological processes
- Sludge management

Influent wastewater may produce objectionable odours if it remains within the sewerage system for excessive periods of time and is allowed to become septic and decompose anaerobically. This anaerobic decomposition produces Hydrogen Sulphide gas and is recognised by the associated “rotten egg” odour. In the case of this development the wastewater when the development is occupied will be relatively fresh when delivered to the treatment plant and under normal circumstances odours from the influent wastewater should not be a problem.

The staging of the development may produce longer than desirable detention times in the rising main to the treatment plant and consideration may need to be given to regular flushing of the main to prevent the deposition of organic material within the main and generation of odours. The provision of a suitable buffer distance to assist with mitigation of odour complaints is dependent upon a number of factors, mainly; topography, prevailing wind direction and treatment process employed. The Planning Guidelines for Water Supply and Sewerage (Department of Energy and Water Supply, 2010) recommended buffer distances shown in Table 18.

Table 18: Recommended Buffer Distances

Plant Design Capacity	Buffer Distance
1,000 EP	300 m
5,000 EP	800 m
20,000 EP	1,200 m

Based on the current plant arrangement and master plan for the site, there is currently a distance of approximately 130 m between the closest habitable area and the treatment plant boundary. As a result, odour capture and treatment is required to minimise potential for nuisance odours. Table 19 outlines the common odour sources as well as minimization strategies to be utilized in the next stage of design.

Table 19: Odour control strategy summary

Location	Details	Odour Potential	Minimization Strategy
Pump Station	• Odorants released from wastewater	High	• Adequate design in gradients for receiving lines • Avoid high turbulence • Periodic cleaning • Containment, ventilation and treatment of odorous gases

	• Organic matter accumulation		
Inlet works	• Organic matter accumulation in screens and filters • Waste disposal accumulation	High	• Avoid accumulation of organic matter • Periodic cleaning of screens and filters • Reduce the height of discharge levels • Containment, ventilation and treatment of odourous gases
Biological and MBR reactors	• Reception of septic waters • Operation at low dissolved oxygen	Low	• Ensure adequate aeration and mixing • Use air diffusers • Cover units • Containment, ventilation and treatment of odorous gases
Biosolids Handling	• Sludge emissions and return wastewater • Sludge accumulation • Fugitive emissions	Moderate	• Avoid sludge accumulation using adequate design capacities • Reduce height in sludge collection and discharge point • Cover units • Containment, ventilation and treatment of odorous gases
Disinfection	-	Low	None required
Storage Tank	-	-	None required

The odour handling and treatment facility will include:

- Covers and extraction of gases from major plant and equipment including:
  - Inlet pump station
  - Inlet works
  - Anoxic and aerobic bioreactors
  - Sludge thickening.
- Removal of odorous compounds through scrubbing
- Venting of treated air through a suitably sized stack.

Design Outputs: The WWTP design includes mitigation of odour emissions, extraction and treatment. Odorous gases are captured and treated via an onsite odour control system which utilizes a counter current wet scrubber.

The odour design encompasses:

- Gas containment and extraction on the inlet works and pump station

- Gas containment and extraction on the anoxic bioreactor
- Gas containment and extraction on the sludge thickener

The odour control unit is currently estimated to be 2m in diameter. Additional information and design is required to determine the vent velocity of treated air and odour dispersion modelling to verify the design mitigates potential nuisance to guests and staff.

Energy Demand

Energy required to operate wastewater treatment facilities is primarily sourced from electricity. Electricity is required to operate equipment, machinery, computers, onsite works and general housekeeping (air conditioning etc). With more stringent environmental discharge limits, the energy demand for a WWTP can be significant.

The design will incorporate various strategies in reducing the energy demand required for the plant, these may include:

- Efficient biological treatment operations (e.g DO monitoring and control)
- Varying process equipment utilization to meet treatment demands (I.e. Operate less reactors when under-loading)
- Varying operations during off-peak periods
- Efficient motor design (i.e. utilizing adjustable speed drives)
- Efficient blowers and diffusers.

Design Outputs: The proposed WWTP is estimated to generate an energy demand of approximately 1540 kWh/day.

Carbon Emissions

Carbon emissions from the treatment process are generated from biological activity. It is generally accepted that if treatment is aerobic in both cases (wastewater and sludge), then there is no production of methane and the carbon dioxide produced is not considered to be Scope 1 emissions because it is biogenic, that is, carbon dioxide eventually will be trapped again in the wastewater through the biological mechanisms of organic matter formation.

6.2.3 Re-use and disposal of non-potable (recycled) water

6.2.3.1 Onsite effluent storage and re-use

As described in Section 5.2.7, a dedicated non-potable water (dual) reticulation network is proposed to distribute Class A+ non-potable water to the proposed buildings, facilities and irrigation areas (including golf course) across the site.

During dry periods, the onsite demand for non-potable water is expected to exceed supply, resulting in no requirement for disposal of surplus effluent. During extended wet weather periods however, the reduced irrigation demand will result in a surplus supply of effluent which will need to be disposed of by either:

- Irrigation to all potentially irrigable areas, at the maximum rate possible without exceeding the soil plant system capacity and contributing to excess run-off.
- Discharge to the onsite farm dam or any of the various creeks within the site.
- Discharge via a pumped outfall to an alternative location, which would be determined with consideration of potential ecological or water quality requirements.

A detailed effluent irrigation feasibility study was completed to investigate whether irrigation of all surplus effluent could be achieved within the confines of the site, and therefore eliminate the need for any significant effluent discharge offsite (NRA, 2017 (a)).

Areas potentially suitable for irrigation in this manner were mapped by NRA on the basis of appropriate land-use and slope (<20%), as shown in Figure 21, noting the following additional management measures:

- Only land identified as suitable for irrigation should be used for effluent disposal.
- Appropriate buffer zones/set-backs nominated in the report should be applied around creeks.
- Irrigable land with moderate slopes (12-20%) should be managed and land condition monitored to prevent run-off and accelerated erosion.
- No effluent irrigation should occur to native vegetation. Effluent from the Rainforest Education Centre should be pumped to the on-site WWTP for treatment.

