KUR-World

Infrastructure

Chapter 7.0

Environmental Impact Statement

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Glossary of Terms

Term	Definition
Advanced Resource Recovery Facility (ARRF)	Waste processing facility that sorts general waste and separates non-organic waste from organic waste. The organic waste is composted. Residual waste is disposed of to landfill.
Alternating current (AC)	An electric current that reverses its direction many times a second at regular intervals.
Anaerobic Digestion (AD)	The breakdown of organic waste in the absence of oxygen by microorganisms in a sealed vessel to produce methane and digestate.
Arup Waste Forecast Tool	An in-house tool developed by Arup to estimate and forecast operational waste generation for different development types based on collated datasets from across the world.
Average Day (AD)	AD demand refers to the total annual demand, divided by 365.

Term	Definition
Average Dry Weather Flow (ADWF)	The average daily sewage flow, measured following seven days without rain.
Average recurrence interval (ARI)	The average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.
Back of House (BoH)	The waste generated from services areas and corridors of a building where customers do not have access (e.g. the kitchen, employee area, office for a restaurant).
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.
Bio-retention	The process in which contaminants and sedimentation are removed from stormwater runoff.
Commercial and Industrial (C&I) Waste	The waste stream generated from commercial and industrial sources.
Construction and Demolition (C&D) Waste	The waste stream generated from construction and demolition sources.
Dial Before You Dig (DBYD)	A service in Australia to protect the network of underground pipes and cables by acting as a single point of contact between underground asset owners and excavators.
Direct current (DC)	An electric current flowing in a single direction only.
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 Areas (GFA's)	The total floor area inside a building, including external walls but excluding the roof.
Gross Pollutants (GP)	Large pieces of debris flushed through urban catchments and stormwater systems.
Gross Pollutant Trap (GPT)	A filter that catches solid waste such as litter and coarse sediment in stormwater.
Kilowatt peak (kWp)	The maximum possible output of a solar generator operating under standard conditions. This is a standardised test for solar panels across all manufacturers to ensure that the values listed are comparable.
Landfill	Burial of waste material.
Light-emitting diodes (LEDs)	A semiconductor diode which emits a visible light when an electric current passes through it.
Material Recovery Facility	A facility that undertakes sorting and separation of mixed waste to recover recyclable components including metals, plastics, paper/card and glass.
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.
Model for Urban Stormwater Improvement Conceptualisation (MUSIC)	A model to predict the performance of stormwater quality management systems using water sensitive urban design.
Municipal solid waste (MSW)	The waste stream generated from a combination of domestic waste and other wastes arising from council activities (such as the management of parks and gardens, and the collection of litter and illegally dumped waste).

Term	Definition
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.
Photovoltaic (PV)	Capable of producing a voltage (usually through photoemission) when exposed to radiant energy, (especially light).
SQID	Stormwater Quality Improvement Device
Swale	Nominally a grassed lined channel for the conveyance of stormwater flows, unless noted otherwise.
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-nitrate.
Total phosphorus (TP)	Sum of all phosphorus compounds that occur in various forms.
Total Suspended Solids (TSS)	Suspended particles that are not dissolved in a sample of water.
Waste Management Plan (WMP)	A plan to identify waste sources and appropriate management measures.
Waste Management System (WMS)	The waste collection and disposal arrangements for the proposed development.
Water Sensitive Urban Design (WSUD)	Planning and design of stormwater systems to integrate the urban water cycle and support health ecosystems.
Water Quality Objectives (WQO)	Objectives for the physical, chemical and biological characteristics of water.
Volt-ampere (VA)	The unit used for the apparent power in an electrical circuit, equal to the product of root-mean-square voltage and current.
Variable Refrigerant Flow (VRF)	A system used for heating, cooling and dehumidifying air for buildings. These systems vary the flow of refrigerant based on demand.

7.0 INFRASTRUCTURE

7.1 Water and Wastewater Infrastructure

7.1.1 Introduction

The purpose of this chapter is to describe the proposed strategy for the provision of water supply and wastewater infrastructure for KUR-World. This chapter addresses the following sections of the Terms of Reference:

- 10.13 – 10.17 Infrastructure requirements (as related to water and wastewater infrastructure)
- 10.19 – 10.22 Water supply and storage
- 10.23 – 10.25 Water infrastructure master plan
- 10.28 – 10.32 Wastewater

It includes a summary of the water balance analysis undertaken to estimate the water demands and wastewater loads generated during each stage of the development, as well as the water supply and wastewater infrastructure proposed to be constructed both internal and external to the site.

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 in Appendix 2A:

- Proposed Water Supply (Potable) Infrastructure, Indicative Layout – 253251-00-C-RD-301, Issue 1A, 01/11/2017
- Proposed Water Supply (Non-Potable) Infrastructure, Indicative Layout – 253251-00-C-RD-303, Issue 1A, 01/11/2017
- Proposed Sewerage Infrastructure, Indicative Layout – 253251-00-C-RD-302, Issue 1A, 01/11/2017
- Proposed Effluent Outfall Options, Indicative Layout – 253251-00-C-RD-304, Issue 1A, 01/11/2017
- Proposed Wastewater Treatment Plant and Groundwater Treatment Plant, General Arrangement – 253251-00-C-RD-351, Issue 1B, 22/11/2017
- Proposed Wastewater Treatment Plant, P&ID – 253251-00-C-RD-352, Issue 1B, 04/09/2017
- Proposed Groundwater Treatment Plant, P&ID – 253251-00-C-RD-353, Issue 1B, 04/09/2017.

Further details on the analysis undertaken to inform the strategy and reference design for the proposed water and wastewater infrastructure presented in this chapter can be found in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B).

7.1.2 Relevant Legislation, Policy and Guidance

An overview of legislation and policy applicable to water resources is provided in Chapter 10, Water Resources and Chapter 9, Water Quality. Legislation, policy and guidance specific to the provision of water and wastewater infrastructure at the site are listed below:

- Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual:
  - The reference design has been developed to be consistent with the requirements of this manual.
- *Water Act 2000* and subordinate legislation:
  - Provides a framework for the sustainable management of surface and groundwater resources in Queensland.
  - Regulates the abstraction of water from watercourses including the Barron River.

- *Environmental Protection Act 1994* and subordinate legislation:
  - Environmentally relevant activities (ERAs) are industrial activities with the potential to release emissions with impacts to the surrounding environment or land uses. ERAs relevant to water and wastewater include Chemical Storage and ERA 63, Sewage Treatment and ERA 64, Water Treatment. The need for environmental authorities for ERAs will be assessed and confirmed during future design stages, and relevant approvals obtained prior to the commencement of the construction activity.
- Mareeba Shire Council Planning Scheme (Operational Works Permits will be obtained for the relevant stage of development following detailed design)

7.1.3 Overview of water supply and wastewater management 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 7-1 illustrates the conceptual water supply and wastewater disposal strategy proposed for KUR-World.

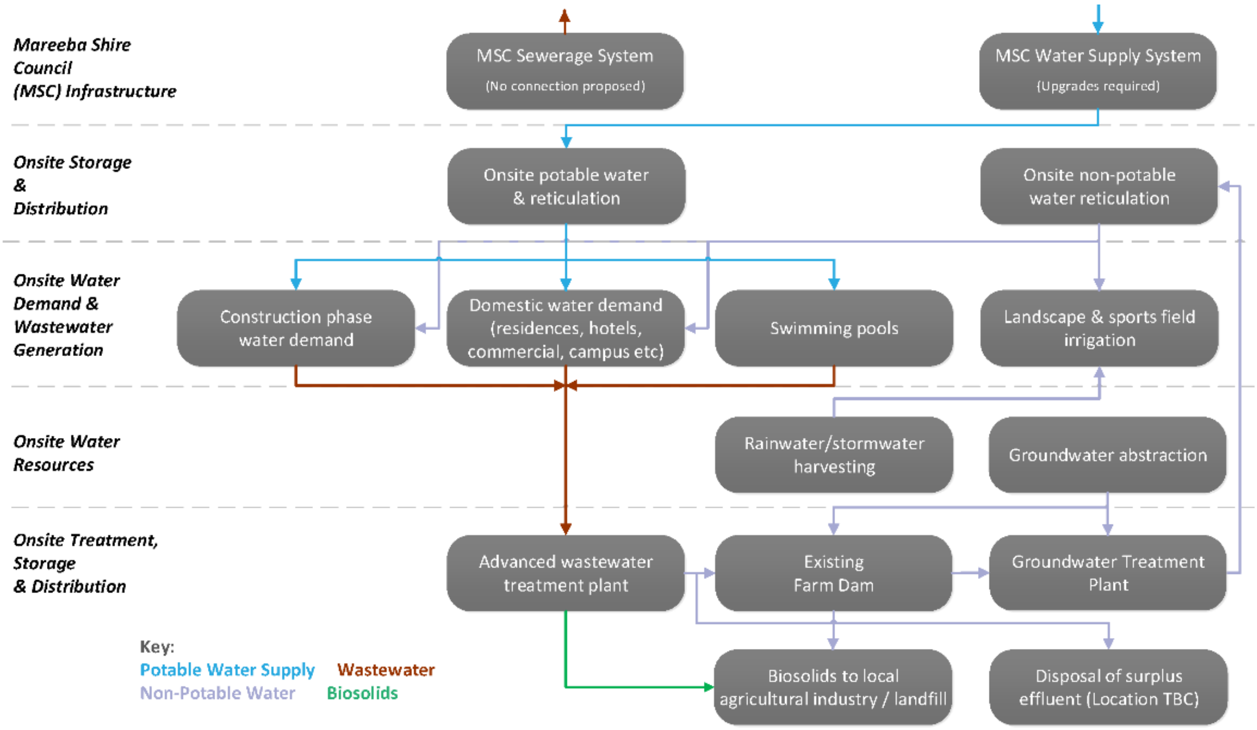


Figure 7-1: Conceptual water supply strategy schematic for KUR-World

The concept strategy has been developed through investigation and analysis of possible options, as described in detail in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Arup, 2017 (b) & Appendix 4B). 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 stormwater. 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.

The requirements and opportunities for water supply and wastewater are summarised in Table 7-1 and Table 7-2 respectively, highlighting opportunities for demand management and minimisation of wastewater generation. As described in Section 7.1.4.2, KUR-World is targeting a 'low' water balance scenario which assumes implementation of many of the demand management and wastewater minimisation opportunities identified below.

Table 7-1: 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).

Application	Required water quality	Opportunities for demand management
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 7-2: 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.

Application	Potential for onsite treatment and reuse	Opportunities for minimising wastewater generation
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.

7.1.4 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.

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.

The basis and outcomes of the analysis are summarised in the following report sections, with further detail provided in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B).

7.1.4.1 Design basis

The water balance analysis was based on the following documents:

- The proposed KUR-World Master Plan, including:
  - Overall Site Master Layout, (drawing 253251-00-C-RD-010, issue 1B – refer to Appendix 2A) (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)).
- The following design guidelines and standards:
  - Far North Queensland Regional Organisation of Councils (FNQROC) Regional Development Manual (FNQROC, 2014)
  - Planning Guidelines for Water Supply and Sewerage (Queensland Water Supply Regulator, Water Supply and Sewerage Services, 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)

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 (Queensland Water Supply Regulator, Water Supply and Sewerage Services, Department of Energy and Water Supply, 2010) to the architectural concept Gross Floor Area (GFA) for the proposed development for the various different commercial, educational, hotel and restaurant buildings.
- Undertaking first principle water demand and wastewater loading calculations for a variety of non-standard aspects of the development including for example golf course irrigation (Ways With Water Pty. Ltd., 2017 (a)) (Lane, 2017), swimming pool and pond evaporation, and swimming pool filter backwashing.
- Undertaking first principle calculations to estimate the breakdown of the water demand from each building and facility into potable and non-potable components.

The estimated water demands are described in further detail in section 7.1.4.3.1 and summarised in Figure 7-2, with the demand on Mareeba Shire Council's (MSC) network summarised in Figure 7-3. The estimated wastewater loads are described in further detail in section 7.1.4.3.2 and summarised in Figure 7-4, with the associated recycled water production discussed in section 7.1.4.3.4 and summarised in Figure 7-5. Groundwater, rainwater and stormwater are discussed in sections 7.1.4.3.3 and 7.1.4.3.5. The total water balance is summarised in Table 7-4.

Section 7.1.4.4 presents the analysis of the water demands and wastewater loads generated by construction phase activities. The analysis was undertaken based on first principles calculations and industry benchmarking; and considered as part of the overall water supply and wastewater management strategy.

Section 4.1 of the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B) summarises key aspects of the proposed masterplan precincts including the proposed floor areas, bed/ room numbers where applicable, staging and demand calculation methods.

7.1.4.2 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 7-1 and Table 7-2).
- 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. The commitments have been summarised into a table [SSG to provide title and cross reference]. The 'Low Scenario' 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 following sections of this report. Details of the medium and high scenario estimates can be found in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B).

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

7.1.4.3 Water balance analysis outcomes

7.1.4.3.1 Estimated water demands

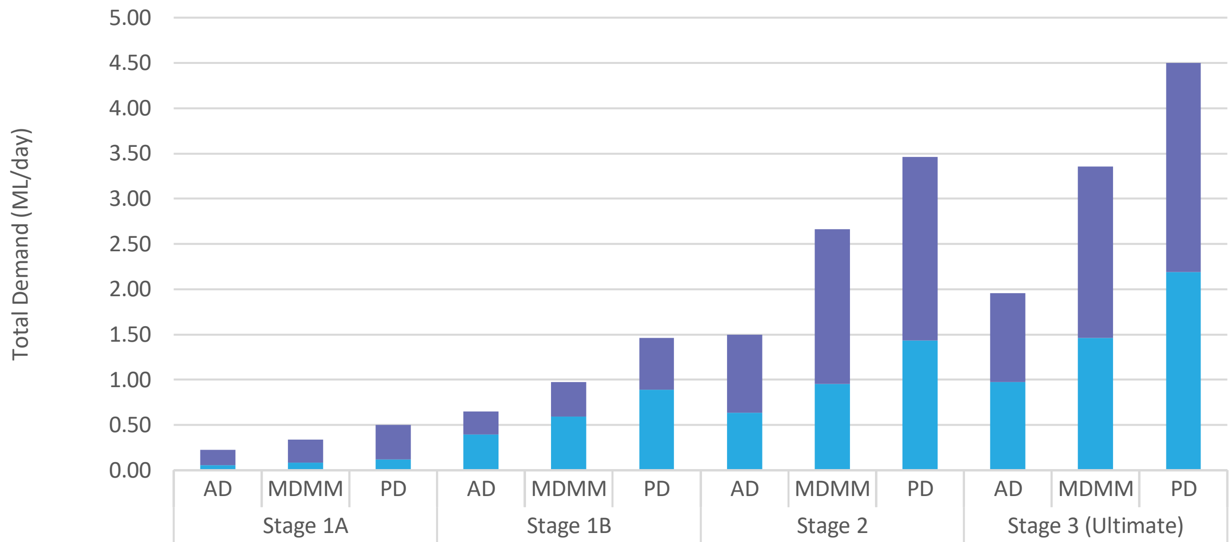
Figure 7-2 shows the estimated total water demands for each stage of the KUR-World development, split into both the potable and non-potable demand components. As shown in the figure:

- Average Day (AD) total water demands increase from 0.22ML/day at Stage 1A, to 1.96ML/day at the ultimate Stage 3. AD demand refers to the total annual demand, divided by 365.
- Mean Day Maximum Month (MDMM) total water demands increase from 0.34ML/day at Stage 1A, to 3.35ML/day at the ultimate Stage 3. MDMM demand refers to the highest 30 day moving average daily water demand.
- Peak Day (PD) total water demands increase from 0.5ML/day at Stage 1A, to 4.5ML/day at the ultimate Stage 3. PD demand refers to the maximum demand in any one day of the year.
- The potable component of the total water demand varies between the different stages (due to the varying requirements for non-potable water for irrigation and other purposes), ranging from 25% to 60% of the total water demand.

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 (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.

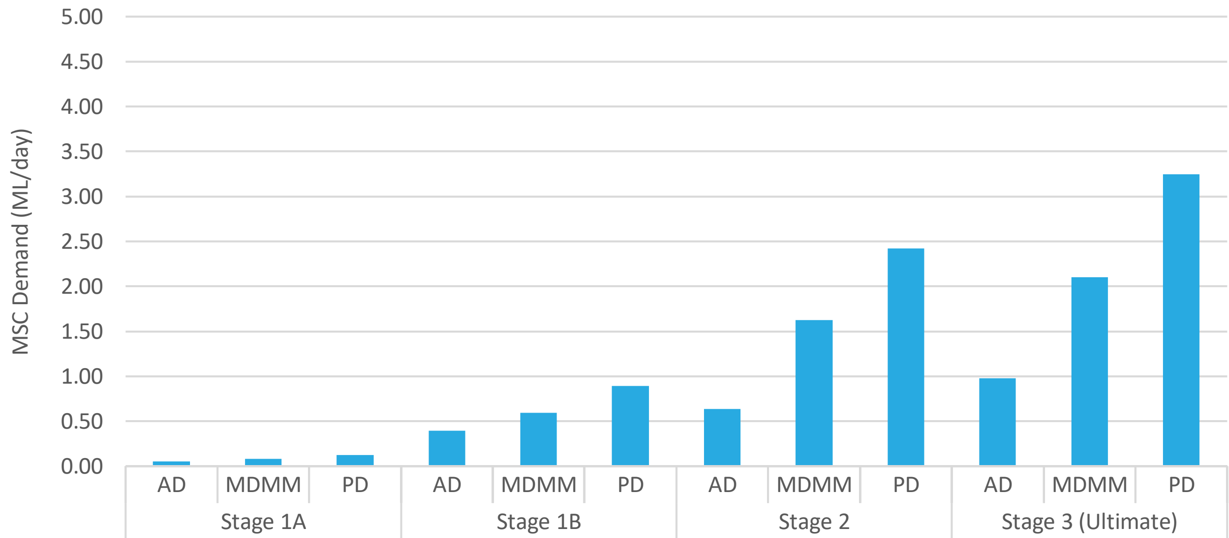
It is important to note that the demands presented in Figure 7-2 represent the total estimated water demands, to be met by a combination of onsite sources (including groundwater, recycled water, rainwater and stormwater), as well as the Mareeba Shire Council (MSC) water network.

The demands on the MSC network are estimated to be significantly less than these figures and are presented separately in Figure 7-3. As summarised in Table 7-4, the analysis shows that for Stage 2, as well as in peak conditions of Stage 3, the total non-potable water demand exceeds the available non-potable water supply available from the site. The deficit in non-potable water supply is proposed to be met by potable water from the MSC network.



	Stage 1A AD	Stage 1A MDMM	Stage 1A PD	Stage 1B AD	Stage 1B MDMM	Stage 1B PD	Stage 2 AD	Stage 2 MDMM	Stage 2 PD	Stage 3 (Ultimate) AD	Stage 3 (Ultimate) MDMM	Stage 3 (Ultimate) PD
Non-Potable	0.17	0.25	0.38	0.25	0.38	0.57	0.86	1.71	2.03	0.98	1.89	2.31
Potable	0.05	0.08	0.12	0.40	0.59	0.89	0.64	0.95	1.43	0.97	1.46	2.19

Figure 7-2: Estimated total water demands (Low Scenario)



	Stage 1A AD	Stage 1A MDMM	Stage 1A PD	Stage 1B AD	Stage 1B MDMM	Stage 1B PD	Stage 2 AD	Stage 2 MDMM	Stage 2 PD	Stage 3 (Ultimate) AD	Stage 3 (Ultimate) MDMM	Stage 3 (Ultimate) PD
Potable	0.05	0.08	0.12	0.40	0.59	0.89	0.64	1.63	2.42	0.97	2.10	3.24

Figure 7-3: Estimated demand on Mareeba Shire Council (MSC) water network (Low Scenario)

7.1.4.3.2 Estimated wastewater loads

Figure 7-4 shows the estimated total wastewater loads for each stage of the KUR-World development. As shown in the figure, the Average Dry Weather Flow (ADWF) total wastewater loads increase from 0.05ML/day at Stage 1A, to 0.79ML/day at the ultimate Stage 3.

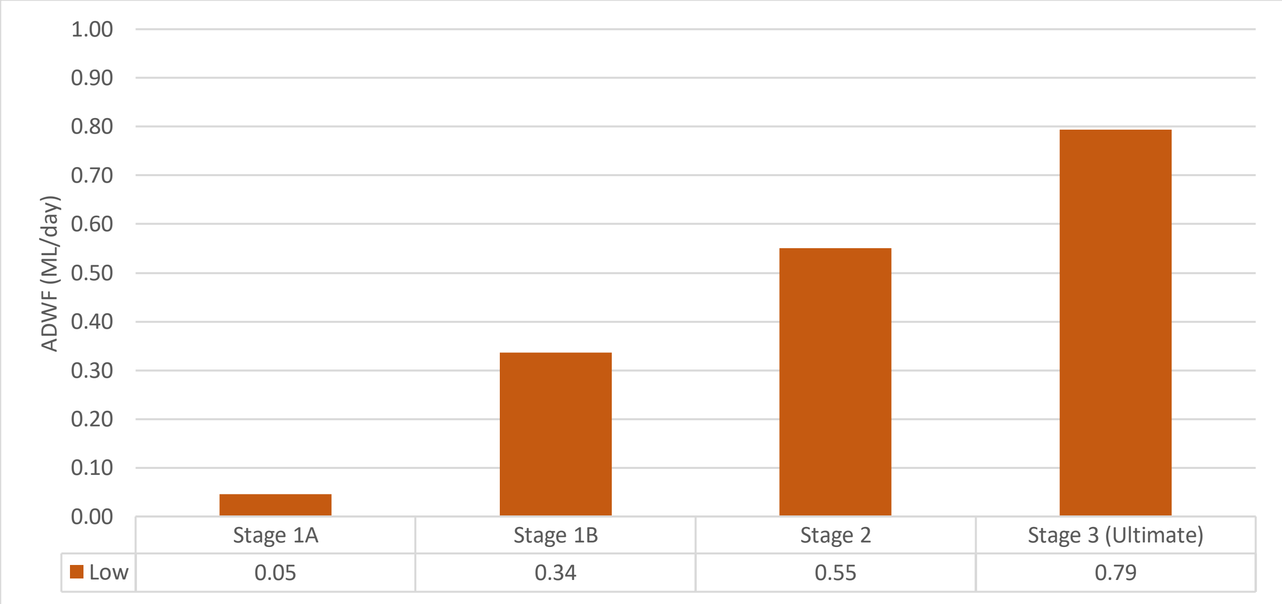


Figure 7-4: Estimated ADWF wastewater generation (Low Scenario)

All site generated wastewater is proposed to be treated via an onsite advanced wastewater treatment plant, which will be constructed during Stage 1B. The relatively small wastewater loads generated during Stage 1A are proposed to be treated via small scale biological treatment systems, with the effluent irrigated to a dedicated pasture area until the centralised wastewater treatment system is brought online.

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 & Appendix 4A). The study mapped areas potentially suitable for irrigation and identified additional management measures. 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 Wastewater Treatment Plant (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 in detail in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B).

7.1.4.3.3 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 (refer to Appendix 6I).

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 7-3. The location of these bores can be seen in drawing 253251-00-C-RD-303 (Proposed Water Supply [Non-Potable] Infrastructure Indicative Layout, issue 1A, 01/11/2017 – refer to Appendix 2A.

Table 7-3: Recommended Long Term Pumping Rates from Existing Groundwater Bores (extracted from Rob Lait and Associates, 2017)

Bore	Individual Pumping Rate	Recommended maximum pumping time per day		Volume/ day based on 14-hour pumping day	
	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, sulphate 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 7-3.

7.1.4.3.4 Estimated recycled water supply

The estimated recycled water supply assumed in the water balance analysis was based on the estimated wastewater loads summarised in Figure 7-3 as well as the high-level reference design for the proposed advanced wastewater treatment plant (drawing 253251-00-C-RD-352, in Appendix 2A). 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 Wastewater Treatment Plant (WWTP) will not be constructed until Stage 1B, no recycled water supply has been assumed during Stage 1A.

It should be noted that the recycled water supply is not planned to include any stormwater, for reasons discussed in section 7.1.4.3.5 and Chapter 7.4.

Figure 7-5 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 increases from 0.3ML/day at Stage 1B, to 0.71ML/day at the ultimate Stage 3.

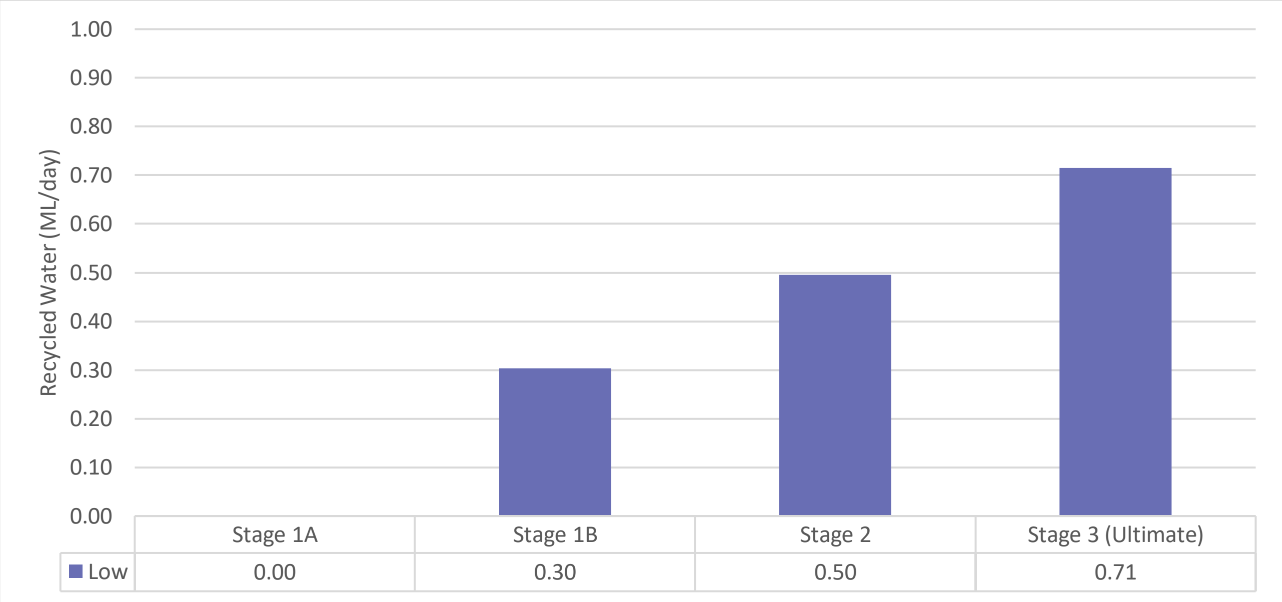


Figure 7-5: Estimated recycled water supply (Low Scenario)

7.1.4.3.5 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 (Stormwater Drainage General Arrangement, Issues 1B, 01/11/2017 – refer to Appendix 2A).

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 located generally central to 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 7-6, Figure 7-7, and Figure 7-8 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.

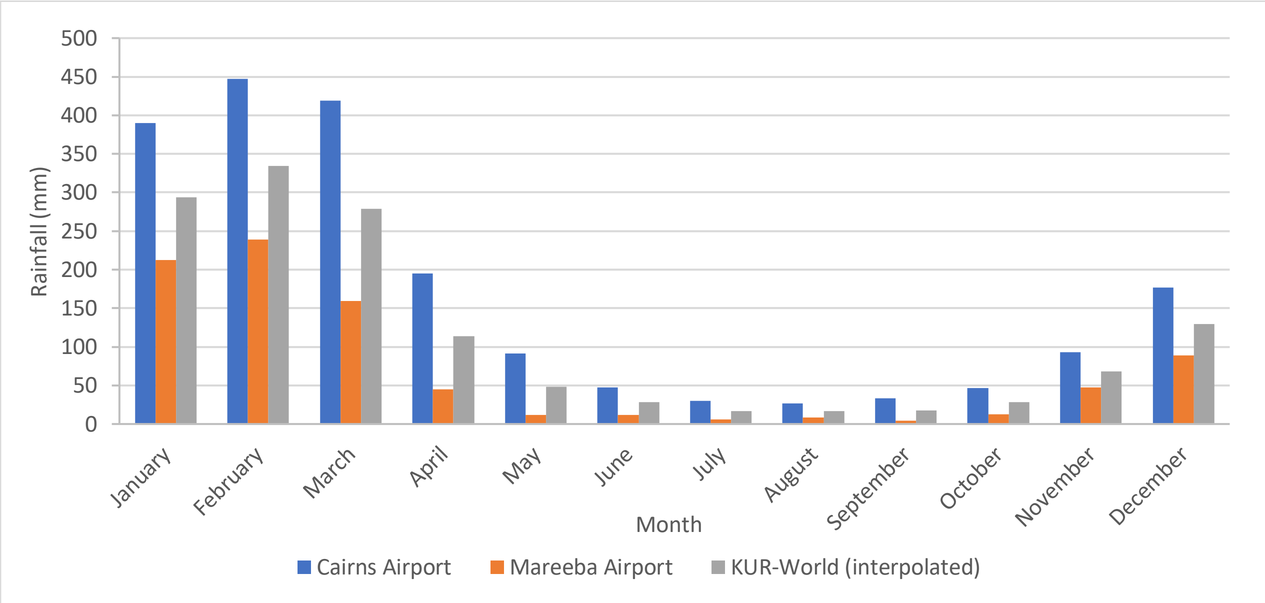


Figure 7-6: Mean monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

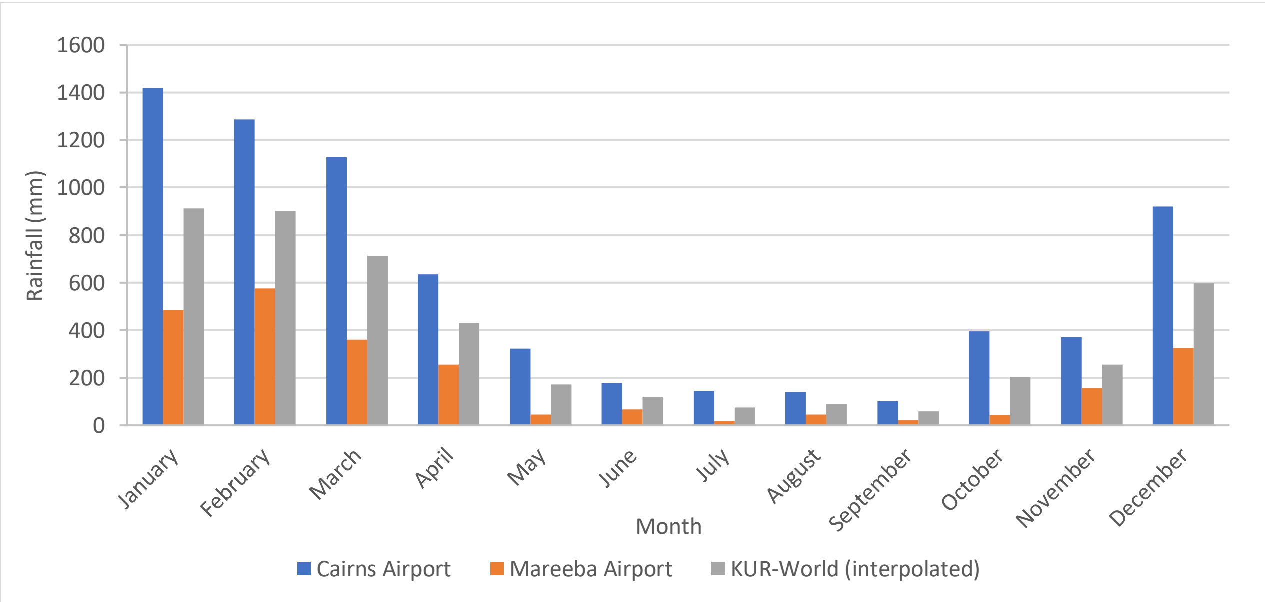


Figure 7-7: Maximum monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

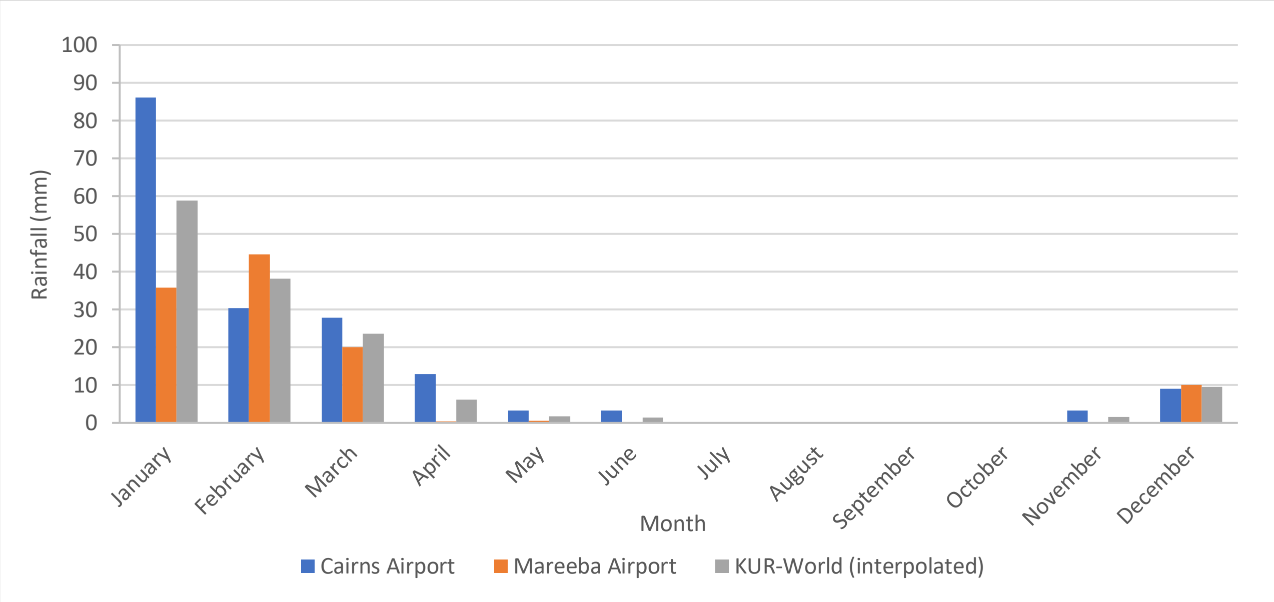


Figure 7-8: Minimum monthly rainfall for Cairns Airport, Mareeba Airport and KUR-World Site (interpolated based on published isohyet contours)

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 (50^{th} percentile) and high (90^{th} 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 (see drawing 253251-00-C-RD-010 – Overall Site Master Layout, Issue 1B, 1/11/17 in Appendix 2A).
- 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 7-9.

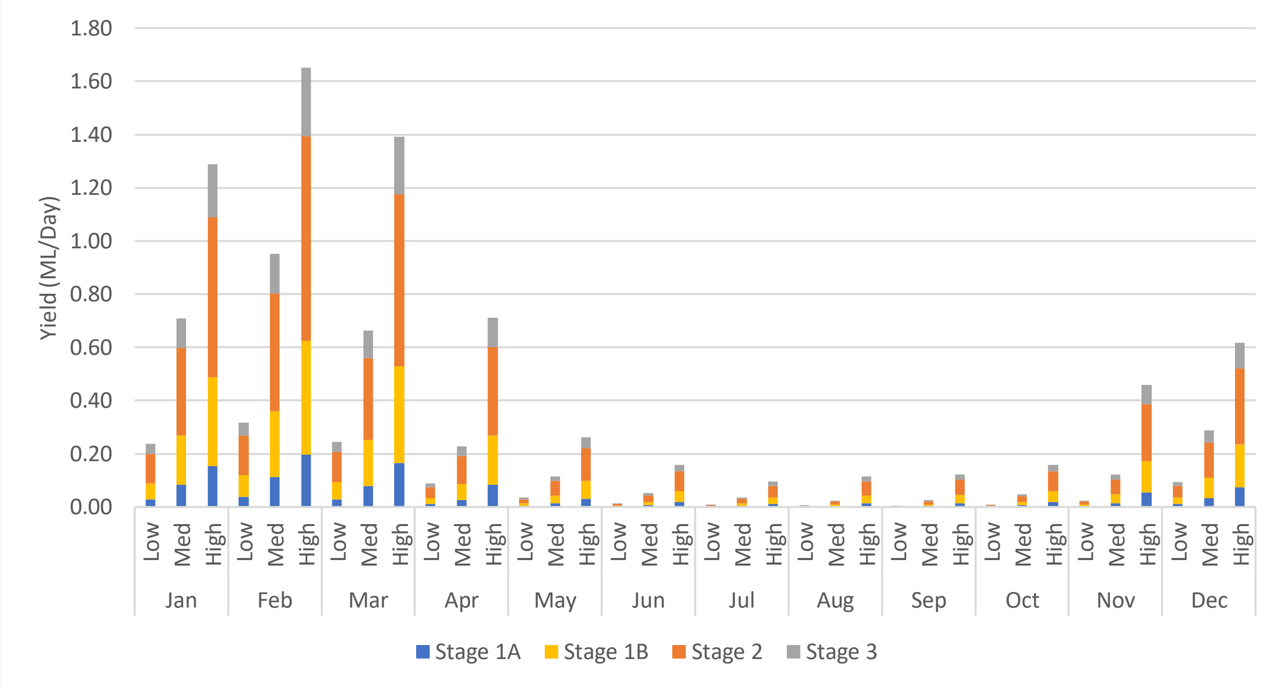


Figure 7-9: Theoretical potential rainwater and stormwater yield

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.

However, 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.

7.1.4.3.6 Water balance summary

Table 7-4 provides a summary of the key outcomes from the water balance analysis, including the key water supply, demand and wastewater loads adopted in developing the high-level water and wastewater infrastructure reference designs. These designs include drawing 253251-00-C-RD-301, -302 and -303 for proposed potable water supply, sewerage and non-potable water supply, respectively (refer to Appendix 2A). The analysis shows that for Stage 2, as well as in peak conditions of Stage 3, the total non-potable water demand exceeds the available non-potable water supply available from the site. The deficit in non-potable water supply is proposed to be met by potable water from the MSC network.

Table 7-4: 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-potable water supply)	***0.05***	***0.11***	***0.12***	***0.40***	***0.59***	***0.89***	***1.63***	***1.63***	***2.42***	***0.97***	***2.10***	***3.24***
Wastewater Load (ADWF only)												
Average Wastewater Generation	0.05	-	-	0.34	-	-	0.55	-	-	0.79	-	-

7.1.4.4 Construction water demand and wastewater load assessment

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 as described in Section 7.1.4.4.2. Table 7-5 summarises the stages of the proposed construction program, adopted as the basis for the construction phase water demand and wastewater load assessment. The construction program is described in Chapter 4.

Table 7-5: 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

7.1.4.4.1 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. 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.

Figure 7-10 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.

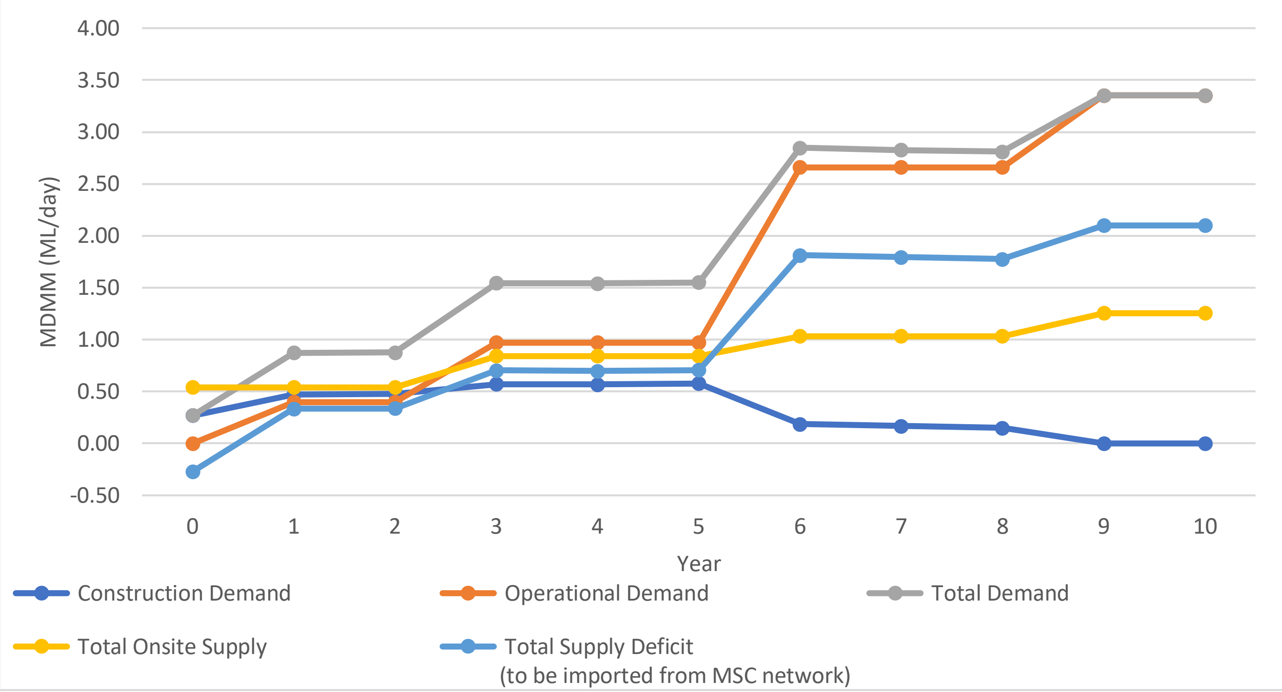


Figure 7-10: Total MDMM water demand and supply throughout construction period

As shown in Table 7-10:

- 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 declining 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.

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.

7.1.4.4.2 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 7-11 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 (ADWF) figures are shown, reflecting the typical daily loads expected from construction activities given that no inflow or infiltration is expected.

As shown in Figure 7-11:

- 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.

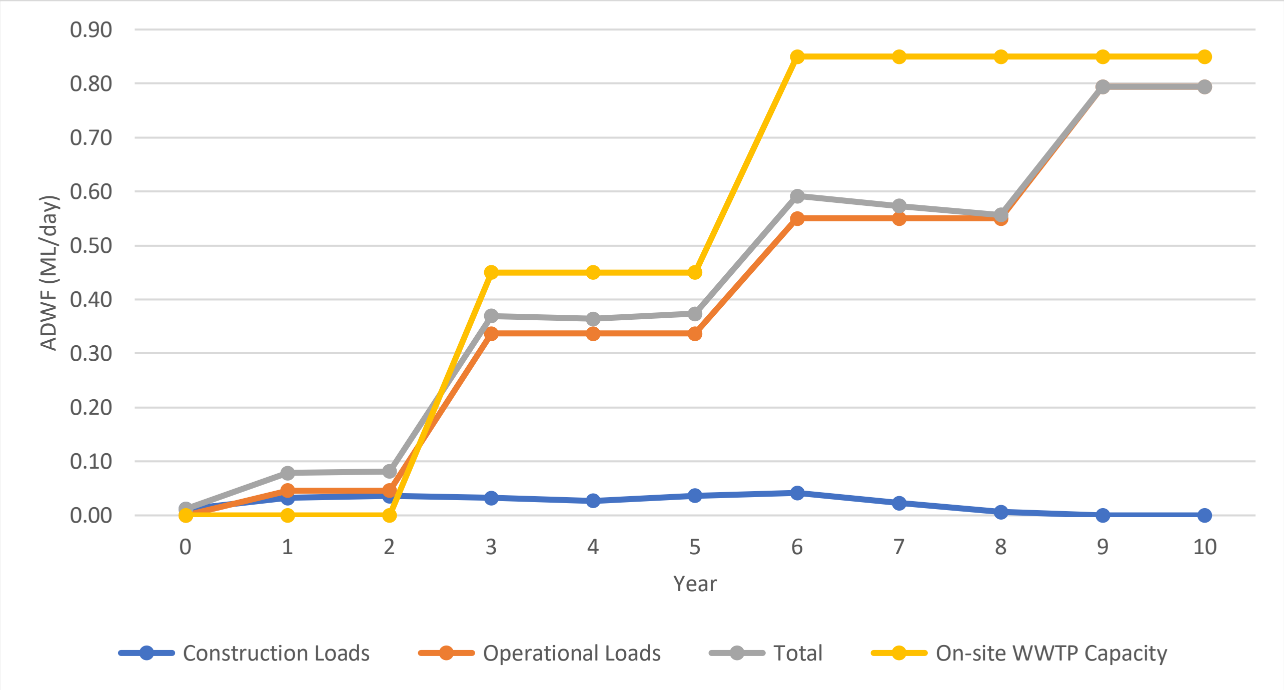


Figure 7-11: Total ADWF wastewater load and treatment capacity throughout construction period

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.

7.1.5 Water supply infrastructure

7.1.5.1 Existing water supply infrastructure

7.1.5.1.1 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 7.1.4.3.3, 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 (Proposed Water Supply (Non-Potable) Infrastructure, Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A).
- 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.

7.1.5.1.2 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 7-12 illustrates the key features of the water supply system in the vicinity of the KUR-World site.

As outlined in Section 7.1.5.2.2, 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.

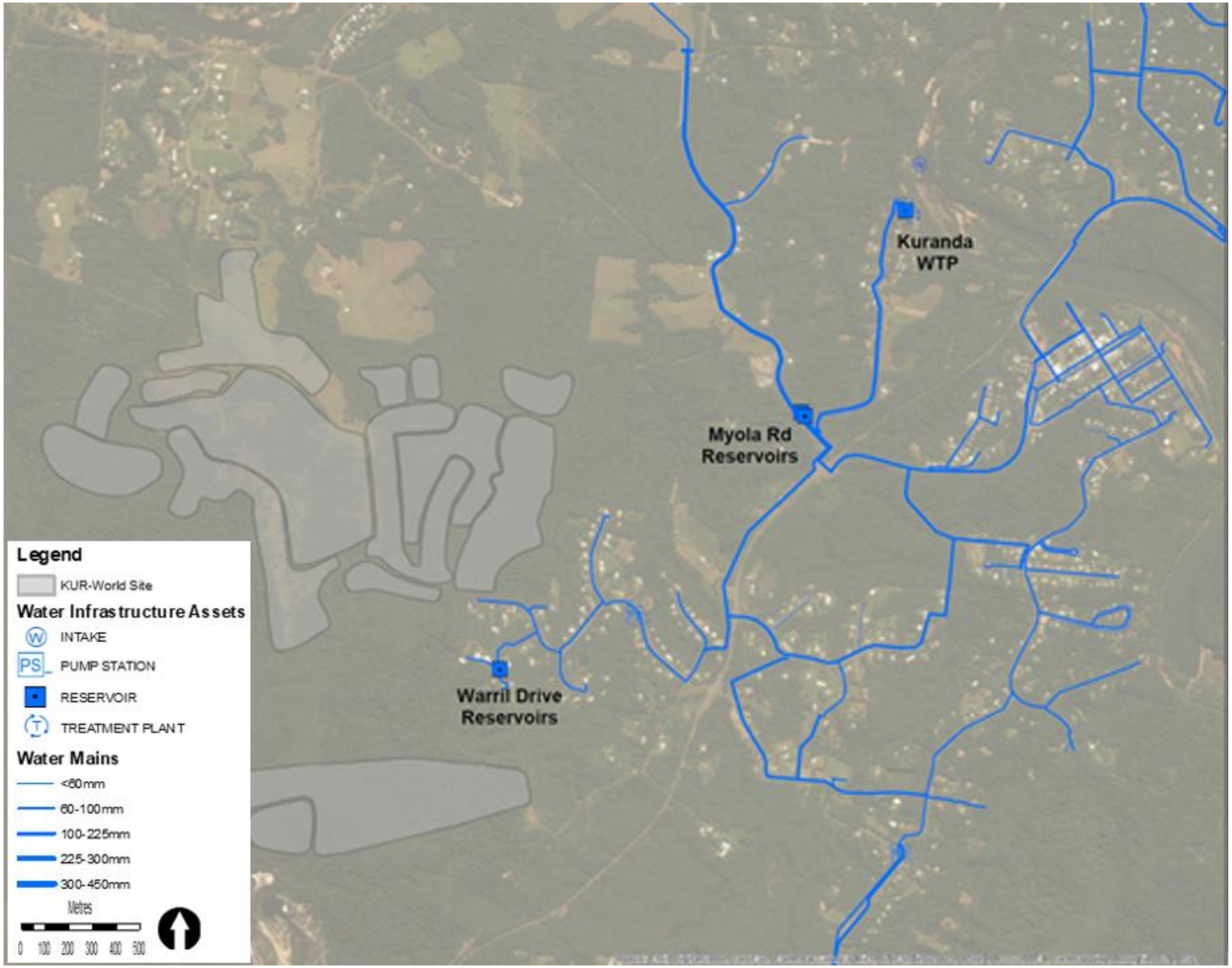


Figure 7-12: Key features of existing MSC water network in vicinity of KUR-World

7.1.5.1.2.1 *Existing Kuranda Water Treatment Plant*

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 MSC planning report, Service Reservoir Assessments – Kuranda, Mount Molloy and Chillagoe (Aurecon 2014), and in accordance with the design criteria outlined in the FNQROC Development Manual (FNQROC, 2014). The results are summarised in Table 7-6.

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.

Table 7-6: 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

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.

7.1.5.1.2.2 *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 7-7.

Table 7-7: 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 7.1.5.2 below.

7.1.5.1.2.3 *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 7.1.5.2 below

7.1.5.2 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 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.
- Provisions for the supply of class A+ non-potable water from the onsite Wastewater Treatment Plant (WWTP), including a supply main delivering recycled water to the non-potable water network 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.
- 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 Appendix 2A (see drawing 253251-00-C-RD-301 – Proposed Water Supply [Potable] Infrastructure, Indicative Layout, issue 1A, 01/11/2017 and drawing 253251-00-C-RD-303 – Proposed Water Supply [Non-Potable] Infrastructure, Indicative Layout, issue 1A, 01/11/2017).

It is noted that the high-level reference designs for all proposed water supply infrastructure have been developed to a 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.

7.1.5.2.1 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 7.1.4.3.1.

The additional storage capacity required for each stage of the development is summarised in Table 7-8.

Table 7-8: 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 (Proposed Water Supply [Potable] Infrastructure, Indicative Layout, Issue 1A, 01/11/2017 – Appendix 2A). 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.

7.1.5.2.2 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 (Proposed Water Supply [Potable] Infrastructure, Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A).

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.

7.1.5.2.3 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 (Proposed Water Supply [Potable] Infrastructure, Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A). 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.

7.1.5.2.4 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 (Proposed Water Supply [Non-Potable] Infrastructure, Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A).

7.1.5.2.5 Groundwater treatment plant

The 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 (Proposed Wastewater Treatment Plant and Groundwater Treatment Plant, General Arrangement, Issue 1B, 22/11/2017 – refer to Appendix 2A) and 253251-00-C-RD-353 (Proposed Groundwater Treatment Plant, Piping and Instrumentation Diagram, Issue 1B, 4/09/2017 – refer to Appendix 2A).