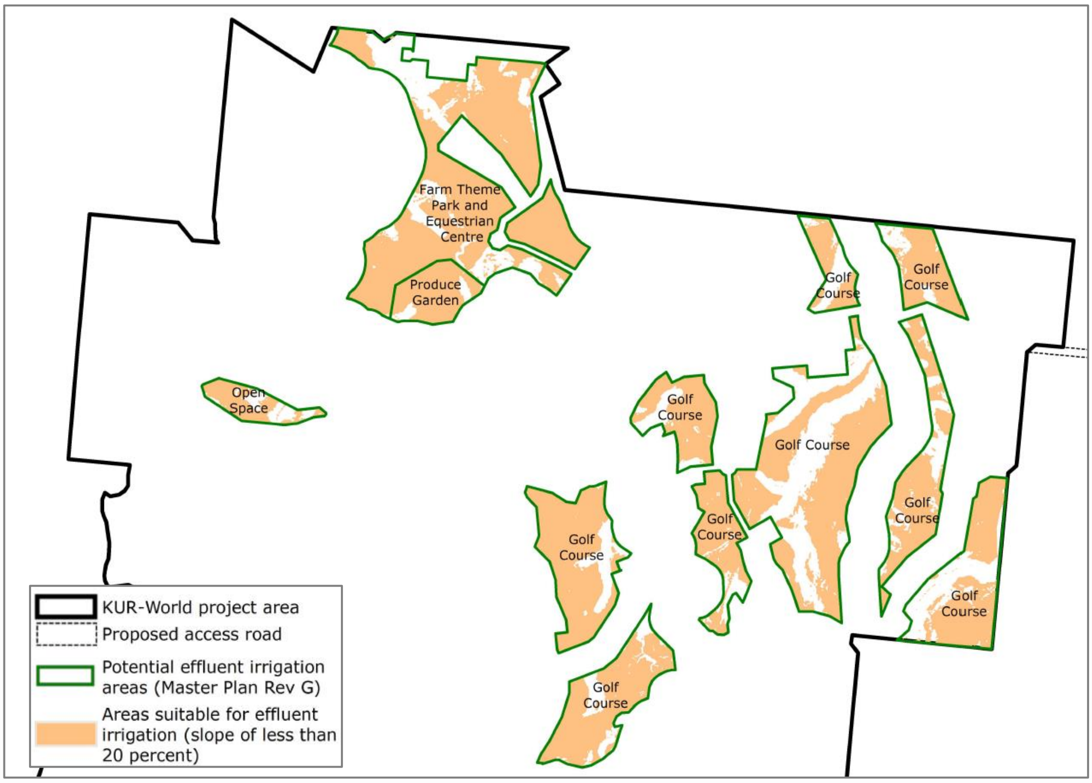

Figure 21: Suitable areas for irrigation of surplus effluent

A range of alternative simulations were modelled with varying levels of effluent storage and total irrigation area, to investigate the extent to which surplus effluent could be irrigated to the site without contributing to increased runoff and nutrient export. The modelling also investigated the potential for the utilisation of the existing farm dam to provide additional balancing effluent storage during the wet season, to minimise overflows.

The results of the analysis, including potential impacts on surface and groundwater systems, are described in detail in the NRA (2017) report. Of most relevance to the design of water and wastewater infrastructure, the study concluded that even with irrigation area and balancing storage at the upper realms of practicality, it would not be possible to irrigate all surplus effluent generated by the proposed WWTP to land without generating at least some level of runoff (or storage overflow) and associated export of nutrients to the onsite water courses. Therefore, disposal of surplus effluent would be required as described below.

6.2.3.2 Disposal of surplus effluent

Given the current uncertainties in the site specific WQOs, and the potential impacts of any potential effluent discharge to onsite water courses, four alternative effluent disposal options have been considered within the KUR-World EIS (refer reference design drawing 253251-00-C-RD-304):

- *Option 1* – Discharge to Haren Creek: This option would involve a gravity outfall from the proposed non-potable water storage reservoir overflow at the WWTP directly to the adjacent Haren Creek. Option 1 represents the lowest cost solution, and would only be acceptable should it be determined through more detailed analysis that direct discharge of the WWTP effluent did not represent any significant risks to the receiving ecosystems.

- *Option 2* – Discharge to Existing Farm Dam: This option would involve pumping surplus effluent from the non-potable storage reservoir to the existing 19ML farm dam, where it would be stored for subsequent treatment and re-use as part of the site-wide non-potable water supply scheme. Water levels in the farm dam would be maintained at a nominal 2m below top water level to provide capacity for discharge of the surplus effluent at times of oversupply. As demonstrated in NRA (2017) however, this could only feasibly facilitate re-use of around 80% of effluent, with the remaining 20% overflowing via the dam overflow to Owen Creek. Option 2 represents the second least costly option, however like Option 1, would only be acceptable should it be determined through more detailed analysis that direct discharge of the WWTP effluent did not represent any significant risks to the receiving ecosystems.
- *Option 3* – Discharge to Cain Creek: This option would involve pumping of surplus effluent from the non-potable storage reservoir to a location on Cain Creek, just beyond the northern boundary of the site adjacent to Barnwell road. As documented in KUR-World Flora and Fauna Technical Report (NRA 2017), Cain Creek has the smallest known Kuranda Tree Frog population. Discharge downstream of the current access road would avoid the known small population upstream of this point. There is also small population at the confluence with Barron River, and further modelling and analysis would be required to determine potential impacts on water quality that may affect this population. Option 3 represents the third least costly option, however like Option 1, would only be acceptable should it be determined through more detailed analysis that direct discharge of the WWTP effluent did not represent any significant risks to the receiving ecosystems.
- *Option 4* - Discharge to Alternative Offsite Location: This option would involve pumping of surplus effluent from the non-potable storage reservoir to an alternative offsite location. The location of the existing Kuranda WWTP outfall on Jum Rum Creek has been identified as one potentially suitable location, given that the effluent from KUR-World will be of a higher quality than that produced by the Kuranda WWTP. Option 4 represents the most expensive option, and would require further consideration of land tenure and approvals requirements. Further modelling and analysis would also be required to confirm mitigation of any risks to the receiving ecosystems.

Indicative alignments for the effluent outfalls under each of the options are shown in drawing 253251-00-C-RD-304 Effluent Outfall Options, Indicative Layout, issue 1A (see Appendix A).