The GWTP has been designed with a maximum capacity of 1.2ML/day. As shown in the block flow diagram in Figure 7-13, 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 also be used to service the actuated valves
- sodium hypochlorite for oxidation and disinfection
- recycled water storage tank
- waste storage and/or disposal.

Figure 7-13: GWTP Block Flow Diagram

Filter backwash water generated by the proposed GWTP will be pumped to the proposed co-located wastewater treatment plant for treatment. During stage 1A (prior to commissioning of the wastewater treatment plant), backwash water from the GWTP will be utilised to supplement the construction phase non-potable demand for uses such as dust suppression, with any surplus backwash water tankered off-site for disposal at an approved regulated facility.

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.

7.1.5.2.6 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 0. The high level reference design for the proposed WWTP is provided in the drawings 253251-00-C-RD-351 (Proposed Wastewater Treatment Plant and Groundwater Treatment Plant, General Arrangement, Issue 1B, 22/11/2017 – refer to Appendix 2A), and 253251-00-C-RD-352 (Proposed Wastewater Treatment Plant, Piping and Instrumentation Diagram, Issue 1B, 4/-9/2017 – refer to Appendix 2A).

7.1.5.2.7 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 7-9.

Table 7-9: 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

7.1.5.2.8 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 drawing 253251-00-C-RD-303 (Proposed Water Supply [Non-Potable] Infrastructure, Issue 1A, 01/11/2017 – refer to Appendix 2A). 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.

7.1.5.3 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 7-10 describes the water supply infrastructure to be constructed, and the operational water supply at each proposed development stage.

Table 7-10: 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 • 1.6ML 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.

7.1.5.4 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.

7.1.6 Wastewater infrastructure

7.1.6.1 Existing wastewater infrastructure

7.1.6.1.1 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, and KUR-Cow facilities.

There is no existing connection to MSC's wastewater network at the site.

7.1.6.1.2 Mareeba Shire Council (MSC) wastewater infrastructure

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

The map in Figure 7-14, 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 many gravity sewers, around 15 sewage pump stations and rising mains discharging to the STP.

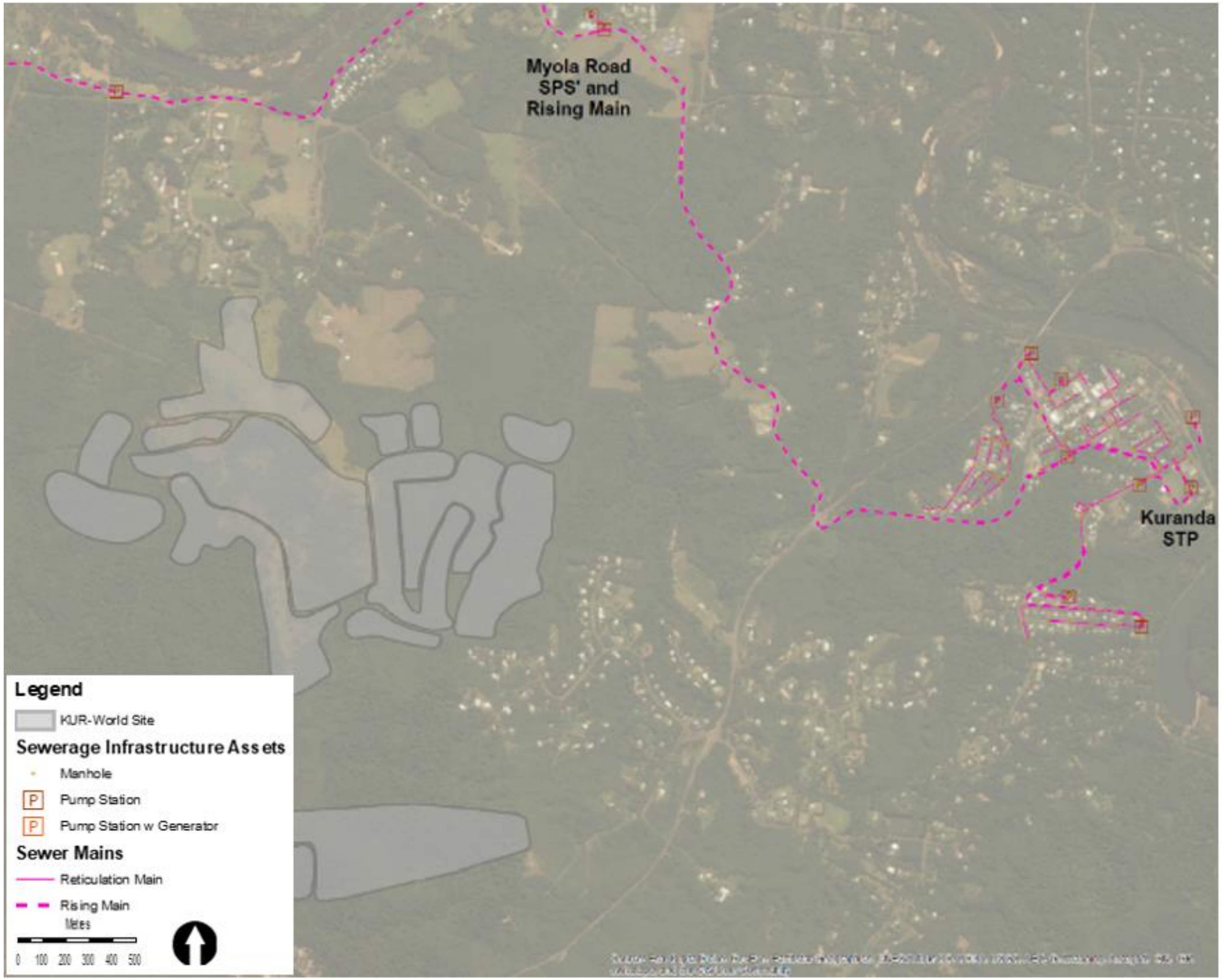


Figure 7-14: Key features of existing MSC water network in vicinity of KUR-World

7.1.6.1.2.1 *Existing Kuranda Wastewater Treatment Plant*

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 7.1.6.2.3). Table 7-11 summarises the results.

As shown in Table 7-11, 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. Refer to Section 7.1.6.2 for further details.

Table 7-11: 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 7.1.6.2.3) to the existing load

7.1.6.1.2.2 *Existing Kuranda wastewater network*

As indicated in Figure 7-14 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.

7.1.6.2 Proposed wastewater infrastructure

The proposed wastewater infrastructure for KUR-World includes:

- 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, 01/11/2017 (refer to Appendix 2A).

The high-level reference designs for all proposed wastewater infrastructure have been developed to a 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.

7.1.6.2.1 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
- 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 7.1.6.3.2 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 by the owners of the individual lots 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. The common effluent drainage system will be constructed and operated by the proponent as part the site-wide wastewater infrastructure scheme.

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) & Appendix 4A). The methods and results of effluent modelling are further described in Chapter 9, Water Quality.

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.

7.1.6.2.2 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 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.

7.1.6.2.3 Onsite Wastewater Treatment Plant (WWTP)

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 (Proposed Wastewater Treatment Plant and Groundwater Treatment Plant, General Arrangement, Issue 1B, 22/11/2017 – refer to Appendix 2A) and 253251-00-C-RD-352 (Proposed Wastewater Treatment Plant, Piping and Instrumentation Diagram, Issue 1B, 4/9/2017 – refer to Appendix 2A), with further details on the basis of design provided in the *KUR-World Water and Wastewater Infrastructure Technical Report* (refer to Appendix 4B).

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.

As shown in the block flow diagram in Figure 7-15, the proposed WWTP includes the following main process components:

- 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.

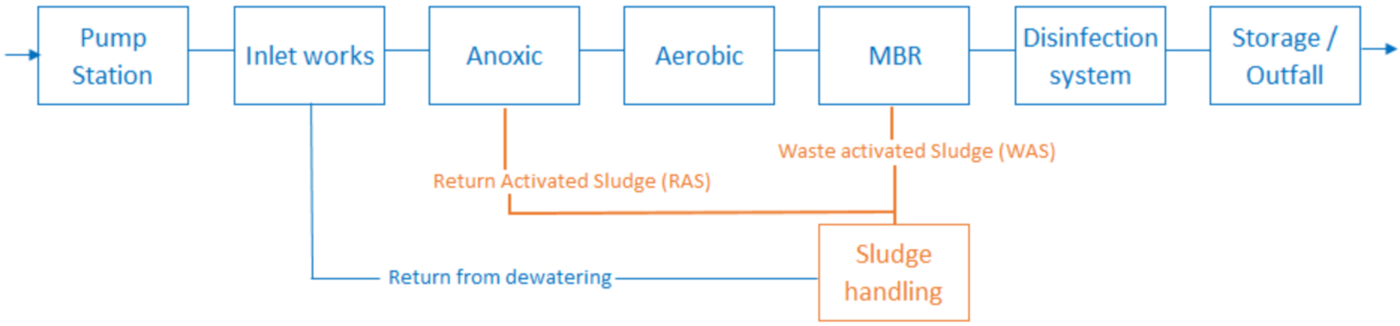


Figure 7-15: WWTP Block Flow Diagram

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.

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

7.1.6.3.1 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 following sections.

7.1.6.3.1.1 *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 7-12.

Table 7-12: 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

7.1.6.3.1.2 *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 Chapter 9, Water Quality. Selected WQOs for parameters relevant to the effluent water quality were developed with reference to ecological requirements and are summarised in Table 7-13.

Table 7-13: 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

Parameter	Units	Water quality objectives for relevant environmental values
		Aquatic ecosystems
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 7-13, and instead typical best practice values for advanced WWTP effluent have been adopted, as listed in Table 7-14. 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.

7.1.6.3.1.3 *Adopted effluent water quality criteria*

Table 7-14 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 7-14: Target WWTP Effluent Quality

Parameter	Unit	95th Percentile limit
pH	pH	6.0 – 8.0
Biochemical Oxygen Demand (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 7.1.6.3.3.

7.1.6.3.2 Onsite effluent storage and re-use

As described in Section 7.1.5.2.8, 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:

1) irrigation to all potentially irrigable areas, at the maximum rate possible without exceeding the soil plant system capacity and contributing to excess run-off
2) discharge to the onsite farm dam or any of the various creeks within the site
3) 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) & Appendix 4A).

Areas potentially suitable for irrigation in this manner were mapped by NRA based on appropriate land-use and slope (<20%), as shown in

Figure 7-16:, 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 (e.g. buffer set back of 10m).
- 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.

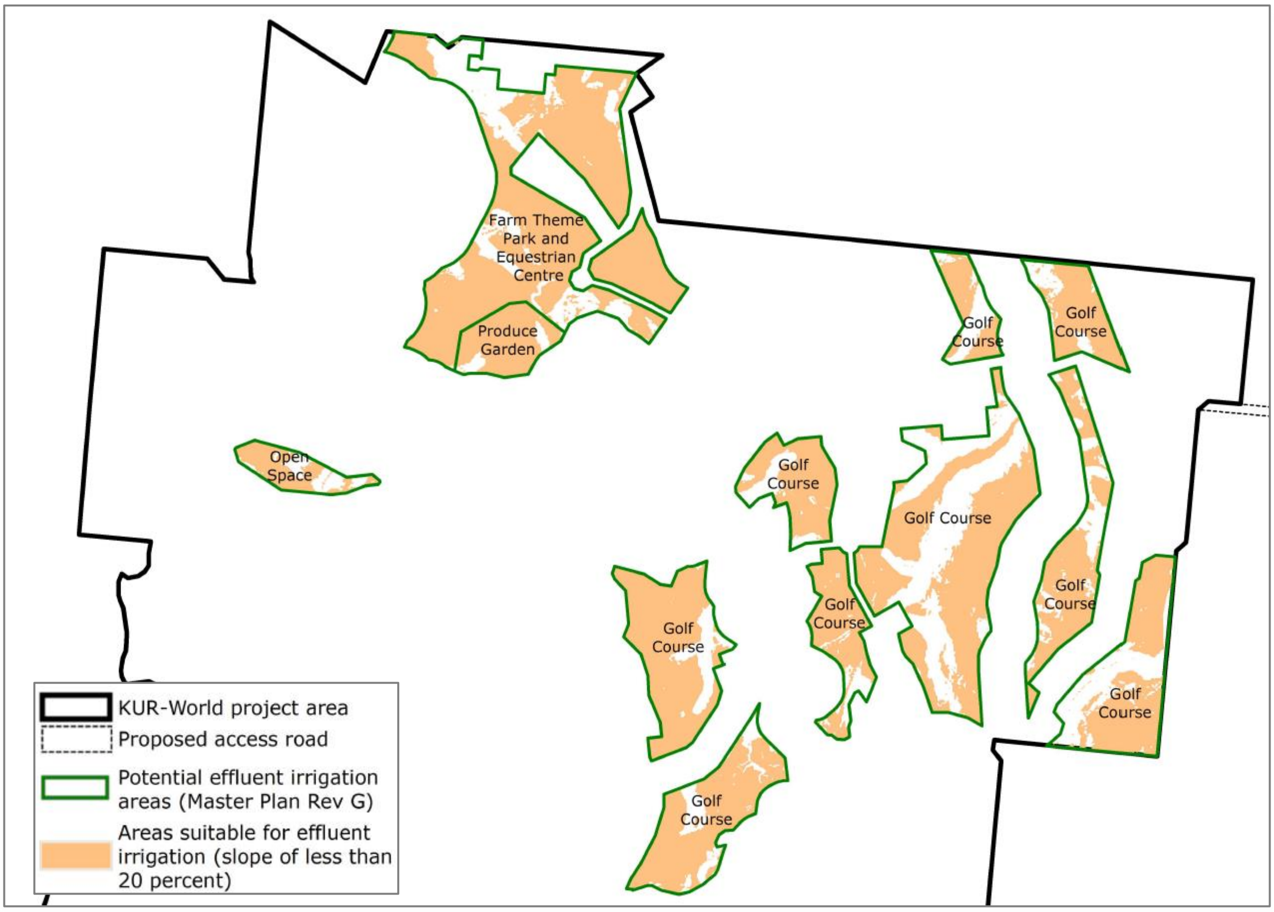


Figure 7-16: Suitable areas for irrigation of surplus effluent

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, and summarised in Chapter 9 Water Quality Chapter. 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.

7.1.6.3.3 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 Effluent Outfall Options Indicative Layout, Issue 1A, 01/11/2017 – refer to Appendix 2A):

- ***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 (2017a) 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 2017c),* 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 a 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 costliest 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, 01/11/2017 (refer to Appendix 2A).

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 7.1.6.3.2 are implemented. An irrigation management plan will 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.

7.1.6.4 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 7-15 describes the wastewater infrastructure to be constructed, and the operational water supply at each proposed development stage.

Table 7-15: 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 7.1.6.3). The effluent discharge location will be confirmed in subsequent design stages.

KUR-World Development Stage	Proposed Wastewater Infrastructure to be Constructed	Description of Operational Water Supply
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.

7.1.6.5 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.

7.1.7 Conclusions

This section 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 2A as water and wastewater infrastructure master plan drawings.

Further details on the analysis undertaken to inform the strategy and reference design for the proposed water and wastewater infrastructure presented in this chapter can be found in the *KUR-World Water and Wastewater Infrastructure Technical Report* (Appendix 4B).

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7.2 Energy Supply

7.2.1 Introduction

This section describes the energy requirements for KUR-World and addresses the terms of reference that relate to Energy Infrastructure. As a summary, this chapter addresses the following:

- energy requirements and energy supply
- transmission and distribution infrastructure requirements
- power generation opportunities
- renewable technologies
- energy efficiency.

A key consideration in the development of the energy strategy for the site is the ongoing long-term performance and environmental impact of the proposed project, and the need for a robust and resilient design. The proposed development contains a number land uses including residential lots (Villas and Queenslander Lots), Farm Theme Park and Equestrian Centre, Golf Course, Business Centre, Five-star Eco-Resort, Health and Wellbeing Retreat, and a University Campus.

This chapter aims to identify the energy requirements for the proposed project and potential impacts on the environment, by estimating site demand and consumption for all the relevant land uses. Initiatives are proposed to reduce environmental impacts, along with design measures that promote operational performance and efficiency, as well as improve resiliency.

7.2.2 Relevant legislation, policy and guidance

A range of legislation, policy and guidance is applicable to the provision of energy infrastructure for the proposed project, including but not limited to the following:

- The *Electricity Act 1994* and *Electricity Regulation 2006* – these are the primary instruments governing Queensland's electricity supply industry which establish Ergon as a Distribution Authority and are the basis for establishing Ergon's contractual relationships with retailers and customers
- *Electrical Safety Act 2002* and *Electrical Safety Regulation 2013*
- Energy Queensland – Queensland Electricity Connection and Metering Manual
- National Electricity Rules that govern the connection process
- National Construction Code, in particular Section J relating to energy efficiency
- Relevant local standards and requirements (Mareeba Shire Council)
- Relevant Australian Standards (including but not limited to):
  - AS5601 – Reticulation of gas piping
  - AS1596 - Storage and Handling of LPG gas.

In addition to the requirements listed above, the project is targeting EnviroDevelopment certification. EnviroDevelopment is a certification scheme for developments that achieve outstanding performance across a range of elements, of which energy is one. For more information on the tool, refer to Section 7.2.5.

7.2.3 Existing energy supply

The electrical network currently servicing the development site is named the 'Kuranda Range' network and is an asset of Ergon Energy. This network is supplied by a substation located in Kamerunga (approximately 7 kilometres southeast of Kuranda), and enters the site from Boyles road to the west of the site. This network is fed from a 22 kilo-volt (kV) substation, and discussions with Ergon concluded that there is approximately 3 Mega Volt-Ampere (MVA) of spare capacity on this network.

Another Ergon electrical network named 'Kuranda' passes within proximity to the development site, though from the east, and is fed by a substation located in Mareeba, approximately 30 kilometres south west of Kuranda. Information obtained from Ergon indicates that this grid contains a secure capacity of 31 Mega Volt Amps (MVA) through the 22-kilovolt substation. The Mareeba substation was subject to a peak load of 19MVA last year, indicating a capacity excess of 12MVA. Although preceding years have seen capacities even larger at 24MVA, indicating only approximately 7MVA capacity excess.

The electrical demand of the existing homestead on the development site is minor. There is a single-phase power feed that is utilised for farming tools, electric fencing and for the KUR-Cow operation.

To meet the substantial energy load attributed to KUR-World, it is proposed that a combination of Kuranda Range and Kuranda networks would be utilised. The exact configuration will ultimately depend on a detailed loads analysis and further input from Ergon, who have been engaged to provide further advice.

Figure 7-17 provides a layout of the two electrical networks described above:

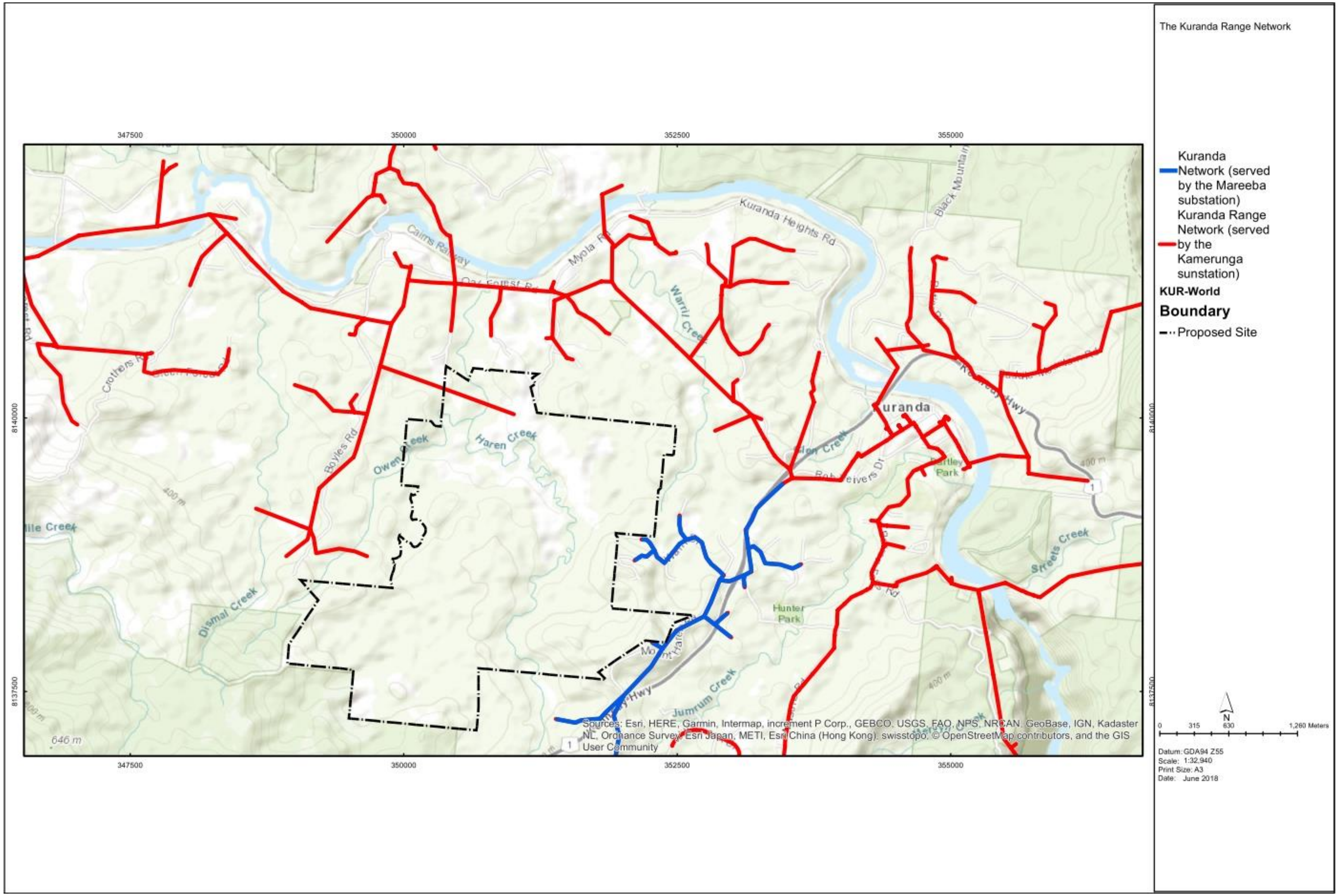

Figure 7-17: Kuranda range network

7.2.3.1 Climate conditions

Kuranda is a tropical environment that is warm and humid all year. The following graphs were developed based on statistical climate data from Cairns, approximately 25 kilometres away (the nearest Bureau of Meteorology observation station to the site). As indicated in Figure 7-18, the annual average temperature does not vary a great deal, as shown by the blue bar.

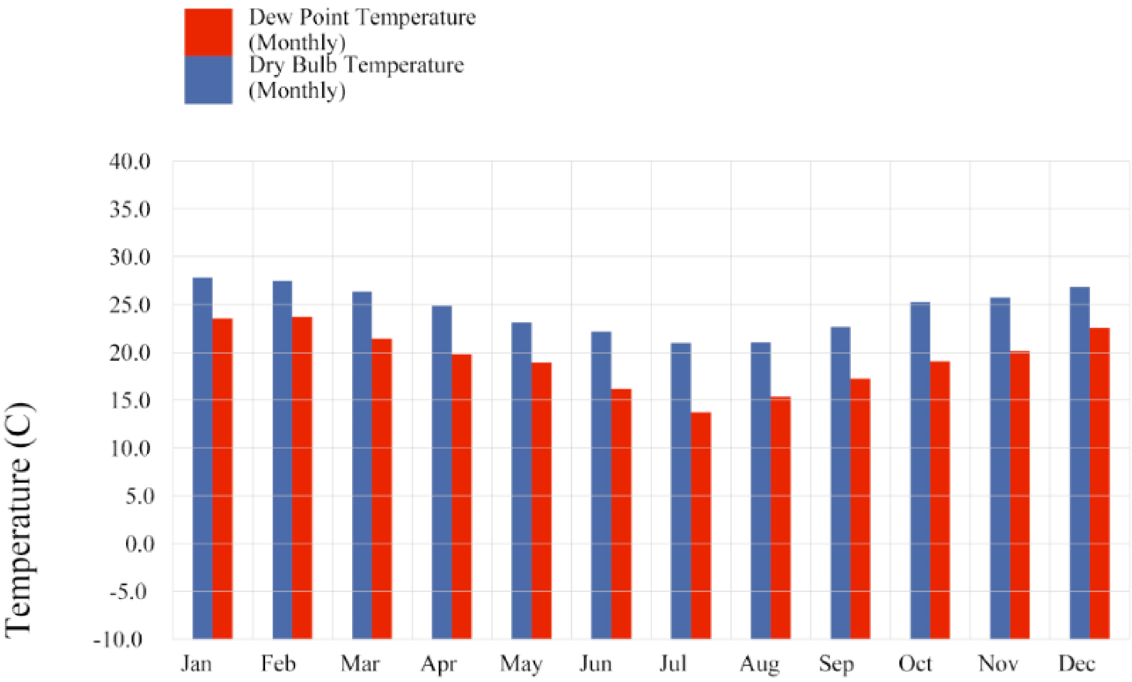

Figure 7-18: Annual average dry bulb and dewpoint temperatures

Figure 7-19 below shows the average cloud cover per month, where it is observed that the average monthly cloud cover remains less than 8% per month throughout the year. The wetter seasons (November to February) have higher levels of cloud.