Figure 22: Indicative alignment of effluent outfall options

Confirmation and refinement of the preferred effluent disposal option will be undertaken as part of the ongoing planning and design of KUR-World on the basis of:

- Refined site specific WQOs developed through ongoing water quality monitoring
- Refinement of the effluent water quality criteria on the basis of refined WQOs
- Detailed modelling and analysis of in-stream dilution and dispersion of effluent to confirm the WQOs are maintained in the adopted effluent disposal strategy. This will be undertaken as part of the Environmentally Relevant Activity application.

It is noted that regardless of which effluent disposal option is adopted, the volume of effluent disposal could be minimised through the irrigation of a portion of the surplus effluent within the confines of the site, provided the management measures described in Section 6.2.3.1 are implemented. An irrigation management plan will need to be developed to ensure all effluent irrigation is managed in a manner that mitigates risks to the receiving environment.

Relevant approvals and operating conditions for any potential effluent discharge to the environment will also be confirmed in subsequent design phases, in consultation with regulatory authorities.

6.2.4 Staging of wastewater infrastructure construction

The construction of the proposed wastewater infrastructure will be staged in accordance with proposed staging of the KUR-World development. Table 12 describes the wastewater infrastructure to be constructed, and the operational water supply at each proposed development stage.

Table 20: Proposed staging of water supply infrastructure construction

KUR-World Development Stage	Proposed Wastewater Infrastructure to be Constructed	Description of Operational Water Supply
Stage 1A	Small scale biological wastewater treatment systems within each of the 21 residential lots, with a common effluent drainage (CED) system draining effluent to the proposed Sewage Pump Station (SPS1) Separate biological wastewater treatment systems servicing the facilities in the farm theme park area, with effluent draining to the proposed Sewage Pump Station (SPS2) Effluent storage provided through a combination of the biological wastewater treatment systems and the pump station wet wells	All wastewater generated during Stage 1A will be treated by the small scale biological treatment systems, draining to the proposed sewage pump station wet wells SPS1 and SPS2. The treated effluent will be pumped from SPS1 and SPS2 via temporary, above ground rising mains to a dedicated area of approximately 5ha, where it will be irrigated to the existing open pasture. The direct irrigation of effluent from the Stage 1A biological wastewater treatment systems will occur for around two years until the first stage of the onsite advanced WWTP is constructed as part of Stage 1B.
Stage 1B	First stage of WWTP to produce class A+ recycled water from site generated wastewater (ADWF capacity 0.45ML/day) Commissioning of SPS1 and SPS2 and rising main to the WWTP Portion of sewerage reticulation network servicing Stage 1A development footprint, including: SPS3 and associated gravity sewer network and rising main to the WWTP (servicing rainforest education centre and adventure park). VSPS1 and associated vacuum sewerage network and rising main to WWTP (servicing Stage 1B lifestyle villas). VSPS4 and associated vacuum sewerage network and rising main to WWTP (servicing Stage 1B aspects within KUR-Village, Business & Leisure Hotel) WWTP effluent pump station and outfall (location to be confirmed).	Following construction of first stage of the WWTP during Stage 1B, all wastewater generated onsite will be treated to Class A+ and distributed via the non-potable water (dual) reticulation network for use as part of the non-potable water supply. Disposal of surplus effluent during wet periods will be in accordance with the adopted site-wide effluent disposal strategy (described in Section 6.2.3). The effluent discharge location will be confirmed in subsequent design stages.
Stage 2	Second stage of WWTP to produce class A+ recycled water from site generated wastewater (ADWF capacity 0.85ML/day) Portion of sewerage reticulation network servicing Stage 1A development footprint, including: VSPS3 and associated vacuum sewerage network and rising main to WWTP (servicing Stage 1B premium villas, the remainder of the KUR-Village, Business & Leisure Hotel), and sports precinct).	As per Stage 1B, however with increased WWTP capacity.
Stage 3	Portion of potable and dual-reticulation networks within Stage 3 of development footprint.	As per Stage 2.

6.2.5 Redundancy in wastewater infrastructure

Redundancy will be built into critical elements of the wastewater system to ensure adequate reliability and minimise the risk of wastewater overflows, in accordance with the requirements of FNQROC (FNQROC, 2014). The following key provisions are noted:

- All wastewater infrastructure including gravity and vacuum reticulation, pump stations and the WWTP will been designed to accommodate peak wet weather flows in accordance with FNQROC (FNQROC, 2014).
- Emergency storage will be provided within the vacuum collection chambers and conventional sewage pump station wet-wells, in accordance with FNQROC (FNQROC, 2014).
- The proposed WWTP will include an addition 0.5ML inlet storage tank.
- The proposed WWTP and all sewage pump stations will include back-up generators to maintain the operation of critical equipment in the event of power failure.
- A 1.8ML non-potable water storage reservoir has been proposed to balance the non-potable supply and demand.
- All critical wastewater system assets will be monitored with a supervisory control and data acquisition (SCADA) system, which will enable issues with the potential to cause damage or environmental harm to be identified and rectified early, and to facilitate an adaptive management approach. This will include but not be limited to monitoring of sewage pump station levels, levels and overflows, wastewater treatment plant performance and storage levels, effluent water quality and discharge rates.

7 Conclusion

This report describes the proposed strategy for the provision of water supply and wastewater infrastructure for KUR-World. The strategy is underpinned by a comprehensive water balance analysis of water demands and wastewater loads through the various planned stages of development, including construction phases. The strategy has focused on the utilisation of groundwater and site generated recycled water (produced via an advanced onsite WWTP) to meet the majority of non-potable demand, with the MSC potable water network supplying only the estimated deficit between demand and on-site sources.

It is noted that the existing demand on the Kuranda water supply network is approaching the limit of MSC's existing allocation under the MDWSS. The estimated ultimate demand significantly exceeds this allocation, regardless of whether KUR-World proceeds. Therefore it appears MSC will be required to obtain additional allocation to cater for planned growth in its water demand, and this will be necessary to facilitate the proposed supply of potable water to KUR-World.

Reference designs for the proposed water supply and wastewater infrastructure have been developed based on the analysis, and are included in Appendix A as water and wastewater infrastructure master plan drawings.

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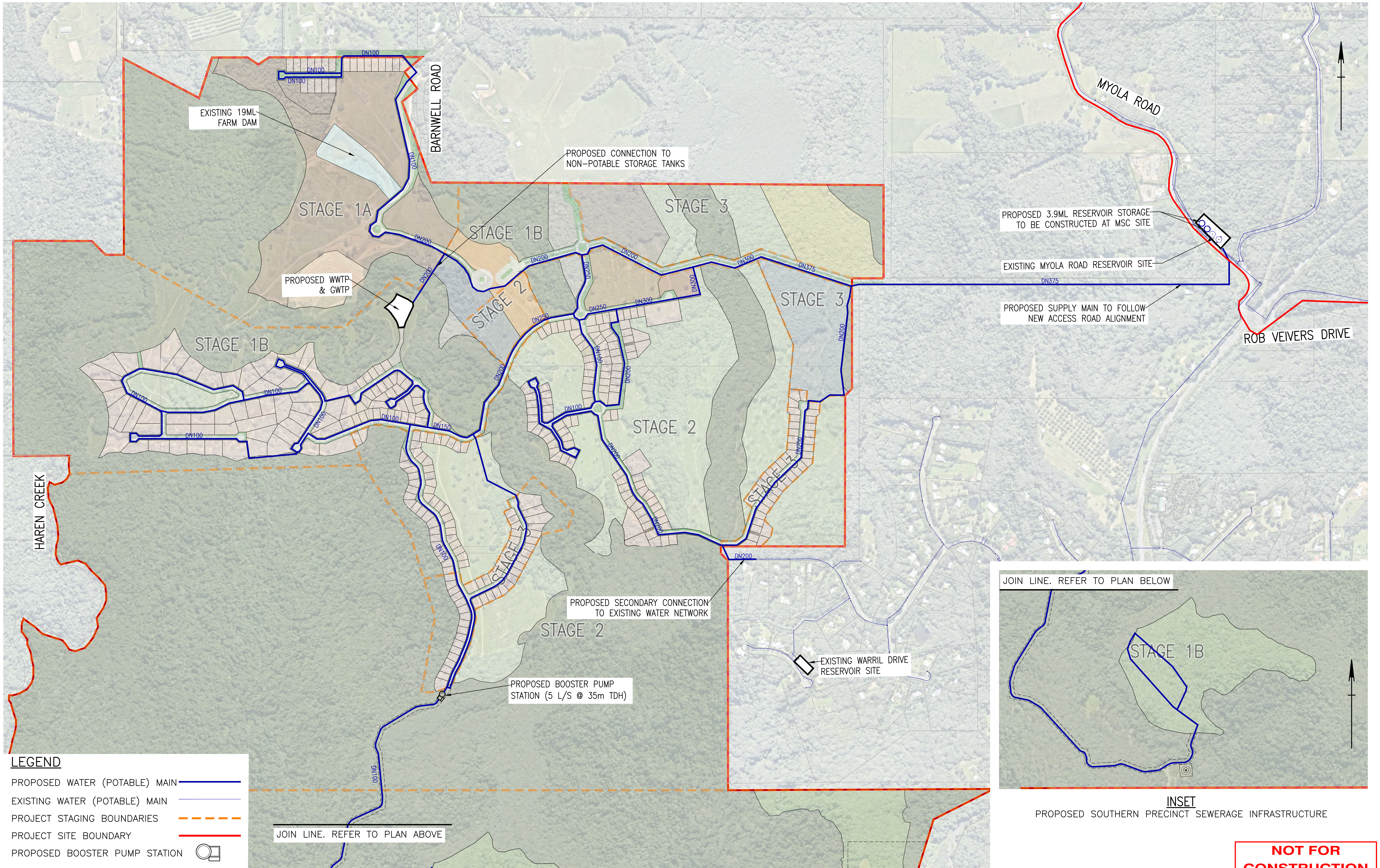
Appendix A

Water and Wastewater Infrastructure Reference Design Drawings



Issue	Description	Date	By	Chkd	Appd
A	DRAFT EIS ISSUE	02/07/18	GOD	NLL	NLL

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Arup Pty Ltd ABN 18 000 966 165

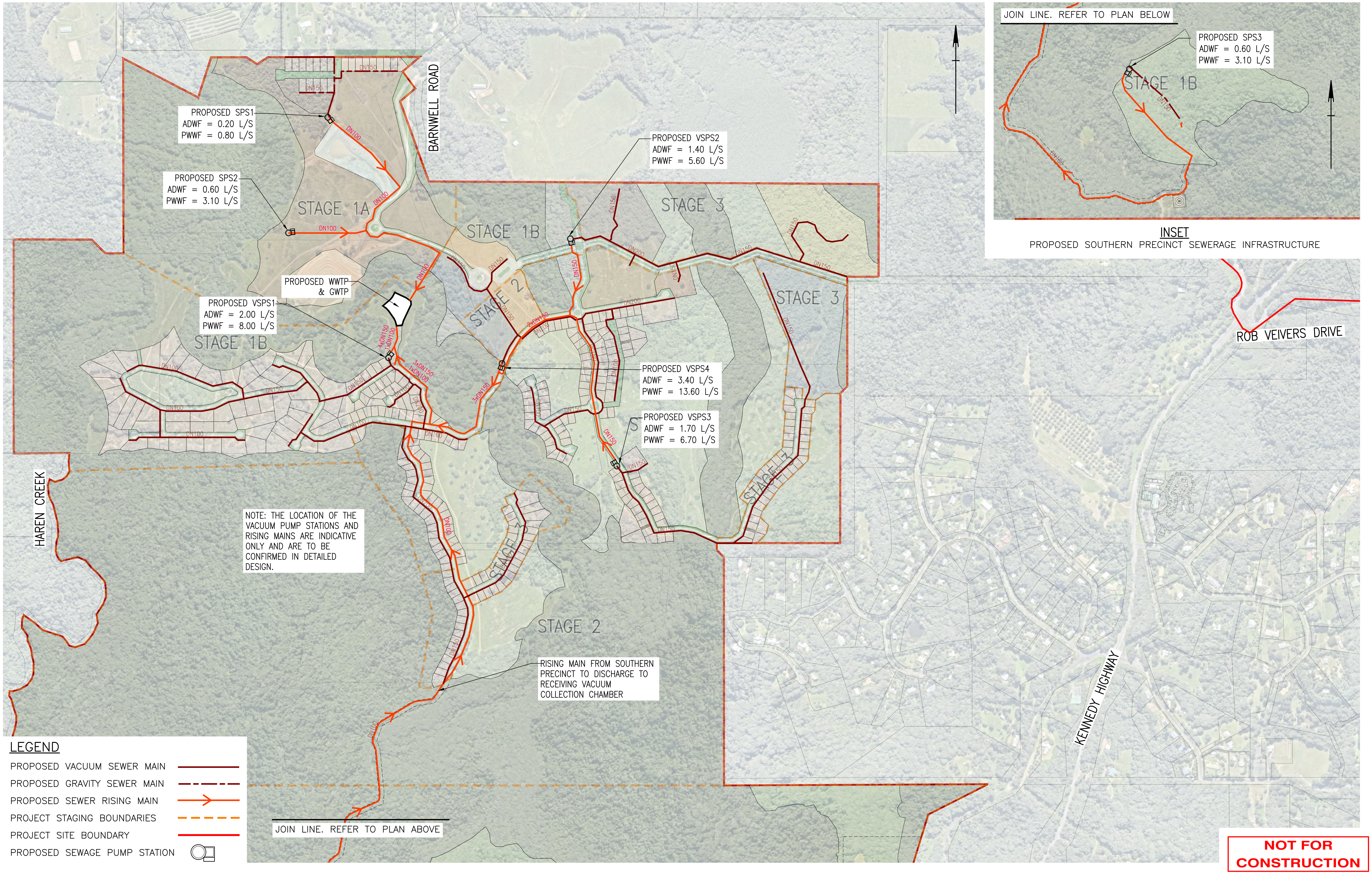
Client
REEVER AND OCEAN PTY. LTD.

Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED WATER SUPPLY (POTABLE) INFRASTRUCTURE INDICATIVE LAYOUT

Scale at A1: 1:1000
Discipline: Civil
Job No: 253251-00
Drawing Status: Preliminary
Drawing No: 253251-00-C-RD-301
Issue: 1B

Do not scale © Arup



NOT FOR CONSTRUCTION

Issue	Description	Date	By	Chkd	Appd
A	DRAFT EIS ISSUE	02/07/18	GOD	NLL	NLL

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FLOVAC SYSTEMS
VACUUM SEWERAGE SPECIALIST

CONSULT AUSTRALIA
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Client
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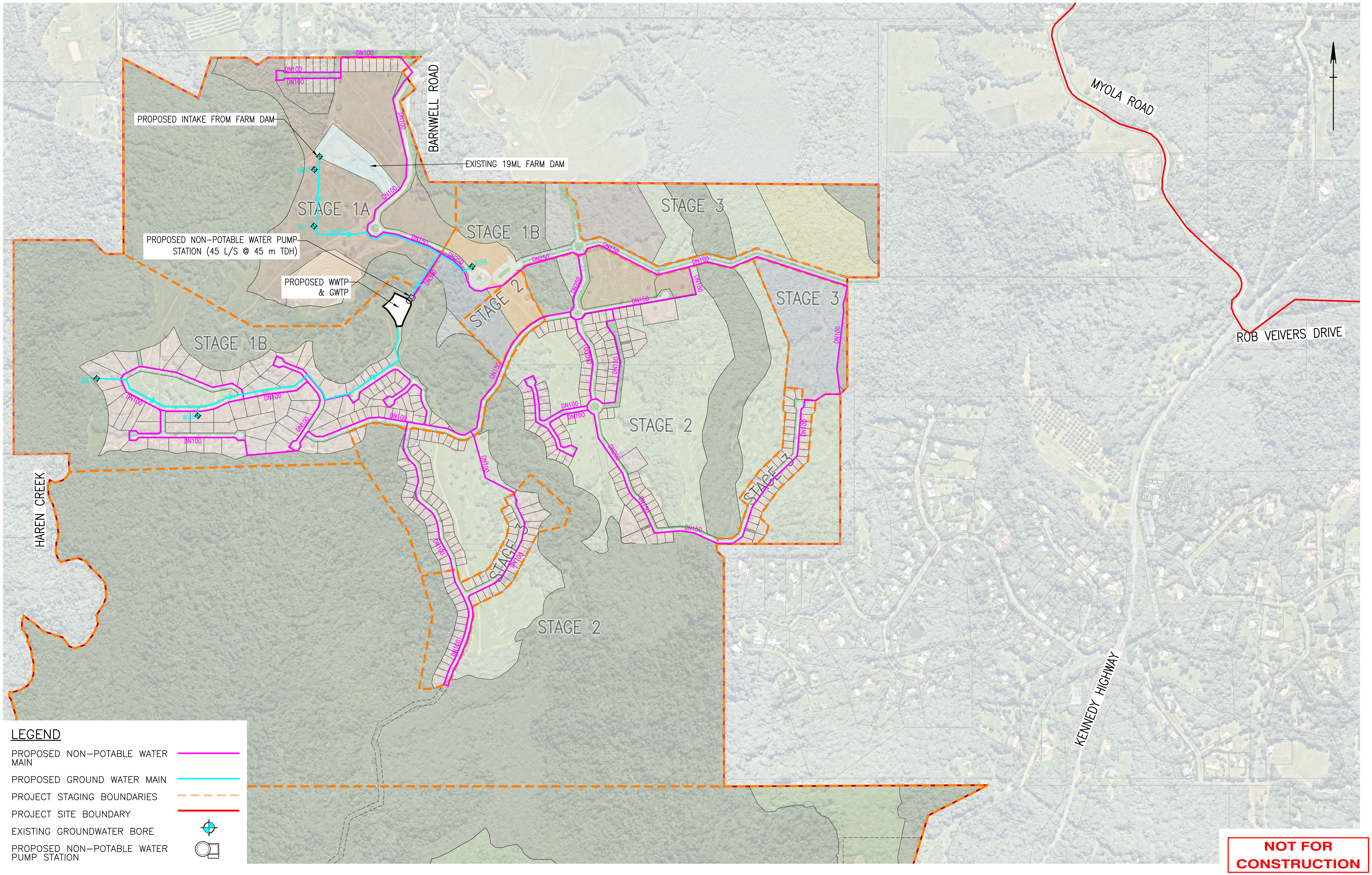
Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED SEWERAGE INFRASTRUCTURE INDICATIVE LAYOUT

Scale at A1: 1:5000
Discipline: Civil
Job No: 253251-00
Drawing Status: Preliminary
Drawing No: 253251-00-C-RD-302
Issue: 1B