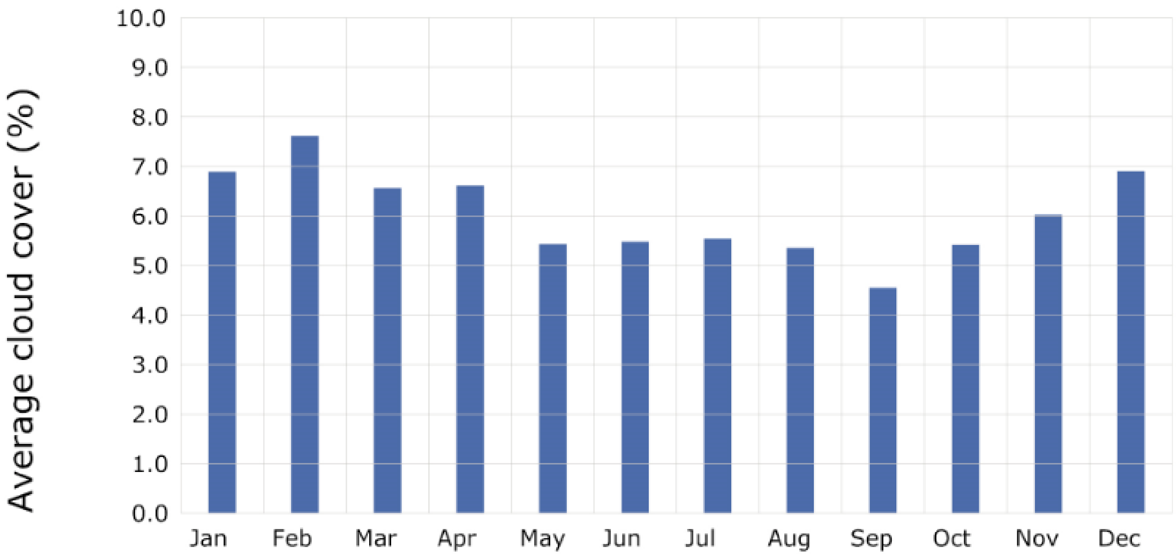

Figure 7-19: Monthly cloud cover averages

The wind profile at the Cairns observation station is displayed in Figure 7-20. Winds are generally prevalent from the south to south east direction, with an annual average ground level wind speed of 4.2 metres per second. Cairns was the closest available location for meteorological data for the wind speed. The specific wind profile for the development site may differ from this figure however, as the Kuranda region is 30km away. The general trend of a dominant southerly profile is expected to remain. The wind rose is particularly useful to assess natural ventilation strategies and building orientation.

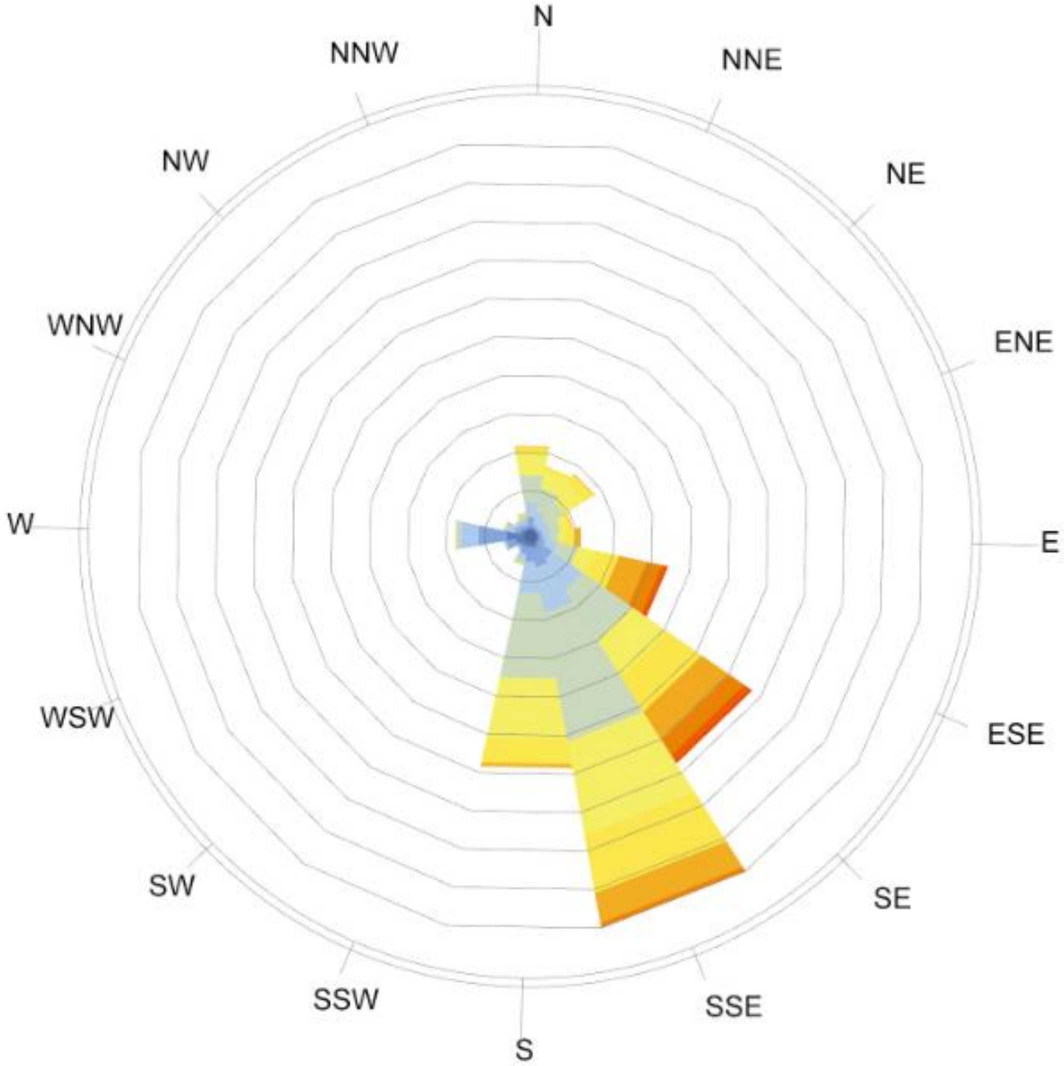

Figure 7-20: Wind rose profile (Cairns observation station)

The proposed project will require year-round cooling to its facilities to ensure visitors are comfortable. There is expected to be minimal space heating requirements, however heating energy will be necessary for hot water purposes. Energy conservation measures have been identified on the basis that the indoor conditioning systems will be cooling-dominated.

7.2.4 Predicted demand

7.2.4.1 Load demand during construction

Throughout the construction stages, electricity will be required to provide power for minor loads at night and significant loads during daytime. The construction stages largest load consumers will include compressors, fans, cranes, vehicles, lighting, hand tools among others.

It is anticipated that the largest loads of construction will occur during the construction of Stage 3, at which stage the main power line to site would be constructed. A preliminary loads analysis has been performed conservatively for each of the stages and is shown in Figure 7-21.

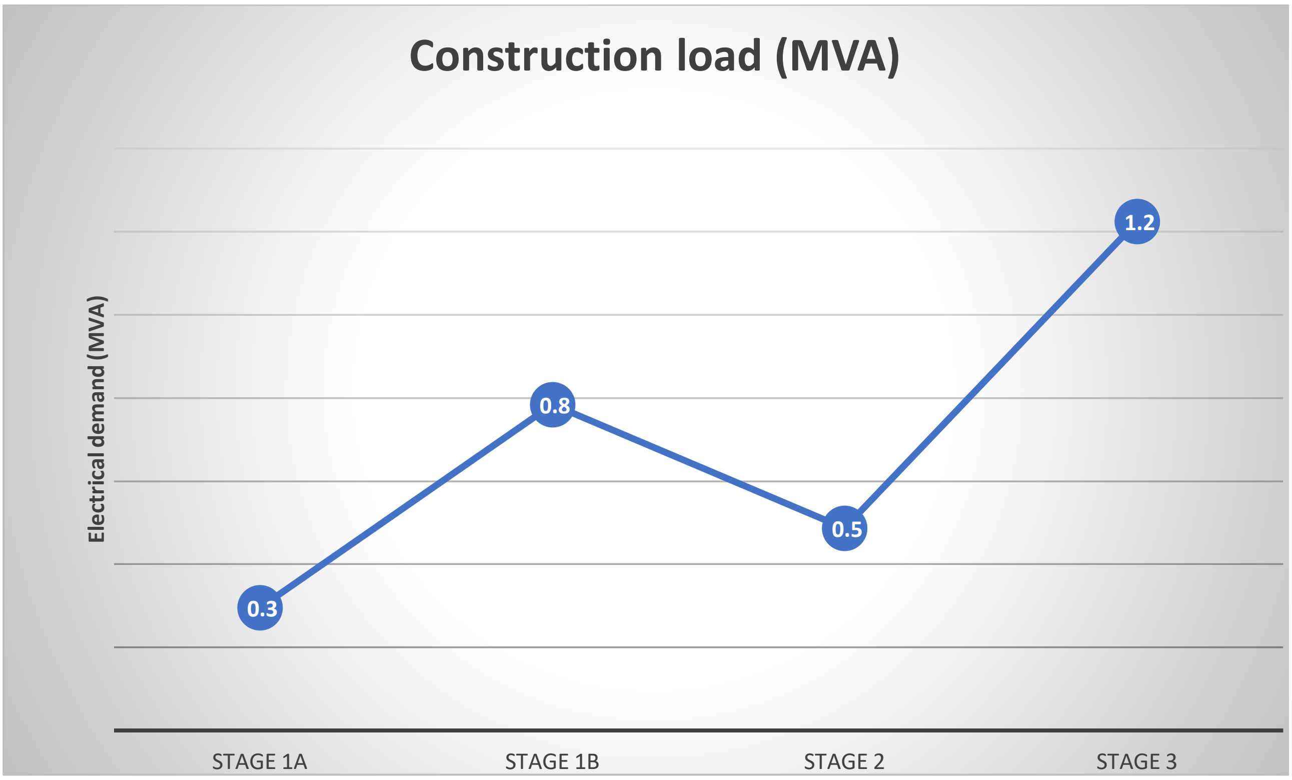

Figure 7-21: Construction stage loads

As the contractor is not yet appointed and the construction methodology is not fully defined, the calculation of construction stage loads has been estimated conservatively using historic data and will require amending once a construction methodology is developed. It is the intent that the majority of construction works would be undertaken by use of generators to provide power, and excavation and other digging and building works through petrol driven engines.

It is proposed that during periods of high demand during the construction phase, diesel generators will be utilised in a dual-mode arrangement operating synchronous with the mains power substation feed such that the total load is met. During periods of low load, the Kuranda network supplying the site power would be sufficient.

It is expected based on initial investigations and discussion with Ergon that any upgrade of substations or transmission infrastructure would be accommodated within existing power easements, to prevent environmental impacts that could arise from new infrastructure networks.

7.2.4.2 Load demand during operation

A preliminary loads analysis has been performed based on the gross floor areas (GFA's) provided in the masterplan layouts provided by Coburn Architects, Revision G, September 2017. It is estimated that upon site completion there will be a peak electrical demand of 7.6MVA. This load estimate includes all the buildings of the site once completed and in operation. Additionally, this load includes the electrical services required for construction within each of the stages. For example, the loads shown for stage 2, includes the construction loads attributed to constructing stage 3.

Specifically incorporated into the loads analysis is an estimate of all lighting, heating, ventilation and air conditioning (HVAC), computers, and equipment for each of the buildings. For this assessment, minimal diversity has been included, this will be accounted for in the next design stage. Figure 7-22 represents the estimated load demand for each stage of the proposed project.

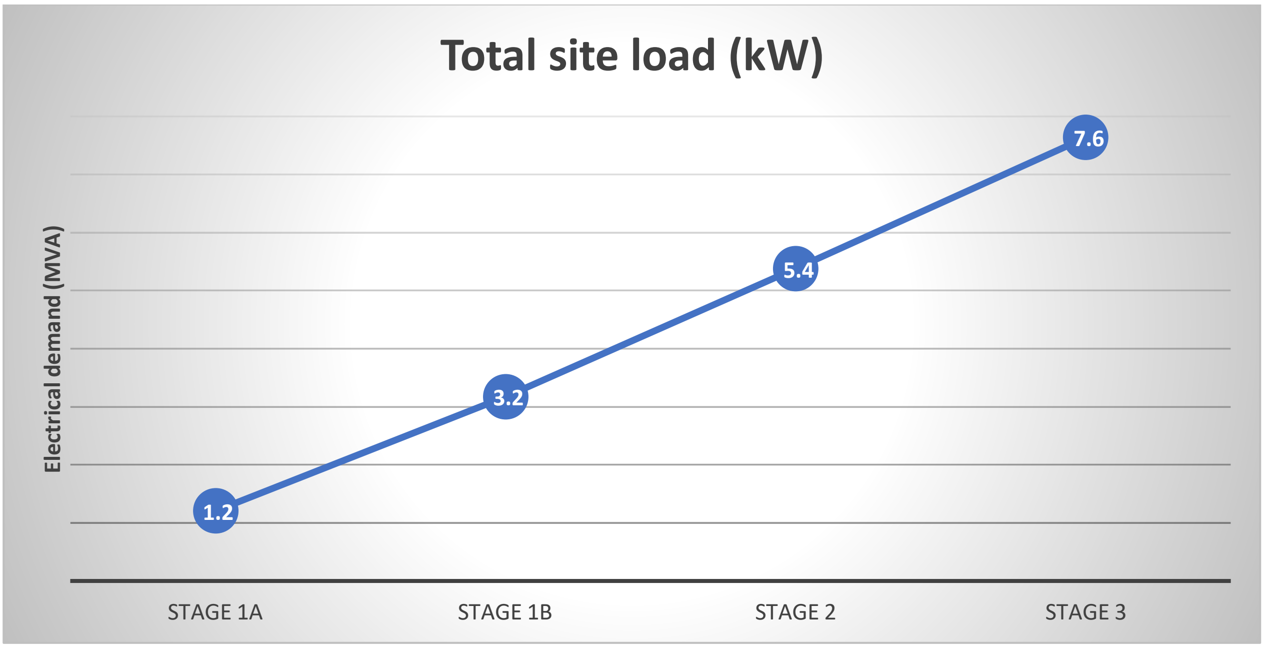

Figure 7-22: Staged breakdown of electrical demand

Table 7-16 below provides the breakdown for each precinct and stage, with their peak load estimates.

Table 7-16: Electrical peak load summary breakdown for stage and precinct

Stage	Precinct	Load Estimate (kVA)	Approx. Stage GFA
Stage 1a	Farm Theme Park and Equestrian Centre	356	14,457
	Queenslander Lots	63	
	Infrastructure services	2	
Stage 1b	Kur-Village & Business & Leisure Hotel & Function Centre	1,383	51,245
	Lifestyle Villas	168	
	Rainforest Education Centre and Adventure Park	264	
	Queenslander Lots	117	

Stage	Precinct	Load Estimate (kVA)	Approx. Stage GFA
	Infrastructure services	6	
Stage 2	Golf Clubhouse and Function Centre	492	21,645
	Sporting Precinct	152	
	Premium Villas	180	
	Hotel	630	
	Infrastructure services	5	
Stage 3	Health and Wellbeing Retreat	333	74,726
	Premium Villas	279	
	KUR-World University Campus	2,229	
	Five Star Eco-Resort	643	
	Infrastructure services	1	

7.2.5 Proposed energy supply strategy

7.2.5.1 Energy overview

Many factors have been considered in developing the energy supply strategy for the site, including:

- grid constraints and sensitivities as provided by the power authority
- capital expenditure capacity (including possible funding available for renewable energy)
- overall ecological values and desirable amount of renewable penetration and emission targets
- long-term economic considerations (for example, the value of carbon, cost inflation of grid electricity, cost of diesel)
- changes to the current design scheme (for example, the impact of different peak loads and loading profiles)
- development staging
- potential environmental impacts of developing new energy infrastructure such as land requirements and vegetation clearing.

Onsite renewable energy generation technologies have potential to minimise the stress on the existing grid, reduce peak load tariffs and save on emissions and costs long term. On site generation will also increase the proposed projects resilience while strengthening its ecological value.

The following sections describe the renewable energy strategies considered for the site, including advantages, disadvantages and feasibility for KUR-World. In summary, wind, solar and waste-to-energy were considered as possible energy supply options. Solar has been identified as the preferred solution, in combination with energy supply from the two surrounding networks, as described further in Section 7.2.5.1.2.

7.2.5.1.1 *Wind*

Wind power has been considered as an option for energy generation at the site. Renewable power generation from wind energy is a technology that has advanced significantly in recent years. Wind power generators are available in many capacities and sizes, and are now manufactured specifically to operate in unique locations, such as high temperatures and/or erratic wind.

- Wind power has the following advantages:
- renewable resource not reliant on fuel supply
- reduced stress on electrical infrastructure supply network
- complements solar PV output
- medium to short term payback period.

Wind power has the following limitations:

- cyclone resistant design or insurance needed
- significant land space requirements
- aesthetics and sound pollution
- specialist knowledge for operation and maintenance
- upfront cost.

Wind turbines are manufactured in a vast range of sizes, but in order to obtain power to match the scale of demand required for KUR-World, mid to utility scale turbines would be required. Utility scale turbines (> one megawatt) are more economical than smaller turbines as they produce much more power relative to the cost increase of their size. However, there are several challenges associated with these turbines such as transportation and installation of large pieces of equipment to the remote location in Kuranda.

Mid-scale turbines are easier to transport as well as construct, however more machines may be required, and costs of energy yield is higher, implying a longer payback period.

Typical wind speed conditions for the Kuranda district have been reviewed. Utilising a NASA dataset, it was determined that the average wind speed at 50 metre elevation was 7.03 metres per second (see Figure 7-23). This corresponds to a Class 4 Wind Power Resource, shown in Table 7-17 below. It is generally seen in practice that Classes 4 or higher are economically feasible.

Table 7-17: Wind power classifications

	10m height		50m height	
Wind Power Class	**Wind Speed (m/s)**	**Power Density (W/m^2)**	**Wind Speed (m/s)**	**Power Density (W/m^2)**
1	0 – 4.4	0 – 100	0 – 5.6	0 – 200
2	4.4 – 5.1	100 -150	5.6 – 6.4	200 – 300
3	5.1 – 5.6	150 – 200	6.4 – 7.0	300 – 400
4	5.6 – 6.0	200 – 250	7.0 – 7.5	400 – 500
5	6.0 – 6.4	250 – 300	7.5 – 8.0	500 – 600
6	6.4 – 7.0	300 – 400	8.0 – 8.8	600 – 800
7	7.0 – 9.4	400 - 1000	8.8 – 11.9	800 – 2000

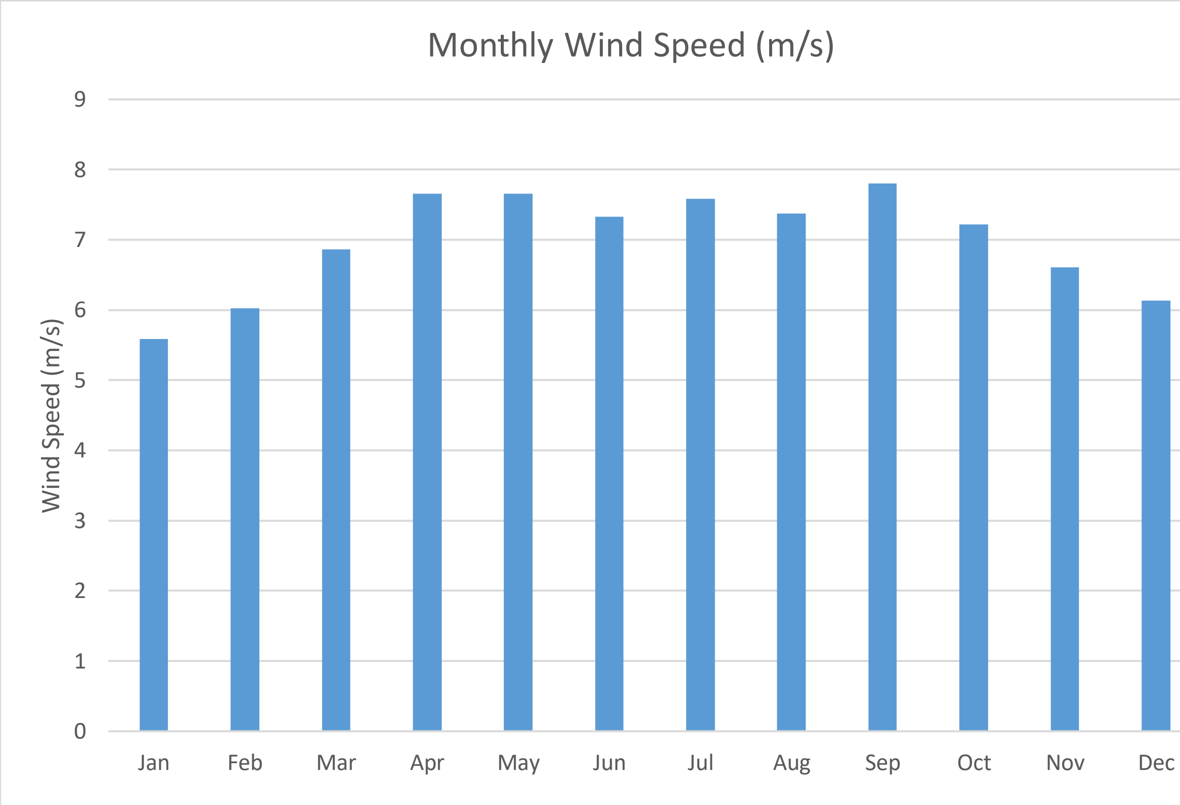

Figure 7-23: NASA Wind Speed incident in the region at 50m above sea level

The review of wind power for the proposed development has identified that although the site may classify as a Class 4 Wind Power Resource (subject to further confirmation based on site-specific data), the limitations to the delivery of wind power for the site mean that it is not currently proposed as part of the energy supply strategy. Further investigation including collection of site-specific wind data would be required in future design stages if wind power generation were to be included in the design.

7.2.5.1.2 Solar

Photovoltaic (PV) panels are an array of cells that convert solar radiation into direct current electricity. The technology is well developed and widely available, with the costs of PV generation now cheaper than thermal coal.

PV can be fitted to most types of roof or can be standalone. Advancements in the technology now allows for PV to be incorporated within the window, roof and façade constructions.

PV offers electricity generation with zero carbon dioxide emissions.

Other advantages of PV electricity generation include:

- reasonable payback periods (typically 6-10 years)
- feed-in tariffs often negotiable with local power authority
- option of “behind the metre” for smaller payback period
- minimal maintenance (cleaning panels every few months).

The limitations of PV electricity generation include a relatively high capital cost, although its warrantee period is often upwards of 25 years, requiring little maintenance. Utility prices are increasing each year which makes PV a more favourable technology.

Solar electricity is not available at night and its efficiency is reduced in cloudy weather conditions and during the winter seasons, so a grid supply or a battery power storage system may be required depending on the building operation. The hybrid panels give a higher output in cloudy weather but are more expensive to install.

To maintain an optimal efficiency, the panels should be kept clean of dust. The frequency of cleaning will depend on the local site environment. Other considerations for inclusion of PV in the design include:

- impact of PV on building structures
- additional clearing if larger scale PV were required

The design would require an inverter to convert the direct current (DC) to useful alternating current (AC). A supplemental grid supply would also be needed to provide the top up electrical load. North facing roof spaces give optimum efficiency and angle optimisation with shade prevention potential for traditional panels, however new technologies can be placed in multiple orientations.

It is estimated that the payback period for the investment in solar power will be between six to ten years, depending upon several aspects such as the configuration to grid and cost of electricity. The ideal configuration is "behind the meter", such that all solar energy can be utilised, as oppose to exporting to the grid.

The current design proposes to include a substantial amount of solar PV across the many rooftops of each precinct. The following table presents the proposed amount of solar installed across each stage:

Table 7-18: Proposed solar power

Stage	Proposed Installed Solar PV capacity per stage (kWp)
Stage 1a	248
Stage 1b	485
Stage 2	367
Stage 3	521

The proposed solar strategy includes:

- 20% of precinct rooftops to include Solar PV if practical
- each Villa to include a 4kWp Solar system if practical.

It should be noted that the current architectural plans are lacking the necessary detail in terms of building massing's, height and rooftop areas to provide a more robust analysis on the solar locations and feasibility. As the design progresses, the proposed capacities in the above table are expected to change, however the target of a total precinct rooftop area of 20% will remain.

In addition to the 4kWp systems provided for each Villa, an electrical battery storage system is proposed for the Villas. The batteries will reduce the load demand on the network and increase the electrical resiliency of the Villas and Queenslander Lots. The batteries would be charged by solar each day, typically when most occupants are not home to use power. The solar energy is then used throughout the night as each the Villa is occupied. This offset in energy usage will provide significant costs savings to the project, as the Villas and Queenslander Lots will use considerably less grid power, especially at peak times in the evening.

Conservatively assuming no diversity in the overall development's load, approximately 20% of the project's peak load could be met by solar energy. This would provide the proposed project with an annual energy usage that comprises approximately 10% renewable energy, resulting in a greenhouse gas emission savings of approximately 3,000 Tonnes per annum.

7.2.5.1.3 Waste to energy

A centralised anaerobic digester (waste to energy plant) has been considered for the site as part of the overall sustainability strategy for the development. Any non-recyclable site waste along with the on-site algae, black water, and organic waste from vegetation could be fed into the anaerobic digester. Biogas from the digester can then be burned in the co-generation engine along with other fuels as required such as natural gas. The other output of the digester is a low odour pathogen free fertiliser which could be used for the landscaping on site.

Many anaerobic digestion technologies are commercially available and have been demonstrated for use with agricultural wastes and for treating municipal and industrial wastewater. Figure 7-24 below depicts the anaerobic digestion process.

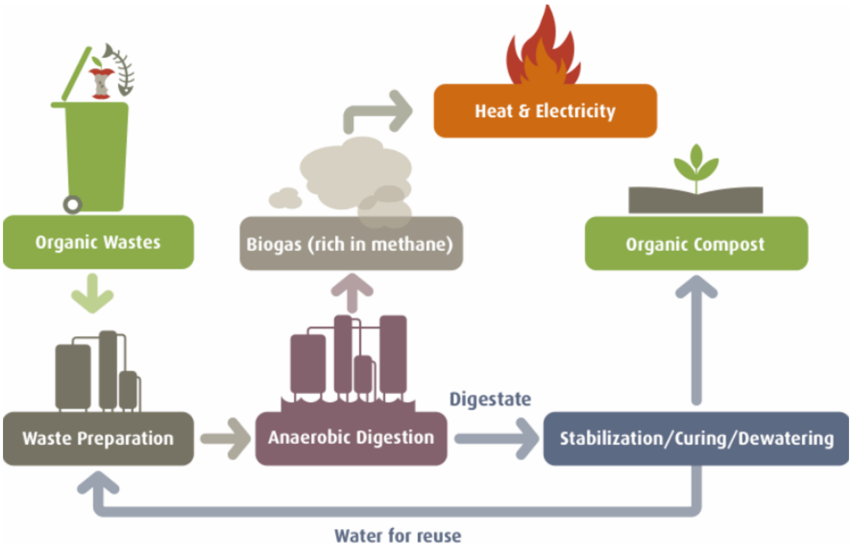

Figure 7-24: Anaerobic digestion process (Image courtesy of IRIS Advanced Engineering)

The advantages of a waste to energy plant include:

- providing a use for onsite organic waste
- renewable energy source
- on-site production of biomass into gas for use in a cogeneration engine
- production of fertiliser for use in on-site landscape/ food production gardens
- there is also an opportunity for input from the local community, with converting waste into biofuels and biomass.

The limitations of a waste to energy plant include:

- maintenance of the system
- set-up costs
- need for steady stream of biomass (waste) input
- plant processing facilities necessary on site and with skilled operators/maintainers.

The critical aspects that relate to the performance and feasibility of an aerobic digester (waste to energy plant) are the requirements for a steady stream of waste and the need for sufficient space to allow for storage volume and plant process equipment.

The utilisation of a centralised waste to energy plant was not included in the final concept design due to the requirements and complexities of managing the many varied waste streams all on site, and the constraints of space and cost. However as described in Chapter 15, Waste Management, small scale self-contained anaerobic digestion systems may be feasible for consideration at a further stage of project design.

7.2.5.2 Proposed energy supply infrastructure and staging

The proposed project holds a number of challenges associated with energy supply. These include a lack of current adequate power on site, and limited excess capacity in the surrounding two grids. However, a feasible concept strategy has been developed which includes utilising the two surrounding networks, along with solar power and battery storage systems for the Queenslander Lots.

Stage 1a, which comprises 21 Queenslander Lots as well as the Farm Theme Park and Equestrian Centre is proposed to be powered by the Kuranda Range network, which has approximately 3MVA excess. This will be implemented through an extension and upgrade of the current supply services along Barnwell Road. Each Lot will also comprise a small solar array and battery store.

Stage 1b will be serviced from the Kuranda Range feed also, which would have enough spare capacity to meet Stage 1a and Stage 1b. The Kuranda Range network is serviced by the Kamerunga substation and Ergon have verbally confirmed capacity to meet Stage 1a and 1b.

Stage 2 will trigger the requirement for additional power, which would come from Mareeba (Kuranda network). Discussions with Ergon are ongoing in regard to how this feed would be constructed and the preferred method of distribution. This will be investigated further and finalised in detailed design stage.

Whether underground or overhead distribution is implemented, existing supply routes will be utilised for this mains connection from Mareeba, predominantly by way of the Kennedy Highway. This will involve new infrastructure for the connection, as a new supply line and support infrastructure will be required for the connection to KUR-World. It is understood that the current supply line from Mareeba is aged, with considerable losses along the transmission route. Ergon Energy have been engaged to provide input as to the specific infrastructure requirements and construction process.

A site incoming substation will be built during the construction of Stage 1a, to the north end of the development. This substation will be fed by the Kuranda Range network high voltage transmission line along Barnwell Road. This will provide a secondary distribution to the demands of Stage 1a and Stage 1b through several smaller pad mount sub stations. These smaller substations are shown notionally in Figure 7-25 through to Figure 7-28, with the precise location, capacity, and amount, to be confirmed in the detailed design stage. Each primary substation and pad-mount substations will be located within easements on the project site. The location of each easement will be approved by the electrical authority. Indicative easements have been shown in blue in Figure 7-25 through to Figure 7-28.

By the completion of Stage 2, the connection from Mareeba will be established. Another substation will be constructed throughout Stage 2, which will take the connection from Mareeba. A number of secondary pad mount substations will step down the voltage again from the site substation to serve the various precinct areas.

Through the construction of Stage 3, further pad-mounts will be built. These will provide the final electrical supply for the Stage 3 buildings. It is also proposed that a number of the Lots of Stage 3 will utilise the existing Kuranda network connection, and this is shown in Figure 7-28.

The two site primary substations are proposed to be assets of Ergon Energy. The first primary substation built to provide electrical power for Stages 1a and 1b is proposed to be in the form of 3 transformers each sized at 1MVA capacity. This substation will be connected to the Kuranda Range electrical network. The land area requirement for this has been shown notionally in Figure 7-25, estimated to be 100 m^2.

The second primary substation built to provide electrical power for Stages 2 and 3 is proposed to be in the form of 3 transformers with 1.5MVA capacities and 1 transformer with a 500kVA capacity. Each transformer would be located within the primary substation shown notionally in Figure 7-27. This substation will be connected to the Kuranda network, serviced by the Mareeba supply route. The land area requirement for this has been shown notionally in Figure 7-27, estimated to be 90 m^2.

Figure 7-25 through to Figure 7-28 depict the energy supply strategy for each stage of the development along with the substation easement locations. These figures are snapshots taken from the set of drawings issued for Energy Infrastructure. Specifically, the drawings are:

- Figure 7-25 - Electrical Supply Stage 1a – 253251-00-C-RD-401
- Figure 7-26- Electrical Supply Stage 1b – 253251-00-C-RD-402
- Figure 7-27- Electrical Supply Stage 2 – 253251-00-C-RD-403
- Figure 7-28- Electrical Supply Stage 2 – 253251-00-C-RD-404

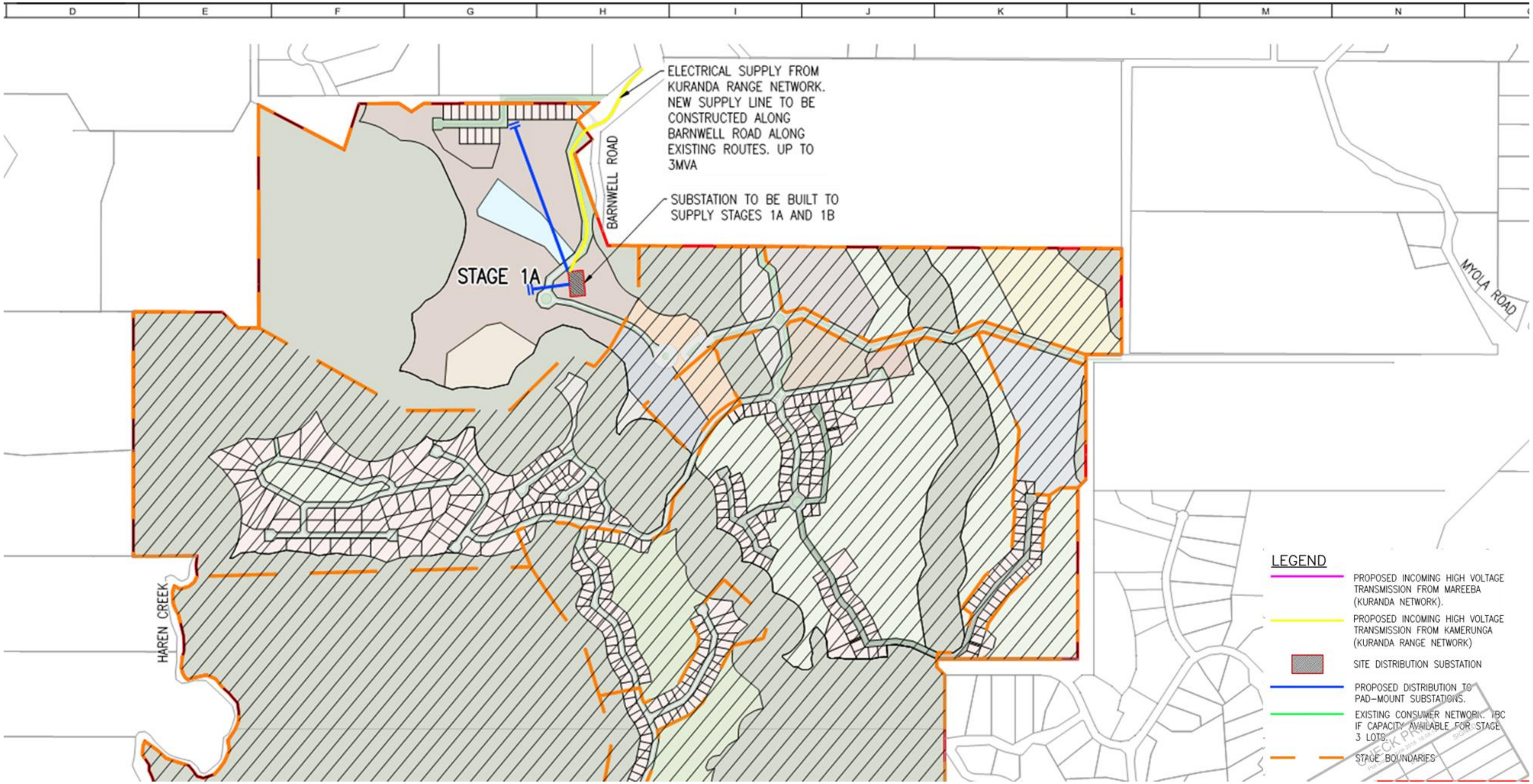

Figure 7-25: Stage 1a energy supply strategy

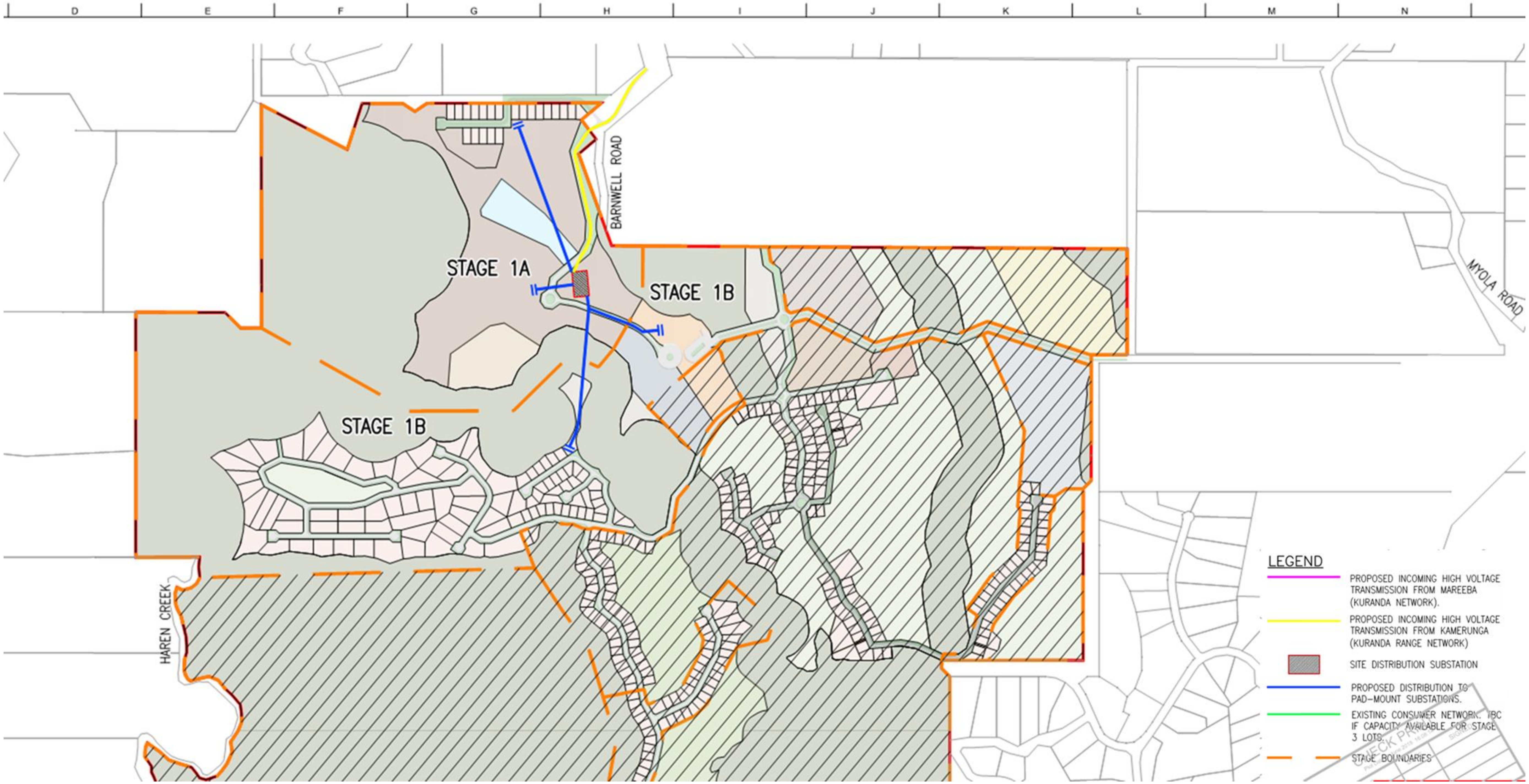

Figure 7-26: Stage 1b energy supply strategy

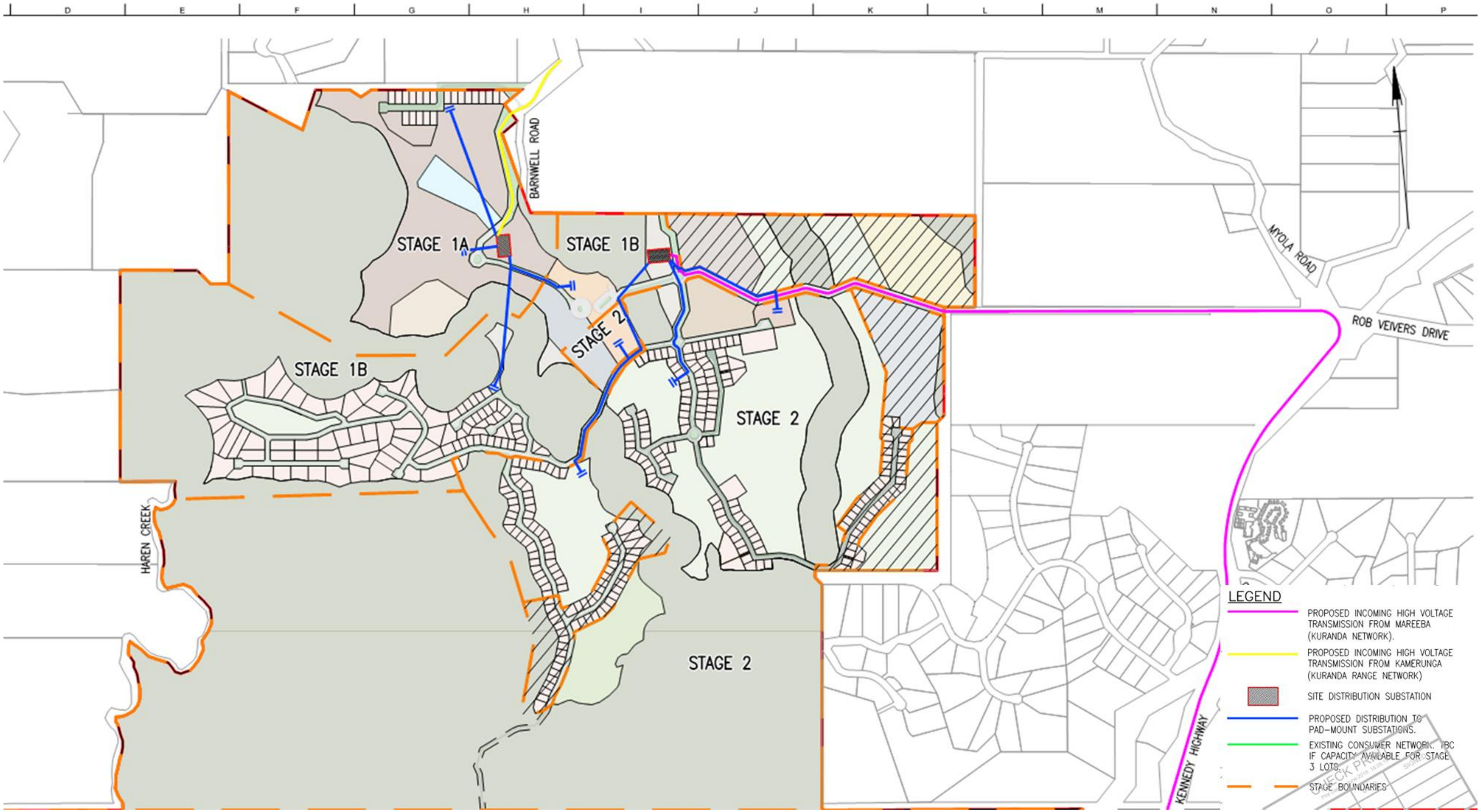

Figure 7-27: Stage 2 energy supply strategy

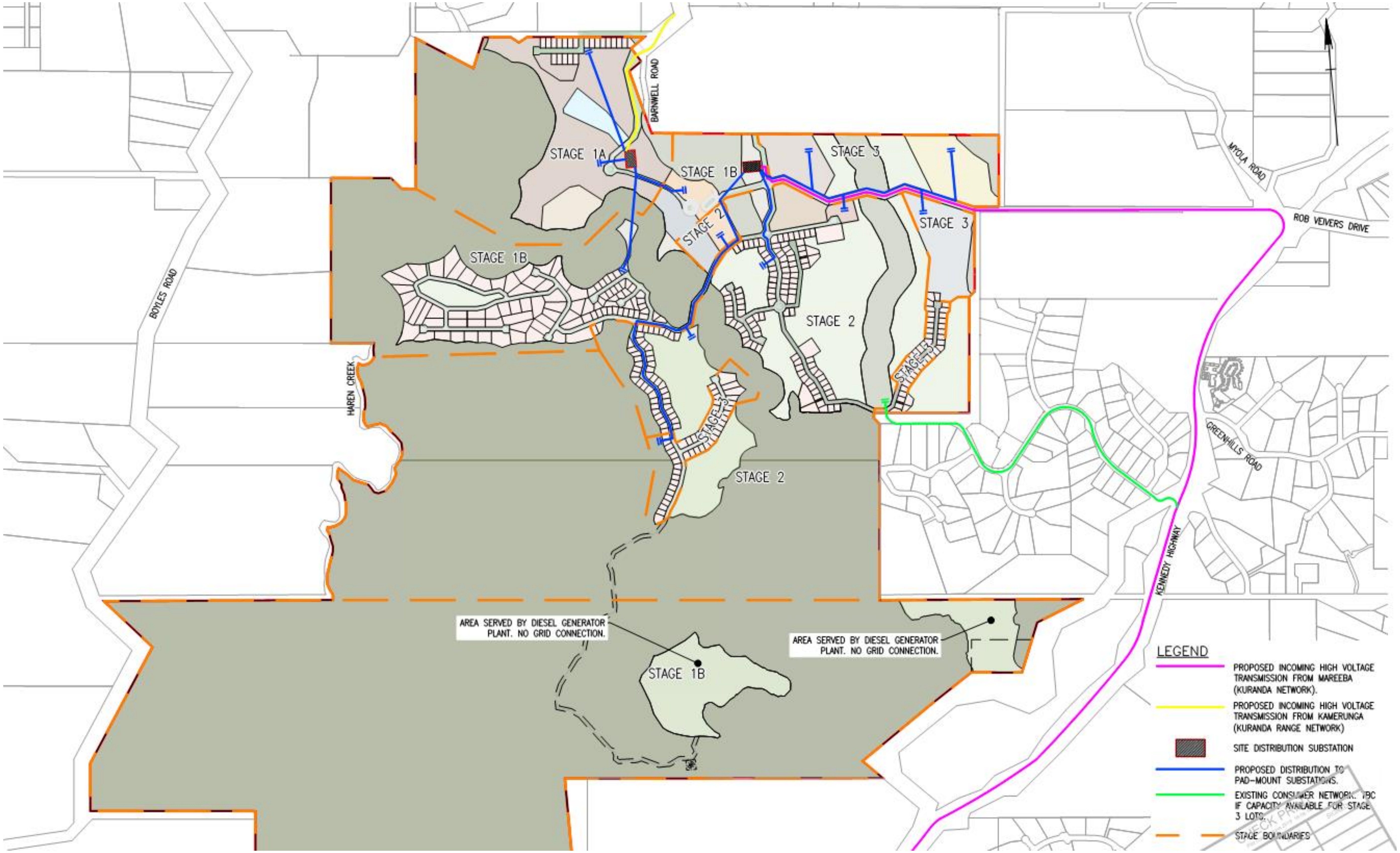

Figure 7-28: Stage 3 energy supply strategy

7.2.5.3 Impact on existing infrastructure

As described in Section 7.2.4, annual energy demands for the completed KUR-World Integrated Eco-resort during operation are estimated to be in excess of 30 gigawatt hours per annum, at a peak of 7.6MVA. This figure is an estimation of all the loads attributed to lighting, air conditioning, general power, cooking and hot water for the various buildings of the proposed project. This annual load profile can be visualised in Appendix 4C – Energy Load Profiles, which displays the annual energy estimate for the development, based on the calculated peak load. The loads analysis accounts for the various and unique characteristic for each of the buildings, including a KUR-World University Campus, residential lots, hotel and restaurants. Each building type is subject to different load types and usage profiles. The complete load estimate breakdown for each space type and building type can be found in Appendix 4C – Space Type Load Profiles.

This predicted load, being conservative, does not account for any reductions that may be attributed to energy efficiency measures, which are discussed in Section 7.2.5.5 . Furthermore, inclusions of renewable power sources or storage will assist in reducing this major load on the existing grid. Issues such as reverse flow will be managed by appropriate controls and equipment. Reverse flow can occur when a large flow of solar power is generated at midday when there is no demand, resulting in a back flow to the substation. One possible solution would be line drop compensation (voltage regulator), however this will be subject to detailed modelling as the design progresses.

It is estimated that Solar PV can meet up to 20% of the total site electrical demand. While solar will greatly reduce impact on the electrical network and carbon emissions, the design and sizing process must consider worst case conditions, where no solar would be available under peak demand conditions, therefore the peak demand of 7.6MVA remains.

For a peak demand up to 7.6MVA, either of the two existing networks do not have sufficient capacity alone. This conclusion is based on the peak loads observed from the Mareeba substation and preliminary discussions held with Ergon. Therefore, as described in Section 7.2.5.2, the strategy for the KUR-World development includes a mix of renewable (solar) supply and a connection from both existing networks.

It is expected that infrastructure and substation upgrades are required. The details of these upgrade requirements will be confirmed as the design progresses, and in consultation with Ergon Energy who have been engaged for the project. Inherently, implications on the local network will exist as these upgrades are required. Negative implications will be managed through the strategic implementation and timing of upgrades to ensure that local community is not adversely affected.

KUR-World will create significant additional demand to the local electrical distribution network. The project will trigger the requirement of improvements and upgrades to the network. Once complete however, these upgrades will provide a benefit to the local community and environment as the current electrical infrastructure in the network is aged and inefficient. The current network sees a high number of call out issues for rectification issues. Additionally, current the network has major losses in the distribution network, putting a strain on the entire grid as more energy is required to distribute the power, resulting in greater carbon emissions.

7.2.5.4 Gas supply

The major gas demands for the precinct will be the restaurants and hot water usage for the Business and Leisure Hotel and Function Centre, the Queenslander Lots and Lifestyle/Premium Villas. Gas will be provided as bottled and replaced with a new canister at specific intervals as agreed with the gas authority.

The gas will be delivered by truck to each building throughout the precinct as per the agreement with the gas authority. The strategy of the site gas supply will remain operationally similar to the existing system used for the residential and commercial properties in the area that do not have a centralised distribution of reticulated gas. It is proposed that one of the existing gas suppliers in the region would be used, which would enable existing infrastructure, delivery equipment and processes to be retained.

7.2.5.5 Proposed energy management approach

7.2.5.5.1 Goals and objectives

The goals of the sustainability and energy strategy for the proposed project are primarily:

1) To be resilient
2) Reduce impact on existing electrical infrastructure
3) To minimise or eliminate use of fossil fuels
4) To provide community benefit.

Most importantly, the energy systems within the proposed project must function reliably and efficiently. The proposed project must have an energy supply both resilient to climate and weather conditions, and also manageable under electrical grid disruptions.