Issue	Description	Date	By	Chkd	Appd
A	DRAFT EIS ISSUE	02/07/18	GOD	NLL	NLL

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Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED WATER SUPPLY (NON-POTABLE) INFRASTRUCTURE INDICATIVE LAYOUT

Scale at A1: 1:1000
Discipline: Civil
Job No: 253251-00
Drawing Status: Preliminary
Drawing No: 253251-00-C-RD-303
Issue: 1B

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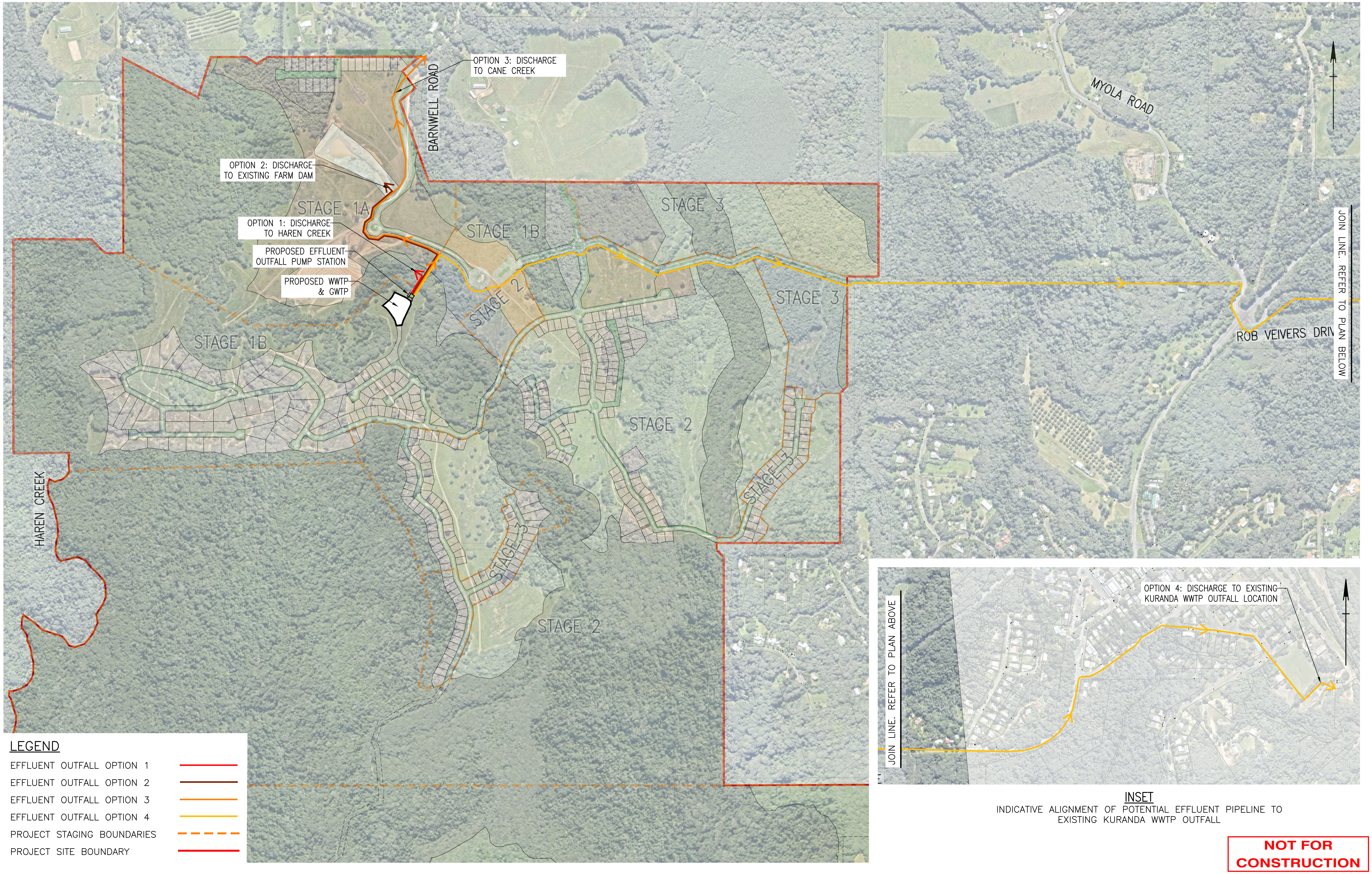

INSET

INDICATIVE ALIGNMENT OF POTENTIAL EFFLUENT PIPELINE TO EXISTING KURANDA WWTP OUTFALL

NOT FOR CONSTRUCTION

Issue	Description	Date	By	Chkd	Appd
A	DRAFT EIS ISSUE	02/07/18	GOD	NLL	NLL

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Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