The following diagram shows the hierarchy used in developing the energy strategy for the site:

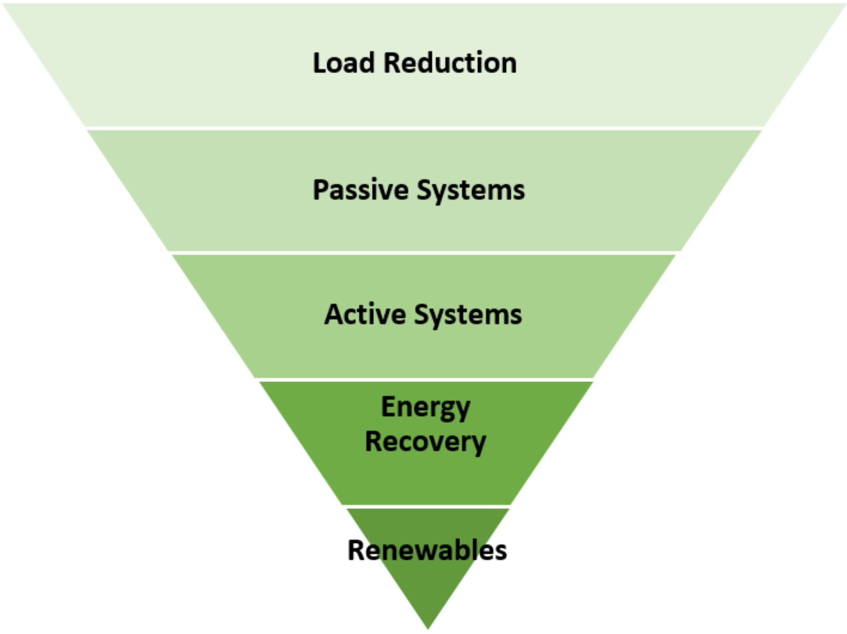

Figure 7-29: Energy reduction hierarchy

The overall sustainability approach for energy use within the proposed projects buildings is to firstly reduce the loads. This is discussed further in Section 7.2.5.5.3, however an example may be to reduce the extent of spaces requiring air conditioning through natural ventilation and implement energy efficient lighting fixtures. Passive strategies include shading, daylighting and other architectural features to reduce the impact of solar energy on the building. Active systems may involve smart lighting and effective cooling systems integrated with natural ventilation. Heat recovery may be achievable with the air conditioning system, whereby heat recovered from the condenser can be utilised for heating water. The remaining energy demand, which has been minimised by the energy efficiency measures is proposed to be supplied by a combination of renewable energy and grid connection.

7.2.5.5.2 Minimise light pollution

As the proposed project will contain restaurants, hotels and university classrooms, outdoor lighting will be essential for occupants until the late hours of each night. The impact of external lighting, in particular from blue light, has been shown to harm human health and affect wildlife.

Both light-emitting diodes (LEDs) and metal halide fixtures contain large amounts of blue in their spectrum which brightens the night sky more than other lighting types.

To minimise lighting pollution, the development proposes to only use external lighting with a colour temperature of less than 3000 Kelvin. This practice is endorsed by the International Dark-sky Association (IDA). Additional measures that will be utilised to minimise any adverse effects of external lighting include:

- fully shielded fixtures
- full cut-off street lights
- fully shielded barn lights
- fully shielded walkway bollards
- all external fixtures to be purchased through retailers endorsed by the IDA (Sourced from: IDA outdoor lighting basics n.d.).

7.2.5.5.3 Potential energy efficiency measures

A national rating tool called 'EnviroDevelopment' has been developed by the Urban Development Institute of Australia (Queensland) and will be targeted for the project. This tool provides independent verification of a projects sustainability performance through a set of criteria which together indicate overall ecological value. The certification criteria assess the following specific categories:

- ecosystems
- waste
- energy
- materials
- water
- community.

The following section details a number of Energy Efficiency Measures (EEMs) that have been committed to for the development. These EEMs cover several categories such as building envelope, lighting, rainwater reuse, efficient cooling and ventilation, as well as operational strategies. Outlined below are the specific measures to be incorporated into the design of the development. Each initiative contributes to improved energy performance or reduced load, resulting in a reduced environmental impact in many cases.

a) Occupancy sensors

Occupancy sensors will be installed in residences, Villas, student facilities among other spaces to save electricity and reduce site load. The sensors ensure that lights are turned off when a space is unoccupied. These sensors can also feed information to the air-conditioning systems, controlling cooling based on occupancy. By provision of sensors, peak electrical demand will be reduced, by lowering air-conditioning and lighting loads. The provision and extent of occupancy sensors will be developed in the detailed design stage as when more architectural and buildings operational detail becomes available.

b) Natural ventilation

Where possible, buildings will make use of natural ventilation to reduce load on air conditioning and mechanical ventilation systems. Natural ventilation may be limited to the buildings with lower occupancy rates and smaller internal loads such as the Villas and other residential buildings. Additionally, natural ventilation is not proposed for spaces which demand a tighter control of temperature and humidity. This would include most of the KUR-World Campus building, Health and Wellbeing Retreat facilities, dining and restaurants, and Function Centres.

c) Green roofs and walls

Vegetation covered over building surfaces provides shading, improves air quality, enhances aesthetic appeal, absorbs carbon dioxide, reduces stormwater runoff and reduces the energy consumption of air conditioning systems. These systems are expensive however and are currently considered as a small-scale inclusion, being subject to further design development.

d) Energy metering and sub-metering (resiliency)

Energy metering can be easily implemented on all essential building services to provide real time data on how the system is operating and performing. By enabling this provision, site operators will have the tools to understand what sources are consuming the most energy, monitor trends and notice where system failures may have occurred. These types of systems would provide most benefit to the larger developments of the project, which are consuming greater amounts of energy and contain more complex systems. This includes the Five Star Eco-Resort and KUR-World University Campus as a minimum.

e) Internal lighting

Energy efficient lighting fixtures such as LED and T5 fluorescents reduce electrical and cooling loads for internal spaces. Spaces that utilise daylight well can further reduce electrical demand, and with daylight sensors, further savings can be obtained by controlling lighting output levels. Site wide inclusion of LED or T5 fluorescent lighting is proposed for all the internal spaces of the project. This will reduce the electrical load demand with resulting energy savings.

f) Air conditioning

A significant portion of the proposed project's electricity will be consumed for air conditioning. Efficient cooling is therefore a critical design aspect to reduce overall consumption. Many technologies exist for efficient cooling. Variable Refrigerant Flow (VRF) technology utilises variable speed compressors to circulate only as much refrigerant as is required to serve the demand, which makes the system uniquely efficient.

This type of system would be applicable to the Villas, studios and hotel rooms, where one outdoor unit can serve multiple indoor spaces. Another advantage of this system type is the reduced requirement of plant space, as there is no need for chillers, air handling units, cooling towers or much ductwork.

VRF systems can also employ the ability of heat recovery, which takes heat from the outdoor condenser unit and exchanges it with water. This heated water may be utilised for domestic hot water for showers and sinks, or to heat pools and spas.

g) Thermal envelope – Section J

The buildings contained within the KUR-World Integrated Eco-resort will all comply with the National Construction Code. Section J of the code relates to energy efficiency and a project target is to improve upon the minimum requirements set out by Section J. A minimum target to increase insulation R-value by $0.5m^2K/W$ for external walls and roofs has been set.

7.3 Telecommunications

7.3.1 Existing situation

The existing site has a single Telstra connection which is serviced from Barnwell Road. An upgrade of the incoming service will be required for the proposed development. The extent of the upgrade, and the costs associated with this, will be determined once discussions are progressed with Telstra in the subsequent stages of design.

Initial information retrieved through Dial Before You Dig (DBYD) indicates that NBN infrastructure has been installed nearby and is currently in service. This service will be extended to the new proposed development.

Between the Telstra and NBN infrastructure, this should provide sufficient telecommunications capacity for the proposed development. Due to the roll out of NBN, the residential developments will most likely receive an NBN connection and the commercial, education and similar facilities will typically be provided with Telstra (and possibly NBN for redundancy) services.

Due to the scale of the project, infrastructure upgrades will likely be required, both internal to the development and upstream of the service providers infrastructure. Therefore, it is believed with relative certainty that fast and reliable telecommunications and internet services will be available to all users.

7.3.2 Requirements during construction and operation phases

Discussions held with the relevant service providers will determine the requirements during construction and operation phases of the project. This may involve the following services, however will need to be confirmed through design stages:

1) Civil works to extend existing communication services to the required locations within the proposed development.
2) Design and construct of a new distribution hub within the development.

7.3.3 Management plan

During future design stages of the project, Telstra and NBN will be consulted to make them aware of the development and identify their requirements for new connections. Consultation with these service providers will identify the capacities that are currently available to enable the appropriate design decisions to supply the demand of the proposed development.

7.3.4 Impact on existing infrastructure

The need and proposed arrangement of new telecommunications services provided to the site will be determined in consultation with service providers and designed to avoid impacts or disruption to existing services and infrastructure.

7.4 Stormwater Drainage Infrastructure

7.4.1 Introduction

This section describes the proposed stormwater drainage infrastructure for KUR-World, addressing Sections 10.13, 10.17 10.26 and 10.27 of the EIS Terms of Reference.

It includes a summary of the stormwater quality and quantity assessment undertaken to develop the proposed stormwater drainage strategy and the infrastructure required to collect, convey, attenuate, treat and discharge stormwater generated across the site.

A high-level reference design for the proposed stormwater drainage infrastructure has been developed based on the stormwater analysis, which is shown in the drawing: Stormwater Drainage General Arrangement – 253251-00-C-RD-202, Issue 1B, 01/11/2017 (refer to Appendix 2A). The reference design drawings detail the proposed stormwater infrastructure within the site and any required upgrades external to the site.

The Flooding Technical Report (Appendix 20) documents a flood study undertaken to describe the flood risk to the site and downstream properties under existing and developed conditions, including assessment of flood impact, mitigation measures and risks associated with the development, and should be read in conjunction with this chapter.

7.4.2 Overview of stormwater management strategy

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 and 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 including rainwater tanks, swales, detention basins, bio-retention systems, ponds and lakes will be used to collect, attenuate and treat excess rainwater and stormwater, and enable harvesting for re-use onsite where feasible.

7.4.3 Design basis

The KUR-World stormwater drainage strategy has been developed to meet the requirements of Section D5.08 of the Far North Queensland Regional Organisation of Councils (FNQROC) Development Manual for Stormwater Quality Management (FNQROC, 2014), including:

- All developments are required to include appropriate interception devices that ensure removal of suspended matter (litter) and treatment of contaminated stormwater prior to crossing the boundary of the development or discharge into downstream roadside gutters, stormwater drainage systems or waterways.
- Water quality interception devices or a combination of interception devices and treatments are required to remove at least 90% of total suspended solids (litter) of size greater than 3.0mm as well as sand, 60% of total phosphorus, and 40% of nitrogen and shall be configured to prevent re-injection of captured contaminants.
- Water quality interception devices or a combination of interception devices and treatments are designed to treat all first flush runoff, defined as that volume of water equivalent to the runoff from the three-month average recurrence interval (ARI) storm event (60% of the one-year ARI storm event).

The site-specific surface Water Quality Objectives (WQOs) for environmental values, described in Chapter 9 Water Quality, were also taken into consideration however the target WQOs for total nitrogen and total phosphorus were not achieved by the reference design. The impacts, mitigation measures and risks are also described in Chapter 9 Water Quality.

7.4.4 Existing and proposed catchment description

KUR-World is currently an agricultural site comprised of predominantly open pasture used for cattle grazing, and natural vegetation. There is no urban drainage infrastructure on the site, with all stormwater naturally draining to the various creeks across the site.

The proposed development is an integrated eco-resort, comprising of residential lots, a farm theme park, golf course, business centre, five-star eco-resort, health and wellbeing retreat, and a university campus. A breakdown of the proposed precincts and land-use areas used as the basis for the stormwater assessment is provided in Table 7-19, based on the KUR-World Concept Master Layout, Revision G (Arup, 2017).

Table 7-19: Catchment areas and precincts

Precinct	Road area (ha) (100% impervious)	Roof area (ha) (100% impervious)	Landscape area (ha)	Pervious fraction of Landscape area
Farm Theme Park and Equestrian Centre	1.56	1.53	17.72	99%
Produce Garden	0.00	0.04	2.47	100%
Business Hotel and Function Centre	0.18	0.77	2.12	96%
KUR-Village	0.59	1.15	0.97	88%
Rainforest Education Centre and Adventure Park	0.00	0.79	16.34	100%
KUR-World University Campus	0.68	0.83	2.51	97%
Sporting Precinct	0.88	0.52	1.12	95%
Golf Club House and Function Centre	0.16	0.32	0.21	85%
Golf Course	0.00	0.00	46.39	100%
Five Star Eco-Resort	0.34	1.45	4.42	97%
Health and Wellbeing Retreat	0.47	0.92	4.27	98%
Premium Villas	2.82	5.60	11.80	95%
Lifestyle Villas	2.94	0.97	10.27	99%
Queenslander Lots	0.56	0.17	1.03	98%
Open Space	0.00	0.00	1.75	100%

7.4.5 Stormwater quality assessment

A high-level stormwater quality assessment has been undertaken to confirm the extent of stormwater quality improvement infrastructure required to comply with design requirements in Section 7.4.3. The stormwater quality assessment was undertaken using the stormwater quality performance tool Model for Urban Stormwater Improvement Conceptualisation (MUSIC), and was used to inform the reference design for stormwater infrastructure.

7.4.5.1 Model configuration

A coarse conceptual model was developed using MUSIC, to analyse the catchments and proposed stormwater quality improvement devices at the precinct level. Within the model, the total areas of roofs, roads, pavements and landscaping were modelled as single nodes within each precinct. Similarly, single treatment nodes (swales, Gross Pollutant Traps, and bio retention basins) were generally modelled for each catchment area. A single receiving node was modelled representing the combined stormwater runoff across the site.

This coarse modelling approach was taken as a means of specifying the required elements of the overall stormwater drainage strategy, which will need to be achieved in the stormwater drainage system detailed design. In reality, the site will contain a diverse network of catchments, swales, stormwater quality improvement devices and bio-retention devices, discharging to the various water-courses across the site. An indicative stormwater drainage system is shown in the KUR-World reference design (drawing 253251-00-C-RD-202: Stormwater Drainage General Arrangement, issue 1B, 01/11/2017 – refer to Appendix 2A), which will need to be further analysed and refined as the project progresses in detail.

The meteorological data (rainfall and evaporation), soil parameters and pollutant generation parameters applied in the MUSIC model were adopted for Cairns (the closest location to the project site with data built into the MUSIC software), using a 6-minute time step. To be consistent with the built-in setting of the MUSIC software)

7.4.5.2 Modelled stormwater quality improvement measures

In accordance with the proposed stormwater strategy described in Section 7.4.2, the following treatment measures were modelled:

- Rainwater tanks: 5kL rainwater tanks for all residential villas and 20kL rainwater tanks for all commercial development, which will collect runoff from the building roofs. Harvested water will be used for WC flushing and irrigation purposes. Overflows from the rainwater tanks will drain into swales.
- Gross Pollutant Traps: The Rocla CleansAll® Gross Pollutant Trap (GPT) has been included as primary treatment for the commercial catchment landscape areas and the road areas to initially target litter. Flows from the GPTs will discharge into swales.
- Swales: Vegetated swales are located around the site, as treatment for runoff from the site, including a combination of pervious and impervious area. The swale length for each catchment has been designed as a minimum of 100m, to be sized appropriately during detailed design.
- Bio-retention: Bio-retention systems have been included for each catchment as treatment for runoff from the site, including a combination of pervious and impervious area. The bio-retention systems have been sized as a minimum of 2% of each catchment (with the exception of 1% for the golf course). The bio retention systems are fed by the swales and fall into creeks at various locations. The bio retention systems have a minor detention component.

The modelled design characteristics for the treatment measures within each precinct are summarised in Table 7-20.

Table 7-20: Treatment measure design specification

Precinct	Rocla CleansAll® GPT - Road Treatment	Rainwater Tank Size – Roof Treatment (kL)	Rocla CleansAll® GPT - Landscape Treatment	Swale length – Catchment Treatment (m)	Bioretention Area – Catchment Treatment (m^2)
Farm Theme Park and equestrian Centre	CA375	20	CA900	100	3543
Produce garden		5			
Business and Leisure Hotel and Function Centre	CA375	20	CA375	100	423
KUR-Village	CA375	20	CA375	100	194
Rainforest Education Centre and Adventure Park		20	CA900	100	3268
KUR-World University Campus	CA375	20	CA375	100	503
Sporting Precinct	CA375	20	CA375	100	223
Golf Club House and Function Centre	CA375	20	CA375	100	43
Golf Course			CA1350	100	4639
Five Star Eco-Resort	CA375	20	CA600	100	883
Health and Wellbeing Retreat	CA375	20	CA600	100	853
Premium Villas	CA375	5 per villa		100	2361
Lifestyle Villas	CA375	5 per villa		100	2053
Queenslander Lots	CA375	5 per villa		100	206
Open Space					

7.4.5.3 Stormwater quality model results

Table 7-21 summarises the estimated annual pollutant loads for Total Suspended Solids, Nitrogen, Phosphorus and Gross Pollutants from the overall KUR-World site, both without (source) and with the proposed stormwater quality improvement measures (residual load) described in Section 7.4.5.2. The percentage reductions in pollutant loads achieved by proposed stormwater quality improvement measures are also shown. As shown in the table, the proposed stormwater strategy for the post developed site complies with all of the FNQROC criteria for stormwater quality improvement (FNQROC, 2014).

Table 7-22 summarises the peak day maximum concentration and loadings for Total Suspended Solids, Total Nitrogen, Total Phosphorous and Gross Pollutants respectively.

Table 7-21: MUSIC Model Results

Parameter	Source Load	Residual Load	% Reduction	FNQROC Criteria	Criteria Achieved?
Flow (ML/Year)	1090	934	14%	n/a	n/a
Total Suspended Solids (kg/yr)	156000	9140	94.2%	90%	Yes

Parameter	Source Load	Residual Load	% Reduction	FNQROC Criteria	Criteria Achieved?
Total Phosphorus (kg/yr)	366	123	66.3%	60%	Yes
Total Nitrogen (kg/yr)	2890	888	69.3%	40%	Yes
Gross Pollutants (kg/yr)	9500	0	100%	100%	Yes

Table 7-22: TSS Daily Maxima Statistics

Daily Maxima Statistic	Concentration (mg/L)			Load (kg/Day)			
	TSS	TN	TP	TSS	TN	TP	GP
Mean	12.3	1.57	0.208	2.97	0.134	2.97	0.00
Standard Deviation	16.1	1.61	0.163	26.6	0.937	26.6	0.00
Median	2.92	0.668	0.129	1.09e-3	235e-6	1.09e-3	0.00
Maximum	77.3	5.97	0.671	405	14.9	405	0.00
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 Percentile	2.15	0.600	0.119	790e-9	99.5e-9	790e-9	0.00
90 Percentile	36.8	4.45	0.503	0.226	46.6e-3	0.226	0.00

7.4.6 Stormwater quantity assessment

A high-level stormwater quantity assessment was undertaken to estimate preliminary sizing for the stormwater detention infrastructure, in order to attenuate peak flows from the site, in accordance with the design requirements in Section 7.4.3.

A hydrologic model developed as part of the flood study (refer Chapter 18.11 Flooding), was used to generate stormwater hydrographs from each of the sub-catchments across the KUR-World site under both pre-development (existing) and post-development conditions. Hydrographs were developed for a range of storm durations, in order to identify the critical 100-year average recurrence interval (ARI) storm event for each sub-catchment. Following the procedure outlined in Section 5.5.1 of the Queensland Urban Drainage Manual (Department of Energy and Water Supply, 2013), the pre and post development flow hydrographs were used to calculate the total detention volume required to be incorporated into each sub-catchment, in order to attenuate the 100 year ARI peak flows to pre-development conditions.

Table 7-23 presents the outcomes of the analysis, summarising the peak 100-year ARI flows from each sub-catchment under pre-development and post-development conditions, along with the total estimated detention volume required for attenuation. The locations of each sub-catchment across the site are shown in Figure 7-30.

Table 7-23: Estimated detention volumes required for each sub-catchment

Sub-Catchment	Corresponding Precinct	Pre-development flow (m3/s)	Post Development flow (m3/s)	Detention Volume (m3)
1A	Environmental area	15.179	15.181	171

Sub-Catchment	Corresponding Precinct	Pre-development flow (m3/s)	Post Development flow (m3/s)	Detention Volume (m3)
1B	Environmental area/ Farm/ Produce garden/ Lifestyle villas/ Open space	5.699	5.700	78
2	Health and wellbeing retreat/ Premium villas / Five-star eco resort	53.573	53.601	2233
3	No development	82.418	82.418	0
4	Environmental area/ Lifestyle villas	136.373	136.375	156
5+6	No development	31.322	31.322	0
8	Premium villas/Golf course/Environmental area	9.952	9.954	171
9	Rainforest education centre/ Environmental area	18.933	18.933	0
10	Rainforest education centre/ Environmental area	25.894	25.894	0
11	Lifestyle villas/ Environmental area	18.869	18.873	335
12	Five-star eco resort/ Golf course/ Health and wellbeing retreat	10.112	10.126	1137
13	Premium villas/Golf course/Golf clubhouse/ KUR world Campus/Sporting precinct/ Environmental area	22.633	22.741	8428
14b	Premium villas/ Golf course/Environmental area/Business centre/ Services / Produce Garden	13.854	13.962	8370
15	Farm /Queenslander Lots	6.643	6.645	218
16	No development	16.077	16.077	0
19	Lifestyle villas/ Premium lots/ Golf course/ Environmental area	10.570	10.628	4563
20	KUR Village/Environmental area	13.794	13.854	4630
21	No development	10.990	10.990	0
22	No development	25.154	25.154	0
23	No development	19.873	19.873	0

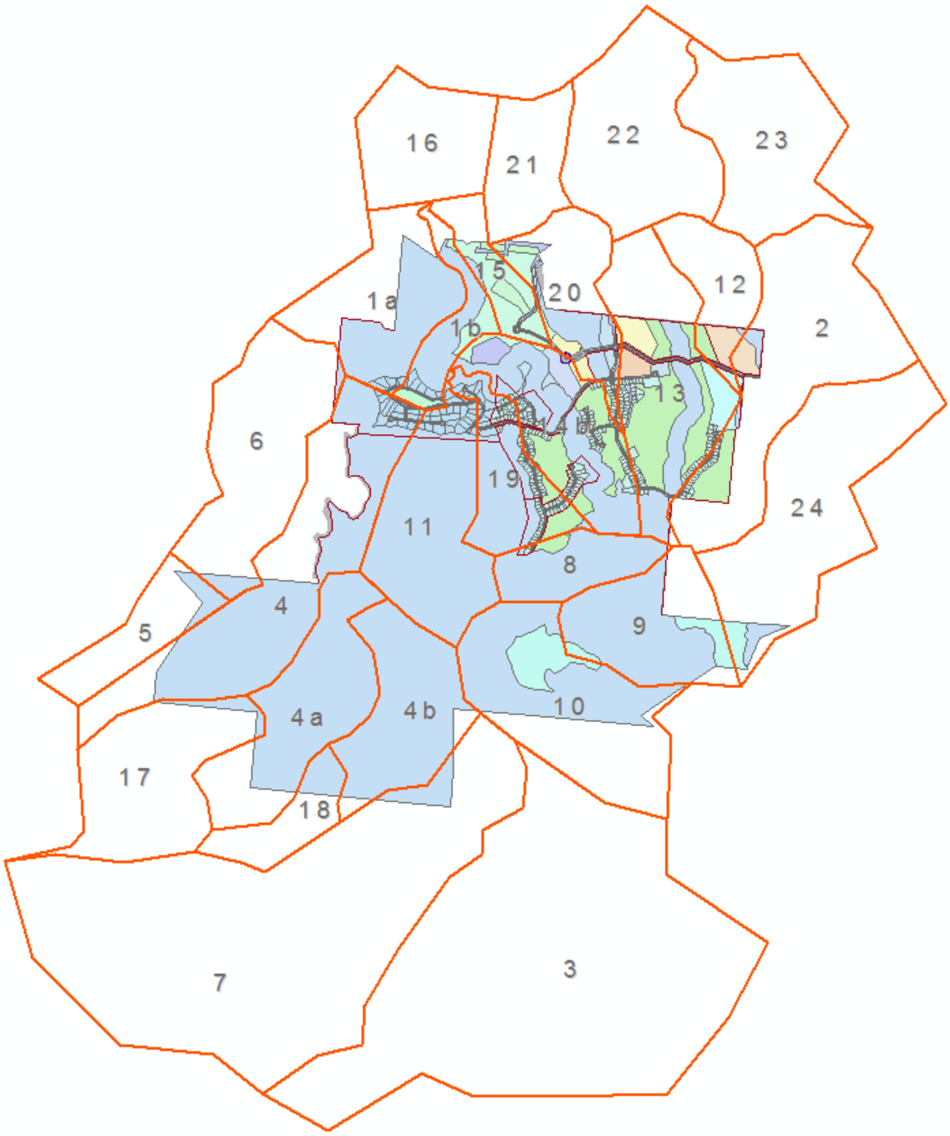

Figure 7-30: Sub catchment locations

7.4.7 Rainwater and stormwater harvesting and re-use assessment

A high-level assessment of the potential for rainwater and stormwater harvesting for utilisation as part of the KUR-World non-potable water supply strategy is described in Section 7.1 Water and Wastewater Infrastructure.

The assessment found that 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 was not 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.

7.4.8 Proposed stormwater drainage infrastructure

A high-level reference design for the proposed stormwater drainage system has been developed based on the outcomes of the stormwater quality and quantity assessments, and in accordance with general stormwater management strategy described in 7.4.2. The reference design is shown in the drawing: Stormwater Drainage General Arrangement – 253251-00-C-RD-202 (refer to Appendix 2A).