EFFLUENT OUTFALL OPTIONS INDICATIVE LAYOUT

Scale at A1

Discipline: Civil

Job No: 253251-00

Drawing Status: Work in Progress

Drawing No: 253251-00-C-RD-304

Issue

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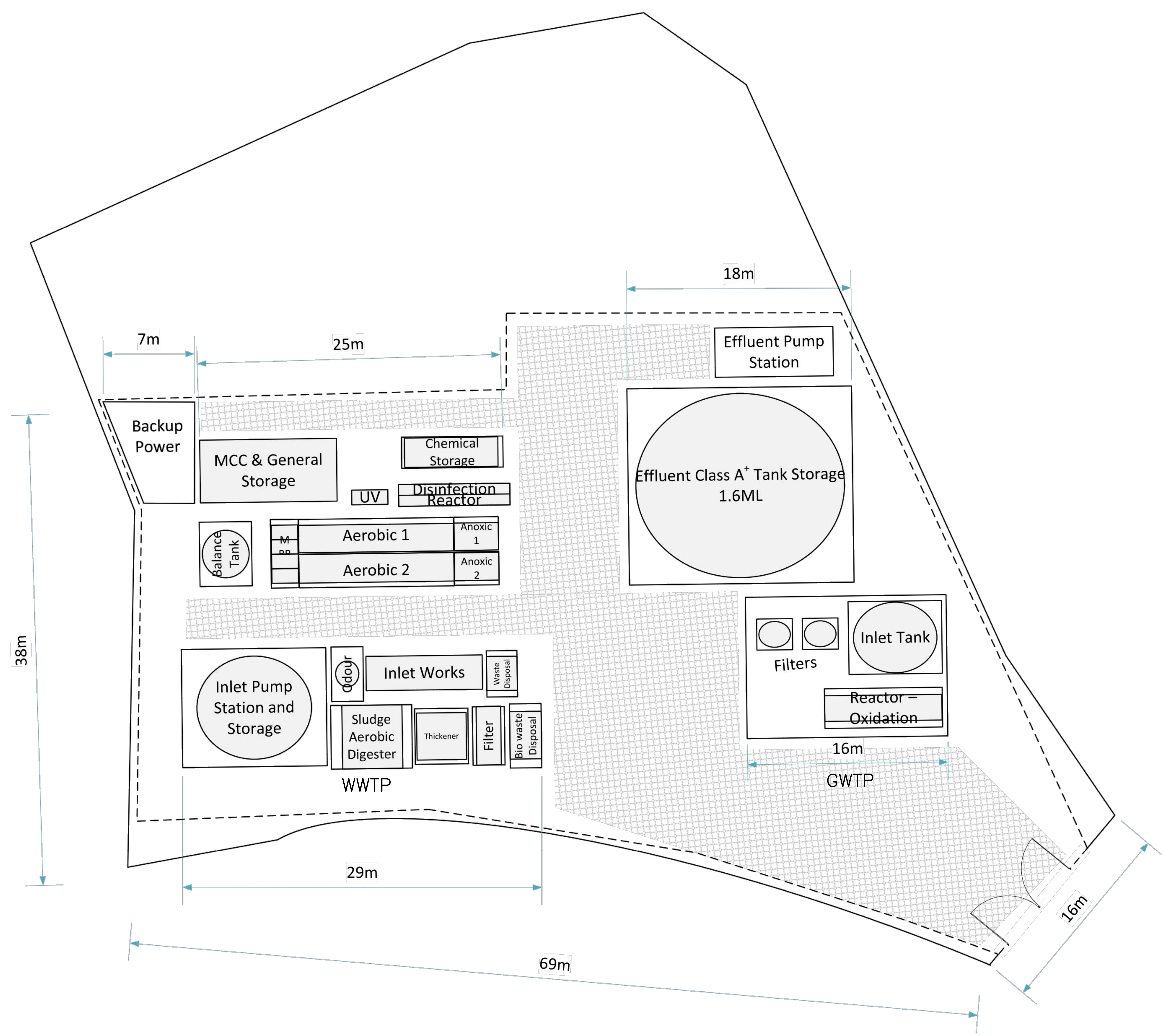

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Issue	Description	Date	By	Chkd	Appd
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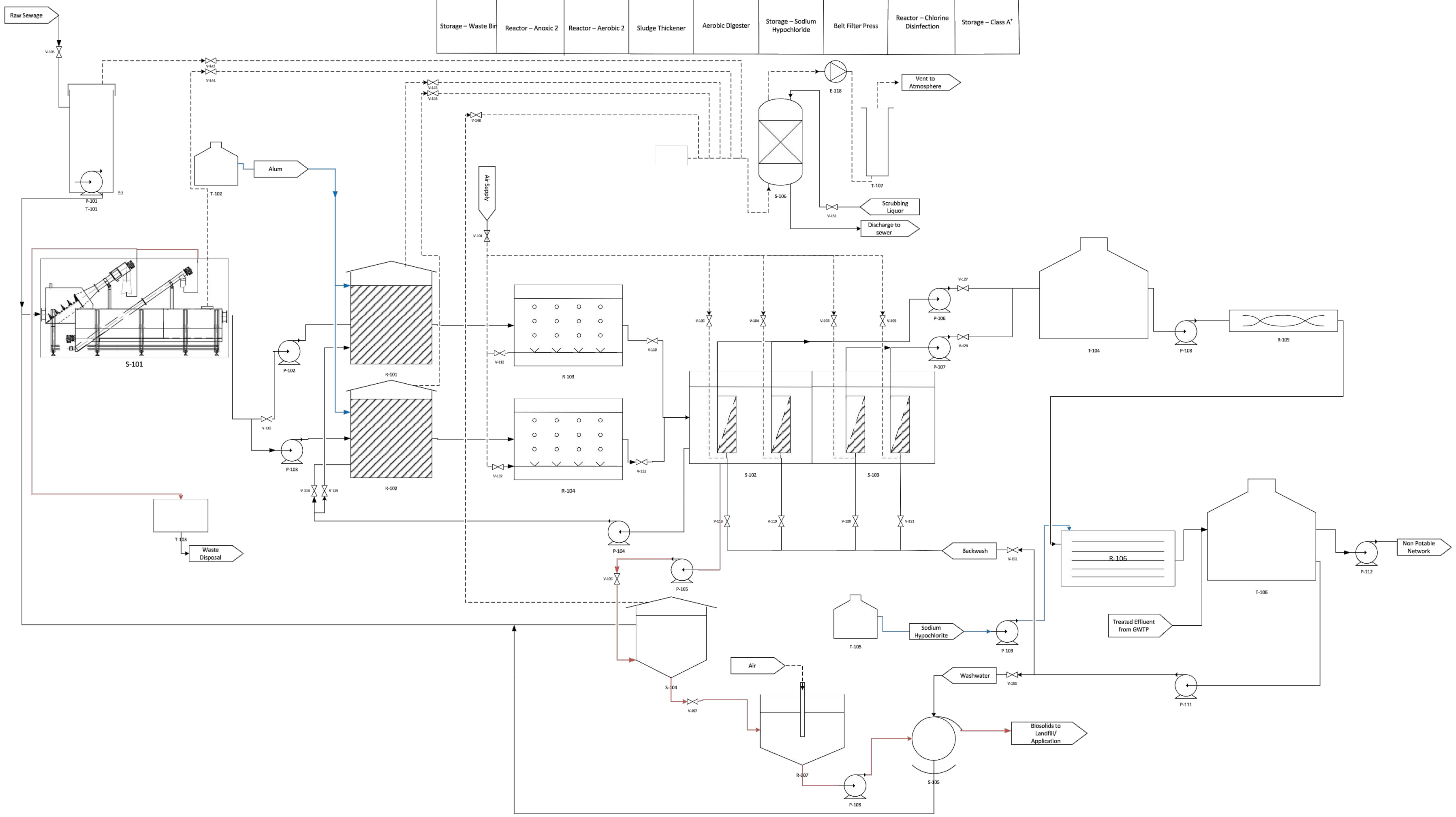
Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED WASTEWATER AND GROUNDWATER TREATMENT PLANTS GENERAL ARRANGEMENT