The proposed stormwater drainage infrastructure includes (refer Figure 7-31):

- Rainwater tanks are installed within all residential lots (~5kL per villa) and major commercial facilities (~20kL per precinct) to attenuate runoff and facilitate rainwater harvesting and re-use.
- Gross Pollutant Traps (GPTs), are used to provide pre-treatment of stormwater generated from all significant road and hardstand areas across the site, and will be located, sized and designed in accordance with FNQROC (FNQROC, 2014) design requirements.
- Swales and vegetated buffer strips provide pre-treatment of all stormwater across the site, with an average treatment length of around 100m.
- Bio retention basins are integrated throughout the development, within a minimum treatment area equivalent to at least 1% of the catchment area for the golf course, and 2% of the catchment area for all other catchments.
- Stormwater detention is integrated through the bio-retention and other stormwater detention basins as required, designed to attenuate the peak 100-year average recurrence interval (ARI) flows to pre-development conditions. Minimum volumes for stormwater detention for each sub-catchment are outlined in Table 7-23.

Figure 7-31: Overall Stormwater Drainage Strategy

At a precinct scale (refer Figure 7-32):

- Within residential precincts, roof harvested rain water will be collected in domestic rainwater tanks for re-use. Excess rainwater (rainwater tank overflows), and other stormwater generated from the residential lots is proposed to drain naturally via a combination of grass lined swales, overland sheet flow (vegetated buffers) toward the existing natural flow paths (valleys in the site topography). Bio-retention and detention basins are proposed to be installed to detain and treat stormwater from these catchments where practical, prior to flow entering the natural water courses.
- Within the more intensely developed commercial/ retail/ educational precincts, stormwater will be treated by proprietary stormwater improvement devices (for example, the Rocla CleansAll® Gross Pollutant Trap), prior to conveyance via grass lined swales to bio-retention and detention basins. Larger rainwater tanks within these areas will also be used to collect roof harvested rain water for re-use.

- Road runoff across the site will be collected in a conventional kerb and channel/ pipe and pit stormwater drainage network, will be treated by proprietary stormwater improvement devices (for example, the Rocla CleansAll® Gross Pollutant Trap), prior to discharging via short outfalls to grass lined swales and bio retention basins.

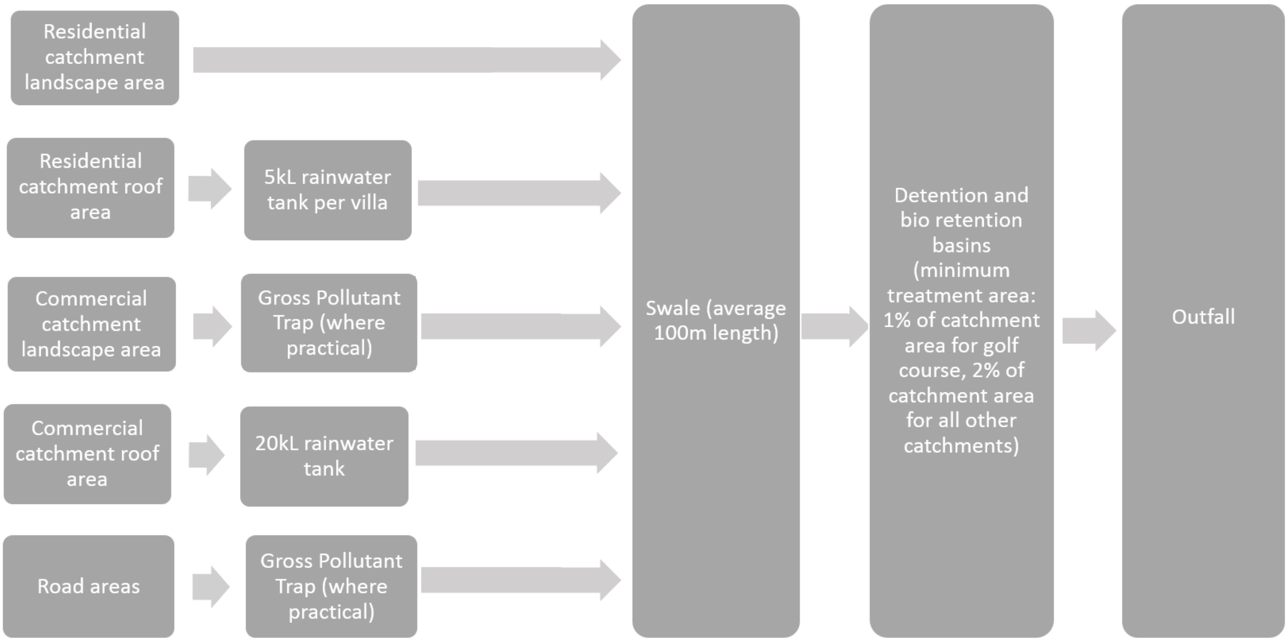

Figure 7-32: Proposed stormwater drainage strategy schematic

The reference design is shown in drawing: Stormwater Drainage General Arrangement - 253251-00-C-RD-202, issue 1B, 01/11/2017 (refer to Appendix 2A).

It is noted that the high-level reference designs have been developed to a 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.

More detailed analysis of stormwater hydraulics and water quality will need to be undertaken as the design develops, to ensure appropriate stormwater detention and treatment devices are implemented and appropriately located and sized, in accordance with the general principles described in this chapter.

7.4.9 Conclusions

It is proposed to provide stormwater infrastructure to service the proposed development and manage the stormwater flows as described in the sections above.

7.4.10 References

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7.5 Waste Disposal

7.5.1 Introduction

This section provides an assessment of the likely environmental effects of solid waste generation associated with the demolition, construction and operational phases of KUR-World (the proposed development). This chapter also relates to the Waste Management Plan (WMP) chapter (Chapter 15) for the proposed development which should be read in conjunction with this section.

This assessment has been undertaken in the context of the relevant statutory framework, as well as local, state and national waste management policies, strategies, guidance, and the Coordinator-General's Terms of Reference (Sections 12.30 to 12.35).

The principal objective of sustainable resource and waste management is to use material resources more efficiently and to reduce the amount of waste requiring final disposal by landfill. Where waste is generated it should be managed in accordance to the waste hierarchy which advocates the following order of preference:

- prevention
- re-use
- recycling
- other recovery
- disposal as a last resort.

Resource and waste management should actively contribute to the economic, social and environmental goals of sustainable development.

7.5.2 Methodology and assumptions

7.5.2.1 Methodology

The existing conditions regarding waste have been determined through a desktop review of available data as well as consultation with Mareeba Shire Council (MSC), Cairns Regional Council (CRC), Arkwood Organic Recycling and Remondis.

The likely environmental impacts of the anticipated waste generated by the proposed development has been assessed by forecasting the future generation of key waste streams and assessing these against the current baseline.

The impact assessment has been undertaken with consideration of:

- The magnitude of impacts (significance/consequence) as defined in Table 7-24. No industry standard criteria have yet been established for the assessment of waste effects from new developments in Queensland, Australia. The criteria have been developed to correspond to the overarching consequence categories used for other assessments in the EIS (as described in Chapter 1 Introduction) whilst being specific to waste management impacts.
- The likelihood of impact as provided in Table 7-25.
- The risk assessment matrix as provided in Table 7-26.

These factors were considered together to determine the initial unmitigated risk assessment, as well as a residual risk assessment once additional mitigation measures are applied.

The generation, transportation, treatment and disposal of waste can result in environmental impacts if not properly managed including:

- exposure of people or ecosystems to harmful materials
- soil, air, ground and surface water pollution
- odour
- nuisance and impact on amenity
- sustainability of natural resources
- climate change.

Good practice waste management can protect human health and the quality of the environment whilst reducing the consumption and thereby increasing the sustainability of renewable and non-renewable resources. Due to the location of the proposed development and surrounding environmental values it is especially important that waste generation does not impact on environmental receptors. Therefore mitigation measures are in place to:

- avoid and reduce waste generation
- recover waste materials for re-use and to reduce the quantity of waste sent to landfill
- recover waste materials for re-use on-site
- mitigate potential impacts on amenity and the environment from the generation and management of waste have also been provided and detailed.

Table 7-24: Impact consequence for solid waste management

Impact significance/consequence	Description
Catastrophic	Irreversible and severe change to current amenity (for example, visual amenity, odour), resulting in the displacement of residents and businesses. Irreversible and significant disturbance of ecology due to contamination of the environment (for example, land contamination, water quality impacts, and improper waste management causing wildlife poisoning, physical injury or death) over a regional spatial scale. Mitigation measures are unable to reduce impacts. All solid waste generated by the project is disposed to landfill, with no reuse or recycling. A significant volume of solid waste beyond baseline levels is generated, representing >30% of waste processed at facilities in the region.
Major	Extensive disturbance to current amenity (for example, visual amenity, odour). Considerable permanent adverse disturbance of ecology due to contamination over a local scale. Mitigation measures and detailed design work are unlikely to remove all of the significant effects. The majority of solid waste generated by the project is disposed to landfill, with little reuse or recycling. A high volume of solid waste beyond baseline levels is generated, representing 20-30% of waste processed at facilities in the region.
Moderate	Adverse change resulting in some loss of amenity. Loss and permanent damage to ecology on a local scale. Some recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate some impacts. Some solid waste generated by the project is disposed to landfill. The relevant Waste Avoidance and Resource (WAR) Productivity Strategy (2014-2024) recycling targets for Queensland are met. These targets are as follows: • 50% state wide municipal solid waste recycling rate (55% metropolitan, 45% regional centre) by 2024. • 55% state wide commercial and industrial recycling waste rate by 2024. • 80% state wide construction and demolition waste recycling rate by 2024. A moderate volume of solid waste beyond baseline levels is generated, representing 10-20% of waste processed at facilities in the region.

Impact significance/consequence	Description
Minor	Limited or temporary effects resulting in low levels of disturbance or loss to local amenity and ecology. Close to full recovery is anticipated following completion of the works concerned. Mitigation measures are anticipated to alleviate close to all impacts. The majority of solid waste generated by the project is reused or recycled with the relevant 2024 WAR Productivity Strategy recycling targets for Queensland being met or exceeded (refer above). A small volume of solid waste beyond baseline levels is generated, representing 0-10% of waste processed at facilities in the region.
Insignificant	No appreciable impact upon local amenity or ecology. Effects are within normal bounds of variation or within the margin of forecasting error. No additional solid waste is generated beyond baseline levels.

Table 7-25: Likelihood rating

Likelihood	Annual Exceedance Probability (AEP)	Average Recurrence Interval (indicative)	Frequency (indicative)
Almost Certain	63% per year or more	Less than 1 year	Once or more per year
Likely	10% to <63% per year	1 to <10 years	Once per 10 years
Unlikely	1% to <10% per year	10 to <100 years	Once per 100 years
Rare	0.1% to <1% per year	100 to <1000 years	Once per 1000 years
Very Rare	0.01% to <0.1% per year	1000 to <10,000 years	Once per 10,000 years
Extremely rare	Less than 0.01% per year	10,000 years or more	Once per 100,000 years

Table 7-26: Risk assessment matrix

	Consequence level				
Likelihood	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	Extreme	Extreme
Unlikely	Low	Low	Medium	High	Extreme
Rare	Very low	Low	Medium	High	High
Very rare	Very low	Very low	Low	Medium	High
Extremely rare	Very low	Very low	Low	Medium	High

7.5.2.2 Limitations and assumptions

This Chapter addresses solid waste and wastewater treatment residues (comprising screenings/grit and biosolids). Wastewater is addressed in Chapter 7 Infrastructure.

7.5.3 Legislation and policy

7.5.3.1 Legislative framework

The National Waste Policy is the strategic national framework for waste management and resource recovery in Australia to 2020. This framework provides the basis for collaboration between jurisdictions to deliver effective and efficient approaches to national waste issues and ensure that waste management remains aligned with Australia's international obligations.

Waste management is primarily regulated on a state level.

The following legislative framework applies to waste management within Queensland:

- *Environmental Protection Act 1994* (EP Act) and associated legislation, including *the Environmental Protection (Waste) Policy 2000* and *the Environmental Protection (Waste) Regulation 2000*
- *Waste Reduction and Recycling Act 2011* and *Waste Reduction and Recycling Regulation 2011*
- *Environment Protection Regulation 2008.*

Key elements of the framework include:

- Section 13 of the EP Act defines waste as "anything that is a left over, surplus, or an unwanted by-product, from an industrial commercial, domestic or other activity. Waste can be a gas, liquid, solid or energy, or a combination of any of these."
- Under Section 319 of the EP Act, waste generators are bound by the general environmental duty defined as "a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm." The waste generator must follow this general environmental duty and ensure that waste is transported by a licensed transporter and that it is delivered to a licensed facility.
- Under Queensland's environmental protection legislation waste handlers are required to submit waste tracking information to the Department of Environment and Heritage Protection as part of the system for tracking waste types as listed in Schedule 2E of the *Environmental Protection Regulation 2008* (the regulation).

7.5.3.2 Waste management strategy and policy

Mareeba Shire Council (MSC) does not have a published solid waste management strategy, although it is understood one is being drafted at the time of writing (as per communications with MSC). There is a MSC policy for "trade waste" however this relates to liquid waste only.

The neighbouring Cairns Regional Council (CRC) has a waste management strategy for the period 2010-2015, which at the time of writing has not been updated. This strategy outlines the key principles, targets and objectives for CRC in the five-year period as well as baseline data for waste generation.

The "Queensland Waste Avoidance and Resource (WAR) Productivity Strategy (2014-2024) (EHP, 2014)" outlines the high-level direction for waste management and resource recovery between 2014 and 2024 in Queensland. This strategy is currently under review by the Department of Environment and Science. It includes a series of targets including:

- 50% state wide municipal solid waste recycling rate (55% metropolitan, 45% regional centre) by 2024
- 55% state wide commercial and industrial recycling waste rate by 2024
- 80% state wide construction and demolition waste recycling rate by 2024.

7.5.3.3 EnviroDevelopment certification

The proposed development will be aiming for EnviroDevelopment certification. EnviroDevelopment is a certification scheme for developments that achieve outstanding performance across a range of elements, of which waste management is one. This includes the objective that there will be "reduced waste sent to landfill, more efficient use of resources." The target required is that the "development that has implemented waste management procedures and practices which reduce the amount of waste that is disposed of to landfill and facilitates recycling." There are five principles that underpin this:

- encourage recycling of construction and demolition materials and reduce the amount of waste being dispatched to landfill
- minimise on-site pollution during the construction phase
- promote the re-use of existing buildings and materials and reduce demand for resources
- promote occupancy awareness and encourage recycling, composting and waste reduction through the provision of appropriate facilities
- more efficient use of resources.

Assuming that the proposed development will be classified under "master planned communities", the proposed development will set out to achieve all credits under 2.1, 2.2, achieve credit 2.3.1 and at least one credit from 2.3.2 to 2.3.4. These credits are outlined in Table 7-27 (EnviroDevelopment, 2014).

Table 7-27: EnviroDevelopment credits for waste

Criteria	Credit(s)	Required supporting documentation	Relevant section in this chapter
2.1 Essential Action	2.1.1 Identify the local recyclers, secondary product manufacturers and material streams available to the site to be used in the pre-construction and construction phase. Provide reasoning for the selection of the appropriate rationale for waste management. Information provided under this criterion will be used, in tandem with criteria-specific statements and documentation, to assess the project's performance under 2.2 and 2.3. Note: Non-metropolitan sites may apply for special consideration under specific sections within this element where recycling facilities are not nearby.	Map highlighting relevant facilities and clear evidence of the amount of materials flowing through to off-site facilities. Statement of compliance from developer or sustainability consultant providing reasoning for the site-specific waste rationale. Details of off-site recycling agreements, including license/approval details of the facility.	Key facilities are highlighted in Section 7.5.4.2.3. Further detail to be confirmed in a further project stage/certification process.
2.2 Pre-construction, civil works and construction phase	2.2.1 The contractor implements a comprehensive, project specific, waste management plan for the pre-construction, civil works and construction phases of the project. At a minimum, the waste management plan should meet state/territory legislation and align with relevant waste targets (where set and applicable) and include the following: • waste generation • waste systems • minimisation strategy • performance/reduction targets • bin quantity and size • collection frequency • waste contractors	Site waste management plan endorsed by the developer, with further statements from the engineer as appropriate. The plan must address each of the requirements for the pre-construction and construction phases.	Construction Waste Management Plan recommended prior to construction, see Section 15.4.

Criteria	Credit(s)	Required supporting documentation	Relevant section in this chapter
	• monitoring and reporting including frequency and method.		
	2.2.2 Recycle or reuse a minimum of 60% (by volume) of demolition, land clearing and civil works materials/ products (including vegetative debris) on site. In the event that demolition, land clearing or civil works materials cannot be recycled on site, full details of the operators to be engaged (including all licenses they hold to operate) and materials streams to be recovered as part of the off-site activity must be provided. Note: (i) Hazardous materials (for example, asbestos, contaminated soil) are excluded. (ii) If reuse on site is not feasible, the establishment of partnerships which embrace industrial ecology principles is strongly encouraged.	Details of existing materials on-site and arrangements and estimates of waste streams and generation.	Minimum 80% target adopted, with potential to aim for industry best practice target of 95%, see Section 7.5.7.2.
	2.2.3 Manage and dispose/treat all hazardous substances, pollutants and contaminants in accordance with all state regulatory requirements. Where these materials are treated or used on site, they must be in accordance with a sanctioned remediation process.	Details of any on-site treatment processes for hazardous substances, pollutants, contaminants or acid sulphate soils must be provided and such processes must be supported by approved State Agency requirements and laws.	This guidance will be formalised in the Construction Waste Management Plan, however see Section 15.4 for some preliminary guidance.
	2.2.4 Provide guidance for builders working on-site regarding waste practices. At a minimum, the following should be included: • The use of skip bins rather than cages. • Maintenance of waste records. • Use of contractors who transport waste to a licensed recycling centre. • Select materials and products which minimise and/or recycle packaging. • Design dwellings to maximise use of standard sizes of materials wherever possible. The above requirements are also expected to be mandated in display villages and buildings directly controlled by the developer.	Design guidelines, educational information or similar.	This guidance will be formalised in the Construction Waste Management Plan, however see Section 15.4 for some preliminary guidance.

Criteria	Credit(s)	Required supporting documentation	Relevant section in this chapter
2.3 Post-construction phase	2.3.1 Where waste infrastructure is required to be installed in public spaces, include separate waste receptacles for general and recyclable waste.	Evidence in plans and statement of compliance from developer and local authority.	This is recommended as part of Section 15.5. Compliance will have to be demonstrated post-construction.
	2.3.2 Provide on lot and/or on-site facilities for a compost facility for use by each dwelling/facility. If individual household/facility compost bins cannot be provided, a communal facility may be provided. Compost facility should be at least one cubic metre in size and can be used to recycle a balanced mix of green material (fruit and vegetable scraps) and brown material (twigs).	In the instance that a communal compost facility is provided evidence in the form of an agreement or contract should be provided detailing how the responsibility and ongoing maintenance of the facility will be managed.	Centralised on-site composting proposed, see Section 15.5.
	2.3.3 Ensure that there are arrangements in place (for example, contract with appropriate organisation, body corporate procedures or local government service) to provide collection and reuse of garden/green waste.	Statement of compliance from developer and local authority or service provider.	Garden/green waste generated through landscaping, maintenance and upkeep will be reticulated to central composting facility see Section 15.5.
	2.3.4 Establish and/or facilitate during development and occupancy phases, use of a recycling centre where mulch, rock, fencing, and other construction materials can be crushed and reused to provide landscaping supplies for occupants.	Evidence of proposed location and timing for recycling centre.	This could be investigated in future stages however is not one of the key initiatives at this time.

7.5.3.4 Guidance

The "EIS information guideline – waste management" published by the Queensland Department of Environment and Heritage Protection (2016) has been used to guide and inform this EIS chapter (except liquid wastes which are described in Chapter 7 Infrastructure) where relevant. However, it should be noted that this guidance document is intended to inform resource projects requiring EIS, and therefore can require a high level of detail and assessment than is proportional than for the proposed development. The main information requirements under the guideline are:

- identify, quantify and describe waste sources associated with construction, operation and decommissioning of the project
- describe operational handling, storage and fate of all wastes including solid wastes, general waste, building waste, regulated waste, hazardous waste, trade wastes and liquid wastes
- review cleaner production opportunities and detail realistic strategies for avoidance, minimisation
- reuse/recovery and treatment to minimise the impacts of waste generation and disposal
- account for potential level of residual impact on environmental and community values and pests
- consider the cumulative impacts of the wastes that would be generated by the development.

7.5.4 Existing waste sources, generation and management infrastructure (baseline)

7.5.4.1 Waste sources

The existing site use comprises a small farm holding and stables, and undeveloped greenfield land. Refer to Chapter 6 for further details about the current use. Existing site waste generation is expected to be negligible and include minor amounts of domestic waste from the farmhouse, green waste from property maintenance and animal waste from the stables. No assessment of waste generation of the recently commenced Tourist Attraction has been undertaken.

The proposed development will generate construction waste during construction. Commercial and Industrial (C&I) waste will be as generated during operation, as well as green waste and waste water treatment residues.

The site is located within Mareeba Shire local government area, under the jurisdiction of MSC. However, waste generated within MSC is typically managed on a regional basis with the adjacent CRC.

The soils and geology assessment for the site did not identify any existing contamination at the site (Refer Appendix 1 Soils and Geology).

7.5.4.1.1 Construction and demolition waste generation

The "Recycling and Waste in Queensland 2017" report (Department of Environment and Heritage Protection [DEHP], 2017) presents a total of 103,624 tonnes of Construction and Demolition (C&D) waste generated in Cairns in 2017-18 disposed of to landfill or sent to incineration.

There is no publicly available data for the Cairns region on re-used, recycled or recovered C&D waste.

7.5.4.1.2 Commercial and industrial waste generation

The "Recycling and waste in Queensland 2017" report (DEHP, 2017) presents a total of 120,722 tonnes of C&I waste generated in Cairns in 2017-18 disposed of to landfill or sent to incineration.

There is no publicly available data for the Cairns region on re-used, recycled or recovered C&I waste.

7.5.4.1.3 Green waste generation

The "Recycling and waste in Queensland 2017" report (DEHP, 2017) states a total of 33,534 tonnes of green waste generated in Cairns in 2017-17 and sent for recovery by local government.

7.5.4.1.4 Waste water treatment residues generation

There is no publicly available data on the quantity of waste water treatment residues generated within the Cairns region. However, consultation with CRC indicates approximately 24,000 tonnes per annum of biosolids are generated within the Cairns region (as of 2017).

7.5.4.2 Waste collection and management

ıt is not known what the current waste collection provision is for the site of the proposed development. MSC offer a two-bin collection comprising a bin for mixed general waste and a bin for co-mingled recycling to council residents, and it is likely this service or similar is provided to the current site.

7.5.4.2.1 Commercial and industrial waste collection

Limited information is publicly available on current C&I waste collection, however, there are a variety of private waste service providers offering C&I waste collection in the Mareeba Shire and wider Cairns area, including Suez, JJ Richards, Remondis and Cleanaway.

7.5.4.2.2 Waste water treatment residues collection

Arkwood Organic Recycling services the vast majority of biosolids generated by MSC and CRC wastewater treatment plants (as per communications with MSC and CRC). Arkwood Organic Recycling utilise collected biosolids for beneficial disposal, which typically comprises land spreading for use as a fertiliser on agricultural land. As per communications with Arkwood, in 2016/17 approximately 95% of the biosolids they collected were applied to land, with approximately 5% being disposed of to landfill (this can occur during periods of wet weather due to runoff concerns or lower demand). It is understood there are other smaller private contractors who also offer collection of biosolids in the Mareeba Shire and wider Cairns area.

7.5.4.2.3 Waste management facilities

The main waste management facilities in the area are listed as follows:

- the Cairns Material Recovery Facility (CMRF) in Portsmith, CRC, approximately 40 kilometres south east by road from the proposed development
- the Advanced Resource Recovery Facility (ARRF) in Portsmith, CRC, located adjacent to the CMRF and approximately 40 kilometres south east by road from the proposed development
- Mareeba Landfill in MSC, approximately 45 kilometres south west by road from the proposed development
- Springmount Landfill in MSC, approximately 65 kilometres south west by road from the proposed development

CMRF in Portsmith

The CMRF in Portsmith is operated by CRC and receives dry recyclables from MSC and surrounding councils as well as commercial businesses. The co-mingled recycling is sorted and separated into plastics, paper, steel and aluminium. The recyclables are then baled and sold onto secondary recovery markets, mostly via Brisbane or southern States for further processing. The CMRF has a capacity of approximately 15,000 tonnes per annum as of 2017 (as per communications with CRC) for dry co-mingled recycling. Consultation with CRC indicates that the CMRF is currently not operating at maximum capacity. Furthermore, a series of improvements and upgrades are planned over an eighteen-month period (October 2017 to April 2019), cumulating in a total capacity of at least 30,000 tonnes per annum by the end of 2019.

ARRF in Portsmith

The ARRF in Portsmith currently operates under contract (until 2026) by Suez. It accepts household municipal solid waste (MSW) from the local Government areas of Mareeba, Cairns and Douglas as well as accepting trade waste from C&I clients. It processes approximately 125,000 tonnes of mixed general waste per annum. The facility sorts general waste and separates non-organic waste from organic waste. The organic waste is composted to produce compost, although it is understood that the compost has limited end-uses due to contamination issues and is mainly applied to non-food agricultural land. Residual waste from the facility (that is, non-organic waste that is not suitable for composting) is disposed of to landfill.

Mareeba Landfill

There is a landfill at Mareeba transfer station and landfill, owned and operated by Mareeba Shire Council. This is a fully engineered landfill approved to accept up to 100,000 tonnes of waste per annum. It primarily receives residual waste from the ARRF at Portsmith, as well as household kerbside collections from neighbouring councils, C&I and C&D waste from commercial waste companies. Consultation with MSC reveals that it is currently expected to operate until December 2019.