Scale at A1: NTS
Discipline: Civil
Job No: 253251-00
Drawing Status: Preliminary
Drawing No: 253251-00-C-RD-351
Issue: 1B

T-101	T-102	S-101	R-101	R-103	S-102	S-103	S-106	T-107	T-104	R-105
Sewage Pump Station	Storage – Alum	Screen & Grit	Reactor – Anoxic 1	Reactor – Aerobic 1	MBR 1	MBR 2	Odour Control Scrubber	Vent Stack	Storage - Post Bio Treatment Balance Tank	Reactor – UV Disinfection

T-103	R-102	R-104	S-104	R-107	T-105	S-105	R-105	T-106
Storage – Waste Bin	Reactor – Anoxic 2	Reactor – Aerobic 2	Sludge Thickener	Aerobic Digester	Storage – Sodium Hypochloride	Belt Filter Press	Reactor – Chlorine Disinfection	Storage – Class A+



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A	DRAFT EIS ISSUE	02/07/18	GOD	NLL	NLL
Issue	Description	Date	By	Chkd	Appd

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Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER TREATMENT PLANT PIPING AND INSTRUMENTATION DIAGRAM

Scale at A1: NTS
Discipline: Civil
Job No: 253251-00
Drawing Status: Preliminary
Drawing No: 253251-00-C-RD-352
Issue: 1B

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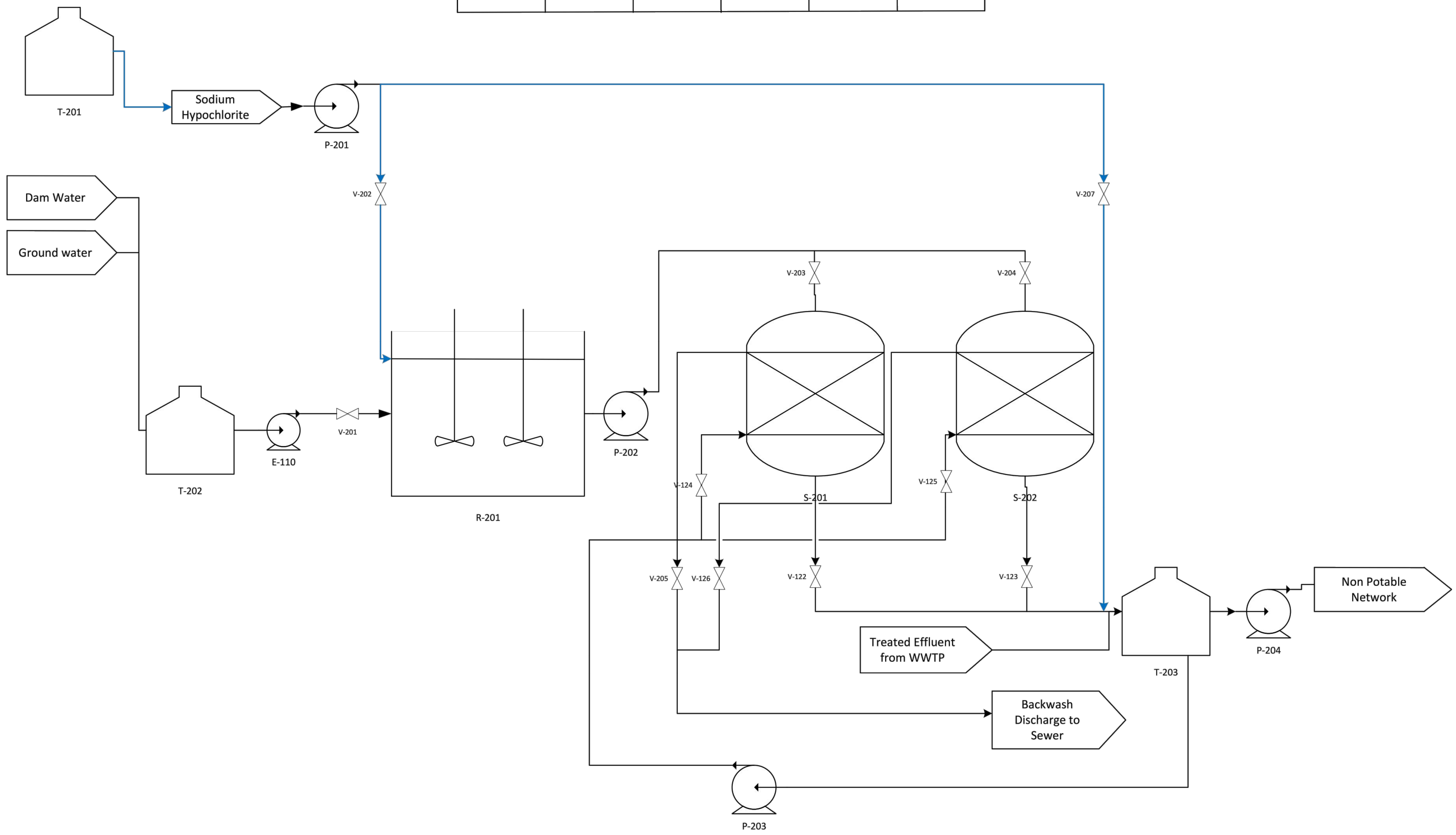
T-201	T-202	R-201	S-201	S-202	T-203
Storage – Sodium Hypochlorite	Storage – Balance Tank	Reactor – Oxidation	Media Filter 1	Media Filter 2	Storage – Class A+



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Issue	Description	Date	By	Chkd	Appd
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Job Title
KUR-WORLD INTEGRATED ECO-RESORT DEVELOPMENT ENVIRONMENTAL IMPACT STATEMENT

GROUNDWATER TREATMENT PLANT PIPING AND INSTRUMENTATION DIAGRAM

Scale at A1 NTS
Discipline Civil
Job No 253251-00
Drawing Status Preliminary
Drawing No 253251-00-C-RD-353
Issue 1B

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