Springmount Landfill

The Springmount landfill is a joint venture between FGF Developments Pty Ltd and Remondis Pty Ltd. It is a fully engineered landfill that has been in operation since 2004. It is understood to have significant capacity to receive up to 200,000 tonnes of waste per annum, with an approximate lifespan of 50 years at current disposal rates (as per communication with Remondis). The landfill accepts C&D and C&I waste as well as MSW waste from some neighbouring councils.

Recycling Stations

There are MSC recycling stations where residents can take their recycling to at Mareeba, Kuranda, Julatten, Dimbulah, Mutchilba, Mt Molloy and Mount Carbine.

7.5.5 Construction

7.5.5.1 Construction workforce waste generation

Construction waste generated by the construction workforce has been estimated in Table 7-28. In the absence of any available data on construction workforce waste generation, this estimate is based on the per capita rate of total waste generation for Queensland (Qld State of the Environment (now DES), 2014-2015) of 540 kg per person per year. This is a conservative metric to use for estimation as it represents total waste generation for households, which will result in higher waste generation than workers on a construction site.

Table 7-28: Estimated waste generation by the construction workforce

Year	Total construction workforce	Total waste generated, tonnes per annum
2018/19	128	69
2019/20	299	161
2020/21	348	188
2021/22	299	161
2022/23	235	127
2023/24	303	164
2024/25	347	187
2025/26	193	104
2026/27	62	33
2027/28	0	0

The maximum waste estimated to be generated by the construction workforce per year is 188 tonnes.

7.5.5.2 Construction waste quantity estimates

Construction waste estimates are presented in Table 7-29. These estimates have been developed using the materials estimate for buildings scheduled in the Construction Phase – Regional Supply Capacity Report (Thirkell Consulting Engineers & Building Design, December 2017) and preliminary estimates for the length of roads and waste, wastewater and stormwater conveyance within the precinct. These data sources provide limited information regarding some elements of site infrastructure and do not include waste from the construction or installation of:

- upgrades to existing trunk water and sewer mains
- upgrades to Mareeba Shire Council infrastructure
- stormwater culverts, pits and harvesting system

- water storage reservoirs
- pump stations
- wastewater treatment plant
- electricity and communications infrastructure and conduits
- cladding and fit out of buildings.

Timber roof framing will be largely constructed offsite and it has therefore been assumed to generate negligible waste.

Table 7-29 Estimated construction waste generation, not including project net spoil or canteen waste generated by construction workers.

Material	Original Units	Stage 1, (original units)	Stage 2, (original units)	Stage 3, (original units)	Conversion factor from original units to tonnes	Stage 1, tonnes	Stage 2, tonnes	Stage 3, tonnes	Wastage rate	Stage 1 waste, tonnes	Stage 2 waste, tonnes	Stage 3 waste, tonnes
Concrete (Max)	m^3	18342	15523	11849	2.400	44021	37255	28438	10%	4402	3726	2844
Reinforcement	t	4344	3936	3364	1.000	4344	3936	3364	10%	434	394	336
Timber (Max)	t	1310	1174	871	1.000	1087	1024	686	10%	109	102	69
Steel (Max)	t	306	230	227	1.000	306	230	227	10%	31	23	23
Gravel	m^3	15300	4125	800	1.300	19890	5363	1040	10%	1989	536	104
Pavement Seal	m^3	1836	495	96	1.300	2387	644	125	10%	239	64	12
Glazing	m^2	13988	9017	5584	0.015	210	135	84	10%	21	14	8
Roof Sheeting	m^2	36234	32900	24274	0.008	272	247	182	10%	27	25	18
Water supply pipe	m	11400	5700	1900	0.033	380	190	63	10%	38	19	6
Sewer pipe	m	12000	6000	2000	0.033	400	200	67	10%	40	20	7
Stormwater pipe	m	3900	1950	650	0.067	260	130	43	10%	26	13	4
Total										**7,356**	**4,935**	**3,432**

The following assumptions were made in estimating construction waste:

- Water supply pipes correspond to specification DN150 steel pipe, sewer pipes correspond to specification DN150 steel pipe and stormwater pipe correspond to specification DN300 steel pipe. An assumption that the construction of the Produce Garden and Golf Course precincts would generate negligible quantities of construction waste, as they will primarily comprise bulk earthworks (refer to the cut and fill balance) and landscaping with minimal building works, civil infrastructure or other structures.
- A wastage rate for all materials of 10%. This is considered a conservative value and in practice lower wastage rates should be achievable.

Estimates for spoil generation and assessment of construction waste impacts are presented in Section 7.5.7.2.

7.5.6 Operation

The operational assessment assumes all construction stages are complete and fully in operation.

The Arup Waste Forecast Tool has been utilised to estimate operational waste generation based on a global database of waste generation rates for defined land use and activities. The Arup Waste Forecast Tool is an in-house tool developed by Arup to estimate and forecast operational waste generation for different development types based on collated datasets from across the world. It has been utilised on a range of development projects to estimate operational waste generation and is considered a suitable tool for this purpose. Refer to section 7.5.6.2 for further information on how operational waste quantities have been forecast and a list of detailed assumptions.

7.5.6.1 Operational waste generation

The waste streams that are expected to be generated during the operation of the proposed development are identified in Table 7-30.

Table 7-30: Operational waste streams for the proposed development

Waste stream	Operational precinct	Destination
General waste	All operational areas.	Regional disposal, likely to be landfill.
Back of House (BoH) food waste	Five-star eco-resort. Health and wellbeing retreat. Business and leisure hotel and function centre. Golf clubhouse and function centre.	De-centralised small-scale on-site food waste treatment, or on-site centralised composting.
Co-mingled recycling	All operational areas.	Regional infrastructure, for example, Cairns Material Recovery Facility (CMRF) and/or regional commercial recyclers.
Green waste	Landscaping and garden maintenance from all operational precincts. Golf course.	On-site centralised composting.
Manure waste and used bedding material	Farm theme park and equestrian centre.	On-site centralised composting.
Hard/bulky items	Business and leisure hotel and function centre. KUR-World campus.	Recycling/landfill.

Waste stream	Operational precinct	Destination
	Five-star eco-resort. Premium Villas. Lifestyle Villas. Queenslander Lots.	
Electronic waste (e-waste)	Business and leisure hotel and function centre. KUR-World campus. Five-star eco-resort. Premium Villas. Lifestyle Villas. Queenslander Lots.	Recycling/safe disposal.
Cooking oil	Business and leisure hotel and function centre. KUR-Village. KUR-World campus. Golf clubhouse and function centre. Five-star eco-resort. Health and wellbeing retreat.	Recycling.
Sanitary waste	All operational areas.	Regional disposal to landfill.
Waste water treatment residues (regulated waste)	Services/infrastructure.	Off-site beneficial disposal via licensed regulated waste collection contractor

7.5.6.2 Operational waste quantity estimates

Utilising Arup's in-house Waste Forecast tool, estimates for operational waste have been calculated, utilising key metrics including floor areas and number of units (as provided by Myriad/Coburn Architecture, Revision C dated 25 August 2017). A full breakdown of the operational waste forecast is provided in Appendix 4C – Detailed Operational Waste Forecast.

The following key assumptions were made in calculating the operational waste generation estimates:

- The Produce Garden, swimming pools and sports surfaces (for example, the tennis courts) do not generate any solid waste, with the exception of the soccer field in the sports precinct which will generate green waste.
- A total of 48 horses stabled in the Equestrian Centre at any one time, and manure and used bedding is the only solid waste generated by this land use. Used bedding is assumed to comprise of straw or similar organic material.
- There is no information currently available on proposed livestock numbers, so the corresponding manure waste has not been estimated.
- 75% capture rate for food waste generated in back of house areas, with the remaining 25% entering the general waste stream.
- 75% capture rate for all co-mingled recycling, with the remaining 25% entering the general waste stream.
- A bulk density of 0.131 tonnes per cubic metre for general waste whilst uncompacted, and a bulk density of 0.524 tonnes per cubic metre for general waste when compacted (4:1 compaction ratio).
- A bulk density of 0.250 tonnes per cubic metre for co-mingled recycling (comprising paper, cardboard, plastics, glass and metals).
- A bulk density of 0.514 tonnes per cubic metre for food waste.

- The proposed development will operate 7 days a week, 365 days a year.
- Estimates have not been provided for other waste streams such as hard/bulky waste, hazardous waste, e-waste, sanitary waste and cooking oil waste due to their anticipated small volume and a lack of practical estimation metrics available.

The Arup Waste Forecast Tool estimates operational waste generation based on a global database of waste generation rates for defined land use and activities. Where possible, data for Australia has been used. Due to the specific nature of some of the land-uses defined in the master plan for KUR-World, some waste generation rates have been allocated on a "best-fit" basis and therefore may not collate directly with the prescribed land use and furthermore the waste generation rate may not be an accurate estimation of the actual generation rate.

Table 7-31 presents headline operational waste generation estimates.

Table 7-31: Estimated operational solid waste generation for the completed development

Operational precinct	General waste, tonnes per annum	Co-mingled recycling, tonnes per annum	BoH food waste, tonnes per annum	Green and manure waste, tonnes per annum	Total, tonnes per annum
Farm Theme Park and Equestrian Centre (excl. stables)	349.2	519.3			868.6
Farm Theme Park and Equestrian Centre (stables only)				528.0	528.0
Queenslander lots	21.5	6.1			27.5
Kur-Village & Business & Leisure Hotel & Function Centre	909.4	2315.7	1487.4		4712.5
Lifestyle Villas	59.2	16.1			75.3
Rainforest Education Centre and Adventure Park	363.2	328.8			692.0
Golf Clubhouse and Function Centre	46.9	218.5			265.4
Golf Course				51.9	51.9
Sporting Precinct (excl. soccer field)	3.5	1.0			4.5
Sporting Precinct (soccer field only)				0.8	0.8
Five Star Eco-Resort	195.0	175.2	118.5		488.7
KUR-World University Campus	465.8	233.7			699.6
Premium Villas	61.3	17.3			78.6
Health and Wellbeing Retreat	57.4	31.7	19.7		108.8
Total	**2532.5**	**3863.5**	**1625.6**	**580.6**	**8602.2**

During operation, the proposed development will also generate waste residues from the on-site Waste Water Treatment Plant (WWTP). These are summarised below in Table 7-32 and have been estimated using preliminary design calculations in referred to the wastewater plant reference design. Refer to section 7.1 Water and Wastewater for more information.

Table 7-32: Residue waste from on-site Waste Water Treatment Plant

Screenings and grit, litres per day	Sludge (wet), litres per day	Screenings and grit, litres per week[1]	Biosolids (wet), litres per week[1]	Screenings and grit, tonnes per annum	Biosolids (wet), tonnes per annum
170	1135	1,190	7,945	127	497

Operational waste impacts are assessed in Section 7.5.7.3.

7.5.7 Potential impacts

This section assesses the potential environmental impacts of waste generation from construction and operation of the proposed development and the impacts on local/regional waste infrastructure. The generation, transportation, treatment and disposal of waste can result in environmental impacts if not properly managed including:

- exposure of people or ecosystems to harmful materials
- soil, air, ground and surface water pollution
- odour
- nuisance and impact on amenity
- sustainability of natural resources
- climate change.

Good practice waste management can protect human health and the quality of the environment whilst reducing the consumption and thereby increasing the sustainability of renewable and non-renewable resources. Due to the environmentally sensitive location of the proposed development it is especially important that waste generation does not adversely impact on environmental receptors. Mitigation for potential impacts from waste are presented in section 7.5.7.2.1 and 7.5.7.3.1 for construction and operation respectively.

7.5.7.1 Demolition impacts

Demolition will be undertaken as part of the proposed development; however, a demolition plan is as yet unavailable.

7.5.7.2 Construction impacts

To assess the likely impacts of the construction of the proposed development, the total construction waste likely to be generated has been assessed against the baseline for the region.

The proposed development will also generate excavated material due to the reduction in ground level required to construct foundations, piles, surface water drainage and other services and infrastructure. A high-level cut and fill balance has been modelled as part of the design. A more accurate cut and fill balance will be provided following additional design and co-ordination between building platforms, bridge locations, drainage storage areas, flooding requirements and detailed intersection layouts.

The estimated forecast of the total quantity of cut and fill excavated material likely to be generated by the proposed development is shown in Table 7-33.

[1] Assuming a density of 2.05 kg/L for screenings and grit, and 1.20 kg/L for biosolids (wet)

Table 7-33: Excavation quantities by construction stage (cut and fill balance)

Construction stage	Total cut material, m^3	Total fill material, m^3	Net balance of material, m^3
Stage 1A	-17,510	13,620	-3,890
Stage 1B	-181,005	217,035	36,030
Stage 2	-84,595	35,755	-48,840
Stage 3	-58,210	61,955	3,745
Project Total	**-341,320**	**328,365**	**-12,955**

It is predicted there will be a net surplus of earthworks and landscaping material of approximately 12,955[3] cubic metres. Where possible, surplus material will be utilised as part of the detailed design of landscaping and the golf course. In the event this is not possible, material will be exported off-site for re-use in other construction projects as a priority.

The forecast of the total quantity of construction waste likely to be generated by the proposed development has been estimated in Section 7.5.6.2. These quantities are summarised as follows in Table 7-34.

Table 7-34: Construction waste for all stages

Construction stage	Construction waste generated, tonnes	Total construction waste generated, maximum tonnes per annum[2]	Construction period
Stage 1	7,356	3,130	2.5 years: July 2018-December 2020
Stage 2	4,935	1,833	3 years: January 2021-December 2023
Stage 3	3,432	1,332	3 years: January 2024-2026
Total	**15,723**		

Table 7-35 presents the total annual quantities of construction waste and surplus excavated material that would require disposal to landfill in the absence of any mitigation measures. The annual estimated construction waste disposed to landfill for the proposed development would represent up to 16.91% annual C&D disposal quantity for the Cairns region. Without mitigation, this represents a **moderate impact significance**, and in terms of likelihood **is likely**. This therefore represents a **high risk** for the proposed development.

[2] Based on pro-rata per annum taking into account construction period. All construction stages are staged sequentially, therefore multiple construction stages will not be occurring simultaneously. This annual figure also includes the maximum estimated waste generated by the construction workforce, at 188 tonnes per annum.

[3] As cut and fill will be balanced as efficiently as possible throughout the construction period, only the surplus material of 12,955 m^3 will potentially require disposal during construction, at the end of stage 3. This volume has been converted into tonnes assuming a bulk density of 1.25 tonnes per m^3 and applied only in the final year for the project.

Table 7-35: Total construction waste for disposal for all stages

Construction stage	Total construction waste generated, maximum per annum, tonnes	Net surplus of excavated material tonnes	C&D waste disposed of to landfill in Cairns in 2016/17, tonnes	% of landfill disposal quantity
Stage 1	3,130	N/A	103,624	3.02%
Stage 2	1,833	N/A	103,624	1.77%
Stage 3	1,332	16,194[3]	103,624	16.91%

7.5.7.2.1 Construction mitigation measures and residual impacts

In line with the Queensland Waste Avoidance and Resource (WAR) Productivity Strategy C&D target by 2024, a minimum of 80% of construction waste generated by the proposed development will be diverted from landfill through re-use, recycling and recovery on and off-site. The implementation of this target and the resultant quantities of materials that would be re-used, recycled and recovered or disposed of to landfill are summarised in Table 7-36.

Table 7-36: Implementation of 80% construction waste diversion target

Construction stage	Total construction waste and excavation material generated, maximum per annum, tonnes	Minimum of 80% diverted from landfill per annum, tonnes	Maximum of 20% to landfill per annum, tonnes	C&D waste disposed of to landfill in Cairns in 2016/17, tonnes	% of landfill disposal quantity
Stage 1	3,130	2,504	626	103,624	0.60%
Stage 2	1,833	1,466	367	103,624	0.35%
Stage 3	17,536	14,020	3,505	103,624	3.38%

With the implementation of 80% diversion from landfill, the annual estimated construction waste disposed to landfill for the proposed development will not exceed 5% of the annual C&D disposal quantity for the Cairns region. This represents a **minor impact significance**, and in terms of likelihood **is likely**. This therefore represents a **medium risk** for the proposed development.

Construction waste management measures and controls that will work towards achievement of this diversion rate are presented in Section 15.4.

The construction waste that is re-used, recycled or recovered will be utilised on-site (for example, as inert fill or sub base) or by commercial recyclers.

Further measures and controls that will help reduce construction waste generation as well as the potential impact on amenity and the surrounding environment are detailed in Table 7-37.

Table 7-37: Other potential impacts from construction waste, unmitigated risk level and proposed mitigation

Potential impact	Unmitigated risk level	Proposed mitigation	Potential residual risk level
Contamination of soil and/or groundwater/surface water as a result of waste management activities	Major consequence, unlikely to happen, therefore **high risk** level.	All construction collected and taken off-site will only be done so by licensed waste service providers, and waste transported off-site will be in service and covered receptacles. Any hazardous or potentially hazardous construction waste will be sorted in covered, separate areas with protection bunds. Minimal quantities of liquid hydrocarbons and potentially hazardous or hazardous substances will be kept on-site. An inventory of safety data sheets for hazardous substances will be kept on site and kept up to date. Spill kits and a dedicated spill response protocol will be developed and implemented. A minimal number of temporary and mobile ablution facilities will be used on site at any one time, to avoid excess sewage generation.	Moderate consequence, rare likelihood, therefore **medium risk** level.
Litter impacting on surrounding flora and fauna and other environmental receptors, as well as impacting upon visual amenity and operational precincts of the development.	Moderate consequence, likely to happen, therefore **high risk** level.	There will be a focus on minimising packaging, with packaging take back schemes for suppliers implemented. Education and signage will be utilised at all waste management areas, and all construction staff given toolbox talk training. All waste management areas will be inspected on a daily basis to ensure that capacity is optimised and there is no overflow. If instances of litter are observed, immediate remedial clean-up will be implemented. All receptacles and bins will be secure and covered, and all waste collected and transported off-site will be covered.	Minor consequence, unlikely to happen, therefore **low risk** level.
Impact on amenity and environment from odour, noise and dust from waste management activities, waste handling and storage. Includes potential impact of operational precincts of the proposed development.	Moderate consequence, likely to happen, therefore **high risk** level.	All receptacles and bins will be secure and covered when not in use. Dedicated, segregated bins for construction wastes in each key construction area. Stockpiles with potential for fugitive dust will be kept damp. All waste management areas will be inspected on a daily basis and kept clean and tidy at all times.	Minor consequence, unlikely to happen, therefore **low risk** level.

Potential impact	Unmitigated risk level	Proposed mitigation	Potential residual risk level
		Bins will be washed frequently. Waste will be removed regularly.	
Vermin (for example, rats, mosquitos)	Minor consequence, likely to happen, therefore **medium risk** level.	All receptacles and bins will be secure and covered. All waste management areas will be inspected on a daily basis and kept clean and tidy at all times. If evidence of vermin is found, vermin control measures will be introduced. Bins will be washed frequently. Waste will be removed regularly.	Minor consequence, unlikely to happen, therefore **low risk** level.

The proposed construction waste management is detailed in Section 15.4.

7.5.7.3 Operational impacts

During operation, the proposed development is expected to generate the following key waste streams:

- general waste
- segregated food waste from back of house facilities (assuming a capture rate of 75%, with the remaining 25% entering the general waste stream)
- co-mingled recycling (assuming a capture rate of 75%, with the remaining 25% entering the general waste stream)
- green waste
- manure waste and used bedding material from the stables
- wastewater treatment residues (screenings and grit as well as biosolids).

The proposed waste management system for operational waste is detailed in Section 15.5.5.

To assess the likely impacts of operation of the proposed development, the total operational waste likely to be generated has been forecast and assessed against the baseline. The full forecast is presented in Section 7.5.6.2, except for residues from WWTP. These quantities are summarised as follows in Table 7-38.

Table 7-38: Operational solid waste for all precincts

Operational precinct	General waste, tonnes per annum	Co-mingled recycling, tonnes per annum	BoH food waste, tonnes per annum	Green and manure waste, tonnes per annum	Screenings and grit from WWTP, tonnes per annum	Biosolids (wet) from WWTP, tonnes per annum	Total, tonnes per annum
All operational precincts	3498	2898	1626	581	170	497	8,602

As there will be BOH food waste segregation it is likely the general waste will have a low organics content making it not particularly suitable for processing at the ARRF. It is assumed general waste will be disposed of at Springmount Landfill. General waste represents 40% of total waste, as shown in Table 7-38. This would therefore be equivalent to a worst-case landfill diversion rate of 60%.

The annual estimated operational waste disposed to landfill for the proposed development will comprise 3.04% of the current annual disposal quantity for the Cairns region, as shown in Table 7-39. This represents a **minor impact significance**, and in terms of likelihood **is likely**. This therefore represents a **medium risk** for the proposed development.

Table 7-39: General waste to landfill

Screenings and grit from WWTP, tonnes per annum	General waste to landfill, tonnes per annum	Total waste to landfill, tonnes per annum	C&I waste disposed of in Cairns in 2016/17, tonnes	% of current disposal quantity
170	3498	3668	120,722	3.04%

The annual estimated operational co-mingled recycling requiring processing at CMRF will comprise 9.66% of the predicted capacity of the CMRF at that time, as shown in Table 7-40. This represents a **minor impact significance**, and in terms of likelihood is **likely**. This therefore represents **a medium risk** for the proposed development.

Table 7-40: Comingled recycling to CMRF

Co-mingled recycling to material recovery, tonnes per annum	Capacity of CMRF in 2019, tonnes per annum	% of CMRF processing capacity
2898	30,000	9.66

It is intended that all segregated BoH food waste and green/manure waste will be managed and processed on-site and will not be disposed of to landfill. Without mitigation there is the potential for limited amenity impacts on site, therefore, this represents a **minor impact significance** and is **likely**. Therefore, this represents a **low risk** for the proposed development.

The annual estimated operational biosolids requiring disposal within the Cairns region will comprise 2.07% of the annual disposal quantity for the Cairns region, as shown in Table 7-41. This represents a **minor impact significance,** and in terms of likelihood **is likely.** This therefore represents **a medium risk** for the proposed development.

Table 7-41: Biosolids disposal

Biosolids (wet), tonnes per annum	Approximate biosolids generation in Cairns region (2017), tonnes per annum	% of disposal quantity
497	24,000	2.07

7.5.7.3.1 Operation mitigation measures and residual impacts

Other potential impacts from operational waste, their risk level and proposed mitigation are summarised in Table 7-42 below.

Table 7-42: Other potential impacts from operational waste, potential risk level and proposed mitigation

Potential impact	Unmitigated risk level	Proposed mitigation	Potential residual risk level
Contamination of soil and/or groundwater/surface water as a result of waste management activities	High consequence, unlikely to happen, therefore **high risk** level.	All waste and recycling collected and taken off-site will only be done so by licensed waste service providers, and waste transported off-site will be in service and covered receptacles. Any hazardous or potentially hazardous waste will be sorted in covered, separate areas with protection bunds. Spill kits and a dedicated spill response protocol will be developed and implemented.	High consequence, rare likelihood, therefore **medium risk** level.
Litter including food packaging and plastic bags impacting on surrounding flora and fauna and other environmental receptors, as well as impacting upon visual amenity.	Moderate consequence, likely to happen, therefore **high risk** level.	The proposed development shall operate as a plastic bag free resort. Single use plastic bags will not be used, with re-useable alternatives employed where required. Similarly, there will be a focus on minimising single use disposable food and drink packaging. Education and signage will be utilised including International Organisation for Standardisation (ISO) signage to encourage proper use. All public realm bin stations will be inspected on a daily basis to ensure that capacity is optimised and there is no overflow. If instances of litter are observed, immediate remedial clean-up will be implemented. All receptacles and bins will be secure and covered, and all waste collected and transported off-site will be covered.	Minor consequence, unlikely to happen, therefore **low risk** level.
Impact on amenity from odour, noise and dust from waste management activities, waste handling and storage.	Moderate consequence, likely to happen, therefore **high risk** level.	Electric Collection Vehicles (ECVs) will be used for the majority of waste collection within the resort, including servicing villas and Queenslander lots. ECVs have a low noise impact compared to conventional diesel Refuse Collection Vehicles, and have zero emissions at operation meaning no impact on local air quality. All receptacles and bins will be secure and covered, and collected and emptied on a daily basis to the central waste storage area. Any bins/receptacles that become dirty will be washed at the dedicated washing facility. All putrescible food waste will only be stored in bins on a temporary	Minor consequence, unlikely to happen, therefore **low risk** level.

Potential impact	Unmitigated risk level	Proposed mitigation	Potential residual risk level
		basis prior to the defined treatment option. All containers will have tight fitting lids and smooth washable internal surfaces. The central waste and recycling area will be within a closed building. The central composting area will be subject to an Environmental Management System and best practice measures including those under ERA 53 (as required) will be adhered to. Only appropriately licensed waste management contractors will be used to collect waste from site, including regulated wastes (WWTP residues).	
Vermin (for example, rats, mosquitos)	Minor consequence, likely to happen, therefore **medium risk** level.	All receptacles and bins will be secure and covered, including food waste and organics bins. All public realm bins and waste management areas will be inspected on a daily basis. If evidence of vermin is found, vermin control measures will be introduced. Bins will be washed frequently. Waste will be removed regularly. The central composting area will be subject to an Environmental Management System and best practice measures including those under ERA 53 (as required) will be adhered to.	Minor consequence, unlikely to happen, therefore **low risk** level.

The proposed operational waste management is detailed in Section 15.5.

7.5.8 Summary

The potential waste related impacts of the proposed development will:

- not exceed a **medium risk** for the construction phase, assuming proposed mitigation measures are implemented
- not exceed a **medium risk** for the operation phase, assuming proposed mitigation measures are implemented.

7.5.9 References

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